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(54) MULTI-LOOP PLATE HEAT EXCHANGER

(57) Disclosed is a multi-loop plate heat exchanger, comprising: a plurality of heat exchange plates arranged in a stacked manner; heat exchange channels formed between adjacent heat exchange plates in the plurality of heat exchange plates; and port channels extending through the heat exchange plates and respectively used for inflow and outflow of a heat exchange medium, at least one of the port channels comprising at least two fluid channels which are separated from each other and used for inflow or outflow of at least two of multiple loops of refrigerant. The at least two fluid channels share one of the port channels, and the at least two fluid channels are arranged side by side in the radial direction of the port channel.

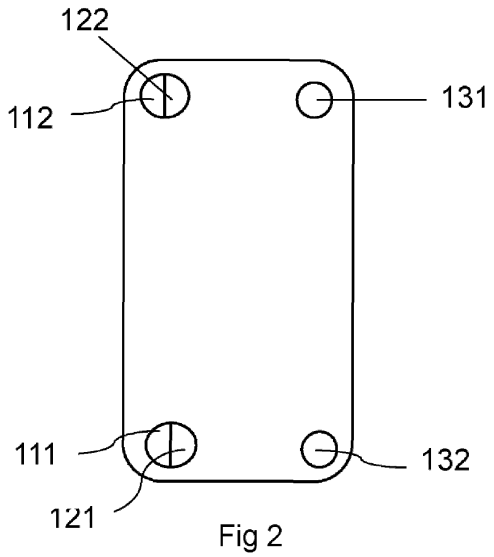

Fig 2

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Description

[0001] The present application claims the right of priority for Chinese patent application No. 201811632290.6, filed on 28 December 2018 and entitled "多回路板式换热器 [Multi-loop Plate Heat Exchanger]", which is incorporated herein by reference in its entirety.

Technical Field

[0002] The present invention relates to the fields of refrigeration, air conditioning, industrial refrigeration, heating, etc., and in particular to a multi-loop plate heat exchanger.

Background Art

[0003] For a plate heat exchanger, four ports are generally provided by means of stamping. Two of the ports are used for one working fluid, and the other two ports are used for another working fluid. A plate heat exchanger for use in a multi-loop system has six or more ports. This has the following shortcomings or disadvantages:

1) since regions at the ports cannot be used for heat exchange, the configuration of too many ports reduces the effective heat exchange area;
2) since the regions at the ports are always the weakest portions in the plate heat exchanger, the configuration of too many ports will reduce the strength of the plate heat exchanger; and
3) each port needs to be connected to a port connector, which leads to a high potential leakage risk and high cost.

Summary of the Invention

[0004] The purpose of the present invention is to solve at least one aspect of the above problems and defects that exist in the prior art.

[0005] According to one aspect of the present invention, a multi-loop plate heat exchanger is provided. The plate heat exchanger comprises:

a plurality of heat exchange plates arranged in a stacked manner;
heat exchange channels formed between two adjacent heat exchange plates in the plurality of heat exchange plates; and
port channels extending through the heat exchange plates and respectively used for inflow and outflow of a heat exchange medium, at least one of the port channels comprising at least two fluid channels which are separated from each other and used for inflow or outflow of at least two of the multiple loops of refrigerant,

wherein the at least two fluid channels share one of the port channels, and the at least two fluid channels are arranged side by side in the radial direction of the port channel.

[0006] In some embodiments, the at least two fluid channels are separated from each other by means of a separator.

[0007] In some embodiments, at least part of the separator is integrally formed on the corresponding heat exchange plate or independent of the heat exchange plate.

[0008] In some embodiments, the separator comprises a flanging bridge, which is formed by deformation in the region of one of the at least two fluid channels of the corresponding heat exchange plate in the port channel.

[0009] In some embodiments, the at least two fluid channels include a first fluid channel for one of the at least two loops of refrigerant and a second fluid channel for the other of the at least two loops of refrigerant,

the heat exchange channels include a first heat exchange channel for one of the at least two loops of refrigerant and a second heat exchange channel for the other of the at least two loops of refrigerant, and the first fluid channel is in fluid communication with the first heat exchange channel through a first fluid channel hole, and the second fluid channel is in fluid communication with the second heat exchange channel through a second fluid channel hole.

[0010] In some embodiments, the first fluid channel holes and the second fluid channel holes are alternately arranged in the extension direction of the port channel.

[0011] In some embodiments, the first fluid channel hole and the second fluid channel hole are located in the respective corresponding fluid channels.

[0012] In some embodiments, at least one of the first fluid channel hole and the second fluid channel hole is provided in an annular member, and at least part of the annular member is integrally formed on the corresponding heat exchange plate or independent of the heat exchange plate.

[0013] In some embodiments, the annular member comprises a flange, which is formed by deformation in the region of one of the at least two fluid channels of the corresponding heat exchange plate in the port channel.

[0014] In some embodiments, part of the annular member is arranged in the first fluid channel, and the other part is arranged in the second fluid channel; the part, arranged in the second fluid channel of the annular member provided with the first fluid channel hole blocks the second fluid channel and the first heat exchange channel; and/or
the part, arranged in the first fluid channel of the annular member provided with the second fluid channel hole blocks the first fluid channel and the second heat exchange channel.

[0015] In some embodiments, the annular member

provided with the first fluid channel hole is located between the adjacent heat exchange plates that form the first heat exchange channel; and/or
the annular member provided with the second fluid channel hole is located between the adjacent heat exchange plates that form the second heat exchange channel.

[0016] In some embodiments, the separator comprises a plurality of baffles which are arranged in the annular member, with ends of the plurality of baffles being connected so as to separate the at least one port channel into the at least two fluid channels.

[0017] In some embodiments, the plate heat exchanger further comprises a port connector connected to the at least one port channel, the port connector comprising at least two connection channels separated by a separation plate, the at least two connection channels being respectively corresponding to and in communication with the at least two fluid channels, thereby forming two passages isolated from each other for inflow or outflow of the refrigerant.

Brief Description of the Drawings

[0018] These and/or other aspects and advantages of the present invention will become apparent and easy to understand from the following description of the preferred embodiments in conjunction with the accompanying drawings, in which

Fig. 1 shows a schematic diagram of a port structural arrangement of a plate heat exchanger in the prior art;
Fig. 2 shows a schematic diagram of a port structure arrangement of a plate heat exchanger according to the embodiments of the present invention;
Fig. 3 is a cross-sectional view of a plate heat exchanger according to an embodiment of the present invention;
Fig. 4A is a cross-sectional view of a plate heat exchanger according to another embodiment of the present invention;
Figs. 4B and 4C respectively show structural schematic diagrams of a separator in a port channel in two adjacent heat exchange plates;
Fig. 5 is a cross-sectional view of a plate heat exchanger according to another embodiment of the present invention; and
Figs. 6A and 6B respectively show a structural schematic diagram and a cross-sectional view of a port connector according to the embodiments of the present invention.

Detailed Description of Embodiments

[0019] The technical solutions of the present invention will be further described in detail below with reference to the embodiments and in conjunction with the accompanying drawings. In the specification, the same or similar reference numerals denote the same or similar components. The following description of the embodiments of the present invention with reference 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.

[0020] Fig. 1 shows a schematic diagram of a port layout of a plate heat exchanger in the prior art. Specifically, the port arrangement shown in Fig. 1 can be used in a three-loop refrigeration system. Ports 11 and 12 are respectively used as an inlet and an outlet for a first fluid, ports 21 and 22 are respectively used as an inlet and an outlet for a second fluid, and ports 31 and 32 are respectively used as an inlet and an outlet for a third fluid.

[0021] At present, for an existing plate heat exchanger, as shown in Fig. 1, one port or port channel corresponds to one port connector. In general, two port channels and two port connectors are required for one working fluid, with the port of one of the port channels being an inlet, and the port of the other port channel being an outlet. Such a common design and port layout limit or reduce the effective heat exchange area and strength of the plate heat exchanger, such that it is necessary to expand the ports to increase the heat transfer capacity.

[0022] Therefore, the plate heat exchanger in the prior art generally has the shortcomings mentioned in the background art of the present invention.

[0023] In view of this technical problem, the present invention provides a new inventive concept in order to at least partially alleviate or eliminate these shortcomings.

[0024] Specifically, the present invention provides a special port design, in which ports or port channels for at least two working fluids can be joined together. In addition, the new special port design can also allow simple pipe connection and make the corresponding refrigeration system have a more compact structure. Further, it can also allow reduction in the number of the port connectors connected thereto, thereby reducing the cost.

[0025] In an example of the present invention, the present invention provides a port channel, comprising at least two fluid channels, which are separated from each other and used for inflow or outflow of at least two loops of refrigerant.

[0026] In the present invention, a port channel originally used for one fluid is separated into at least two port channels independent of each other, replacing the at least two port channels with at least two loops of refrigerant in the prior art. In other words, by means of integrating at least two port channels into one port channel, it is possible to at least partially solve the problem discussed in the prior art due to the need of providing more port channels on the plate heat exchanger.

[0027] In addition, the solution of the present invention can increase the effective heat transfer area by means of reducing the number of port channels, and can also simplify the connection complexity of pipes connected to the port channels to a certain extent.

[0028] Obviously, compared with the solution in the pri-

or art, the number of distributors and gaskets can be reduced by at least 50%.

[0029] It can be seen from the above aspects that the solution of the present invention can reduce the cost, simplify the complexity, and also improve the performance of the plate heat exchanger.

[0030] The present invention aims to expand the effective heat exchange area and simplify the connection between the port connector and the plate heat exchanger without the loss in strength and performance. Therefore, the concept of separating one port channel into at least two fluid channels (e.g., the at least two fluid channels being arranged side by side in the radial direction of the port channel) is proposed. In this case, the at least two loops of refrigerant fluid respectively flow through the at least two fluid channels in the port channel and are relatively independent, without causing the refrigerant fluid to mix with each other. It should be noted that the at least two loops of refrigerant fluid referred to in the present invention are not limited to whether the refrigerant fluids are of the same type. For example, the loops of refrigerant fluid may be refrigerant fluids of the same type, or may be refrigerant fluids of different types.

[0031] Specifically, the concept of the plate heat exchanger in an embodiment of the present invention is specifically as follows:

> the plate heat exchanger has a multi-loop system and comprises:
> a plurality of heat exchange plates arranged in a stacked manner;
> heat exchange channels formed between two adjacent heat exchange plates in the plurality of heat exchange plates; and
> port channels extending through the heat exchange plates and respectively used for inflow and outflow of a heat exchange medium, at least one of the port channels comprising at least two fluid channels which are separated from each other and used for inflow or outflow of at least two of multiple loops of refrigerant,
> wherein the at least two fluid channels share one of the port channels, and the at least two fluid channels are arranged side by side in the radial direction of the port channel.

[0032] Fig. 2 shows that, in this embodiment, one port channel as shown in Fig. 1 is separated into two fluid channels, i.e., a first fluid channel and a second fluid channel. It can be understood that, in this embodiment, the design concept of the present invention is explained and described by taking the example in which one port channel as shown in Fig. 1 is separated into two fluid channels. However, those skilled in the art would have understood that the one port channel can also be separated into three or more fluid channels, with the configuration or structural arrangement being similar to the case in which the one port is divided into two fluid channels, which will not be illustrated separately by examples.

[0033] As shown in Fig. 2, a circular port channel for inflow of the heat exchange medium in the lower left corner is separated into two fluid channels 111 and 121 for inflow of the fluid, and accordingly, a circular port channel for outflow of the heat exchange medium in the upper left corner is separated into two fluid channels 112 and 122 for outflow of the fluid. For comparison, a circular port channel 131 in the upper right corner is still used for inflow of another fluid, and a circular port channel 132 in the lower right corner is used for outflow of another fluid, such as a secondary refrigerant. The positions of all port channels are not limited to those shown in the figure.

[0034] It should be noted that the two fluid channels 131 and 132 arranged on the right side can also be separated into at least two fluid channels by using the design concept of the present invention, and the specific configuration and number can be selected by those skilled in the art according to actual needs.

[0035] In addition, at least one of the port channels where the fluid channels 111 and 121 are located and the port channels where the fluid channels 112 and 122 are located can also be separated into at least three fluid channels, one of which is used for inflow or outflow of the secondary refrigerant, such that the illustrated fluid channels 131 and/or 132 may not be separately provided.

[0036] It can be understood that, after separately flowing into the fluid channels 111 and 121, the two loops of heat exchange medium need to continue to remain independent of each other to avoid interference with each other, so a separator will be provided between the two fluid channels 111 and 121, or the two fluid channels will be separated from each other by means of a separator. Herein, the design concept of the present invention is mainly described by taking the port channel for inflow of the fluid as an example. However, the design concept of the present invention can also be applied to the port channel for outflow of the fluid, which will not be repeated in detail.

[0037] The following will focus on the specific configuration of the components, such as the separator and the fluid channel holes in the port channel.

[0038] Fig. 3 shows a cross-sectional view of a plate heat exchanger according to an embodiment of the present invention, with a port channel being separated into two fluid channels 111 and 121 by means of a separator 141 such as a baffle and an annular member 142 such as a distribution ring.

[0039] As shown in the figure, the two fluid channels 111 and 121 include a first fluid channel 111 for one of the two loops of refrigerant and a second fluid channel 121 for the other of the loops of refrigerant. The two heat exchange channels include a first heat exchange channel 151 for one of the two loops of refrigerant and a second heat exchange channel 152 for the other of the loops of refrigerant.

[0040] One distribution ring 142 is arranged in the port channel and at a position corresponding to the heat ex-

change channels 151 and 152 formed by every two heat exchange plates. One baffle 141 is provided in the middle of each distribution ring 142 to separate the distribution ring into two parts which are isolated from each other in a sealed manner. The plurality of baffles 141 are aligned with one another when being mounted in the port channel, with ends thereof being connected to achieve sealed isolation. Of course, the plurality of baffles 141 can also be arranged as a longer single baffle, that is, one end of the baffle is inserted into the plurality of distribution rings 142 to separate the distribution rings into two parts.

[0041] In this embodiment, some of the plurality of distribution rings 142 are arranged in the first fluid channel 111, and the other distribution rings are arranged in the second fluid channel 121. Some distribution rings 142 are located between the adjacent heat exchange plates that form the corresponding first heat exchange channel 151, and the other distribution rings 142 are located between the adjacent heat exchange plates that form the corresponding second heat exchange channel 152.

[0042] Specifically, the first fluid channel 111 is in fluid communication with the first heat exchange channel 151 through a first fluid channel hole 1111 provided in the distribution ring 142, and the portion of the distribution ring 142 that is located in the second fluid channel 121 can be used to block the second fluid channel 121 and the first heat exchange channel 151. The second fluid channel 121 is in fluid communication with the second heat exchange channel 152 through a second fluid channel hole 1211 provided in the distribution ring 142, and the portion of the distribution ring 142 that is located in the first fluid channel 111 can be used to block the first fluid channel 111 and the second heat exchange channel 152. That is to say, when the distribution ring is in communication with the corresponding fluid channel and the corresponding heat exchange channel, the portion of the distribution ring that is located in other fluid channel can be used to block the other fluid channel and the heat exchange channel. It can be seen that part of the distribution ring 142 serves as a distributor, and the other part thereof serves as a gasket for isolation, such that the present invention can reduce the number of distributors and gaskets by at least 50%.

[0043] In general, since the first heat exchange channels 151 and the second heat exchange channels 152 are alternately arranged in the plate heat exchanger, the first fluid channel holes 1111 and the second fluid channel holes 1211 are also alternately arranged in the extension direction of the port channel (i.e., approximately the top-to-bottom direction of the page of the figure). The first fluid channel hole 1111 and the second fluid channel hole 1211 are located in the respective corresponding fluid channels 151 and 152.

[0044] Specifically, the first fluid channel 111 is in fluid communication with the first heat exchange channel 151 through the first fluid channel hole 1111, and the second fluid channel 121 is in fluid communication with the second heat exchange channel 152 through the second fluid channel hole 1211.

[0045] Although the figure shows only one fluid channel hole in communication with one heat exchange channel, it should be understood that a plurality of fluid channel holes can be provided to be in communication with one heat exchange channel.

[0046] In addition, in a port connector 160 connected to the port channel, one separation plate 163 is provided in the middle of the port connector 160 to separate the port connector into two connection channels 161 and 162. The two connection channels 161 and 162 are respectively corresponding to and in communication with the two fluid channels 111 and 121, thereby forming two passages isolated from each other for inflow or outflow of the refrigerant.

[0047] Fig. 4A shows a cross-sectional view of a plate heat exchanger according to another embodiment of the present invention, with a port channel being separated into two fluid channels 111 and 121 by means of a separator 241 that is integrally formed on the corresponding heat exchange plate.

[0048] As shown in the figure, the two fluid channels 111 and 121 include a first fluid channel 111 for one of the two loops of refrigerant and a second fluid channel 121 for the other of the loops of refrigerant. The two heat exchange channels include a first heat exchange channel 151 for one of the two loops of refrigerant and a second heat exchange channel 152 for the other of the loops of refrigerant.

[0049] Specifically, the first fluid channel 111 is in fluid communication with the first heat exchange channel 151 through the first fluid channel hole 1111, and the second fluid channel 121 is in fluid communication with the second heat exchange channel 152 through the second fluid channel hole 1211.

[0050] In general, since the first heat exchange channels 151 and the second heat exchange channels 152 are alternately arranged in the plate heat exchanger, the first fluid channel holes 1111 and the second fluid channel holes 1211 are also alternately arranged in the extension direction of the port channel (i.e., approximately the top-to-bottom direction of the page of the figure). The first fluid channel hole 1111 and the second fluid channel hole 1211 are located in the respective corresponding fluid channels 151 and 152.

[0051] Although the figure shows only one fluid channel hole in communication with one heat exchange channel, it should be understood that a plurality of fluid channel holes can be provided to be in communication with one heat exchange channel.

[0052] Fig. 4A is mainly characterized in that the separator is configured to be integrally formed on the corresponding heat exchange plate, while in Fig. 3, the separator is formed by a baffle independent of the heat exchange plate. One function of the annular members 142 and 242 is to communicate with one fluid channel and the corresponding heat exchange channel. For example, when the annular member is arranged at an inlet port,

the refrigerant is distributed to the corresponding heat exchange channel through the fluid channel hole, and when the annular member is arranged at an outlet port, the annular member can also function to enhance the strength of the port. The annular members 142 and 242 can also block other fluid channels and the heat exchange channels. The position, the function, etc. of the annular member 242 are described in detail above with reference to the distribution ring 142 in the embodiment of Fig. 3, which will not be repeated here. The annular member 242 in Fig. 4 is configured to be integrally formed on the corresponding heat exchange plate, while the annular member (the distribution ring 142) in Fig. 3 is an independent component. It can be understood that one annular member 242 can be configured such that part of the annular member is integrally formed on the corresponding heat exchange plate, and the other part is an independent component, for example, the independent distribution ring 142 may be a semi-ring. In the plurality of the annular members of the heat exchanger, part of the annular member can be integrally formed on the corresponding heat exchange plate, and the other part is an independent component.

[0053] As shown in Figs. 4B and 4C, the separator 240 comprises a flanging bridge 241. The flanging bridge 241 is formed by deformation in the region of the corresponding heat exchange plate in the port channel (e.g., at the fluid channel). Fig. 4B shows the structure of a flanging bridge 241 used at a first fluid channel 111, and Fig. 4C shows the structure of a flanging bridge 241 used at a second fluid channel 121. The flanging bridges 241 shown in Figs. 4B and 4C are similar in structure and mainly different in that, when a plurality of heat exchange plates are assembled together, two adjacent heat exchange plates respectively provided with the flanging bridges 241 shown in Figs. 4B and 4C can be assembled with each other, and the port channel is separated into two fluid channels. That is, the flanging bridges 241 shown in Figs. 4B and 4C can cooperate with each other and achieve sealed isolation for the port channel by means of, for example, welding.

[0054] An annular member 242 is also provided at the position of each heat exchange plate corresponding to the port channel, and at least part of the annular member 242 is integrally formed on the corresponding heat exchange plate. Alternatively, the annular member 242 can also be configured as a separate component independent of the heat exchange plate, and is then welded together with each heat exchange plate. The distribution ring 142 in Fig. 3 is taken as an example.

[0055] The annular member 242 comprises a plurality of flanges, which are formed by deformation in the region of the corresponding heat exchange plate in the port channel (e.g., at one fluid channel). The flanges of the adjacent heat exchange plates cooperate with each other and are connected together by means of, for example, crimping, welding or bonding.

[0056] In this embodiment, part of the annular member 242 is arranged in the first fluid channel 111 and is located between the adjacent heat exchange plates that form the corresponding first heat exchange channel 151; and accordingly, the remaining part of the annular member 242 is arranged in the first fluid channel 121 and is located between the adjacent heat exchange plates that form the corresponding second heat exchange channel 152.

[0057] In addition, in the port connector 160 of the port channel connected to an inlet connection pipe, one separation plate 163 is provided in the middle of the port connector 160 to separate the port connector into two connection channels 161 and 162. The two connection channels 161 and 162 are respectively corresponding to and in communication with the two fluid channels 111 and 121, thereby forming two passages isolated from each other for inflow or outflow of the refrigerant.

[0058] The annular member in Fig. 4A has the function substantially the same as that of the distribution ring shown in Fig. 3, which will not be described in detail.

[0059] Fig. 5 shows a cross-sectional view of a plate heat exchanger according to another embodiment of the present invention, only showing the part of the port channel that is separated into two fluid channels.

[0060] Fig. 5 shows an example of a combination of the annular member in Fig. 4 and the separator shown in Fig. 3. Specifically, in Fig. 5, the separator is not integrally formed on the corresponding heat exchange plate, but is formed by a plurality of baffles. In Fig. 5, at least part of the annular member is integrally formed on the corresponding heat exchange plate.

[0061] Specifically, the plate heat exchanger comprises a plate assembly 300, which is provided with inlet and outlet channels for three working fluids. The plate assembly comprises a first heat exchange plate 301, a second heat exchange plate 302, a third heat exchange plate 303 and a fourth heat exchange plate 304, which have the periphery of the same shape. The heat exchange plates are arranged in such a manner that the first heat exchange plates 301, the second heat exchange plate 302, the third heat exchange plate 303 and the fourth heat exchange plate 304 are sequentially arranged in cycle. A first heat exchange channel 151 for a first fluid R1 to flow through is provided between the first heat exchange plate 301 and the second heat exchange plate 302, a second heat exchange channel 152 for a second fluid R2 to flow through is provided between the third heat exchange plate 303 and the fourth heat exchange plate 304, and third heat exchange channels 153 for a third fluid W to flow through are provided between the second heat exchange plate 302 and the third heat exchange plate 303 and between the fourth heat exchange plate 304 and the adjacent first heat exchange plates 301.

[0062] The plate assembly 300 further comprises at least one separation space 311 in the port channel and corresponding to the two adjacent first heat exchange channels 151 and two adjacent second heat exchange channels 152, and in the respective fluid channel, the separation space 311 is closed for the other one of the

first fluid R1 and the second fluid R2. That is, in the first fluid channel 111, the first fluid R1 flows into the first heat exchange channel 151 through the first fluid flow channel hole 1111, while the second fluid R2 flows into the second heat exchange channel 152 through the second fluid flow channel hole 1211.

[0063] As shown in Fig. 5, in the case where at least two separation spaces 311 are provided, the annular members 142 for the third heat exchange plate 303 and the fourth heat exchange plate 304 of one separation space 311 and for the first heat exchange plate 301 and the second heat exchange plate 302 of another adjacent separation space are connected to each other at the port channel so as to form an annular contact portion surrounding the port channel. For simplicity of illustration, only three annular contact portions in the port channel are shown as an example. At the annular contact portion, four heat exchange plates 301, 302, 303 and 304 are in contact with one another by means of, for example, crimping, welding or bonding.

[0064] In the port channel, a baffle 141 is provided between the adjacent annular contact portions 314, and the adjacent baffles 141 are connected to each other to separate the port channel into two fluid channels.

[0065] In various embodiments of the present invention, the fluid flow channel hole can be a depression region integrally formed in the heat exchange plate or a through hole passing through the port channel. The fluid flow channel hole may be of a circular, semi-circular, elliptical, rectangular, trapezoidal and other arbitrary shapes.

[0066] Figs. 6A and 6B respectively show a structural schematic diagram and a cross-sectional view of a port connector according to the embodiments of the present invention.

[0067] In order to achieve the purpose of the port connector 160 being provided with two connection channels 161 and 162, a separation plate 163 is provided substantially in the middle of the port connector 160. Of course, the port connector 160 is not necessarily separated, by means of the separation plate 163, into two approximately equal parts, and may also be separated into two parts of different sizes.

[0068] The above description is merely some embodiments of the present invention, and those of ordinary skill in the art would have understood that changes could be made to these embodiments without departing from the principle and spirit of the general inventive concept, and the scope of the present invention is defined by the claims and the equivalents thereof.

Claims

1. A multi-loop plate heat exchanger, comprising:

a plurality of heat exchange plates arranged in a stacked manner;

heat exchange channels formed between two adjacent heat exchange plates in the plurality of heat exchange plates; and

port channels extending through the heat exchange plates and respectively used for inflow and outflow of a heat exchange medium, at least one of the port channels comprising at least two fluid channels which are separated from each other and used for inflow or outflow of at least two of multiple loops of refrigerant,

wherein the at least two fluid channels share one of the port channels, and the at least two fluid channels are arranged side by side in the radial direction of the port channel.

2. The multi-loop plate heat exchanger as claimed in claim 1, wherein
the at least two fluid channels are separated from each other by means of a separator.

3. The multi-loop plate heat exchanger as claimed in claim 2, wherein
at least part of the separator is integrally formed on the corresponding heat exchange plate or independent of the heat exchange plate.

4. The multi-loop plate heat exchanger as claimed in claim 2 or 3, wherein
the separator comprises a flanging bridge, which is formed by deformation in the region of the corresponding heat exchange plate in the port channel.

5. The multi-loop plate heat exchanger as claimed in claim 1 or 2, wherein

the at least two fluid channels include a first fluid channel for one of the at least two loops of refrigerant and a second fluid channel for the other of the at least two loops of refrigerant,

the heat exchange channels include a first heat exchange channel for one of the at least two loops of refrigerant and a second heat exchange channel for the other of the at least two loops of refrigerant, and

the first fluid channel is in fluid communication with the first heat exchange channel through a first fluid channel hole, and the second fluid channel is in fluid communication with the second heat exchange channel through a second fluid channel hole.

6. The multi-loop plate heat exchanger as claimed in claim 5, wherein
the first fluid channel holes and the second fluid channel holes are alternately arranged in the extension direction of the port channel.

7. The multi-loop plate heat exchanger as claimed in

claim 5, wherein
the first fluid channel hole and the second fluid channel hole are located in the respective corresponding fluid channels.

8. The multi-loop plate heat exchanger as claimed in claim 5, wherein
at least one of the first fluid channel hole and the second fluid channel hole is provided in an annular member, and at least part of the annular member is integrally formed on the corresponding heat exchange plate or independent of the heat exchange plate.

9. The multi-loop plate heat exchanger as claimed in claim 8, wherein
the annular member comprises a flange, which is formed by deformation in the region of the corresponding heat exchange plate in the port channel.

10. The multi-loop plate heat exchanger as claimed in claim 8, wherein

part of the annular member is arranged in the first fluid channel, and the other part is arranged in the second fluid channel;
the part, arranged in the second fluid channel, of the annular member provided with the first fluid channel hole blocks the second fluid channel and the first heat exchange channel; and/or
the part, arranged in the first fluid channel, of the annular member provided with the second fluid channel hole blocks the first fluid channel and the second heat exchange channel.

11. The multi-loop plate heat exchanger as claimed in claim 8, wherein

the annular member provided with the first fluid channel hole is located between the adjacent heat exchange plates that form the first heat exchange channel; and/or
the annular member provided with the second fluid channel hole is located between the adjacent heat exchange plates that form the second heat exchange channel.

12. The multi-loop plate heat exchanger as claimed in claim 8 when referring to claim 2, wherein
the separator comprises a plurality of baffles which are arranged in the annular member, with ends of the plurality of baffles being connected so as to separate the at least one port channel into the at least two fluid channels.

13. The multi-loop plate heat exchanger as claimed in any one of claims 1-3 and 6-12, further comprising:
a port connector connected to the at least one port channel, the port connector comprising at least two connection channels separated by a separation plate, the at least two connection channels being respectively corresponding to and in communication with the at least two fluid channels, thereby forming two passages isolated from each other for inflow or outflow of the refrigerant.

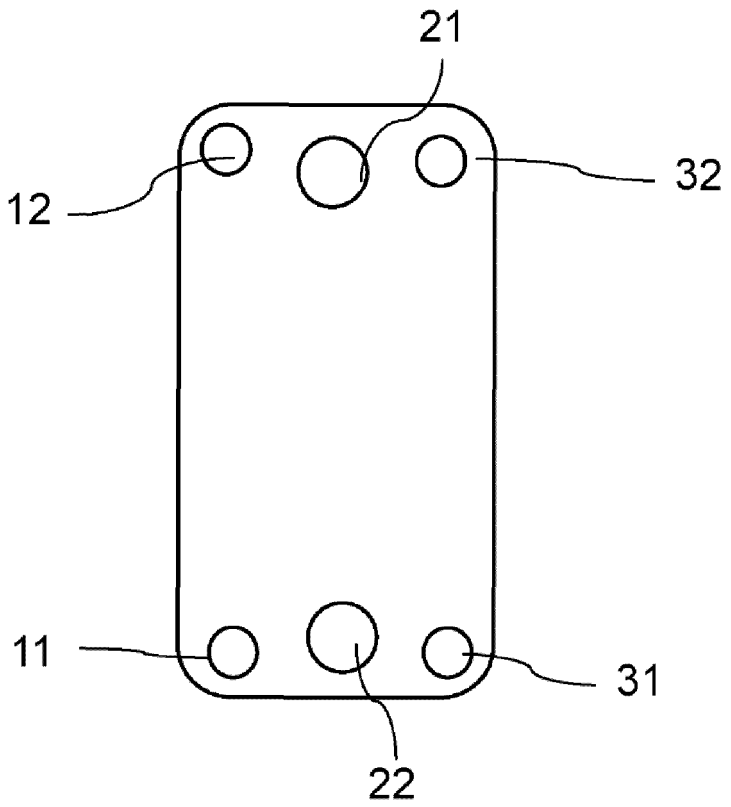

Fig 1

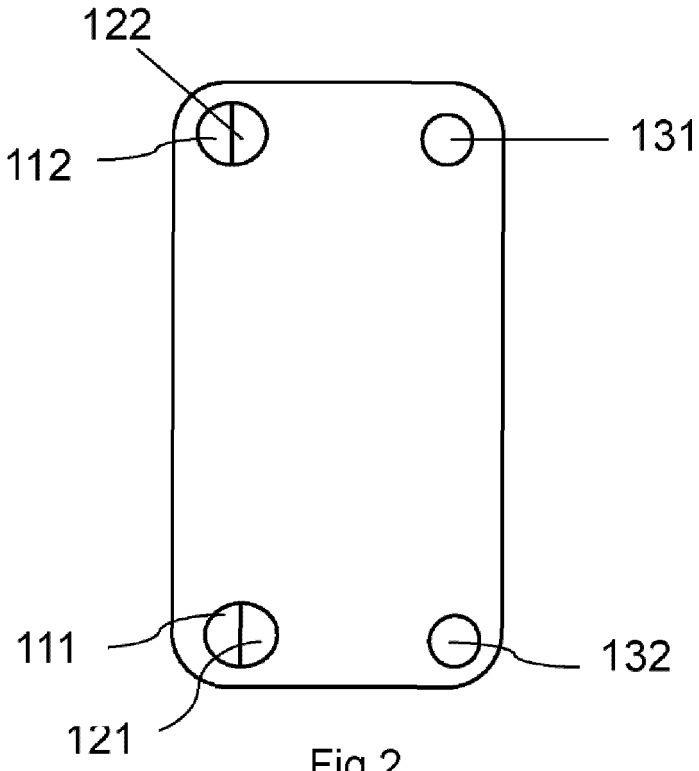

Fig 2

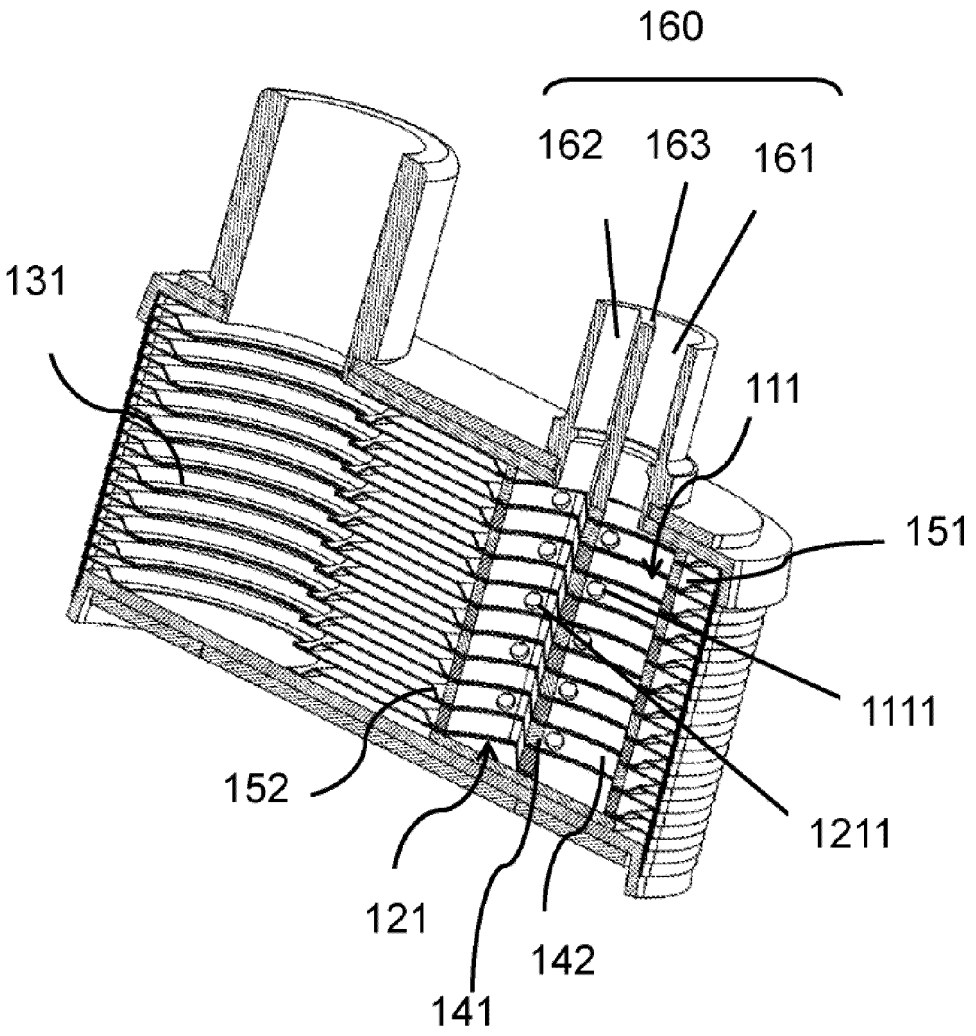

Fig 3

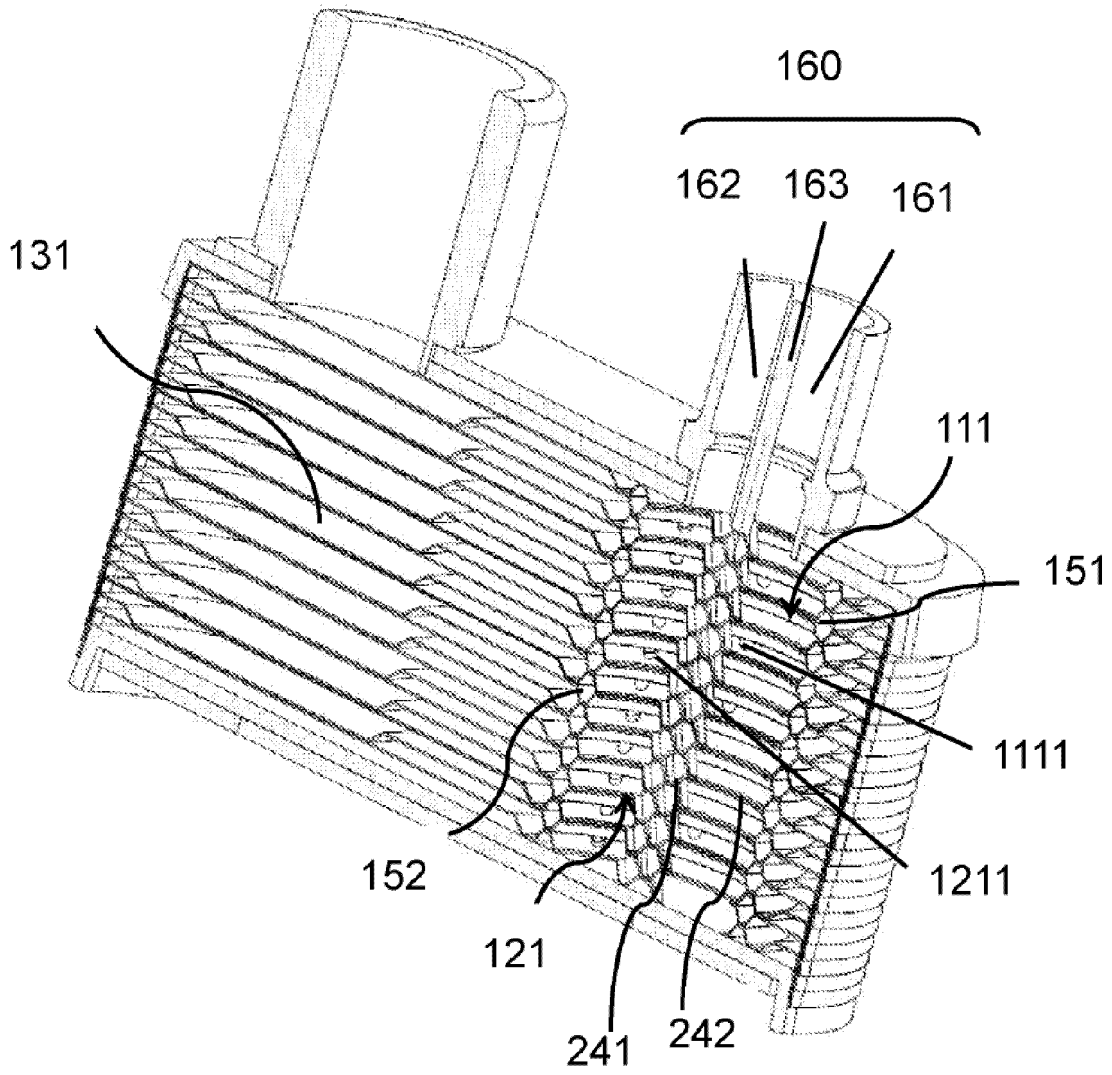

Fig 4A

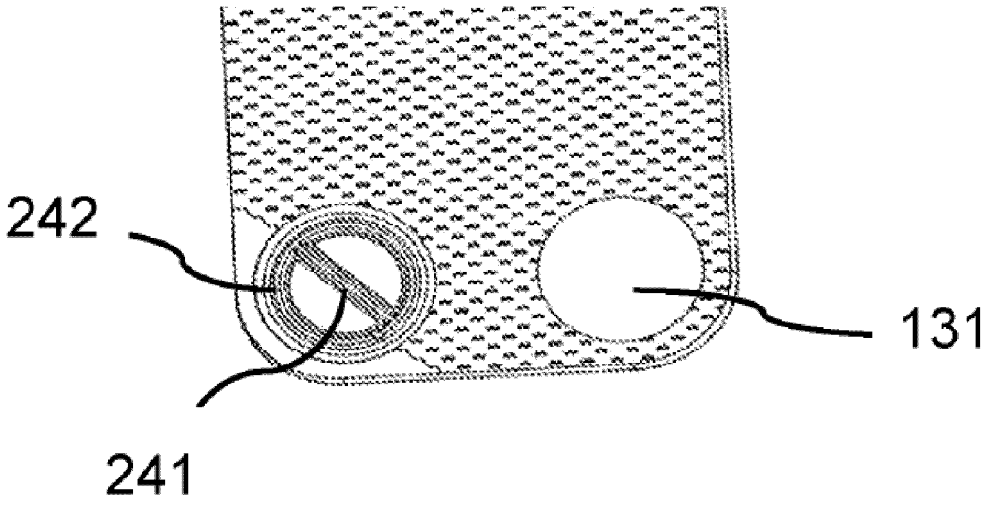

Fig 4B

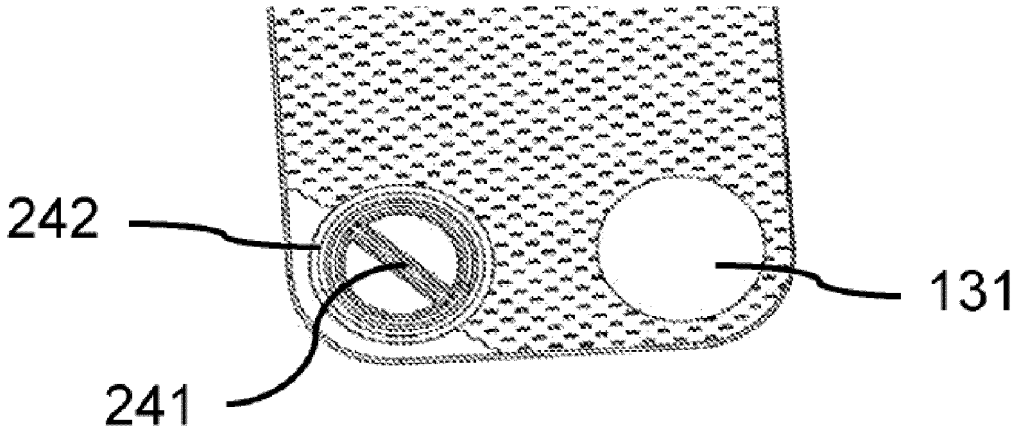

Fig 4C

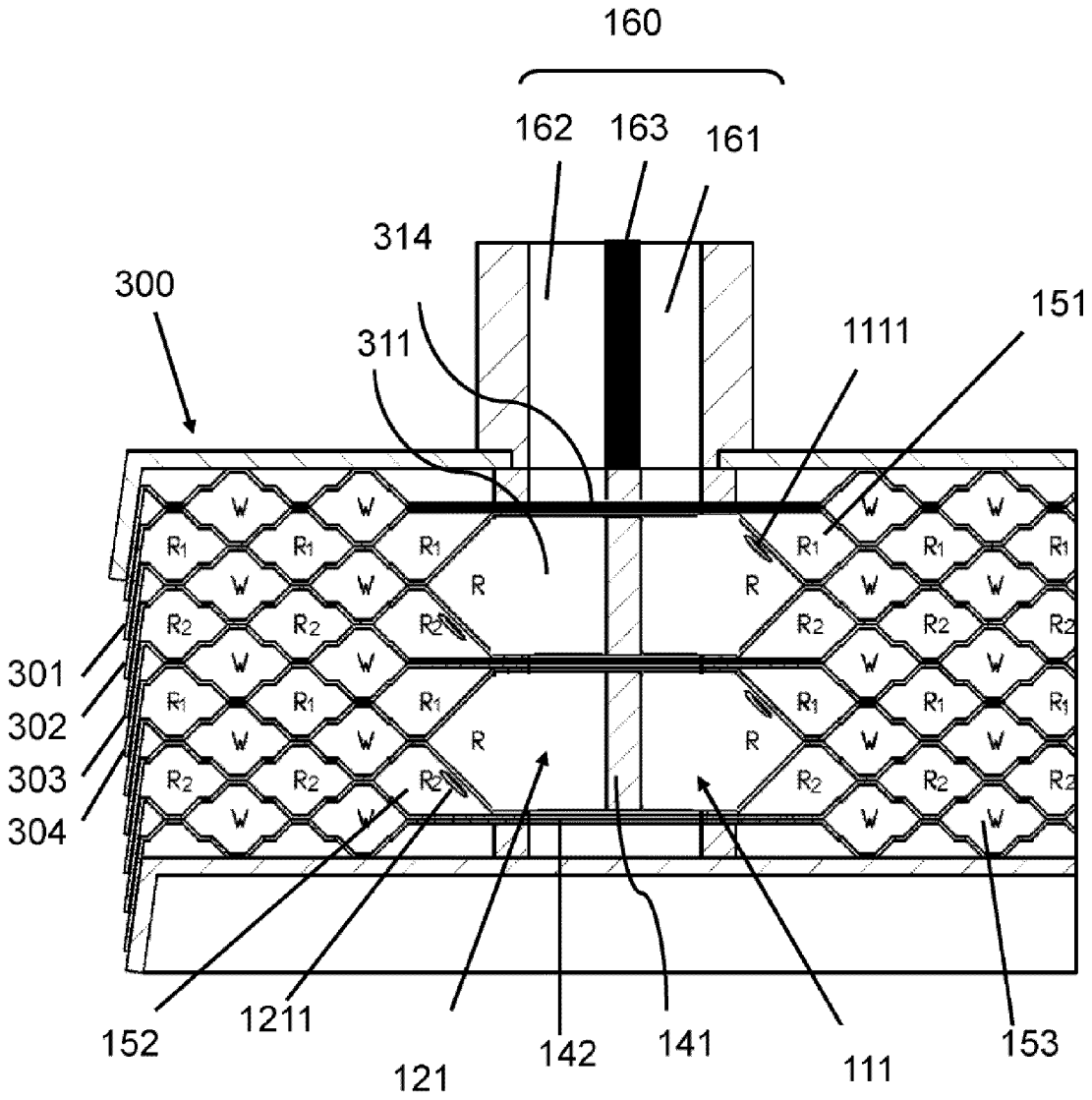
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Fig 5

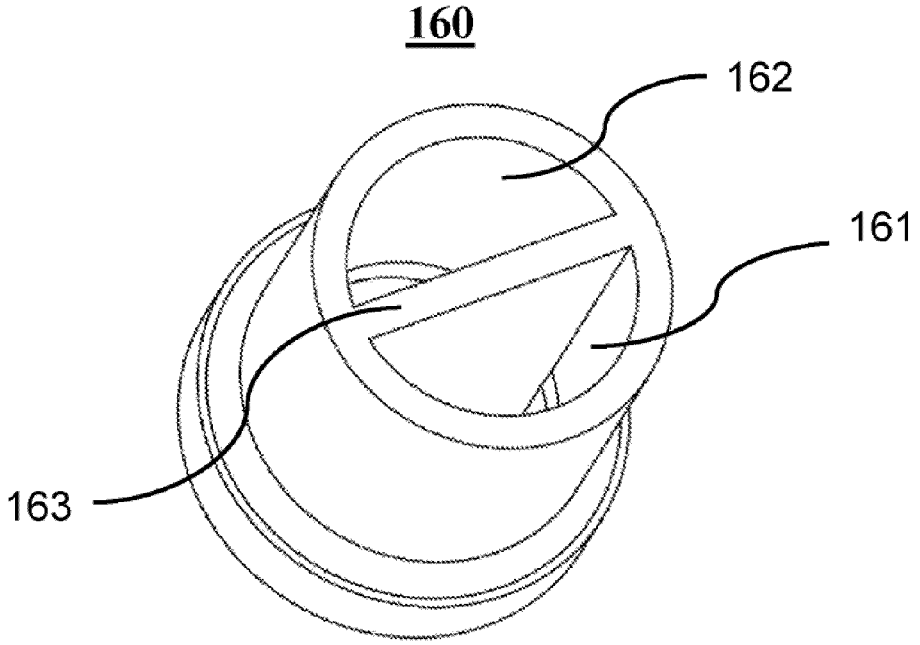

Fig 6A

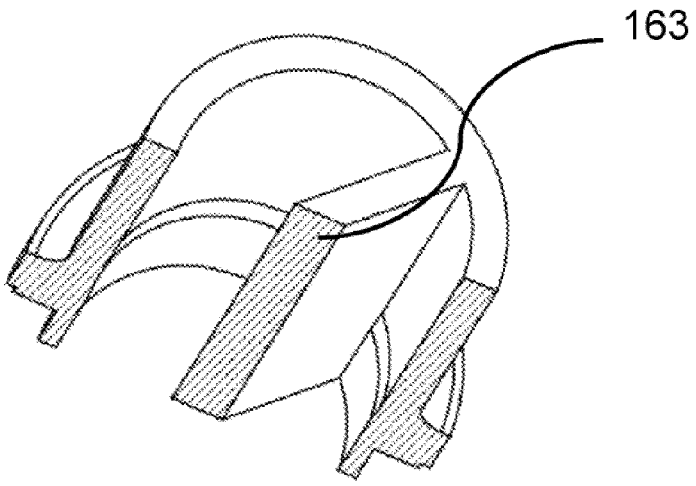

Fig 6B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2019/122699

A. CLASSIFICATION OF SUBJECT MATTER

F28F 3/08(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)

F28F3; F28F9; F28D1

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)

VEN; CNABS; CNKI: 换热器, 板式, 多回路, 多路, 通道, 分隔, 隔开, 端口, 共用, 合用, heat exchange, port, operable, communion, entrance, plate, entry

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2056648 A (APV CO., LTD.) 18 March 1981 (1981-03-18) description, columns 1-3, and figures 1-8	1-13
A	CN 107228582 A (DANFOSS MICRO-CHANNEL HEAT EXCHANGER (JIAXING) CO., LTD.) 03 October 2017 (2017-10-03) entire document	1-13
A	WO 2013126424 A1 (MARLOW INDUSTRIES, INC.) 29 August 2013 (2013-08-29) entire document	1-13

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
04 February 2020	**27 February 2020**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088** **China** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2019/122699

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
GB 2056648 A	18 March 1981	GB 2056648 B	28 September 1983
CN 107228582 A	03 October 2017	None	
WO 2013126424 A1	29 August 2013	US 2013213449 A1	22 August 2013

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 201811632290 **[0001]**