



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
20.02.2019 Bulletin 2019/08

(51) Int Cl.:
F28D 15/04 ^(2006.01)

(21) Application number: **16898354.2**

(86) International application number:
PCT/CN2016/086179

(22) Date of filing: **17.06.2016**

(87) International publication number:
WO 2017/177539 (19.10.2017 Gazette 2017/42)

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

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(30) Priority: **14.04.2016 CN 201610230643**

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(54) **HEAT CONDUCTING PLATE AND METHOD FOR PRODUCING PLATE BODY THEREOF**

(57) A heat conducting plate and a method for producing a plate body thereof. The heat conducting plate comprises an integrally formed plate body (100). The plate body (100) comprises a front surface (11), and several capillary tube cavities (20) formed in the plate body (100) and allowing flow of a heat exchange medium. Each capillary tube cavity (20) extends along a first direction parallel to the front surface (11), and a micro-tooth structure (21) is provided on the inner wall of each capillary tube cavity. The heat exchange medium may flow in the capillary tube cavities (20) along the first direction. By

means of the integrally formed plate body (100) and the capillary tube cavities (20) provided in the plate body (100), the temperature homogenizing effect and heat exchange efficiency of the heat conducting plate are significantly improved; by providing the micro-tooth structure (21), the heat exchange medium may form a capillary phenomenon along the micro-tooth structure (21), thereby further improving the heat exchange efficiency; by means of the integrally formed plate body (100), a simple processing technology is achieved and reduced production costs can be ensured.

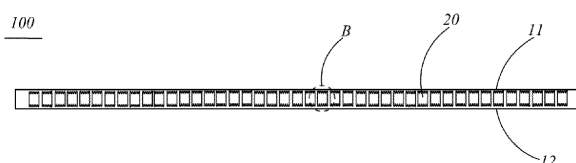


Fig. 2

Description

TECHNICAL FIELD

[0001] The present invention relates to a heat conducting plate and a production method for a plate body thereof, which belongs to the technical field of heat exchange.

BACKGROUND

[0002] Heat conducting plates are widely applied in heat exchange devices and the heat conduction efficiency and temperature equalization effect thereof are key factors to decide the performance thereof. For example, in the technical field of rapid freezing and/or rapid unfreezing of food, the rapid freezing plate/rapid unfreezing plate is a heat conducting plate which can be used to reduce the waiting time of unfreezing and improve the freezing efficiency.

[0003] At present, as disclosed in patent No. CN201520301251. 3, the existing rapid freezing plate/rapid unfreezing plate is usually formed by the combination of an upper aluminum alloy plate, a lower aluminum alloy plate and a heat tube formed separately, with poor temperature equalization effect and low heat conduction efficiency. Moreover, during the production of the rapid freezing plate/rapid unfreezing plate, usually the upper aluminum alloy plate and the lower aluminum alloy plate are formed separately and then assembled with the heat tube, resulting high production costs and complicated processes.

SUMMARY

[0004] In order to solve at least one of the above technical problems, an object of the present invention is to provide a heat conducting plate and a production method for a plate body thereof, which can not only improve the temperature equalization effect and heat conduction efficiency but also has a simple process and lower production costs.

[0005] In order to realize one of the above invention objects, an embodiment of the present invention provides a heat conducting plate. The heat conducting plate comprises an integrally formed plate body, the plate body comprising a front surface and a plurality of capillary tube cavities formed inside the plate body and provided for a heat exchange medium to flow, each capillary tube cavity extending along a first direction parallel to the front surface and provided with a micro-tooth structure on the inner wall thereof, and the heat exchange medium being capable of flowing along the first direction in the capillary tube cavity.

[0006] As an improvement to an embodiment of the present invention, some of the capillary tube cavities are distributed evenly side by side along a second direction perpendicular to the first direction and parallel to the front surface.

[0007] As a further improvement to an embodiment of the present invention, the micro-tooth structure comprises micro combs distributed continuously and a comb groove between two adjacent micro combs, and the comb groove extends along the first direction so that the heat exchange medium is capable of flowing in the comb groove to form capillarity.

[0008] As a further improvement to an embodiment of the present invention, the micro groove comprises valleys away from the center of the capillary tube cavity and peaks close to the center of the capillary tube cavity, the valleys and/or the peaks being of an arc shape.

[0009] As a further improvement to an embodiment of the present invention, the micro-tooth structure is at least provided on the inner wall of the capillary tube cavity away from the front surface.

[0010] As a further improvement to an embodiment of the present invention, the capillary tube cavity is provided as a closed space filled with the heat exchange medium, the heat exchange medium flowing circularly in the capillary tube cavity.

[0011] As a further improvement to an embodiment of the present invention, the capillary tube cavity comprises a first opening and a second opening provided oppositely along the extension direction thereof and the heat exchange medium is capable of flowing into and out of the capillary tube cavity through the first opening and the second opening.

[0012] In order to realize one of the above invention objects, an embodiment of the present invention also provides a production method for a plate body of a heat conducting plate mentioned above. The method comprises: forming a basic plate body through an extrusion process, the basic plate body comprising a plurality of capillary tube cavities formed therein, each capillary tube cavity comprising a first opening and a second opening provided at a first end and a second end of the basic plate body respectively; crimping the first end to seal the first opening; communicating the second opening with a vacuum pump through a filling tube and vacuumizing the capillary tube cavity; injecting the heat exchange medium into the capillary tube cavity; and crimping and banding the basic plate body along the extension direction of the capillary tube cavity according to a fixed length and cutting off the same to obtain at least one plate body.

[0013] As an improvement to an embodiment of the present invention, the inner wall of each capillary tube cavity is provided with a micro-tooth structure.

[0014] As a further improvement to an embodiment of the present invention, the step of communicating the second opening with a vacuum pump through a filling tube and vacuumizing the capillary tube cavity comprises: communicating the second opening with a filling tube by welding the filling tube to the second end; and communicating the filling tube with a vacuum pump and vacuumizing the capillary tube cavity.

[0015] As a further improvement to an embodiment of the present invention, the step of injecting the heat ex-

change medium into the capillary tube cavity comprises: injecting the heat exchange medium into the capillary tube cavity through the filling tube.

[0016] As a further improvement to an embodiment of the present invention, the step of crimping and banding the basic plate body along the extension direction of the capillary tube cavity according to a fixed length and cutting off the same to obtain at least one plate body comprises: crimping and banding the basic plate body along the extension direction of the capillary tube cavity according to a fixed length and cutting off the same; and welding the cut-off section to obtain at least one basic plate body.

[0017] Compared to the prior art, the present invention has the following beneficial effects: the integrally formed plate body and the capillary tube cavities provided in the plate body greatly improve the temperature equalization effect and heat exchange efficiency of the heat conducting plate; the micro-tooth structure enables the heat exchange medium to form capillarity along the micro-tooth structure, further enhancing the heat exchange efficiency; and the integrally formed plate body has a simple production process and lower production costs.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Fig. 1 is a structure diagram of a plate body of a heat conducting plate according to an embodiment of the present invention;

Fig. 2 is a longitudinal section view along the line A-A in Fig. 1;

Fig. 3 is a partial enlargement diagram of region B in Fig. 2;

Fig. 4 is a flowchart of a production method for a plate body of a heat conducting plate according to an embodiment of the present invention; and

Fig. 5 is a production state change view of a plate body of a heat conducting plate according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0019] Hereinafter, the present invention will be described in detail in combination with the particular embodiments shown in the accompanying drawings. However, these embodiments do not limit the present invention, and the structure, method or function transforms made by those skilled in the art according to these embodiments are all contained in the protection scope of the present invention.

[0020] It should be understood that unless explicitly defined and stated otherwise, in the description of the present invention, the orientation or location relationships indicated by terms "center", "longitudinal", "lateral", "upper", "lower", "front", "back", "left", "right", "vertical", "horizontal", "top", "bottom", "inner", and "outer" are orientation or location relationships shown in the figure, which is merely for the sake of describing the present invention and simplifying the description rather than indicating or implying that the referred device or element must have a specific orientation, be constructed and operated with a specific orientation and thus shall not be understood as a limitation to the present invention. In addition, terms "first" and "second" are merely used for description and shall not be understood as indicating or implying relative importance.

[0021] For the sake of clear and simple description, referring to Fig. 1, direction X is defined as a first direction, direction Y perpendicular to direction X is defined as a second direction, and the direction perpendicular to direction X and direction Y is the vertical direction.

[0022] Referring to Figs. 1 to 3, an embodiment of the present invention provides a heat conducting plate, in particular a heat conducting plate for quick freezing or quick unfreezing. The heat conducting plate includes a plate body 100.

[0023] The plate body 100 is integrally formed by an aluminum alloy material, including a front surface 11 and a rear surface 12 provided oppositely in the vertical direction. The front surface 11 is parallel to the first direction and the second direction. The front surface 11 is located on the side of the plate body 100 which has a larger surface area.

[0024] The plate body 100 has a plurality of capillary tube cavities 20 formed therein. Each capillary tube cavity 20 is provided for a heat exchange medium to flow. The heat exchange medium may perform direct heat exchange with the ambient environment of the plate body 100. Preferably, the heat exchange medium may be provided as alcohol or R134a (full name 1, 1, 1, 2-tetrafluoroethane).

[0025] In an embodiment of the present invention, each capillary tube cavity 20 is provided as elongate and extends along the first direction. When the heat conducting plate is used for quickly freezing and unfreezing food, the heat exchange medium may flow in the capillary tube cavity 20 along the first direction to accelerate the heat exchange rate. The flowing may be incurred by the phase change of the heat exchange medium or incurred by an external pressure and so on, which all belong to the scope of flowing.

[0026] In addition, the plurality of capillary tube cavities 20 is distributed evenly side by side inside the plate body along the second direction so that on one hand the heat exchange rate can be improved to accelerate the quick freezing and unfreezing speed and on the other hand can also improve the temperature equalization effect.

[0027] Any two capillary tube cavities 20 are separated from each other without communication.

[0028] The inner wall of each capillary tube cavity 20 is provided with a micro-tooth structure 21. The micro-

tooth structure 21 includes micro combs 211 distributed continuously and a comb groove 212 located between two adjacent micro combs 211. The micro-tooth structure 21 is provided so that the comb groove 212 extends along the first direction so that the heat exchange medium may flow to form capillarity along the comb groove 212 to further accelerate the heat exchange rate and improve the temperature equalization effect.

[0029] In an embodiment of the present invention, on the longitudinal cross section parallel to the second direction, the micro-tooth structure 21 is provided of a wave shape. The comb groove 212 includes valleys 2120 away from the center of the capillary tube cavity 20. The valleys 2120 are provided of an arc shape so that the flowing rate of the heat exchange medium at the valleys 2120 can be avoided from lowering due to excessive resistance and the flowing of the heat exchange medium can be smoother to improve the heat exchange efficiency. Likewise, the micro combs 211 include peaks 2110 close to the center of the capillary tube cavity 20. The peaks 2110 are also provided of an arc shape to improve the heat exchange efficiency. At the same time, the valleys 2120 and peaks 2110 in arc shapes may also reduce the formation difficulty of the plate body 100 and ensure the product quality.

[0030] In addition, on the longitudinal cross section parallel to the second direction, the capillary tube cavity 20 is provided of a rectangular shape, including a top wall and a bottom wall provided oppositely in the vertical direction and two side walls provided oppositely along the second direction. The top wall is located on the side close to the front surface 11. The bottom wall is located on the side close to the rear surface 12. The micro-tooth structure 21 is at least provided on the bottom wall. In the embodiment shown in the figure, the micro-tooth structure 21 is provided on the bottom wall and the top wall. Of course, except from being provided on the top wall and the bottom wall, the micro-tooth structure 21 may also be provided on the two side walls.

[0031] In addition, the included angle between two adjacent micro combs 211 is approximately 20 degrees.

[0032] In the embodiment shown in the figure, the capillary tube cavity 20 is provided as an enclosed space. The enclosed space is filled with the heat exchange medium, that is, the capillary tube cavity 20 does not communicate with the external space of the plate body 100. The heat exchange medium can only flow circularly in the capillary tube cavity 20. In particular, the plate body 100 further includes bonding portions 13 provided at the opposite sides thereof along the first direction. Any capillary tube cavity 20 extends to the inner side of the two bonding portions along the first direction and is enclosed by the bonding portions 13. As such, the temperature equalization effect of the plate body 100 may be enhanced.

[0033] In other embodiments, the capillary tube cavity 20 may also be provided as an open space. In particular, the capillary tube cavity 20 comprises a first opening and

a second opening. The heat exchange medium is capable of flowing into and out of the capillary tube cavity 20 through the first opening and the second opening. That is, the capillary tube cavity 20 may communicate with other devices accommodating the heat exchange medium through the first opening and the second opening. The first opening and the second opening are provided oppositely along the extension direction of the capillary direction 20 to increase the flowing rate of the heat exchange medium.

[0034] In addition, referring to Figs. 4 and 5, an embodiment of the present invention also provides a production method for a plate body 100 of a heat conducting plate mentioned above. The method comprises the steps of: forming a basic plate body through an extrusion process, the basic plate body comprising a plurality of capillary tube cavities formed therein, each capillary tube cavity comprising a first opening and a second opening provided at a first end and a second end of the basic plate body respectively; crimping the first end to seal the first opening; communicating the second opening with a vacuum pump through a filling tube and vacuumizing the capillary tube cavity; injecting the heat exchange medium into the capillary tube cavity; and crimping and banding the basic plate body along the extension direction of the capillary tube cavity according to a fixed length and cutting off the same to obtain at least one plate body.

[0035] In particular, taking the embodiment shown in Fig. 4 as an example, the method comprises the steps of: forming a basic plate body 1 through an extrusion process in a mold, the basic plate body 1 being provided of an aluminum alloy material and comprising a plurality of capillary tube cavities formed therein, each capillary tube cavity comprising a first opening and a second opening provided at a first end 101 and a second end 102 of the basic plate body 1 respectively; crimping the first end 101 to seal the first opening; for example, the first end 101 may be rolled and pressed to form a bonding portion 13, during which process, the first openings at the first end 101 are all closed so that the capillary tube cavity merely communicates with the external space of the basic plate body 1 through the second opening; communicating the second opening with a vacuum pump through a filling tube 200 and vacuumizing the capillary tube cavity; injecting the heat exchange medium into the capillary tube cavity; the heat exchange medium may be provided as alcohol or R134a (full name 1, 1, 1, 2-tetrafluoroethane); crimping and banding the basic plate body 1 along the extension direction of the capillary tube cavity according to a fixed length and cutting off the same in particular with a rolling and pressing manner to obtain at least one plate body 100.

[0036] The extension direction of the capillary tube cavity is defined as the first direction. The first end 101 and the second end 102 are provided oppositely along the first direction. The capillary tube cavity may communicate with the external space of the basic plate body 1 through the first opening and the second opening.

[0037] Some of the capillary tube cavities are distributed evenly side by side along a second direction perpendicular to the first direction. The inner wall of each capillary tube cavity is provided with a micro-tooth structure.

[0038] In an embodiment of the present invention, the step of communicating the second opening with a vacuum pump through a filling tube 200 and vacuumizing the capillary tube cavity comprises: communicating the second opening with a filling tube 200 by welding the filling tube 200 to the second end 102; and connecting the filling tube 200 to a vacuum pump and vacuumizing the capillary tube cavity.

[0039] The step of injecting the heat exchange medium into the capillary tube cavity comprises: injecting the heat exchange medium into the capillary tube cavity through the filling tube 200.

[0040] As such, during the process of vacuumizing and injecting the heat exchange medium, the filling tube 200 may be used as a channel to realize the communication with the capillary tube cavity, reducing the process complexity.

[0041] In addition, in an embodiment of the present invention, the step of crimping and banding the basic plate body 1 along the extension direction of the capillary tube cavity according to a fixed length and cutting off the same to obtain at least one plate body 100 comprises: crimping and banding the basic plate body 1 along the extension direction of the capillary tube cavity according to a fixed length and cutting off the same; and welding the cut-off section to obtain at least one basic plate body 100.

[0042] As such, the simultaneous production of a plurality of plate bodies 100 can be realized, which not only ensures the product quality but also greatly improves the production efficiency.

[0043] Compared to the prior art, the present invention has the following beneficial effects: the integrally formed plate body and the capillary tube cavities provided in the plate body greatly improve the temperature equalization effect and heat exchange efficiency of the heat conducting plate; the micro-tooth structure enables the heat exchange medium to form capillarity along the micro-tooth structure, further enhancing the heat exchange efficiency; and the integrally formed plate body has a simple production process and lower production costs.

[0044] The detailed description listed above is merely a particular description of feasible embodiments of the present invention which is not used to limit the protection scope of the present invention. All equivalent embodiments or changes made without departing from the technical spirit of the present invention shall be included within the protection scope of the present invention.

Claims

1. A heat conducting plate, comprising an integrally

formed plate body, the plate body comprising a front surface and a plurality of capillary tube cavities formed inside the plate body and provided for a heat exchange medium to flow, each capillary tube cavity extending along a first direction parallel to the front surface and provided with a micro-tooth structure on the inner wall thereof, and the heat exchange medium being capable of flowing along the first direction in the capillary tube cavity.

2. The heat conducting plate according to claim 1, wherein some of the capillary tube cavities are distributed evenly side by side along a second direction perpendicular to the first direction and parallel to the front surface.

3. The heat conducting plate according to claim 1, wherein the micro-tooth structure comprises micro combs distributed continuously and a comb groove between two adjacent micro combs, and the comb groove extends along the first direction so that the heat exchange medium is capable of flowing in the comb groove to form capillarity.

4. The heat conducting plate according to claim 3, wherein the micro groove comprises valleys away from the center of the capillary tube cavity and peaks close to the center of the capillary tube cavity, the valleys and/or the peaks being of an arc shape.

5. The heat conducting plate according to claim 1, wherein the micro-tooth structure is at least provided on the inner wall of the capillary tube cavity away from the front surface.

6. The heat conducting plate according to claim 1, wherein the capillary tube cavity is provided as a closed space filled with the heat exchange medium, the heat exchange medium flowing circularly in the capillary tube cavity.

7. The heat conducting plate according to claim 1, wherein the capillary tube cavity comprises a first opening and a second opening provided oppositely along the extension direction thereof and the heat exchange medium is capable of flowing into and out of the capillary tube cavity through the first opening and the second opening.

8. A production method for a plate body of a heat conducting plate according to any one of claims 1 to 6, comprising:

forming a basic plate body through an extrusion process, the basic plate body comprising a plurality of capillary tube cavities formed therein, each capillary tube cavity comprising a first opening and a second opening provided at a

first end and a second end of the basic plate body respectively;
 crimping the first end to seal the first opening;
 communicating the second opening with a vacuum pump through a filling tube and vacuumizing the capillary tube cavity; 5
 injecting the heat exchange medium into the capillary tube cavity; and
 crimping and banding the basic plate body along the extension direction of the capillary tube cavity according to a fixed length and cutting off the same to obtain at least one plate body. 10

9. The production method for a plate body of a heat conducting plate according to claim 8, wherein the inner wall of each capillary tube cavity is provided with a micro-tooth structure. 15

10. The production method for a plate body of a heat conducting plate according to claim 9, wherein the step of communicating the second opening with a vacuum pump through a filling tube and vacuumizing the capillary tube cavity comprises: 20

communicating the second opening with a filling tube by welding the filling tube to the second end; and
 communicating the filling tube with a vacuum pump and vacuumizing the capillary tube cavity. 25

11. The production method for a plate body of a heat conducting plate according to claim 8, wherein the step of injecting the heat exchange medium into the capillary tube cavity comprises: 30
 injecting the heat exchange medium into the capillary tube cavity through the filling tube. 35

12. The production method for a plate body of a heat conducting plate according to claim 8, wherein the step of crimping and banding the basic plate body along the extension direction of the capillary tube cavity according to a fixed length and cutting off the same to obtain at least one plate body comprises: 40

crimping and banding the basic plate body along the extension direction of the capillary tube cavity according to a fixed length and cutting off the same; and
 welding the cut-off section to obtain at least one basic plate body. 45
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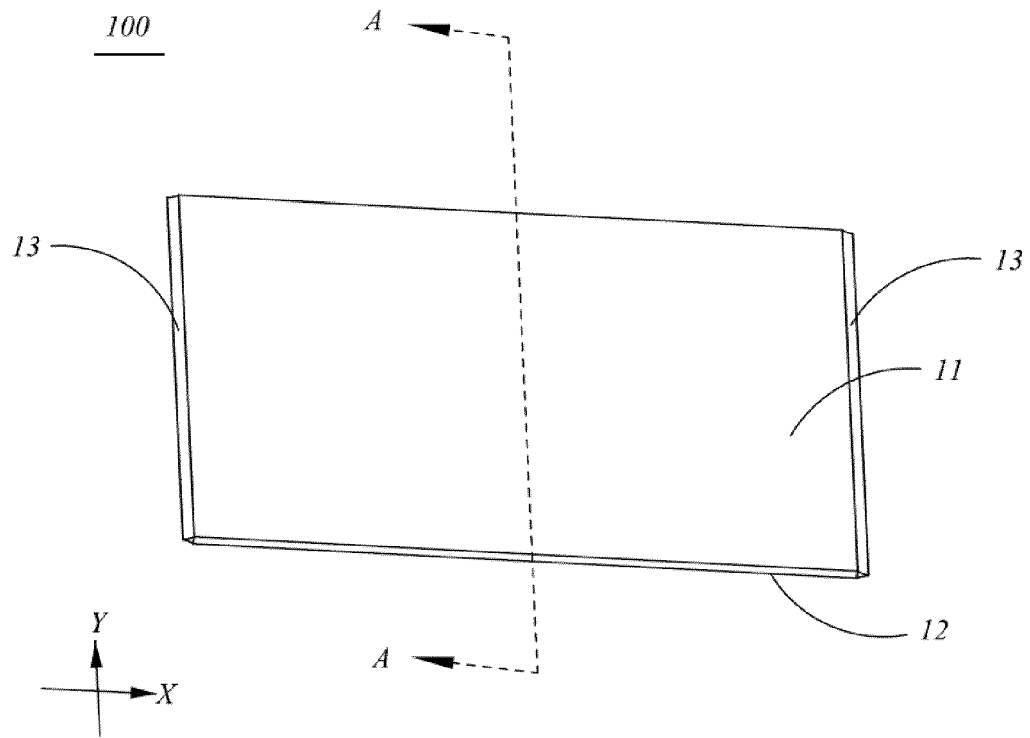


Fig. 1

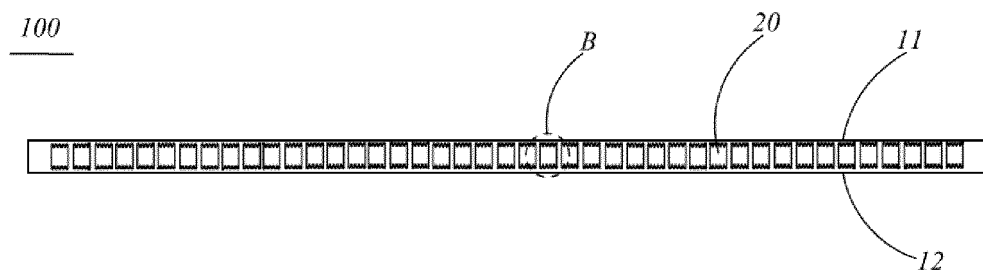


Fig. 2

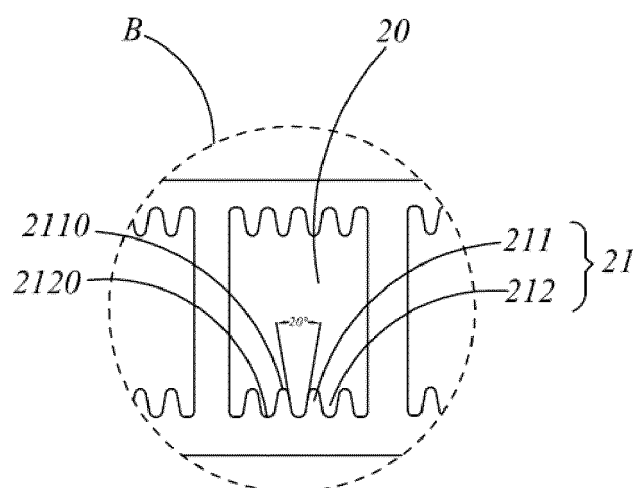


Fig. 3

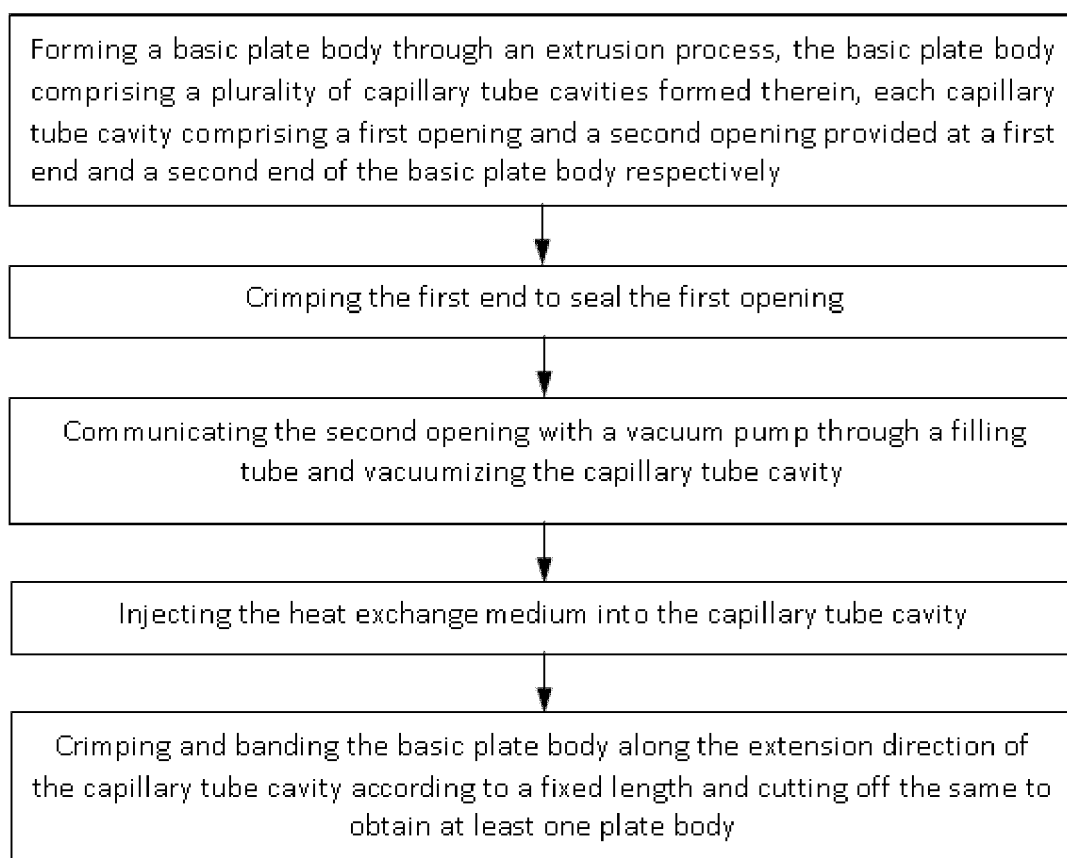


Fig. 4

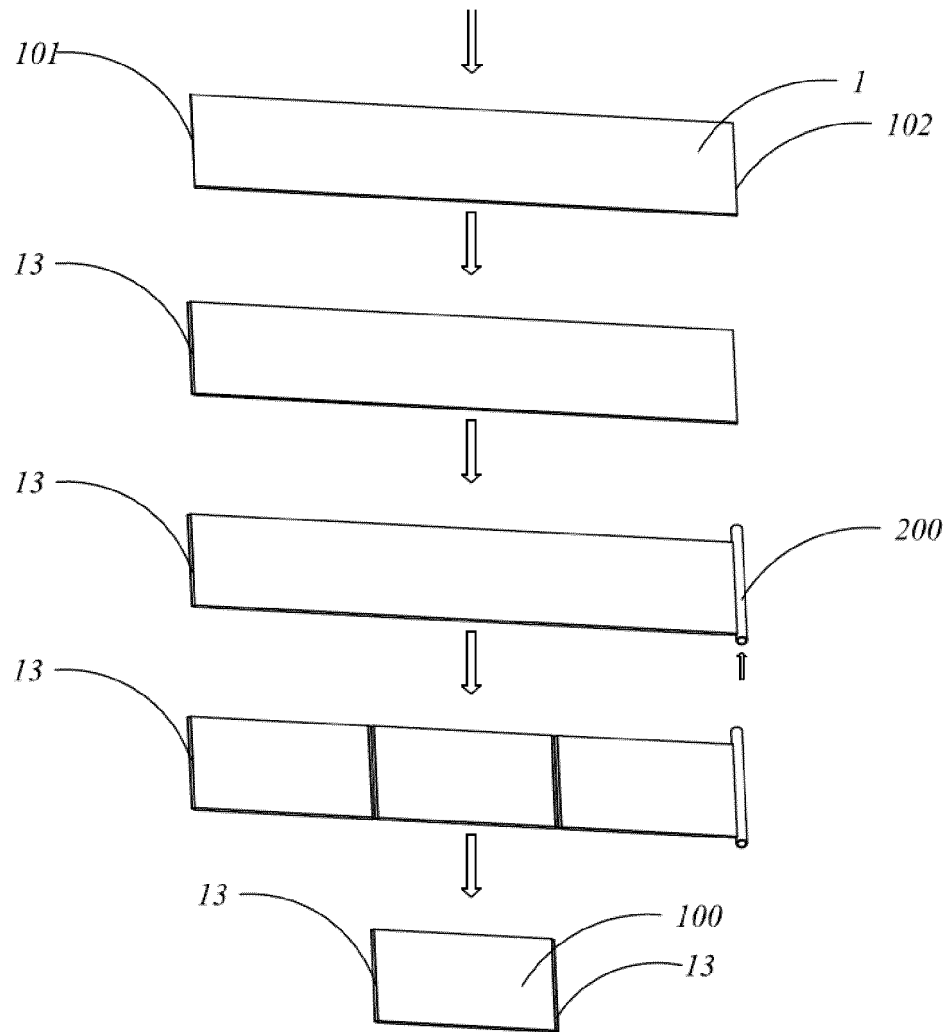


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2016/086179

A. CLASSIFICATION OF SUBJECT MATTER

F28D 15/04 (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 15/-; F28F 1/-

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)

CNPAT, EPODOC, WPI, CNTXT, CNKI: HAIER; thermal conductivity, heat transfer, heat exchange, heat dissipation, uniform temperature, thermotube, heat, transfer+, exchange+, dissip+, cool+, refrigerat+, temperature, equal+, plate, board, tube, capillar+, t??th, concave, projection

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 201548107 U (ZHAO, Yaohua), 11 August 2010 (11.08.2010), description, paragraphs [0031]-[0042], and figures 1-6	1-6, 8-12
Y	CN 201548107 U (ZHAO, Yaohua), 11 August 2010 (11.08.2010), description, paragraphs [0031]-[0042], and figures 1-6	7
Y	US 2008/0223560 A1 (WHIRLPOOL S.A.), 18 September 2008 (18.09.2008), description, paragraphs [0022]-[0027], and figures 1-5	7
X	CN 204555773 U (JIANG, Jinsong), 12 August 2015 (12.08.2015), description, paragraphs [0031]-[0034], and figures 1-4	1-6
X	CN 101762197 A (ZOU, Feilong et al.), 30 June 2010 (30.06.2010), description, paragraphs [0022]-[0035], and figures 1-2	1-6
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☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Date of the actual completion of the international search

13 December 2016 (13.12.2016)

Date of mailing of the international search report

22 December 2016 (22.12.2016)

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2016/086179

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
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Form PCT/ISA/210 (patent family annex) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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