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(71) Applicant: **SANYO ELECTRIC CO., LTD.**
Moriguchi-shi, Osaka 570-8677 (JP)

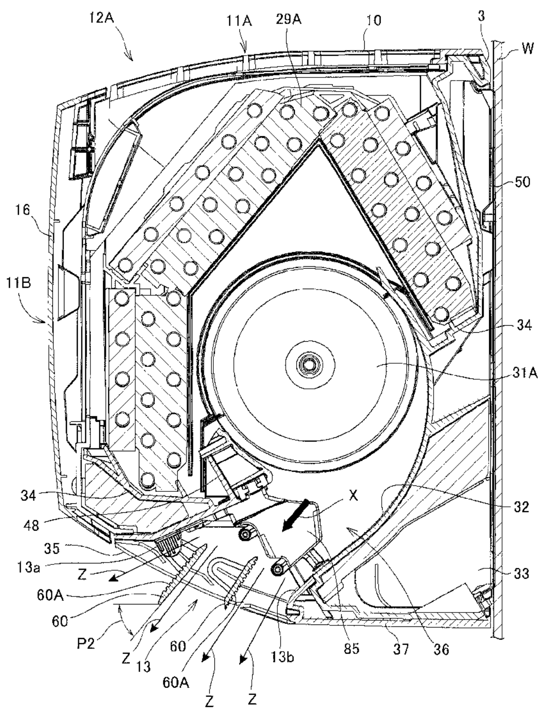
(72) Inventors:
- **Yamauchi, Jun**
  Moriguchi-shi, Osaka 570-8677 (JP)
- **Kamata, Shigemitsu**
  Moriguchi-shi, Osaka 570-8677 (JP)
- **Idei, Nobuhiro**
  Moriguchi-shi, Osaka 570-8677 (JP)
- **Moteki, Yasuhiro**
  Moriguchi-shi, Osaka 570-8677 (JP)
- **Saito, Mayumi**
  Moriguchi-shi, Osaka 570-8677 (JP)

(74) Representative: **Glawe, Delfs, Moll**
Patent- und Rechtsanwälte
Postfach 26 01 62
80058 München (DE)

(54) Air conditioner having horizontal flap and method for preventing occurrence of dew condensation on horizontal flap

(57) An air conditioner including an indoor unit including a horizontal flap for vertically adjusting a blowing angle at which air blown out from an air blowing fan is blown out from a blow-out port to a room to be air-conditioned, and a controller for controlling a tilt angle of the horizontal flap in a vertical direction with respect to a horizontal position, wherein the controller changes the tilt angle of the horizontal flap to a tilt angle at which airflow resistance to the air blown out from the air blowing fan is reduced when the tilt angle of the horizontal flap is set to a tilt angle at which the airflow resistance to the air blown out from the air blowing fan is large, the rotational number of the air blowing fan is set to a low value, and a continuing time of cooling operation reaches a predetermined time.

FIG.6



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an air conditioner having a horizontal flap that is disposed at an air blow-out port of an indoor unit to adjust an air blowing angle in a vertical direction, and a method of preventing occurrence on dew condensation on the horizontal flap.

2. Description of the Related Art

[0002] In some type of air conditioners each having a horizontal flap that is disposed at an air blow-out port of an indoor unit to adjust an air blowing angle in a vertical direction, when the temperature of an indoor heat exchanger which is detected by a temperature detecting unit is equal to a predetermined reference temperature or less for a fixed time during cooling operation, it is determined that dew condensation occurs on the horizontal flap with high probability, and thus dew-condensation preventing control is executed to increase the rotation number of an air blowing fan of an indoor unit by only a predetermined amount, thereby preventing dew condensation on the horizontal flap (for example, see JP-A-10-253136).

[0003] However, according to the above air conditioner, the rotation number of the air blowing fan of the indoor unit is increased to prevent dew condensation, so that the dew-condensation preventing control described above may vary the amount of evaporation of refrigerant in an indoor heat exchanger during cooling operation and thus affect the operation of a compressor of an outdoor unit. Particularly when plural indoor units are connected to the outdoor unit, the operation state of the compressor of an outdoor unit is varied by the above dew-condensation preventing control, which affects the operation of the other indoor units.

SUMMARY OF THE INVENTION

[0004] The present invention has been implemented in view of the foregoing situation, and has an object to provide an air conditioner having a horizontal flap in which dew condensation onto the horizontal flap can be prevented without affecting the operation of a compressor of an outdoor unit.

[0005] In order to attain the above object, according to an aspect of the present invention, an air conditioner including a wall-mount type indoor unit comprises: a horizontal flap for vertically adjusting a blowing angle at which air blown out from an air blowing fan is blown out from a blow-out port to a room to be air-conditioned; and a controller for controlling a tilt angle of the horizontal flap in a vertical direction with respect to a horizontal position, wherein the controller changes the tilt angle of the horizontal flap to a tilt angle at which airflow resistance to the air blown out from the air blowing fan is reduced when the following conditions are satisfied: the tilt angle of the horizontal flap is set to a tilt angle at which the airflow resistance to the air blown out from the air blowing fan is large; the rotational number of the air blowing fan is set to a low value; and a continuing time of cooling operation reaches a predetermined time.

[0006] In the above air conditioner, the horizontal flap may be configured so that the tilt angle thereof is changeable at plural stages in the vertical direction, the rotational number of the air blowing fan may be changeable among plural values, and when the tilt angle of the horizontal flap is set to a tilt angle nearest to the horizontal position out of the plural stages, the rotational number of the air blowing fan is set to the lowest value, and the continuing time of the cooling operation reaches the predetermined time, the controller may change the tilt angle of the horizontal flap to a tilt angle at which the horizontal flap is further vertically upwardly or downwardly tilted by at least one stage.

[0007] In the above air conditioner, the air conditioner may be a multiple type air conditioner in which plural indoor units are connected to one outdoor unit.

[0008] In the above air conditioner, the controller may further tilt the horizontal flap to a vertical position to reduce the airflow resistance, and the angle at which the airflow resistance to the air is large may correspond to an uppermost stage under an open state of the horizontal flap in setting of the tilt angle of the horizontal flap.

[0009] The above air conditioner may further comprise a remote controller, wherein the controller displays an indication representing the change of the tilt angle of the horizontal flap on the remote controller.

[0010] In the above air conditioner, after the tilt angle of the horizontal flap is changed, the controller may keep the changed tilt angle until any one of an instruction of changing the tilt angle of the horizontal flap, an instruction of changing to any one of heating operation and air blowing operation and an instruction of changing the rotational number of the air blowing fan is made.

[0011] In the above air conditioner, the horizontal flap has dimples on at least one of the upper and lower surfaces thereof to suppress occurrence of turbulence flow along the horizontal flap.

[0012] According to another aspect of the present invention, a method for preventing dew condensation on a horizontal flap which is changeable in tilt angle in a vertical direction to vertically adjust a blowing angle at which air blown out from an air blowing fan is blown out from a blow-out port to a room to be air-conditioned, comprises the steps of: determining whether the tilt angle of the horizontal flap is set to a tilt angle at which the airflow resistance to the air blown out from the air blowing fan is large; determining whether a rotational number of the air blowing fan is set to a low value; determining whether a continuing time of cooling operation reaches a predetermined time; and changing the tilt angle of the horizontal flap to a tilt angle at which airflow resistance to the air blown out from the air blowing fan is reduced.

[0013] According to the present invention, in an air conditioner having a horizontal flap, occurrence of dew condensation on the horizontal flap can be prevented without affecting the operation of a compressor of an outdoor unit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Fig. 1 is a diagram showing a refrigerant circuit of an air conditioner according to the present invention;
Fig. 2 is a cross-sectional view showing an indoor unit;
Fig. 3 is an exploded perspective view showing the indoor unit;
Fig. 4 is a perspective view of the indoor unit when the indoor unit is viewed from the lower side;
Fig. 5 is a cross-sectional view of the indoor unit;
Fig. 6 is a cross-sectional view of the indoor unit; and
Fig. 7 is a flowchart showing the processing of a dew-condensation preventing operation.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0015] A preferred embodiment according to the present invention will be described hereunder with reference to the accompanying drawings.

[0016] Fig. 1 is a diagram showing a refrigerant circuit of an air conditioner according to the present invention. First, the construction of the refrigerant circuit 5 of the air conditioner 100 will be described.

[0017] The air conditioner 100 has an outdoor unit 6 disposed outdoors, and plural (for example, three) indoor units 12A to 12C disposed indoors in different rooms. An outdoor refrigerant pipe 7 of the outdoor unit 6 and each of respective indoor refrigerant pipes 14A to 14C of the indoor units 12A to 12C is connected to each other through a connection pipe 58. That is, the air conditioner 100 is a so-called multiple type air conditioner in which plural indoor units 12A to 12C are connected to one outdoor unit 6.

[0018] As shown in Fig. 1, a compressor 8 is disposed in the outdoor refrigerant pipe 7. An accumulator 9 is disposed at the suction side of the compressor 8 in the outdoor refrigerant pipe 7, and a four-way valve 18, an outdoor heat exchanger 19, an outdoor expansion valve 20 and a liquid receiver 21 are successively disposed through an oil separator 17 at the discharge side of the compressor 8. An outdoor fan 25 for blowing air to the outdoor heat exchanger 19 is disposed to be adjacent to the outdoor heat exchanger 19. The outdoor unit 6 has an outdoor unit side controller 75 for controlling the outdoor expansion valve 20, the compressor 8, the outdoor fan 25, the four-way valve 18, etc.

[0019] In each of the indoor units 12A to 12C, each of indoor heat exchangers 29A to 29C is disposed in each of the indoor refrigerant pipes 14A to 14C. Furthermore, each of indoor expansion valves 30A to 30B is disposed in the neighborhood of each of the indoor heat exchangers 29A to 29C in each of the indoor refrigerant pipes 14A to 14C. Air blowing fans 31A to 31 are disposed to be adjacent to the indoor heat exchangers 29A to 29C respectively, and the respective air blowing fans 31A to 31C blow air to the respective indoor heat exchangers 29A to 29C.

[0020] Furthermore, the indoor units 12A to 12C have indoor unit side controllers 76A to 76C (controllers) for controlling the air blowing fans 31A to 31C, the indoor expansion valves 30A to 30C, etc. Remote controllers 77A to 77C through which users operate the respective indoor units 12A to 12C are connected to the respective indoor unit side controllers 76A to 76C.

[0021] In the air conditioner 100, the cooling operation and the heating operation are switched to each other by switching the four-way valve 18. When the four-way valve 18 is switched to the cooling side, refrigerant flows along a solid-line arrow shown in Fig. 1, the outdoor heat exchanger 19 serves as a condenser, and the indoor heat exchangers 29A to 29C serve as evaporators. Furthermore, refrigerant discharged from the compressor 8 is successively passed through the four-way valve 18, the outdoor heat exchanger 19, the outdoor expansion valve 20, a connection pipe 58, each of the indoor heat exchangers 29A to 29C, the connection pipe 58 and then the four-way valve 18 in this order, returned to the suction side of the compressor 8, and each of the indoor heat exchangers 29A to 29C is set to a cooling operation state under which the room is cooled. Under cooling operation, the valve opening degree of each of the indoor expansion valves 30A to 30C is adjusted in accordance with an air-conditioning load.

[0022] When the four-way valve 18 is switched to the heating side, refrigerant flows along a broken-line arrow shown in Fig. 1, the indoor heat exchangers 29A to 29C serve as condensers and the outdoor heat exchanger 19 serves as an evaporator. Refrigerant discharged from the compressor 8 is successively passed through the four-way valve 18, the connection pipe 58, the respective indoor heat exchangers 29A to 29C, the connection pipe 58, the outdoor expansion valve 20, the outdoor heat exchanger 19 and then the four-way valve 18 in this order, returned to the suction side of the compressor 8 and each of the indoor heat exchangers 29A to 29C is set to a heating operation state under which the room is heated. Under heating operation, the valve opening degree of each of the outdoor expansion valve 20 and the indoor expansion valves 30A to 30C is adjusted in accordance with an air-conditioning load.

[0023] Furthermore, when the air conditioner 100 is set to a thermo OFF state under which the compressor 8 is stopped, each of the air blowing fans 31A to 31C is operated to blow air, whereby an air blowing operation can be performed.

[0024] Fig. 2 is a cross-sectional view of the indoor unit 12A, and Fig. 3 is an exploded perspective view of the indoor unit 12A.

[0025] Each of the indoor units 12A to 12C is a wall-mount type indoor unit which is secured on the wall W of a room to be air-conditioned. The respective indoor units 12A to 12C are configured to have the same construction, and thus the indoor unit 12A will be representatively described below.

[0026] As shown in Figs. 2 and 3, the indoor unit 12A has a fin-and-tube type indoor heat exchanger 29A which is designed to be substantially C-shaped in section and disposed in a frame 3, and an air blowing fan 31A is disposed inside the indoor heat exchanger 29A. A grille 10 is covered on the indoor heat exchanger 29A. The frame 3 is a member which is formed to be substantially L-shaped in section by resin molding, and it has a drain pan 34 for receiving drain water dropped from the indoor heat exchanger 29A and a scroll portion 32 in which the air blowing fan 31A is mounted. A recess portion for receiving a fitting pawl 51 of a fixing plate 50 is formed on the back surface of the frame 3. The housing of the indoor unit 12A is constructed by the frame 3 and the grille 10.

[0027] The frame 3 and the fixing plate 50, and the frame 3 and the grille 10 are joined to each other by screws, and a service hole 15 through which a screwing work is executed is opened in the lower surface of the grille 10. The service hole 15 is covered by a cap 14 when the air conditioner is normally used.

[0028] The air blowing fan 31A comprises a so-called cross flow fan, and it is mounted between a tongue portion 48 provided to the frame 3 and a scroll portion 32. Both the ends of the air blowing fan 31A extending cylindrically are supported on the frame 3 through a bearing portion 44 having a bearing 43 and a bearing portion 45.

[0029] One end of the air blowing fan 31A is joined to a fan motor 46, and the fan motor 46 is secured to the frame 3 through a bearing 47. More specifically, a hole 41 in which the output shaft of the fan motor 46 is inserted is provided to one end of the air blowing fan 31A, the output shaft of the fan motor inserted in the hole 41 is fixed to the air blowing fan 31A by a set screw 42 which is threadably inserted from the side surface of the air blowing fan 31A. Furthermore, an electrical component box 55 in which an indoor unit side controller 76A is mounted is disposed at a side of the fan motor 46.

[0030] A pipe mount portion 33 as an elongated space for mounting the refrigerant pipe and a drain pipe is formed at the lower portion of the back surface side of the frame 3, and pipe holding members 52 and 53 for holding the above pipes in the pipe mount portion 33 under pressure are secured to the pipe mount portion 33.

[0031] The grille 10 has an upper suction port 11A and a front suction port 11B which are opened in the grille 10 so as to extend in the longitudinal direction of the indoor unit 12A, and a front panel 16 is secured to the grille 10 so as to cover the front suction port 11B.

[0032] An air blow-out face 35 which is continuous with the lower edge of the front panel 16 and sloped downwardly to the wall W side, and a lower end face 37 which extends substantially horizontally from the air blow-out face 35 to the wall W side are formed on the lower surface of the indoor unit 12A. An air blow-out port 13 through which air blown from the air blowing fan 31A is blown out is provided to the air blow-out face 35, and the air blow-out port 13 is covered by plate-shaped flaps 60 (horizontal flaps) so as to be freely opened and closed.

[0033] The air blowing fan 31A sucks indoor air from the upper suction port 11A and the front suction port 11B through the indoor heat exchanger 29A, and blows out air heat-exchanged by the heat exchanger 29A from the air blow-out port 13 into a room to be air-conditioned. A guide chamber 36 for guiding air stream from the air blowing fan 31A to the air blow-out port 13 is provided between the air blowing fan 31A and the air blow-out port 13. The upper surface of the guide chamber 36 is formed by the lower portion of the drain pan 34 which is sloped downwardly to the front surface side of the indoor unit 12A, and the lower portion of the guide chamber 36 is formed by the lower portion of the scroll portion 32 which is sloped downwardly to the front surface side of the indoor unit 12A. Air blown out from the air blow-out port 13 is guided by the guide chamber 36, and flows obliquely to the lower front side of the front surface side of the indoor unit 12A.

[0034] The air blowing fan 31A is configured so that the rotational number thereof is switched among three stages of high, middle and low levels (i.e., the rotational number of the air blowing fan is changeable at three stages), and as the rotational number is higher, the amount of air blown out from the air blowing fan 31A increases. That is, the air flowing amount can be selectively set to strong, middle and weak levels.

[0035] The flaps 60 are two horizontal blades for adjusting the airflow direction of air blown out from the air blow-out port 13 in the vertical direction. Each flap 60 is designed in a plate-like shape so as to extend in the longitudinal direction of the indoor unit 12A, and also has a flap shaft 61 extending in the longitudinal direction of the flap 60. Each flap 60 is turned in the vertical direction around the flap shaft 61. The two flaps 60 are driven interlockingly with each other by a flap driving motor 63 of the indoor unit 12A to open/close the air blow-out port 13 so that substantially parallel positional relationship is kept between the flaps 60, and change the air flowing direction of air blown out from the air blow-out port 13 in the vertical direction. Here, dimples 60A (projections and recesses) for suppressing occurrence of turbulence flow around the periphery of the upper and lower surfaces of the flaps 60 may be formed on the flaps 60 as shown in Figs. 5 and 6.

[0036] Plural vertical blades 85 for adjusting the air flowing direction in the right-and-left direction are arranged side by side at the exit side of the scroll portion 32. The vertical blades 85 are joined to one another by a link member 87 at the back side of the scroll portion 32 every plural (five in this embodiment) vertical blades 85 as one set. The vertical blades 85 are connected to a vertical blade driving motor (not show) , and the orientation thereof is changed in the right-and-left direction by operating the vertical blade driving motor or operating an operation lever 86 at the front end.

[0037] A fan guard 70 is provided between the vertical blade 85 and the flap 60 to prevent insertion of a hand into the rear side of the air blow-out port 13. The fan guard 70 has two wires 71 which are bridged in parallel along the longitudinal direction of the air blow-out port 13, and support members 72 and 73 for bundling both the ends of these wires 71.

[0038] Fig. 4 is a perspective view of the indoor unit 12A when the indoor unit 12A is viewed from the lower side. In Fig. 4, the flap 60 is omitted from the illustration for the sake of convenience of understanding.

[0039] The support member 72 of the fan guard 70 is secured to one end side of the elongated air blow-out port 13, and the support member 73 is secured to the other end side of the air blow-out port 13.

[0040] The air blow-out port 13 is provided with two support poles 65 for supporting the flaps 60 so that the air blow-out port is divided into three parts in the longitudinal direction of the indoor unit 12A by the support poles 65. Each support pole 65 is bridged between the upper and lower edge portions 13a and 13b of the air blow-out port 13, and has two support holes 66 in which the flap shafts 61 of the two flaps 60 are inset. Flap support portions 68 are provided to both the ends of the air blow-out port 13 to secure the flap portions 60 to the air blow-out port 13. Each of the right and left flap support portions 68 has support holes 69 in which the flap shafts 61 of the two flaps 60 are inset. That is, each flap 60 is supported by the two support poles 65 and the two flap support portions 68 so as to be turnable. The fan guard 70 is fixed so that the wires 71 are located at the back side of the support holes 66 and 69 to which the flaps 60 are secured, and also at the front side of the vertical blades 85.

[0041] In the indoor unit 12A, when cooling operation is continuously carried out, the temperature of the flaps 60 decreases, and indoor air of relatively high temperature comes into contact with the temperature-decreasing flaps 60, whereby dew condensation occurs on the flaps 60. Therefore, according to this embodiment, in an operation state under which dew condensation is liable to occur, a dew-condensation preventing operation of preventing occurrence of dew condensation by changing the orientation of the flaps 60 is executed. The dew-condensation preventing operation will be described.

[0042] Figs. 5 and 6 are cross-sectional views showing the indoor unit 12A.

[0043] In the indoor unit 12A, the flaps 60 are configured so that the opening degree thereof is adjustable at five stages. Specifically, the full-close state of the air blow-out port 13 shown in Fig. 2 is set as the uppermost stage, and the tilt angle at which the flaps 60 are gradually tilted to the vertical direction is changed every stage as shown in Figs. 5 and 6. At the lowest stage of the adjustable range of the flaps 60, the tilt direction (the tilt angle) of the flaps 60 is nearest to the vertical direction in the adjustable range.

[0044] The uppermost stage of the open state of the flaps 60 is a state shown in Fig. 5, and this state corresponds to a state under which the flaps 60 are further vertically tilted from the full-close state by one stage. The state of Fig. 6 corresponds to a state under which the flaps 60 are further vertically tilted from the uppermost stage of the open state shown in Fig. 5 by only one stage. Hereinafter, the state at the uppermost stage of the open state of the flaps 60 is referred to as a tilt angle P1 (an angle at which flow resistance increases), and the state under which the flaps 60 are further vertically tilted from the tilt angle P1 by only one stage is referred to as a tilt angle P2 (a downward-facing direction). The tilt angles P1 and P2 are set on the basis of the horizontal state. In this case, the difference between the tilt angles P1 and P2 is set to 15°.

[0045] When the flaps 60 are located at the tilt angle P1, the flaps 60 are in a position nearest to the horizontal position under the open state. This angle is suitable for cooling operation, and air guided by the flaps 60 reaches the farthest place in a room. As the tilt angle of the flaps 60 is further increased toward the vertical angle so that the flaps are further tilted to the vertical position (i.e., further approach to the vertical position), air guided by the flaps 60 flows downwardly and thus the arrival distance of the air is shortened.

[0046] As shown in Fig. 5, under the state that the flaps 60 are located at the tilt angle P1, the ventilation resistance (air flow resistance) to air streams Y blown out along the flaps 60 is large, and turbulence flow D in which air around the flaps 60 is sucked occurs along the lower surfaces of the flaps 60. Therefore, when the flaps 60 are excessively cooled under the state of the tilt angle P1, dew condensation occurs from the sucked air and thus dew is attached to the lower surfaces of the flaps 60. The turbulence flow D in which the air around the flaps 60 is sucked occurs more easily particularly when the rotational number of the air blowing fan 31A is low and thus the airflow amount is small, and the turbulence flow hardly occurs when the rotational number of the air blowing fan 31A is a high level and a middle level.

[0047] As shown in Fig. 6, under the state of the tilt angle P2, the air flow resistance to air streams Z blown out along the flaps 60 is small, and thus the turbulence flow D hardly occurs along the lower surfaces of the flaps 60. Therefore, under the state of the tilt angle P2, no dew condensation occurs on the lower surfaces of the flaps 60. That is, the flaps 60 are operated at the tilt angle P2 under cooling operation, whereby the dew condensation (attachment) onto the flaps 60 can be prevented.

[0048] It has been experimentally proved that dew condensation (attachment) is prevented by changing the tilt angle of the flaps 60 from the tilt angle P1 to the tilt angle P2 under cooling operation when the airflow amount is small (i.e., airflow level is weak).

[0049] Here, the following is one of factors for causing occurrence of turbulence flow D around the flaps 60 under the state of the tilt angle P1. That is, under the state of the tilt angle P1, the flaps 60 are tilted (inclined) with respect to the direction of an air stream X which is guided from the air blowing fan 31A to the lower front side of the indoor unit 12A by the guide chamber 36, so that the air flow resistance is increased. On the other hand, under the state of the tilt angle P2, the flaps 60 are disposed substantially in parallel to the air stream X, and thus the air flow resistance is reduced.

[0050] Next, the processing of the dew condensation (attachment) preventing operation will be described in detail.

[0051] Fig. 7 is a flowchart showing the processing of the dew condensation preventing operation.

[0052] First, under operation of the indoor unit 12A, the indoor side controller 76A determines whether a dew condensation preventing flag is set to ON state (step S23). Here, the dew condensation preventing flag is set to ON state when there is a high probability that dew condensation occurs on the flaps 60, and it is written into a memory of the indoor side controller 76A.

[0053] When the dew condensation preventing flag is not set to ON state in the determination of the step S11 (step S11: No), the indoor side controller 76A determines whether the indoor unit 12A is under heating operation or under an operation other than an air blowing operation (step S12).

[0054] When the indoor unit 12A is under heating operation or executes an operation other than the air blowing operation, that is, executes cooling operation in the determination of the step S12 (step S12: Yes), the indoor side controller 76A determines whether the indoor unit 12A is under thermo-ON state or not (step S13)

[0055] When the indoor unit 12A is under the thermo-ON state in the determination of the step S13 (step S13: Yes), the indoor side controller 76A determines whether the setting of the air flow amount (air flow level) of the air blowing fan 31A is set to a small (weak) level or not (step S14).

[0056] When the setting of the air flow level of the air blowing fan 31A is weak in the determination of the step S14 (step S14: Yes), the indoor side controller 76A determines whether the position of the flaps 60 is set to the tilt angle P1 or not (step S15).

[0057] When the position of the flaps 60 is set to the tilt angle P1 in the determination of the step S15 (step S15: Yes), the indoor unit side controller 76A adds the count value of a timer by only a fixed amount (step S16), and then determines whether the count value of the timer reaches a predetermined time T (step S17).

[0058] When the count value of the timer reaches the predetermined time T in the determination of the step S17 (step S17: Yes), the indoor unit side controller 76A sets the dew condensation preventing flag to the ON state (step S18).

[0059] That is, the condition under which the dew condensation preventing flag is set to the ON state through the processing of the steps S12 to S17 is satisfied when the setting level of the airflow amount of the air blowing fan 31A is set to the weak level, the flaps 60 are disposed at the tilt angle P1 and the cooling operation under the thermo-ON state is continued over the predetermined time T. Under the ON state of the dew condensation preventing flag, the airflow amount (level) is small (weak) and the flaps 60 are disposed nearly in a horizontal position. Therefore, the turbulence flow D occurs around the flaps 60, and dew condensation (dew attachment) is liable to occur. Here, the predetermined time T is set to one hour, for example.

[0060] When the count value of the timer does not reach the predetermined time T in the determination of the step S17 (step S17: No), the indoor unit side controller 76A finishes the processing of the dew condensation preventing operation. The processing of the dew condensation preventing operation is repetitively executed at a predetermined time interval. In this case, it is executed every one second, for example. The count value of the timer is added every time the step S16 is repeated.

[0061] Furthermore, when the indoor unit 12A is under heating operation or under air blowing operation in the determination of the step S12 (step S12: No) , when the indoor unit 12A is under thermo-OFF state in the determination of the step S13 (step S13: No), when the setting of the airflow amount of the air blowing fan 31A is set to the middle or strong level in the determination of the step S14 (step S14: No) and when the flaps 60 are disposed at a tilt angle other than the tilt angle P1 in the determination of the step S15 (step S15: No), the indoor unit side controller 76A clears the count value of the timer of the step S16 (step S19), and finishes the processing of the dew condensation preventing operation.

[0062] When the dew condensation preventing flag is set to the ON state in the determination of the step S11 (step S11: Yes), the indoor unit side controller 76A determines whether the tilt angle of the flaps 60 is changed or not (step S20). In the determination of the step S20, when the tilt angle of the flaps 60 is not changed from the tilt angle P1 (step S20: No), the indoor unit side controller 76A determines whether the operation mode of the indoor unit 12A is changed to the heating operation or the air blowing operation (step S21).

[0063] When the operation mode of the indoor unit 12A is not changed to the heating operation or the air blowing operation in the determination of the step S21 (step S21: No), that is, when the cooling operation is continued, the indoor unit side controller 76A determines whether the setting of the airflow amount of the air blowing fan 31A is changed from the weak level or not (step S22).

[0064] When the setting of the airflow amount of the air blowing fan 31A is not changed from the weak level in the determination of the step S22 (step S22: No), the indoor unit side controller 76A controls a flap driving motor 63 to change the tilt angle of the flaps 60 from the tilt angle P1 to the tilt angle P2 (step S23) , and then displays on a remote controller 77A an indication representing that the tilt angle of the flaps 60 is changed to the tilt angle P2 by the dew condensation preventing control. Thereafter, the indoor unit side controller 76A finishes the processing of the dew condensation preventing operation.

[0065] Furthermore, when the title angle P1 of the flaps 60 is changed in the determination of the step S20 (step S20: Yes), when the operation mode of the indoor unit 12A is changed to the heating operation or the air blowing operation in the determination of the step S21 (step S21: Yes) , and when the setting of the airflow amount of the air blowing fan 31A is changed from the weak level in the determination of the step S22 (step S22: Yes) , the indoor unit side controller 76a sets the dew condensation preventing flag to the OFF state (step S24), and finishes the processing of the dew condensation preventing operation. Accordingly, under the state that the tilt angle of the flaps 60 is changed to the tilt angle P2 by the dew condensation preventing control, the indoor unit side controller 76A keeps the tilt angle of the flaps 60 to the tilt angle P2 until any one of an instruction of changing the tilt angle of the flaps 60, an instruction of changing to the heating operation or the air blowing operation and an instruction of changing the rotational number of the air blowing fan 31A is made.

[0066] Here, the instruction of the change of the tilt angle, the instruction of the change of the operation mode such as the change to the heating operation or the like, and the instruction of the change of the airflow amount setting of the air blowing fan 31A are executed through the remote controller 77A operated by a user.

[0067] That is, the condition under which the indoor unit side controller 76A forcedly changes the tilt angle of the flaps 60 from the tilt angle P1 to the tilt angle P2 is satisfied when under the ON state of the dew condensation preventing flag, the cooling operation is continued while the tilt angle of the flaps 60 is set to the tilt angle P1 and also the airflow amount of the air blowing fan 31A is not changed from the weak level. As described above, under the operation state that dew condensation easily occurs on the flaps 60, the tilt angle of the flaps 60 is changed to the tilt angle P2 at which no dew condensation occurs, and thus the dew condensation (attachment) onto the flaps 60 can be effectively prevented.

[0068] When the airflow level of the air blowing fan 31A is not the weak level, the tilt angle of the flaps 60 is not changed to the tilt angle P2. Therefore, under an operation state that dew condensation occurs with little probability, the tilt angle is not automatically changed to the tilt angle P2 by the indoor unit side controller 76A, and the operation of the air conditioner can be performed along the air flowing direction intended by the user.

[0069] Furthermore, when the tilt angle of the flaps 60 is not the tilt angle P1, the tilt angle is not changed to the tilt angle P2. Therefore, under the operation state that dew condensation occurs with little probability, the tilt angle is not changed without permission and thus the operation of the air conditioner can be performed along the air flowing direction intended by the user.

[0070] In the air conditioner 100, the tilt angle of the flaps 60 is controlled to the tilt angle P2 by the indoor unit side controller 76A, whereby dew condensation is prevented at the indoor unit 12A side. Therefore, it is unnecessary to change the rotational number of the air blowing fan 31A in order to prevent dew condensation. Accordingly, the amount of evaporation of refrigerant of the indoor heat exchanger 29A is not varied by the dew condensation preventing operation, and thus the rotational number of the compressor 8 of the outdoor unit 6 can be prevented from being affected by the dew condensation preventing operation.

[0071] As described above, according to this embodiment, when the tilt angle of the flaps 60 is set to the tilt angle P1 at which the air flow resistance to the air blown from the air blowing fan is large, the rotational number of the air blowing fan 31 is set to a low value and also the continuing time of the cooling operation reaches the predetermined time T, the indoor unit side controller 76A changes the tilt angle of the flaps 60 to a further vertically tilted angle P2 (i.e., P2 > P1) so that the air flow resistance to the air blown from the air blowing fan is smaller. Therefore, occurrence of dew condensation (attachment of dew) can be prevented by merely changing the tilt angle of the flaps 60, and dew condensation (attachment) onto the flaps 60 can be prevented without affecting the operation of the compressor 8 of the outdoor unit 6. Furthermore, dew condensation onto the flaps 60 can be prevented with a simple construction without using any temperature sensor for measuring the temperature of the indoor heat exchanger 29A.

[0072] Furthermore, when the flaps 60 is set to the tilt angle P1 near to the horizontal position, the rotational number of the air blowing fan 31A is set to the lowest value and also the continuing time of the cooling operation reaches the predetermined time T, the indoor unit side controller 76A changes the tilt angle of the flaps 60 to the tilt angle P2 at which the flaps 60 are further vertically tilted (i.e., nearer to the vertical angle), and the title angle of the flaps 60 is changed to the further tilted angle on the basis of the continuing time of the cooling operation. Therefore, occurrence of dew condensation (attachment of dew) can be prevented by merely changing the tilt angle of the flaps 60, and dew condensation (attachment) onto the flaps 60 can be prevented without affecting the operation of the compressor 8 of the outdoor unit 6. Furthermore, the tilt angle of the flaps 60 is changed from the tilt angle P1 nearest to the horizontal position (reference angle: 0°) under the open state to the tilt angle P2 which is nearer to the vertical angle (90°) than the tilt angle P1 by only one stage, that it, the flaps 60 is further vertically tilted from the tilt position of the tilt angle P1 by only one stage. Therefore, the change of the tilt angle of the flaps 60 can be prevented from being conspicuous.

[0073] Furthermore, in the multi-type air conditioner 100, the tilt angle of the flaps 60 is controlled to the tilt angle P2 by the indoor unit side controller 76A to prevent occurrence of dew condensation at the indoor unit 12A side. Therefore, it is unnecessary to change the rotational number of the air blowing fan 31A in order to prevent dew condensation. Accordingly, the amount of evaporation of refrigerant in the indoor heat exchanger 29A is not varied by the dew condensation preventing operation, and the rotational number of the compressor 8 of the outdoor unit 6 can be prevented from being affected by the dew condensation preventing operation. Therefore, the dew condensation preventing operation of the indoor unit 12A can be prevented from affecting the operation of the indoor units 12B and 12c.

[0074] Furthermore, the angle nearest to the horizontal position under the open state is the tilt angle P1 which corresponds to the uppermost stage under the open state in the setting of the tilt angle of the flaps 60, and dew condensation on the flaps 60 can be prevented by further vertically tilting the flaps 60 to the tilt angle P2 which is nearer to the vertical angle than the tilt angle P1 by only one stage. Furthermore, the tilt angle is changed to the tilt angle P2 which is vertically tilted by only one stage, so that the arrival distance of blown air can be secured with preventing dew condensation.

[0075] An indication that the tilt angle of the flaps 60 is changed is displayed on the remote controller 77A of the indoor unit 12A, and thus the user can known the change of the tilt angle. That is, according to this embodiment, the angular position (orientation) of the flaps 60 is changed from the tilt angle P1 to the tilt angle P2 which is further vertically (downwardly) tilted from the tilt angle P1 by only one stage. Therefore, it is not conspicuous that the tilt angle of the flaps 60 is forcedly changed, however, the user can check the display of the remote controller 77A as to whether the tilt angle is changed to the tilt angle P2 by the dew condensation preventing operation.

[0076] Furthermore, the indoor unit side controller 76A keeps the tilt angle of the flaps 60 to the tilt angle P2 until any one of an instruction of changing the tilt angle of the flaps 60, an instruction of changing to the heating operation or the air blowing operation and an instruction of changing the rotational number of the air blowing fan 31A is made. Therefore, under the operation state that dew condensation occurs with high probability, the dew condensation on the flaps 60 can be surely prevented.

[0077] Furthermore, occurrence of turbulence flow D can be suppressed by the dimples 60A which are formed on at least one of the upper and lower surfaces of each of the flaps 60. In Figs. 2, 5 and 6, the dimples are illustrated as being formed on only one surface of each flap 60, however, the dimples may be formed on both the sides of each flap so that occurrence of turbulence flow D can be more remarkably suppressed by the dimples.

[0078] The present invention is not limited to the above embodiment, and various modifications may be made without departing from the subject matter.

[0079] In the above embodiment, at the tilt angle P1 at the uppermost stage under the open state of the flaps 60, the airflow resistance to air streams passing along the flaps 60 is increased. However, the airflow resistance to the air streams passing along the horizontal flaps is varied in accordance with the shape of the air blow-out port 13, the arrangement position of the horizontal flaps or the like, and the airflow resistance is not necessarily larger or largest at the uppermost stage. That is, the airflow resistance may be smaller at the tilt angle P1 and the airflow resistance may be larger at the tilt angle P2 in accordance with the shape of the air blow-out port 13 or the arrangement position of the horizontal flaps, so that dew condensation may more frequently occur at the tilt angle P2. In this case, under the state that the cooling operation is executed while the horizontal flaps are set to the tilt angle P2, the tilt angle is further upwardly (or horizontally) tilted to the tilt angle P1 by one stage to reduce the airflow resistance and thus prevent occurrence of dew condensation. That is, in the above embodiment, it is assumed that dew condensation occurs at the tilt angle P1, and thus the tilt angle is changed to the tilt angle P2 which is further downwardly (vertically) tilted by one stage. However, this invention is not limited to this style. In short, when the operation time at the flap position at which occurrence of dew condensation is expected reaches a predetermined time T, the flap position concerned is changed. Accordingly, the flap position may be changed to a new flap position corresponding to a flap angle at which the flaps are further upwardly (horizontally) or downwardly (vertically) tilted by at least one stage.

[0080] In the above embodiment, the tilt angle is changed from the tilt angle P1 to the tilt angle P2 which is nearer to the vertical angle by one angular unit (a predetermined angle such as 5°, 10°, 15° or the like). However, when the tilt angle at which the airflow resistance is smallest is a tile angle which is further nearer to the vertical angle or the horizontal angle in accordance with the shape of the air blow-out port 13, the arrangement position of the horizontal flaps or the like, the tilt angle may be changed to be further nearer to the vertical angle or horizontal angle by two or more stages (i.e. , the flaps may be upwardly or downwardly tilted by one or more stages) to prevent dew condensation. Furthermore, the number of flaps is not limited to two in the above embodiment, and it may be set to one or three or more.

[0081] Furthermore, in the above embodiment, the air conditioner 100 is a multi-type air conditioner. However, the present invention is not limited to this embodiment. For example, the present invention may be applied to an air conditioner in which one indoor unit is provided in connection with one outdoor unit.

Claims

1. An air conditioner including a wall-mount type indoor unit comprising:

a horizontal flap for vertically adjusting a blowing angle at which air blown out from an air blowing fan is blown out from a blow-out port to a room to be air-conditioned; and

a controller for controlling a tilt angle of the horizontal flap in a vertical direction with respect to a horizontal position, wherein the controller changes the tilt angle of the horizontal flap to a tilt angle at which airflow resistance to the air blown out from the air blowing fan is reduced when the following conditions are satisfied: the tilt angle of the horizontal flap is set to a tilt angle at which the airflow resistance to the air blown out from the air blowing fan is large; the rotational number of the air blowing fan is set to a low value; and a continuing time of cooling operation reaches a predetermined time.

2. The air conditioner according to claim 1, wherein the horizontal flap is configured so that the tilt angle thereof is changeable at plural stages in the vertical direction, the rotational number of the air blowing fan is changeable among plural values, and when the tilt angle of the horizontal flap is set to a tilt angle nearest to the horizontal position out of the plural stages, the rotational number of the air blowing fan is set to the lowest value among plural values, and the continuing time of the cooling operation reaches the predetermined time, the controller changes the tilt angle of the horizontal flap to a tilt angle at which the horizontal flap is further vertically tilted by at least one stage.

3. The air conditioner according to claim 1 or 2, wherein the air conditioner is a multiple type air conditioner in which plural indoor units are connected to one outdoor unit.

4. The air conditioner according to claim 1, 2 or 3, wherein the controller further tilts the flap to a vertical position to reduce the airflow resistance, and the angle at which the airflow resistance to the air is large corresponds to an uppermost stage under an open state of the horizontal flap in setting of the tilt angle of the horizontal flap.

5. The air conditioner according to one of claims 1 to 4, further comprising a remote controller, wherein the controller displays an indication representing the change of the tilt angle of the horizontal flap on the remote controller.

6. The air conditioner according to one of claims 1 to 5, wherein after the tilt angle of the horizontal flap is changed, the controller keeps the changed tilt angle until any one of an instruction of changing the tilt angle of the horizontal flap, an instruction of changing to any one of heating operation and air blowing operation and an instruction of changing the rotational number of the air blowing fan is made.

7. The air conditioner according to one of claims 1 to 6, wherein the horizontal flap has dimples on at least one of the upper and lower surfaces thereof to suppress occurrence of turbulence flow along the horizontal flap.

8. A method for preventing dew condensation on a horizontal flap which is changeable in tilt angle in a vertical direction to vertically adjust a blowing angle at which air blown out from an air blowing fan is blown out from a blow-out port to a room to be air-conditioned, comprising the steps of:

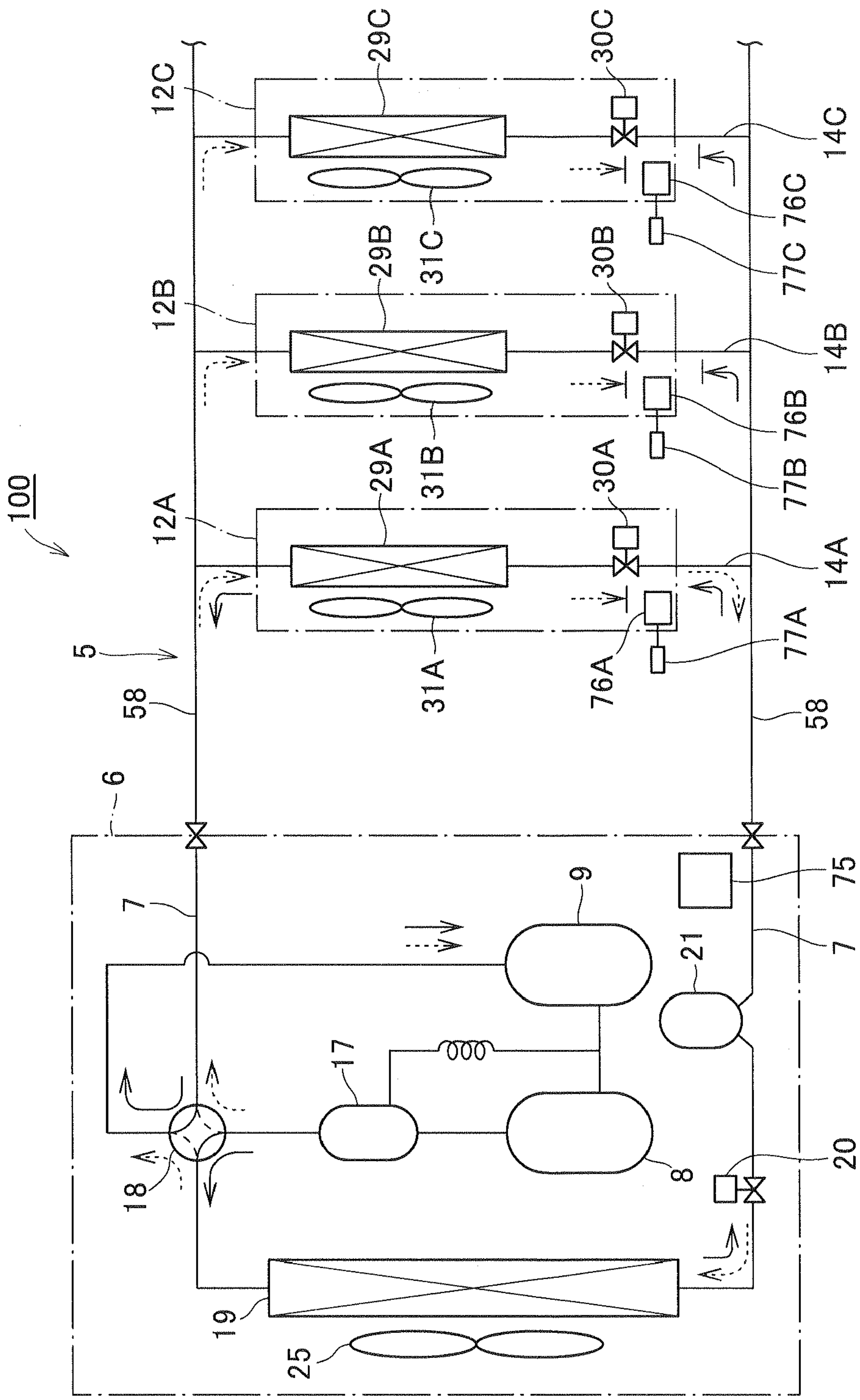
determining whether the tilt angle of the horizontal flap is set to a tilt angle at which the airflow resistance to the air blown out from the air blowing fan is large;

determining whether a rotational number of the air blowing fan is set to a low value;

determining whether a continuing time of cooling operation reaches a predetermined time; and

changing the tilt angle of the horizontal flap to a tilt angle at which airflow resistance to the air blown out from the air blowing fan is reduced.

FIG. 1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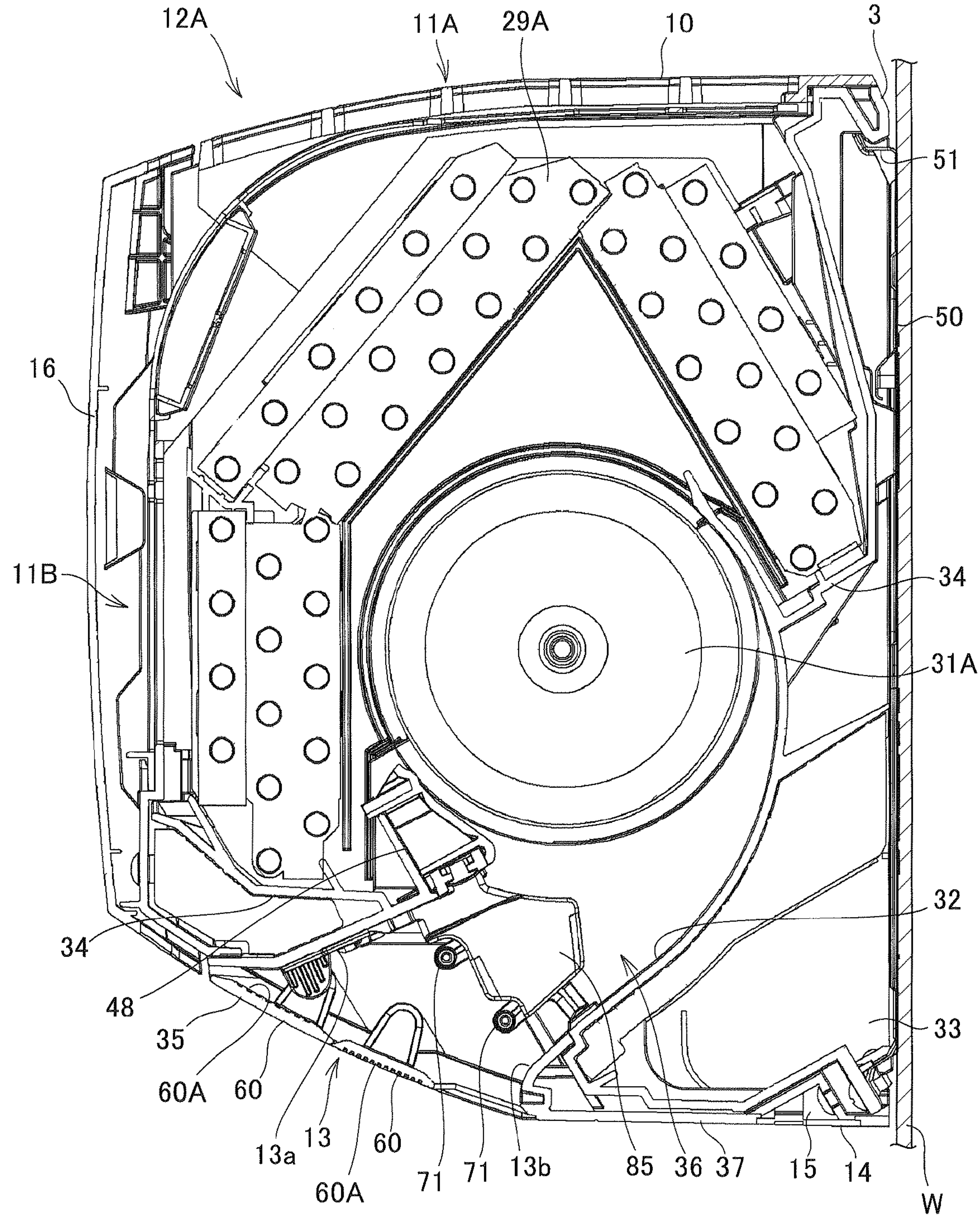
77C

FIG.2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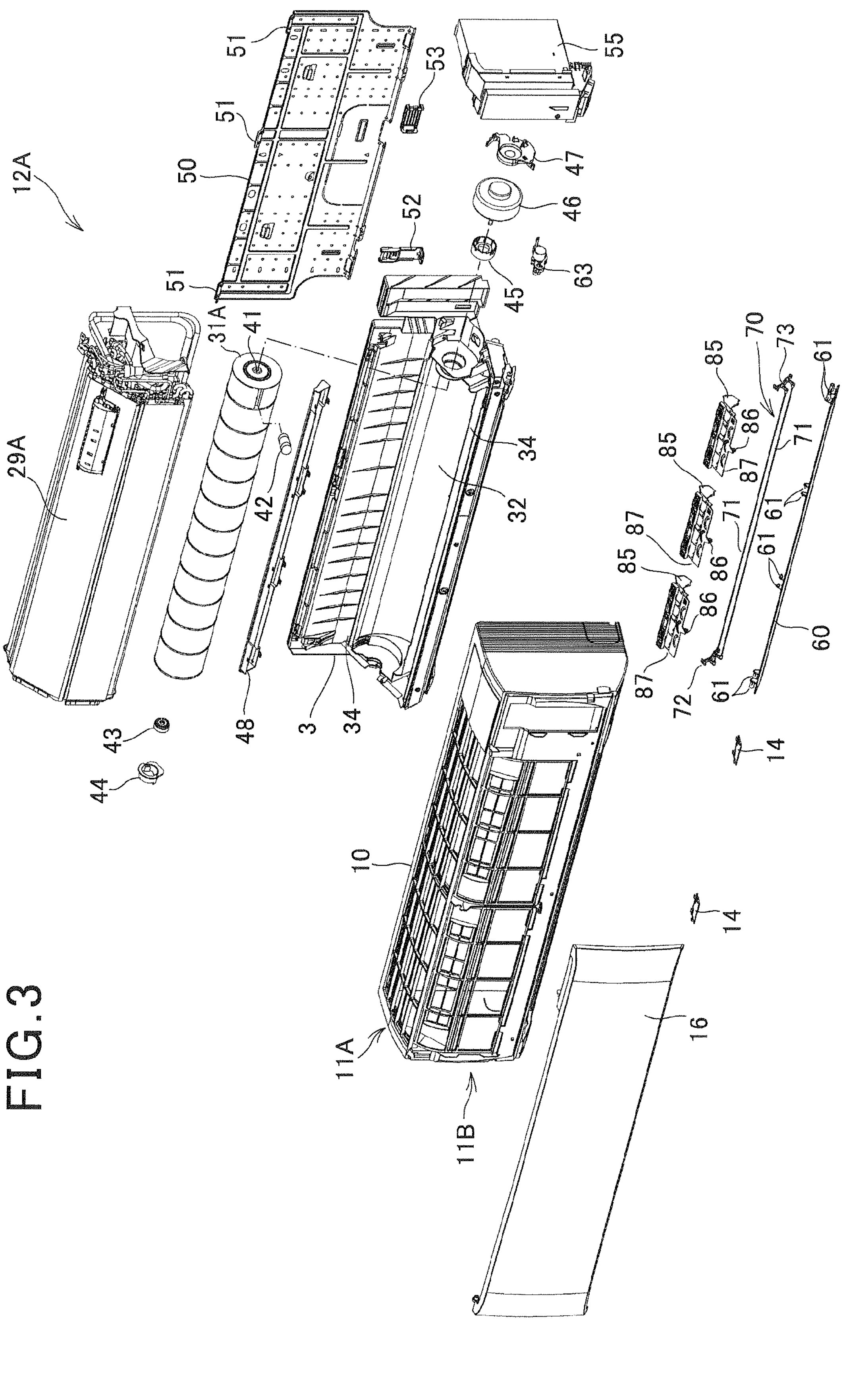
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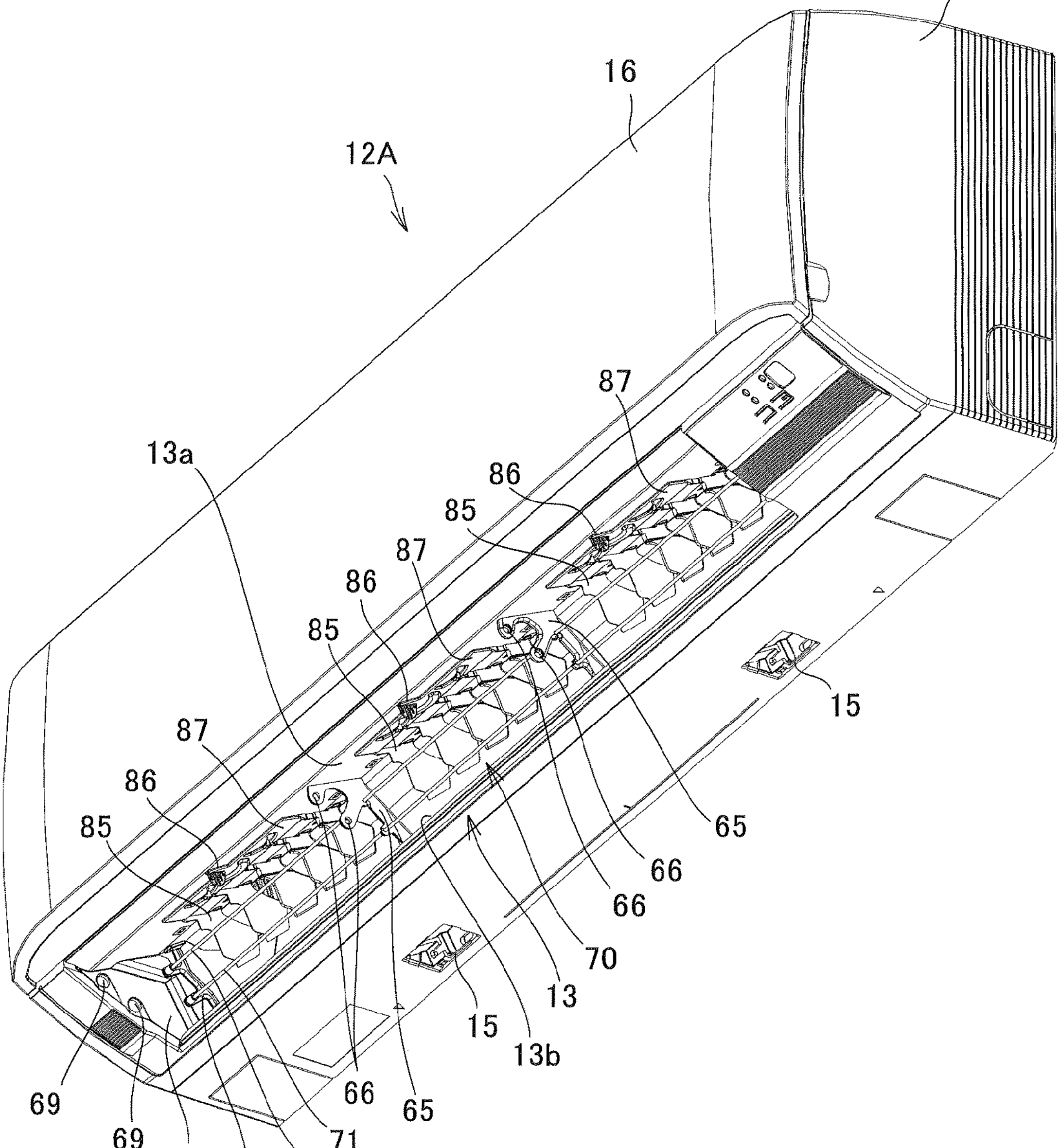
11B

FIG. 3

FIG.4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13b
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65

FIG.5

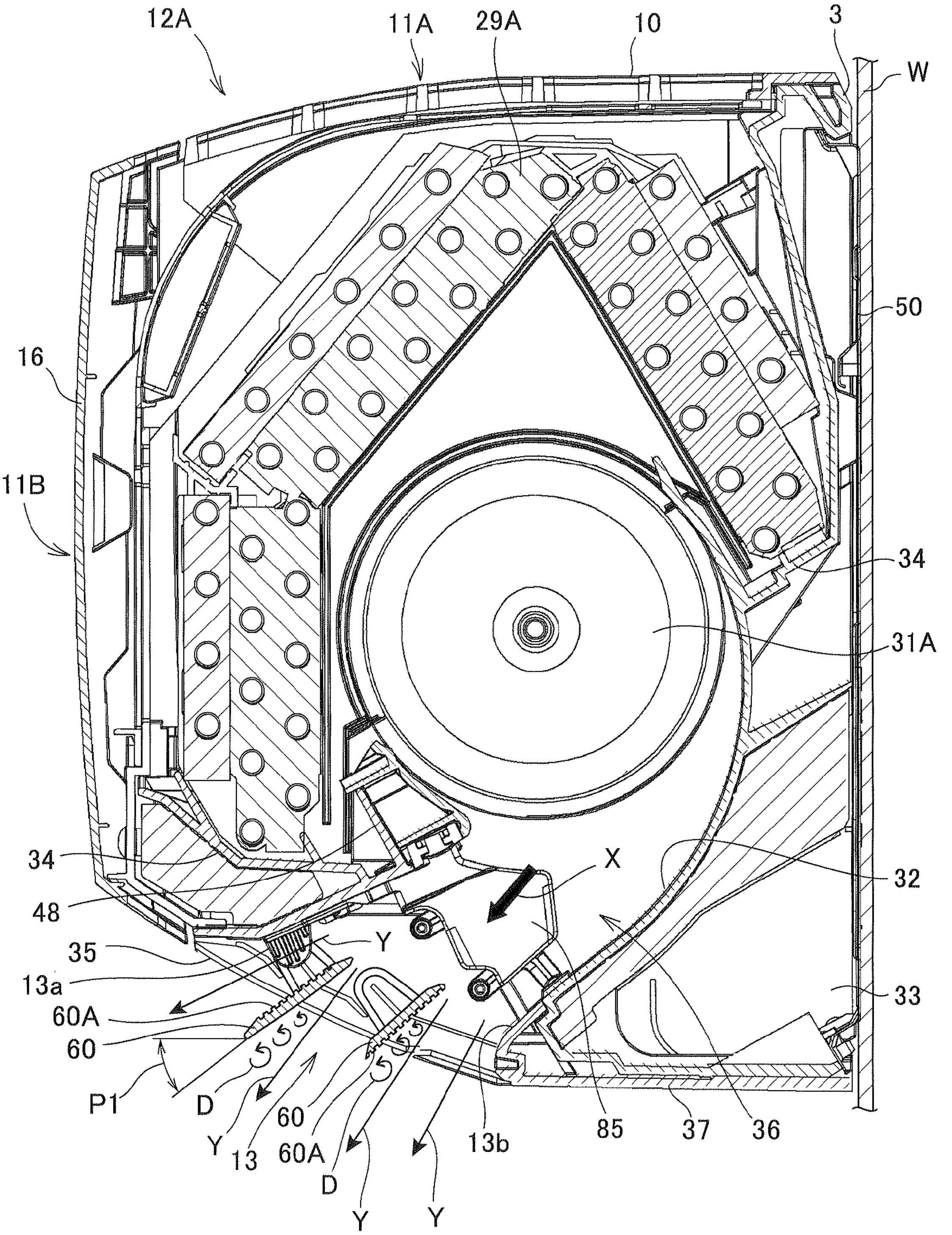
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FIG.6

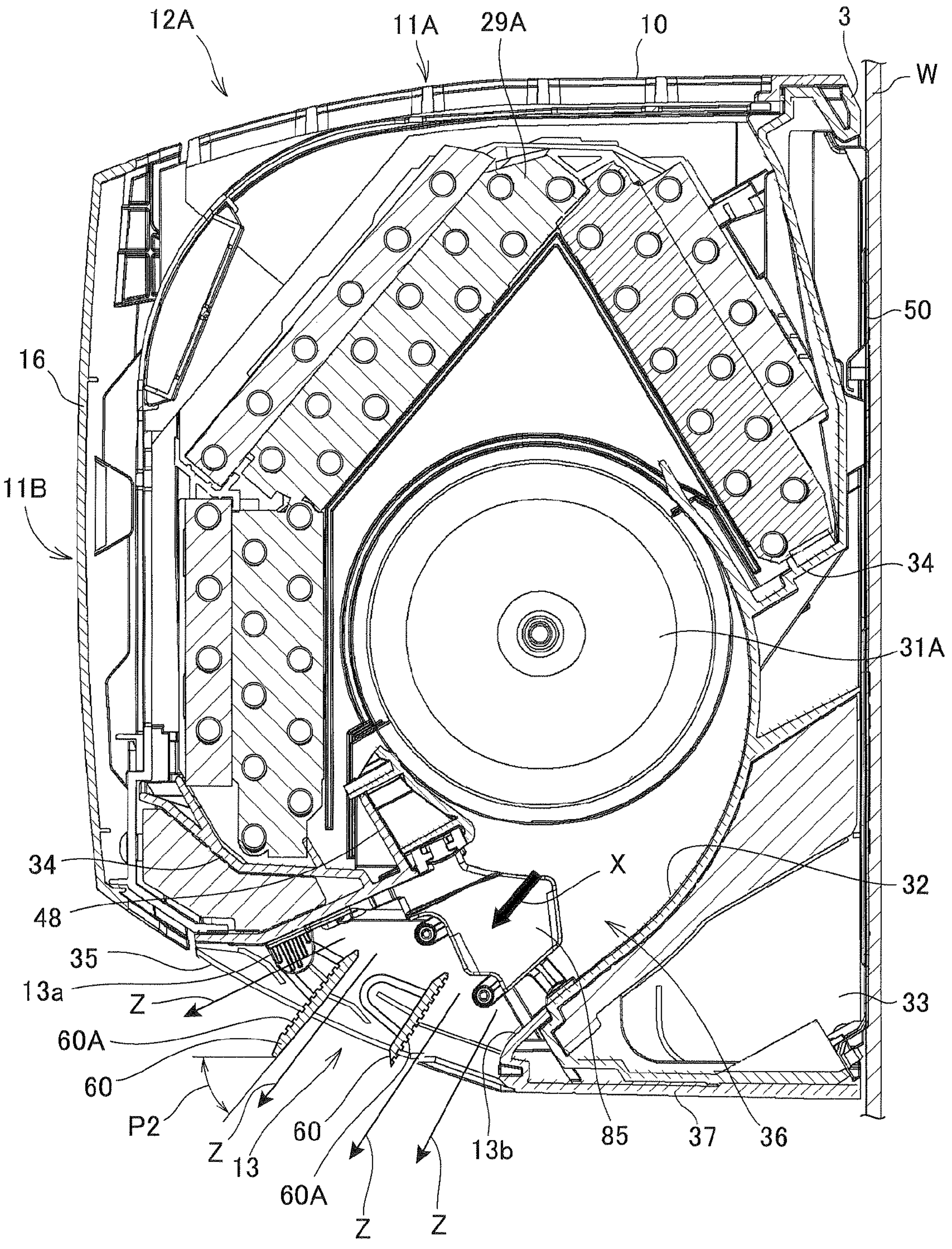
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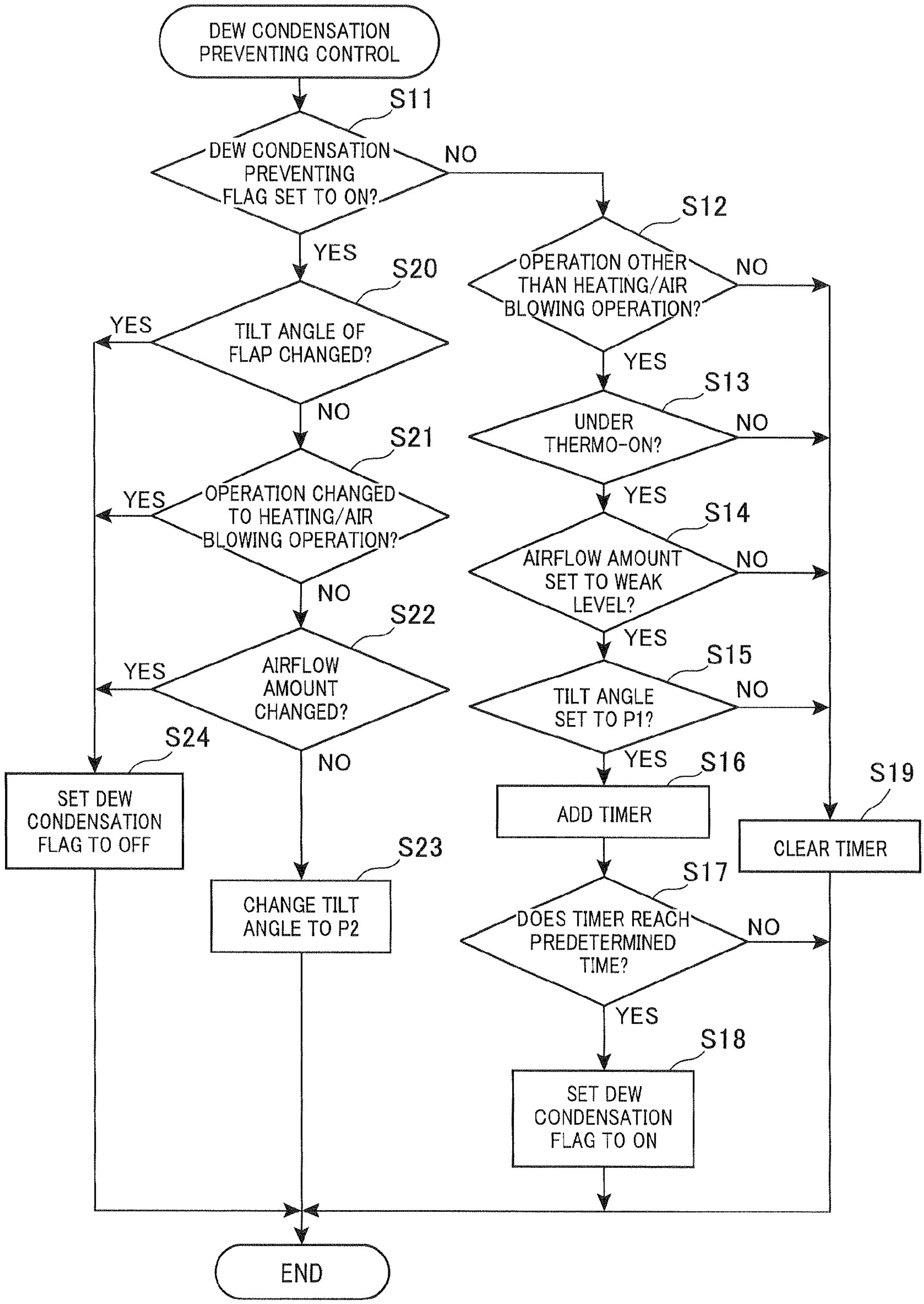
FIG.7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DEW CONDENSATION PREVENTING FLAG SET TO ON?
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YES
S12
OPERATION OTHER THAN HEATING/AIR BLOWING OPERATION?
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YES
S13
UNDER THERMO-ON?
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YES
S14
AIRFLOW AMOUNT SET TO WEAK LEVEL?
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YES
S15
TILT ANGLE SET TO P1?
NO
YES
S16
ADD TIMER
S17
DOES TIMER REACH PREDETERMINED TIME?
NO
YES
S18
SET DEW CONDENSATION FLAG TO ON
S19
CLEAR TIMER
S20
TILT ANGLE OF FLAP CHANGED?
YES
NO
S21
OPERATION CHANGED TO HEATING/AIR BLOWING OPERATION?
YES
NO
S22
AIRFLOW AMOUNT CHANGED?
YES
NO
S23
CHANGE TILT ANGLE TO P2
S24
SET DEW CONDENSATION FLAG TO OFF
END

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EUROPEAN SEARCH REPORT

Application Number
EP 11 17 4810

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 5 385 031 A (KIZAWA YOSHIHIRO [JP] ET AL) 31 January 1995 (1995-01-31) * abstract; figures 1,2,3 * * column 1, lines 60-64 * * column 2, lines 20-23 * -----	1-8	INV. F24F1/00 F24F11/00
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X	JP 7 180895 A (SHARP KK) 18 July 1995 (1995-07-18) * abstract * * paragraph [0042] - paragraph [0044] * -----	1-8	
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A	JP 11 037537 A (MITSUBISHI ELECTRIC CORP) 12 February 1999 (1999-02-12) * abstract * -----	1-8	TECHNICAL FIELDS SEARCHED (IPC) F24F
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The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
Munich	24 October 2011	Vuc, Arianda

CATEGORY OF CITED DOCUMENTS

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EP 11 17 4810

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The members are as contained in the European Patent Office EDP file on
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24-10-2011

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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