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

(11) EP 2 792 964 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
22.10.2014 Bulletin 2014/43

(51) Int Cl.:
F24F 13/22 *(2006.01)* ***F24F 1/00*** *(2011.01)*
F24F 13/30 *(2006.01)*

(21) Application number: **14164541.6**

(22) Date of filing: **14.04.2014**

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

(30) Priority: **19.04.2013 KR 20130043404**
02.07.2013 KR 20130077000

(71) Applicant: **LG Electronics, Inc.**
Seoul 150-721 (KR)

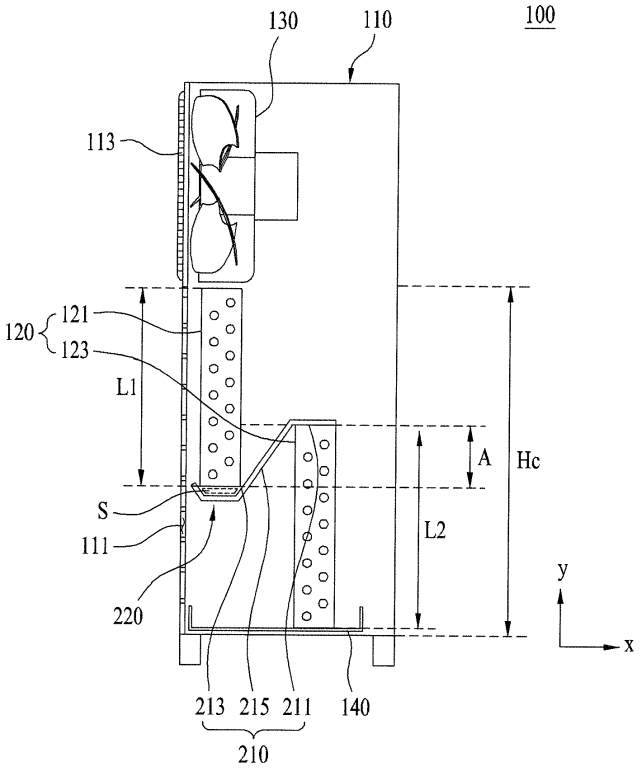
(72) Inventors:
- **Cho, Eunjun**
  153-802 Seoul (KR)
- **Park, Kiwoong**
  153-802 Seoul (KR)
- **Seo, Beomsoo**
  153-802 Seoul (KR)

(74) Representative: **Vossius & Partner**
Siebertstrasse 4
81675 München (DE)

(54) Air conditioner

(57) An air conditioner includes a case having an inlet and an outlet; a first heat exchanger arranged in the case; a second heat exchanger being spaced apart from the first heat exchanger; a guide member to block a space between adjacent edges of the first heat exchanger and the second heat exchanger, and a water collecting member provided at the guide member to collect condensed water from the first heat exchanger.

FIG. 1



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Description

[0001] The present disclosure relates to an air conditioner which can improve a heat exchange performance.

[0002] In general, the air conditioner is a machine for heating/cooling a room or cleaning room air for providing a more comfortable environment to a user.

[0003] In the air conditioners, there are a split type air conditioner which has an indoor unit and an outdoor unit split from each other, and a unitary air conditioner which has the indoor unit and the outdoor unit produced as one unit.

[0004] In this case, the split type air conditioner is provided with the indoor unit having an indoor heat exchanger mounted thereto for cooling or heating the room, and the outdoor unit having a compressor mounted thereto for compressing refrigerant to a high temperature and high pressure and discharging the same.

[0005] And, the indoor unit and the outdoor unit are respectively installed in a room and on an outside of the room split from each other, and connected with a refrigerant pipeline.

[0006] In the meantime, the air conditioner has a total heat exchange area of the heat exchangers in a case fixed according to a standard of a product case size. In this case, a problem takes place, in which the smaller the heat exchange area of the heat exchanger compared to a flow rate of the air introduced thereto, the smaller the flow rate becomes due to a pressure loss.

[0007] In order to solve the problem, a plurality of heat exchangers may be installed for increasing the heat exchange area within a limited case space. And, the plurality of heat exchangers may be installed in a width direction (An x-axis direction in FIG. 1), or in a height direction (A y-axis direction in FIG. 1) of the case in succession.

[0008] However, the system in which the plurality of heat exchangers are installed in the width direction of the case in succession is liable to cause the pressure loss of the air as the air introduced thereto passes the plurality of the heat exchangers in succession.

[0009] Therefore, if the plurality of heat exchangers are installed in the case of a predetermined product standard size, a new arrangement design is required, which can reduce the pressure loss for increasing the flow rate of the air to be heat exchanged.

[0010] In the meantime, if the heat exchanger is operated as an evaporator, condensed water formed on a surface of the heat exchanger flows down from the heat exchanger by gravity. According to this, problems take place in that, as the flow of the condensed water becomes greater as the condensed water flows down to a lower side of the heat exchanger, the heat exchange performance of the heat exchanger becomes poorer and the flow rate of the air becomes lower.

[0011] To solve the problems, one object is to provide an air conditioner which can reduce a pressure loss of the air as well as increase a heat exchange area.

[0012] Another object is to provide an air conditioner which can prevent air from flowing between edges of adjacent heat exchangers, if a plurality of the heat exchangers are mounted.

[0013] Another object is to provide an air conditioner which can reduce a pressure loss of the air being introduced to each heat exchanger, if a plurality of the heat exchangers are mounted.

[0014] Another object is to provide an air conditioner which can prevent a heat exchange performance from becoming poor due to condensed water.

[0015] Additional advantages, objects, and features of the disclosure will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0016] To achieve these objects and other advantages, as embodied and broadly described herein, an air conditioner includes a case having an inlet and an outlet; a first heat exchanger arranged in the case; a second heat exchanger being spaced apart from the first heat exchanger; a guide member to block a space between adjacent edges of the first heat exchanger and the second heat exchanger, and a water collecting member provided at the guide member to collect condensed water from the first heat exchanger.

[0017] In another aspect, an air conditioner includes a case having an inlet and an outlet, an first heat exchanger arranged in the case, a second heat exchanger positioned below the first heat exchanger to have a region overlapped with the first heat exchanger, a guide member for blocking a space between adjacent edges of the first heat exchanger and the second heat exchanger, and a water collecting member provided at the guide member for collecting condensed water from the first heat exchanger.

[0018] The water collecting member may have a holding space for collecting the condensed water, and the first heat exchanger has a lower end portion positioned within the holding space.

[0019] The water collecting member may include a blocking portion extended from a bottom of the holding space toward the first heat exchanger.

[0020] The upper heat exchanger may have its underside arranged spaced a predetermined distance from an inside circumferential surface of the water collecting member.

[0021] The guide member may include a first coupling portion positioned on a top side of the second heat exchanger, a second coupling portion positioned on an underside of the first heat exchanger, and a baffle portion connected between the first and second coupling portions for blocking the space between adjacent edges of the first heat exchanger and the second heat exchanger.

[0022] The water collecting member may be provided at the second coupling portion.

[0023] The water collecting member may have one side connected to the second coupling portion, and the other side provided with a guide portion tiltedly extended upward.

[0024] The air conditioner may further include a side blocking member provided to both sides of the guide member for preventing air from flowing through a space between both sides of at least one of the first heat exchanger and the second heat exchanger and the case.

[0025] The guide member and the water collecting member may include heat insulating material provided thereto.

[0026] The water collecting member is stream lined.

[0027] The first heat exchanger and the second heat exchanger may be tilted by predetermined angles from the inlet, respectively.

[0028] The overlapped region of the first heat exchanger and the second heat exchanger may have a height determined with reference to any one of the first heat exchanger and the second heat exchanger having a higher flow rate loss.

[0029] The height of the overlapped region of the first heat exchanger and the second heat exchanger may be less than 60% of a height of the first heat exchanger.

[0030] The first heat exchanger may have a height smaller than a height of the second heat exchanger.

[0031] The air conditioner may further include a drain pan positioned under the first and second heat exchangers, for guiding the condensed water from the first heat exchanger to the drain pan through the water collecting member.

[0032] In another aspect, an air conditioner includes a case having an inlet and an outlet, a first heat exchanger arranged in the case, a second heat exchanger being spaced apart from the first heat exchanger, a guide member for blocking a space between adjacent edges of the first heat exchanger and the second heat exchanger, the guide member having a water collecting groove for collecting the condensed water from the first heat exchanger, and a drain pan positioned under the first and second heat exchangers.

[0033] The guide member includes a first coupling portion positioned on a top side of the second heat exchanger, a second coupling portion positioned on an underside of the first heat exchanger, and a baffle portion connected between the first and second coupling portions for blocking the space between adjacent edges of the first heat exchanger and the second heat exchanger.

[0034] The water collecting groove may be provided to the baffle portion.

[0035] The water collecting groove may have a bottom positioned lower than the second coupling portion.

[0036] The first heat exchanger has at least a region arranged to face the water collecting groove.

[0037] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are not intended to limit the scope of the claims.

[0038] The accompanying drawings, which are included to provide a further understanding of the disclosure, illustrate embodiments of the invention and together with the description serve to explain the principle of the invention.

[0039] In the drawings:

FIG. 1 illustrates a cross-section of an air conditioner in accordance with a preferred embodiment of the present invention.

FIG. 2 illustrates a perspective view of a variation of the guide member in FIG. 1.

FIGS. 3A and 3B illustrate cross-sections, each showing another variation of the guide member in FIG. 1.

FIGS. 4A and 4B illustrate cross-sections, each showing another variation of the guide member in FIG. 1.

FIG. 5 illustrates a perspective view of another variation of the guide member in FIG. 1.

FIG. 6 illustrates a front view of an air conditioner having the guide member in FIG. 5 mounted thereto.

FIG. 7 illustrates a cross-section for describing a flow process of air passing through a plurality of heat exchangers.

FIGS. 8A and 8B illustrate a cross-section of an air conditioner having a plurality of heat exchangers mounted tiltedly in a case, respectively, in accordance with a preferred embodiment of the invention.

FIGS. 9 and 10 illustrate perspective views each for describing another variation of a heat exchanger.

FIG. 11 illustrates a cross-section of a duct type air conditioner.

FIGS. 12, 13A, and 13B illustrate cross-sections of key parts of an air conditioner in accordance with a second preferred embodiment of the present invention, respectively.

FIG. 14 illustrates a cross-section of an air conditioner in accordance with a third preferred embodiment of the present invention.

FIGS. 15 and 16 illustrate perspective views of the guide member in FIG. 14, respectively.

FIGS. 17A and 17B illustrate conceptual drawings for describing positional relations of a plurality of heat exchangers, respectively.

FIG. 18 illustrates a graph showing a performance of an air conditioner in accordance with a third preferred embodiment of the present invention.

[0040] Reference will now be made in detail to the specific embodiments of the present invention, examples of which are illustrated in the accompanying drawings. The attached drawings are for illustrating exemplary embodiments of the present invention, for providing the disclosure, but not for confining technical scopes of the present invention.

[0041] Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts, repetitive description of which will be omitted, and, for convenience of description, a size or a shape of a member may be shown exaggerated or not to scale, perfectly.

[0042] In the meantime, though terms including ordinal numbers, such as first or second, can be used for describing various elements, the elements are not confined by the terms, but are used only for making one element distinctive from other elements.

[0043] FIG. 1 illustrates a cross-section of an air conditioner in accordance with a preferred embodiment of the present invention, FIG. 2 illustrates a perspective view of a variation of the guide member in FIG. 1, and FIGS. 3A and 3B illustrate cross-sections, each showing another variation of the guide member in FIG. 1.

[0044] The air conditioner 100 to be described in this specification may be a split type air conditioner having an indoor unit and an outdoor unit split from each other, and the air conditioner 100 may indicate the indoor unit of the split type air conditioner, only.

[0045] Referring to FIG. 1, the air conditioner 100 includes a case 110, a plurality of heat exchangers 120: 121, and 123, a fan 130, and a guide member 210.

[0046] The air conditioner 100 includes a case 110 having an inlet 111 and an outlet 113, an upper heat exchanger 121 arranged in the case 110, and a lower heat exchanger 123 being spaced apart from the upper heat exchanger 121. A lower heat exchanger 123 may be positioned below the upper heat exchanger 121 to have a region overlapped with the upper heat exchanger 121.

[0047] And, the air conditioner 100 also includes a guide member 210 for blocking a space between adjacent edges of the upper heat exchanger 121 and the lower heat exchanger 123, and a water collecting member 220 provided to the guide member 210 for collecting and draining condensed water from the upper heat exchanger 121.

[0048] The case 110 forms an exterior appearance of the air conditioner 100, and has the inlet 111 and the outlet 113.

[0049] And, upon putting the fan 130 in the case 110 into operation, the air is introduced into the case through the inlet 111. Then, the air is heated or cooled in a course of passing through the plurality of heat exchangers 120, and the air heated or cooled thus is discharged to an outside of the air conditioner through the outlet 113.

[0050] The inlet 111 may be provided in the case 110 lower than the outlet 113, and the fan 130 may be arranged at a side of the outlet 113.

[0051] The plurality of heat exchangers 120 are arranged in the case 110 in a state spaced in up/down and front/rear directions.

[0052] Referring to FIG. 1, the upper heat exchanger 121 and the lower heat exchanger 123 are arranged spaced by predetermined distances in a width direction (Hereafter, an x-axis direction), and in a height direction (Hereafter, a y-axis direction) of the case 110, respectively.

[0053] And, for convenience of description, in the first embodiment, a heat exchanger positioned on an upper side in the y-axis direction in FIG. 1 relatively will be called as an upper heat exchanger 121 or a first heat exchanger 121, and a heat exchanger positioned on a lower side in the y-axis direction in FIG. 1 relatively will be called as a lower heat exchanger 123 or a second heat exchanger 123.

[0054] In this case, the upper and lower heat exchangers 121 and 123 are arranged to have a region thereof overlapped with each other when the heat exchangers 121 and 123 are seen from the inlet 111.

[0055] That is, the upper heat exchanger 121 and the lower heat exchanger 123 are arranged to have a region thereof overlapped in the y-axis direction. More specifically, with reference to the inlet 111, a portion of a lower side of the upper heat exchanger 121 and a portion of an upper side of the lower heat exchanger 123 are overlapped.

[0056] In the meantime, a largest length of a heat exchanger area is limited by a height Hc of a space in the case 110 the heat exchangers are mounted therein. However, the air conditioner of the embodiment suggests overlapping of the regions of the upper and lower heat exchangers 121 and 123 for increasing a total heat exchanger area.

[0057] Moreover, as the heat exchanger 120 is divided into the plurality of the heat exchangers 121 and 123, heights L1 and L2 of the upper and the lower heat exchangers 121 and 123 can be reduced, respectively.

[0058] Moreover, the upper and the lower heat exchangers 121 and 123 may be of fin-tube type heat exchangers, respectively.

[0059] And, by reducing the heights of the upper and the lower heat exchangers 121 and 123, amounts of the condensed water formed at the surfaces of the upper and the lower heat exchangers 121 and 123 may be reduced, respectively.

[0060] In detail, if the condensed water is formed at the upper heat exchanger 121, the condensed water flows down to a lower side of the upper heat exchanger 121 by gravity. According to this, the flow of the condensed water increases as the condensed water goes to the lower side of the upper heat exchanger 121 to make the heat exchange performance of the upper heat exchanger 121 poor.

[0061] However, since the air conditioner of the embodiment can reduce the heights of the upper and lower heat exchangers 121 and 123 respectively, the flow of the condensed water can be reduced, enabling to improve the heat exchange performances of the upper and lower heat exchangers 121 and 123, respectively.

[0062] In the meantime, it is important to prevent the air from flowing through a space between the adjacent edges of the upper heat exchanger 121 and the lower

heat exchanger 123 arranged spaced in the x-axis direction and the y-axis direction, respectively.

[0063] The guide member 210 performs a function of blocking the space between the adjacent edges of the upper heat exchanger 121 and the lower heat exchanger 123.

[0064] Moreover, the guide member 210 performs a function of guiding the air introduced through the inlet 111 to pass through the upper heat exchanger 121 and the lower heat exchanger 123, respectively.

[0065] That is, even in a case the upper heat exchanger 121 and the lower heat exchanger 123 have regions overlapped with each other, the guide member 210 performs the function of guiding the air flow to make adequate heat exchange throughout an entire height L1 of the upper heat exchanger 121 and an entire height L2 of the lower heat exchanger 123.

[0066] As one variation, the guide member 210 may include a first coupling portion 211 positioned on a top side of the lower heat exchanger 123, a second coupling portion 213 positioned on an underside of the upper heat exchanger 121, and a baffle portion 215 connected between the first and second coupling portions 211 and 213 to block the space between the adjacent edges of the upper heat exchanger 121 and the lower heat exchanger 123.

[0067] It is preferable that the first coupling portion 211 is in close contact with the top side of the lower heat exchanger 123, and the second coupling portion 213 is in close contact with the underside of the upper heat exchanger 121.

[0068] In this case, as the first coupling portion 211 is in close contact with the top side of the lower heat exchanger 123 to cover the top side, a contact area between the first coupling portion 211 and the heat exchanger 123 can be increased.

[0069] According to this, shaking of the guide member 210 by the air flow can also be prevented.

[0070] The baffle portion 215 has a shape of a diagonal extension between the first coupling portion 211 and the second coupling portion 213.

[0071] In the meantime, the water collecting member 220 is provided to the guide member 210 for performing functions of collecting the condensed water from the surface of the upper heat exchanger 121, and draining the condensed water collected thus to an outside of the air conditioner. The collecting member 220 has at least one drainage hole 227.

[0072] In detail, if the upper heat exchanger 121 is operated as an evaporator, the condensed water formed at the surface of the upper heat exchanger 121 flows down by gravity, possibly, toward the surface of the lower heat exchanger 123.

[0073] In the embodiment, the water collecting member 220 collects the condensed water from the upper heat exchanger 121 as well as prevents the condensed water from flowing toward the lower heat exchanger 123. That is, condensed water from the upper heat exchanger is guided to the drain pan 140 through the drainage hole 227 of the water collecting member 220.

[0074] According to this, by preventing the condensed water from dropping down to the lower heat exchanger 123, it is possible to prevent the condensed water of the upper heat exchanger 121 from making the heat exchange performance of the lower heat exchanger 123 poor.

[0075] And, of the two heat exchangers 120 having ends overlapped with each other, it is preferable that the water collecting member 220 is provided to the guide member 210 at a position corresponding to a condensed water dropping direction of the upper heat exchanger 121.

[0076] For example, the water collecting member 220 may be provided to the second coupling portion 213 of the guide member 210, which is in close contact with the underside of the upper heat exchanger 121.

[0077] And, the water collecting member 220 may have a holding space S to position the underside of the upper heat exchanger 121 therein for collecting the condensed water thereto.

[0078] And, the water collecting member 220 may have a box shape with an opened upper side.

[0079] That is, in order to secure the holding space S, the upper heat exchanger 121 may have at least the underside spaced a predetermined distance from an inside circumferential surface of the water collecting member 220.

[0080] And, the water collecting member 220 can prevent the condensed water dropping to a lower side of the upper heat exchanger 121 from splashing to an outside of the water collecting member 220.

[0081] Moreover, the guide member 210 and the water collecting member 220 have extensions in a length direction of the upper heat exchanger 121 or the lower heat exchanger 123. The guide member 210 and the water collecting member 220 have lengths the same as a length direction length of the upper heat exchanger 121 or the lower heat exchanger 123. According to this, the condensed water dropping to the lower side of the upper heat exchanger 120 can be collected at the water collecting member 220, entirely.

[0082] Referring to FIGS. 3A and 3B, the water collecting member 220 may have a blocking portion 221 extended toward the upper heat exchanger 121 from a bottom of the holding space S.

[0083] The blocking portion 221 performs a function of blocking the air which does not pass the upper heat exchanger 121, but through the holding space S, to by pass the upper heat exchanger 121.

[0084] That is, by guiding the air passing the holding space S through a gap between the second coupling portion 213 of the guide member 210 and the underside of the upper heat exchanger 121 to an upper side of the upper heat exchanger 121, the blocking portion 221 can guide the air introduced to the holding space S to an inside of the upper heat exchanger 121.

[0085] In this case, the blocking portion 221 may be extended from the bottom of the holding space S vertically to a height Hp at which the blocking portion 221 abuts with the underside of the upper heat exchanger 121. According to this, the blocking portion 221 can guide the air introduced to the holding space S to the upper heat exchanger 121, entirely.

[0086] And, referring to FIG. 3B, the water collecting member 220 may have a guide portion 223 extended tilted upward.

[0087] And, the water collecting member 220 has one side connected to the second coupling portion 213, and the other side provided with the guide portion 223 extended tilted upward.

[0088] The guide portion 223 performs a function of guiding the condensed water splashing from the surface of the upper heat exchanger 121 toward the air flow direction (The x-axis direction in FIG. 1) by the air being introduced thereto to the inside of the holding space S.

[0089] In this case, it is preferable that a top side of the guide portion 223 is extended tilted upward higher than the underside of the upper heat exchanger 121.

[0090] And, if the upper heat exchanger 121 is positioned in rear of the lower heat exchanger 123 with reference to the air introduction direction, the guide portion 223 may be provided to the water collecting member 220.

[0091] FIGS. 4A and 4B illustrate cross-sections each showing another variation of the guide member in FIG. 1.

[0092] Referring to FIG. 4A, a heat insulating material 230 may be provided to at least one of the water collecting member 220 and the guide member 210.

[0093] The heat insulating material 230 provided to the water collecting member 220 blocks heat exchange between the condensed water collected at the holding space S and the air passed through the lower heat exchanger 123, for preventing a total heat exchange performance from dropping.

[0094] And, the heat insulating material 230 provided to the guide member 210 prevents heat exchange from taking place between the air passed through the lower heat exchanger 123 and the air introduced to the upper heat exchanger 121 with the guide member 210 disposed therebetween, thereby improving the heat exchange performance.

[0095] In the meantime, the first coupling portion 211 of the guide member 210 may be in close contact with the lower heat exchanger 123 to cover only a portion of the top side of the lower heat exchanger 123.

[0096] At the time the guide member 210 is being mounted in the air conditioner, after mounting the plurality of the heat exchangers 120, the guide member 210 may be inserted in, and secured to, the space between the plurality of heat exchangers 120.

[0097] That is, if the first coupling portion 211 is formed to be in close contact with only the portion of the top side of the lower heat exchanger 123, reducing a length of the first coupling portion 211, the insertion of the guide member 210 in the space between the upper and lower heat exchangers 121 and 123 becomes easier.

[0098] And, referring to FIG. 4B, the water collecting member 220 may be stream lined, that is, sharp edges may be removed, for guiding the air flowing in contact with the underside of the water collecting member 220 smoothly, thereby reducing air flow resistance.

[0099] Preferably, only the underside of the water collecting member 220 may be stream lined. Similarly, in order to reduce the air flow resistance, the guide member 223 may also be stream lined.

[0100] And, the water collecting member 220 may have a supplementary blocking portion 225 provided between the blocking portion 221 and the guide portion 223. The supplementary blocking portion 225 may be a vertical extension from a bottom of the water collecting member 220 to be in close contact with a side of a lower portion of the upper heat exchanger 121.

[0101] Similar to the blocking portion 221, the supplementary blocking portion 225 performs a function of blocking the air moving around the upper heat exchanger 121 through the holding space S. Moreover, since the supplementary blocking portion 225 increases the contact area to the upper heat exchanger 121, the shaking of the water collecting member 220 by the air flow may be prevented.

[0102] FIG. 5 illustrates a perspective view of another variation of the guide member in FIG. 1, and FIG. 6 illustrates a front view of an air conditioner having the guide member in FIG. 5 mounted thereto.

[0103] Referring to FIGS. 5 and 6, the guide member 210 may have a side blocking member 240 provided thereto.

[0104] And, the side blocking member 240 is provided to both sides of the guide member 210 to be positioned between both sides of the upper and lower heat exchangers 121 and 123, and an inside of the case 110.

[0105] The side blocking member 240 blocks both sides of the overlapped one end portion of each of the heat exchangers 121 and 123 for blocking the air flow through the space G between both sides of the plurality of the upper and lower heat exchangers 121 and 123, and the inside of the case 110.

[0106] The guide member 210, the water collecting member 220, and the side blocking member 240 may be formed as one unit. According to this, since the guide member 210, the water collecting member 220, and the side blocking member 240 are not required to be assembled again after the guide member 210, the water collecting member 220, and the side blocking member 240 are fabricated, a fabrication process can be reduced.

[0107] And, since the guide member 210, the water collecting member 220, and the side blocking member 240 are formed as one unit, by securing the side blocking member 240 to the case 110, the guide member 210, and the water collecting member 220 can be secured to the inside of the case 110 without securing the guide member 210, and the water collecting member 220 to the upper or lower heat exchanger 121 or 123 or the case

110, separately.

[0108] The foregoing air conditioner will be described taking a detailed example.

[0109] The air conditioner of the present invention includes a case 110, a first heat exchanger 121 and a second heat exchanger 123 provided in the case 110, a guide member 210 for blocking a gap between the first heat exchanger 121 and the second heat exchanger 123, and a water collecting member 220 provided to the guide member 210.

[0110] In this case, the second heat exchanger 123 is provided below the first heat exchanger 121 arranged to have an upper portion of the second heat exchanger 123 overlapped with a lower portion of the first heat exchanger 121.

[0111] The guide member 210 is extended from a top side of the second heat exchanger 123 to an underside of the first heat exchanger 121 to block the gap between the underside of the first heat exchanger 121 and the top side of the second heat exchanger 123.

[0112] And, the guide member 210 is provided such that the water collecting member 220 is positioned on the underside of the first heat exchanger 121 for collecting the condensed water from the first heat exchanger 121.

[0113] The water collecting member 220 has a holding space S provided thereto for collecting the condensed water, and a lower end portion of the first heat exchanger 121 may be positioned within the holding space S.

[0114] The water collecting member 220 includes a blocking portion 221 projected from the bottom of the holding space S for blocking the air bypassing the first heat exchanger 121 through the holding space S to prevent the heat exchanger performance from dropping.

[0115] And, the water collecting member 220 may include a guide portion 223 for guiding the condensed water splashing from the first heat exchanger 121 by the air flow.

[0116] FIG. 7 illustrates a cross-section for describing a flow process of air passing through a plurality of heat exchangers.

[0117] Referring to FIG. 7, three or more heat exchangers 120a, 120b, 120c, and 120d may be provided in the case 110.

[0118] For convenience of description, the heat exchangers may be called as a first heat exchanger 120a, a second heat exchanger 120b, a third heat exchanger 120c, and a fourth heat exchanger 120d starting from an upper side of the inside of the case 110.

[0119] The first heat exchanger 120a and the fourth heat exchanger 120d have only one overlapped ends respectively, and the second heat exchanger 120b, and the third heat exchanger 120c positioned in middle have both ends overlapped with adjacent heat exchangers, respectively.

[0120] In this case, the guide member 210 may be plural for the guide member 210 to be provided between the plurality of heat exchangers 120, respectively. Similarly, the water collecting member 220 may be plural for providing the water collecting member 220 to each of the plurality of guide members 210.

[0121] In this case, the water collecting member 220 may be provided to collect the condensed water from one of adjacent heat exchangers 120 positioned higher than the other.

[0122] FIGS. 8A and 8B illustrate a cross-section of an air conditioner having a plurality of heat exchangers mounted tiltedly mounted in the case, respectively, in accordance with a preferred embodiment of the invention.

[0123] Referring to FIG. 8A, the first heat exchanger 121 and the second heat exchanger 123 may be arranged tilted by predetermined angles from the inlet 111, respectively.

[0124] And, the first heat exchanger 121 and the second heat exchanger 123 may be arranged tilted by the same angle from the inlet 111. Also, the second heat exchanger 123 may be positioned below the first heat exchanger 121 to have a region overlapped with the first heat exchanger 121.

[0125] If the heat exchangers 121 and 123 are tiltedly mounted, enabling to secure an adequate space between the inlet 111 in the case 110 and the first and second heat exchangers 121 and 123, flow resistance and a flow rate of the air can be increased.

[0126] Referring to FIG. 8B, the first heat exchanger 121' and the second heat exchanger 123' may be arranged tilted by predetermined angles from the inlet 111, respectively. Also, the second heat exchanger 123' may be spaced apart from the first heat exchanger 121'. And, the second heat exchanger 123' may not be positioned below the first heat exchanger 121 to have a region overlapped with the first heat exchanger 121.

[0127] A guide member 210' may block a gap between the first heat exchanger 121' and the second heat exchanger 123', and a water collecting member 220' provided to the guide member 210'.

[0128] In this case, the second heat exchanger 123' is provided below the first heat exchanger 121'.

[0129] The guide member 210' is extended from a top side of the second heat exchanger 123' to an underside of the first heat exchanger 121' to block the gap between the underside of the first heat exchanger 121' and the top side of the second heat exchanger 123'.

[0130] And, the guide member 210' is provided such that the water collecting member 220' is positioned on the underside of the first heat exchanger 121' for collecting the condensed water from the first heat exchanger 121'.

[0131] The water collecting member 220' has a holding space provided thereto for collecting the condensed water, and a lower end portion of the first heat exchanger 121' may be positioned within the holding space.

[0132] FIGS. 9 and 10 illustrate perspective views each for describing another variation of a heat exchanger.

[0133] Referring to FIGS. 9 and 10, the heat exchanger 120 may have a bent shape. In this case, the guide mem-

ber 210 and the water collecting member 220 may also have a bent shape to match with the bent shape of the heat exchanger 120.

[0134] That is, if the inlet 111 is provided, not only in a front of the case 110, but also in a side of the case 110, in order to position the heat exchanger 120 throughout an entire region of the inlet 111, the heat exchanger 120 may have bent shapes of '∟' (See FIG. 9), '⊏', and '□' (See FIG. 10).

[0135] FIG. 11 illustrates a cross-section of a duct type air conditioner.

[0136] The air conditioner of the embodiment can be applied, not only to a stand type air conditioner, but also to a duct type air conditioner shown in FIG. 11.

[0137] In detail, the case 110 of the duct type air conditioner has an inlet 111 and an outlet 113, and the inlet 111 and the outlet 113 in the case 110 have ducts 117 mounted thereto, respectively.

[0138] Similarly, the plurality of heat exchangers 120: 121, and 123 are arranged to have one end portions overlapped with each other respectively, and the guide members 210 are provided between the plurality of heat exchangers 120, respectively.

[0139] FIGS. 12, 13A, and 13B illustrate sections of key parts of an air conditioner in accordance with a second preferred embodiment of the present invention, respectively.

[0140] Referring to FIG. 12, the air conditioner includes a plurality of heat exchangers 121 and 123, and guide members 310 provided between the plurality of heat exchangers 121 and 123, respectively.

[0141] In detail, the air conditioner includes a case 100 having an inlet 111 and an outlet 113, a first heat exchanger 121 arranged in the case 100, and a second heat exchanger 123 positioned below the first heat exchanger 121 to have a region overlapped with the first heat exchanger 121.

[0142] And, the air conditioner includes a guide member 310 having a water collecting groove 317 for blocking a space between adjacent edges of the first heat exchanger 121 and the second heat exchanger 123 and collecting condensed water from the first heat exchanger 121.

[0143] And, the air conditioner includes a drain pan 140 (See FIG. 14) positioned under the first and second heat exchangers 121 and 123.

[0144] In this case, the guide member 310 may have the water collecting groove 317 provided thereto for collecting the condensed water from the upper heat exchanger 121.

[0145] The guide member 310 may include a first coupling portion 311 and a second coupling portion 313 positioned in an up/down direction in close contact with the overlapped ends of the upper and lower heat exchangers 121 and 123 respectively, and a baffle portion 315 extended between the first coupling portion 311 and the second coupling portion 313.

[0146] In the embodiment, the water collecting groove 317 is provided to the baffle portion 315 of the guide member 310, and the water collecting groove 317 has a bottom positioned lower than the second coupling portion 313.

[0147] According to this, the condensed water from the upper heat exchanger 121 may drop to the second coupling portion 313, and, therefrom, may be guided to the water collecting groove 317 which is positioned relatively low along a surface of the guide member 310.

[0148] Thus, since the water collecting groove 317 can prevent the condensed water from flowing to the other heat exchanger 123 positioned lower than the upper heat exchanger 121, dropping of the heat exchange performance of the lower heat exchanger 123 by the condensed water from the upper heat exchanger 121 can be prevented.

[0149] In this case, the second coupling portion 313 may be in close contact with the upper heat exchanger 121 to surround an underside of the upper heat exchanger 121.

[0150] In the meantime, it is preferable that the condensed water collected at the water collecting member 210 and the water collecting groove 317 is guided, and drained to the drain pan 140.

[0151] Referring to FIG. 13A, the guide member 310 may have a tilted guide portion 319 provided thereto extended upward from the second coupling portion 313.

[0152] And, the guide portion 319 prevents the condensed water splashing from the surface of the upper heat exchanger 121 in an air flow direction from dropping to an outside of the second coupling portion 313.

[0153] The guide portion 319 may have a top side that is higher than the underside of the upper heat exchanger 121.

[0154] The guide member 310 may have a heat insulating material 320 provided thereto, for blocking heat exchange between the condensed water collected at the water collecting groove 317 and the air passed through the lower heat exchanger 123, thereby preventing the heat exchange performance from becoming poor.

[0155] The heat insulating material 320 blocks heat exchange between the air passed through the lower heat exchanger 123 and the air flowing toward the upper heat exchanger 121 with the guide member 310 disposed therebetween, thereby preventing the heat exchange performance of the air conditioner from becoming poor.

[0156] The guide member 310 may be stream lined. According to this, resistance of the air flowing in contact with the guide member 310 can be reduced.

[0157] In comparison to the air conditioner in accordance with the first preferred embodiment, the air conditioner in accordance with the second preferred embodiment has no water collecting member coupled thereto additionally, but has the water collecting groove 317 formed at the guide member 310, to provide an advantage of easy fabrication. However, a length of the baffle portion 315, which becomes longer for providing the water collecting groove 317, is liable to cause a horizontal

gap T between the upper and lower heat exchangers 121 and 123 to be larger.

[0158] Referring to FIG. 13B, the upper heat exchanger 121 may be moved forward toward the lower heat exchanger 123 by a predetermined distance d so that a portion of the underside of the upper heat exchanger 121 is in contact with the second coupling portion 313.

[0159] In detail, the upper heat exchanger 121 may have at least a portion arranged to face the water collecting groove 317.

[0160] That is, the second coupling portion 313 may be provided to support only the portion of the upper heat exchanger 121 for reducing a horizontal gap T' between the upper heat exchanger 121 and the lower heat exchanger 123.

[0161] FIG. 14 illustrates a cross-section of an air conditioner in accordance with a third preferred embodiment of the present invention, and FIGS. 15 and 16 illustrate perspective views of the guide member in FIG. 14, respectively.

[0162] Referring to FIG. 14, the air conditioner 100 includes a case 110, a plurality of heat exchangers 20: 21 and 22, a fan 130, and a guide member 10.

[0163] In detail, the air conditioner 100 includes a case 110 having an inlet 111 and an outlet 113, a first heat exchanger 21 arranged on an inlet 111 side, a second heat exchanger 23 arranged to have a region thereof overlapped with the first heat exchanger 21 with reference to the inlet, and a guide member 10 for blocking a space between adjacent edges of the first heat exchanger 21 and the second heat exchanger 23.

[0164] In this case, it is preferable that the overlapped region of the first heat exchanger 21 and the second heat exchanger 23 has a height A to be determined with reference to a height L1 or L2 of the first heat exchanger 21 or the second heat exchanger 23.

[0165] Referring to FIG. 14, the first heat exchanger 21 and the second heat exchanger 23 are arranged in a state where the first heat exchanger 21 and the second heat exchanger 23 are spaced by predetermined distances in a width direction (Hereafter, an x-axis direction) and a height direction (Hereafter, a y-axis direction) of the case 110, respectively.

[0166] For convenience of description, one of the heat exchangers positioned close to the inlet 111 side is called the first heat exchanger 21, and the other heat exchanger positioned in rear of the first heat exchanger 21 is called the second heat exchanger 23.

[0167] In this case, the first and second heat exchangers 21 and 23 are arranged to have an overlapped region if seen from the inlet 111. That is, the first heat exchanger 21 and the second heat exchanger 23 are arranged to have the overlapped region in the y-axis direction. In detail, with reference to the inlet 111, a lower end portion of the first heat exchanger 21 and an upper end portion of the second heat exchanger 23 are overlapped.

[0168] In the meantime, a largest length of a heat exchange area is limited by a height Hc of a heat exchanger mounting space in the case 110. However, since the air conditioner of the embodiment has the overlapped region between the first and second heat exchangers 21 and 23, increasing the heat exchange area, a total heat exchange area can be increased.

[0169] Moreover, as the heat exchanger 20 is divided into the plurality of the heat exchangers 21, and 23, heights L1 and L2 of the upper and the lower heat exchangers 21 and 23 can be reduced, respectively.

[0170] Moreover, the upper and the lower heat exchangers 21 and 23 may be of fin-tube type heat exchangers, respectively.

[0171] In the meantime, it is important to prevent the air from flowing through a space between the adjacent edges of the first heat exchanger 21 and the second heat exchanger 23 arranged spaced in the x-axis direction and the y-axis direction, respectively.

[0172] The guide member 10 performs a function of blocking the space between the adjacent edges of the first heat exchanger 21 and the second heat exchanger 23. Moreover, the guide member 10 performs a function of guiding the air introduced through the inlet 111 to pass through the first heat exchanger 21 and the second heat exchanger 23.

[0173] That is, even in a case the first heat exchanger 21 and the second heat exchanger 23 have regions overlapped with each other, the guide member 10 performs the function of guiding the air flow to make adequate heat exchange throughout an entire height L1 of the first heat exchanger 21 and an entire height L2 of the second heat exchanger 23.

[0174] Referring to FIGS. 14 and 15, the guide member 10 may include a first coupling portion 11 mounted to the first heat exchanger 21, a second coupling portion 13 mounted to the second heat exchanger 23, and a baffle portion 15 connected between the first and second coupling portions to block the space between the adjacent edges of the first heat exchanger and the second heat exchanger.

[0175] As a variation, the first coupling portion 11 performs a function of supporting the underside of the first heat exchanger 21, and the second coupling portion 13 performs a function of supporting the top side of the second heat exchanger 23.

[0176] In detail, the first coupling portion 11 may be in close contact with the underside of the first heat exchanger 21, and the second coupling portion 13 maybe in close contact with the top side of the second heat exchanger.

[0177] Heat insulating material (not shown) may be provided to at least one of the first coupling portion 11 and the second coupling portion 13, and description of the insulating material is the same with the description made in the first embodiment.

[0178] And, the baffle portion 15 may be a diagonal extension due to a difference of in height between the first coupling portion 11 and the second coupling portion 13.

[0179] Referring to FIG. 16, the guide member 10 may

include a side blocking member 240 provided to at least one of the first coupling portion 11 and the second coupling portion 13, for performing a function of preventing introduction of the air through a space between both sides of at least one of the heat exchangers and the case 110.

[0180] In the meantime, in the case 110, there may be a drain pan 140 provided under the first heat exchanger 21 and the second heat exchanger 23. The drain pan 140 performs a function of collecting the condensed water from the first heat exchanger 21 and the second heat exchanger 23.

[0181] As described before, if the first heat exchanger 21 and the second heat exchanger 23 are arranged to have the overlapped region, an air flow rate may be reduced due to a pressure loss of the air.

[0182] Therefore, it is preferred to determine a height A of the overlapped region.

[0183] As a variation, the height A of the overlapped region of the first heat exchanger 21 and the second heat exchanger 23 may be determined with reference to the height of any one of the heat exchangers 21 and 23 having a larger flow rate loss.

[0184] A height of the first heat exchanger 21 and a height of the second heat exchanger 23 may be determined to be different from each other, and, in this case, the height A of the overlapped region of the first heat exchanger 21 and the second heat exchanger 23 may be determined to be less than 60% of the height of any one of the heat exchangers 21 and 23 having a smaller height.

[0185] The height A of the overlapped region of the first heat exchanger 21 and the second heat exchanger 23 may be determined to be less than 60% of the height L1 of the first heat exchanger 21 or less than 60% of the height L2 of the second heat exchanger 23.

[0186] FIGS. 17A and 17B illustrate conceptual drawings for describing positional relations of a plurality of heat exchangers respectively, and FIG. 18 illustrates a graph showing a performance of an air conditioner in accordance with a third preferred embodiment of the present invention.

[0187] FIG. 17A illustrates a case in which the first heat exchanger 21 is positioned on an upper side and the second heat exchanger 23 is positioned on a lower side, and FIG. 17B illustrates a case in which the first heat exchanger 21 is positioned on the lower side and the second heat exchanger 23 is positioned on the upper side.

[0188] Referring to FIG. 17A, the first heat exchanger 21 has a region positioned above the second heat exchanger 23, and it is preferable that the height of the overlapped region A of the first heat exchanger 21 and the second heat exchanger 23 is determined to be less than 60% of the height L1 of the first heat exchanger.

[0189] Or, the height L1 of the first heat exchanger 21 and the height L2 of the second heat exchanger 23 may be configured to be the same. However, if the second heat exchanger 23 is arranged close to the drain pan 140, the pressure loss of a second heat exchanger 23 side may be higher than the pressure loss of a first heat exchanger 21 side.

[0190] In order to compensate for the pressure loss, the height L1 of the first heat exchanger 21 may be determined to be smaller than the height L2 of the second heat exchanger 23. This is because the fin-tube type heat exchanger has a pressure loss which becomes the lower as a height of the heat exchanger becomes the higher, to have an increased air flow rate.

[0191] And, if the first heat exchanger 21 is positioned above the second heat exchanger 23, the guide member 10 may have a water collecting member (Not shown) provided thereto with a holding space for collecting the condensed water from the first heat exchanger 21. In this case the water collecting member may be provided to the first coupling portion 11 of the guide member 10.

[0192] In the meantime, as described in the first embodiment, the water collecting member performs a function of preventing the condensed water from the surface of the first heat exchanger 21 from flowing to the second heat exchanger 23.

[0193] Different from this, referring to FIG. 17B, the second heat exchanger 23 has a region positioned above the first heat exchanger 21.

[0194] In this structure, the guide member 30 has the first coupling portion 31 provided to position higher than the second coupling portion 33, and the baffle portion 35 may be a downward diagonal extension in the x-axis direction.

[0195] In the meantime, it is preferable that the height A of the overlapped region of the first heat exchanger 21 and the second heat exchanger 23 is determined to be less than 60% of the height L2 of the second heat exchanger.

[0196] The height L1 of the first heat exchanger 21 and the height L2 of the second heat exchanger 23 may be configured to be the same. However, if the first heat exchanger 21 is arranged close to the drain pan 140, the pressure loss of a first heat exchanger 21 side may be higher than the pressure loss of a second heat exchanger 23 side.

[0197] In order to compensate for the pressure loss, the height L2 of the second heat exchanger 23 may be determined to be smaller than the height L1 of the first heat exchanger 21. This is because the fin-tube type heat exchanger has a pressure loss which becomes the lower as a height of the heat exchanger becomes the higher, to have an increased air flow rate.

[0198] And, if the second heat exchanger 23 is positioned above the first heat exchanger 21, the guide member 10 may have a water collecting member (Not shown) provided thereto with a holding space for collecting the condensed water from the second heat exchanger 23. In this case the water collecting member may be provided to the second coupling portion 33 of the guide member 30.

[0199] In the meantime, the water collecting member

performs a function of preventing the condensed water from the surface of the second heat exchanger 23 positioned on an upper side from flowing to the first heat exchanger 21 positioned on a lower side. A detailed description of the water collecting member is the same with the water collecting member described in the first embodiment.

[0200] Referring to FIG. 18, a transverse axis denotes a ratio A/L1 or A/L2 of the height of the overlapped region to the height of the first or second heat exchanger, and a longitudinal axis denotes an air flow rate. Curves in the graph denote rotation speeds of fans different from one another, respectively.

[0201] In this case, the graph shows a characteristic in which the flow rates increase according to increase of the height A of the overlapped region even if the rotation speeds of the fans are different from one another, and it can be noted that the graph shows a trend in which the flow rates decrease contrary to above, if the height A of the overlapped region increases, further.

[0202] That is, it is preferable that the height A of the overlapped region is determined to be less than 60% of the height L1 of the first heat exchanger 21 or the height L2 of the second heat exchanger 23. More preferably, the height A of the overlapped region is determined to be 20% to 40% of the height L1 of the first heat exchanger 21 or the height L2 of the second heat exchanger 23.

[0203] As described before, the height A of the overlapped region of the first heat exchanger 21 and the second heat exchanger 23 may be determined with reference to the height of any one of the heat exchangers 21 and 23 having a larger flow rate loss.

[0204] And, in a case the height L1 of the first heat exchanger 21 and the height L2 of the second heat exchanger 23 are determined to be different from each other, it is preferable that the height A of the overlapped region of the first heat exchanger 21 and the second heat exchanger 23 is determined to be less than 60% of the height of any one of the heat exchangers 21 and 23 having a smaller height.

[0205] More preferably, the height A of the overlapped region of the first heat exchanger 21 and the second heat exchanger 23 is determined to be 20% to 40% of the height of any one of the heat exchangers 21 and 23 having a smaller height.

[0206] Referring to FIGS. 17A and 18, a transverse axis denotes a ratio of the height A of the overlapped region to the height L1 of the first heat exchanger, and a longitudinal axis denotes the flow rate.

[0207] As described before, if the first heat exchanger 21 is positioned above the second heat exchanger 23 relatively, the second heat exchanger 23 has a higher pressure loss.

[0208] Therefore, the second heat exchanger 23 may have a height L2 determined higher than the height L1 of the first heat exchanger 21.

[0209] In this case, the height A of the overlapped region may be determined with reference to the height L1 of the first heat exchanger 21, and, preferably, the height A of the overlapped region may be determined to be less than 60% of the height L1 of the first heat exchanger 21. More preferably, the height A of the overlapped region may be determined to be 20% ~ 40% of the height L1 of the first heat exchanger 21.

[0210] Different from this, referring to FIGS. 17B and 18, a transverse axis denotes a ratio of the height A of the overlapped region to the height L2 of the second heat exchanger, and a longitudinal axis denotes the flow rate.

[0211] As described before, if the second heat exchanger 23 is positioned above the first heat exchanger 21 relatively, the first heat exchanger 21 has a higher pressure loss.

[0212] Therefore, the first heat exchanger 21 may have a height L1 determined higher than the height L2 of the second heat exchanger 23.

[0213] In this case, the height A of the overlapped region may be determined with reference to the height L2 of the second heat exchanger 22, and, preferably, the height A of the overlapped region may be determined to be less than 60% of the height L2 of the second heat exchanger 23. More preferably, the height A of the overlapped region may be determined to be 20% ~ 40% of the height L2 of the second heat exchanger 23.

[0214] In the meantime, in the first embodiment and the second embodiment too, the height A of the overlapped region is determined the same with the description in the third embodiment.

[0215] As has been described, the air conditioner related to one embodiment of the present invention can reduce a pressure loss of the air as well as increase a heat exchange area.

[0216] The air conditioner related to one embodiment of the present invention can prevent air from flowing between edges of adjacent heat exchangers, if a plurality of the heat exchangers are mounted.

[0217] The air conditioner related to one embodiment of the present invention can reduce a pressure loss of the air being introduced to each heat exchanger, if a plurality of the heat exchangers are mounted.

[0218] The air conditioner related to one embodiment of the present invention can prevent a heat exchange performance from becoming poor due to condensed water.

Claims

1. An air conditioner comprising:

a case having an inlet and an outlet;
a first heat exchanger arranged in the case;
a second heat exchanger being spaced apart from the first heat exchanger;
a guide member to block a space between adjacent edges of the first heat exchanger and the second heat exchanger, and

a water collecting member provided at the guide member to collect condensed water from the first heat exchanger.

2. The air conditioner as claimed in claim 1, wherein the second heat exchanger is positioned below the first heat exchanger to have a region overlapped with the first heat exchanger.

3. The air conditioner as claimed in claims 1 or 2, wherein the water collecting member has a holding space to collect the condensed water, and the first heat exchanger has a lower end portion positioned within the holding space.

4. The air conditioner as claimed in any one of claims 1 to 3, wherein the water collecting member includes a blocking portion extended from a bottom of the holding space toward the first heat exchanger.

5. The air conditioner as claimed in any one of claims 1 to 4, wherein an underside of the first heat exchanger is arranged spaced a predetermined distance from an inside circumferential surface of the water collecting member.

6. The air conditioner as claimed in any one of claims 1 to 5, wherein the guide member includes;
a first coupling portion positioned on a top side of the second heat exchanger,
a second coupling portion positioned on an underside of the first heat exchanger, and a baffle portion connected between the first and second coupling portions to block the space between adjacent edges of the first heat exchanger and the second heat exchanger.

7. The air conditioner as claimed in claim 6, wherein the water collecting member is provided at the second coupling portion.

8. The air conditioner as claimed in claims 6 or 7, wherein the water collecting member has one side connected to the second coupling portion, and the other side provided with a guide portion tiltedly extended upward.

9. The air conditioner as claimed in any one of claims 1 to 8, further comprising a side blocking member provided to both sides of the guide member to prevent air from flowing through a space between both sides of at least one of the first heat exchanger and the second heat exchanger and the case.

10. The air conditioner as claimed in any one of claims 1 to 9, wherein the guide member and the water collecting member include heat insulating material.

11. The air conditioner as claimed in any one of claims 1 to 10, wherein the first heat exchanger and the second heat exchanger are tilted by predetermined angles from the inlet, respectively.

12. The air conditioner as claimed in any one of claims 2 to 11, wherein the overlapped region of the first heat exchanger and the second heat exchanger has a height determined with reference to any one of the first heat exchanger and the second heat exchanger having a higher flow rate loss.

13. The air conditioner as claimed in claim 12, wherein the height of the overlapped region of the first heat exchanger and the second heat exchanger is less than 60% of a height of the first heat exchanger.

14. The air conditioner as claimed in claims 12 or 13, wherein the first heat exchanger has a height smaller than a height of the second heat exchanger.

15. The air conditioner as claimed in any one of claims 1 to 14, further comprising a drain pan positioned under the first and second heat exchangers,
wherein the water collecting member guides the condensed water from the first heat exchanger to the drain pan.

FIG. 1

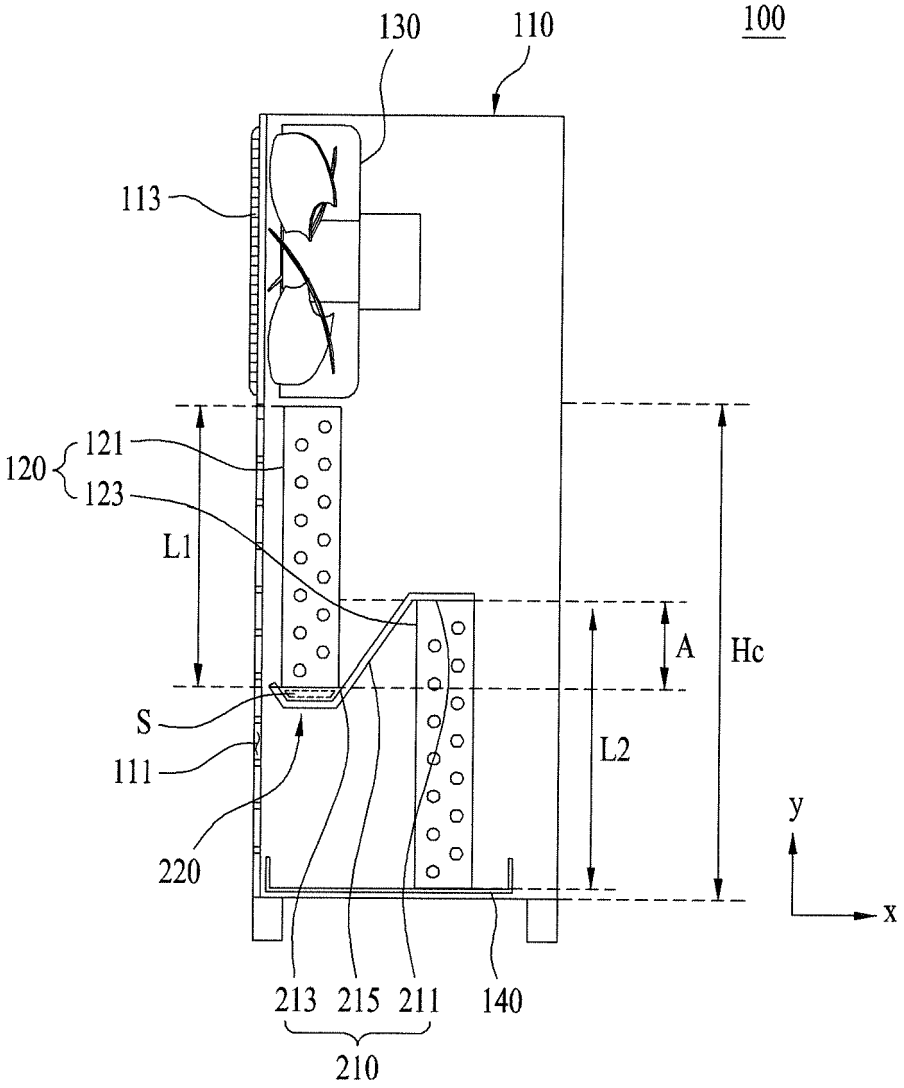

130
110
100
113
120
121
123
L1
A
Hc
S
111
L2
220
y
x
213
215
211
140
210

FIG. 2

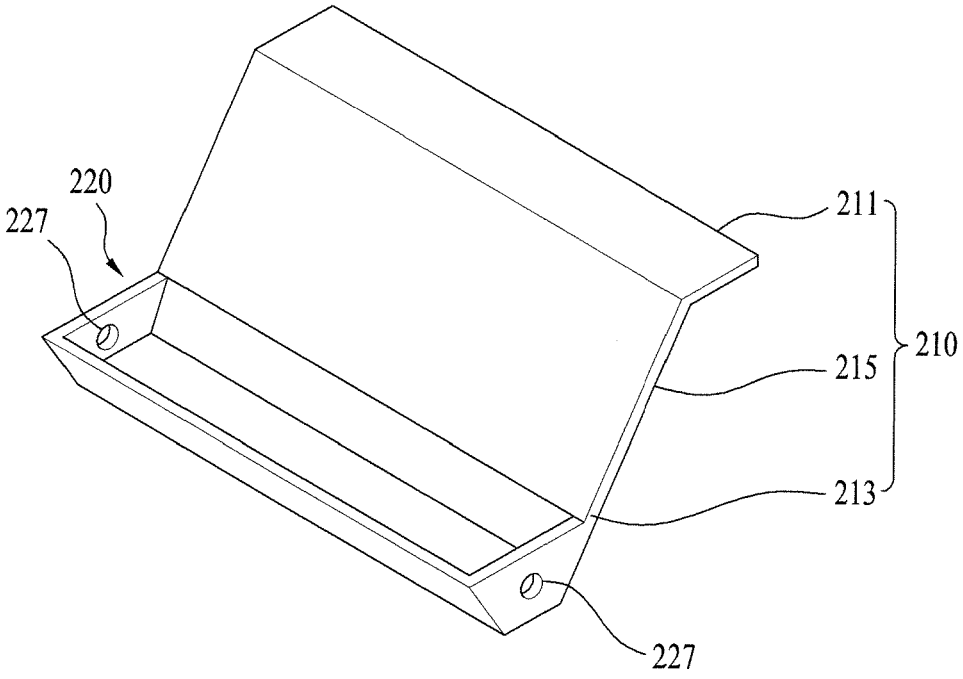


FIG. 3A

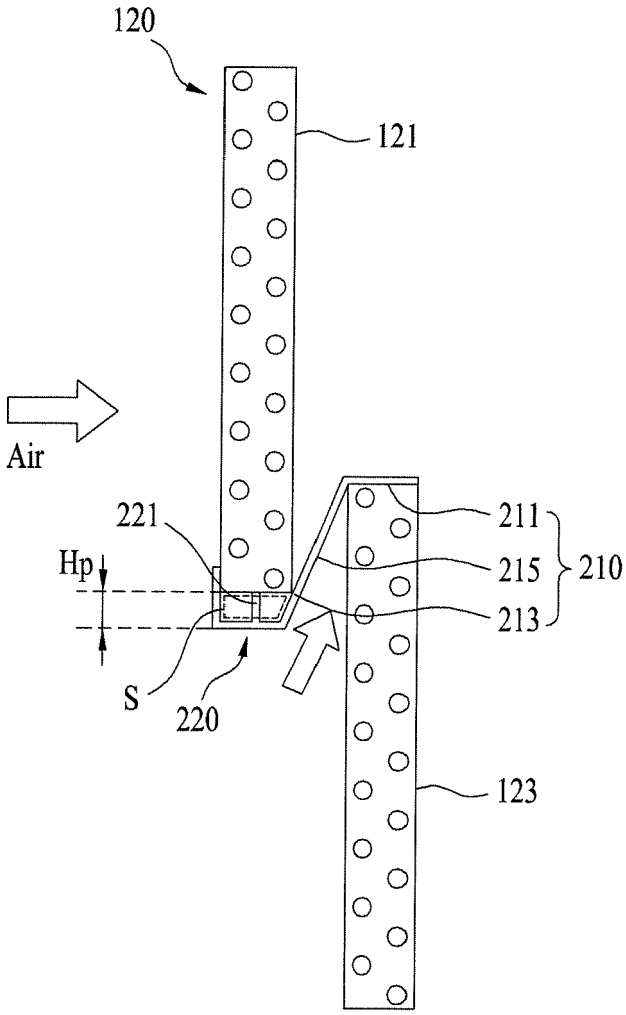


FIG. 3B

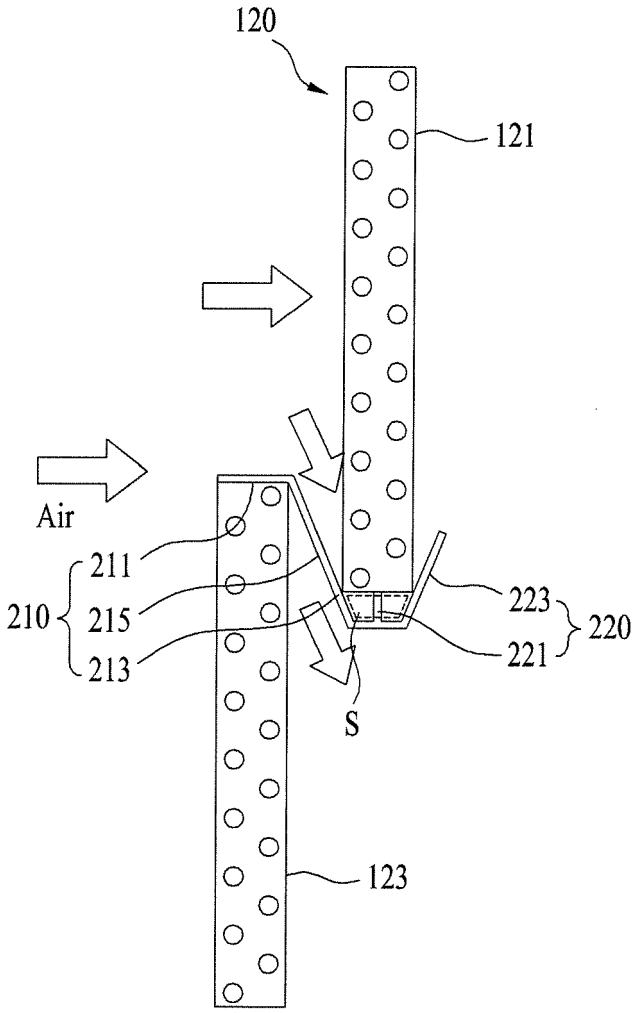


FIG. 4A

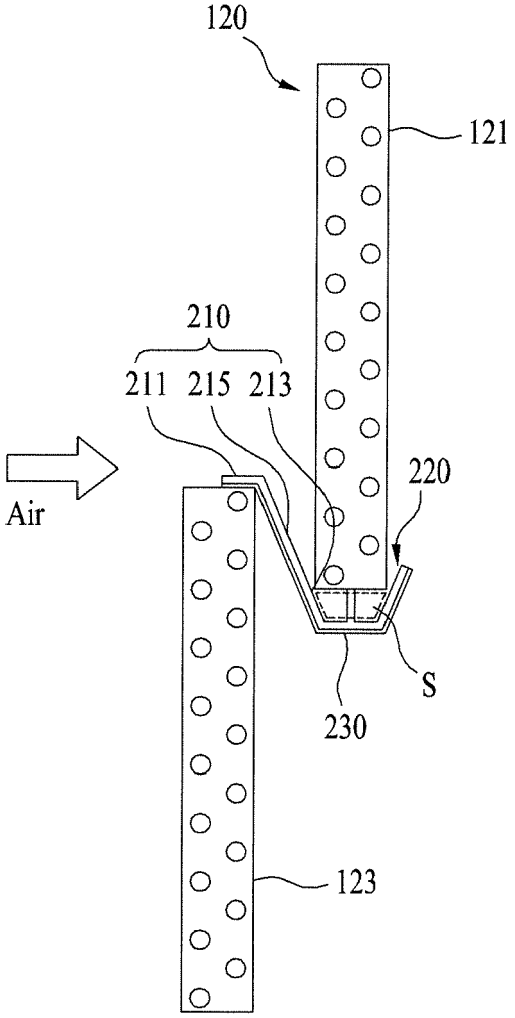


FIG. 4B

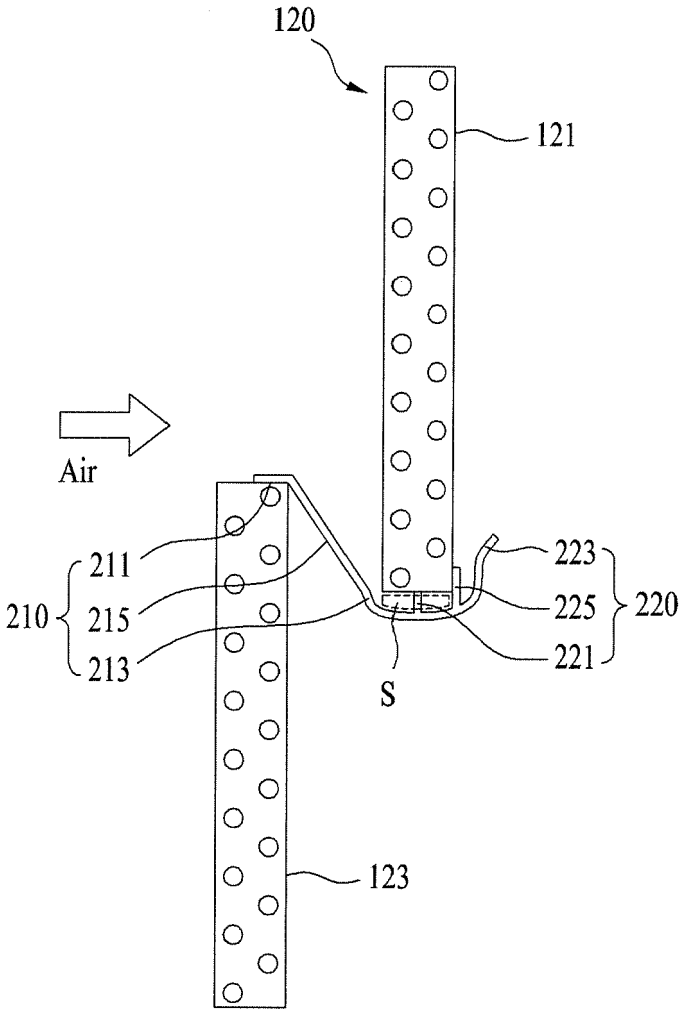


FIG. 5

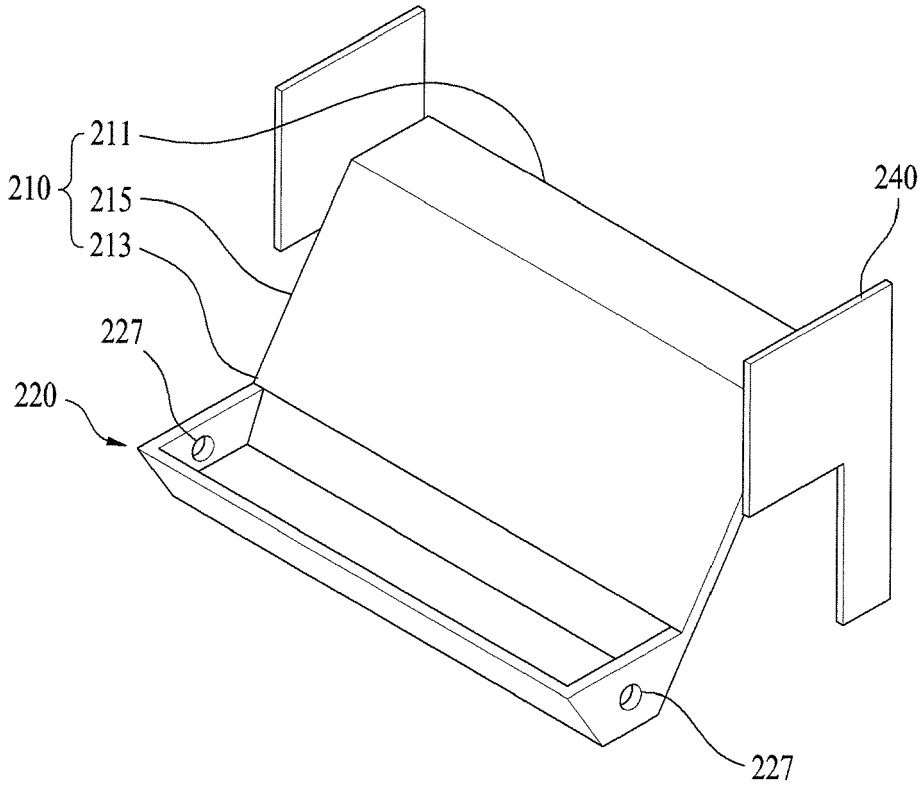


FIG. 6

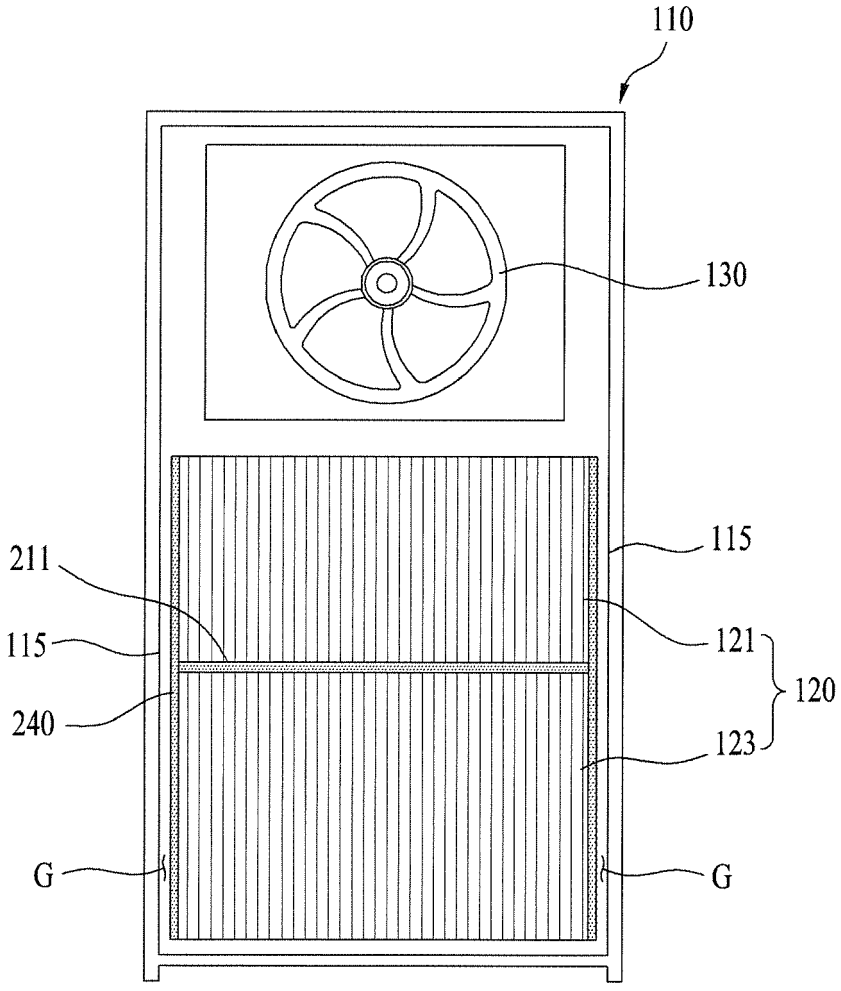


FIG. 7

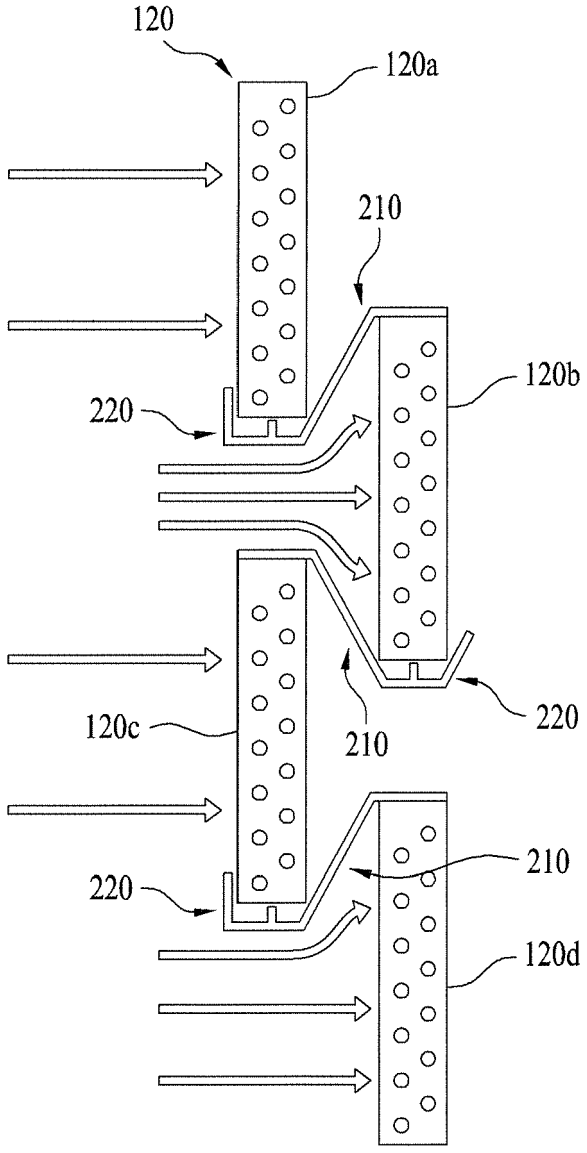


FIG. 8A

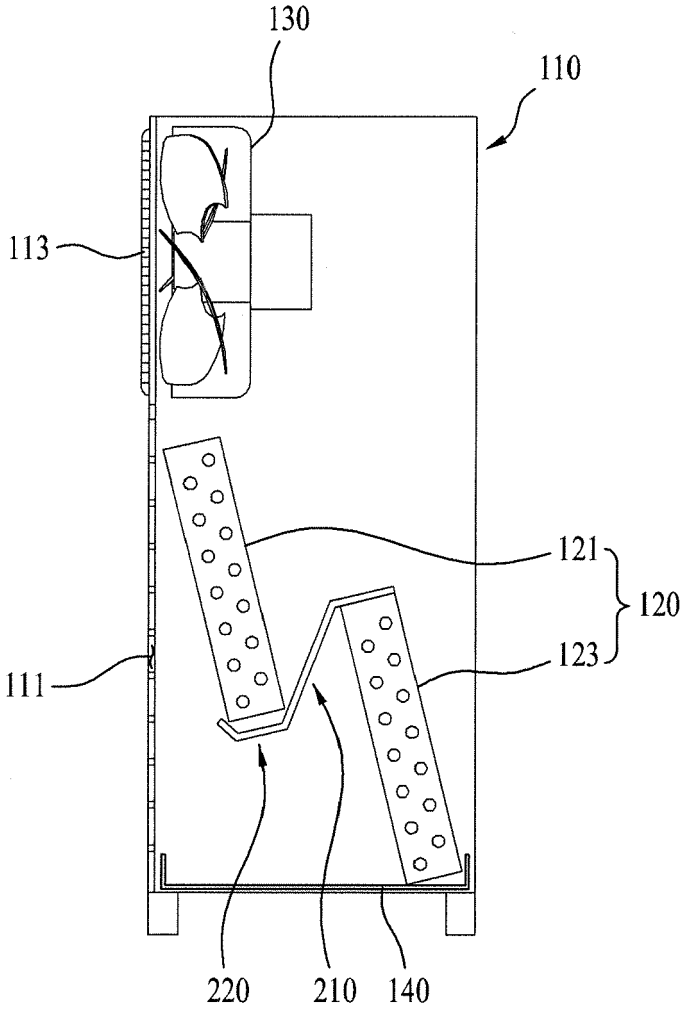


FIG. 8B

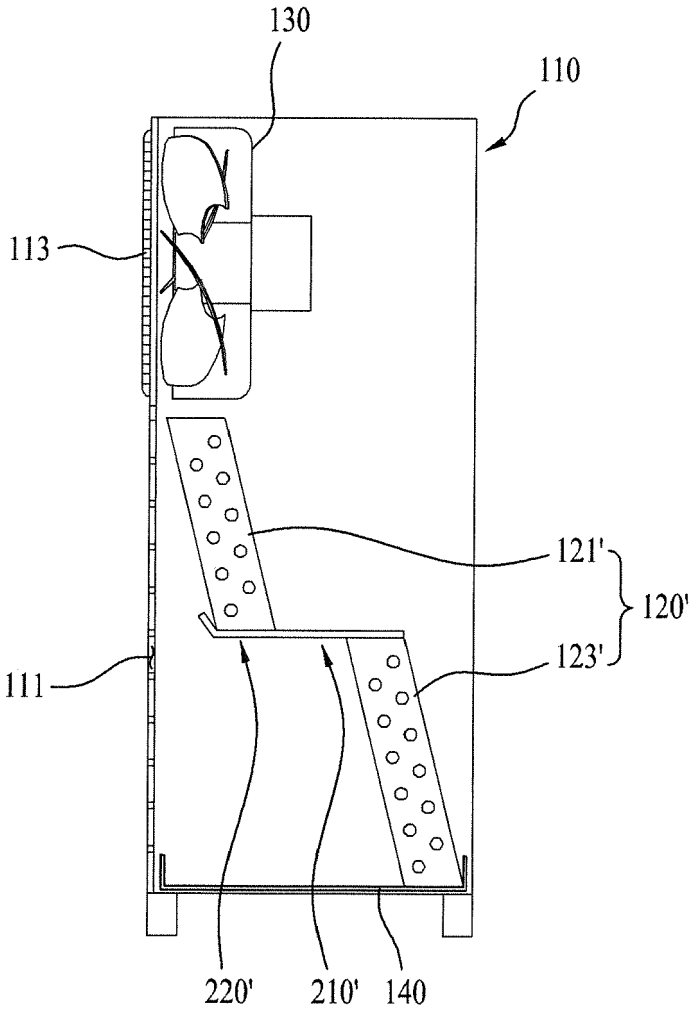


FIG. 9

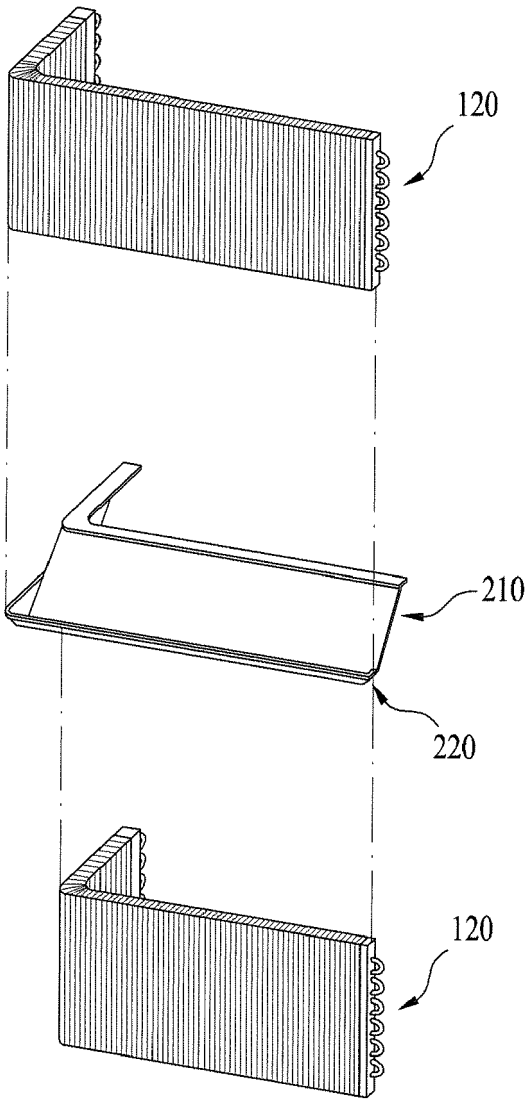


FIG. 10

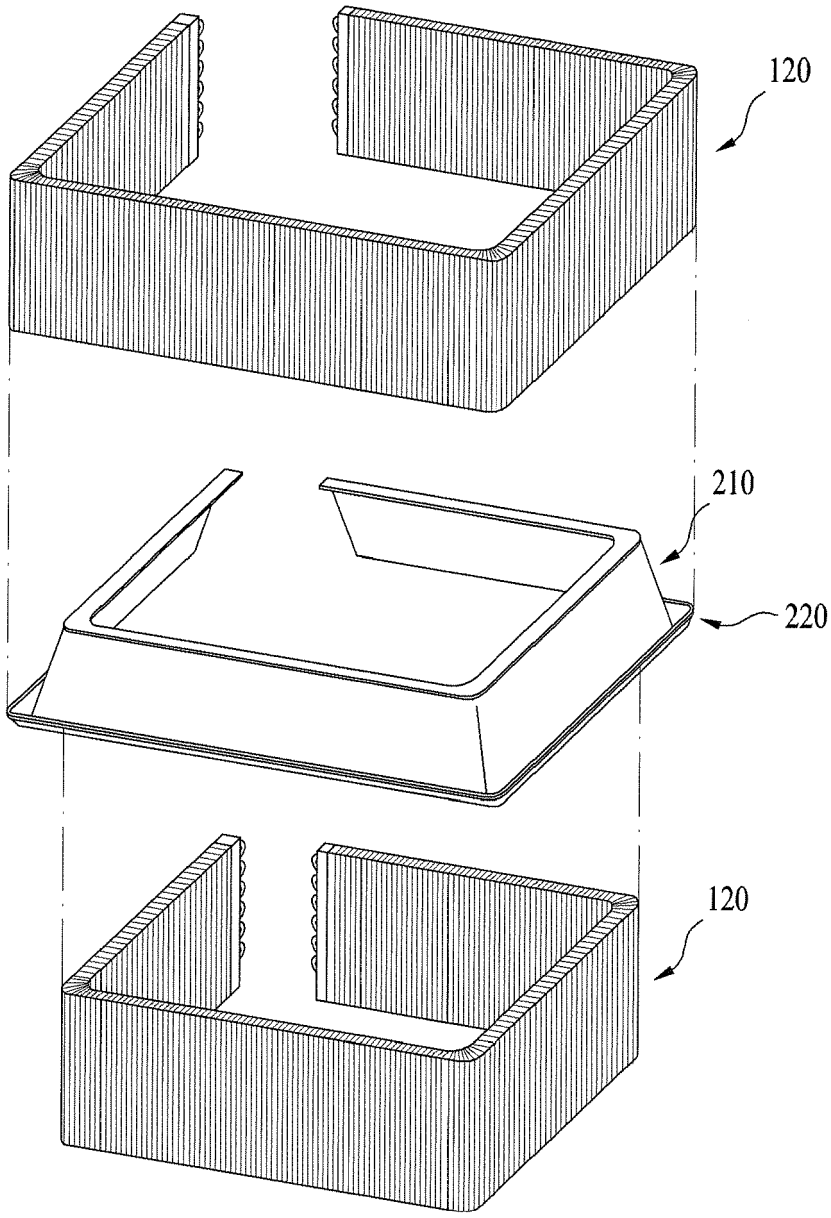


FIG. 11

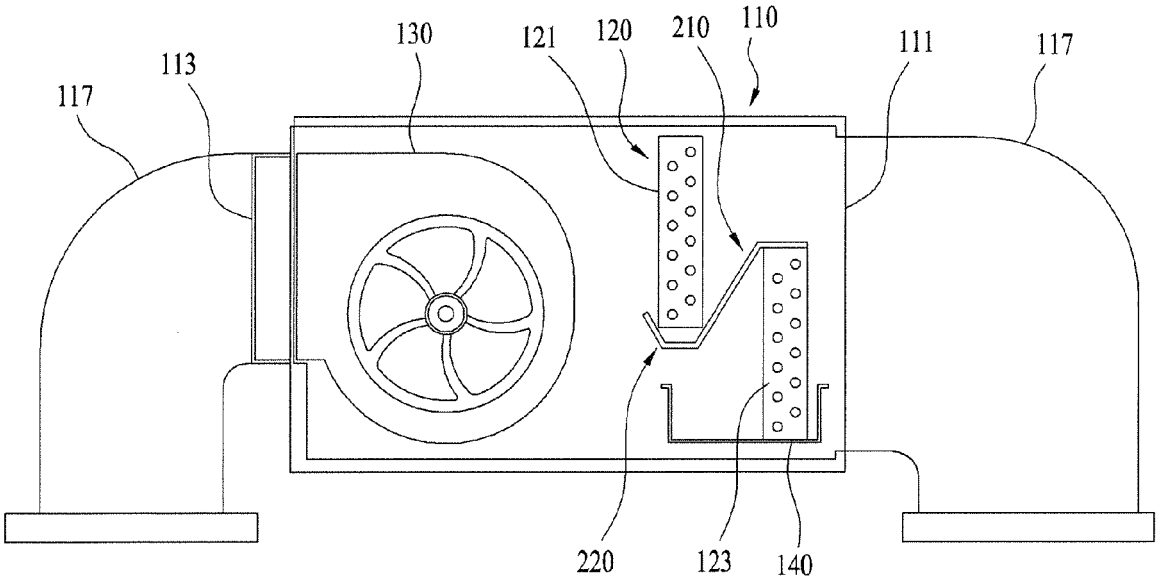


FIG. 12

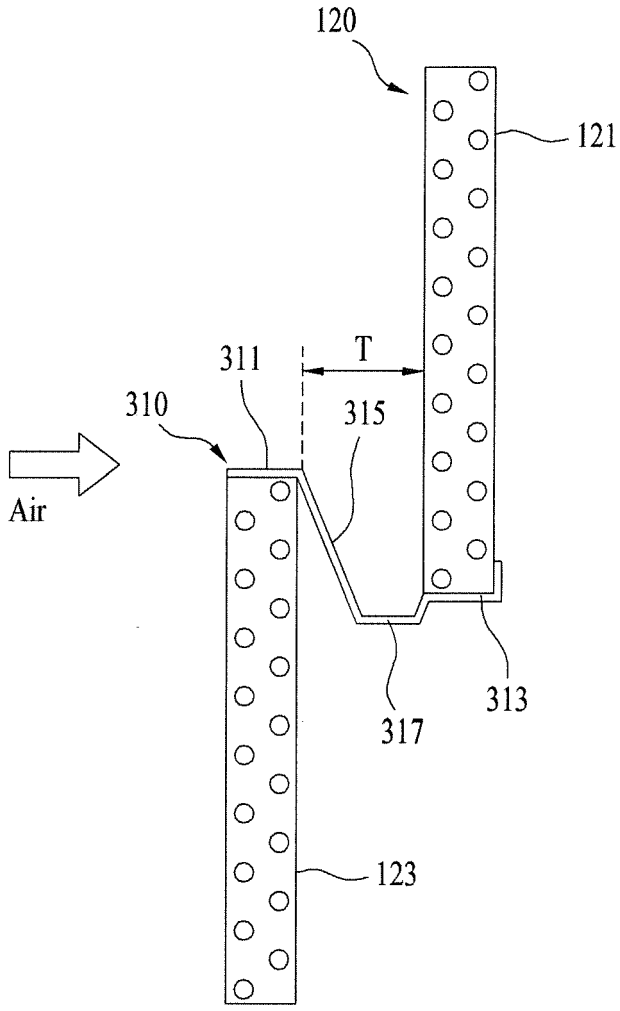


FIG. 13A

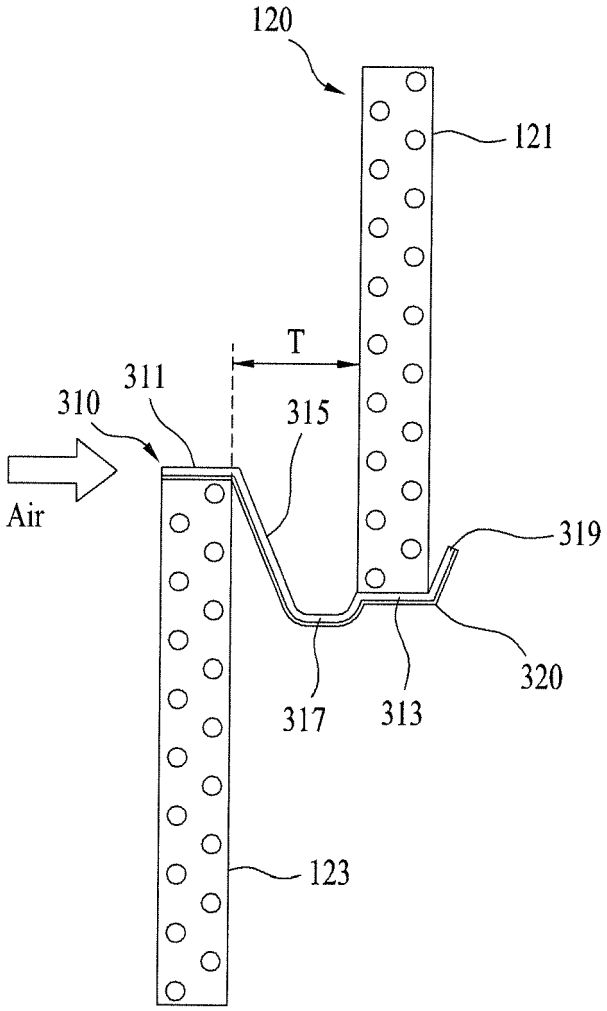


FIG. 13B

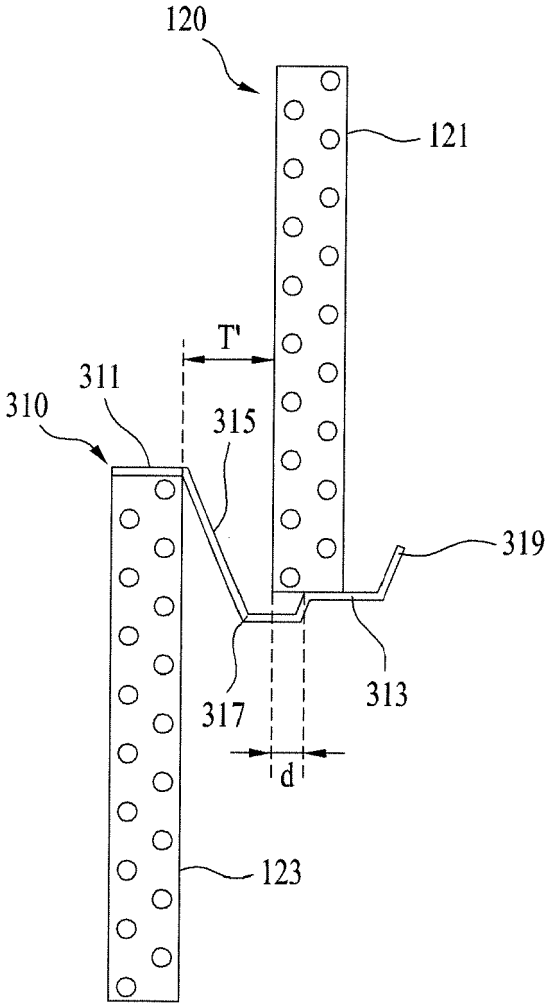


FIG. 14

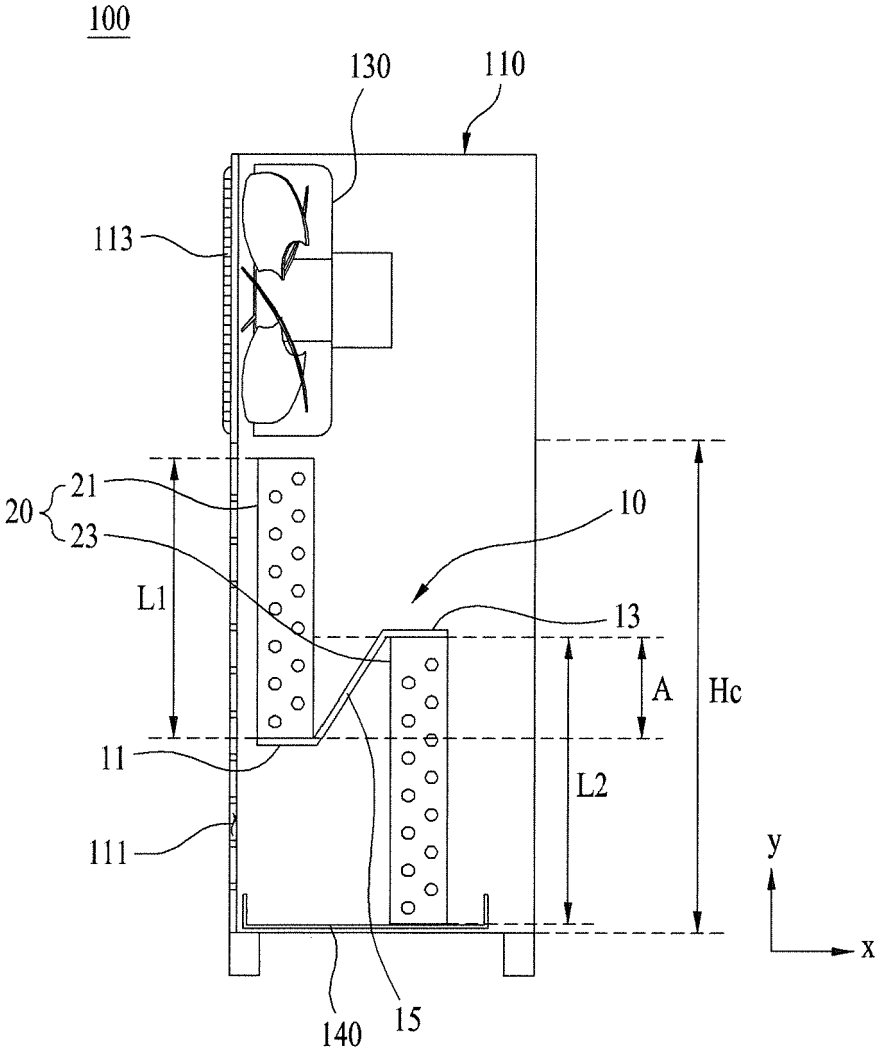


FIG. 15

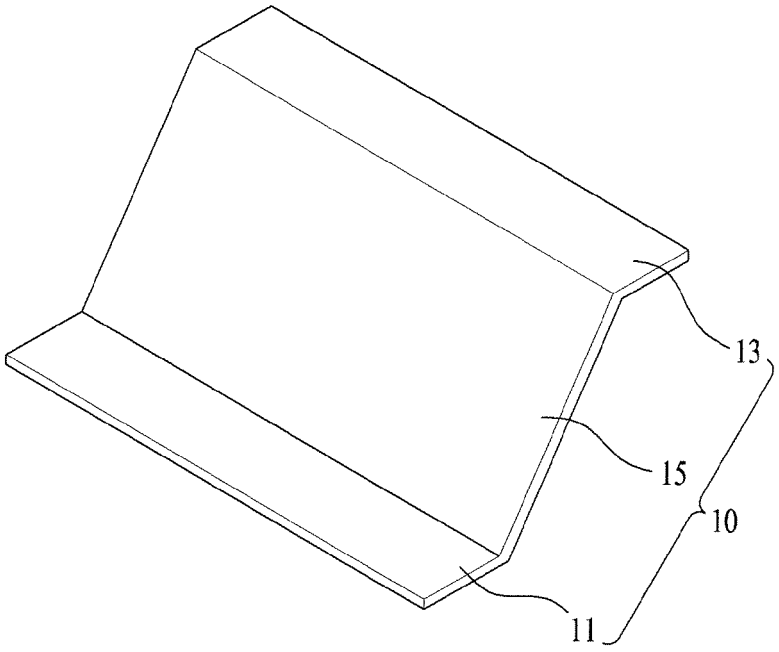


FIG. 16

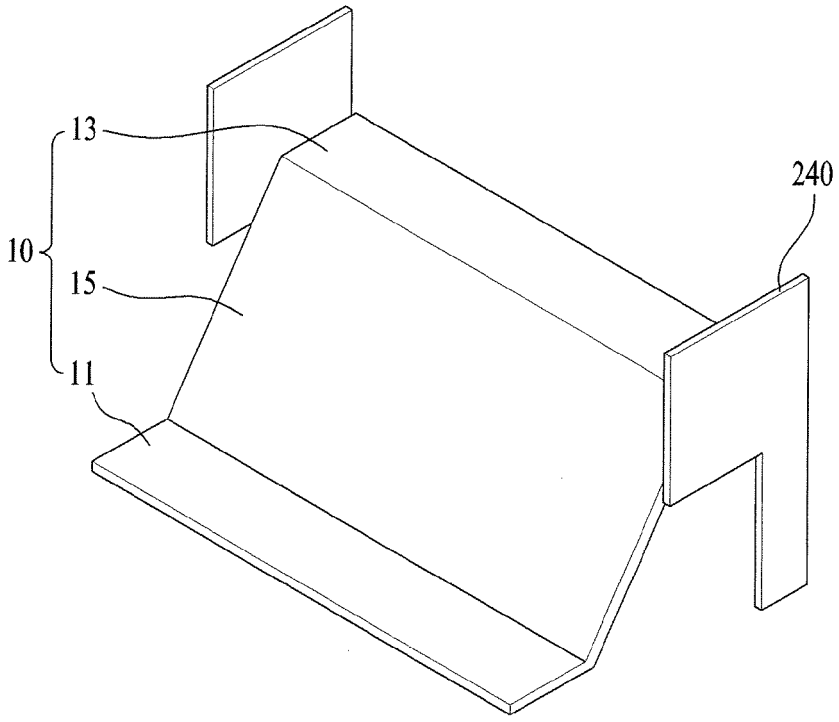


FIG. 17A

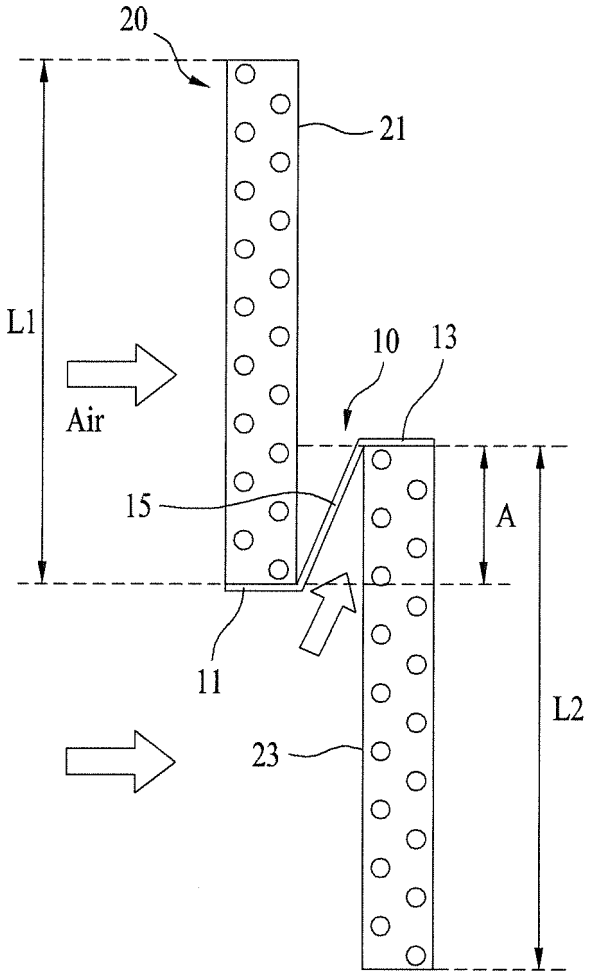


FIG. 17B

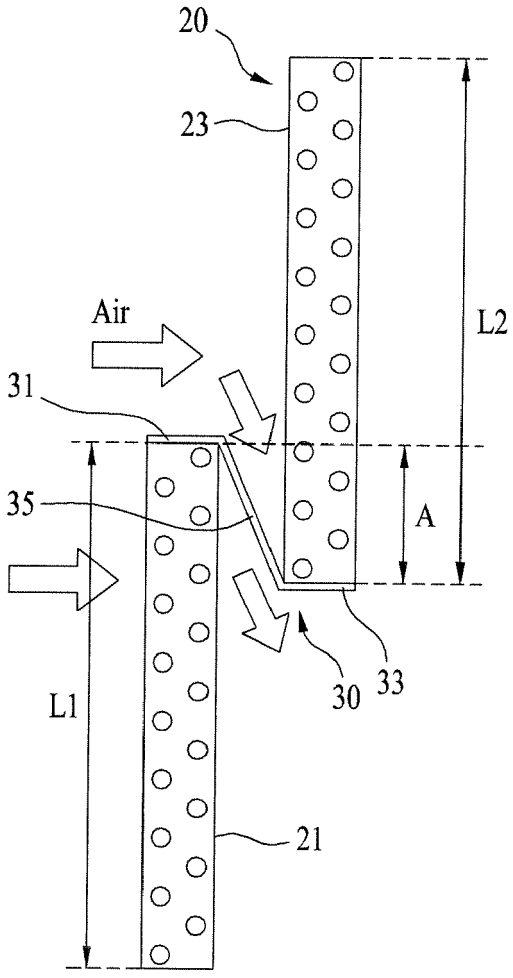
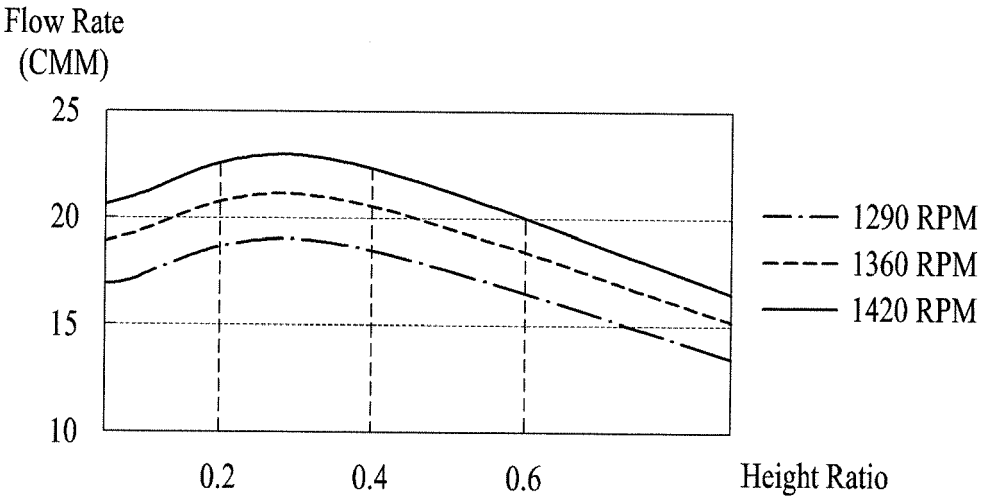


FIG. 18


Flow Rate
(CMM)
25
20
15
10
0.2
0.4
0.6
Height Ratio
1290 RPM
1360 RPM
1420 RPM