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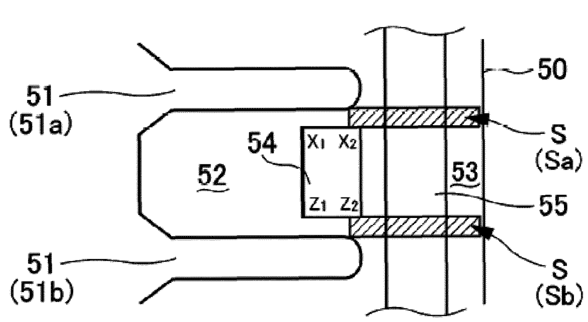
(54) **AIR CONDITIONER**

(57) A heat exchanger (31) includes a plurality of flat tubes (40), a fin (50) that includes a plurality of notch portions (51) arranged side by side in a vertical direction, to which the plurality of flat tubes (40) are inserted, and includes intermediate regions (52) each formed between two of the notch portions (51) adjacent to each other in a vertical direction, and a connection region (53) connecting the intermediate regions (52) to each other, first bulging portions (54) at least partly positioned on the intermediate regions (52), and a second bulging portion (55) provided on the connection region (53) and blocking a gap (S) between the flat tubes (40) and the first bulging portions (54), wherein each first bulging portion (54) and the second bulging portion (55) are arranged to cause an air flow to pass through at least one of these portions in a ventilation direction.

FIG.4



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Description

Field

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

Background

[0002] Conventionally, for air conditioners, heat exchangers using flat tubes have been known. In order to improve the heat transfer coefficient, some of these heat exchangers are provided with bulging portions, each of which protrudes intersecting with the flow direction of an air flow, on the places of the fins between the upper and lower flat tubes (intermediate regions). However, there is a case where a phenomenon (deflected flows) occurs such that the flow velocity of air flows passing through the bulging portions and through the gaps between the bulging portions and the flat tubes becomes greatly different. In this case, the heat exchange comes to be improperly performed, and makes it difficult to achieve the performance improvement expected to the heat exchanger.

[0003] On the other hand, in order to suppress the deflected flows on the surface of the fins, some technology has been disclosed (for example, see Patent Literature 1) in which, other than first bulging portions provided in the intermediate regions, a second bulging portion is provided on a connection region of the fins that connects the intermediate regions to each other, to overlap with the gaps generated between the first bulging portions and the flat tubes when viewed in the ventilation directions. According to this technology, the air flows passing through the heat exchanger are less likely to generate deflected flows in which the flow velocity in passing through the gaps is significantly larger than the flow velocity in passing around the protruding portions. As a result, the heat exchange comes to be properly performed between the air flows and the refrigerant in the flat tubes, and makes it possible to achieve the performance improvement expected by providing the bulging portions.

[0004] However, the technology of Patent Literature 1 can suppress the deflected flows on the surface of the fins, but has a problem in that the structure according to this technology is not designed to suppress so-called dew splash in which the condensed water accumulated around the flat tubes is scattered.

Citation List

Patent Literature

[0005] Patent Literature 1: Japanese Laid-open Patent Publication No. 2017-194264

Summary

Technical Problem

[0006] The present invention has been made to solve the problems described above, and has an object to suppress the dew splash of condensed water accumulated on the surface of the fins or flat tubes.

Solution to Problem

[0007]

(1). According to an aspect of an embodiment, an air conditioner includes a heat exchanger that is arranged in a ventilation flue inside a housing, and a blower that is arranged in the ventilation flue, wherein the heat exchanger includes a plurality of flat tubes, and a fin that includes a plurality of notch portions arranged side by side in a vertical direction, to which the plurality of flat tubes are inserted, and includes intermediate regions each formed between two of the notch portions adjacent to each other in a vertical direction, and a connection region connecting the intermediate regions to each other, the heat exchanger is arranged in a state where the intermediate regions are present on a windward side in a ventilation direction of air flowing in the ventilation flue, with respect to the connection region, the heat exchanger includes first bulging portions that are at least partly positioned on the intermediate regions, and a second bulging portion that overlaps with a gap generated between the first bulging portions and the flat tubes when the heat exchanger is viewed from the windward side in a direction of a drag line, and the drag line is defined by a virtual line that extends from a start point at a point where condensed water is accumulated on the fin, on the windward side, to an end point at a point where a static pressure in the ventilation flue is lowest, on a leeward side.

(2). The air conditioner according to (1), wherein the blower is provided on a downstream side in the ventilation direction from the heat exchanger in the ventilation flue, and the end point is at a center of the blower.

(3). The air conditioner according to (1), wherein

the blower is provided on an upstream side in the ventilation direction from the heat exchanger in the ventilation flue, and
the end point is at a center of a position where a flow passage cross-sectional area is minimum in the ventilation flue.

(4). The air conditioner according to (1), wherein each of the first bulging portions is formed with an upper end edge positioned to fall within a range of 4 mm or less from a lower side of a first notch portion on an upper side.

(5). The air conditioner according to (1), wherein the first bulging portions and the second bulging portion are formed such that a distance between the notch portions and the second bulging portion is equal to or larger than a distance between the first bulging portions and the second bulging portion. Advantageous Effects of Invention

[0008] According to the present invention, it is possible to suppress the dew splash of condensed water accumulated on the surface of the fins or flat tubes.

Brief Description of Drawings

[0009]

FIG. 1A is a diagram for explaining an example of an air conditioner according to an embodiment of the present invention, which is a refrigerant circuit diagram illustrating a refrigerant circuit of the air conditioner.

FIG. 1B is a block diagram illustrating a control means.

FIG. 2A is a diagram for explaining a heat exchanger according to the embodiment of the present invention, which is a plan view illustrating the heat exchanger.

FIG. 2B is a front view illustrating the heat exchanger.

FIG. 3 is a diagram for explaining the relationship between flat tubes and a fin.

FIG. 4 is a diagram for explaining a first bulging portion and a second bulging portion.

FIG. 5 is a diagram for explaining in an enlarged state the relationship between a heat exchanger and a fan in the case of a suction type.

FIG. 6 is a diagram for explaining in an enlarged state the relationship between a fan and a heat exchanger in the case of a blowout type.

FIG. 7 is a diagram for explaining the positional relationship of first bulging portions by a front side view.

FIG. 8A is a diagram for explaining the distance between the upper end edge of a first bulging portion and the lower side of a first notch portion, which is a front view illustrating the state of the upper end edge of the first bulging portion and the lower side of the first notch portion by a front side view.

FIG. 8B is a side view illustrating the state of the upper end edge of the first bulging portion and the lower side of the first notch portion by a lateral side view.

FIG. 9 is a diagram for explaining the distance between a second bulging portion and the intermediate region-side end of a notch portion, and the distance between a first bulging portion and the second bulging portion.

FIG. 10 is a diagram illustrating the relationship between a heat exchanger and a fan by a duct type in the case of the suction type.

FIG. 11 is a diagram illustrating the relationship between a heat exchanger and a fan by a wall-mounted type in the case of the suction type.

FIG. 12 is a diagram illustrating the relationship between a heat exchanger and fans by a floor-standing type in the case of the suction type.

FIG. 13 is a diagram illustrating the relationship between a heat exchanger and a fan by a vertical duct type in the case of the suction type.

FIG. 14 is a top view illustrating the relationship between a heat exchanger and a fan by a window type in the case of the suction type.

FIG. 15 is a diagram illustrating the relationship between a fan and a heat exchanger by a duct type in the case of the blowout type.

FIG. 16 is a diagram illustrating the relationship between a fan and a heat exchanger by a ceiling suspension type in the case of the blowout type.

FIG. 17 is a diagram illustrating the relationship between a fan and a heat exchanger by a ceiling-embedded type in the case of the blowout type.

FIG. 18 is a diagram illustrating the relationship between a fan and a heat exchanger by a wall-mounted type in the case of the blowout type.

FIG. 19A is a table indicating the size d2 of each droplet when the contact angle $\theta = 10°$.

FIG. 19B is a table indicating the size d2 of each droplet when the contact angle $\theta = 60°$.

Description of Embodiments

(Embodiment)

[0010] An embodiment of the present invention will be explained below in detail with reference to the accompanying drawings. The present invention is not limited to the following embodiment, but may be modified in various ways without departing from the gist of the present invention.

<Configuration of Refrigerant Circuit>

[0011] First, with reference to FIG. 1A, an explanation will be given of a refrigerant circuit of an air conditioner 1 including an outdoor unit 2. As illustrated in FIG. 1A, the air conditioner 1 according to this embodiment includes the outdoor unit 2 disposed outdoors and the indoor unit 3 installed indoors and connected to the outdoor unit 2 through a liquid pipe 4 and a gas pipe 5. Specifically, a liquid side closing valve 25 of the outdoor unit 2 and a liquid pipe connector 33 of the indoor unit 3 are connected by the liquid pipe 4. Further, a gas side closing valve 26 of the outdoor unit 2 and a gas pipe connector 34 of the indoor unit 3 are connected by the gas pipe 5. With this arrangement, a refrigerant circuit 10 of the air conditioner 1 is formed.

<<Refrigerant Circuit of Outdoor Unit>>

[0012] First, the outdoor unit 2 will be explained. The outdoor unit 2 includes a compressor 21, a four-way valve 22, an outdoor heat exchanger 23, an expansion valve 24, the liquid side closing valve 25 to which the liquid pipe 4 is connected, the gas side closing valve 26 to which the gas pipe 5 is connected, and an outdoor fan 27. Further, these respective devices except the outdoor fan 27 are connected to each other by respective refrigerant pipes described later to form an outdoor unit refrigerant circuit 10a that serves as one section of the refrigerant circuit 10. Here, an accumulator (not illustrated) may be provided on the refrigerant suction side of the compressor 21.

[0013] The compressor 21 is a variable capacity type compressor that can change the operation capacity by controlling the number of revolutions with an inverter (not illustrated). The refrigerant discharge side of the compressor 21 is connected to the port "a" of the four-way valve 22 by a discharge pipe 61. Further, the refrigerant suction side of the compressor 21 is connected to the port "c" of the four-way valve 22 by a suction pipe 66.

[0014] The four-way valve 22 is a valve for switching the flow direction of the refrigerant, and includes four ports of "a, b, c, and d". The port "a" is connected to the refrigerant discharge side of the compressor 21 by the discharge pipe 61, as described above. The port "b" is connected to one of the refrigerant gateways of the outdoor heat exchanger 23 by a refrigerant pipe 62. The port "c" is connected to the refrigerant suction side of the compressor 21 by the suction pipe 66, as described above. Further, the port "d" is connected to the gas side closing valve 26 by an outdoor unit gas pipe 64. Here, the four-way valve 22 is a flow passage switching means according to the present invention.

[0015] The outdoor heat exchanger 23 serves to perform heat exchange between the refrigerant and the outside air taken into the inside of the outdoor unit 2 by rotation of the outdoor fan 27, as described later. One of the refrigerant gateways of the outdoor heat exchanger 23 is connected to the port "b" of the four-way valve 22 by the refrigerant pipe 62, as described above, and the other of the refrigerant gateways is connected to the liquid side closing valve 25 by an outdoor unit liquid pipe 63. The outdoor heat exchanger 23 functions as a condenser during the cooling operation, and functions as an evaporator during the heating operation, by switching of the four-way valve 22, as described later.

[0016] The expansion valve 24 is an electronic expansion valve to be driven by a pulse motor (not illustrated). Specifically, the opening degree of the expansion valve 24 is adjusted by the number of pulses added to the pulse motor. The opening degree of the expansion valve 24 during the heating operation is adjusted so that the discharge temperature, which is the temperature of the refrigerant discharged from the compressor 21, can become a predetermined target temperature.

[0017] The outdoor fan 27 is made of a resin material, and is arranged near the outdoor heat exchanger 23. The outdoor fan 27 has its central portion connected to the rotary shaft of a fan motor (not illustrated). As the fan motor rotates, the outdoor fan 27 is rotated. By rotation of the outdoor fan 27, outside air is taken into the inside of the outdoor unit 2 from a suction port (not illustrated) of the outdoor unit 2, and the outside air subjected to heat exchange with the refrigerant in the outdoor heat exchanger 23 is discharged to the outside of the outdoor unit 2 from a blowout port (not illustrated) of the outdoor unit 2.

[0018] In addition to the configuration described above, the outdoor unit 2 is provided with various sensors. As illustrated in FIG. 1A, the discharge pipe 61 is provided with a discharge pressure sensor 71 that detects the pressure of the refrigerant being discharged from the compressor 21, and a discharge temperature sensor 73 that detects the temperature of the refrigerant being discharged from the compressor 21 (the discharge temperature described above). The suction pipe 66 is provided with a suction pressure sensor 72 that detects the pressure of the refrigerant being sucked into the compressor 21, and a suction temperature sensor 74 that detects the temperature of the refrigerant being sucked into the compressor 21.

[0019] At an approximate middle of a refrigerant path (not illustrated) of the outdoor heat exchanger 23, a heat exchange temperature sensor 75 is provided that detects an outdoor heat exchange temperature, which is the temperature of the outdoor heat exchanger 23. Further, near the suction port (not illustrated) of the outdoor unit 2, an outside air temperature sensor 76 is provided that detects the temperature of outside air flowing into the inside of the outdoor unit 2, i.e. an outside air temperature.

[0020] Further, the outdoor unit 2 is provided with an outdoor unit control means 200. The outdoor unit control means 200 is mounted on a control board housed in an electric component box (not illustrated) of the outdoor unit 2. As illustrated in FIG. 1B, the outdoor unit control means 200 includes a CPU 210, a storage part 220, a communication part 230, and a sensor input part 240.

[0021] The storage part 220 is composed of a flash memory, and stores control programs for the outdoor unit 2, detection values corresponding to detection signals from various sensors, control states of the compressor 21, the outdoor fan 27, etc. and so forth. Further, although not illustrated, the storage part 220 has stored in advance a table of the number of revolutions that specifies the numbers of revolutions of the compressor 21 in accordance with requested performance to be received from the indoor unit 3.

[0022] The communication part 230 is an interface for performing communication with the indoor unit 3. The sensor input part 240 takes in detection results obtained by the various sensors of the outdoor unit 2, and outputs these detection results to the CPU 210.

[0023] The CPU 210 takes in detection results from the respective sensors of the outdoor unit 2 described above via the sensor input part 240. Further, the CPU 210 takes in control signals transmitted from the indoor unit 3, via the communication part 230. The CPU 210 performs drive control over the compressor 21 and the outdoor fan 27, on the basis of the detection results and the control signals thus taken in and so forth. Further, the CPU 210 performs switching control over the four-way valve 22, on the basis of the detection results and the control signals thus taken in. Furthermore, the CPU 210 performs opening degree adjustment over the expansion valve 24, on the basis of the detection results and the control signals thus taken in.

<<Refrigerant Circuit of Indoor Unit>>

[0024] Next, with reference to FIG. 1A, the indoor unit 3 will be explained. The indoor unit 3 includes an indoor heat exchanger 31, an indoor fan 32, the liquid pipe connector 33 to which the other end of the liquid pipe 4 is connected, and the gas pipe connector 34 to which the other end of the gas pipe 5 is connected. Further, these respective devices except the indoor fan 32 are connected to each other by respective refrigerant pipes described below in detail to form an indoor unit refrigerant circuit 10b that serves as one section of the refrigerant circuit 10.

[0025] The indoor heat exchanger 31 serves to perform heat exchange between the refrigerant and the indoor air taken into the inside of the indoor unit 3 from a suction port (not illustrated) of the indoor unit 3 by rotation of the indoor fan 32, as described later. One of the refrigerant gateways of the indoor heat exchanger 31 is connected to the liquid pipe connector 33 by an indoor unit liquid pipe 67. The other of the refrigerant gateways of the indoor heat exchanger 31 is connected to the gas pipe connector 34 by an indoor unit gas pipe 68. The indoor heat exchanger 31 functions as an evaporator when the indoor unit 3 performs the cooling operation, and functions as a condenser when the indoor unit 3 performs the heating operation.

[0026] The indoor fan 32 is made of a resin material, and is arranged near the indoor heat exchanger 31. As the indoor fan 32 is rotated by a fan motor (not illustrated), indoor air is taken into the inside of the indoor unit 3 from the suction port (not illustrated) of the indoor unit 3, and the indoor air subjected to heat exchange with the refrigerant in the indoor heat exchanger 31 is blown out into the room from a blowout port (not illustrated) of the indoor unit 3.

[0027] In addition to the configuration described above, the indoor unit 3 is provided with various sensors. The indoor unit liquid pipe 67 is provided with a liquid-side temperature sensor 77 that detects the temperature of the refrigerant flowing into the indoor heat exchanger 31 or flowing out of the indoor heat exchanger 31. The indoor unit gas pipe 68 is provided with a gas-side temperature sensor 78 that detects the temperature of the refrigerant flowing out of the indoor heat exchanger 31 or flowing into the indoor heat exchanger 31. Further, near the suction port (not illustrated) of the indoor unit 3, a room temperature sensor 79 is provided that detects the temperature of indoor air flowing into the inside of the indoor unit 3, i.e., the room temperature.

[0028] Further, the indoor unit 3 is provided with an indoor unit control means 300. As illustrated in FIG. 1B, the indoor unit control means 300 includes a CPU 310, a storage part 320, a communication part 330, and a sensor input part 340 (here, in this specification, the indoor unit control means 300 may be simply referred to as "control means").

[0029] The storage part 320 is composed of a flash memory, and stores control programs for the indoor unit 3, detection values corresponding to detection signals from various sensors, control states of the indoor fan 32 etc. and so forth. Further, although not illustrated, the storage part 320 has stored in advance a table of the number of revolutions or the like that specifies the numbers of revolutions of the indoor fan 32, including the number of revolutions for monitoring leakage of the refrigerant during the operation shutdown described later.

[0030] The communication part 330 is an interface for performing communication with the outdoor unit 2. The sensor input part 340 takes in detection results obtained by the various sensors of the indoor unit 3, and outputs these detection results to the CPU 310.

[0031] The CPU 310 takes in detection results from the respective sensors of the indoor unit 3 described above via the sensor input part 340. Further, the CPU 310 takes in control signals transmitted from the outdoor unit 2, via the communication part 330. The CPU 310 performs drive control over the indoor fan 32, including a drive for monitoring leakage of the refrigerant during the operation shutdown described later, on the basis of the detection results and the control signals thus taken in. Further, the CPU 310 calculates the temperature difference between a set temperature set by the user by operating a remote controller (not illustrated) and a room temperature detected by the room temperature sensor 79, and transmits requested performance based on the temperature difference thus calculated to the outdoor unit control means 200 of the outdoor unit 2 via the communication part 330.

<Operation of Refrigerant Circuit>

[0032] Next, with reference to FIG. 1A, an explanation will be given of the flow of the refrigerant and the operation of each part in the refrigerant circuit 10 during an air conditioning operation of the air conditioner 1 according to this embodiment. In the following, an explanation will be given of a case where the indoor unit 3 performs the heating operation, on the bases of the flow of the refrigerant indicated by solid lines in FIG. 1A. On the other hand, the flow of the refrigerant indicated by broken lines illustrates the cooling operation.

[0033] When the indoor unit 3 performs the heating operation, as illustrated in FIG. 1A, the CPU 210 switches the four-way valve 22 into a state illustrated by the solid lines, i.e. a state where the port "a" and the port "d" communicate with each other and the port "b" and the port "c" communicate with each other. Consequently, the refrigerant circulates in a direction indicated by the solid line arrows in the refrigerant circuit 10, and thereby makes a heating cycle in which the outdoor heat exchanger 23 functions as an evaporator and the indoor heat exchanger 31 functions as a condenser.

[0034] The refrigerant with a high pressure discharged from the compressor 21 flows through the discharge pipe 61, and flows into the four-way valve 22. The refrigerant that has flowed into the port "a" of the four-way valve 22 flows from the port "d" of the four-way valve 22 through the outdoor unit gas pipe 64, and flows into the gas pipe 5 via the gas side closing valve 26. The refrigerant that has flowed through the gas pipe 5 flows into the indoor unit 3 via the gas pipe connector 34.

[0035] The refrigerant that has flowed into the indoor unit 3 flows through the indoor unit gas pipe 68, and flows into the indoor heat exchanger 31, where the refrigerant is subjected to heat exchange with the indoor air taken into the inside of the indoor unit 3 by rotation of the indoor fan 32, and is condensed. In this way, the indoor heat exchanger 31 functions as a condenser, and the indoor air subjected to heat exchange with the refrigerant in the indoor heat exchanger 31 is blown out from the blowout port (not illustrated) into the room, so as to achieve heating inside the room where the indoor unit 3 is installed.

[0036] The refrigerant that has flowed out of the indoor heat exchanger 31 flows through the indoor unit liquid pipe 67, and flows into the liquid pipe 4 via the liquid pipe connector 33. The refrigerant that has flowed through the liquid pipe 4 and flowed into the outdoor unit 2 through the liquid side closing valve 25 is decompressed when the refrigerant flows through the outdoor unit liquid pipe 63 and passes through the expansion valve 24. As described above, the opening degree of the expansion valve 24 during the heating operation is adjusted so that the discharge temperature of the compressor 21 can become a predetermined target temperature.

[0037] The refrigerant that has passed through the expansion valve 24 and flowed into the outdoor heat exchanger 23 is evaporated by being subjected to heat exchange with the outside air taken into the inside of the outdoor unit 2 by rotation of the outdoor fan 27. The refrigerant that has flowed out of the outdoor heat exchanger 23 into the refrigerant pipe 62 flows through the port "b" and the port "c" of the four-way valve 22 and the suction pipe 66, and is sucked by the compressor 21 and compressed again.

<Heat Exchanger>

[0038] The heat exchanger according to this embodiment is applicable to the indoor heat exchanger 31 of the indoor unit 3 and the outdoor heat exchanger 23 of the outdoor unit 2. However, in the following description, the heat exchanger will be explained as being applied to the indoor heat exchanger (which will be simply referred to as "heat exchanger", hereinafter) 31 of the indoor unit 3, which functions as a condenser during the heating operation.

[0039] FIGS. 2A and 2B are diagrams for explaining the heat exchanger 31 according to this embodiment, in which FIG. 2A illustrates a plan view of the heat exchanger 31, and FIG. 2B illustrates a front view of the heat exchanger 31. As illustrated in FIGS. 2A and 2B, the heat exchanger 31 includes a plurality of flat tubes 40 that are composed of heat transfer tubes each with a cross-section of a long elliptical shape or rectangular shape having rounded corners and are arrayed in the vertical direction (a direction perpendicular to the refrigerant flow direction) with their side surfaces (wider surfaces) facing each other. The heat exchanger 31 further includes a pair of left and right headers 12 connected to the opposite ends of the flat tubes 40, and a plurality of fins 50 arranged in a direction intersecting with the flat tubes 40 and joined thereto. In the following description, with respect to the plurality of flat tubes 40, two flat tubes 40 vertically adjacent to each other may be identified such that the tube on the upper side in the drawings is referred to as "first flat tube 40a" and the tube on the lower side in the drawings is referred to as "second flat tube 40b". In addition to the components described above, the heat exchanger 31 is provided with refrigerant pipes (not illustrated) in the headers 12, which provide connection to other components of the air conditioner 1 and allow the refrigerant to flow therein.

[0040] To explain in more detail, the flat tubes 40 are arranged along a direction in which the refrigerant flows between the pair of headers 12 (which may also be referred to as "longitudinal direction"), and each has a flat shape in a direction in which air flows (which may also be referred to as "shorter side direction"). Inside each of the flat tubes 40, a plurality of refrigerant flow passages are formed through which the refrigerant flows in the longitudinal direction. The plurality of flat tubes 40 are arranged in parallel with each other in the vertical direction with apertures S1 interposed therebetween for air to pass through, and their opposite ends are connected to the pair of headers 12. Specifically, the plurality of flat tubes 40 extending along the longitudinal direction are arrayed in the vertical direction at a predetermined array pitch Ph (the distance of each of the apertures S1 in the vertical direction), and their opposite ends are connected to the headers 12.

[0041] Each of the headers 12 has a cylindrical shape, inside of which refrigerant flow passages (not illustrated) are formed that serve to branch the refrigerant supplied to the heat exchanger 31 into portions flowing into the plurality of flat tubes 40, and to merge portions of the refrigerant flowing out of the plurality of flat tubes 40.

[0042] Each of the fins 50 has a flat plate shape, and the fins 50 are arranged in a multi-layered state in a direction intersecting with the flat tubes 40 in a front side view, and are arranged in parallel with each other with the apertures S1 interposed therebetween for air to pass through. Specifically, the plurality of fins 50 extending along the vertical direction are arrayed on the flat tubes 40 in the longitudinal direction thereof at a predetermined fin pitch Pv (the distance of each of the apertures S1 in the longitudinal direction). In the following description, with respect to the plurality of fins 50, two fins 50 horizontally adjacent to each other may be identified such that the fin on the left side in the drawings is referred to as "first fin 50a" and the fin on the right side in the drawings is referred to as "second fin 50b".

<Flat Tube, Fin and Bulging Portion, and Fan>

[0043] Next, with reference to FIG. 3 and the following, an explanation will be given of the relationship between the flat tubes 40, the fins 50, first bulging portions 54 and a second bulging portion 55, and the indoor fan (which will be simply referred to as "fan") 32. First, as illustrated in FIG. 3, each of the fins 50 is provided with a plurality of notch portions 51 arranged side by side in the vertical direction to insert therein the plurality of flat tubes 40. Each of the fins 50 includes intermediate regions 52 (on the windward side) each formed between notch portions 51 vertically adjacent to each other (a first notch portion 51a and a second notch portion 51b), and a connection region 53 (on the leeward side) that connects the plurality of intermediate regions 52 to each other. In the following description, with respect to the plurality of notch portions 51, two notch portions 51 adjacent to each other across the corresponding intermediate region 52 will be identified such that the notch portion on the upper side in the drawings is referred to as "first notch portion 51a" and the notch portion 51 on the lower side is referred to as "second notch portion 51b". The first flat tube 40a is inserted in the first notch portion 51a, and the second flat tube 40b is inserted in the second notch portion 51b. Inside each of the flat tubes 40, a plurality of refrigerant flow passages 41 are provided for the refrigerant to flow through.

[0044] As illustrated in FIG. 4, each of the intermediate regions 52 of the fins 50 is provided with a first bulging portion 54 between the first notch portion 51a and the second notch portion 51b. The first bulging portion 54 includes an upper end edge X1-X2 and a lower end edge Z1-Z2 positioned from the intermediate region 52 to the connection region 53. More specifically, the first bulging portion 54 is provided such that at least part thereof is positioned on the corresponding intermediate region 52, and a connection region side edge X2-Z2 is positioned on the connection region 53. The first bulging portions 54 promote drainage of condensed water deposited on the surface of the flat pipes 40 or the fins 50.

[0045] Since each first bulging portion 54 is provided in a state of being at least partly positioned on the corresponding intermediate region 52, condensed water deposited around the first flat tube 40a (not illustrated in FIG. 4: see FIG. 3) inserted in the first notch portion 51a above the first bulging portion 54 beyond the upper end edge X1-X2 of the first bulging portion 54 travels along the leeward side end (the right side end in FIG. 4) of the first notch portion 51a (and/or the first flat tube 40a) and reaches the upper end edge X1-X2 of the first bulging portion 54.

[0046] Thereafter, the condensed water flows down along an intermediate region side edge X1-Z1 connecting a first upper end X1 and a first lower end Z1, and a connection region side edge X2-Z2 connecting a second upper end X2 and a second lower end Z2. The condensed water that has reached the lower end edge Z1-Z2 flows to the second flat tube 40b or connection region 53, and is drained in sequence.

[0047] A second bulging portion 55 is further provided on the leeward side (on the right side in FIG. 4) of the connection region side edge X2-Z2 of each first bulging portion 54. The second bulging portion 55 is provided on the connection region 53 to overlap with the gaps S between the notch portions 51 or thus the flat tubes 40 and the first bulging portions 54, when viewed in the ventilation directions. With this arrangement, the air flows passing through the gaps S receive an increased flow passage resistance and thereby decrease the flow velocity. As the flow velocity is lower, the drag applied to condensed water in each ventilation direction (the force received from each air flow in the ventilation direction) decreases, and thus it is possible to suppress dew splash in which droplets of condensed water deposited on the surface of the flat tubes 40 or fins 50 are scattered from the gaps S to the leeward side. FIG. 4 illustrates an example where the single second bulging portion 55 is provided to block both of the gap Sa between the first notch portion 51a or thus the first flat tube 40a and the first bulging portion 54, and the gap Sb between the second notch portion 51b or thus the second flat tube 40b and the first bulging portion 54. However, the second bulging portion 55 may be divided into portions that block the gap Sa and the gap Sb separately.

[0048] In the above description, an explanation is give of a case where each ventilation direction is along the cross-sectional longitudinal direction of the flat tubes 40 (a direction from left to right in FIG. 3). However, the ventilation directions vary in accordance with the type of the indoor unit 3, depending on the positional relationship of the heat exchanger 31, the indoor fan 32, and so forth. In this embodiment, the ventilation directions are set in accordance with the type of indoor unit 3 as follows. That is, each drag line is defined by a virtual line AF that extends from a start point AU at a point on a fin 50 where condensed water is accumulated, on the windward side in a ventilation flue 35, to an end point AD at a point where the static pressure of air in the ventilation flue is lowest, on the leeward side in the ventilation flue 35. Specifically, as illustrated in FIG. 5, when the air flows are generated by a type in which the heat exchanger 31 is positioned on the windward side and the indoor fan 32 is positioned on the leeward side in the ventilation flue 35, i.e., the "suction type", the ventilation directions are set by virtual lines AF, each of which extends from a start point AU at a location where condensed water is accumulated, on the windward side, to an end point AD at a site where the static pressure is lowest (the center of the indoor fan 32), on the leeward side. In other words, the air that has passed through the heat exchanger 31 flows toward the site where the static pressure is lowest. Therefore, the direction of the drag received by the condensed water accumulated at the start point AU becomes the direction of each virtual line AF.

[0049] Further, as illustrated in FIG. 6, when the air flows are generated by a type in which the indoor fan 32 is positioned on the windward side and the heat exchanger 31 is positioned on the leeward side in the ventilation flue 35, i.e., the "blowout type", the ventilation directions are set by virtual lines AF, each of which extends from a start point AU at a location where condensed water is accumulated, on the windward side, to an end point AD at a site where the static pressure is lowest (the center of the minimum cross-sectional area portion in the ventilation flue 35 on the leeward side of the heat exchanger 31), on the leeward side.

[0050] In each case, the start point AU, which is a location where condensed water is accumulated, is at the connection region side end of a flat tube 40 or the second lower end Z2 of a first bulging portion 54. Each virtual line AF passes through at least one of the corresponding first bulging portion 54 and the second bulging portion 55, depending on the positional relationship, such as the inclination of the heat exchanger 31. The setting of virtual lines AF in accordance with various types of the indoor unit 3 (duct type, wall-mounted type, floor-standing type, vertical duct type, window type, ceiling suspension type, ceiling-embedded type, etc.) will be described later.

[0051] Here, as illustrated in FIG. 7, in order to smoothly drain condensed water accumulated around the first flat tube 40a, each first bulging portion is preferably formed in a position where the distance d1 between the first upper end X1 of the first bulging portion 54 and the lower side of the first notch portion 51a (corresponding to the lower side of the first flat tube 40a in FIG. 7) falls within a range of 4 mm or less. The reason for setting the distance d1 to fall within a range of 4 mm or less is based on the verification result explained below. Here, in FIG. 7, the second bulging portion 55 is omitted.

[0052] FIGS. 19 are tables that compare the size d2 of condensed water (droplet) accumulated around the first flat tube 40a in association with different contact angles θ. FIG. 19A indicates the average value of measurement results on the size d2 of each droplet obtained by an individual fin pitch (1.0 mm, 1.5 mm, or 2.0 mm) when the contact angle θ = 10°. FIG. 19B indicates the average value of measurement results on the size d2 of each droplet obtained by an individual fin pitch (1.0 mm, 1.5 mm, or 2.0 mm) when the contact angle θ = 60°.

[0053] The size d2 of each droplet was measured for condensed water accumulated between the first fin 50a and the second fin 50b adjacent to each other as illustrated in FIG. 7, under the test conditions as follows: The fin pitch Pv of the fins 50 was set to each of the three types of 1.0 mm, 1.5 mm, and 2.0 mm, and (1) the contact angle θ was set to 10 degrees by a state where the hydrophilic processing on the surface of the fins 50 was sufficiently functioning, or (2) the contact angle θ was set to 60 degrees by a state where the hydrophilic processing on the surface of the fins 50 was not functioning due to deterioration and/or contamination. Here, the contact angle θ was adjusted by mixing a surfactant in the water forming the droplet. Specifically, the contact angle θ of the droplet was reduced by increasing the amount of surfactant. In this test, the fins were made of acrylic material.

[0054] As illustrated in FIG. 19A, when the size d2 of each droplet was measured under the conditions with the contact angle θ = 10° and the fin pitch Pv = 1.0 mm, the average value resulted in 3.0. Further, as illustrated in FIG. 19A, when the size d2 of each droplet was measured under the conditions with the contact angle θ = 10° and the fin pitch Pv = 1.5 mm, the average value resulted in 3.3. Further, as illustrated in FIG. 19A, when the size d2 of each droplet was measured under the conditions with the contact angle θ = 10° and the fin pitch Pv = 2.0 mm, the average value resulted in 3.1.

[0055] Further, as illustrated in FIG. 19B, when the size d2 of each droplet was measured under the conditions with the contact angle θ = 60° and the fin pitch Pv = 1.0 mm, the average value resulted in 11.0. Further, as illustrated in FIG. 19B, when the size d2 of each droplet was measured under the conditions with the contact angle θ = 60° and the fin pitch Pv = 1.5 mm, the average value resulted in 11.2. Further, as illustrated in FIG. 19B, when the size d2 of each droplet was measured under the conditions with the contact angle θ = 60° and the fin pitch Pv = 2.0 mm, the average value resulted in 11.3.

[0056] Since the size d2 of each droplet becomes smaller as the contact angle θ is smaller, as indicated by the measurement results described above, it is preferable to set smaller the distance d1 between the first upper end X1 of each first bulging portion 54 and the lower side of the first notch portion 51a. In general, the fins 50 have been subjected to a hydrophilic treatment on the surface, and the contact angle θ of the droplet accumulated on the surface of the fins subjected to the hydrophilic treatment is set to 20° or less. Since the effect of the hydrophilic treatment on the fins 50 is gradually reduced by contamination and/or degradation, the distance d1 between the first upper end X1 of the first bulging portion 54 and the lower side of the first notch portion 51a is preferably set to deal with the size d2 of each droplet in the case of the contact angle θ = 20° of a new product state.

[0057] In light of the above, on the basis of the measurement results described above, an approximate formula for the size d2 of each droplet according to the contact angle θ was created, and the size d2 of each droplet at the contact angle θ = 20° was calculated. As a result, it has been found that, when the distance d1 is set to 4 mm or less, the first upper end X1 of the first bulging portion 54 comes into contact with the lower end of the droplet even with the contact angle θ = 20°.

[0058] Therefore, the distance d1, illustrated in FIG. 8B, between the first upper end X1 of the first bulging portion 54 and the lower side of the first notch portion 51a (which corresponds to the lower side of the first flat tube 40a in FIG. 8B) may be set to 4 mm or less. In this case, even with a contact angle of 20 degrees (a state where the hydrophilic treatment on the surface of the fins 50 is sufficiently functioning) by which the size d2 of each droplet of condensed water is small, the distance d1 can be smaller than the minimum value 4.6 mm of the size d2 of each droplet (the fin pitch Pv is 1.0 mm), and thus the droplet can reach the first upper end X1 of the first bulging portion 54. Here, in FIG. 8B, the second bulging portion 55 is omitted.

[0059] After the droplet of condensed water reaches the first upper end X1 of the first bulging portion 54 in this way, the droplet wet-spreads on the upper end edge X1-X2 by the influence of surface tension, and further travels through the first upper end X1 and the second upper end X2 to the intermediate region side edge X1-Z1 and the connection region side edge X2-Z2. Since the droplet receives the influence of gravity in addition to the influence of surface tension, on the intermediate region side edge X1-Z1 and the connection region side edge X2-Z2, the droplets can be easily discharged by the first bulging portion 54 thus provided.

[0060] Further, as illustrated in FIG. 9, each first bulging portion 54 and the second bulging portion 55 are preferably formed such that the distance d3 between the connection region side end of each notch portion 51 and the second bulging portion 55 is equal to or larger than the distance d4 between the first bulging portion 54 and the second bulging portion 55. Further, the first bulging portion 54 and the second bulging portion 55 are not integrated with each other (i.e., d4 ≠ 0). The reason why the distance d3 may be set longer than the distance d4 resides in that the dead water zone behind the flat tubes 40 has a slower wind speed, and thus is less susceptible to the influence of the air flows, as compared with the wind speed on the leeward side of the first bulging portion 54, so that the droplet of condensed water is less caused to flow.

[0061] Since each first bulging portion 54 is arranged straddling the boundary between the corresponding intermediate region 52 and the connection region 53 of the individual fin 50 (see FIG. 9), the first bulging portion 54 also contributes to suppression of the warping or bending of the fin 50 during the assembly process or the like.

<Ventilation Direction>

[0062] Next, with reference to FIGS. 10 to 18, explanations will be given of the ventilation directions according to the type of the indoor unit 3 mentioned above. Each of FIGS. 10 to 14 illustrates a case where the air flows are generated by a type in which a heat exchanger 31 is positioned on the windward side and an indoor fan 32 is positioned on the leeward side in the ventilation flue 35, i.e., the "suction type". Each of FIGS. 15 to 18 illustrates a case where the air flows are generated by a type in which an indoor fan 32 is positioned on the windward side and a heat exchanger 31 is positioned on the leeward side in the ventilation flue 35, i.e., the "blowout type". Here, in FIGS. 10 to 18, the illustration omits the first bulging portions 54 and the second bulging portion 55.

<<Suction Type>>

[0063] FIG. 10 illustrates a duct type indoor unit 3, FIG. 11 illustrates a wall-mounted type indoor unit 3, FIG. 12 illustrates a floor-standing type indoor unit 3, FIG. 13 illustrates a vertical duct type indoor unit 3, and FIG. 14 illustrates a window type indoor unit 3 (which is integrated with the outdoor unit 2). In the case of the indoor unit 3 according to each of these suction types, as illustrated in FIGS. 10 to 14, the ventilation directions are set by virtual lines AF, each of which extends from a start point AU at the connection region side end of a flat tube 40, as a location where condensed water is accumulated, to an end point AD at the center of the indoor fan 32, as a site where the static pressure is lowest. Each virtual line AF is set to extend across the second bulging portion 55 provided on the connection region 53.

[0064] Here, examples are illustrated that use, as the indoor fan 32, a sirocco fan in the case of the duct type (FIG. 10), the vertical duct type (FIG. 13), and the window type (FIG. 14), and a cross-flow fan in the case of the wall-mounted type (FIG. 11) and the floor-standing type (FIG. 12).

[0065] Of these examples, for the indoor unit 3 in which the heat exchanger 31 is composed of a plurality of heat exchanging units, as in the wall-mounted type (FIG. 11) and the vertical duct type (FIG. 13), the ventilation directions in the ventilation flue 35 are set by virtual lines AF, each of which extends from a start point AU at the connection region side end of an individual heat exchanging unit, to an end point AD at the center of the single indoor fan 32. On the other hand, for the indoor unit 3, in which a plurality of indoor fans 32 are provided, as in the floor-standing type (FIG. 12), the ventilation directions are set by virtual lines AF, each of which extends from a start point AU at the connection region side end of the single heat exchanger 31, to an end point AD at the center of one of the two indoor fans 32.

<<Blowout Type>>

[0066] FIG. 15 illustrates a duct type indoor unit 3, FIG. 16 illustrates a ceiling suspension type indoor unit 3, FIG. 17 illustrates a ceiling-embedded type indoor unit 3, and

FIG. 18 illustrates a wall-mounted type indoor unit 3. In the case of the indoor unit 3 according to each of these blowout types, as illustrated in FIGS. 15 to 18, the ventilation directions in the ventilation flue 35 are defined by directions (virtual lines AF), each of which extends from a start point AU at the connection region side end of a flat tube 40, as a location where condensed water is accumulated, to an end point AD where the static pressure is lowest, on the leeward side of the heat exchanger 31. The air that has passed through the heat exchanger 31 flows toward the site (the end point AD) where the static pressure is lowest. Therefore, the direction of the drag received by the condensed water accumulated at the start point AU becomes the direction of each virtual line AF. Each virtual line AF is set to extend across the second bulging portion 55 provided on the connection region 53.

[0067] Here, examples are illustrated that use, as the indoor fan 32, a sirocco fan in the case of the duct type (FIG. 15), the ceiling suspension type (FIG. 16), and the ceiling-embedded type (FIG. 17), and a propeller fan in the case of the wall-mounted type (FIG. 12).

[0068] Of these examples, for the indoor unit 3 in which the minimum cross-sectional area portion on the leeward side of the heat exchanger 31 serves as a blowout port from the heat exchanger 31, as in the duct type (FIG. 15) and the ceiling suspension type (FIG. 16), the ventilation directions in the ventilation flue 35 are set by virtual lines AF, each of which extends from a start point AU at the connection region side end of the heat exchanger 31, to an end point AD at the center of the blowout port. On the other hand, for the indoor unit 3, in which the minimum cross-sectional area portion in the ventilation flue 35 does not serve as a blowout port from the heat exchanger 31, as in the ceiling-embedded type (FIG. 17) and the wall-mounted type (FIG. 18), the ventilation directions are set by virtual lines AF, each of which extends from a start point AU at the connection region side end of the heat exchanger 31, to an end point AD at the center of the minimum cross-sectional area portion that depends on the structure of an individual ventilation flue 35. In the indoor unit 3 illustrated in each of the FIGS. 17 and 18, the heat exchanger 31 is composed of a plurality of heat exchanging units, and a plurality of end points AD are provided in accordance with the air flows passing through the respective heat exchanging units.

<Effect of Embodiment>

[0069] The heat exchanger 31 according to this embodiment can suppress the dew splash of condensed water accumulated on the surface of the fins 50 or flat tubes 40. Specifically, the first bulging portion 54 is provided on each of the intermediate regions 52 of the fins 50 positioned below the flat tubes 40, and condensed water around the flat tubes 40 is thereby drained. In addition, each resultant droplet is made smaller, and the second bulging portion 55 is further provided on the connection region 53 of the fins 50, so that the flow velocity of the air flows becomes lower, and the drag applied to condensed water in each ventilation direction (the force received from each air flow in the ventilation direction) decreases. As a result, it is possible to suppress dew splash in which condensed water is scattered from the heat exchanger 31 toward the leeward side. Further, the ventilation directions in the ventilation flue 35 are set by virtual lines AF, each of which extends from a start point AU at the connection region side end of a flat tube 40, as a location where condensed water is accumulated, to an end point AD at the center of the minimum cross-sectional area portion on the leeward side of the heat exchanger 31, as a site where the static pressure is lowest. As a result, it is possible to set the positions of each first bulging portion 54 and the second bulging portion 55, in accordance with the direction of the drag applied to condensed water inside the ventilation flue 35.

Reference Signs List

[0070]

1	air conditioner
2	outdoor unit
3	indoor unit
4	liquid pipe
5	gas pipe
10	refrigerant circuit
10a	outdoor unit refrigerant circuit
10b	indoor unit refrigerant circuit
12	header
21	compressor
22	four-way valve
23	outdoor heat exchanger
24	expansion valve
25	liquid side closing valve
26	gas side closing valve
27	outdoor fan
31	indoor heat exchanger
32	indoor fan
33	liquid pipe connector
34	gas pipe connector
35	ventilation flue
40	flat tube
50	fin
51	notch portion
52	intermediate region
53	connection region
54	first bulging portion
55	second bulging portion
61	discharge pipe
62	refrigerant pipe
63	outdoor unit liquid pipe
64	outdoor unit gas pipe
66	suction pipe
67	indoor unit liquid pipe
68	indoor unit gas pipe
71	discharge pressure sensor

72 suction pressure sensor
73 discharge temperature sensor
74 suction temperature sensor
75 heat exchange temperature sensor
76 outside air temperature sensor
77 liquid-side temperature sensor
78 gas-side temperature sensor
79 room temperature sensor
200 outdoor unit control means
210 CPU
220 storage part
230 communication part
240 sensor input part
300 indoor unit control means
310 CPU
320 storage part
330 communication part
340 sensor input part

Claims

1. An air conditioner comprising

a heat exchanger that is arranged in a ventilation flue inside a housing, and
a blower that is arranged in the ventilation flue,
wherein the heat exchanger includes

a plurality of flat tubes, and
a fin that includes a plurality of notch portions arranged side by side in a vertical direction, to which the plurality of flat tubes are inserted, and includes intermediate regions each formed between two of the notch portions adjacent to each other in a vertical direction, and a connection region connecting the intermediate regions to each other,

the heat exchanger is arranged in a state where the intermediate regions are present on a windward side in a ventilation direction of air flowing in the ventilation flue, with respect to the connection region,
the heat exchanger includes

first bulging portions that are at least partly positioned on the intermediate regions, and
a second bulging portion that overlaps with a gap generated between the first bulging portions and the flat tubes when the heat exchanger is viewed from the windward side in a direction of a drag line, and

the drag line is defined by a virtual line that extends from a start point at a point where condensed water is accumulated on the fin, on the windward side, to an end point at a point where a static pressure in the ventilation flue is lowest, on a leeward side.

2. The air conditioner according to claim 1, wherein

the blower is provided on a downstream side in the ventilation direction from the heat exchanger in the ventilation flue, and
the end point is at a center of the blower.

3. The air conditioner according to claim 1, wherein

the blower is provided on an upstream side in the ventilation direction from the heat exchanger in the ventilation flue, and
the end point is at a center of a position where a flow passage cross-sectional area is minimum in the ventilation flue.

4. The air conditioner according to claim 1, wherein each of the first bulging portions is formed with an upper end edge positioned to fall within a range of 4 mm or less from a lower side of a first notch portion on an upper side.

5. The air conditioner according to claim 1, wherein the first bulging portions and the second bulging portion are formed such that a distance between the notch portions and the second bulging portion is equal to or larger than a distance between the first bulging portions and the second bulging portion.

FIG.1A

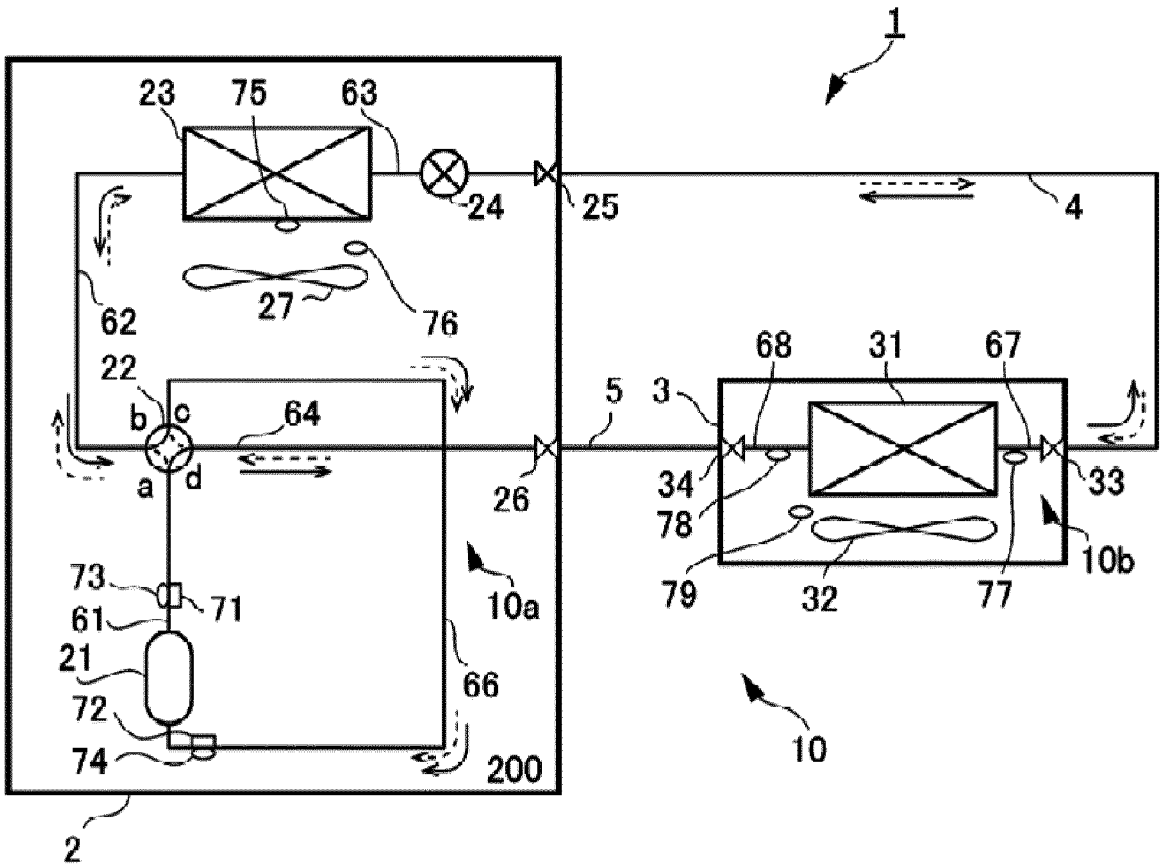

1
23
75
63
24
25
4
62
27
76
68
31
67
22
b
c
64
5
3
a
d
26
34
78
33
10b
79
32
77
73
71
61
10a
21
66
72
10
74
200
2

FIG.1B

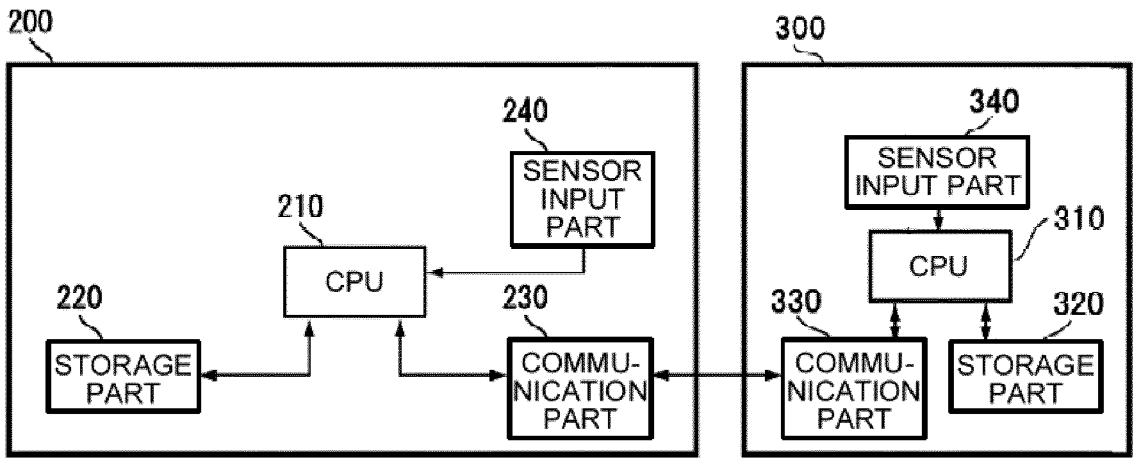

200
300
240
SENSOR INPUT PART
340
SENSOR INPUT PART
210
310
CPU
CPU
220
230
330
320
STORAGE PART
COMMU-NICATION PART
COMMU-NICATION PART
STORAGE PART

FIG.2A

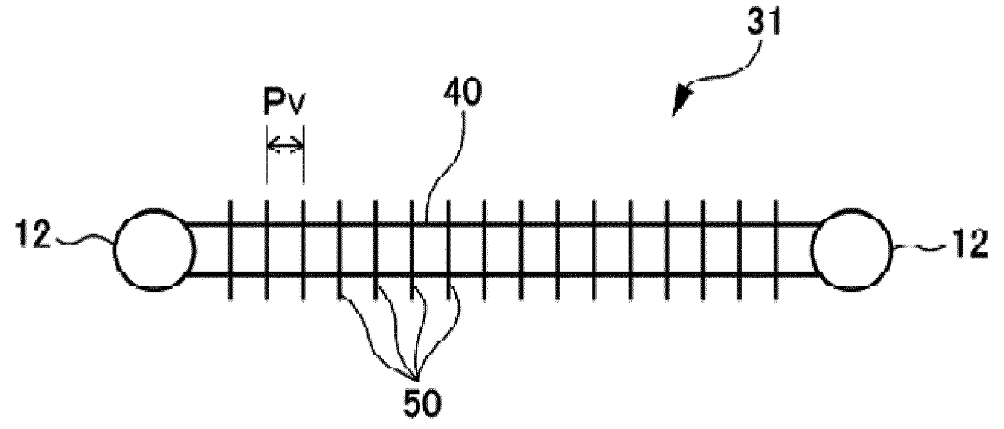


FIG.2B

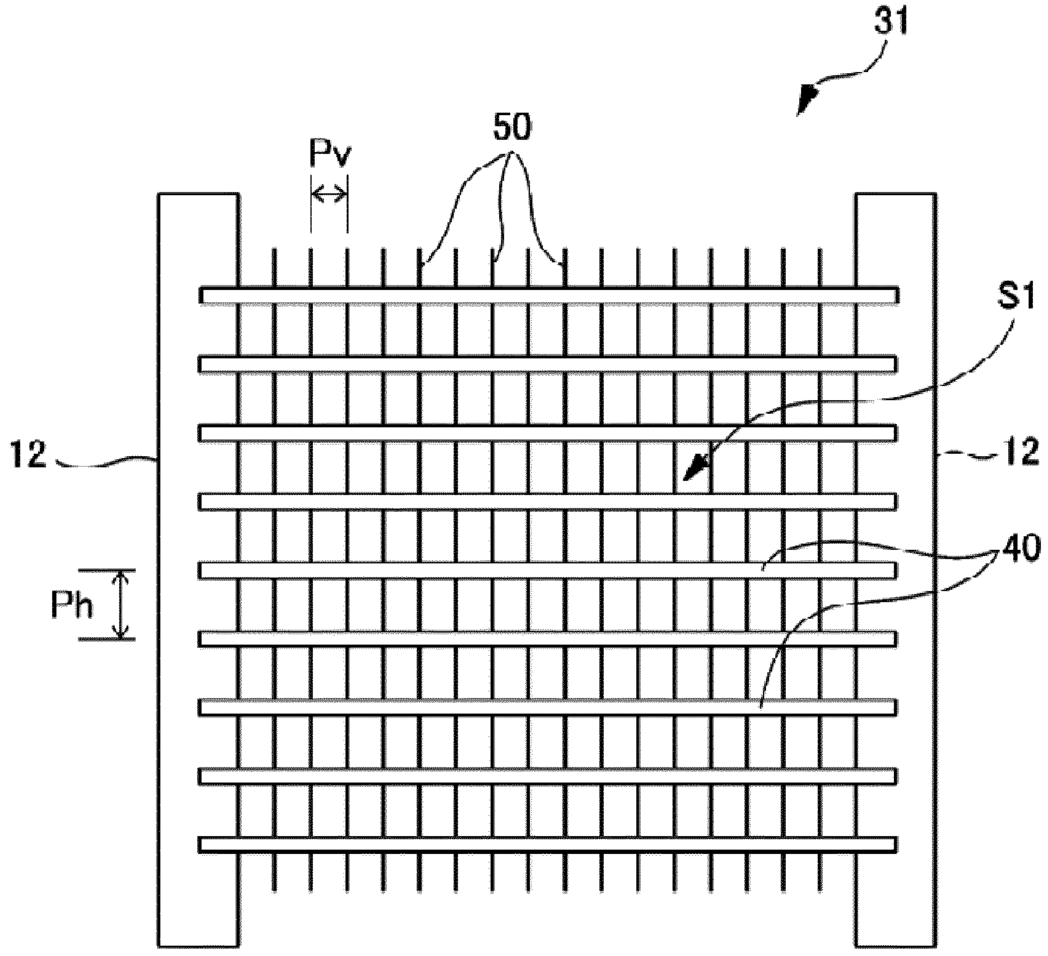


FIG.3

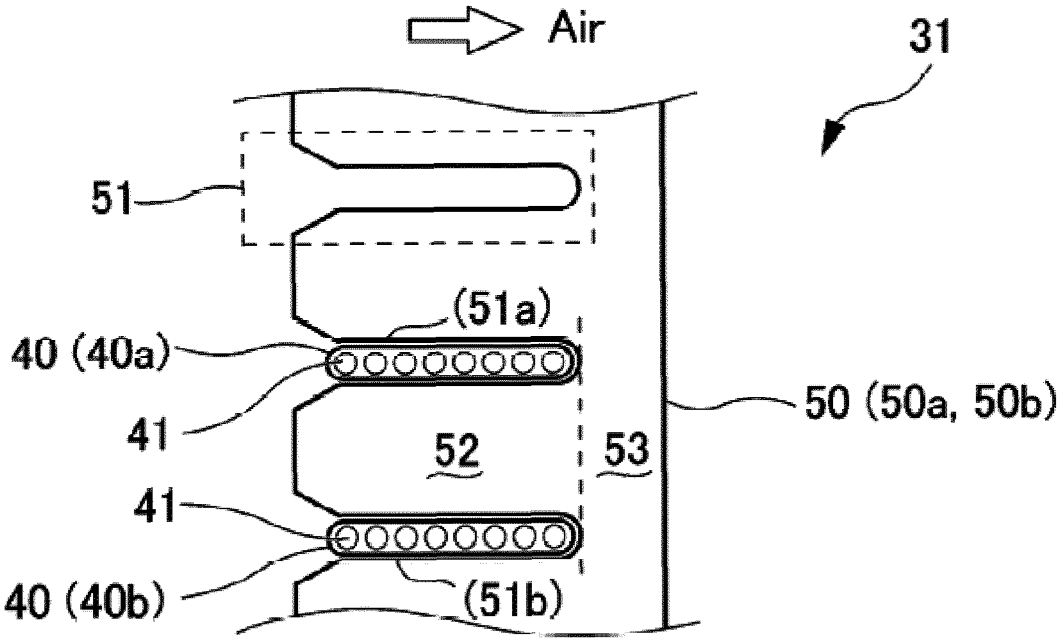

Air
31
51
(51a)
40 (40a)
41
52
53
50 (50a, 50b)
41
40 (40b)
(51b)

FIG.4

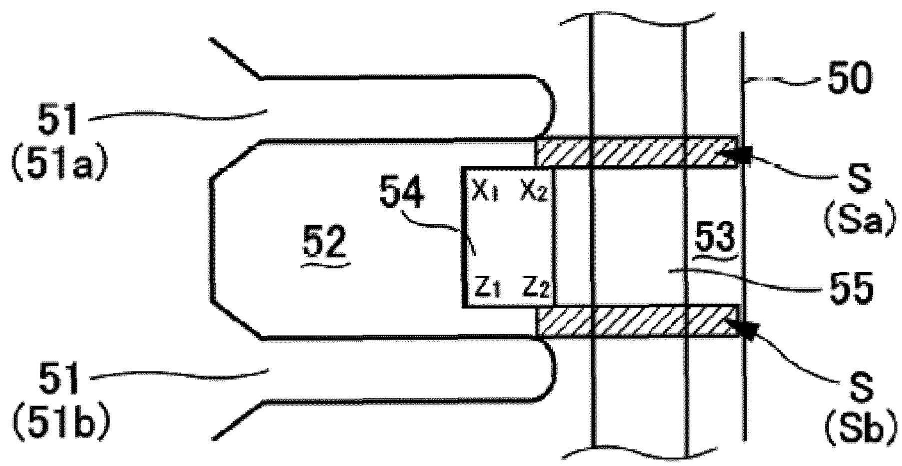

50
51
(51a)
54
X1
X2
52
53
S
(Sa)
Z1
Z2
55
51
(51b)
S
(Sb)

FIG.5

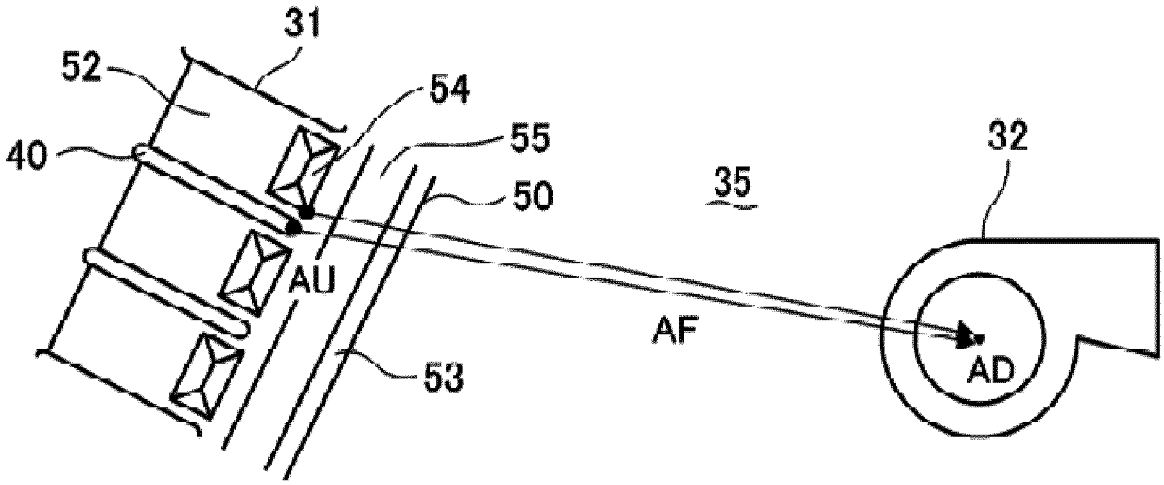


FIG.6

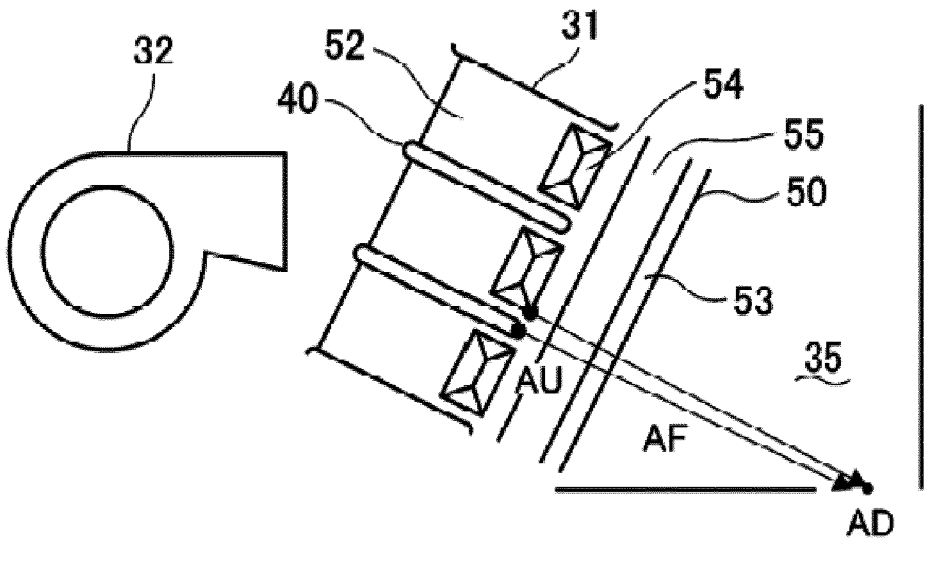


FIG.7

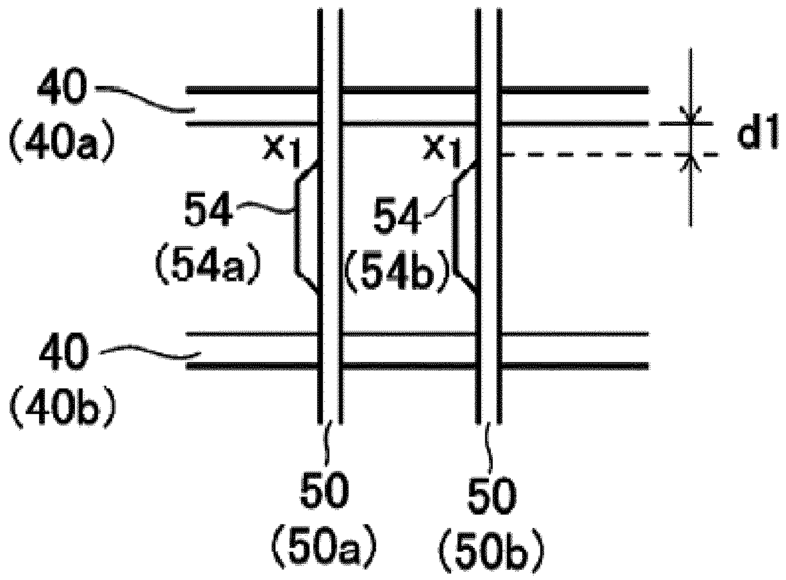


FIG.8A

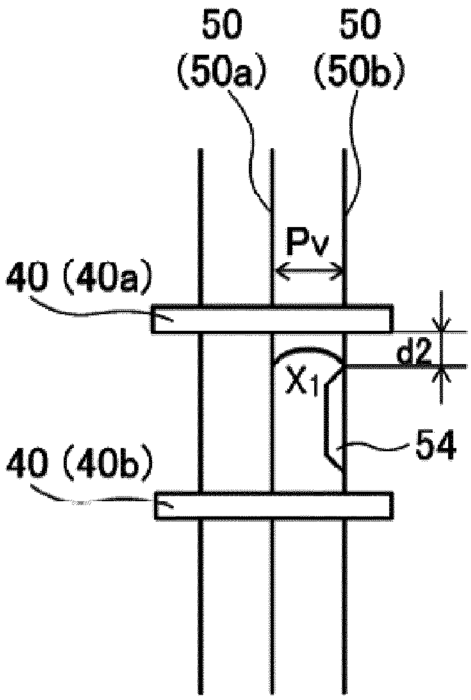

50
(50a)
50
(50b)
Pv
40 (40a)
d2
X1
54
40 (40b)

FIG.8B

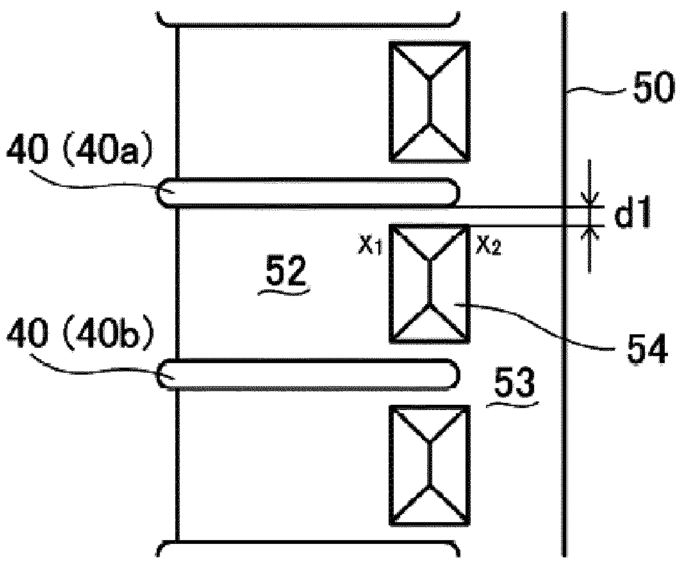
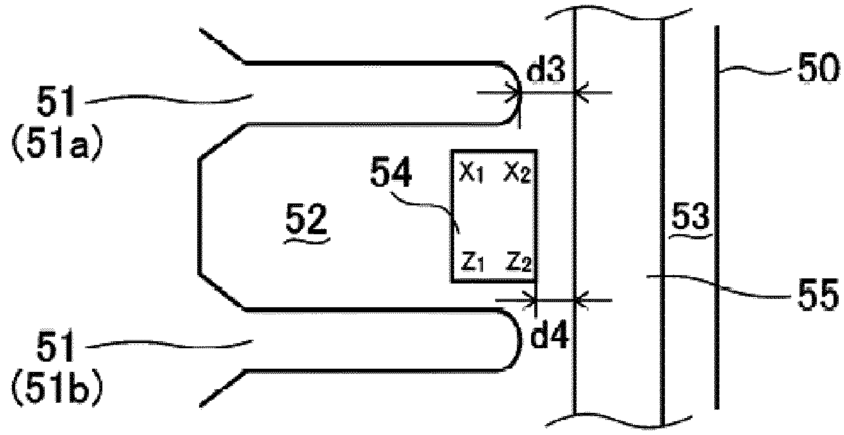
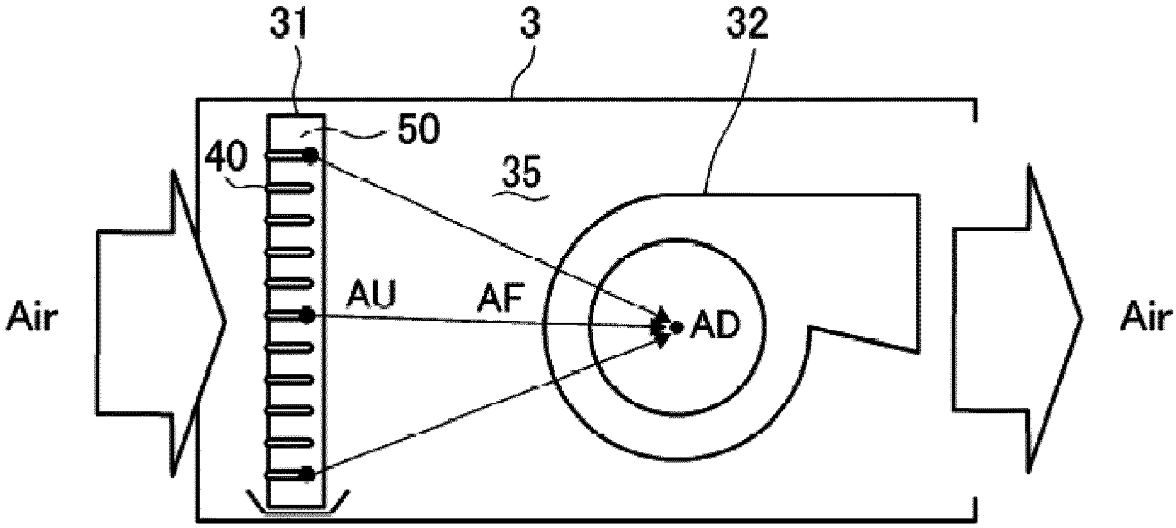

50
40 (40a)
d1
X1
X2
52
54
40 (40b)
53

FIG.9



d3
50
51
(51a)
54
X1 X2
52
53
Z1 Z2
55
51
d4
(51b)

FIG.10



31
3
32
50
40
35
Air
AU
AF
AD
Air

FIG.11

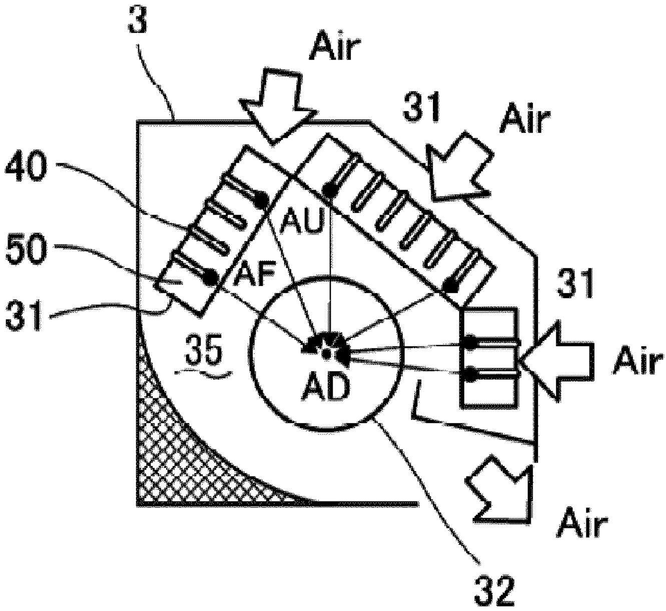

3
Air
31
Air
40
AU
50
AF
31
31
Air
35
AD
Air
32

FIG.12

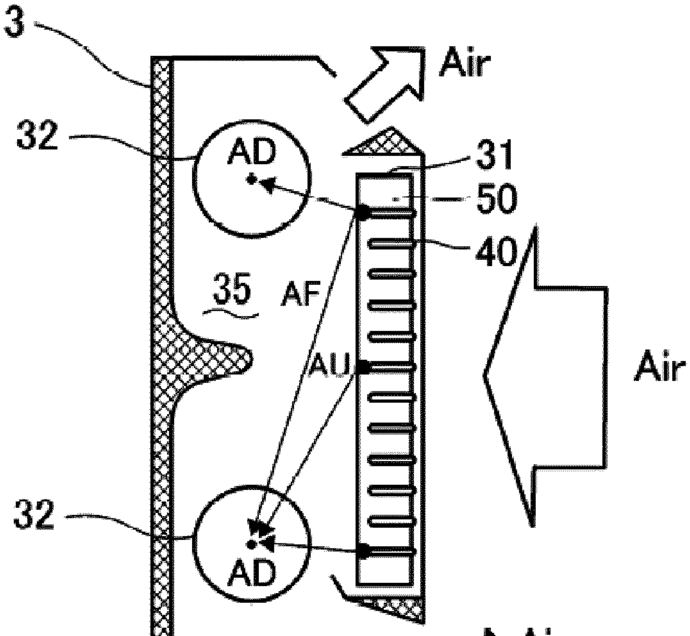

3
Air
32
AD
31
50
40
35
AF
AU
Air
32
AD
Air

FIG.13

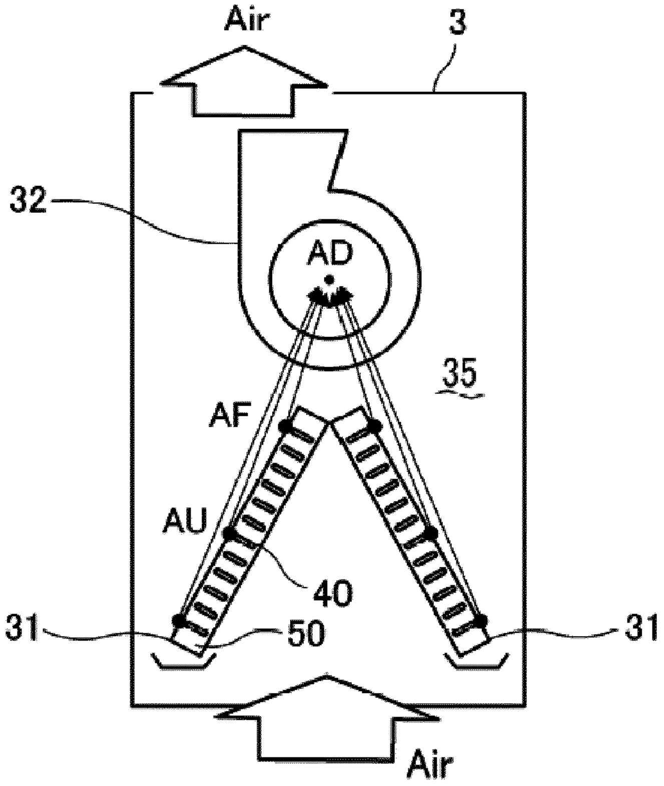


FIG.14

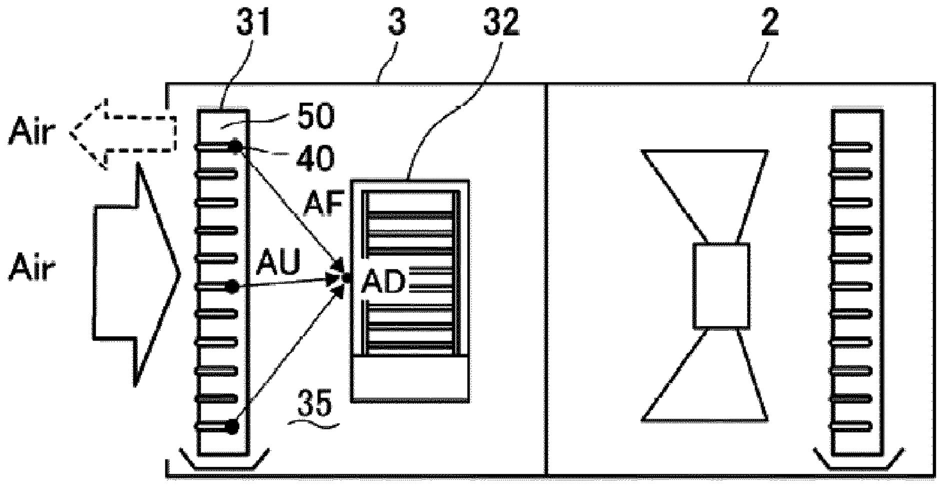


FIG.15

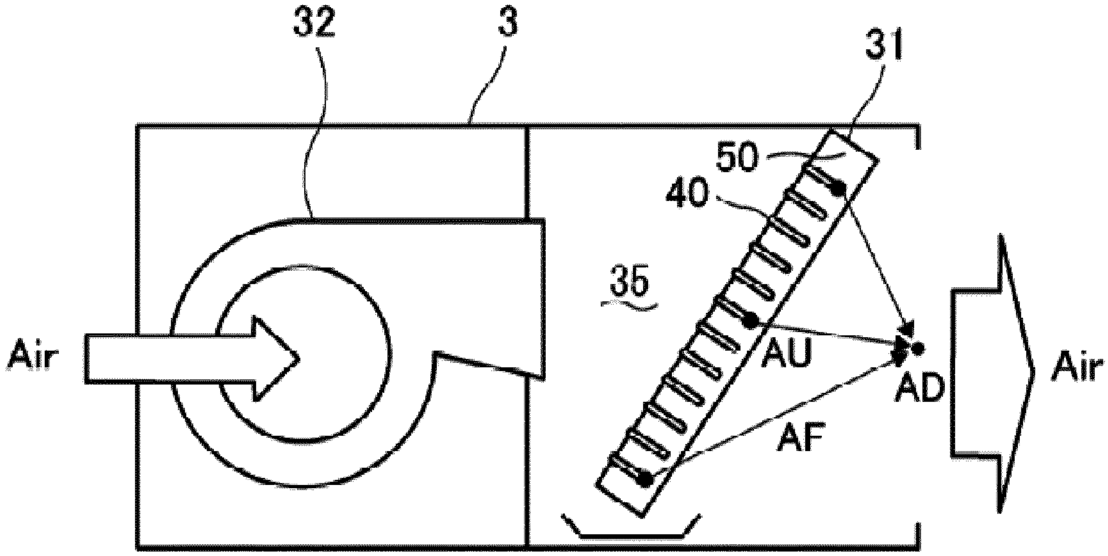


FIG.16

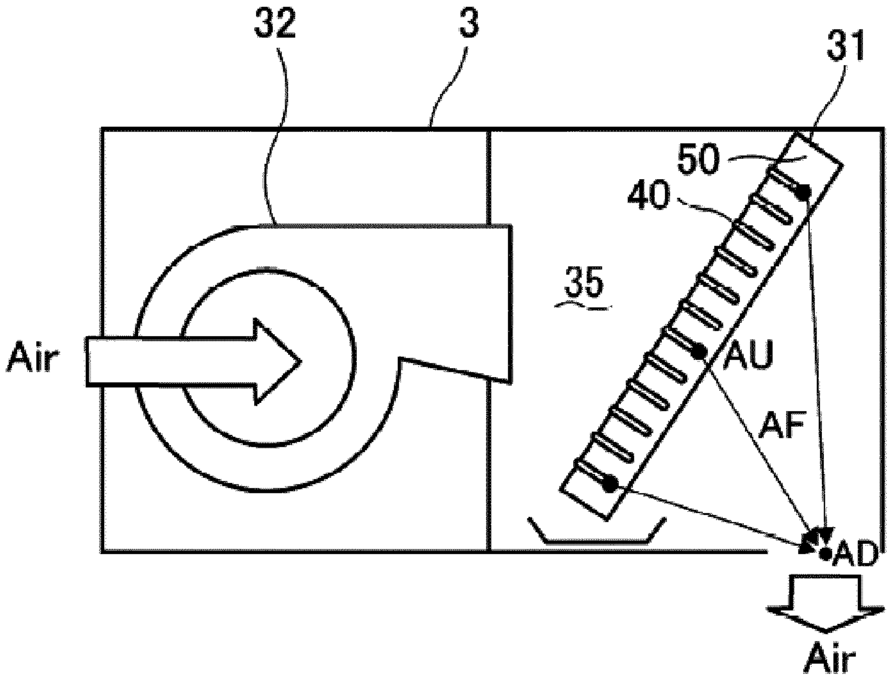


FIG.17

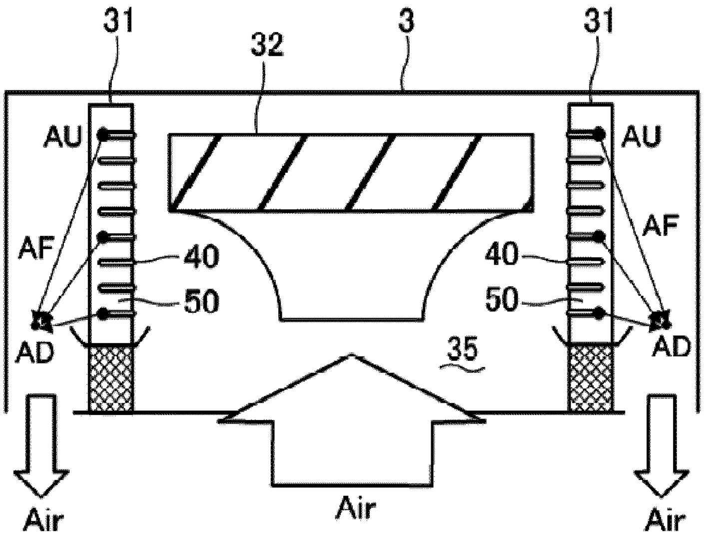

31
32
3
31
AU
AU
AF
AF
40
40
50
50
AD
AD
35
Air
Air
Air

FIG.18

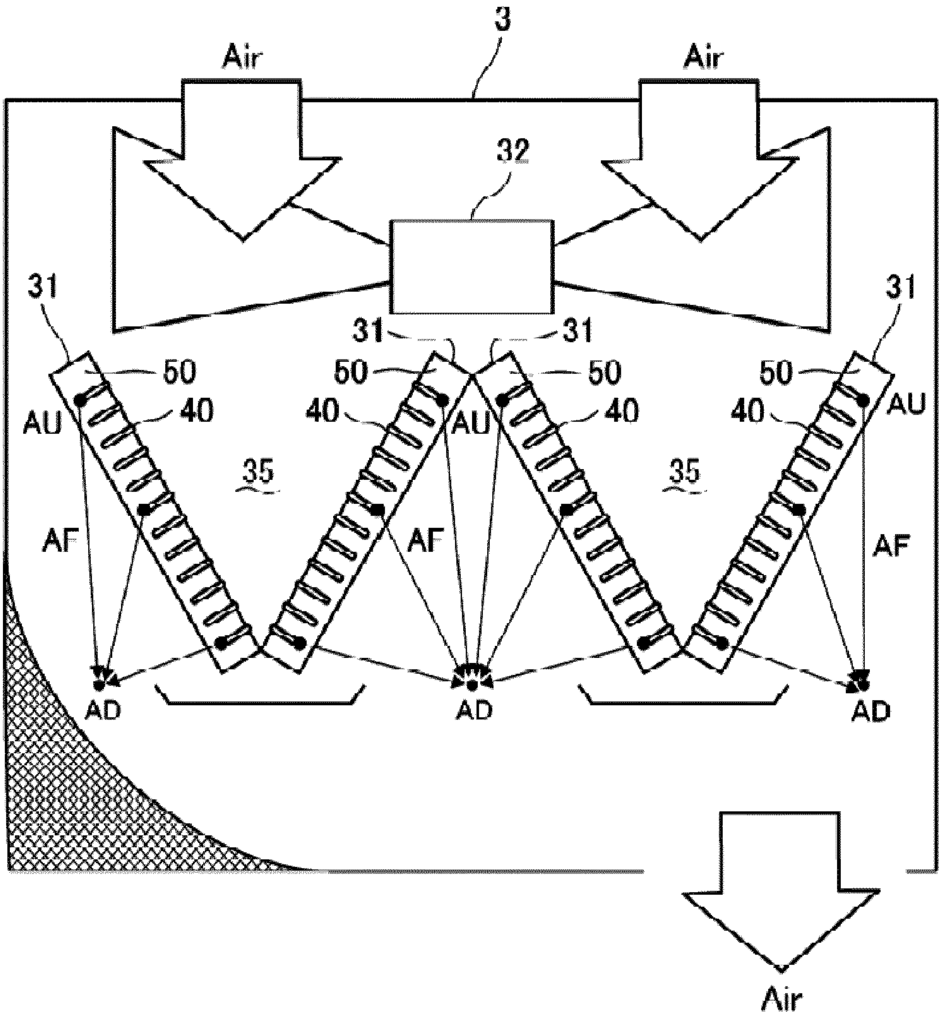

3
Air
Air
32
31
31
31
31
50
50
50
50
AU
AU
AU
40
40
40
40
35
35
AF
AF
AF
AD
AD
AD
Air

FIG.19A

CONTACT ANGLE θ	[°]	10		
FIN PITCH Pv	[mm]	1.0	1.5	2.0
DROPLET SIZE d2	[mm]	3.0	3.3	3.0

FIG.19B

CONTACT ANGLE θ	[°]	60		
FIN PITCH Pv	[mm]	1.0	1.5	2.0
DROPLET SIZE d2	[mm]	11.0	11.0	11.3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/003638

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F28D1/053(2006.01)i, F28F1/02(2006.01)i, F28F1/32(2006.01)i, F24F1/0067(2019.01)i
FI: F24F1/0067, F28D1/053A, F28F1/02B, F28F1/32A, F28F1/32L, F28F1/32Y
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)
Int.Cl. F28D1/053, F28F1/02, F28F1/32, F24F1/0067

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2020
Registered utility model specifications of Japan	1996-2020
Published registered utility model applications of Japan	1994-2020

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 Y	WO 2017/208493 A1 (HITACHI-JOHNSON CONTROLS AIR CONDITIONING INC.) 07.12.2017 (2017-12-07), paragraphs [0022]-[0090], fig. 1-3, 7, 8	1-2, 4 3, 5
X Y	JP 2015-31490 A (DAIKIN INDUSTRIES, LTD.) 16.02.2015 (2015-02-16), paragraphs [0027], [0028], [0055]-[0083], fig. 5	1, 5 5
Y	JP 2001-227771 A (FUJITSU GENERAL LIMITED) 24.08.2001 (2001-08-24), paragraph [0002], fig. 4	3
A	JP 2012-154491 A (DAIKIN INDUSTRIES, LTD.) 16.08.2012 (2012-08-16), entire text, all drawings	1-5
A	WO 2018/003123 A1 (MITSUBISHI ELECTRIC CORPORATION) 04.01.2018 (2018-01-04), entire text, all drawings	1-5

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25.02.2020	10.03.2020

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/003638

WO 2017/208493 A1	07.12.2017	(Family: none)
JP 2015-31490 A	16.02.2015	(Family: none)
JP 2001-227771 A	24.08.2001	(Family: none)
JP 2012-154491 A	16.08.2012	(Family: none)
WO 2018/003123 A1	04.01.2018	(Family: none)

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2017194264 A **[0005]**