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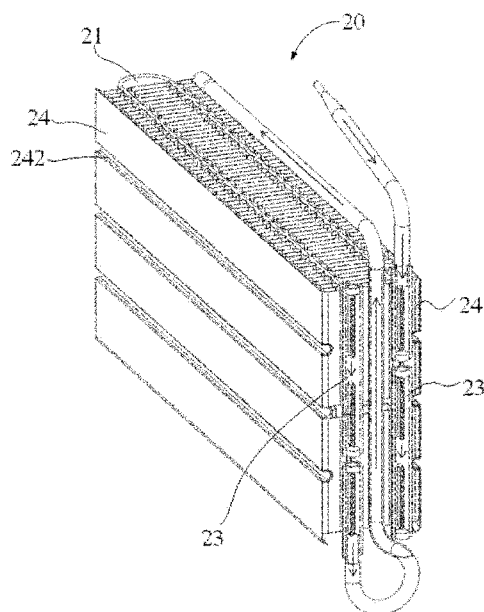


FIG. 2

(57) **Abstract:** A micro-channel heat exchanger (20) and a refrigeration appliance (10) are provided. The micro-channel heat exchanger (20) includes a flat tube assembly (21) and heat sinks (22). The flat tube assembly (21) includes a plurality of flat tubes (211). The flat tube (211) includes two straight tubes (212) which are parallel to each other and a bending tube (213) connecting the two straight tubes (212). The two straight tubes (212) and the bending tube (213) of the flat tube (211) define a child accommodation chamber. Neighboring flat tubes (211) are arranged layer by layer. The child accommodation chambers of the flat tubes (211) are in communication with each other to form an accommodation chamber of the micro-channel heat exchanger (20). This solution can improve the heat exchange efficiency of the micro-channel heat exchanger (20).



MICRO-CHANNEL HEAT EXCHANGER AND REFRIGERATION APPLIANCE

BACKGROUND

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Technical Field

Embodiments of the present invention relate to the field of refrigeration technologies, and more particularly to a micro-channel heat exchanger and a refrigeration appliance.

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Related Art

Currently, refrigeration systems of frost-free refrigerators generally adopt finned evaporators. There are mainly two types of finned evaporators: small-fin expansion tube and large-fin oblique tube. Finned evaporators in frost-free refrigerators generally adopt air cooling for heat dissipation. After the refrigerator works for a period of time, frosting occurs on the finned evaporator. The finned evaporator needs to be defrosted regularly to turn the frost into water for drainage.

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However, both finned evaporators of the small-fin expansion tube type and finned evaporators of large-fin oblique tube type have low heat exchange efficiency.

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SUMMARY

An objective of the embodiments of the present invention is to improve the heat exchange efficiency.

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To resolve the above technical problem, the embodiments of the present invention provide a micro-channel heat exchanger, including a flat tube assembly and heat sinks, wherein the flat tube assembly includes a plurality of flat tubes, the flat tube includes two straight tubes which are parallel to each other and a bending tube connecting the two straight tubes, the two straight tubes and the bending tube of the flat tube define a child accommodation chamber, neighboring flat tubes are arranged layer by layer, and the child accommodation chambers of

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the flat tubes are in communication with each other to form an accommodation chamber of the micro-channel heat exchanger.

5 Compared with the prior art, the technical solution of the embodiments of the present invention has the following beneficial effects:

10 The micro-channel heat exchanger adopts the flat tube assembly as the refrigerant channel, the flat tubes are arranged layer by layer, and the refrigerant can fully expand in the flat tubes to exchange heat with the flat tube assembly, so that the utilization of the cooling capacity of the refrigerant can be improved. Because the flat tubes are arranged layer by layer and the child accommodation chambers are in communication with each other, the resistance to the air flow can be reduced in the case of forced heat exchange via air cooling, thereby improving the heat exchange efficiency. The flat tube assembly has the same cross-sectional area as and a larger outer perimeter than an existing circular tube, so that the contact area between the flat tube assembly and the heat sink can be increased, thereby improving the heat exchange efficiency.

20 Optionally, the micro-channel heat exchanger further includes a connecting tube, wherein the connecting tube is connected to an inlet of one of neighboring two flat tubes and an outlet of the other one of the neighboring flat tubes. The refrigerant sequentially flows through the flat tubes of the flat tube assembly and fully expands in the flat tubes to exchange heat with the flat tube assembly, so that the utilization of the cooling capacity of the refrigerant can be improved.

25 Optionally, a direction of an air flow flowing through the micro-channel heat exchanger is consistent with an extending direction of the accommodation chamber. In this way, the resistance to the air flow can be reduced, thereby improving the working efficiency of the refrigeration appliance.

30 Optionally, the heat sinks surround the flat tube assembly..

Optionally, the heat sink is provided with a plurality of slots, and the slots are configured for placing the flat tubes. The design of slots makes the structure the micro-channel heat

exchanger simpler and easy to install, and better ensures the contact between the flat tube assembly and the heat sink, so that the heat exchange efficiency can be improved.

Optionally, the heat sink is disposed in the accommodation chamber.

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Optionally, the heat sink is disposed on at least one outer side of the flat tube assembly.

Optionally, the micro-channel heat exchanger further includes a side plate located on an outer side of the flat tube assembly, wherein the heat sink is disposed between the side plate and the outer side of the flat tube assembly.

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Optionally, a flow direction of frost water or condensate water on the heat sink is consistent with the extending direction of the accommodation chamber. This facilitates the drainage of the frost water and the condensate water, making the air flow direction consistent with the water flow direction.

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Optionally, the side plate is provided with a projection, and the projection faces toward the heat sink.

Optionally, a first groove is provided on one side of the side plate, and the first groove forms the projection on the other side of the side plate.

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Optionally, a second groove is provided on the heat sink adjacent to the side plate, and the second groove is configured to accommodate the projection. In this way, the structural integrity of the micro-channel heat exchanger can be enhanced.

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Optionally, the heat sink includes: a first fin layer; and a second fin layer connected to the first fin layer, wherein a spacing of the second fin layer is greater than a spacing of the first fin layer. The configuration of different spacing for the first fin layer and the second fin layer can improve the heat exchange efficiency.

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The embodiments of the present invention further provide a refrigeration appliance, including a refrigeration system, wherein the refrigeration system includes any micro-channel heat exchanger described above.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic structural diagram of a refrigeration appliance according to an embodiment of the present invention;

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FIG. 2 is a schematic structural diagram of a micro-channel heat exchanger according to an embodiment of the present invention;

FIG. 3 is an exploded view corresponding to FIG. 2;

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FIG. 4 is a schematic structural diagram of a flat tube assembly according to an embodiment of the present invention;

FIG. 5 is a schematic structural diagram of a connecting tube according to an embodiment of the present invention;

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FIG. 6 and FIG. 7 are schematic structural diagrams of another micro-channel heat exchanger from different viewing angles according to an embodiment of the present invention; and

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FIG. 8 is an exploded view corresponding to FIG. 6.

DETAILED DESCRIPTION

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To make the objectives, features and advantages of the embodiments of the present invention more comprehensible, specific embodiments of the present invention are described in detail below with reference to the accompanying drawings.

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FIG. 1 is a schematic structural diagram of a refrigeration appliance according to an embodiment of the present invention. This embodiment of the present invention provides a refrigeration appliance 10, including a refrigeration system. The refrigeration system includes a micro-channel heat exchanger 20. The micro-channel heat exchanger 20 may serve as an evaporator in the refrigeration system. The refrigeration appliance 10 may be a frost-free

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refrigerator.

A fan 30 can speed up the flow of air and can cause low-temperature air obtained through cooling in the micro-channel heat exchanger 20 to enter a storage chamber of the refrigeration appliance 10 through an air supply vent 12 of the refrigeration appliance 10. The low-temperature air exchanges heat with air in the storage chamber to lower or maintain the temperature in the storage chamber. After the heat exchange, the low-temperature air flows into the micro-channel heat exchanger 20 again through a return air vent 14 to enter the next air circulation cycle. The directions indicated by arrows in FIG. 1 approximately represent the flow direction of air.

It may be understood that in practical applications, the positions and numbers of the air supply vent 12 and the return air vent 14 of the refrigeration appliance 10 may be set depending on the structure of the refrigeration appliance 10 and the position at which the micro-channel heat exchanger 20 is arranged.

FIG. 2 is a schematic structural diagram of a micro-channel heat exchanger according to an embodiment of the present invention. FIG. 3 is an exploded view of FIG. 2. FIG. 4 is a schematic structural diagram of a flat tube assembly according to an embodiment of the present invention. FIG. 5 is a schematic structural diagram of a connecting tube according to an embodiment of the present invention. FIG. 6 and FIG. 7 are schematic structural diagrams of another micro-channel heat exchanger from different viewing angles according to an embodiment of the present invention. FIG. 8 is an exploded view of FIG. 6. The structure of the micro-channel heat exchanger is described below with reference to FIG. 1 to FIG. 8.

The micro-channel heat exchanger 20 may include a flat tube assembly 21 and heat sinks 22. The flat tube assembly 21 may include a plurality of flat tubes 211. Each of the flat tubes 211 may include two straight tubes 212 which are parallel to each other and a bending tube 213. The bending tube 213 is located between the two straight tubes 212, and is configured to connect the two straight tubes 212. The two straight tubes 212 and the bending tube 213 define a child accommodation chamber. Neighboring flat tubes 211 are arranged layer by layer, that is, the flat tubes 211 are stacked in the same direction, so that the child accommodation chambers are in communication with each other to form an accommodation chamber of the micro-channel heat exchanger 20. The accommodation chamber extends along a direction A-A.

In a specific implementation, the specific number, size and shape of the flat tubes 211 may be set depending on the actual refrigerating capacity required by the refrigeration appliance.

- 5 A low-temperature refrigerant flows in the flat tube assembly 21. The low-temperature refrigerant can exchange heat with the flat tube assembly 21 to cool the flat tube assembly 21. The heat sink 22 can exchange heat with the flat tube assembly 21. The heat sink 22 can speed up the heat exchange.
- 10 Among various shapes having the same cross-sectional area, a circle has the smallest perimeter. Therefore, the flat tube assembly 21 has a larger outer perimeter than an existing circular tube, that is, the flat tube assembly 21 has a larger surface area, so that the contact area between the flat tube assembly 21 and the heat sink 22 is increased, speeding up the heat exchange. Because the flat tubes 211 are arranged layer by layer and the child
- 15 accommodation chambers are in communication with each other to the accommodation chamber of form the micro-channel heat exchanger 20, air flows along the accommodation chamber in the case of forced heat exchange via air cooling, so that the resistance to the air flow can be reduced, and the heat exchange between air and the heat sink 22 as well as the flat tube assembly 21 can be sped up, thereby improving the heat exchange efficiency of the
- 20 micro-channel heat exchanger 20.

In a specific implementation, the micro-channel heat exchanger 20 may further include: the connecting tube 23. The connecting tube 23 is connected to an inlet of one of neighboring two flat tubes 211 and an outlet of the other one of the neighboring flat tubes 211.

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- For example, referring to FIG. 4, the flat tube assembly 21 includes three flat tubes 211, where a connecting tube 23 connects an outlet 211a of one flat tube 211 to an inlet 211b of the other flat tube 211, so that the connecting tube 23 can sequentially connect in series the flat tubes 211 disposed neighboring to each other. The refrigerant enters the connecting tube
- 30 23 from an inlet tube 40, sequentially flows through the flat tube 211 at the first layer, the flat tube 211 at the second layer and the flat tube 211 at the third layer, and flows out of the flat tube assembly 21 through an outlet tube 50. The directions indicated by arrows in the figure represent the flow direction of the refrigerant. It may be understood that in practical applications, the flow direction of the refrigerant may also be an opposite direction. The flow

direction of the refrigerant is not limited herein. The refrigerant sequentially flows through the flat tubes 211 of the flat tube assembly 21, and fully expands in the flat tubes 211 to exchange heat with the flat tube assembly 21, so that the utilization of the cooling capacity of the refrigerant can be improved.

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Referring to FIG. 5, an opening 231 may be provided on a side wall of the connecting tube 23. The opening 231 is connected to the flat tube 211. The number of openings 231 on the connecting tube 23 varies with the number of flat tubes 211 to be connected to the connecting tube 23. For example, when the connecting tube 23 needs to be connected to the inlet tube 40 or the outlet tube 50, the number of openings 231 provided on the connecting tube 23 is one; when the connecting tube 23 needs to be connected to two flat tubes 211, the number of openings 231 provided on the connecting tube 23 is two. Two ends of the connecting tube 23 may be closed, or may include one open end and one closed end. The number of openings 231 provided on the connecting tube 23 and whether the two ends of the connecting tube 23 are closed may be set according to actual requirements.

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In an embodiment of the present invention, to further improve the heat exchange efficiency, a direction of an air flow flowing through the micro-channel heat exchanger 20 is consistent with an extending direction of the accommodation chamber. Air flows along the extending direction of the accommodation chamber, so that the resistance to the air flow can be reduced, and the heat exchange between air and the heat sink as well as the flat tube assembly can be sped up, thereby improving the working efficiency of the refrigeration appliance.

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In a specific implementation, an air supply device 30 may be used to supply air to the micro-channel heat exchanger 20. The air supply device 30 may be mounted at one end of the accommodation chamber. The air supply device 30 is a fan or other device capable of supplying air. When the accommodation chamber extends in a vertical direction, the air supply device 30 may be located above or below the micro-channel heat exchanger 20. When the micro-channel heat exchanger 20 is inclined, the air supply device 30 is located at any end of the accommodation chamber. The actual position of the air supply device 30 may be arranged according to the arrangement of the micro-channel heat exchanger 20, as long as air supplied by the air supply device 30 can flow through the accommodation chamber of the micro-channel heat exchanger 20.

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After the air supplied by the air supply device 30 flows through the micro-channel heat exchanger 20, the heat exchange between air and the heat sink 22 as well as the flat tube assembly 21 can be sped up. Low-temperature air obtained is introduced to the storage chamber of the refrigeration appliance 10. The low-temperature air flows through the storage chamber and flows out of the storage chamber through the return air vent. By means of air circulation, the temperature in the storage chamber can be lowered or maintained.

In a specific implementation, the heat sinks 22 may surround the flat tube assembly 21. Specifically, there may be various relationships between the relative positions of the heat sink 22 and the flat tube assembly 21.

Referring to FIG. 4 to FIG. 8, in an embodiment of the present invention, the heat sink 22 is provided with a plurality of slots 224, and the flat tubes 211 are located in the slots 224. To improve the utilization and the heat exchange efficiency, the slots 224 may be evenly distributed on the heat sink 22. It may be understood that the slots 224 may also be unevenly distributed on the heat sink 22.

During the installation of the heat sink 22 and the flat tube assembly 21, the flat tubes 211 may be sequentially inserted into the corresponding slots 224. After the installation of the flat tubes 211 is complete, the neighboring flat tubes 211 may be connected together by using the connecting tube 23.

Referring to FIG. 2 to FIG. 5, in another embodiment of the present invention, the heat sink 22 is disposed in the accommodation chamber. To further improve the heat exchange efficiency, the heat sink 22 is disposed on at least one side of the flat tube assembly 21. For example, the heat sink 22 may be disposed on any side of the flat tube assembly 21, or the heat sink 22 may be disposed on both sides of the flat tube assembly 21.

In a specific implementation, because the surface temperature of the heat sink 22 is low, frosting is likely to occur on the surface of the heat sink 22 after the micro-channel heat exchanger 20 runs for a period of time. The occurrence of frosting affects the heat exchange efficiency of the micro-channel heat exchanger 20. To improve the heat exchange efficiency

of the micro-channel heat exchanger 20, the micro-channel heat exchanger 20 needs to be defrosted regularly.

5 In an embodiment of the present invention, a flow direction of frost water or condensate water on the heat sink 22 is consistent with the extending direction of the accommodation chamber. When the micro-channel heat exchanger 20 is placed, the accommodation chamber may extend in a vertical direction or may be inclined by an angle relative to the horizontal plane, so that the frost water or the condensate water on the heat sink 22 may flow downward under gravity, thereby facilitating the drainage of the frost water or the condensate
10 water on the heat sink 22 to avoid water accumulation.

In an embodiment of the present invention, the micro-channel heat exchanger 20 may further include a side plate 24. The side plate 24 is located on an outer side of the flat tube assembly 21, wherein the heat sink 22 is disposed between the side plate 24 and the outer
15 side of the flat tube assembly 21. The side plate 24 provided may be configured for installing a defrosting heater. The defrosting heater can increase the temperature of the heat sink 22 to cause the frost on the heat sink 22 to turn into water more quickly.

20 In a specific implementation, the side plate 24 is provided with a projection 241, and the projection 241 faces toward the heat sink 22. A first groove 242 is provided on one side of the side plate 24, and the first groove 242 forms the projection 241 on the other side of the side plate 24. The first groove 242 is configured for installing the defrosting heater, facilitating the installation of the defrosting heater.

25 When an aluminum-pipe defrosting heater is used, the installation requires the use of the side plate 24 and the first groove 242 of the side plate 24. When a steel-pipe defrosting heater is used, because the steel-pipe defrosting heater is located below the micro-channel heat exchanger, the installation of the steel-pipe defrosting heater does not require the use of the side plate 24. In this case, the first groove 242 does not need to be provided on the side
30 plate 24.

In a specific implementation, a second groove 223 is provided on the heat sink 22 adjacent to the side plate 24, and the second groove 223 is configured to accommodate the projection

241. The configuration of the second groove 223 for accommodating the projection 241 makes the entire structure of the micro-channel heat exchanger 20 more compact.

In FIG. 6 to FIG. 8, the side plate 24 is not shown. In practical applications, the side plate 24 of any of the above types may be disposed at least one side of the heat sink 22 according to actual requirements.

In an embodiment of the present invention, the heat sink 22 includes a first fin layer 221 and a second fin layer 222. The first fin layer 221 is connected to the second fin layer 222, and a spacing of the second fin layer 222 is greater than a spacing of the first fin layer 221. In practical applications, the spacings of the first fin layer 221 and the second fin layer 222 may also be the same.

The relative positions of the first fin layer 221 and the second fin layer 222 may be related to the flow direction of air supplied by the air supply device 30. Air sequentially flows through the first fin layer 221 and the second fin layer 222. The relative positions of the first fin layer 221 and the second fin layer 222 may also be related to the flow direction of the refrigerant in the flat tube assembly 21. The refrigerant first flows through the flat tube 211 which is in contact with the first fin layer 221, and then flows through the flat tube 211 which is in contact with the second fin layer 222. Because the fin spacing in the first fin layer 221 is less than the fin spacing in the second fin layer 222, sufficient heat exchange can be achieved, thereby improving the heat exchange efficiency.

Although the present invention has been disclosed above, the present invention is not limited thereto. A person skilled in the art may make variations and modifications without departing from the spirit and scope of the present invention. Therefore, the protection scope of the present invention should be subject to the appended claims.

CLAIMS

What is claimed is:

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1. A micro-channel heat exchanger (20), comprising a flat tube assembly (21) and heat sinks (22), wherein

the flat tube assembly (21) comprises a plurality of flat tubes (211), the flat tube (211) comprises two straight tubes (212) which are parallel to each other and a bending tube (213) connecting the two straight tubes (212), the two straight tubes (212) and the bending tube (213) of the flat tube (211) define a child accommodation chamber, neighboring flat tubes (211) are arranged layer by layer, and the child accommodation chambers of the flat tubes (211) are in communication with each other to form an accommodation chamber of the micro-channel heat exchanger (20).

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2. The micro-channel heat exchanger (20) according to claim 1, further comprising a connecting tube (23), wherein the connecting tube (23) is connected to an inlet of one of neighboring two flat tubes (211) and an outlet of the other one of the neighboring flat tubes (211).

20

3. The micro-channel heat exchanger (20) according to claim 1, wherein a direction of an air flow flowing through the micro-channel heat exchanger (20) is consistent with an extending direction of the accommodation chamber.

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4. The micro-channel heat exchanger (20) according to claim 1, wherein the heat sinks (22) surround the flat tube assembly (21).

5. The micro-channel heat exchanger (20) according to claim 4, wherein the heat sink (22) is provided with a plurality of slots (224), and the slots (224) are configured for placing the flat tubes (211).

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6. The micro-channel heat exchanger (20) according to claim 1, wherein the heat sink (22) is disposed in the accommodation chamber.

7. The micro-channel heat exchanger (20) according to claim 1, wherein the heat sink (22) is disposed on at least one outer side of the flat tube assembly (21).
- 5 8. The micro-channel heat exchanger (20) according to claim 1, further comprising a side plate (24) located on an outer side of the flat tube assembly (21), wherein the heat sink (22) is disposed between the side plate (24) and the outer side of the flat tube assembly (21).
- 10 9. The micro-channel heat exchanger (20) according to any one of claims 1 to 8, wherein a flow direction of frost water or condensate water on the heat sink (22) is consistent with the extending direction of the accommodation chamber.
- 15 10. The micro-channel heat exchanger (20) according to claim 8, wherein the side plate (24) is provided with a projection (241), and the projection (241) faces toward the heat sink (22).
- 20 11. The micro-channel heat exchanger (20) according to claim 10, wherein a first groove (242) is provided on one side of the side plate (24), and the first groove (242) forms the projection (241) on the other side of the side plate (24).
12. The micro-channel heat exchanger (20) according to claim 10 or 11, wherein a second groove (223) is provided on the heat sink (22) adjacent to the side plate (24), and the second groove (223) is configured to accommodate the projection (241).
- 25 13. The micro-channel heat exchanger (20) according to any one of claims 1 to 8, wherein the heat sink (22) comprises:
a first fin layer (221); and
a second fin layer (222) connected to the first fin layer (221), wherein a spacing of the second fin layer (222) is greater than a spacing of the first fin layer (221).
- 30 14. A refrigeration appliance, comprising a refrigeration system, wherein the refrigeration system comprises the micro-channel heat exchanger (20) according to any one of claims 1 to 13.

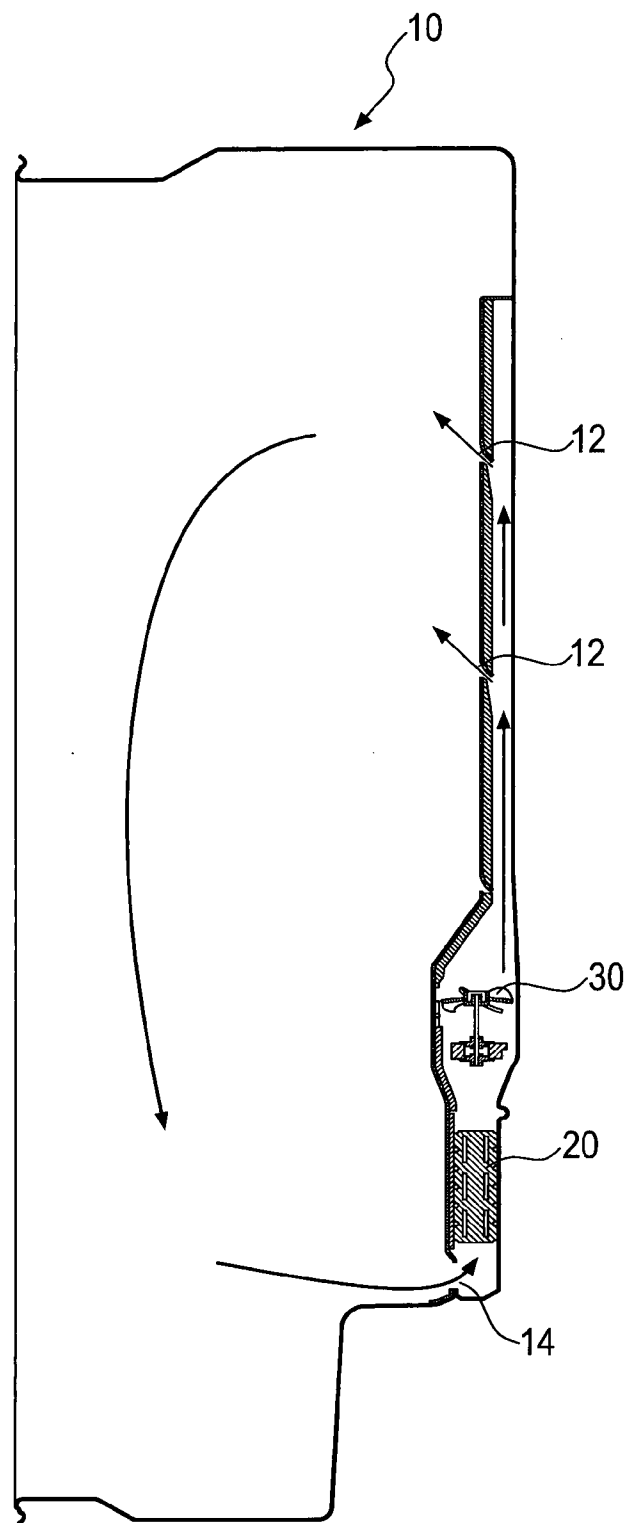


FIG. 1

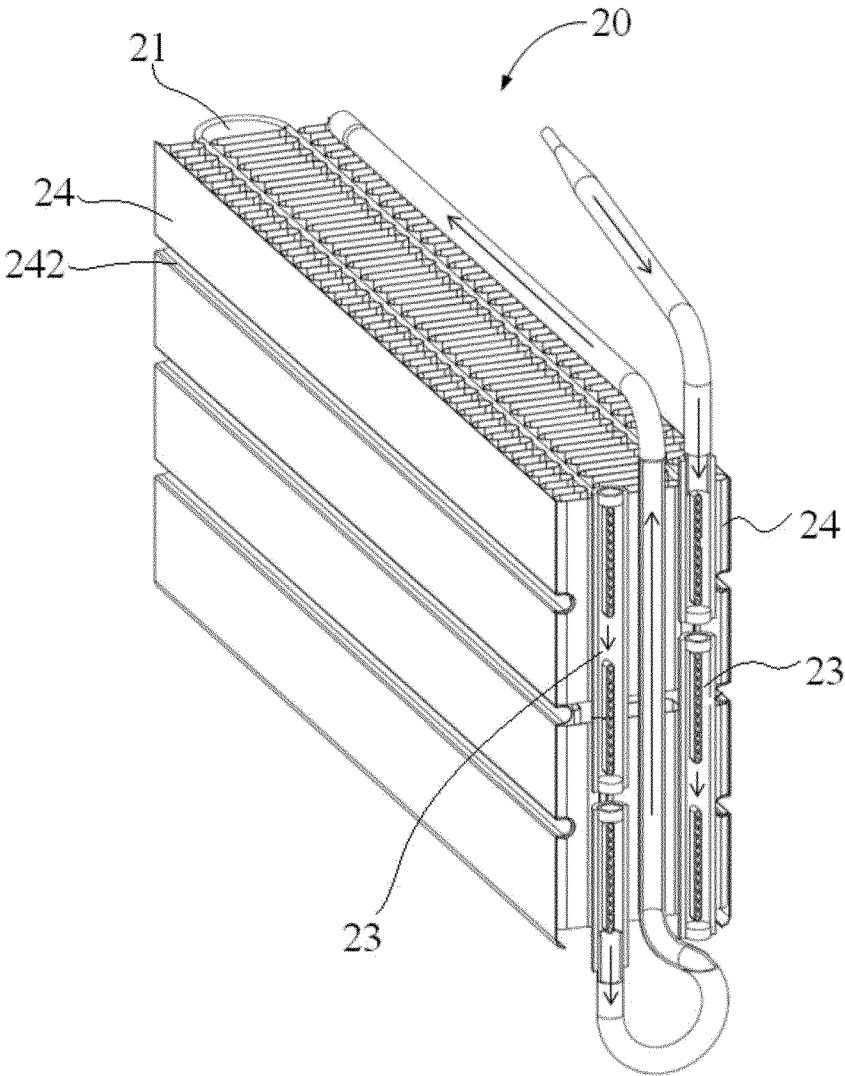


FIG. 2

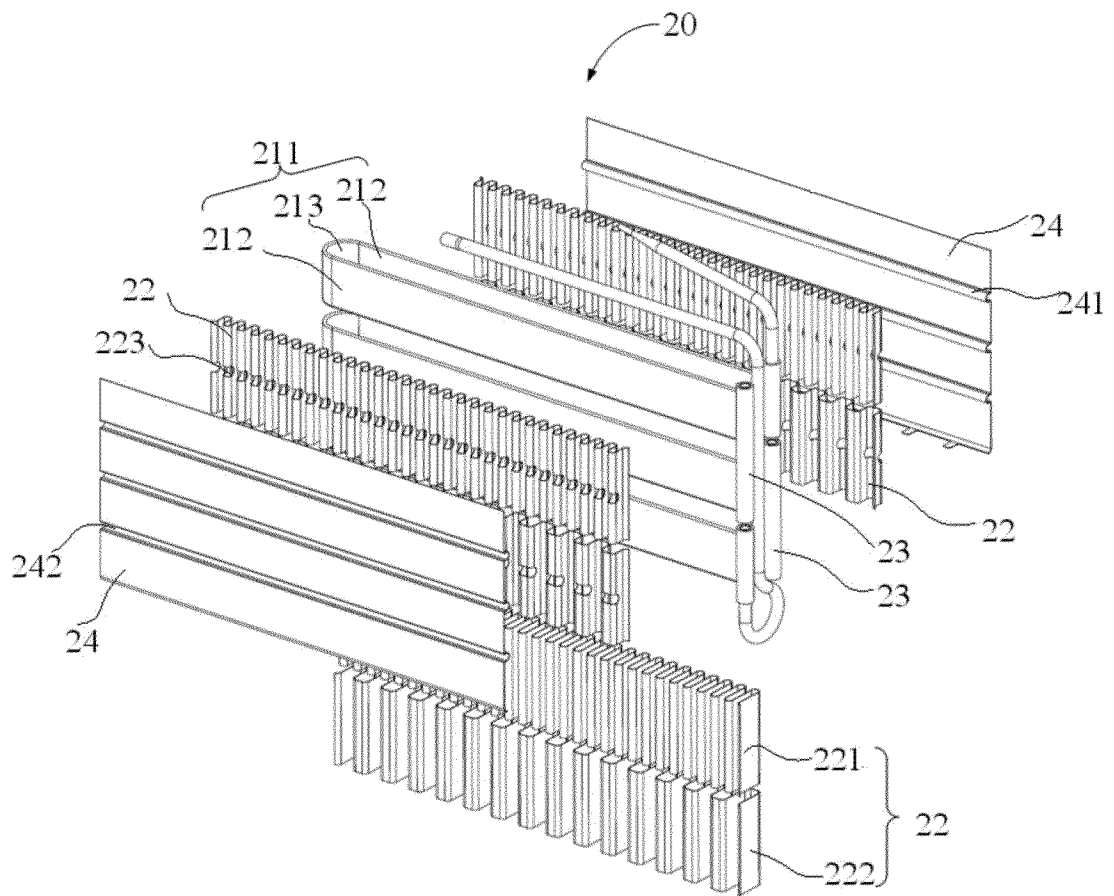


FIG. 3

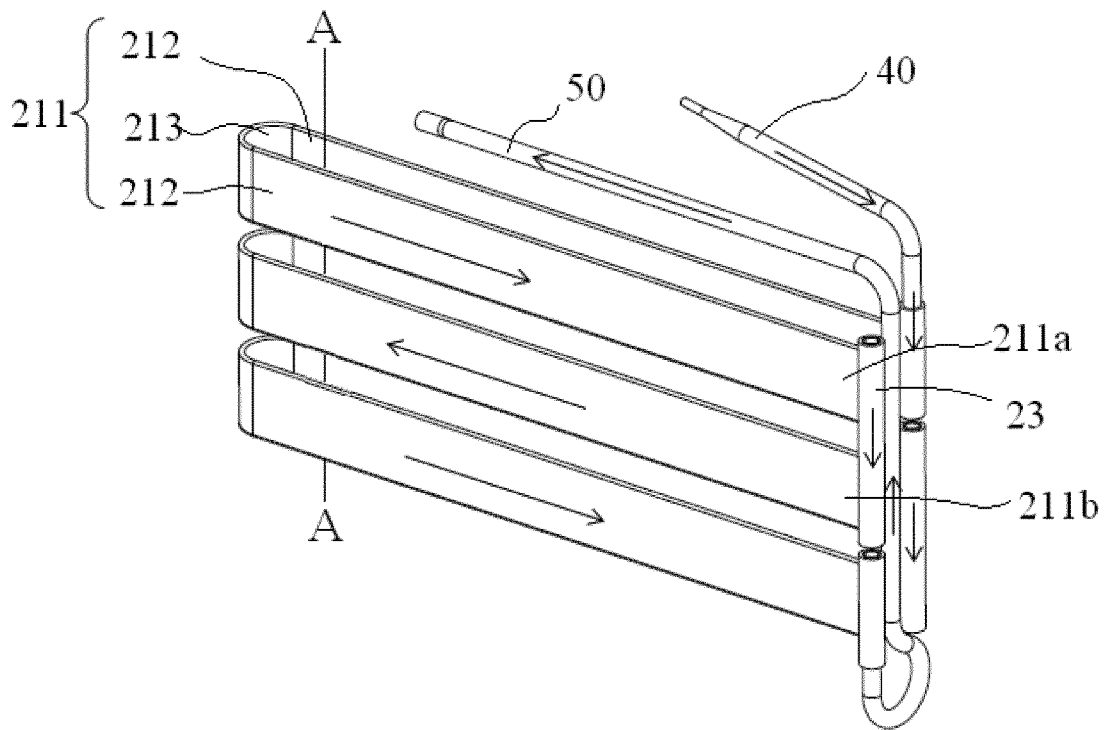


FIG. 4

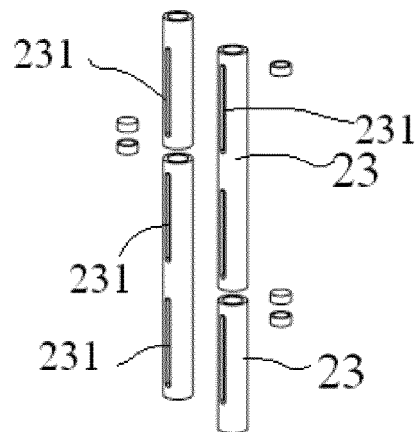


FIG. 5

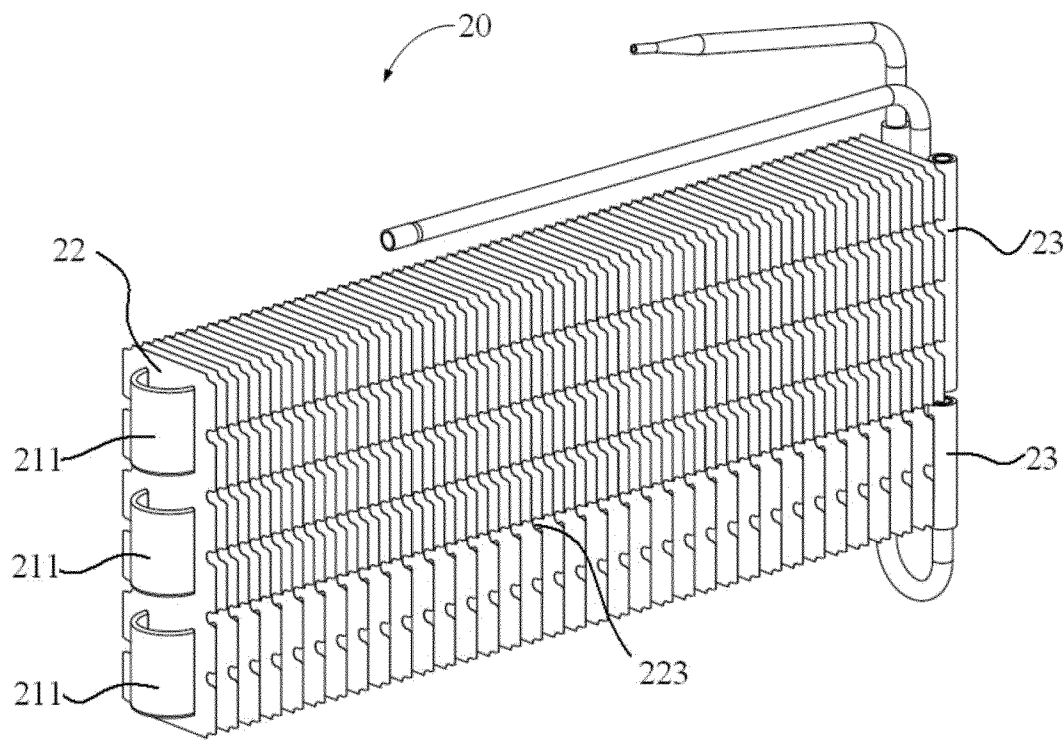


FIG. 6

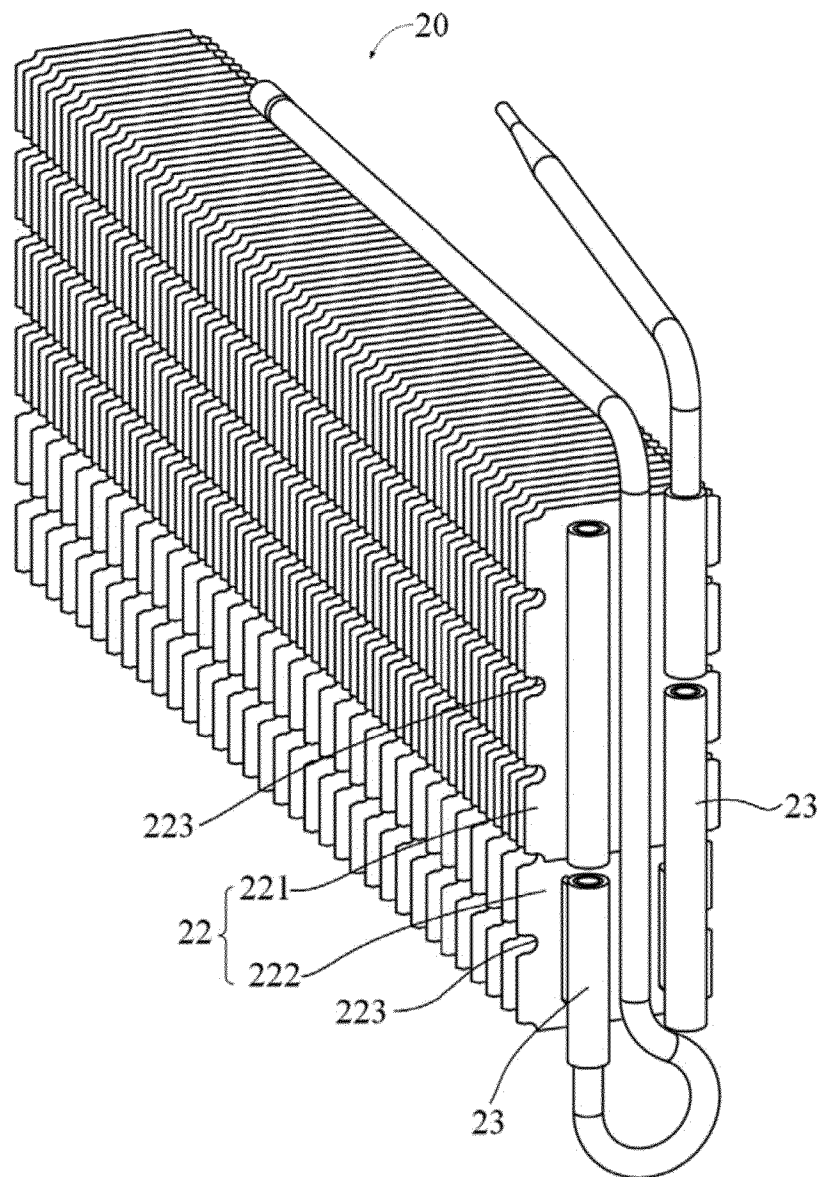


FIG. 7

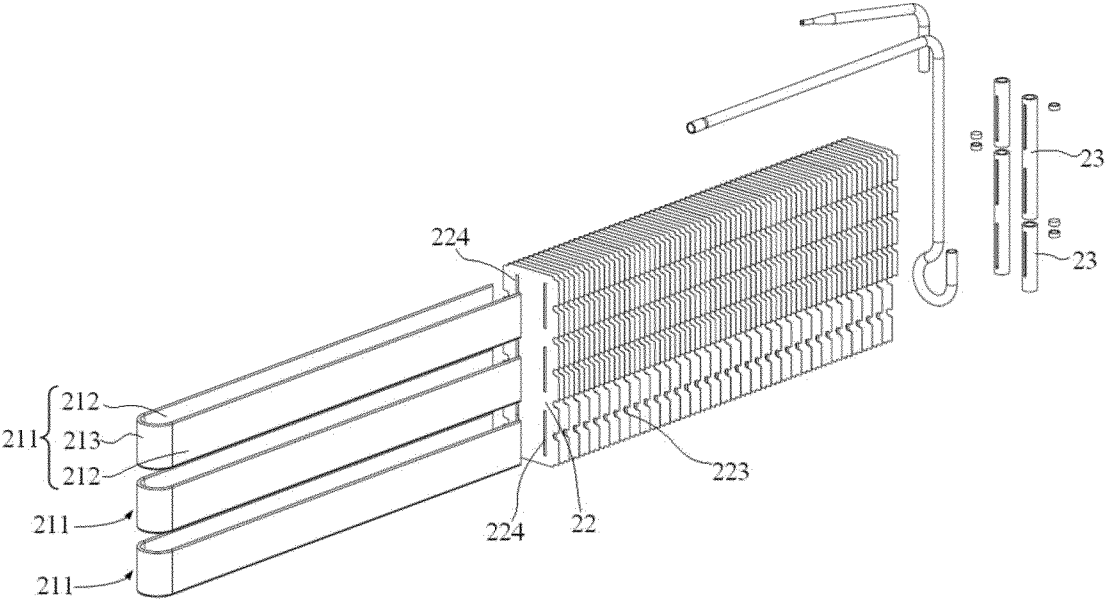


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/079384

A. CLASSIFICATION OF SUBJECT MATTER

INV. F28F1/32 F28D1/047 F28F1/12 F28F9/00 F25B39/02
F25D17/06

ADD.

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)

F28F F28D F25B F25D

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2014/129318 A1 (SHARP KK [JP]) 28 August 2014 (2014-08-28) abstract; figures 1-16 -----	1-7,9, 13,14
X	CN 106 322 850 A (HEFEI MIDEA REFRIGERATOR CO; HEFEI HUALING CO LTD; MIDEA GROUP CO LTD) 11 January 2017 (2017-01-11) figures -----	1-4,6,7, 9,14
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X	JP S56 130595 A (HITACHI LTD) 13 October 1981 (1981-10-13) abstract; figures 1-5 -----	1,2,6



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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