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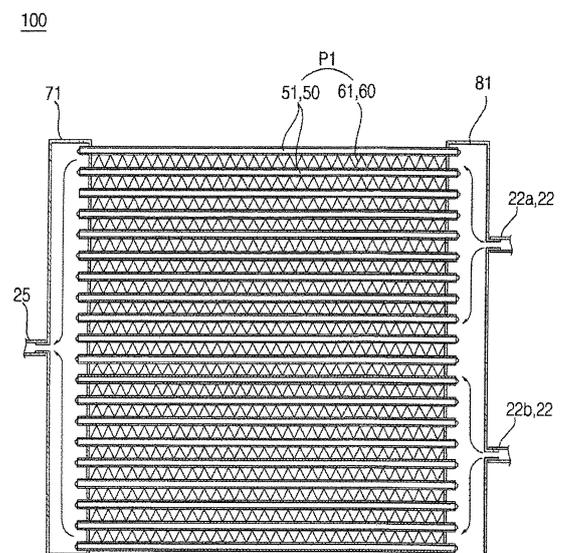
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(54) **HEAT EXCHANGER OF REFRIGERATOR**

(57) A heat exchanger for a refrigerator, which is of a microchannel type, according to the present invention includes a first heat exchange unit including a plurality of flat tubes, which serves to exchange heat between refrigerant and are connected to an introduction pipe, a second heat exchange unit including a plurality of flat tubes, which serve to exchange heat between the refrigerant and air and are disposed outside the first heat exchange unit so as to be connected to a discharge tube, and a connecting pipe connecting the first heat exchange unit to the second heat exchange unit to supply the refrigerant to the second heat exchange unit, wherein the first heat exchange unit is disposed so as to exchange heat with air, and wherein a total cross-sectional area of the flat tubes of the first heat exchange unit is larger than that of the flat tubes of the second heat exchange unit.

FIG. 5



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Description

[Disclosure]

[Technical Field]

[Technical Problem]

[0001] The present invention relates to a heat exchanger for a refrigerator.

5 **[0009]** It is an object, which is intended to be accomplished by the present invention, to provide a heat exchanger for a refrigerator, which enables refrigerant to efficiently flow even when the heat exchanger is used as a condenser.

[Background Art]

[0002] In general, a heat exchanger may be used as a condenser or an evaporator in a refrigeration cycle apparatus, which is composed of a compressor, a condenser, an expander and an evaporator.

10 **[0010]** It is another object of the present invention to provide a heat exchanger for a refrigerator, which includes a plurality of rows in order to improve heat exchange.

[0003] A heat exchanger is mounted in a vehicle, a refrigerator or the like so as to exchange heat between refrigerant and air.

15 **[0011]** It is a further object of the present invention to provide a heat exchanger for a refrigerator, which minimizes the difference in pressure between the plurality of rows.

[0004] A heat exchanger may be classified into a fin-tube-type heat exchanger, a microchannel-type heat exchanger and the like.

20 **[0012]** The objects of the present invention are not limited to the above-mentioned objects, and other objects, which are not mentioned, will be apparent to and understood by those skilled in the art from the following disclosure.

[0005] The fin-tube-type heat exchanger is made of a copper material, and the microchannel-type heat exchanger is made of an aluminum material.

[Technical Solution]

[0006] Since the microchannel-type heat exchanger is provided therein with fine flow passages, the microchannel-type heat exchanger has an advantage in that efficiency thereof is better than that of the fin-tube-type heat exchanger.

25 **[0013]** A heat exchanger for a refrigerator according to the present invention is characterized in that a second heat exchange unit first exchanges heat with external air before a first heat exchange unit and in that the total cross-sectional area of the flat tubes of the first heat exchange unit is larger than the total cross-sectional area of the flat tubes of the second heat exchange unit.

[0007] Because a small-sized microchannel-type heat exchanger, which is used in a conventional refrigerator or the like, is manufactured in a one turn manner, there are problems in that only a simple refrigerant pass can be designed and in that heat exchange efficiency is decreased. Furthermore, since the small-sized microchannel-type heat exchanger, which is used in a refrigerator or the like, is constructed such that the numbers of refrigerant tubes disposed at an inlet and an outlet are equal to each other, the heat exchange capability is increased but efficiency of heat exchange is decreased in a zone in which a high-temperature refrigerant is introduced because the difference in temperature between the refrigerant and air is increased, whereas the heat exchange capability is decreased but efficiency of heat exchange is increased in a zone in which a low-temperature refrigerant is discharged because the difference in temperature between the refrigerant and air is decreased, thereby producing a problem whereby the overall efficiency of heat exchange is deteriorated.

30 **[0014]** The heat exchanger for a refrigerator is characterized in that, when an intermediate heat exchange unit is disposed between the first heat exchange unit and the second heat exchange unit, the total cross-sectional area of the flat tubes of the intermediate heat exchange unit is equal to or smaller than the total cross-sectional area of the flat tubes of the first heat exchange unit.

[0008] In addition, because a refrigerant tube of the conventional heat exchanger has the same cross-sectional area in the zone in which the refrigerant is introduced and in the zone in which the refrigerant is discharged, it is impossible to consider variation in the specific volume of the refrigerant, thereby causing a problem in which the amount of heat exchange is decreased.

35 **[0015]** The heat exchanger for a refrigerator according to the present invention is characterized in that the inner diameter of the flat tubes of the first heat exchange unit is equal to the inner diameter of the second flat tubes and in that the number of flat tubes of the first heat exchange unit is larger than the number of flat tubes of the second heat exchange unit.

[Advantageous Effects]

40 **[0016]** The heat exchanger for a refrigerator according to the present invention has one or more of the following effects.

45 **[0017]** First, since the second heat exchange unit first exchanges heat with external air before the first heat exchange unit and since the total cross-sectional area of the flat tubes of the first heat exchange unit is larger than the total cross-sectional area of the flat tubes of the second heat exchange unit, there is an advantage in that it

is possible to realize the optimal amount and efficiency of heat exchange relative to the specific volume of the refrigerant.

[0018] Second, it is possible to maximize utilization of space by arranging the heat exchange planes of the first heat exchange unit in a plurality of rows.

[0019] Third, since the difference in refrigerant pressure between the first heat exchange unit and the second heat exchange unit is decreased even when a plurality of microchannel-type heat exchangers are layered one on top of another, there is an advantage in that the refrigerant efficiently flows.

[0020] Fourth, it is possible to use the intermediate heat exchange unit when an increased amount of heat exchange is strongly required, and it is also possible to increase the efficiency and amount of heat exchange when the intermediate heat exchange unit is used.

[Description of Drawings]

[0021]

FIG. 1 is a block diagram illustrating a refrigeration cycle apparatus according to a first embodiment of the present invention;

FIG. 2 is a perspective view illustrating the interior of an outdoor unit shown in FIG. 1;

FIG. 3 is a perspective view of the outdoor heat exchanger shown in FIG. 2;

FIG. 4 is an exploded perspective view of the outdoor heat exchanger shown in FIG. 2;

FIG. 5 is a cross-sectional view of a first heat exchange unit shown in FIG. 4;

FIG. 6 is a cross-sectional view of a second heat exchange unit shown in FIG. 4.

FIG. 7 is a graph illustrating an amount of heat exchange according to the area ratio of the flat tubes of the first heat exchange unit and the flat tubes of the second heat exchange unit;

FIG. 8 is a plan view of an outdoor heat exchanger according to a second embodiment of the present invention;

FIG. 9 is a plan view of an outdoor heat exchanger according to a third embodiment of the present invention; and

FIG. 10 is a plan view of an outdoor heat exchanger according to a fourth embodiment of the present invention.

[Best Mode]

[0022] Reference will now be made in detail to embodiments, examples of which are illustrated in the accompanying drawings. However, the present disclosure may be embodied in many different forms and should not be construed as being limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will

fully convey the scope of the disclosure to those skilled in the art. The present disclosure is defined only by the categories of the claims. In certain embodiments, detailed descriptions of device constructions or processes well known in the art may be omitted in order to avoid obscuring appreciation of the disclosure by a person of ordinary skill in the art. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0023] Spatially relative terms such as "below", "beneath", "lower", "above", or "upper" may be used herein to describe one element's relationship to another element as illustrated in the figures. It will be understood that such spatially relative terms are intended to encompass different orientations of the device in addition to the orientation depicted in the figures. For example, if the device in one of the figures is inverted, elements described as "below" or "beneath" other elements would then be oriented "above" or "above" the other elements. The exemplary terms "below" or "beneath" can, therefore, encompass the positional relationships of both above and below. Since the device may be oriented in another direction, the spatially-relative terms may be interpreted in accordance with the orientation of the device.

[0024] The terminology used in the present disclosure is for the purpose of describing particular embodiments only, and is not intended to limit the disclosure. As used in the disclosure and the appended claims, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising", when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0025] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meanings as those commonly understood by one of ordinary skill in the art. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having meanings consistent with their meaning in the context of the relevant art and the present disclosure, and are not to be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0026] In the drawings, the thickness or size of each layer is exaggerated, omitted, or schematically illustrated for convenience of description and clarity. Also, the size or area of each constituent element may not accurately reflect the actual size thereof.

[0027] Angles or directions used to describe the structures according to embodiments are based on those shown in the drawings. Unless there is, in the specification, no definition of a reference point to describe angular positional relations in the structures according to embodiments, reference may be made to the associated draw-

ings.

[0028] Hereinafter, the present invention will be described in detail with reference to the accompanying drawings.

[0029] FIG. 1 is a block diagram illustrating a refrigeration cycle apparatus according to a first embodiment of the present invention. FIG. 2 is a perspective view illustrating the interior of an outdoor unit shown in FIG. 1.

[0030] Referring to FIGS. 1 and 2, the refrigeration cycle apparatus according to the embodiment may include a compressor 10 for compressing a refrigerant, an outdoor heat exchanger 20 at which the refrigerant exchanges heat with the outdoor air, an expander 12 at which the refrigerant is expanded, and an indoor heat exchanger 13 at which the refrigerant exchanges heat with the indoor air.

[0031] The refrigerant, which has been compressed in the compressor 10, may exchange heat with the outdoor air and may thus be condensed while passing through the outdoor heat exchanger 20.

[0032] The outdoor heat exchanger 20 may be used as a condenser.

[0033] The refrigerant, which has been condensed in the outdoor heat exchanger, may flow to the expander 12 and may then be expanded therein. The refrigerant, which is expanded in the expander 12, may exchange heat with the indoor air and may thus evaporated while passing through the indoor heat exchanger 13.

[0034] The indoor heat exchanger 12 may be used as an evaporator for evaporating the refrigerant.

[0035] The refrigerant, which has been evaporated in the heat exchanger 12, may be recovered to the compressor 10.

[0036] The refrigerant is circulated through the compressor 10, the outdoor heat exchanger 20, the expander 12 and the indoor heat exchanger 13 in a cooling cycle.

[0037] An introduction flow passage for the compressor 10, which serves to guide the refrigerant that has passed through the indoor heat exchanger 13 to the compressor 10, may be connected to the compressor 10. The introduction flow passage for the compressor 10 may be provided with an accumulator 14 in which the liquid refrigerant is accumulated.

[0038] A refrigerant flow passage, through which the refrigerant passes, may be formed in the indoor heat exchanger 13.

[0039] The refrigeration cycle apparatus may be a split-type air conditioner, in which the indoor unit I and the outdoor unit O are separated from each other. In this case, the compressor 10 and the outdoor heat exchanger 20 may be provided in the outdoor unit O. The refrigeration cycle apparatus may be a refrigerator, in which the indoor heat exchanger 13 may be disposed so as to exchange heat with the air in a foodstuff storage compartment and the outdoor heat exchanger 20 may be disposed so as to exchange heat with the air outside the foodstuff storage compartment. In the case of a refrigerator, both the indoor unit I and the outdoor unit O may be disposed in the

refrigerator body.

[0040] The expander 12 may be provided in any one of the indoor unit I and the outdoor unit O.

[0041] The indoor heat exchanger 13 may be provided in the indoor unit I.

[0042] The outdoor unit O may be provided with an outdoor fan 15 for blowing the outdoor air to the outdoor heat exchanger 20.

[0043] The indoor unit I may be provided with an indoor fan 16 for blowing the indoor air to the indoor heat exchanger 13.

[0044] FIG. 3 is a perspective view of the outdoor heat exchanger 20 shown in FIG. 2. FIG. 4 is an exploded perspective view of the outdoor heat exchanger 20 shown in FIG. 2. FIG. 5 is a cross-sectional view of a first heat exchange unit 100 shown in FIG. 4. FIG. 6 is a cross-sectional view of a second heat exchange unit 200 shown in FIG. 4.

[0045] The outdoor heat exchanger 20 is a microchannel-type heat exchanger. The outdoor heat exchanger 20 is made of an aluminum material.

[0046] The outdoor heat exchanger 20 is composed of the first heat exchange unit 100 and the second heat exchange unit 200. Unlike the embodiment, the outdoor heat exchanger 20 may be composed of two or more heat exchange units, which are layered one on top of another.

[0047] The outdoor heat exchanger 20 includes the first heat exchange unit 100, the second heat exchange unit 200, which is layered on the first heat exchange unit 100, an introduction pipe 22 connected to the first heat exchange unit 100 so as to supply the refrigerant thereto, a discharge pipe 24 connected to the second heat exchange unit 200 so as to discharge the refrigerant, and a connecting pipe 25 connecting the first heat exchange unit 100 to the second heat exchange unit 200 so as to allow the refrigerant to flow from the first heat exchange unit 100 to the second heat exchange unit 200.

[0048] The first heat exchange unit 100 is disposed so as to exchange heat with the air that has exchanged heat with the second heat exchange unit 200. Specifically, the first heat exchange unit 100 and the second heat exchange unit 200 are disposed along the path through which the outdoor air flows. The outdoor air primarily exchanges heat with the second heat exchange unit 200 and secondly exchanges heat with the first heat exchange unit 100. More specifically, the outdoor unit is provided with an air introduction part H1, into which the outdoor air is introduced, and an air discharge part H2, from which the air that has exchanged heat with the heat exchange units is discharged. The second heat exchange unit 200 is disposed closer to the air introduction part H1 than the first heat exchange unit 100 is.

[0049] Consequently, the first heat exchange unit 100, through which high-temperature refrigerant flows, is disposed in a zone in which the temperature of external air is high, and the second heat exchange unit 200, through which low-temperature refrigerant flows, is disposed in

a zone in which the temperature of external air is low, thereby improving the efficiency of heat exchange of the outdoor heat exchanger 20.

[0050] The first heat exchange unit 100 and the second heat exchange unit 200 may be disposed so as to define heat exchange planes P, which are orthogonal to the direction in which air flows. The first heat exchange unit 100 and the second heat exchange unit 200 define heat exchange planes, which are orthogonal to the direction in which the air flows and through which the air passes while exchanging heat therewith. The first heat exchange unit 100 and the second heat exchange unit 200 may be layered one on top of another in the direction in which the air flows.

[0051] Each of the first heat exchange unit 100 and the second heat exchange unit 200 is prepared by layering a plurality of flat tubes 50 one on top of another. The first heat exchange unit 100 and the second heat exchange unit 200 are constructed such that the flat tubes 50 are disposed horizontally so as to allow the refrigerant to flow horizontally.

[0052] Specifically, when the air flows in an anteroposterior direction, the flat tubes 50 of the first heat exchange unit 100 and the second heat exchange unit 200 may be longitudinally disposed horizontally (laterally) and may be layered one on top of another vertically. The air exchanges heat with the refrigerant in the flat tubes 50 while passing through the spaces between the plurality of flat tubes 50, which are layered one on top of another vertically (longitudinally). The plurality of flat tubes 50, which are layered one on top of another vertically, define the heat exchange plane P1 in conjunction with fins 60, which will be described later.

[0053] The first heat exchange unit 100 may include the flat tubes 50, a left header, a right header and the fins 60. Specifically, the first heat exchange unit 100 includes a plurality of first flat tubes 51 in which a plurality of flow passages are defined, first fins 61 connecting the first flat tubes 51 to each other in order to allow heat to be conducted therebetween, a first left header 71, which is coupled to first side ends of the plurality of first flat tubes 51 and which communicates with the first side ends of the plurality of first flat tubes 51 so as to allow the refrigerant to flow therethrough, and a first right header 81, which is coupled to the second side ends of the plurality of first flat tubes 51 and which communicates with the second side ends of the plurality of first flat tubes 51 so as to allow the refrigerant to flow therethrough.

[0054] The first flat tubes 51 are disposed so as to extend laterally. The first flat tubes 51 include therein flow passages, through which the refrigerant flows.

[0055] The first flat tubes 51 are disposed horizontally. The plurality of first flat tubes 51 are layered one on top of another in an up-and-down direction. The first flat tubes 51 may be provided therein with a plurality of flow passages.

[0056] The left side ends of the first flat tubes 51 communicate with the first left header 71, and the right side

ends of the first flat tubes 51 communicate with the first right header 81.

[0057] Each of the first fins 61 is bent in an up-and-down direction so as to connect two adjacent first flat tubes 51, which are layered one on top of another in an up-and-down direction, thereby allowing heat to be conducted therebetween.

[0058] The first right header 81 communicates with the second side ends of the plurality of first flat tubes 51. The right header 81 is oriented so as to extend in an up-and-down direction and is connected to the introduction pipe 22. The first right header 81 defines therein a single space such that the refrigerant, introduced through the introduction pipe 22, is distributed to the plurality of first flat tubes 51.

[0059] The first right header 81 may be connected to a single introduction pipe 22 or to a plurality of introduction pipes 22. In a first embodiment, the introduction pipe 22 may include a first introduction pipe 22a and a second introduction pipe 22b, which is disposed lower than the first introduction pipe 22.

[0060] The first left header 71 communicates with the first side ends of the plurality of first flat tubes 51. The first left header 71 is oriented so as to extend in an up-and-down direction and is connected to the connecting pipe 25. The first left header 71 defines therein a single space such that the refrigerant discharged from the second side ends of the plurality of first flat tubes 51 is guided to the connecting pipe 25.

[0061] The first left header 71 may be connected to a single connecting pipe 25 or to a plurality of connecting pipes 25. In the first embodiment, a single connecting pipe 25 is connected to the center of the first left header 71. The first side end of the connecting pipe 25 is connected to the first left header 71 of the first heat exchange unit 100, and the second side end of the connecting pipe 25 is connected to the second left header 70 of the second heat exchange unit 200.

[0062] The refrigerant that has been introduced through the introduction pipe 22 is supplied to the plurality of first flat tubes 51 through the first right header 81. The refrigerant that passes through the first flat tubes 51 exchanges heat with air, and is supplied to the connecting pipe 25 through the first left header 71. The introduction pipe 22 is connected to the compressor 10 so as to supply high-temperature and high-pressure refrigerant to the first heat exchange unit 100.

[0063] Like the first heat exchange unit 100, the second heat exchange unit 200 may include the plurality of flat tubes 50, the fins 60, the left header and the right header.

[0064] Specifically, the second heat exchange unit 200 includes a plurality of second flat tubes 52, second fins 62, a second left header 70 and a second right header 80.

[0065] The second heat exchange unit 200 includes the plurality of second flat tubes 52, which define therein a plurality of flow passages, the second fins 62 connecting the second flat tubes 52 to each other in order to allow heat to be conducted therebetween, the second left

header 70, which is coupled to first side ends of the plurality of second flat tubes 52 and which communicate with the first side ends of the plurality of second flat tubes 52 so as to allow the refrigerant to flow therethrough, and the second right header 80, which is coupled to the second side ends of the plurality of second flat tubes 52 and which communicates with the second side ends of the plurality of second flat tubes 52 so as to allow the refrigerant to flow therethrough.

[0066] The second flat tubes 52 are disposed so as to extend laterally. The second flat tubes 52 define therein the flow passages through which the refrigerant flows.

[0067] The second flat tubes 52 are disposed horizontally. The plurality of second flat tubes 52 are layered one on top of another in an up-and-down direction. The second flat tubes 52 define therein a plurality of flow passages.

[0068] The left side ends of the second flat tubes 52 communicate with the second left header 70, and the right side ends of the second flat tubes 52 communicate with the second right header 80.

[0069] The second fins 62 are bent in an up-and-down direction. Each of the second fins 62 connects two adjacent flat tubes 52, which are layered one on top of another in an up-and-down direction, in order to allow heat to be conducted therebetween.

[0070] The second right header 80 communicates with the second side ends of the second flat tubes 52. The second right header 80 is disposed so as to extend in an up-and-down direction, and is connected to the discharge pipe 24. The second right header 80 is provided therein with a single space such that the refrigerant that has been discharged from the plurality of second flat tubes 52 is supplied to the discharge pipe 24.

[0071] The second right header 80 may be connected to a single discharge pipe 24 or to a plurality of discharge pipes 24.

[0072] The second left header 70 communicates with the first side ends of the plurality of second flat tubes 52. The second left header 70 is disposed so as to extend vertically, and is connected to the connecting pipe 25. The second left header 70 is provided therein with a single space such that the refrigerant that has been supplied through the connecting pipe 25 is supplied to the second flat tubes 52.

[0073] The second left header 70 may be connected to a single connecting pipe 25 or to a plurality of connecting pipes 25. In the first embodiment, a single connecting pipe 25 is connected to the center of the second left header 70. Since the connecting pipe 25 connects the first left header 71 to the second left header 70, there are advantages in that the length of the connecting pipe 25 is reduced and manufacturing costs reduced.

[0074] Because the refrigerant, which exchanges heat in the first heat exchange unit 100, is high-temperature and high-pressure gas that is discharged from the compressor 10, the refrigerant has a high specific volume. The refrigerant, which exchanges heat in the second heat

exchange unit 200, is gas or a mixture of gas and liquid that has a lower temperature than the refrigerant in the first heat exchange unit 100, which completes the heat exchange. Accordingly, the refrigerant that exchanges heat in the second heat exchange unit has a lower specific volume than the refrigerant that exchanges heat in the first heat exchange unit 100.

[0075] If the first heat exchange unit 100 and the second heat exchange unit 200 are constructed such that the surface area of heat exchange of the first heat exchange unit 100 is equal to the surface area of heat exchange of the second heat exchange unit 200, there is a problem in that the amount of heat exchange and the efficiency of heat exchange in the first heat exchange unit 100 are greatly lowered because of the higher specific volume of the refrigerant in the first heat exchange unit 100.

[0076] Accordingly, according to the embodiment, by setting the total surface area of the flat tubes 50 of the first heat exchange unit 100 to be higher than the total surface area of the flat tubes 50 of the second heat exchange unit 200, it is possible to increase the amount of heat exchange in the first heat exchange unit 100.

[0077] For example, the ratio of the total surface area of the flat tubes 50 of the first heat exchange unit 100 to the total surface area of the flat tubes 50 of the second heat exchange unit 200 may be set to be 7-9 : 1-2. The ratio of the total surface area of the flat tubes 50 of the first heat exchange unit 100 to the total surface area of the flat tubes 50 of the second heat exchange unit 200 is preferably 8 : 2. Here, the heat exchange between the first heat exchange unit 100 and the second heat exchange unit 200 is preferably minimized. Specifically, the heat exchange plane Pa of the first heat exchange unit 100 and the heat exchange plane P2 of the second heat exchange unit 200 are disposed so as to be spaced apart from each other.

[0078] Specifically, although the cross-sectional area of the flat tubes 50 of the first heat exchange unit 100 and the cross-sectional area of the flat tubes 50 of the second heat exchange unit 200 may be controlled by changing the inner diameters of the flat tubes 50, the number of flat tubes 50 having the same diameter is preferably changed in consideration of manufacturing cost and convenience.

[0079] The inner diameter of the flat tubes 50 of the first heat exchange unit 100 may be equal to the inner diameter of the second flat tubes 52, and the number of flat tubes 50 of the first exchange unit 100 may be greater than the number of flat tubes 50 of the second heat exchange unit 200. The inner diameter of the flat tubes 50 of the first heat exchange unit 100 may be equal to the inner diameter of the second flat tubes 52, and the ratio of the number of flat tubes 50 of the first heat exchange unit 100 to the number of flat tubes 50 of the second heat exchange unit 200 may be 7-9 : 1-2. The inner diameter of the flat tubes 50 of the first heat exchange unit 100 is preferably equal to the inner diameter of the second flat

tubes 52, and the ratio of the number of flat tubes 50 of the first heat exchange unit 100 to the number of flat tubes 50 of the second heat exchange unit 200 is preferably 8 : 2.

[0080] If the number of flat tubes 50 of the first heat exchange unit 100 is larger than the number of flat tubes 50 of the second heat exchange unit 200, the pitch between the first flat tubes 51 of the first heat exchange unit 100 is preferably equal to the pitch between the second flat tubes 52 of the second heat exchange unit 200. The pitch between the first flat tubes 51 of the first heat exchange unit 100 may, of course, be smaller than the pitch between the second flat tubes 52 of the second heat exchange unit 200.

[0081] For the purpose of more efficient heat exchange and air flow, the first flat tubes 51 of the first heat exchange unit 100 and the second flat tubes 52 of the second heat exchange unit may be disposed so as not overlap each other in a direction in which air flows (in an anteroposterior direction). The air that has passed through the space between the first flat tubes 51 of the first heat exchange unit 100 flows into the space between the second flat tubes 52 of the second heat exchange unit and is changed in direction thereat, whereby the time period for which the air remains is increased.

[0082] FIG. 7 is a graph illustrating the amount of heat exchange according to the area ratio of the flat tubes 50 of the first heat exchange unit 100 and the flat tubes 50 of the second heat exchange unit 200.

[0083] Referring to FIG. 7, it noted that the maximum amount of heat exchange is achieved when the inner diameter of the flat tubes 50 of the first heat exchange unit 100 is equal to the inner diameter of the second flat tubes 52 and the ratio of the number of the flat tubes 50 of the first heat exchange unit 100 to the number of the flat tubes 50 of the second heat exchange unit 200 is 8 : 2.

[0084] FIG. 8 is a plan view of an outdoor heat exchanger 20 according to a second embodiment of the present invention.

[0085] Comparing the second embodiment with the first embodiment, there is a difference as to the number of heat exchange planes of the first heat exchange unit 100 or the second heat exchange unit 200.

[0086] Referring to FIG. 8, the flat tubes 50 of the first heat exchange unit 100 or the second heat exchange unit 200 may be classified into a plurality of groups of flat tube 50, and the plurality of groups of flat tubes 50 may constitute a plurality of rows in the direction in which air flows.

[0087] Because the refrigerant in the first heat exchange unit 100 has a greater specific volume than the refrigerant in the second heat exchange unit 200, the number of flat tubes 50 of the first heat exchange unit 100 has to be larger than the number of flat tube 50 of the second heat exchange unit 200. Here, when each of the first heat exchange unit 100 and the second heat exchange unit 200 is disposed in a single row, there is a problem in that the size of the first heat exchange unit

100 is overly increased.

[0088] Accordingly, the heat exchange planes of the first heat exchange unit 100 are disposed in multiple rows in the second embodiment. Specifically, the plurality of first flat tubes 51 of the first heat exchange unit 100 are disposed at a predetermined pitch in an up-and-down direction so as to constitute one group, thereby defining one heat exchange plane P1. The plurality of groups of flat tubes 50 may define a plurality of rows in the direction in which air flows (in an anteroposterior direction). In other words, the heat exchange planes pla, plb and P1c are spaced apart from each other in an anteroposterior direction, thereby defining a plurality of rows.

[0089] In this case, the left header or the right header may be composed of a plurality of headers, which correspond to the respective heat exchange planes. The right header 81 is composed of three headers, which are disposed at the first side of three heat exchange planes of the first heat exchange unit 100. Each of the first right headers 81 is connected to the introduction pipe 22. The first left header 71 may be disposed at each of the heat exchange planes of the first heat exchange unit 100. The first left header 71 is composed of three headers, which are disposed at the second side ends of the three heat exchange planes of the first heat exchange unit 100. Each of the first left headers 71 is connected to the connecting pipe 25.

[0090] Consequently, it is possible to maximize utilization of space by arranging the first heat exchange unit 100 in a plurality of rows in a confined space while increasing the area of heat exchange of the first heat exchange unit 100.

[0091] FIG. 9 is a plan view of an outdoor heat exchanger 20 according to a third embodiment of the present invention.

[0092] Comparing the third embodiment with the second embodiment, there is a difference as to the structure of the left header or the right header.

[0093] Referring to FIG. 9, the left header or the right header according to the third embodiment may communicate with a plurality of flat tubes 50, which are disposed on each of heat exchange planes. Specifically, the first left header 71 of the first heat exchange unit 100 communicates with the plurality of heat exchange planes. The first heat exchange unit 100 has a structure in which one first left header 71 communicates with the plurality of heat exchange planes. The first right header 81 of the first heat exchange unit 100 communicates with the plurality of heat exchange planes. The first heat exchange unit 100 has a structure in which one first right header 81 communicates with the plurality of heat exchange planes.

[0094] Consequently, since it is possible to share the left header or the right header, manufacturing costs are reduced.

[0095] FIG. 10 is a plan view of an outdoor heat exchanger 20 according to a fourth embodiment of the present invention.

[0096] Comparing the fourth embodiment with the third

embodiment, there is a difference in that an intermediate heat exchange unit 300 is further provided.

[0097] Referring to FIG. 10, the intermediate heat exchange unit 300 includes a plurality of flat tubes 50, in which the refrigerant and air exchange heat with each other. The intermediate heat exchange unit 300 exchanges heat with the refrigerant that has been discharged from the first heat exchange unit 100 and supplies the refrigerant to the second heat exchange unit 200.

[0098] The intermediate heat exchange unit 300 is disposed so as to exchange heat with the refrigerant that has passed through the first heat exchange unit 100 and then to supply the refrigerant to the second heat exchange unit 200.

[0099] Like the first heat exchange unit 100, the intermediate heat exchange unit 300 may include the flat tubes 50, a third left header 73, a third right header 83 and fins 60.

[0100] Specifically, the left side ends of the flat tubes 50 of the intermediate heat exchange unit 300 are connected to the third left header 73, and the right side ends of the flat tubes 50 are connected to the third right header 83. The flat tubes 50 of the intermediate heat exchange unit 300 define heat exchange planes P3.

[0101] The third left header 73 is connected to the first left header 71 via a first connecting pipe 25a, and the third right header 83 is connected to the second right header 80 via a second connecting pipe 25b.

[0102] The specific volume of the refrigerant in the intermediate heat exchange unit 300 is smaller than the specific volume of the refrigerant in the first heat exchange unit 100 but is larger than the specific volume of the refrigerant in the second heat exchange unit 200.

[0103] The total cross-sectional area of the flat tubes 50 of the intermediate heat exchange unit 300 may be equal to or smaller than the total cross-sectional area of the flat tubes 50 of the first heat exchange unit 100, but may be equal to or greater than the total cross-sectional area of the flat tubes 50 of the second heat exchange unit 200.

[0104] The ratio of the total cross-sectional area of the flat tubes 50 of the first heat exchange unit 100, the total cross-sectional area of the flat tubes 50 of the intermediate heat exchange unit 300 and the total cross-sectional area of the flat tubes of the second heat exchange unit 200 may be 7-9 : 7-9 : 1-2.

[0105] Specifically, as mentioned above, for the purpose of convenience in manufacture, the inner diameter of the flat tubes 50 of the first heat exchange unit 100, the inner diameter of the second flat tubes 52 and the inner diameter of the flat tubes 50 of the intermediate heat exchange unit 300 may be equal to one another, and the number of flat tubes 50 of the intermediate heat exchange unit 300 may be equal to or smaller than the number of flat tubes of the first heat exchange unit 100 but may be equal to or larger than the number of flat tubes 50 of the second heat exchange unit 200.

[0106] Accordingly, it is possible to use the intermedi-

ate heat exchange unit 300 in a circumstance in which a greatly increased amount of heat exchange is required. It is possible to increase the efficiency of heat exchange and the amount of heat exchange even when the intermediate heat exchange unit 300 is used.

[0107] Although the embodiments of the present invention have been described with reference to the accompanying drawings, it will be understood that the present invention is not limited to the above embodiments and may be embodied in various forms and that other specific forms may be advised by a person having ordinary skill in the art to which the present invention pertains without changing the technical idea or the essential characteristics of the present invention. Accordingly, it is to be understood that the above-described embodiments are illustrative and not restrictive in all aspects.

Claims

1. A heat exchanger for a refrigerator, which is of a microchannel type, comprising:

a first heat exchange unit including a plurality of flat tubes for exchanging heat between refrigerant and air, the first heat exchange unit being connected to an introduction pipe into which the refrigerant is introduced;

a second heat exchange unit including a plurality of flat tubes for exchanging heat between the refrigerant and air, the second heat exchange unit being disposed outside the first heat exchange unit and being connected to a discharge tube from which the refrigerant is discharged; and

a connecting pipe connecting the first heat exchange unit to the second heat exchange unit so as to supply the refrigerant that has been discharged from the first heat exchange unit to the second heat exchange unit, wherein the first heat exchange unit is disposed so as to exchange heat with air that has exchanged heat with the second heat exchange unit, and

wherein a ratio of a total cross-sectional area of the flat tubes of the first heat exchange unit and a total cross-sectional area of the flat tubes of the second heat exchange unit is 7-9 : 1-2.

2. The heat exchanger according to claim 1, further comprising:

an air introduction portion into which external air is introduced; and

an air discharge portion, from which the air that has been introduced into the air introduction portion and has exchanged heat with the heat exchange units, is discharged,

- wherein the second heat exchange unit is disposed closer to the air introduction portion than the first heat exchange unit is.
3. The heat exchanger according to claim 1, wherein the flat tubes of the first heat exchange unit are classified into a plurality of groups of flat tubes, the plurality of groups of flat tubes defining a plurality of rows in a direction in which air flows.
 4. The heat exchanger according to claim 1, wherein the first heat exchange unit or the second heat exchange unit includes:
 - the plurality of flat tubes, which extend laterally and which are longitudinally spaced apart from each other;
 - fins connecting the plurality of flat tubes to each other so as to conduct heat therebetween;
 - a left header coupled to first side ends of the plurality of flat tubes so as to communicate therewith and to allow the refrigerant to flow thereinto; and
 - a right header coupled to second side ends of the plurality of flat tubes so as to communicate therewith and to allow the refrigerant to flow thereinto.
 5. The heat exchanger according to claim 4, wherein, in the first heat exchange unit, the plurality of flat tubes and the plurality of fins connecting the plurality of flat tubes to each other define a heat exchange plane, which is orthogonal to a direction in which air flows, and wherein the heat exchange plane includes a plurality of heat exchange planes, which are spaced apart from each other.
 6. The heat exchanger according to claim 5, wherein the left header or the right header includes a plurality of headers, which are disposed so as to correspond to respective ones among the plurality of heat exchange planes.
 7. The heat exchanger according to claim 5, wherein the left header or the right header communicates with the plurality of flat tubes, which are disposed at the heat exchange plane.
 8. The heat exchanger according to claim 4, wherein the connecting pipe connects the left header of the first heat exchange unit to the right header of the second heat exchange unit.
 9. The heat exchanger according to claim 1, further comprising an intermediate heat exchange unit including a plurality of flat tubes for exchanging heat between the refrigerant and air, the intermediate heat exchange unit exchanging heat with refrigerant from the first heat exchange unit and supplying the refrigerant to the second heat exchange unit, wherein a total cross-sectional area of the flat tubes of the intermediate heat exchange unit is equal to or smaller than a total cross-sectional area of the flat tubes of the first heat exchange unit but is equal to or larger than a total cross-sectional area of the flat tubes of the second heat exchange unit.
 10. A heat exchanger for a refrigerator, which is of a microchannel type, comprising:
 - a first heat exchange unit including a plurality of flat tubes for exchanging heat between refrigerant and air, the first heat exchange unit being connected to an introduction pipe into which the refrigerant is introduced;
 - a second heat exchange unit including a plurality of flat tubes for exchanging heat between the refrigerant and air, the second heat exchange unit being disposed outside the first heat exchange unit and being connected to a discharge tube from which the refrigerant is discharged; and
 - a connecting pipe connecting the first heat exchange unit to the second heat exchange unit so as to supply the refrigerant that has been discharged from the first heat exchange unit to the second heat exchange unit, wherein the first heat exchange unit is disposed so as to exchange heat with air that has exchanged heat with the second heat exchange unit, wherein an inner diameter of the flat tubes of the first heat exchange unit is equal to an inner diameter of the second flat tubes, and wherein a ratio of a number of flat tubes of the first heat exchange unit and a number of flat tubes of the second heat exchange unit is 7-9 : 1-2.
 11. The heat exchanger according to claim 10, further comprising an intermediate heat exchange unit including a plurality of flat tubes for exchanging heat between the refrigerant and air, the intermediate heat exchange unit exchanging heat with refrigerant from the first heat exchange unit and supplying the refrigerant to the second heat exchange unit, wherein a number of flat tubes of the intermediate heat exchange unit is equal to or smaller than a number of flat tubes of the first heat exchange unit but is equal to or larger than a number of flat tubes of the second heat exchange unit.
 12. A heat exchanger for a refrigerator, which is of a microchannel type, comprising:

a first heat exchange unit including a plurality of flat tubes for exchanging heat between refrigerant and air, the first heat exchange unit being connected to an introduction pipe into which the refrigerant is introduced;

a second heat exchange unit including a plurality of flat tubes for exchanging heat between the refrigerant and air, the second heat exchange unit being disposed outside the first heat exchange unit and being connected to a discharge tube from which the refrigerant is discharged; and

a connecting pipe connecting the first heat exchange unit to the second heat exchange unit so as to supply the refrigerant that has been discharged from the first heat exchange unit to the second heat exchange unit,

wherein the first heat exchange unit is disposed so as to exchange heat with air that has exchanged heat with the second heat exchange unit, and

wherein a total cross-sectional area of the flat tubes of the first heat exchange unit is larger than a total cross-sectional area of the flat tubes of the second heat exchange unit.

13. The heat exchanger according to claim 12, further comprising an intermediate heat exchange unit including a plurality of flat tubes for exchanging heat between the refrigerant and air, the intermediate heat exchange unit exchanging heat with refrigerant from the first heat exchange unit and supplying the refrigerant to the second heat exchange unit, wherein a total cross-sectional area of the flat tubes of the intermediate heat exchange unit is equal to or smaller than a total cross-sectional area of the flat tubes of the first heat exchange unit but is equal to or larger than a total cross-sectional area of the flat tubes of the second heat exchange unit.

14. A heat exchanger for a refrigerator, which is of a microchannel type, comprising:

a first heat exchange unit including a plurality of flat tubes for exchanging heat between refrigerant and air, the first heat exchange unit being connected to an introduction pipe into which the refrigerant is introduced;

a second heat exchange unit including a plurality of flat tubes for exchanging heat between the refrigerant and air, the second heat exchange unit being disposed outside the first heat exchange unit and being connected to a discharge tube from which the refrigerant is discharged; and

a connecting pipe connecting the first heat exchange unit to the second heat exchange unit so as to supply the refrigerant that has been dis-

charged from the first heat exchange unit to the second heat exchange unit, wherein the first heat exchange unit is disposed so as to exchange heat with air that has exchanged heat with the second heat exchange unit,

wherein an inner diameter of the flat tubes of the first heat exchange unit is equal to an inner diameter of the second flat tubes, and

wherein a number of flat tubes of the first heat exchange unit is larger than a number of flat tubes of the second heat exchange unit.

15. The heat exchanger according to claim 12, further comprising an intermediate heat exchange unit including a plurality of flat tubes for exchanging heat between the refrigerant and air, the intermediate heat exchange unit exchanging heat with refrigerant from the first heat exchange unit and supplying the refrigerant to the second heat exchange unit, wherein an inner diameter of the third heat exchange unit is equal to an inner diameter of the first flat tubes, and wherein a number of flat tubes of the third heat exchange unit is equal to or smaller than a number of flat tubes of the first heat exchange unit but is equal to or larger than a number of flat tubes of the second heat exchange unit.

FIG. 1

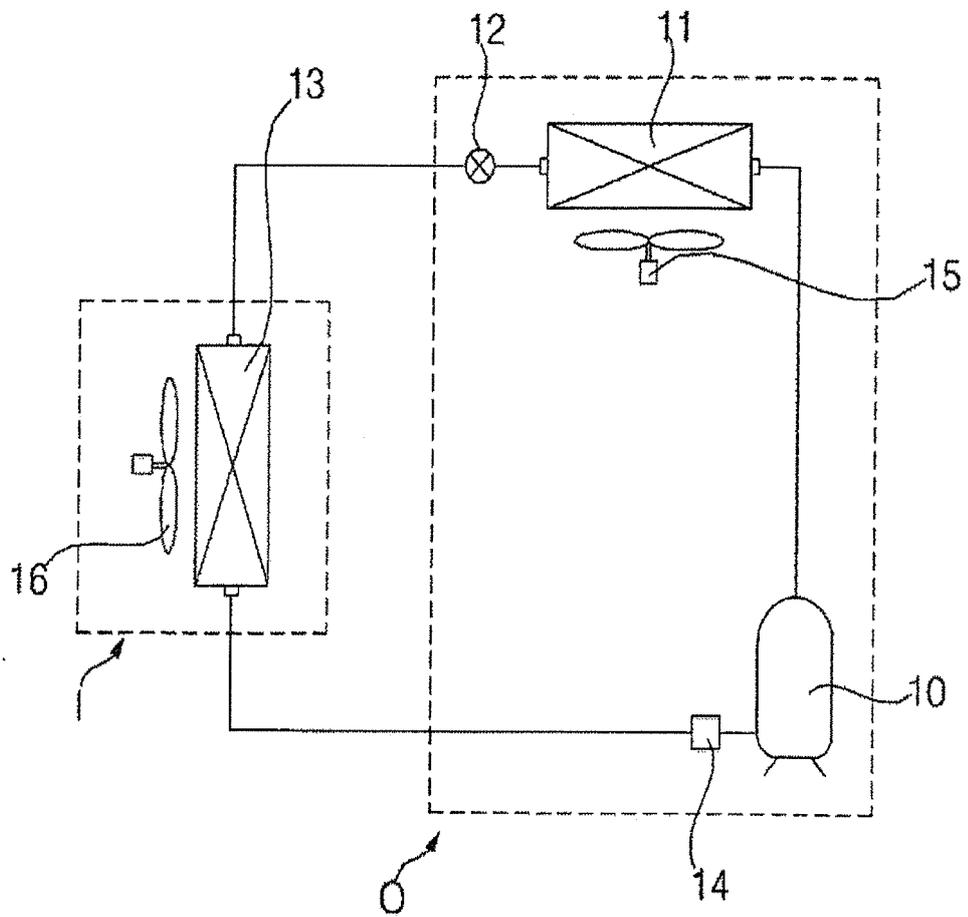


FIG. 2

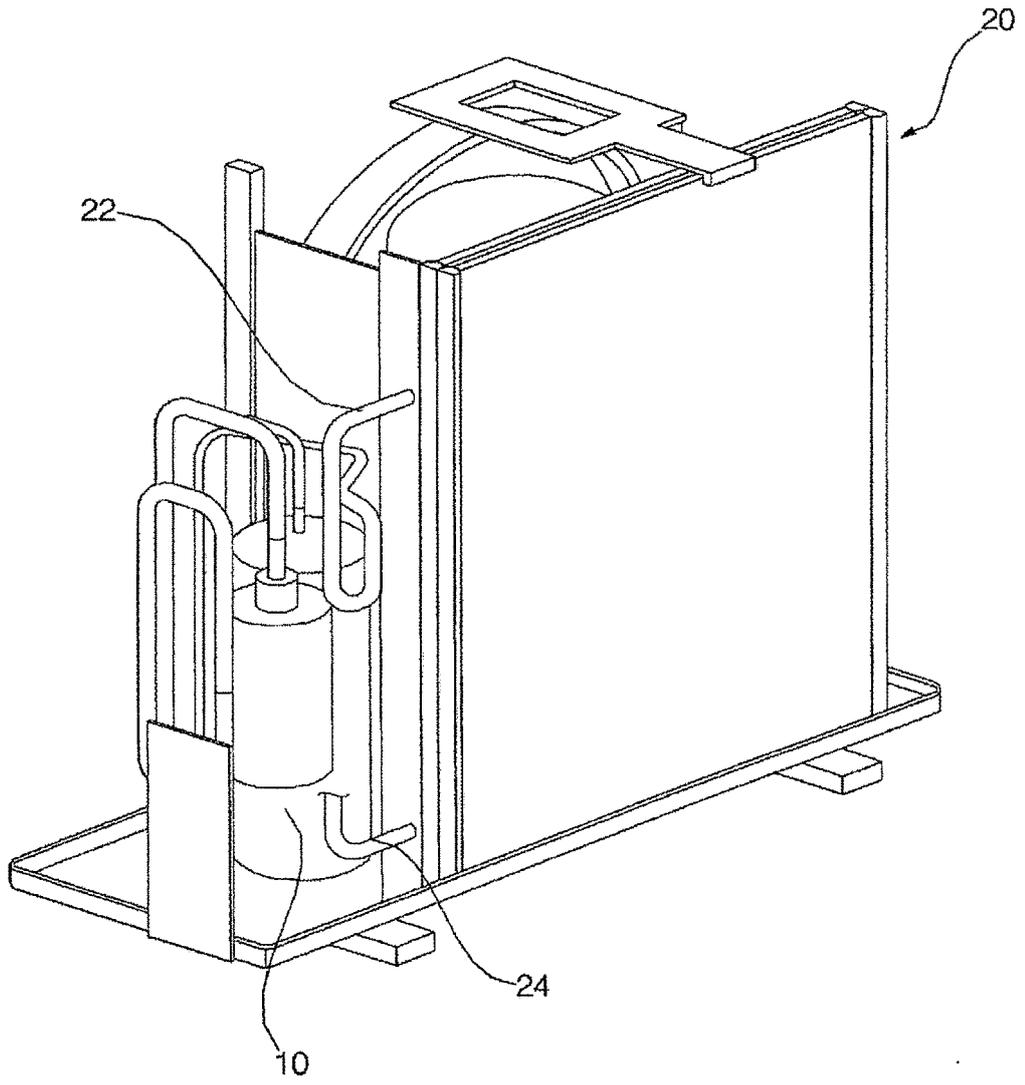


FIG. 3

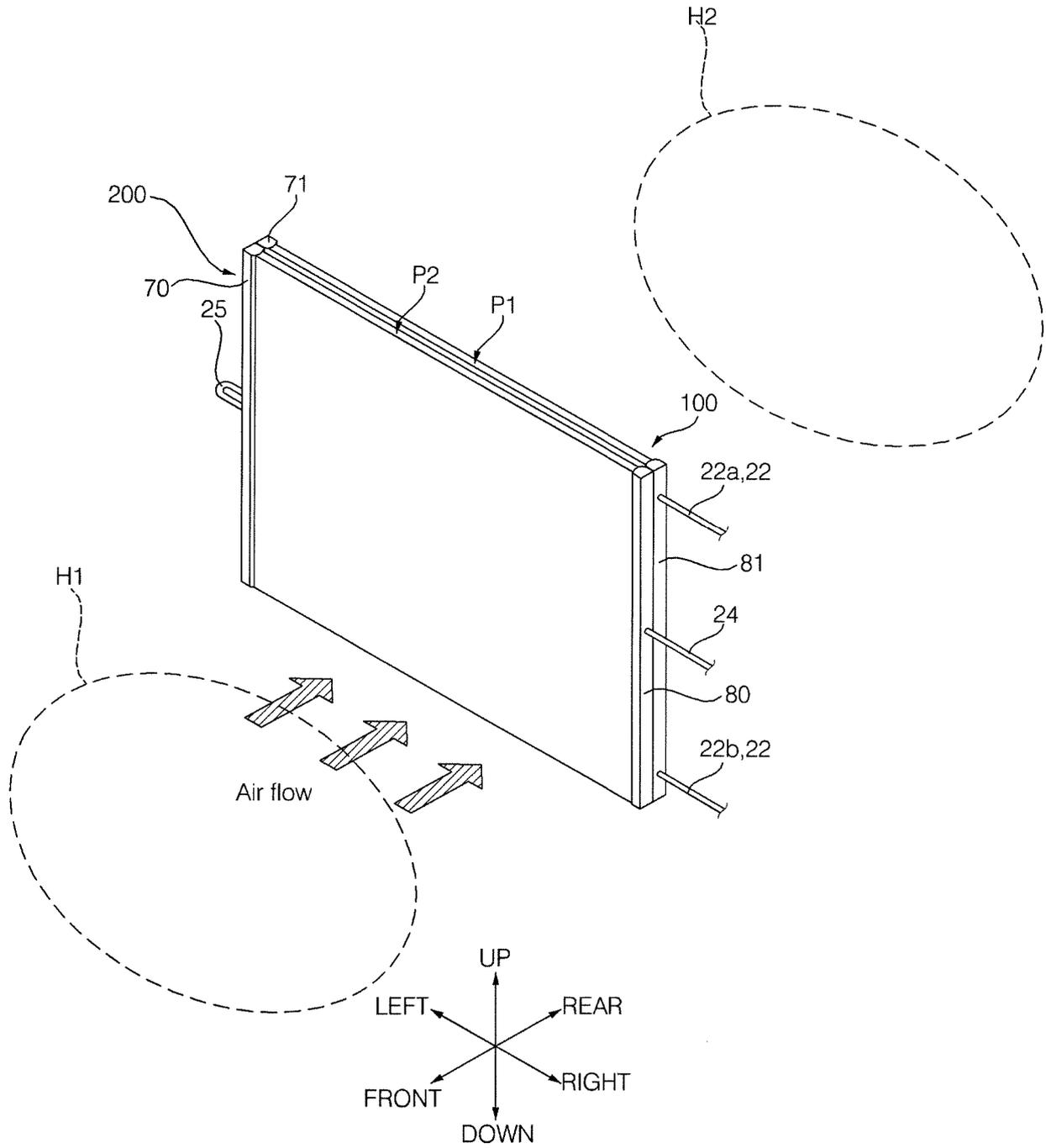


FIG. 4

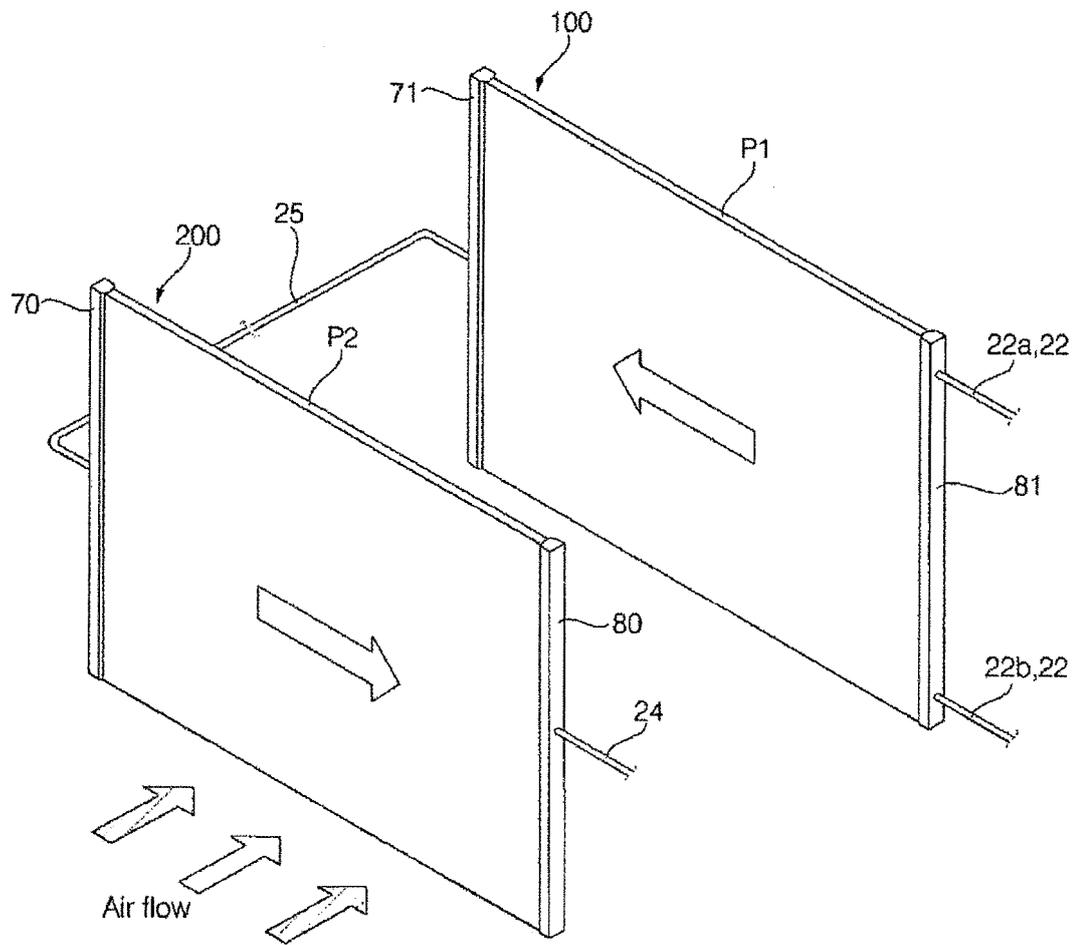


FIG. 5

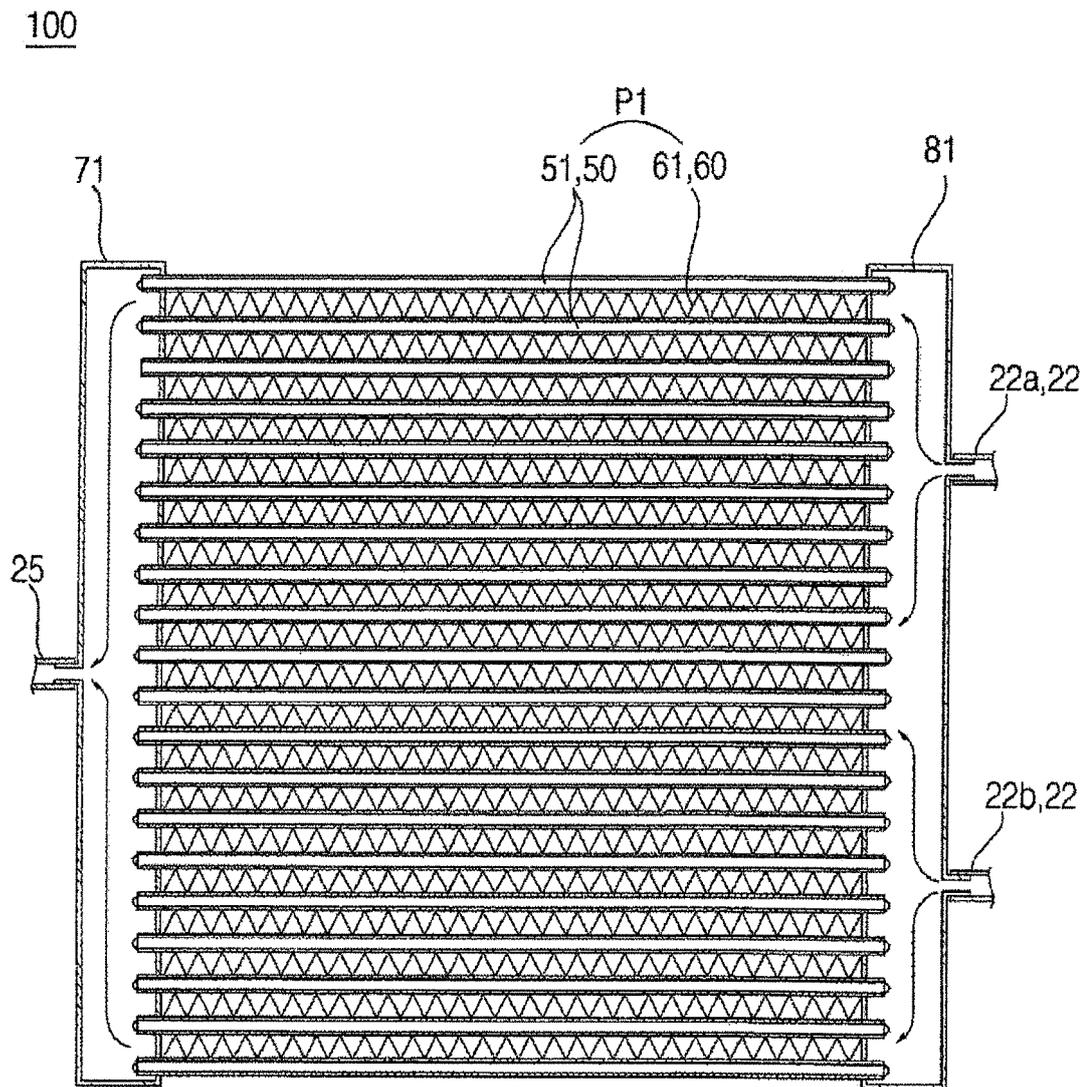


FIG. 6

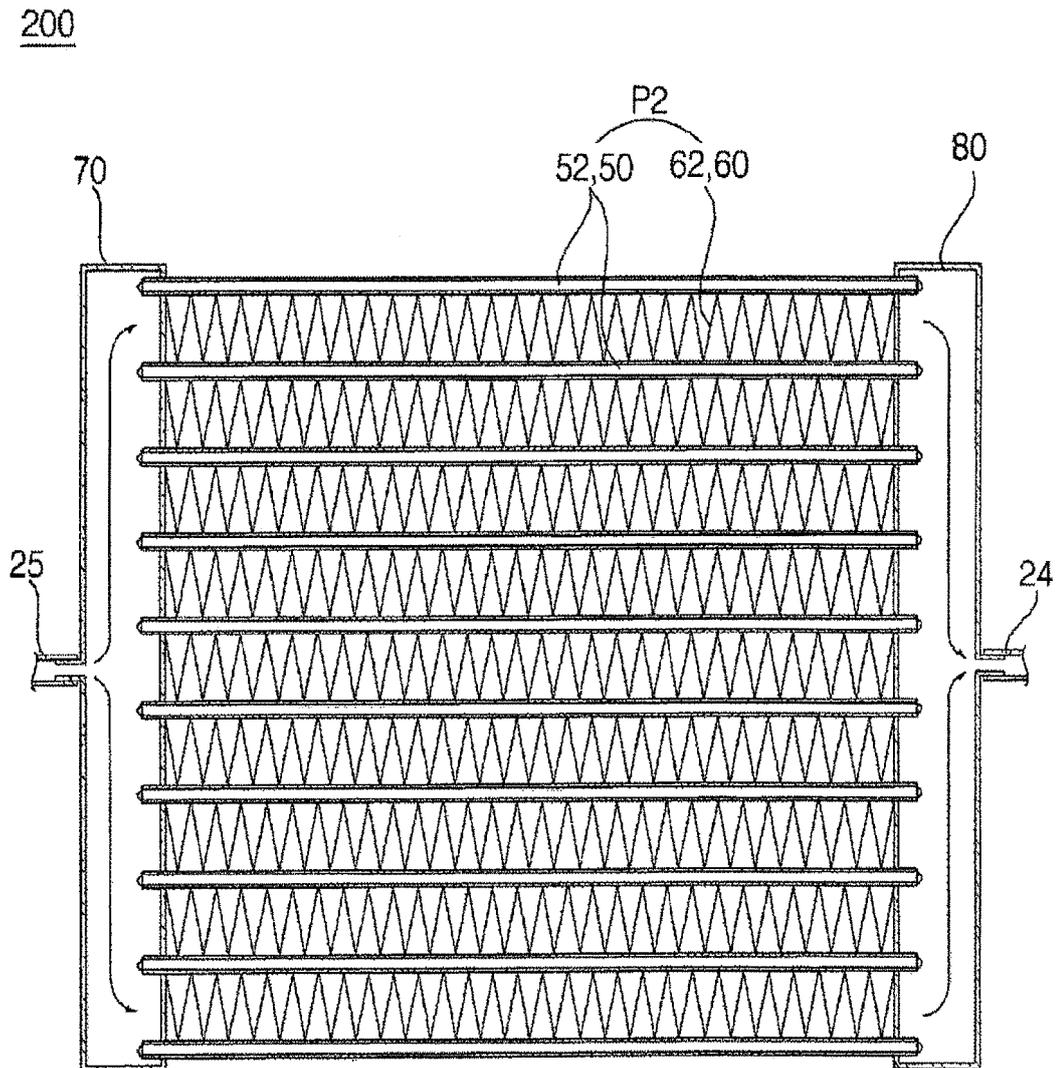


FIG. 7

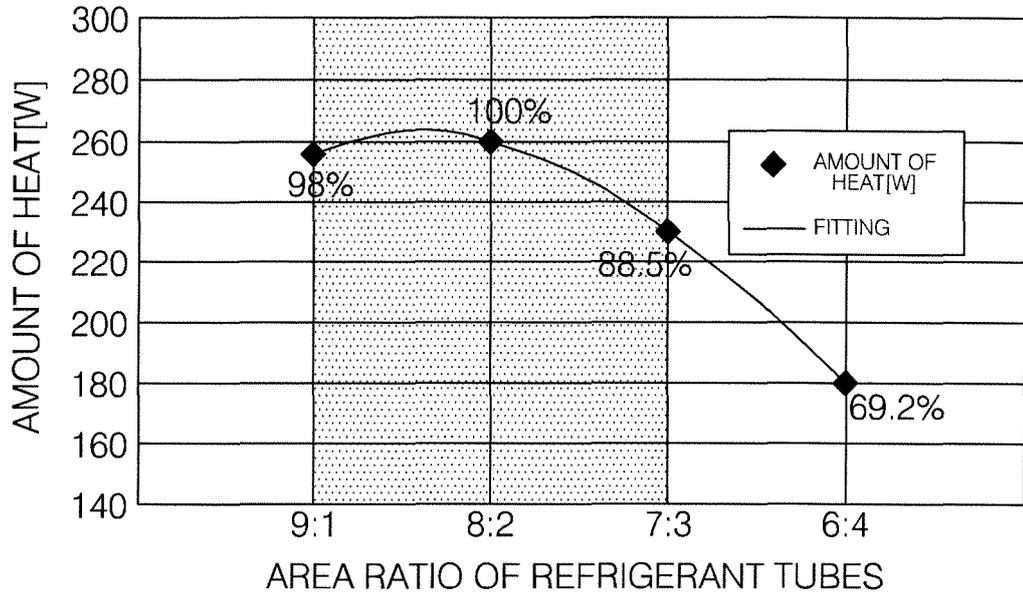


FIG. 8

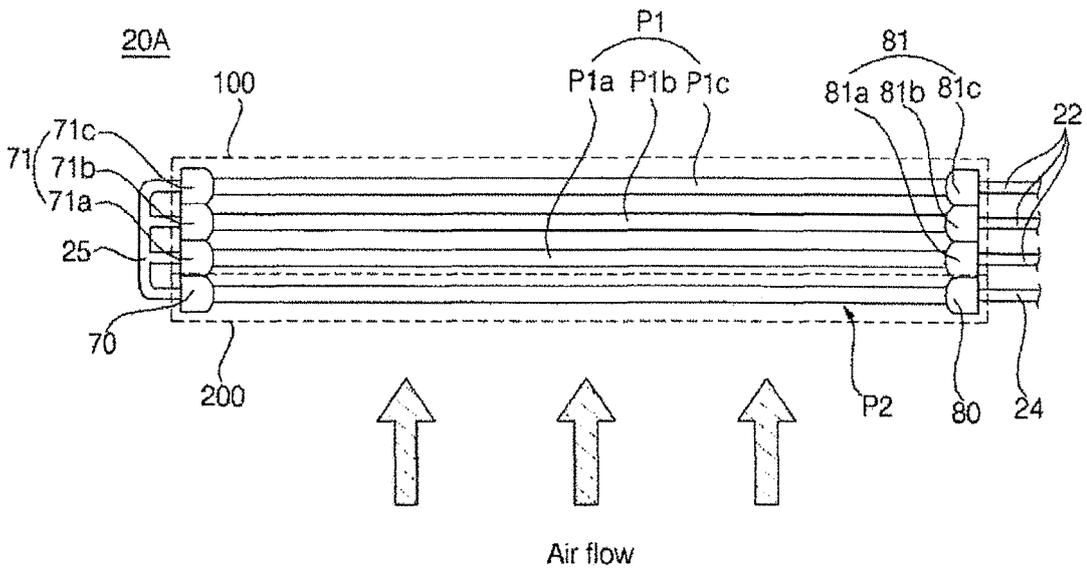


FIG. 9

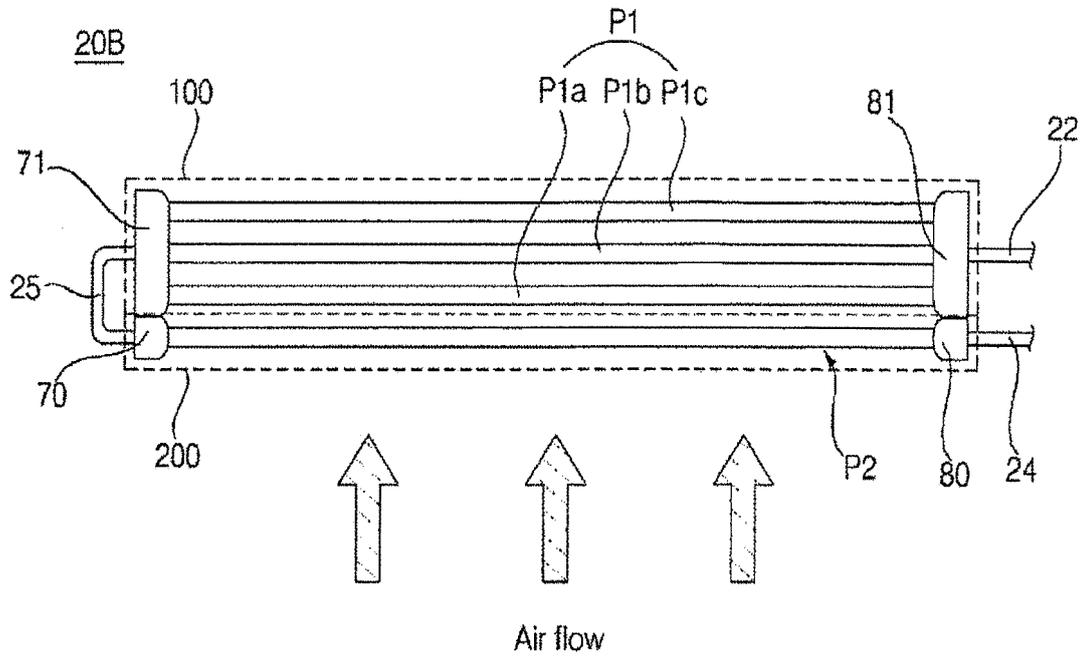
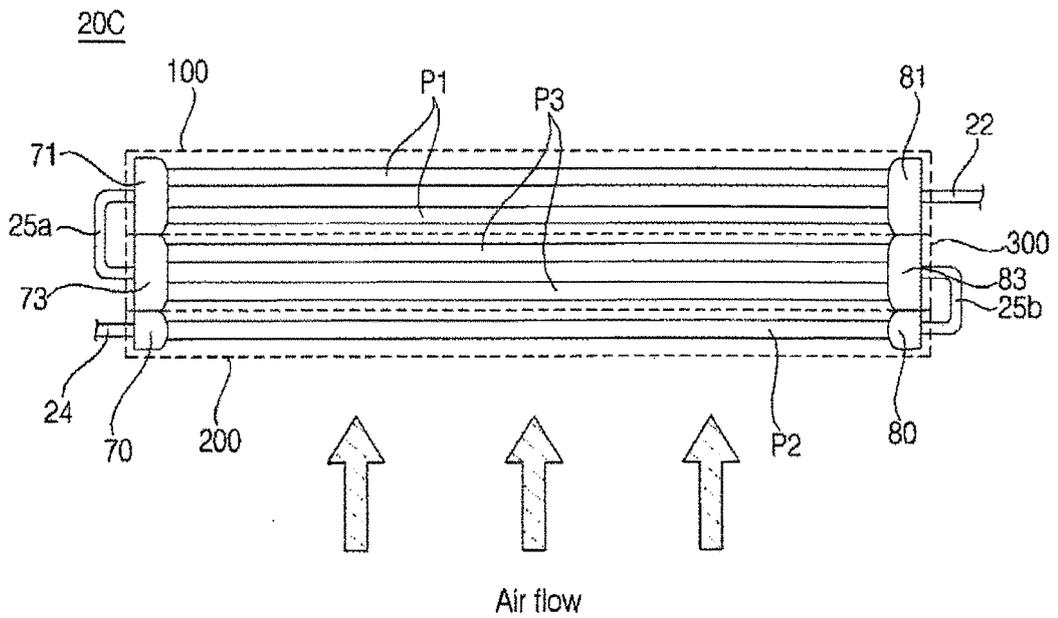


FIG. 10



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2018/001098

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A. CLASSIFICATION OF SUBJECT MATTER
F28D 1/053(2006.01)i, F25B 39/04(2006.01)i, F28F 1/12(2006.01)i, F25D 19/00(2006.01)i, F28F 3/04(2006.01)i, F28D 21/00(2006.01)i
 According to International Patent Classification (IPC) or to both national classification and IPC

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B. FIELDS SEARCHED
 Minimum documentation searched (classification system followed by classification symbols)
 F28D 1/053; F28D 7/00; F24F 1/00; F28F 9/02; F25B 39/02; F28F 1/32; F25B 39/00; F28F 17/00; F28F 9/26; F25B 39/04; F28F 1/12; F25D 19/00; F28F 3/04; F28D 21/00

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
 Korean Utility models and applications for Utility models: IPC as above
 Japanese Utility models and applications for Utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
 eKOMPASS (KIPO internal) & Keywords: heat exchanger, micro channel, flat tube, heat exchange part, connection pipe, cross sectional area, number, header, fin

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-2016-0131577 A (LG ELECTRONICS INC.) 16 November 2016 See paragraphs [0029], [0055]-[0082], [0087], [0103], claim 2 and figures 5, 6.	1-15
Y	CN 204421425 U (HANGZHOU SANHUA INSTITUTE CO., LTD.) 24 June 2015 See paragraph [0061] and figure 12.	1-15
A	JP 2005-009808 A (SHINKO KOGYO CO., LTD.) 13 January 2005 See paragraphs [0006]-[0010] and figures 1-3.	1-15
A	JP 2006-284134 A (MATSUSHITA ELECTRIC IND. CO., LTD.) 19 October 2006 See claim 1 and figure 1.	1-15
A	KR 10-2014-0000987 A (KOREA NATIONAL UNIVERSITY OF TRANSPORTATION INDUSTRY-ACADEMIC COOPERATION FOUNDATION) 06 January 2014 See paragraphs [0073]-[0093] and figures 9a-10b.	1-15

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

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* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

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Date of the actual completion of the international search 01 JUNE 2018 (01.06.2018)	Date of mailing of the international search report 01 JUNE 2018 (01.06.2018)
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2018/001098

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JP 2006-284134 A	19/10/2006	NONE	
KR 10-2014-0000987 A	06/01/2014	NONE	