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(54) **INLET FLOW REGULATING STRUCTURE AND PLATE HEAT EXCHANGER**

(57) Disclosed is a plate heat exchanger with an inlet flow regulating structure (11), comprising a refrigerant inlet coupling (4), a side plate (1) assembled with the refrigerant inlet coupling (4), and at least one inlet flow regulating structure (11). The in - let flow regulating struc-

ture (11) is arranged on a path from the refrigerant inlet coupling (4) to a main body of the plate heat exchanger, and is provided with at least one flow regulating element (12, 13, 14, 15) which is provided corresponding to a refrigerant inlet passage of the plate heat exchanger.

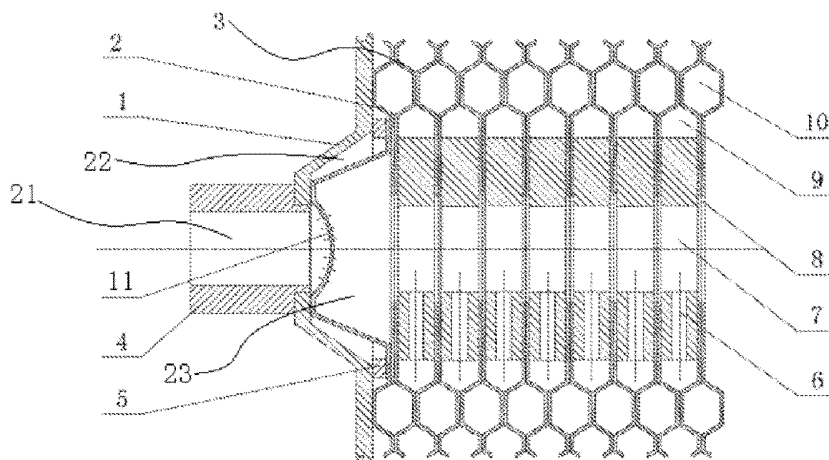


Fig. 2

Description

[0001] The present application claims the priority of Chinese Patent Application No. 201510933718.0, filed on 15 December 2015 and entitled "Inlet flow regulating structure and plate heat exchanger", which is incorporated herein by reference in its entirety.

Technical Field

[0002] The present invention relates to the fields of heating, ventilation, and air conditioning (HVAC), automobiles, refrigeration, and transportation, and in particular, to a plate heat exchanger and an inlet flow regulating structure for a plate heat exchanger.

Background Art

[0003] Mal-distribution of a refrigerant is a worldwide technical problem for a heat exchanger (evaporator) with parallel channels, especially a plate heat exchanger and a microchannel heat exchanger. The refrigerant that enters a heat exchanger usually exists in the form of two phases. It is quite difficult to achieve uniform distribution of the refrigerant because of the complexity of application conditions and two-phase flow. In many cases, an excessive amount of a liquid refrigerant flows into some channels, and an excessive gaseous refrigerant flows into some other channels. As a result, the overall performance of an evaporator is severely affected.

[0004] Distributors are disposed in inlet positions of various refrigerant channels in the evaporator in the existing solution. A major design concept is to use small sectional areas of inlets of channels and a certain pressure difference between inlets and outlets to control the mass flow rate of a gas-liquid two-phase flow that enters the various refrigerant channels, so as to eventually obtain good effects of distribution and heat exchange.

[0005] However, the design of evaporators faces greater challenges with gradually increased demands of unit energy efficiency and increasingly strict requirements of environmental friendliness of the refrigerant.

[0006] In an aspect, with the development of variable frequency technology for compressors, a design reference point of an evaporator gradually develops from the initial working condition of a single application to application requirements of a plurality of points. Both full load operation and part load operation need to be considered in the design of distributors. Flow types and flow states of a two-phase flow in fixed evaporator inlet structures and distributors are vastly different. The design difficulty is significantly increased. In addition, for evaporator products such as a plate heat exchanger and a microchannel heat exchanger, the same distributor structure is usually used for products that have different capability requirements or are in different capability ranges. For distribution technology, especially the flow and flow type features of an evaporator inlet, a certain optimal working range ex-

ists, and when beyond the range, the distribution effect is affected.

[0007] In another aspect, a novel refrigerant is gradually developed and applied, which also poses a challenge in designing the evaporator. Due to different physical properties of working media, the characteristics of flow and heat exchange of the refrigerant are significantly different in the same evaporator. Many evaporators can only be designed specifically for one kind or one type of refrigerant, resulting in a big family of related products and therefore high management and maintenance costs.

Summary of the Invention

[0008] The object of the present invention is to solve at least one aspect of the above-mentioned problems and defects that exist in the prior art.

[0009] An evaporator inlet state is important content among related influence factors in refrigerant distribution technology. Different load capabilities and refrigerant types have significant influences in this aspect.

[0010] In a design concept of the present invention, a flow regulating structure is disposed in an evaporator inlet area, and a gas-liquid two-phase flow is re-excited, so that an uncontrolled fluid inlet state is converted into a stable homogeneous state, so as to provide a stable inlet flow condition for a subsequent distribution process, obtain a stable distribution effect, and eventually improve the heat exchange performance and unit energy efficiency of an evaporator.

[0011] As claimed in an aspect of the present invention, an inlet flow regulating structure for a plate heat exchanger is provided, the plate heat exchanger comprising a refrigerant inlet connector and a side plate assembled with the refrigerant inlet connector, wherein at least one inlet flow regulating structure is arranged on a path from the refrigerant inlet connector to a main body of the plate heat exchanger, and at least one flow regulating element is disposed on each inlet flow regulating structure, the flow regulating element being provided corresponding to a refrigerant inlet passage of the plate heat exchanger.

[0012] In an example, each inlet flow regulating structure comprises one layer or at least two layers spaced apart from each other, wherein the flow regulating element is disposed on each layer.

[0013] In an example, at least two inlet flow regulating structures are spaced apart from each other and disposed side by side in a direction from the refrigerant inlet connector to a distribution chamber of the plate heat exchanger.

[0014] In an example, the flow regulating element is a flow regulating hole, a flow regulating slot or any combination thereof.

[0015] In an example, the inlet flow regulating structure is in the form of an arc, a flat plate or a flow regulating gasket.

[0016] In an example, a plurality of circular rings are

disposed on the layer of the inlet flow regulating structure, and a plurality of flow regulating holes are spaced apart on each of the circular rings; or

a plurality of annular strips are disposed on the layer of the inlet flow regulating structure, and a plurality of flow regulating slots, spaced apart and extending straightly or obliquely, are disposed on each of the annular strips.

[0017] In an example, each of the flow regulating slots is rectangular or sickle-shaped.

[0018] In an example, one flow regulating hole is provided at the center of the layer of the inlet flow regulating structure.

[0019] In an example, a flaring chamber is disposed in the inlet flow regulating structure.

[0020] In an example, the side plate or the refrigerant inlet connector has a flaring chamber at least partially accommodating the flaring chamber of the inlet flow regulating structure.

[0021] In an example, a top surface of the flaring chamber of the inlet flow regulating structure and a top surface of the flaring chamber of the side plate or the refrigerant inlet connector are at least partially in contact with each other and are generally located at the same level of height.

[0022] In an example, the size of the bottom of the flaring chamber matches the size of a distributor chamber of the plate heat exchanger, such that a two-phase refrigerant flow from a refrigerant inlet flows through the flaring chamber and then smoothly enters the distribution chamber and is distributed into corresponding refrigerant channels.

[0023] In an example, the inlet flow regulating structure is disposed at any position from the refrigerant inlet connector to a distributor chamber along a central axis of the distributor chamber.

[0024] In an example, the inlet flow regulating structure is disposed between the side plate and a jet hole of a first distributor.

[0025] In an example, the inlet flow regulating structure is disposed or integrated on a first heat exchange plate sheet I or a first heat exchange plate sheet II starting from the refrigerant inlet or between a first heat exchange plate sheet II and a first distributor.

[0026] In an example, for a dual-circuit plate heat exchanger formed by heat exchange plate sheets I and heat exchange plate sheets II, in a distributor chamber of a second circuit, a seal is provided between a first heat exchange plate sheet II and a second heat exchange plate sheet I, and the inlet flow regulating structure is disposed or integrated on a first heat exchange sheet I, a first heat exchange sheet II, the second heat exchange plate sheet I or a second heat exchange plate sheet II; or for a dual-circuit plate heat exchanger formed by heat exchange plate sheets I, heat exchange plate sheets II, heat exchange plate sheets III, and heat exchange plate sheets IV, in a distributor chamber of a second circuit, a seal is provided between a first heat exchange plate sheet II and a first heat exchange plate sheet III, and the

inlet flow regulating structure is disposed or integrated on a first heat exchange sheet I, a first heat exchange sheet II, the first heat exchange plate sheet III, or a first heat exchange plate sheet IV.

[0027] As claimed in another aspect of the present invention, a plate heat exchanger is provided which comprises the above-mentioned inlet flow regulating structure.

Brief Description of the Drawings

[0028] These and/or other aspects and advantages of the present invention will become apparent and should be readily understood from the following description of the preferred embodiments in conjunction with the accompanying drawings, in which:

Fig. 1a is an overall view of a plate heat exchanger in the prior art;

Fig. 1b is a schematic structural diagram of an inlet and a distribution chamber of the plate heat exchanger shown in Fig. 1a;

Fig. 2 is a schematic structural diagram of an inlet and a distribution chamber of a plate heat exchanger as claimed in an embodiment of the present invention;

Figs. 3a-3d are respectively top views of different variant examples of a flow regulating element as claimed in the present invention;

Figs. 4a-4e are respectively schematic structural diagrams of an inlet flow regulating structure being disposed in different arrangement positions of a plate heat exchanger as claimed in another embodiment of the present invention;

Fig. 5 is a schematic structural diagram of an inlet and a distribution chamber of a plate heat exchanger as claimed in another embodiment of the present invention, wherein an inlet flow regulating structure uses the form of a planar unit;

Fig. 6 is a schematic structural diagram of an inlet and a distribution chamber of a plate heat exchanger as claimed in another embodiment of the present invention, wherein an inlet flow regulating structure uses the form of a simple flow regulating unit; and

Fig. 7 is a top view of another variant example of an inlet flow regulating structure as claimed in the present invention.

Detailed Description of Embodiments

[0029] By means of the following embodiments and in conjunction with the accompanying drawings, the technical solutions of the present invention are further specifically described. Identical or similar reference signs in the description denote identical or similar components. The following description of the embodiments of the present invention referring to the accompanying drawings is intended to explain the general inventive concept

of the present invention, and should not be construed as limiting the present invention.

[0030] Referring to Fig. 1a and Fig. 1b, respectively, shown are an overall view of a plate heat exchanger in the prior art and a schematic structural diagram of an inlet and a distribution chamber of the plate heat exchanger. Fig. 1a shows the plate heat exchanger through which two different fluids can flow. For example, the two different fluids may be water and a refrigerant. The plate heat exchanger in such a form is known in the prior art, and is therefore no longer described in detail herein. Only one inlet connector 4 used for the refrigerant to flow in is shown. Certainly, the position of the inlet connector 4 may be specifically chosen as claimed in the requirements, but is not limited to the case shown in the figure.

[0031] Fig. 1b shows specific structures of the inlet and the distribution chamber of the plate heat exchanger in detail. A side plate 1, and heat exchange plate sheets I 2 and heat exchange plate sheets II 3 that are alternately disposed, are sequentially arranged from left to right. A heat exchange plate sheet I 2 and a heat exchange plate sheet II 3 that are adjacent have structures matching each other, so that water channels 10 and refrigerant channels 9 having heat exchange spaces and support strength can be formed to implement heat exchange between cold and hot fluids. As shown in the figure, the water channels 10 and the refrigerant channels 9 are alternately arranged. An inlet connector 4 on a refrigerant side (an evaporator) is used for connection to a pipeline of a unit system and an expansion valve at a front end. It should be noted herein that Fig. 1a and Fig. 1b show the structures of the inlet and the distribution chamber of the plate heat exchanger used as an evaporator.

[0032] In addition, a sealing structure 5, for example a seal ring, is provided between the side plate 1 and a first heat exchange plate sheet (a heat exchange plate sheet I 2 in this example). The seal ring 5 is usually made of metal, and is assembled between the side plate 1 and the first heat exchange plate sheet 2 by using a brazing process. A distributor 6 of each of the refrigerant channels 9 is usually disposed in an inlet position of each of the refrigerant channels 9, and is usually designed into the form of one or more small holes, and the refrigerant is evenly distributed in a manner of limiting flowing sectional areas and increasing pressure drop. The distributor of the present invention may be disposed on a heat exchange plate sheet or integrated with the heat exchange plate sheet. Plate holes 8 are provided in positions corresponding to the inlet connector 4 on the heat exchange plate sheets I 2 and the heat exchange plate sheets II 3. A plurality of distributor chambers 7 are formed together by the plate holes 8 on the heat exchange plate sheets I 2 and the heat exchange plate sheets II 3 and the distributors 6. In a position where a plate hole 8 is located, a sealing surface around the plate hole 8 is used to implement a sealing effect in the refrigerant distribution chamber 7, and a brazing process is usually used for assembly. As discussed above, in the solution in the prior

art shown in Fig. 1a and Fig. 1b, the distributor 6 is affected by the factors such as the shown inlet connector 4, and an upstream pipeline, a flow rate and a flow type change of the inlet connector, resulting in mal-distribution of the refrigerant in the inlet connector.

[0033] To improve a flow state and a flow type of a two-phase flow in an inlet area of an evaporator and further improve a refrigerant distribution effect in the evaporator, so as to improve the heat exchange efficiency of a heat exchanger and the overall performance and efficiency of a unit, the present invention provides an inlet flow regulating structure for a plate heat exchanger and a plate heat exchanger using the inlet flow regulating structure.

[0034] A major inventive concept of the present invention provides an inlet flow regulating structure for a plate heat exchanger. The plate heat exchanger comprises a refrigerant inlet connector and a side plate assembled with the refrigerant inlet connector, wherein at least one inlet flow regulating structure is disposed between the side plate and a main body of the plate heat exchanger, and at least one flow regulating element is disposed on each inlet flow regulating structure. The flow regulating element is provided corresponding to a refrigerant inlet passage of the plate heat exchanger.

[0035] Specifically, the plate heat exchanger of the present invention comprises a refrigerant inlet connector 4 and a side plate 1 assembled with the refrigerant inlet connector 4. Fig. 2 shows that one inlet flow regulating structure 11 is disposed between the side plate 1 and the main body of the plate heat exchanger. At least one flow regulating element 12, 13, 14 and 15 (described below in detail) is provided in the inlet flow regulating structure 11. The flow regulating element 12, 13, 14 and 15 is disposed corresponding to a refrigerant inlet passage 21 of the plate heat exchanger. A main improvement of the present invention is a refrigerant inlet area in the plate heat exchanger, and therefore the same reference numerals are used for the same components in Fig. 1a and Fig. 1b, and details are no longer described.

[0036] Here, the refrigerant inlet passage 21 is a passage in the inlet connector 4.

[0037] It may be understood that the inlet flow regulating structure 11 may comprise one layer or at least two layers spaced apart from each other, wherein the flow regulating element is disposed on each layer. Where at least two inlet flow regulating structures 11 are provided, the at least two inlet flow regulating structures 11 may be spaced apart from each other and disposed side by side in a direction from the refrigerant inlet connector 4 to a distribution chamber of the plate heat exchanger.

[0038] As shown in Fig. 2, compared with Fig. 1b, in an embodiment of the present invention, the inlet flow regulating structure 11 having a flaring chamber 23 is disposed between a seal ring 5 and a first heat exchange plate sheet I 2. A flaring chamber 22 having a fitting effect is also disposed at the side plate 1. In the sectional view shown in Fig. 2, the inlet flow regulating structure 11 in this example is set in the form of an arc. As shown in the

figure, the flaring chamber 22 of the side plate 1 completely accommodates the flaring chamber 23 of the inlet flow regulating structure 11. It may be understood that the present invention is not limited thereto. It may also be set such that the flaring chamber 22 only partially accommodates the flaring chamber 23 of the inlet flow regulating structure 11.

[0039] It may be understood that the inlet flow regulating structure 11 and the flaring chamber 22 may also be disposed in or inside the refrigerant inlet connector 4. In such a case, a pipe leg of the refrigerant inlet connector 4 is assembled with the side plate 1. In this case, the flaring chamber 22 may not be disposed on the side plate 1. It may be understood that the object of arranging a flaring chamber is that the flaring chamber matches the flaring chamber 23 of the inlet flow regulating structure 11, and provides necessary strength support. In an example, an edge of the inlet flow regulating structure of the present invention is fixed on a heat exchange plate or a side plate, and a flaring chamber is disposed in the inlet flow regulating structure. Correspondingly, a flaring chamber accommodating the flaring chamber of the inlet flow regulating structure may be disposed on the refrigerant inlet connector.

[0040] As shown in Fig. 2, a top surface of the flaring chamber 23 of the inlet flow regulating structure 11 and a top surface of the flaring chamber 22 of the side plate 1 are in contact with each other all around and are generally located at the same level of height.

[0041] Figs. 3a-3d respectively show the flow regulating element 12, 13, 14, and 15 in different forms. It may be understood that the flow regulating element may be a flow regulating hole, a flow regulating slot or any combination thereof, but is not merely limited to the cases shown in the figures.

[0042] In Fig. 3a, a plurality of circular rings are disposed on the layer of the inlet flow regulating structure 11, and a plurality of flow regulating holes are spaced apart on each of the circular rings 12.

[0043] In Fig. 3b, a plurality of annular strips are disposed on the layer of the inlet flow regulating structure 11, and a plurality of flow regulating slots 13, spaced apart and extending straightly, are disposed on each of the annular strips. Each of the flow regulating slots 13 is rectangular or strip-shaped.

[0044] In Fig. 3c, a plurality of annular strips are disposed on the layer of the inlet flow regulating structure 11, and a plurality of flow regulating slots 14, spaced apart and extending obliquely, are disposed on each of the annular strips. Each of the flow regulating slots 14 is rectangular or strip-shaped.

[0045] In Fig. 3d, a plurality of annular strips are disposed on the layer of the inlet flow regulating structure 11, and a plurality of flow regulating slots 15, spaced apart and extending obliquely, are disposed on each of the annular strips. Each of the flow regulating slots 15 is sickle-shaped.

[0046] The inlet flow regulating structure 11 may be

made of metal, ceramics, or the like, and certainly may be replaced with a similar mesh system or porous medium, to achieve an equivalent flow regulating effect.

[0047] In a specific working manner, a refrigerant in a two-phase state is throttled by an expansion valve and then enters a refrigerant inlet connector 4 of a heat exchanger along a connecting pipeline. A flow state of the refrigerant is indefinite. The flow state may be a layered flow for a working condition of part load. The flow state may be an annular flow for a working condition of full load. However, under the effects of the special flow regulating element 12, 13, 14, and 15, the two-phase refrigerant is adjusted into a flow state of a homogeneous flow. Meanwhile, by means of the combined action of an arc surface of the inlet flow regulating structure 11 and the flaring chamber 23, the stability of a flow type and a turbulence degree are further enhanced, and eventually the refrigerant enters a distributor chamber 7 in a flow state that facilitates distribution.

[0048] To implement effective cooperation between the flow regulating element 3 and a subsequent distributor chamber 7 in Fig. 2, the present invention further provides a technical solution shown in Fig. 4a. Compared with the case in Fig. 2, the size of the flaring chamber 23 of the inlet flow regulating structure 11 in Fig. 4a is set to be close to or the same as (i.e. matching) the inner diameter of the distribution chamber 7, so that under the effect of a "flaring opening" chamber, the two-phase flow refrigerant smoothly enters the distributor chamber 7, so as to be further distributed into corresponding refrigerant channels 9.

[0049] As claimed in the manner of adjusting the flow type and flow state of refrigerant provided in the present invention, the inlet flow regulating structure 11 in Fig. 4a may be disposed in any suitable position between the side plate 1 and a first distributor 6. Specifically, in Fig. 4a, the inlet flow regulating structure 11 is disposed between the seal ring 5 and a first heat exchange plate sheet I 2.

[0050] Referring to Fig. 4b and Fig. 4c, respectively, shown are cases of the inlet flow regulating structure 11 being formed on the first heat exchange plate sheet I 2 and a first heat exchange plate sheet II 3. Specifically, the inlet flow regulating structure 11 may be integrally formed on the first heat exchange plate sheet I 2 or the first heat exchange plate sheet II 3. Certainly, the inlet flow regulating structure may be formed on the first heat exchange plate sheet I 2 or the first heat exchange plate sheet II 3 in a welding manner or the like.

[0051] Referring to Fig. 4d, shown is a case in which the inlet flow regulating structure 11 is disposed between the first heat exchange plate sheet II 3 and the first distributor 6. It may be understood that a solution known in the art may be used that the inlet flow regulating structure 11 is disposed between the first heat exchange plate sheet II 3 and the first distributor 6.

[0052] In addition to the cases in the above-mentioned figures, a person skilled in the art may understand that

at least one inlet flow regulating structure 11 may be disposed in any height position from the side plate 1 to distributors 6 of the plate heat exchanger, and the present invention is not specifically limited thereto.

[0053] For a dual-circuit plate heat exchanger, a heat exchange plate sheet and a seal ring 15 of another circuit may further exist between the first distributor 6 and the first heat exchange plate sheet II 3.

[0054] As shown in Fig. 4e, a case having two refrigerant circuits is shown. Numeral 15 indicates a seal circle of a first refrigerant circuit, numeral 16 indicates a distributor of a second refrigerant circuit, numeral 17 indicates a channel of the second refrigerant circuit, numeral 18 indicates a water channel, numeral 19 indicates a channel of the first refrigerant circuit, and 20 indicates an adjacent water channel.

[0055] In a distributor chamber 26 of the second refrigerant circuit, a seal circle or ring 15 of the first refrigerant circuit is provided between a first heat exchange plate sheet II 3 and a second heat exchange plate sheet I 2, and is used to seal a corresponding position of the first refrigerant circuit. The inlet flow regulating structure 11 is integrated on the second heat exchange plate sheet I 2, and used to match a subsequent distribution chamber 26. It should be noted that in such a dual-circuit plate heat exchanger, for the flow regulating element in the inlet flow regulating structure 11, any specific form shown in Figs. 3a-3d mentioned above may also be used, that is, an individual flow regulating element may be used or the flow regulating element may be integrated on a second heat exchange plate sheet II. It may be understood that the individual flow regulating element or one flow regulating element may be used for the inlet flow regulating structure 11. Alternatively, in addition to being integrated on the second heat exchange plate sheet I 2, the flow regulating element may further be integrated on a second heat exchange plate sheet II 3.

[0056] That is, for a dual-circuit plate heat exchanger formed by heat exchange plate sheets I and heat exchange plate sheets II, in a distributor chamber of a second circuit, a seal is provided between a first heat exchange plate sheet II and a second heat exchange plate sheet I, and the inlet flow regulating structure is disposed or integrated on the second heat exchange plate sheet I or a second heat exchange plate sheet II.

[0057] For a dual-circuit plate heat exchanger formed by heat exchange plate sheets I, heat exchange plate sheets II, heat exchange plate sheets III, and heat exchange plate sheets IV, in a distributor chamber of a second circuit, a seal is provided between a first heat exchange plate sheet II and a first heat exchange plate sheet III, and the inlet flow regulating structure is disposed or integrated on the first heat exchange plate sheet III or a first heat exchange plate sheet IV.

[0058] It should be noted that, the above-mentioned implementation manner provided on a dual-circuit plate heat exchanger in the present invention is a choice for a specific dual-circuit structure. For the dual-circuit plate

heat exchanger, single-circuit implementation manners shown in Fig. 2 and Figs. 4a-4d may also be used in the present invention. That is, the inlet flow regulating structure 11 is disposed near the side plate 1 and the first heat exchange plate sheet I 2 but does not cross the space of the seal circle 15 of the first circuit in Fig. 4e. This manner is especially applicable to a case in which the inner diameter of the seal circle 15 in Fig. 4e is the same as or close to the inner diameter of the distributor 6.

[0059] In addition, in consideration of the processing difficulty and the assembly simplicity, the inlet flow regulating structure of the present invention may further be changed as follows.

[0060] It should be noted that, the inlet flow regulating structure 11 is disposed at any position from the refrigerant inlet connector 4 to the distributor chamber 7 along a central axis of a distributor chamber 7.

[0061] Referring to Fig. 5, the arc surface structure of the above-mentioned inlet flow regulating structure 11 may be set in a planar form, or may be replaced with a planar unit. However, the design of a flaring cavity is kept. As shown in the figure, a top surface of an inlet flow regulating structure 11' is approximately planar.

[0062] Referring to Fig. 6, the design manner of the above-mentioned arc surface structure and flaring cavity is omitted, but instead, a conventional heat exchanger side plate 1 and a simple inlet flow regulating structure 11" are used. The inlet flow regulating structure 11" is a sheet metal stamping part. As shown in the figure, a sealing step 51 and a porous flow regulating area 12 are shown.

[0063] Referring to Fig. 7, the form of a flow regulating gasket 21 having a uniform thickness may further be used. The flow regulating gasket 21 is used to replace the above-mentioned inlet flow regulating structure, and is disposed in a position the same as that of the above-mentioned inlet flow regulating structure. The flow regulating gasket is sealed with a side plate and a heat exchange plate sheet adjacent thereto by means of the periphery of the flow regulating gasket. A plurality of flow regulating elements such as flow regulating holes are disposed on the flow regulating gasket 21. Certainly, the flow regulating gasket 21 may further use the above-mentioned flow regulating slots as the flow regulating elements as claimed in the requirements.

[0064] It may be understood that the present invention is not only limited to the above-mentioned structures, and may further comprise a combination or deduced manner of the above-mentioned structures. For example, each inlet flow regulating structure comprises a plurality of stacked layers or layers arranged in a stacking manner, the above-mentioned flow regulating elements such as the flow regulating holes or the flow regulating slots or any combination thereof are disposed on each layer, and flow regulating elements between adjacent layers overlap each other or are the same as each other. In addition, two or more inlet flow regulating structures connected in series may further be disposed between the side plate

and the first distributor, and a certain gap is provided between two adjacent inlet flow regulating structures, so that a two-phase flow is regulated twice or for a plurality of times to obtain a homogeneous flow type, thereby improving an eventual distribution effect.

[0065] In addition, another embodiment of the present invention further provides a plate heat exchanger using the above-mentioned inlet flow regulating structure. The inlet flow regulating structure has been described above in detail, and the plate heat exchanger using the inlet flow regulating structure is not changed in other aspects. Therefore, details are no longer described herein.

[0066] As discussed above, the above-mentioned technical solutions of the present invention at least can implement at least one aspect of the following advantages:

firstly, a flow regulating hole or slot, an arc jet end surface, and a flaring jet development cavity will effectively enhance the flow and flow type state of a refrigerant in an evaporator inlet area, so as to provide a stable and reliable inlet condition for a subsequent distribution process, thereby eliminating the influence of physical properties of the refrigerant, operations of a unit in a plurality of working conditions, capability differences of products, and the like on the refrigerant distribution in an evaporator; and secondly, the proposed flow regulating unit or inlet flow regulating structure is mainly in the form of a sheet metal part or a low-cost flow regulating gasket, thus a great advantage are achieved in costs, and there are almost no additional costs for evaporators.

[0067] Above are merely some of the embodiments of the present invention, and it will be understood by those of ordinary skill in the art that changes may be made to these embodiments without departing from the principles and spirit of the general inventive concept, and the scope of the present invention is defined by the claims and their equivalents.

Claims

1. An inlet flow regulating structure for a plate heat exchanger, the plate heat exchanger comprising a refrigerant inlet connector and a side plate assembled with the refrigerant inlet connector, **characterized in that** at least one inlet flow regulating structure is arranged on a path from the refrigerant inlet connector to a main body of the plate heat exchanger, and at least one flow regulating element is disposed on each inlet flow regulating structure, the flow regulating element being provided corresponding to a refrigerant inlet passage of the plate heat exchanger.
2. The inlet flow regulating structure as claimed in claim

1, **characterized in that** each inlet flow regulating structure comprises one layer or at least two layers spaced apart from each other, wherein the flow regulating element is disposed on each layer.

3. The inlet flow regulating structure as claimed in claim 1 or 2, **characterized in that** at least two inlet flow regulating structures are spaced apart from each other and disposed side by side in a direction from the refrigerant inlet connector to a distribution chamber of the plate heat exchanger.
4. The inlet flow regulating structure as claimed in any one of claims 1-3, **characterized in that** the flow regulating element is a flow regulating hole, a flow regulating slot or any combination thereof.
5. The inlet flow regulating structure as claimed in any one of claims 1-4, **characterized in that** the inlet flow regulating structure is in the form of an arc, a flat plate or a flow regulating gasket.
6. The inlet flow regulating structure as claimed in claim 5, **characterized in that** a plurality of circular rings are disposed on the layer of the inlet flow regulating structure, and a plurality of flow regulating holes are spaced apart on each of the circular rings; or a plurality of annular strips are disposed on the layer of the inlet flow regulating structure, and a plurality of flow regulating slots, spaced apart and extending straightly or obliquely, are disposed on each of the annular strips.
7. The inlet flow regulating structure as claimed in claim 6, **characterized in that** each of the flow regulating slots is rectangular or sickle-shaped.
8. The inlet flow regulating structure as claimed in either of claims 6 or 7, **characterized in that** one flow regulating hole is provided at the center of the layer of the inlet flow regulating structure.
9. The inlet flow regulating structure as claimed in any one of claims 1-8, **characterized in that** a flaring chamber is provided in the inlet flow regulating structure.
10. The inlet flow regulating structure as claimed in claim 9, **characterized in that** the side plate or the refrigerant inlet connector has a flaring chamber at least partially accommodating the flaring chamber of the inlet flow regulating structure.
11. The inlet flow regulating structure as claimed in claim 10, **characterized in that** a top surface of the flaring chamber of the inlet flow regulating structure and a top surface of the flaring chamber of the side plate or the refrigerant inlet connector are at least partially

in contact with each other and are generally located at the same level of height.

12. The inlet flow regulating structure as claimed in claim 11, **characterized in that** the size of the bottom of the flaring chamber matches the size of a distributor chamber of the plate heat exchanger, such that a two-phase refrigerant flow from a refrigerant inlet flows through the flaring chamber and then smoothly enters the distribution chamber and is distributed into corresponding refrigerant channels. 5 10
13. The inlet flow regulating structure as claimed in claim 1, **characterized in that** the inlet flow regulating structure is disposed at any position from the refrigerant inlet connector to a distributor chamber along a central axis of the distributor chamber. 15
14. The inlet flow regulating structure as claimed in claim 13, **characterized in that** the inlet flow regulating structure is disposed between the side plate and a jet hole of a first distributor. 20
15. The inlet flow regulating structure as claimed in claim 13, **characterized in that** the inlet flow regulating structure is disposed or integrated on a first heat exchange plate sheet I or a first heat exchange plate sheet II starting from the refrigerant inlet or between a first heat exchange sheet II and a first distributor. 25 30
16. The inlet flow regulating structure as claimed in claim 14, **characterized in that**, for a dual-circuit plate heat exchanger formed by heat exchange plate sheets I and heat exchange plate sheets II, in a distributor chamber of a second circuit, a seal is provided between a first heat exchange plate sheet II and a second heat exchange plate sheet I, and the inlet flow regulating structure is disposed or integrated on a first heat exchange sheet I, a first heat exchange sheet II, a second heat exchange plate sheet I or a second heat exchange plate sheet II; or 35 40
for a dual-circuit plate heat exchanger formed by heat exchange plate sheets I, heat exchange plate sheets II, heat exchange plate sheets III, and heat exchange plate sheets IV, in a distributor chamber of a second circuit, a seal is provided between a first heat exchange plate sheet II and a first heat exchange plate sheet III, and the inlet flow regulating structure is disposed or integrated on a first heat exchange plate sheet I, the first heat exchange plate sheet II, the first heat exchange plate sheet III or a first heat exchange plate sheet IV. 45 50
17. A plate heat exchanger, comprising an inlet flow regulating structure as claimed in any one of claims 1-16. 55

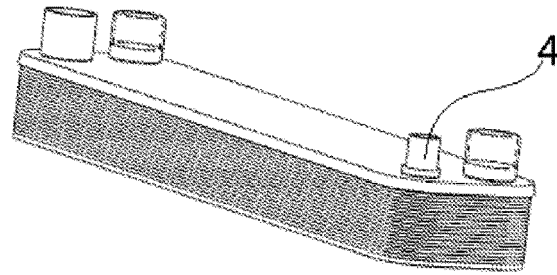


Fig. 1a

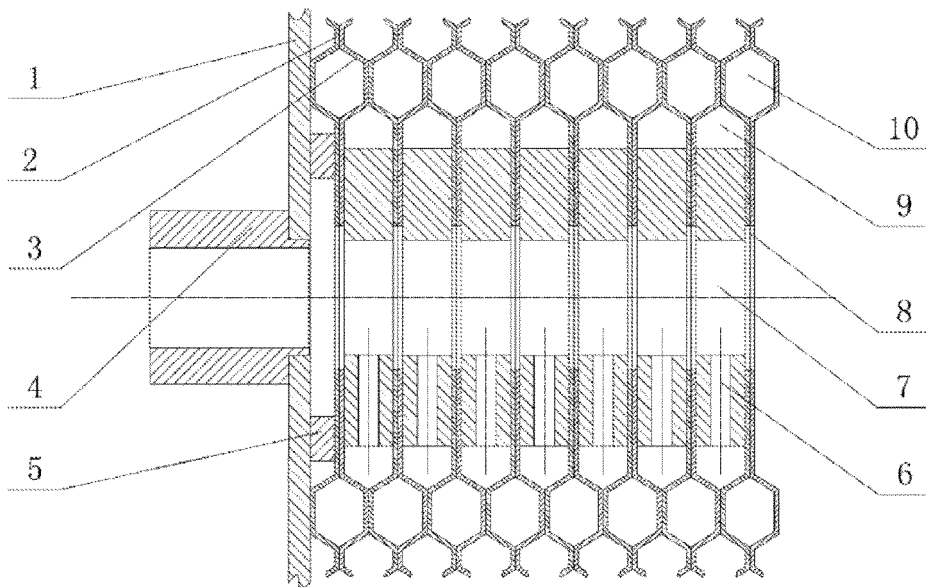


Fig. 1b

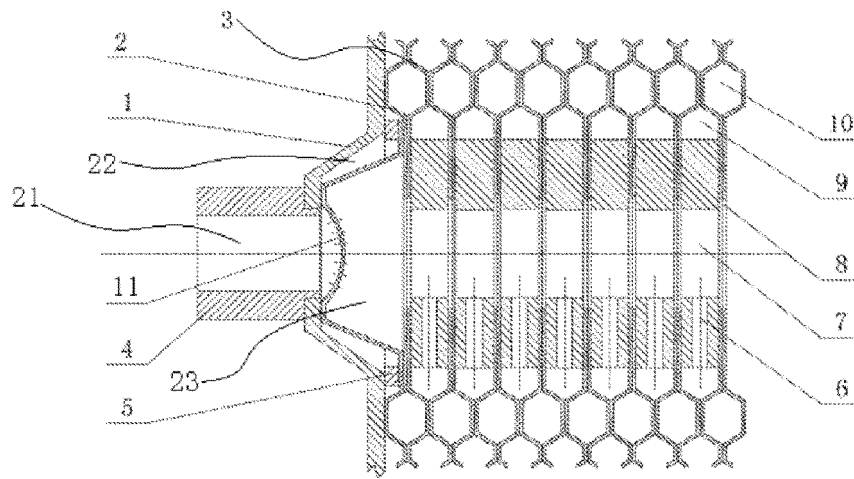


Fig. 2

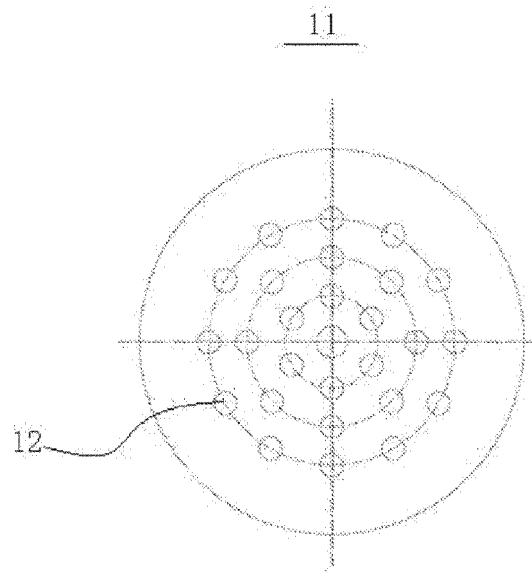


Fig. 3a

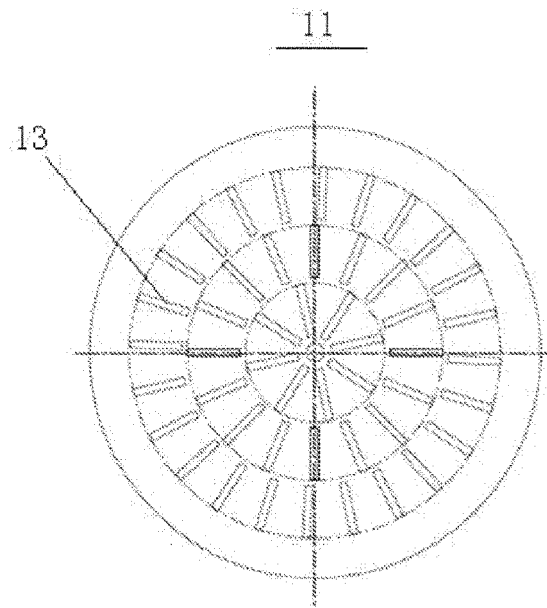


Fig. 3b

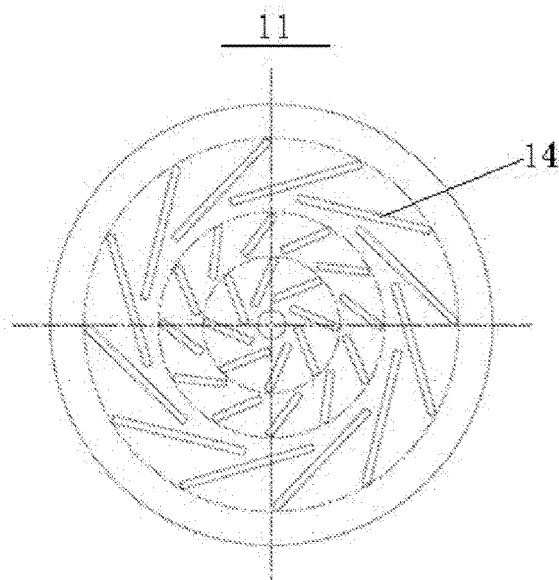


Fig. 3c

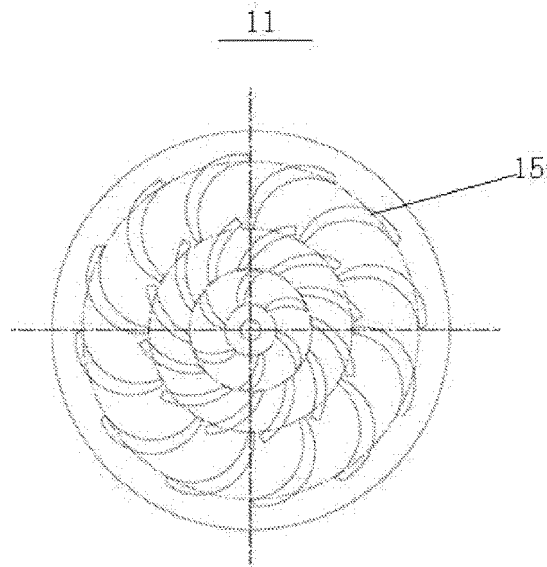


Fig. 3d

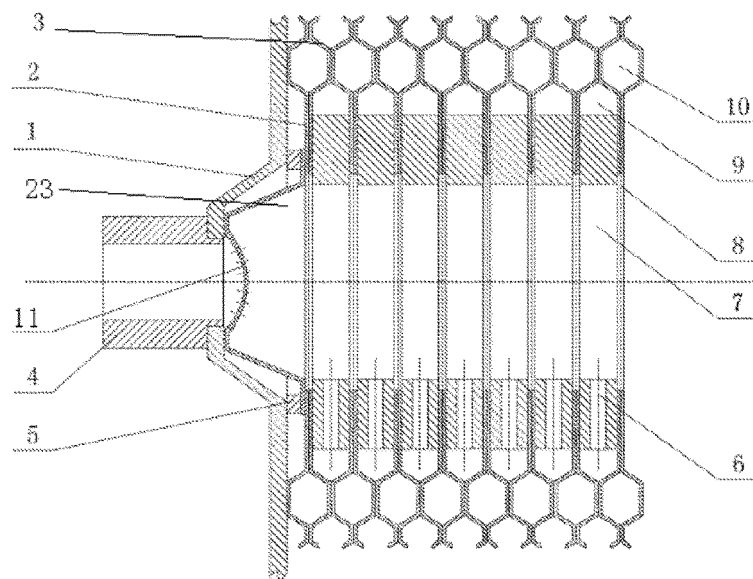


Fig. 4a

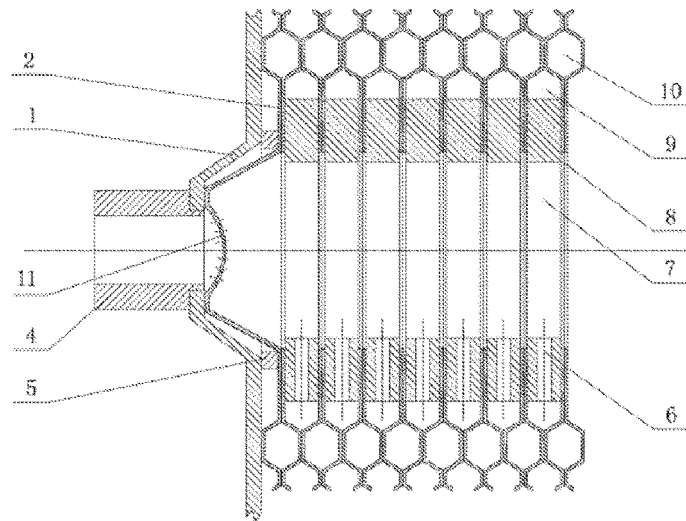


Fig. 4b

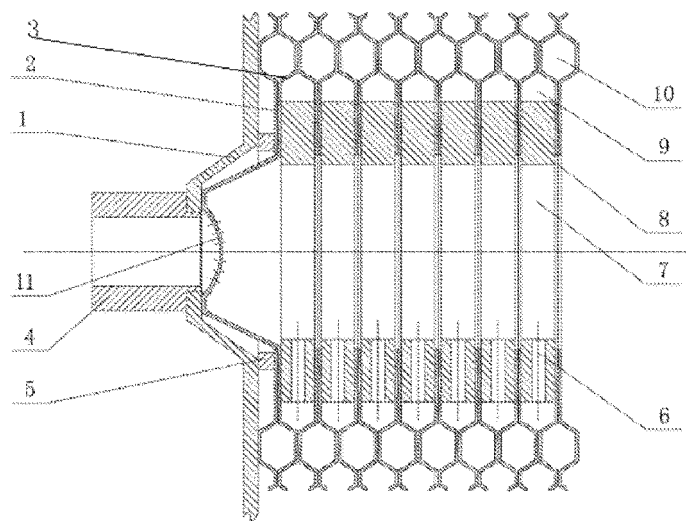


Fig. 4c

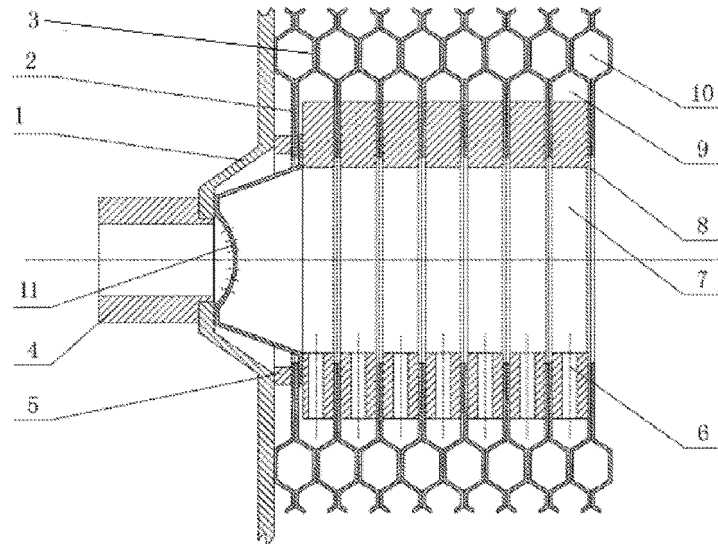


Fig. 4d

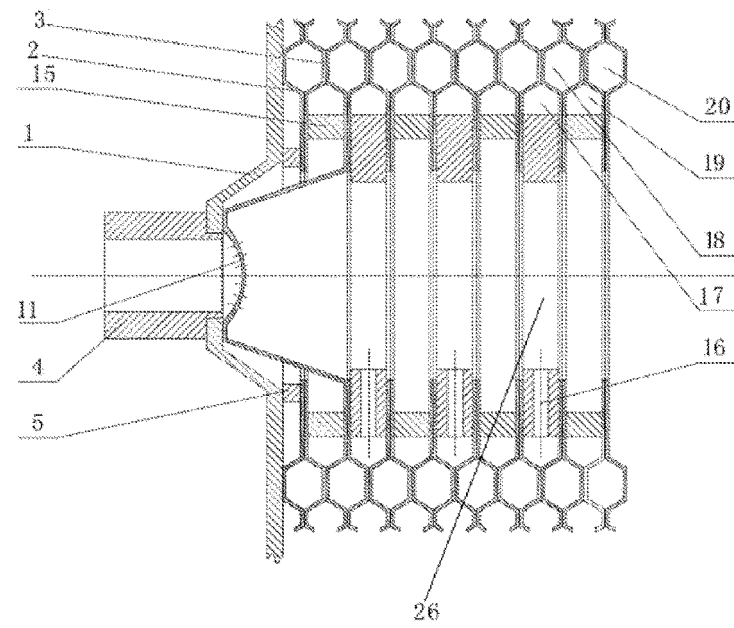


Fig. 4e

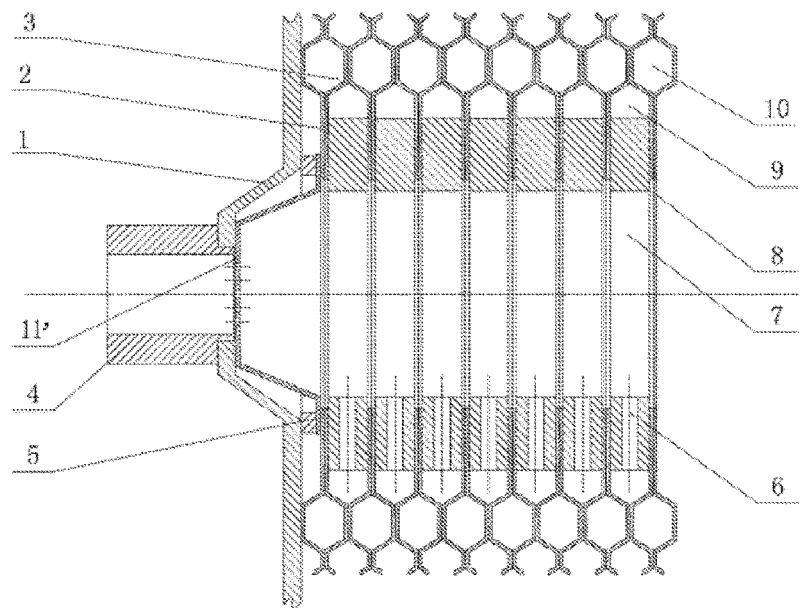


Fig. 5

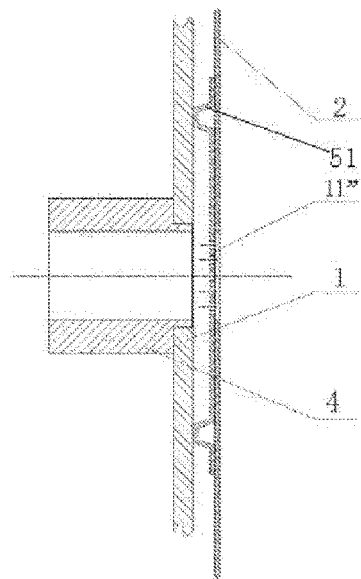


Fig. 6

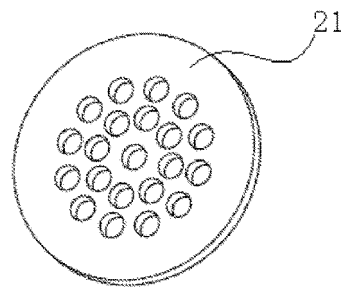


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2016/095280

A. CLASSIFICATION OF SUBJECT MATTER

F28D 9/00 (2006.01) i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F28D, F28F, F28B

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

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

WPI, EPODOC, CNABS, CNKI, CNTXT: heat exchanger, plate-type, sideboard, layer; EXCHANGER, PLATE, BOARD, RECTIFY, INLET, ENTRANCER

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 203785330 U (MITSUBISHI ELECTRIC CORPORATION), 20 August 2014 (20.08.2014), description, pages 4-8, and figures 3-23	1, 4, 5, 9-14, 17
Y	JP 1183352 A (SAN-O INDUSTRIAL CO., LTD.), 26 March 1999 (26.03.1999), description, pages 2 and 3, and figures 1 and 2	1, 4, 5, 9-14, 17
A	JP 0961071 A (SHOEI CO., LTD.), 07 March 1997 (07.03.1997), the whole document	1-17
A	JP 2000002498 A (CALSONIC CORP.), 07 January 2000 (07.01.2000), the whole document	1-17
A	CN 204421430 U (YAMATO SCIENTIFIC CO., LTD.), 24 June 2015 (24.06.2015), the whole document	1-17

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

* 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
"A" document defining the general state of the art which is not considered to be of particular relevance	
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
12 November 2016 (12.11.2016)Date of mailing of the international search report
21 November 2016 (21.11.2016)Name and mailing address of the ISA/CN:
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2016/095280

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 203785330 U	20 August 2014	EP 2977704 A1	27 January 2016
		WO 2014147804 A1	25 September 2014
JP 1183352 A	26 March 1999	JP H1183352 A	26 March 1999
JP 0961071 A	07 March 1997	JP 3052121 B2	12 June 2000
		JP H0961071 A	07 March 1997
JP 2000002498 A	07 January 2000	None	
CN 204421430 U	24 June 2015	None	

Form PCT/ISA/210 (patent family annex) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 201510933718 [0001]