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(54) **MICRO-CHANNEL HEAT EXCHANGER**

(57) A micro-channel heat exchanger (100) is provided. The micro-channel heat exchanger (100) includes a plurality of fins (10) and a plurality of flat tubes (20), wherein the plurality of fins (10) are arranged in parallel to form multiple rows, and the fins (10) are provided with insertion slots (11); and the plurality of flat tubes (20) are arranged in parallel to form multiple layers, and the flat tubes (20) are arranged in the insertion slots (11) in a penetrating manner. The micro-channel heat exchanger (100) further comprises a distributor (30) and adapter tubes (40), wherein the distributor (30) is provided with a plurality of capillary tubes (31), one end of the adapter tube (40) is connected to and in communication with the capillary tubes (31), and the other end of the adapter tube (40) is connected to and in communication with the flat tubes (20).

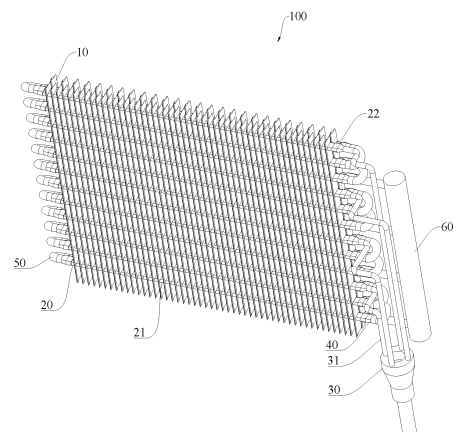


FIG. 1

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to Chinese patent application Nos. 202220403404.5, filed on February 25, 2022, and titled "micro-channel heat exchanger"; 202111302595.2, filed on November 4, 2021, and titled "heat exchanger"; 202220961160.2, filed on April 21, 2022, and titled "micro-channel heat exchanger"; 202210662495.9, filed on June 13, 2022, and titled "adapter and micro-channel heat exchanger thereof"; 202221483863.5, filed on June 13, 2022, and titled "adapter and micro-channel heat exchanger thereof"; and 202122706128.8, filed on November 4, 2021, and titled "heat exchanger", the contents of which are hereby incorporated by reference in their entireties.

TECHNICAL FIELD

[0002] The present disclosure relates to the fields of refrigeration technology, in particular, to a micro-channel heat exchanger.

BACKGROUND

[0003] Micro-channel heat exchangers are a kind of compact, lightweight, and efficient heat exchangers designed to meet the needs of industrial development.

[0004] The micro-channel heat exchanger of the related art is provided with two collecting pipes at each end of a flat tube. Inlets and outlets of the flat tubes are connected to and in communication with the collecting pipes, so that the collecting pipe should be provided with a plurality of flat tube grooves, resulting in difficulties in processing the collecting pipe.

SUMMARY

[0005] In view of embodiments of the present disclosure, a micro-channel heat exchanger is provided.

[0006] A micro-channel heat exchanger is provided in the present disclosure. The micro-channel heat exchanger includes a plurality of fins and a plurality of flat tubes. The plurality of fins are arranged in parallel to form a plurality of rows, and each of the plurality of fins is provided with a plurality of insertion slots. The plurality of flat tubes are arranged in parallel to form a plurality of layers, and the plurality of flat tubes penetrate through the plurality of insertion slots. The micro-channel heat exchanger further includes a distributor and an adapter. The distributor is provided with a plurality of capillary tubes. An end of the adapter is connected to and in communication with corresponding one of the plurality of capillary tubes, and the other end of the adapter is connected to and in communication with corresponding one of the plurality of flat tubes.

[0007] Details of one or more embodiments of the

present disclosure are set forth in the accompanying drawings and description below. Other features, objects, and advantages of the present disclosure will become apparent from the specification, the accompanying drawings, and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Reference may be made to one or more of the accompanying drawings in order to better describe and illustrate those embodiments and/or examples of the disclosure disclosed herein. The additional details or examples used to describe the accompanying drawings should not be considered a limitation on the scope of any of the disclosed disclosures, the presently described embodiments and/or examples, and the best mode of these disclosures as presently understood.

FIG. 1 is a stereo schematic diagram of a micro-channel heat exchanger in one or some embodiments from an angle of view.

FIG. 2 is a stereo schematic diagram of a micro-channel heat exchanger in one or some embodiments from another angle of view.

FIG. 3 is a schematic diagram of an adapter in one or some embodiments.

FIG. 4 is a schematic diagram of a fin in one or some embodiments.

FIG. 5 is a schematic diagram of a fin in one or some embodiments.

FIG. 6 is a schematic diagram of a fin in one or some embodiments.

FIG. 7 is a schematic diagram of a fin in one or some embodiments.

FIG. 8 is a schematic diagram of a fin providing with a second protrusion in one or some embodiments.

FIG. 9 is a schematic diagram of two rows of fins when the two rows of fins abuts against each other in one or some embodiments.

FIG. 10 is a schematic diagram of an adapter in one or some embodiments.

FIG. 11 is a structural schematic diagram in which an adapter is connected to and in communication with the flat tube in one or some embodiments.

FIG. 12 is a partial enlarged figure of A portion in FIG. 11.

FIG. 13 is a structural schematic diagram in which an adapter is connected to and in communication with the flat tube in another embodiment.

FIG. 14 is a partial enlarged figure of b portion in FIG. 13.

FIG. 15 is a structural schematic diagram of a micro-channel heat exchanger in one or some embodiments.

FIG. 16 is a structural schematic diagram of a micro-channel heat exchanger in one or some embodiments.

FIG. 17 is a partial structural schematic diagram of

a micro-channel heat exchanger in one or some embodiments.

FIG. 18 is a structural sectional view in which an adapter is connected to and in communication with the flat tube in one or some embodiments.

FIG. 19 is a partial enlarged figure of A portion in FIG. 18.

FIG. 20 is a structural schematic diagram of a heat exchanger in one or some embodiments.

FIG. 21 is a structural schematic diagram of a bending pipe in one or some embodiments.

FIG. 22 is a structural schematic diagram of a bending pipe in one or some embodiments, in which α is 90° .

FIG. 23 is a structural schematic diagram of a bending pipe in one or some embodiments, in which α is an acute angle.

FIG. 24 is a structural schematic diagram in which a bending pipe is connected to and in communication with the flat tube in one or some embodiments.

FIG. 25 is a structural schematic diagram in which a bending pipe is connected to and in communication with the flat tube in another embodiment.

FIG. 26 is a structural schematic diagram of a tube orifice of a bending pipe in one or some embodiments, in which the tube orifice is square-shaped.

FIG. 27 is a structural schematic diagram of a tube orifice of a bending pipe in one or some embodiments, in which both the first side surface and the second side surface are arc-shaped surfaces, and both the top surface and the bottom surface are tangent to the first side surface.

FIG. 28 is a structural schematic diagram of a tube orifice of a bending pipe in one or some embodiments, in which both the first side surface and the second side surface are arc-shaped surfaces, and both the top surface and the bottom surface are not tangent to the first side surface.

FIG. 29 is a structural schematic diagram of a tube orifice of a bending pipe in one or some embodiments, in which the tube orifice is ellipsoid-shaped.

FIG. 30 is a structural schematic diagram of a tube orifice of a bending pipe in one or some embodiments, in which both the first side surface and the second side surface are elliptic arc-shaped.

FIG. 31 is a structural schematic diagram of a tube orifice of a bending pipe in one or some embodiments, in which both the first side surface and the second side surface are bended surfaces (that is, having a triangle-shaped).

FIG. 32 is a front view in which the fin matches with the flat tube in one or some embodiments.

FIG. 33 is a partial structural schematic diagram of a fin in one or some embodiments.

FIG. 34 is a partial structural schematic diagram of a flanging structure in one or some embodiments.

FIG. 35 is a side view of a part of a fin in one or some embodiments.

FIG. 36 is a schematic diagram in which shows a width and a height of an inserting slot in one or some embodiments.

5 **[0009]** In the figures, 100 represents a micro-channel heat exchanger; 10 represents a fin; 11 represents a insertion slot; 12 represents a first side; 13 represents a second side; 14 represents a first protrusion; 15 represents a stripe-shaped slot; 16 represents a second protrusion; 17 represents a body portion; 18 represents a flanging structure; 181 represents a first flanging; 182 represents a second flanging; 183 represents a third flanging; 20 represents a flat tube; 21 represents a first column of flat tubes; 22 represents a second column of flat tubes; 30 represents a distributor; 31 represents a capillary tube; 32 represents a distributing head; 40 represents an adapter; 401 represents a first tube orifice; 402 represents a limiting portion; 402BA represents a first protruding portion; 402B represents a second protruding portion; 403 represents a first inner surface; 404 represents a second inner surface; 405 represents a second tube orifice; 50 represents a bending pipe; 51 represents a connecting section; 52 represents a bending section; 53 represents a transition section; 60 represents a collecting pipe; 70 represents a shrinking tube; 71 represents a first section; 72 represents a second section; 80 represents a flared tube; and 90 represents a welding ring.

30 DETAILED DESCRIPTION

[0010] In order to make the foregoing objects, features and advantages of the present disclosure more apparent and understandable, specific embodiments of the present disclosure are described in detail below in conjunction with the accompanying drawings. Many specific details are set forth in the following description to facilitate a full understanding of the present disclosure. However, the present disclosure is capable of being implemented in many other ways different from those described herein, and those skilled in the art may make similar improvements without violating the connotations of the present disclosure, and thus the present disclosure is not limited by the specific embodiments disclosed below.

45 **[0011]** It is noted that when a component is said to be "fixed to" or "disposed on" another component, it may be directly on the other component or there may be a centered component. When a component is said to be "connected" to another component, it may be directly attached to the other component or there may be both centered components. The term "vertical", "horizontal", "up", "down", "left", "right", and similar expressions used in the specification of the present disclosure are for illustrative purposes only and are not meant to be exclusive.

55 **[0012]** Furthermore, the terms "first" and "second" are used for descriptive purposes only, and are not to be understood as indicating or implying relative importance or implicitly specifying the number of indicated technical

features. Thus, a feature defined with "first", "second" may expressly or implicitly include at least one such feature. In the description of the present disclosure, "plurality" means at least two, e.g., two, three, etc., unless otherwise expressly and specifically limited.

[0013] In the present disclosure, unless otherwise expressly specified and limited, the first feature "on" or "under" the second feature may be a direct contact between the first feature and the second feature, or an indirect contact between the first feature and the second feature through an intermediate medium. Furthermore, the first feature being "above", "on" or "upon" the second feature may mean that the first feature is directly above or diagonally above the second feature, or simply that the first feature is horizontally higher than the second feature. The first feature being "below", "under" or "underneath" the second feature may be that the first feature is directly below or diagonally below the second feature, or may simply mean that the first feature is horizontally smaller than the second feature.

[0014] Unless otherwise defined, all technical and scientific terms used in the specification of the present disclosure have the same meaning as commonly understood by those skilled in the art of the present disclosure. Terms used in the specification of the present disclosure are used only for the purpose of describing specific embodiments and are not intended to limit the present disclosure. The term "and/or" as used in the specification of the present disclosure includes any and all combinations of one or more of the relevant listed items.

[0015] Referring to FIG. 1 and FIG. 2, a micro-channel heat exchanger 100 is provided in the present disclosure. When the micro-channel heat exchanger 100 is mounted in a refrigeration system, a medium flows in the micro-channel heat exchanger 100, and the micro-channel heat exchanger 100 facilitate heat exchange between the medium and the outside world.

[0016] In details, the micro-channel heat exchanger 100 includes a plurality of fins 10 and a plurality of flat tubes 20. The plurality of fins 10 are arranged in parallel to form a plurality of rows, and each of the plurality of flat tubes 20 are arranged in parallel to form a plurality of layers. The plurality of fins 10 are provided with a plurality of insertion slots 11, and the plurality of flat tubes 20 penetrate through in the plurality of insertion slots 11. It should be noted that in the present disclosure, the plurality of rows of fins 10 indicate that the plurality of fins 10 are arranged to a plurality of rows along a length direction of the flat tube 20, and the plurality of layers of flat tubes 20 indicate that the plurality of flat tubes 20 are arranged in parallel to a plurality of layers along a height direction of the micro-channel heat exchanger 100. The plurality of columns hereinafter indicate that the plurality of flat tubes 20 and the plurality of fins 10 are arranged to a plurality of columns back to front, respectively along a width direction of the micro-channel heat exchanger 100.

[0017] The micro-channel heat exchanger 100 further

includes a distributor 30 and an adapter 40. The distributor 30 is provided with a plurality of capillary tubes 31. An end of the adapter 40 is connected to and in communication with a corresponding one of the plurality of capillary tubes 31, and the other end of the adapter 40 is connected to and in communication with corresponding one of the plurality of capillary tubes 20. It could be understood that the medium is equally distributed and conveyed into the plurality of flat tubes 20. By replacing a collecting pipe in the related art with the distributor 30, a processing can be simplified. The processing can be changed by merely choosing suitable number of distributor 30 and decreasing the number of the capillary tube 31. In the related art, the medium is distributed by the collecting pipe. A plurality of flat tube grooves should be disposed on the collecting pipe 60, and the processing is complex.

[0018] An tube orifice of the flat tube 20 towards the adapter 40 matches with a tube orifice of the flat tube 20, and an end of the flat tube 20 penetrates into the adapter 40, enhancing welding strength between the flat tube 20 and the adapter 40.

[0019] Referring to FIG. 3 and FIG. 7, a width of a tube orifice of the adapter 40 towards the flat tube 20 is defined as W_1 , a width of the tube orifice of the flat tube 20 is defined as W_2 , and the width W_1 of the flat tube 20 is greater than the width W_2 of the second section; and, a height of a tube orifice of the adapter 40 towards the flat tube 20 is defined as H_1 , a height of the tube orifice of the flat tube 20 is defined as H_2 , and the height H_1 of a tube orifice of the adapter 40 towards the flat tube 20 is greater than the height H_2 of the tube orifice of the flat tube 20. It could be understood that since the flat tube 20 and the adapter 40 are made of aluminum and is difficult to be flared, a size of the tube orifice of the adapter 40 is designed greater than the tube orifice of the flat tube 20, which facilitate smooth insertion of an end of the flat tube 20 into the adapter 40. It should be noted that both the width of a tube orifice of the adapter 40 towards the flat tube 20 and the height of a tube orifice of the adapter 40 towards the flat tube 20 are inner sizes of the tube orifice of the adapter 40 towards the flat tube 20, and do not include the thickness of the adapter 40. Similarly, sizes of the tube orifice of the flat tube 20 do not include a thickness of the flat tube 20 as well.

[0020] The present disclosure further provides an adapter 40, which is disposed in the micro-channel heat exchanger 100. The adapter 40 is configured for connection and communication between adjacent two flat tubes 20, or the adapter 40 is configured for connection and communication between the flat tube 20 and the capillary tube 31.

[0021] In the micro-channel heat exchanger of the related art, the flat tube and the adapter are connected to each other without a limiting structure. Therefore, not only a welding process is difficult to be operated between the flat tube and the adapter, but also displacement may occur in the welding process between the flat tube and the

adapter, making the welding process hard.

[0022] In order to solve the problems of the micro-channel heat exchanger in related art, the present disclosure provides the adapter 40 disposed in the micro-channel heat exchanger 100, and the adapter 40 is configured to connect to and be in communication with the flat tube 20. The micro-channel heat exchanger 100 of the present disclosure includes a plurality of the adapters 40. An end of a part of the adapter 40 is connected to and in communication with a capillary tube 31, the other end of the part of the adapter 40 is connected to and in communication with a flat tube 20, and both ends of a part of the adapters 40 are connected to and in communication with the flat tube 20. That is, the tube orifice of the end of the adapter 40 connected to and in communication with the capillary tube 31 is round-shaped, and the other tube orifice of the other end of the adapter 40 is stripe-shaped. The part of the adapters 40, in which both end of the adapters are connected to and in communication with flat tubes 20, are curved tubes.

[0023] The plurality of adapters 40 includes a first tube orifice 401 matching with the flat tube 20. The first tube orifice 401 is configured for insertion of the flat tube 20, an inner surface of the adapter 40 is provided with a limiting portion 402, and the limiting portion 402 abuts against one end of the flat tube 20 and/or a sidewall of the flat tube 20 and is configured for limiting the flat tube 20.

[0024] It should be noted that when adjacent two flat tubes 20 should be connected to and in communication with each other or the flat tube 20 should be connected to and in communication with the capillary 31, each of the plurality of flat tubes 20 should be inserted into each of the plurality of adapters 40 correspondingly, and being welded together. Therefore, in order to avoid displacement between the flat tube 20 and the adapter 40 in the welding process, the limiting portion 402 configured for limiting the flat tube 20 is disposed on the inner surface of the adapter 40.

[0025] In order to ensure connection stability between the flat tube 20 and the adapter 40 before the welding process, along an axis of the flat tube 20, a depth of the flat tube 20 inserting in the adapter 40 should be limited with the limiting portion 402. Along a direction perpendicular to the axis of the flat tube 20, the limiting portion 402 should limit shake of the flat tube 20 in the adapter 40.

[0026] Referring to FIG. 10 and FIG. 11, in an embodiment of the present disclosure, the limiting portion 402 includes a first protruding portion 402A. The first protruding portion 402A is disposed on the inner surface of the adapter 40, and extends towards a direction away from the inner surface of the adapter 40. The first protruding portion 402A is configured to abut against an end of the flat tube 20, making an end surface of the flat tube 20 extending into the adapter 40 abut against the first protruding portion 402A, so as to limit a depth of the flat tube 20 extending in the adapter 40. At the same time, providing the first protruding portion 402A can produce a

turbulent flow to the refrigerant, making homogeneity of the refrigerant better and improving heat exchange efficiency of the heat exchanger.

[0027] Referring to FIG. 11 and FIG. 12, a height of the first protruding portion 402A extending out of the inner surface of the adapter 40 should not be unduly large or unduly small, and should be set in a suitable range. The height of the first protruding portion 402A protruding out of the inner surface of the adapter 40 is defined as H_3 , and a height of the flat tube is defined as H_1 . The adapter 40 includes a first inner surface 403 and a second inner surface 404 opposite to each other. The first protruding portion 402A is disposed on the first inner surface 403 and/or the second inner surface 404. A distance between the first inner surface 403 and the second inner surface 404 is defined as H_2 , and a height of the flat tube 20 is defined as H_1 . The height H_3 of the first protruding portion 402A protruding out of the inner surface of the adapter 40, the height H_1 of the flat tube 20 and the distance H_2 between the first inner surface 403 and the second inner surface 404 satisfy the following formula: $0.2 \text{ mm} \leq [H_3 - (H_2 - H_1)] \leq 3 \text{ mm}$. That is, a value of $[H_3 - (H_2 - H_1)]$ can be 0.2mm, 1mm, 2mm, 3mm or any value fall within the range. The height H_1 of the flat tube 20 is a height of the outside of the flat tube 20, and is not a height of the inner channel of the flat tube 20.

[0028] It should be noted that if the height H_3 of the first protruding portion 402A protruding out of the inner surface of the adapter 40 is unduly great, the first protruding portion 402A obstacles flow of the medium in the adapter 40 to a certain extent, and even throttle in the adapter 40. It should be noted that if the height H_3 of the first protruding portion 402A protruding out of the inner surface of the adapter 40 is unduly small, limiting function may not be realized. Therefore, the height H_3 of the first protruding portion 402A protruding out of the inner surface of the adapter 40 should be set in a suitable range. Thus, not only limitation of the end surface of the flat tube 20 can be ensured, but also unduly great flow resistance of medium caused by unduly high H_3 can be avoided.

[0029] Along a circumference of the inner surface of the adapter 40, the number of the first protruding portion 402A can be one, two, three or multiple. Thus, the number of the first protruding portion 402A is not limited.

[0030] In some embodiments, the first protruding portion 402A is semicircle-shaped, square-shaped or trapezoid-shaped, which is not limited herein.

[0031] In some embodiments, a position that the first protruding portion 402A disposed on the inner surface of the adapter 40 amount to the maximum depth of the flat tube 20 inserting in the adapter 40. The depth of the flat tube 20 inserting into the adapter 40 should be set in a suitable range. A distance between the first protruding portion 402A and an end surface of the first tube orifice 401, that is, the depth of the flat tube 20 inserting into the adapter 40, is defined as L_1 , and the distance L_1 between the first protruding portion 402A and an end surface of the first tube orifice 401 satisfies the following formula: 2

$\text{mm} \leq L_1 \leq 10 \text{ mm}$. That is, the distance L_1 between the first protruding portion 402A and the end surface of the first tube orifice 401 can be 2mm, 4mm, 6mm, 8mm, 10mm or any other value falls within the range, which is not limited herein.

[0032] It should be noted that if the depth L_1 of the flat tube 20 inserting into the adapter 40 is unduly great, flow of the medium in the adapter may be resisted to a certain extent. If the depth L_1 of the flat tube 20 inserting into the adapter 40 is unduly small, a contact area between the flat tube 20 and the adapter 40 can be reduced, thereby reducing welding strength between the flat tube 20 and the adapter 40. Therefore, the distance L_1 between the first protruding portion 402A and the end surface of the first tube orifice 401 satisfies the following formula: $2 \text{ mm} \leq L_1 \leq 10 \text{ mm}$. Thus, the depth L_1 of the flat tube 20 inserting into the adapter 40 can be in a suitable range. Thus, not only choked flow caused by unduly deep insertion of the flat tube 20 into the adapter 40 can be avoided, but also reduction of the welding strength caused by unduly shallow insertion of the flat tube 20 into the adapter 40 can be avoided.

[0033] Referring to FIG. 10 and FIG. 13, in some embodiments, the limiting portion 402 includes a second protruding portion 402B. The second protruding portion 402B is disposed on the inner surface of the adapter 40, and extends towards a direction away from the inner surface of the adapter 40. The second protruding portion 402B is disposed away from the first tube orifice 401 relative to the first protruding portion 402A. A height of the second protruding portion 402B protruding out the inner surface of the adapter 40 is smaller than the height of the first protruding portion 402A protruding out of the inner surface of the adapter 40. The second protruding portion 402B is configured for abutting against the outer surface of the flat tube 20, and mainly configured for avoiding shaking of the flat tube 20 relative to the inner surface of the adapter 40.

[0034] It could be understood that in the present disclosure, the limiting portion 402 includes a first protruding portion 402A and the second protruding portion 402B, the first protruding portion 402A is configured for abutting against an end of the flat tube 20, and the second protruding portion 402B is configured for abutting the outer surface of the flat tube 20. Therefore, the depth of the flat tube 20 inserting into the adapter and shaking of the flat tube 20 in the adapter 40 are limited, therefore ensuring connection stability between the flat tube 20 and the adapter 40 and facilitating the welding process.

[0035] Referring to FIG. 13 and FIG. 14, in order to ensure limiting effect of the second protruding portion 402B to the flat tube 20, the second protruding portion 402B should be interference fit with the outer surface of the flat tube 20. The height of the second protruding portion 402B protruding out of the inner surface of the adapter 40 is defined as H_4 and the second protruding portion 402B is disposed on the first inner surface 403 and/or the second inner surface 404. The height H_1 of the flat

tube 20, the height H_4 of the second protruding portion 402B protruding out of the inner surface of the adapter 40, and the distance H_2 between the first inner surface 403 and the second inner surface 404 conform to the following formula: $0 \text{ mm} \leq [H_4 - (H_2 - H_1)] \leq 0.2 \text{ mm}$. That is, $[H_4 - (H_2 - H_1)]$ can be 0 mm, 0.1 mm, 0.2 mm, or any value falls within the range.

[0036] It should be noted that by making the height H_1 of the flat tube 20, the height H_4 of the second protruding portion 402B protruding out of the inner surface of the adapter 40, and the distance H_2 between the first inner surface 403 and the second inner surface 404 conform to the following formula $0 \text{ mm} \leq [H_4 - (H_2 - H_1)] \leq 0.2 \text{ mm}$, interference fit between the second protruding portion 402B and the flat tube 20 can be ensured. Therefore, flat tube 20 can be fixed in the adapter 40 with the second protruding portion 402B, thereby solving the problem of displacement in the welding process of the flat tube 20 and the adapter 40.

[0037] Along a circumference of the inner surface of the adapter 40, the number of the second protruding portion 402B can be one, two, three or multiple. Thus, the number of the second protruding portion 402B is not limited.

[0038] In some embodiments, the second protruding portion 402B can be semicircle-shaped, square-shaped or trapezoid-shaped, which is not limited herein.

[0039] It should be noted that in the present embodiment, only the first protruding portion 402A or the second protruding portion 402B is disposed on the inner surface of the adapter 40; optionally, both the first protruding portion 402A and the second protruding portion 402B are simultaneously disposed on the inner surface of the adapter 40.

[0040] In order to ensure the welding strength between the flat tube 20 and the adapter 40, a gap is left between the inner surface of the adapter 40 and the outer surface of the flat tube 20, and the gap is configured for pervading of the melt welding flux. A size of the gap should be set in a suitable range. A height H_1 of the flat tube 20 and a distance H_2 between the first inner surface 403 and the second inner surface 404 satisfy the following formula: $0.02 \text{ mm} \leq (H_2 - H_1) \leq 0.4 \text{ mm}$. That is, a value of $(H_2 - H_1)$ can be 0.02mm, 0.1mm, 0.2mm, 0.3mm, 0.4mm or any value falls within the range.

[0041] It should be noted that the gap between the inner surface of the adapter 40 and the outer surface of the flat tube 20 should not be unduly small, and an unduly small gap may make it hard for the welding flux to flow. The gap between the inner surface of the adapter 40 and the outer surface of the flat tube 20 should not be unduly large, and an unduly large gap may make welding between the adapter 40 and the flat tube 20 difficult. By making the height H_1 of the flat tube 20 and the distance H_2 between the first inner surface 403 and the second inner surface 404 conform to the formula $0.02 \text{ mm} \leq (H_2 - H_1) \leq 0.4 \text{ mm}$, the outer surface of the flat tube 20 can be in clearance fit with the inner surface of the adapter

40, thereby facilitating flowing of the welding flux.

[0042] Furthermore, in an embodiment of the present disclosure, the adapter 40 is provided with a second tube orifice 405. The second tube orifice 405 is located at an end of the adapter 40 away from the first tube orifice 401. The second tube orifice 405 is round-shaped, and configured for being connected to and in communication with the capillary tube 31. Since the capillary tube 31 is especially thin and has a round-shaped cross-section, and a cross-section of the flat tube 20 is stripe-shaped, the capillary tube 31 cannot be directly matched with and connected to the flat tube 20, and should be switched via the adapter 40. The end of the adapter 40 adjacent to the capillary tube 31 is round-shaped matching with the capillary tube 31, and the end of the adapter 40 adjacent to the flat tube 20 is stripe-shaped matching with the flat tube 20.

[0043] In some embodiments of the present disclosure, in the plurality of rows of the micro-channel heat exchanger 100, the adapter 40 is a bending pipe, both ends of the adapter 40 are provided with first tube orifices 401, and both ends of the adapter 40 are configured for being connected to and in communication with the flat tubes 20 of the adjacent row of flat tubes 20. In the micro-channel heat exchanger of the related art, the flat tube is generally curved to form a plurality of rows of flat tubes. Curving the flat tube may damage the flat tube, and a curving radius is relatively great and increases an entire volume of the micro-channel heat exchanger. In addition, in the curving process, the fin may deform and the heat exchange efficiency is affected. Therefore, the adapter 40 is connected to and in communication with the adjacent flat tube 20 in the present disclosure, thereby avoiding curving and deformation of the fin 10. When both ends of the adapter 40 are connected to and in communication with the flat tube 20, both ends of the adapter 40 are provided with the first protruding portion 402A and the second protruding portion 402B.

[0044] In the adapter 40 of the present disclosure, by making the limiting portion 402 abut against one end of the flat tube 20 and/or the sidewall of the flat tube 20 and limiting the flat tube 20, connection stability of the flat tube 20 and the adapter 40 can be ensured. Therefore, displacement between the flat tube 20 and the adapter 40 may not occur in the welding process, and welding property between the flat tube 20 and the adapter 40 can be enhanced.

[0045] In the micro-channel heat exchanger of the related art, the flat tube is welded to the adapter by manual welding. The manual welding process is hard to control and has a worse performance, and cannot control the welding flux and the welding line well. In addition, the cost of manual welding is high, not conducive to the use of large quantities.

[0046] Referring to FIG. 16 and FIG. 17, in order to solve the above problems of the micro-channel heat exchanger in related art, the micro-channel heat exchanger 100 of the present disclosure further includes a shrinking

tube 70 and a flared tube 80. The flared tube 80 is connected to and in communication with the adapter 40, and the shrinking tube 70 is connected to and in communication with the flat tube 20. The flat tube 20 shrinks to form the shrinking tube 70, and the adapter 40 flares to form the flared tube 80. Optionally, the shrinking tube 70 is connected to and in communication with the adapter 40, and the flared tube 80 is connected to and in communication with the flat tube 20, the flat tube 20 flared to form the flared tube 80, and the adapter 40 shrinks to form the shrinking tube 70. The shrinking tube 70 is sleeved with a welding ring 90, and the shrinking tube 70 penetrates into the flared tube 80 and is connected to the flared tube 80 by welding.

[0047] It should be noted that in the micro-channel heat exchanger 100 of the present disclosure, the shrinking tube 70 is sleeved with a welding ring 90, the shrinking tube 70 penetrates into the flared tube 80, and then the shrinking tube 70 and the flared tube 80 are subjected to hard-solder in an oven. Therefore, the shrinking tube 70 is fixed to the flared tube. Compared to manual welding, performing a hard-solder in the oven can make welding consistency of the flat tube 20 and the adapter 40 higher. The flat tube 20 and the adapter 40 can be subjected to the welding process with other components of the micro-channel exchanger 100, reducing the cost, improving the welding efficiency, and improving welding consistency between the flat tube 20 and the adapter 40.

[0048] Referring to FIG. 18, in the present embodiment, the flat tube 20 is connected to and in communication with the shrinking tube 70, the adapter 40 is connected to and in communication with the flared tube 80, and the shrinking tube 70 penetrates into the flared tube and is connected to the flared tube 80 by welding. In some embodiments, the adapter 40 can be connected to and in communication with the shrinking tube 70, and the flat tube 20 can be connected to and in communication with the flared tube 80.

[0049] It should be noted that the flat tube 20 being connected to and in communication with the shrinking tube 70 can be a flat tube 20 separated from the shrinking tube 70, or can be a shrinking tube 70 directly formed by shrinking the flat tube 20; and that the adapter 40 being connected to and in communication with the flared tube 80 can be an adapter 40 separated from the flared tube 80, or can be a flared tube formed by flaring the adapter 40. Optionally, that the adapter 40 being connected to and in communication with the shrinking tube 70 can be an adapter 40 separated from the shrinking tube 70, or can be a shrinking tube 70 directly formed by shrinking the adapter 40; and that the flat tube 20 being connected to and in communication with the flared tube 80 can be a flat tube 20 separated from the flared tube 80, or can be a flared tube formed by flaring the flat tube 20.

[0050] Furthermore, the shrinking tube 70 includes a first section 71 and a second section 72 connected to each other. An outer size of the first section 71 gradually decreases along a direction from the first section 71 to

the second section 72. The welding ring 90 is sleeved outside the first section 71. A length of the first section 71 is defined as L_1 along an axis of the shrinking tube 70, and a dimension of a cross section of the welding ring 90 is defined as D_1 , and the dimension D_1 of the cross section of the welding ring 90 and L_1 satisfy the following formula: $D_1 \leq L_1 \leq 1.2D_1$. That is, the length L_1 of the first section 71 can be D_1 , $1.1D_1$, $1.2D_1$ or any value falls within the range.

[0051] In order to leave enough mounting space for disposing the welding ring 90 on the first section 71, ensure that the welding ring 90 is sleeved on the first section 71 better, and make the welding ring 90 do not slide to other positions and affect the welding process, the length L_1 of the first section 71 along the axis of the shrinking tube 70 is at least equal to the dimension D_1 of the welding ring 90, or can be greater than the dimension D_1 of the welding ring 90 to a certain extent. However, the length L_1 of the first section 71 along the axis of the shrinking tube 70 should not be unduly great, and the first section 71 with an unduly great length L_1 may cause unnecessary waste. Therefore, the length L_1 of the first section 71 is suitable in a range of greater than or equal to D_1 and smaller than or equal to $1.2D_1$.

[0052] Furthermore, a length of the second section 72 is defined as L_2 , and L_2 satisfies the following formula: $3 \text{ mm} \leq L_2 \leq 5 \text{ mm}$. That is, the length of the second section 72 can be 3mm, 4mm, 5mm, or any other value falls within the range, which is not limited herein.

[0053] It should be noted that in order to confirm the welding strength between the shrinking tube 70 and the flared tube 80, the second section 72 should have a certain length, and the length of the second section 72 should not be unduly long. Unduly long second section 72 may cause the choked flow to the medium in the shrinking tube 70 and the flared tube 80.

[0054] A cross section of the welding ring 90 is round-shaped. The welding ring 90 is ellipse-shaped as a whole, and sleeved on an outer surface of the first section 71. Thus, the shape of the welding ring 90 matches with the flat tube 20, so that the welding flux can be evenly coated on the outer surface of the shrinking tube along the circumference of the shrinking tube 70, thereby ensuring welding quality. A width of the flat tube 20 is defined as W_1 , a width of the second section 72 is defined as W_2 , a long axis of an inner ring of the welding ring 90 is defined as D , and the width W_1 of the flat tube 20, the width W_2 of the second section 72 and the long axis D of an inner ring of the welding ring 90 satisfy the following formula: $W_2 \leq D \leq W_1$. The width W_1 of the flat tube 20 and W_2 satisfy the following formula: $W_2 < W_1$, so that the welding ring 90 can be smoothly sleeved outside the first section 71. That is, the long axis D of an inner ring of the welding ring 90 can be W_1 , W_2 or any value falls within the range of W_2 to W_1 . The width W_1 of the flat tube 20 indicates an outer width of the flat tube 20, and the width W_2 of the second section 72 indicates an outer width of the second section 72. It should be noted that the inner ring of the

welding ring 90 can be ellipse-shaped. An ellipse has a long axis and a short axis. A long axis of the inner ring of the welding ring 90 is the width of the inner ring of the welding ring 90, that is, a maximum size of the inner ring of the welding ring 90.

[0055] The flat tube 20 in different micro-channel heat exchanger 100 can be in different sizes according to different conditions. When the width of the flat tube 20 is relatively great, a periphery length of the flat tube 20 is relatively long, and more welding flux is required. Therefore, the dimension D_1 of the cross section of the welding ring 90 can proportionally increase along with increasing of the width W_1 of the flat tube 20, so as to ensure the welding strength between the flat tube 20 and the adapter 40. In the present disclosure, the dimension D_1 of the cross section of the welding ring 90 can conform to the following formula $D_1 = 0.06W_1$. That is, the dimension D_1 of the cross section of the welding ring 90 can be 0.06 times of the width W_1 of the flat tube 20.

[0056] Furthermore, an inner width of the shrinking tube 70 is defined as W_3 , and an inner width of the adapter 40 is defined as W_4 , and the inner width W_3 of the shrinking tube 70 and the inner width W_4 of the adapter 40 satisfy the following formula: $0.8W_4 \leq W_3 \leq 1.2W_4$. That is, the inner width of the shrinking tube 70 can be $0.8W_4$, $0.9W_4$, W_4 , $1.1W_4$, or any value in the range of $0.8W_4$ to $1.2W_4$. The inner width W_3 of the shrinking tube 70 indicates a width of the inner channel of the shrinking tube 70, and the inner width of indicates a width W_4 of the inner channel of the adapter 40.

[0057] It should be noted that in the process the medium flows between the flat tube 20 and the adapter 40, an sudden increase or a sudden decrease of the dimension of the tube may increase a flow resistance of the medium, thereby causing loss of flow. In order to solve the problem above, the inner dimension of the tube in the process that the medium flows should be kept the same. Therefore, the width W_3 of the shrinking tube 70 is limited in a range of $0.8W_4$ to $1.2W_4$, reducing medium flow resistance.

[0058] Referring to FIG. 18 and FIG. 19, when the welding ring 90 is sleeved on the outer surface of the first section 71, the shrinking tube 70 extends into the flared tube 80. And end of the flared tube 80 adjacent to the shrinking tube 70 abuts against the welding ring 90. In order to facilitate pervading of the melt welding ring 90 between the outer surface of the shrinking tube 70 and the inner surface of the flared tube 80, the outer surface of the shrinking tube should be in clearance fit with the inner surface of the flared tube, so that the welding flux of the melt welding ring 90 could flow sufficiently in the gap.

[0059] Specifically, the gap between the outer surface of the shrinking tube 70 and the inner surface of the flared tube 80 is defined as H , and H conform to the following formula: $0.1 \text{ mm} \leq H \leq 0.35 \text{ mm}$. That is, the gap between the outer surface of the shrinking tube 70 and the inner surface of the flared tube 80 can be 0.1 mm, 0.2 mm,

0.35 mm or any value falls within the range, which is not limited herein.

[0060] It should be noted that by making the gap H between the outer surface of the shrinking tube 70 and the inner surface of the flared tube 80 conforms to the formula $0.1 \text{ mm} \leq H \leq 0.35 \text{ mm}$, the gap H falls within a suitable range. If the gap H is unduly small, the welding flux cannot flow; and if the gap H is unduly large, the welding strength between the flat tube 20 and the adapter 40 is decreased.

[0061] The micro-channel heat exchanger 100 includes a plurality of columns of flat tubes 20, and adjacent two columns of flat tubes 20 are connected and in communication with each other by the adapter. Therefore, the flat tube 20 is not required to be bended, thereby reducing damage of the flat tube 20 and avoiding influence of bending on the fin 10. The bending radius greatly decreases and a product size is reduced.

[0062] The orifice of the flat tube 20 is flat-shaped, and the capillary tube 31 and the tube flat 20 are connected via transition connection.

[0063] In some embodiment, a tube orifice of an end of the adapter 40 is round-shaped, and connected to the capillary tube 31 by welding, the other end of the adapter 40 is connected to the flat tube 20 via the shrinking tube 70 and the flared tube 80 by welding. In some embodiments, the adapter 40 is U-shaped, and both ends of the adapter 40 are connected to the flat tube 20 via the shrinking tube 70 and the flared tube 80 by welding.

[0064] In the micro-channel heat exchanger 100 of the present disclosure, by sleeving a welding ring 90 on the shrinking tube 70, the shrinking tube 70 extends into the flared tube 80 and is connected to the flared tube 80 by welding. Therefore, the flat tube 20 can be connected to the adapter 40 by hard-solder in an oven. Not only the welding efficiency is increased, but also welding consistency between the flat tube 20 and the adapter 40 can be improved.

[0065] In some embodiments, the micro-channel heat exchanger 100 includes a plurality of columns of flat tubes 20, that is, the plurality of flat tubes 20 includes at least a first column 21 of flat tubes and a second column 22 of flat tubes. The micro-channel heat exchanger 100 further includes a plurality of bending pipes 50. Adjacent two columns of the flat tubes 20 are connected to and in communication with each other via the plurality of bending pipes 50. Optionally, flat tubes 20 in the same column are connected to and in communication with each other via the bending pipe 50. Optionally, flat tubes 20 in adjacent two columns of flat tubes 20 are connected to and in communication with each other via the bending pipes 50, and the flat tubes 20 in the same column are connected to and in communication with each other via the bending pipes 50, so that the medium divers in different processes. The bending pipe 50 is separated from the flat tube 20, and connected to each other by welding, so as to reduce bending processes of the flat tube 20. It could be understood that in the bending process, the fin

10 may deform. In the present disclosure, the bending process is not required, so that deformation of the fin 10 caused by bending may be remit.

[0066] Referring to FIG. 20 to FIG. 36, in some embodiments, the micro-channel heat exchanger 100 includes a plurality of flat tubes 20, and the plurality of flat tubes 20 are separately disposed. The number of the insertion slots is multiple. The plurality of insertion slots are disposed at intervals along a direction the fin 10 extends. A shape of the insertion slot 10 matches with a shape of the flat tube 20, so that the plurality of fins 10 are capable of inserting on the plurality of flat tubes 20 via the plurality of insertion slots 10. The bending pipe 50 includes two connecting sections 51 and a bending section 52. The two connecting sections 51 are disposed at both ends of the bending sections 52, respectively. The two connecting sections 51 and the bending section 52 are connected to and in communication with each other to define a U-shaped tube structure, and the two connecting sections 51 are connected to and in communication with two of the plurality of flat tubes 20, respectively. A depth of the connecting section 51 being sleeved on the flat tube 20 is defined as P, and the depth P of the connecting section being sleeved on the flat tube satisfies the following formula: $2 \text{ mm} \leq P \leq 20 \text{ mm}$.

[0067] In the heat exchanger of present embodiment, the plurality of flat tubes 20 are disposed at intervals along the vertical direction or along a direction defining a small degree (less than 15°) with the vertical direction. In the mounting process, the fin 10 is inserted on the plurality of flat tubes 20, and connected to the flat tube 20 via the bending pipe 50. The heat exchanger includes a plurality of fins 10, and the plurality of fins 10 are inserted at intervals on the flat tube 20 along the direction the flat tube 20 extends. The plurality of fins 10 have vertical chip-type structures. In this way, in the working process of the heat exchanger, the heat exchanger can drain via the plurality of fins 10, improving drainage patency. In the present embodiment, two flat tubes 20 can be connected to and in communication with each other via the bending pipe 50, increasing design flexibility of the circuit. By setting the depth of the connecting section 51 sleeving on the flat tube 20 in the range, the connection strength between the connecting section 51 and the flat tube 20 can be ensured, thereby facilitating the welding process and improving reliability of the entire structure.

[0068] In particular, the bending section 52 in the present embodiment can have a U-shaped bending pipe structure.

[0069] In particular, a transition section 53 is disposed between the connecting section 51 and the bending section 52. Along a direction the bending section 52 extending towards the connecting section 51, a flow area of the transition section gradually decreases. The bending section 52 has a circular-pipe structure, an outer dimension of the bending section 52 is defined as D, and a width of the flat tube 20 is defined as W. When the outer dimension D of the bending section 52 satisfies the formula 5 mm

$\leq D < 6$ mm, the width W of the flat tube 20 and the depth P of the connecting section being sleeved on the flat tube satisfy the following formulas $0 < W \leq 8$ mm, and $2 \text{ mm} \leq P \leq 5$ mm. When the outer dimension D of the bending section 52 satisfies the formula $6 \text{ mm} \leq D < 7$ mm, the width W of the flat tube 20 and the depth P of the connecting section 51 being sleeved on the flat tube 20 satisfy the following formulas $0 < W \leq 10$ mm, and $3 \text{ mm} \leq P \leq 10$ mm. When the outer dimension D of the bending section 52 satisfies the formula $7 \text{ mm} \leq D < 8$ mm, the width W of the flat tube 20 and the depth P of the connecting section 51 being sleeved on the flat tube 20 satisfy the following formulas $0 < W \leq 12$ mm, and $3 \text{ mm} \leq P \leq 15$ mm. When the outer dimension D of the bending section 52 satisfies the formula $8 \text{ mm} \leq D < 10$ mm, the width W of the flat tube 20 and the depth P of the connecting section 51 being sleeved on the flat tube 20 satisfy the following formulas $0 < W \leq 15$ mm, and $3 \text{ mm} \leq P \leq 20$ mm. When the outer dimension D of the bending section 52 satisfies the formula $10 \text{ mm} \leq D < 12$ mm, the width W of the flat tube 20 and the depth P of the connecting section 51 being sleeved on the flat tube 20 satisfy the following formulas $0 < W \leq 18$ mm, and $4 \text{ mm} \leq P \leq 20$ mm. When the outer dimension D of the bending section 52 satisfies the formula $12 \text{ mm} \leq D < 15$ mm, the width W of the flat tube 20 and the depth P of the connecting section 51 being sleeved on the flat tube 20 satisfy the following formulas $0 < W \leq 21$ mm, and $4 \text{ mm} \leq P \leq 25$ mm. When the outer dimension D of the bending section 52 satisfies the formula $15 \text{ mm} \leq D < 18$ mm, the width W of the flat tube 20 and the depth P of the connecting section 51 being sleeved on the flat tube 20 satisfy the following formulas $0 < W \leq 27$ mm, and $5 \text{ mm} \leq P \leq 25$ mm. When the outer dimension D of the bending section 52 satisfies the formula $18 \text{ mm} \leq D < 25$ mm, the width W of the flat tube 20 and the depth P of the connecting section 51 being sleeved on the flat tube 20 satisfy the following formulas $0 < W \leq 38$ mm, and $5 \text{ mm} \leq P \leq 25$ mm.

[0070] In the present embodiment, the inner surface of the connecting section 50 is consisted of a top surface, a first side surface, a bottom surface and a second side surface in order, both the top surface and the bottom surface are planes. Both the first side surface and the second side surface are arc-shaped surfaces. The arc-shaped surface can be tangent to the top surface or the bottom surface, or the arc-shaped surface can be not tangent to the top surface and the bottom surface. The arc-shaped surface can be circular arc-shaped or elliptic arc-shaped. Optionally, both the first side surface and the second side surface are planes, an arc-shaped transition surface is defined between top surface and the first side surface and between the bottom surface and the first side surface, respectively, and an arc-shaped transition surface is defined between top surface and the second side surface and between the bottom surface and the second side surface, respectively. Optionally, both the first side surface and the second side surface are

ellipsoid-shaped surfaces. Optionally, both the first side surface and the second side surface are bended surfaces. The bended surfaces can be a triangle-headed flat tube 20 consisted of two connected planes. Optionally, a cross sectional of the inner surface of the connecting section 51 is an ellipse-shaped surface.

[0071] Specifically, each of the two connecting sections 51 of the bending pipe 50 has an axisymmetric structure, and symmetry centers of the two connecting sections 51 define a connecting axis. An angle between the connecting axis and a length of a orifice of the bending pipe 50 is defined as α , and the angle α between the connecting axis and the length of the orifice of the bending pipe 50 satisfies the following formula: $0 \leq \alpha \leq 90^\circ$. With the structure above, the two connecting sections 51 of the bending pipe 50 can be parallelly disposed or staggered disposed, so that bending pipes 50 having different angles α can be connected to and in communication with flat tubes 20 at different heights and positions. In some embodiments, the angle α between the connecting axis and the length of the orifice of the bending pipe 50 satisfies the following formula: $20^\circ \leq \alpha \leq 90^\circ$.

[0072] In the present embodiment, a width of the insertion slot 11 is defined as G_w , a height of the insertion slot 11 is defined as G_t , and the width G_w of the insertion slot 11 and the height G_t of the insertion slot 11 satisfies the following formula: $1.5 \leq G_w/G_t \leq 10$. With the structure above, stability of insertion can be improved, so that the fin 10 can be stably connected to the flat tube 20.

[0073] In some embodiments, the fin 10 is perpendicular to the flat tube 20. In this way, in the mounting process, the fin 10 can be vertically disposed, thereby facilitating drainage and avoiding influence of heat change effect caused by frosting on the fin 10.

[0074] The fin 10 includes a first side 12 and a second side 13. The first side 12 is adjacent to a windward side. An end of the insertion slot 11 penetrates through the second side 13. In the mounting process, the flat tube 20 is disposed from the first side 12, which can protect the fin 10. Since the fin 10 is relatively thin, disposing the flat tube 20 from the first side 12 can prevent the fin 10 from deforming.

[0075] A chamfer is defined between an inner surface of the slot port of the insertion slot 11 adjacent to the second side 13 and the side surface of the second side 13, so that the flat tube 20 can smoothly penetrate in the insertion slot 11.

[0076] The fin 10 is provided with a plurality of first protrusions 14. The plurality of first protrusions 14 is configured for improving strength of the fin 10 and avoiding deformation of the fin 10.

[0077] Referring to FIG. 4, in an embodiment, the number of the first protrusions 14 is multiple. The plurality of first protrusions 14 are successively arranged to form a corrugation-shaped structure.

[0078] Referring to FIG. 5, in another embodiment, the first protrusion 14 is round-shaped.

[0079] Referring to FIG. 6, in another embodiment, the

first protrusion 14 is crescent-shaped.

[0080] Referring to FIG. 7, in another embodiment, the first protrusion 14 is square-shaped.

[0081] In some embodiments, the first protrusion 14 is corrugation-shaped, which not only plays a role of enhancing strength, but also plays a role of draining away water.

[0082] In some embodiments, the first protrusion 14 can be S-shaped, triangle-shaped, and the like.

[0083] Optionally, the corrugation-shaped first protrusion 14 extends from an end of the fin 10 to the other end of the fin 10, and is cut off at the insertion slot 11, so as to increase drainage effect and prevent frosting caused by untimely discharged condensate water, thereby avoiding effect of heat exchange effect.

[0084] Referring to FIG. 7, the first protrusion 14 is provided with a stripe-shaped slot 15, and the stripe-shaped slot 15 penetrates through two side surfaces of the fin 10 and defines an air passage, so that wind can blow from a current fin 10 to an adjacent fin 10 through the stripe-shaped slot 15 and enhance turbulent flow, so as to improve heat exchange effect.

[0085] In some embodiment, the stripe-shaped slot 15 is provided at both sides of the first protrusion 14, so that the wind can blow in or out from the stripe-shaped slot 15 on the side surface of the first protrusion 14.

[0086] Referring to FIG. 8 and FIG. 9, the fin 10 is vertically disposed. The fin 10 is vertically disposed. A side surface of the fin 10 adjacent to the first side 12 includes a plurality of second protrusions 16. The plurality of second protrusions 16 are disposed in sequence along a width direction of the fin 10 and form a corrugation-shaped structure, both ends of the corrugation structure extend along a length direction of the fin 10 to both ends of the fin 10. The micro-channel heat exchanger 100 of the present embodiment is applied as an evaporator. The first side 12 is adjacent to the windward side of the micro-channel heat exchanger 100, and condensation is more likely to form on the fin 10 adjacent to the first side 12. The second protrusion 16 is disposed adjacent to the windward side of the fin, thereby remitting the problem of frosting and avoiding influence on the fin 10 caused by frosting. It should be noted that the corrugation-shaped structure of the second protrusion 16 in the present disclosure indicates that the second protrusion 16 is stripe-shaped, the plurality of second protrusions 16 form a waved corrugation-shaped structure along the width direction of the fin 10, and a drainage groove is defined between adjacent two second protrusions 16. A cross section of the second protrusion 16 is triangle-shaped, polygon-shaped, and the like.

[0087] A length of the insertion slot 11 is smaller than a width of the fin 10, so that the fin 10 has sufficient space for disposing the second protrusion 16, and the second protrusion 16 is not obstructed by the flat tube 20 and affects drainage.

[0088] In some embodiments, a minimum distance between the fin 10 and the connecting section 51 (that is,

a distance between the end of the fin 10 adjacent to the connecting section 51 and the connecting section 51) is defined as C, and C satisfies the following formula: $0 \leq C \leq 80$ mm. The structure above can facilitate heat exchange and improving heat exchange efficiency.

[0089] In some embodiments, the fin 10 includes a body portion 17 and a flanging structure 18. The flanging structure 18 is connected to the body portion 17. The insertion slot 11, the first protrusion 14 and the second protrusion 16 are disposed on the body portion 17. The flanging structure 18 is disposed at the insertion slot 11. The flanging structure 18 protrudes out of the body portion 17, and the flanging structure 18 is configured for matching with the flat tube 20. At least a part of the flanging structure 18 abuts against a side surface of the flat tube 20, which can increase a welding area between the fin 10 and the flat tube 20 and improve the welding strength, thereby facilitate ensuring the connection stability. With the structure described above, the insertion stability can be further improved.

[0090] The flanging structure 18 includes a first flanging 181, and the first flanging 181 is disposed along a peripheral circumference of the insertion slot 11. The first flanging 181 extends along the length direction of the flat tube 20, and the first flanging 181 abuts against the side surface of the flat tube 20, so that the first flanging 181 surrounds to a shape matching with the flat tube 20. The first flanging 181 can increase the welding area between the fin 10 and the flat tube 20, and improve the welding strength. With the structure above, the contact area between the fin 10 and the flat tube 20 is increased, and the insertion positioning stability of the flat tube 20 is improved.

[0091] Specifically, a height of the first flanging 181 is defined as H_1 , and the height H_1 of the flat tube 20 satisfies the following formula: $0 < H_1 \leq 1$ mm. With the structure above, the insertion stability can be further improved. Specifically, the height of the first flanging 181 is a height of the first flanging 181 protruding out of the body portion.

[0092] The flanging structure 18 further includes a second flanging 182. The second flanging 182 is connected to the first flanging 181, and extends towards a length direction of the flat tube 20. A plane defined by the second flanging 182 coincides with a plane defined by the first flanging 181. The flanging structure can include one second flanging 182, or a plurality of second flangings 182. The plurality of second flangings 182 can be surround the insertion slot 11 at intervals, which can further improve the welding strength between the flat tube 20 and the fin 10. The plurality of second flangings 182 are disposed on the first flanging 181 at intervals along the peripheral circumference of the insertion slot 11, and a plane defined by the plurality of second flangings 182 coincides with a plane defined by the first flanging 181. With the structure above, the insertion stability is further improved. Since the plurality of second flangings 182 are

disposed at intervals, a gap defined between adjacent two second flangings 182 can facilitate disassembling the fin 10.

[0093] Specifically, a height of the second flanging 182 is defined as H_2 , and a height of the insertion slot 11 is defined as Gt , and the height H_2 of the second flanging 182 and the height Gt of the insertion slot 11 satisfy the following formula: $0.25 < H_2/Gt < 1$. With the structure above, not only insertion stability is ensured, but also disassembly is facilitated. Specifically, the height of the second flanging 182 indicates that the height of the second flanging 182 protruding out of the first flanging 181.

[0094] Specifically, the width of the second flanging 182 is in a range of 1 mm to 6 mm.

[0095] The flanging structure further includes a third flanging 183, the third flanging 183 is connected to the second flanging 182. The third flanging 182 is perpendicular to the second flanging 182. The plurality of third flangings 183 are disposed corresponding to the plurality of second flangings 182, and each of the plurality of third flanging 183 is disposed at a side of a second flanging 182 away from the first flanging 181, so as to give way to the insertion slot 11. The third flanging 183 abuts against the adjacent flat tube 20, playing the role of limiting. In some embodiments, the flanging structure 18 includes a plurality of third flangings 183, a preset angle is defined between the second flanging 182 and the third flanging 183, so that the plurality of third flangings 183 are capable of giving way to the plurality of insertion slots 11.

[0096] In some embodiments, the micro-channel heat exchanger 100 includes a plurality of columns of fins 10. Fins 10 in a column of fins 10 adjacent to the windward side of the micro-channel heat exchanger 100 correspondingly abut against fins of the column of fins 10 beside the column of the fins adjacent to the windward side of the micro-channel heat exchanger 100, forming a plurality of columns of fins 10. Each column of the fins 10 includes a plurality of rows of fins disposed at intervals. Fins which are disposed in different columns of the fins but the same row of fins are separately disposed, which can facilitate insertion of the flat tube 20. The fins 10 which are disposed in different columns of fins 10 but the same row of fins have the same orientation, so that the second protrusions 16 of the fins 10 are adjacent to the windward side of the micro-channel heat exchanger 100 and facilitate drainage.

[0097] Referring to FIG. 7 and FIG. 9, the insertion slots 11 in the same row of different columns of fins 10 are interlaced disposed, so that the insertion slots 11 in a front column of fins 10 correspond to the fins 10 in a back column of fins 10. The medium in the flat tube 20 can exchange the heat not only via the fins 10 at both sides of the insertion slot 11, but also via the fins 10 at the back of the flat tube 20. Thus, the fins 10 are fully used to improve the heat exchange effect.

[0098] In some embodiments, centers of the insertions slots 11 define equilateral triangles, and the insertions

slots 11 locate on fins 10 which are disposed in different columns of fins 10 but the same row of fins 10. For example, one of the insertion slots 11, which locates on the first row of first column of fins 10, is right in the middle of adjacent two insertion slots 11 located on the first row of the second column of fins 10. Therefore, it is possible to ensure that both sides of the back of the front row of flat tubes 20 are able to utilize the fins 10 to enhance heat exchange, further enhancing the heat exchange effect.

[0099] In the present embodiment, the number of columns of the flat tube 20 is two, and the number of columns of fins 10 is also two. The bending pipe 50 is disposed at an end of the flat tube 20 away from the distributor 30, and the micro-channel heat exchanger 100 is U-shaped. In some embodiments, the number of columns of the flat tube 20 can be three, four, or over four. Both ends of the flat tube 20 are provided with the bending pipe 50. The micro-channel heat exchanger 100 can be L-shaped, V-shaped, and the like.

[0100] In some embodiments, the number of the columns of the fins 10 is multiple. Each column of the plurality of columns of fins 10 includes a plurality of columns of insertion slots 11 disposed at intervals. Along a height direction of the micro-channel heat exchanger 100, the insertion slots 11 located on the same column of fins are interlaced disposed.

[0101] It should be noted that by providing the interlaced disposed insertion slots 11 on the fins 10, the flat tubes 20 inserted in the insertion slots 11 are interlaced disposed. Thus, heat exchange area of the flat tube 20 is improved, thereby improve heat exchange amount of the micro-channel heat exchanger 100.

[0102] In some embodiments, referring to FIG. 16, the micro-channel heat exchanger 100 further includes a collecting pipe 60. The collecting pipe 60 is connected to an outlet of the flat tube 20, and configured for collecting the medium. An end of the capillary tube 31 is connected to and in communication with the distributor 30, and the other end of the capillary tube 31 is connected to and in communication with the flat tube 20. The outlet of the flat tube 20 is connected to and in communication with the collecting pipe 60, and the refrigerant is distributed via the distributor 30. The collecting pipe 60 is replaced, and the process is simplified.

[0103] In some embodiments, the number of the flat tubes 20 is multiple. The flat tubes 20 in the last column of flat tubes 20 are connected to and in communication with the collecting pipe 60. In the present embodiment, the second column of flat tubes 22 are connected to and in communication with the collecting pipe 60. The medium enters from the first column of flat tubes 21, turns and flows into the second column of flat tubes 22 via the bending pipe 50, and flows into the collecting pipe 60. In some embodiments, the micro-channel heat exchanger includes three columns of flat tubes 20, and the collecting pipe 60 is connected to and in communication with the third column of flat tubes. In this way, multipath of the medium is achieved by the bending pipe 50, and the col-

lecting pipe 60 is merely used for collect the medium in the end and do not requires to turn the medium. Thus, the collecting pipe 60 does not require an isolation plate, and the process of producing the collecting pipe 60 is simplified.

[0104] In some embodiments, the micro-channel heat exchanger 100 includes one column of flat tubes 20, and one column of fins 10. An end of the flat tube 20 is connected to and in communication with the distributor 30 via the adapter 40, and the other end of the flat tube 20 is connected to and in communication with the collecting pipe 60. In the working process, the medium enters from the distributor 30, and is evenly distributed to each of the flat tubes 20 via the capillary tube 31. The medium exchanges heat with the outside world via the fin 10, and flows out centrally from the collecting pipe 60 after heat exchange.

[0105] When the micro-channel heat exchanger 100 includes one column of flat tubes 20, the plurality of flat tubes 20 is one column of flat tubes 20, an end of each of the plurality of flat tubes 20 is connected to and in communication with the adapter 40, the other end of each of the plurality of flat tubes 20 is connected to and in communication with the collecting pipe 60. When the micro-channel heat exchanger 100 includes a plurality of columns of flat tubes 20, an end of each flat tube 20 in the first column of flat tubes 20 are connected to and in communication with the distributor 30 via the adapter 40 and the capillary tube 31, the other end of which are connected to the adapter 40, and outlets of the last column of the flat tubes 20 are connected to and in communication with the collecting pipe 60.

[0106] In the micro-channel heat exchanger 100, the end of the flat tube 20 is connected to and in communication with the distributor 30 via the capillary tube 31 and the adapter 40, which can replace the collecting pipe 60.

[0107] In some embodiments, both the distributor 30 and the collecting pipe 60 are disposed at an end of the flat tube 20 away from the bending pipe 50, so as to improve compactness of structural configuration of the heat exchanger. The distributor 30 includes a distributing heat 32 and a plurality of capillary tubes 31 being connected to and in communication with the distributing head 32. The distributing head 32 includes a plurality of distributing holes, and the plurality of distributing holes are correspondingly disposed to the plurality of capillary tubes 31, so that the fluid flowing through each of the distributing holes flows into the corresponding flat tube 20 via corresponding capillary tubes 31 for heat exchange.

[0108] The technical features of the above-mentioned embodiments can be combined arbitrarily. In order to make the description concise, not all possible combinations of the technical features are described in the embodiments. However, as long as there is no contradiction in the combination of these technical features, the combinations should be considered as in the scope of the present disclosure.

[0109] The above-described embodiments are only several implementations of the present disclosure, and the descriptions are relatively specific and detailed, but they should not be construed as limiting the scope of the present disclosure. It should be understood by those of ordinary skill in the art that various modifications and improvements can be made without departing from the concept of the present disclosure, and all fall within the protection scope of the present disclosure. Therefore, the patent protection of the present disclosure shall be defined by the appended claims.

Claims

1. A micro-channel heat exchanger, comprising

a plurality of fins and a plurality of flat tubes, wherein the plurality of fins are arranged in parallel to form a plurality of rows, each of the plurality of fins are provided with a insertion slot, the plurality of flat tubes are arranged in parallel to form a plurality of layers, and the plurality of flat tubes penetrate through the insertion slot; the micro-channel heat exchanger further comprises a distributor and an adapter, the distributor is provided with a plurality of capillary tubes, an end of the adapter is connected to and in communication with corresponding one of the plurality of capillary tubes, and the other end of the adapter is connected to and in communication with corresponding one of the plurality of flat tubes.
2. The micro-channel heat exchanger of claim 1, wherein the micro-channel heat exchanger comprises a plurality of adapters, one end of one part of the plurality of adapters is connected to and in communication with the plurality of capillary tubes, the other end of the one part of the plurality of adapters is connected to and in communication with the plurality of flat tubes, and both ends of another part of the plurality of adapters are connected to and in communication with the plurality of flat tubes.
3. The micro-channel heat exchanger of claim 2, wherein each of the plurality of adapters comprises a first tube orifice matching with the plurality of flat tubes, the first tube orifice is configured for allowing insertion of the plurality of flat tubes, an inner surface of each of the plurality of adapters is provided with a limiting portion, and the limiting portion abuts against one end of corresponding one of the plurality of flat tubes and/or a sidewall of corresponding one of the plurality of flat tubes and is configured for limiting corresponding one of the plurality of flat tubes.
4. The micro-channel heat exchanger of claim 3,

wherein the limiting portion comprises a first protruding portion and a second protruding portion, the first protruding portion and the second protruding portion are arranged at intervals along a length direction of corresponding one of the plurality of adapters, the first protruding portion is disposed away from the first tube orifice relative to the second protruding portion, a height of the first protruding portion protruding out of the inner wall of corresponding one of the plurality of adapters is greater than a height of the second protruding portion protruding out of the inner wall of corresponding one of the plurality of adapters, the first protruding portion is configured for abutting against the end of corresponding one of the plurality of flat tubes, and the second protruding portion is configured for abutting against an outer surface of corresponding one of the plurality of flat tubes.

5. The micro-channel heat exchanger of claim 4, wherein the height of the second protruding portion protruding out of the inner surface of corresponding one of the plurality of adapters is defined as H_4 , a height of the plurality of flat tubes is defined as H_1 , each of the plurality of adapters comprises a first inner surface and a second inner surface opposite to each other, the second protruding portion is disposed on the first inner surface and/or the second inner surface, a distance between the first inner surface and the second inner surface is defined as H_2 , and the height H_4 of the second protruding portion protruding out of the inner surface of corresponding one of the plurality of adapters, the distance H_2 between the first inner surface and the second inner surface and the height H_1 of the plurality of flat tubes satisfy the following formula:

$$0 \text{ mm} \leq [H_4 - (H_2 - H_1)] \leq 0.2 \text{ mm}.$$

6. The micro-channel heat exchanger of claim 4, wherein the first protruding portion is semicircle-shaped, square-shaped or trapezoid-shaped, and/or, the second protruding portion is semicircle-shaped, square-shaped or trapezoid-shaped.
7. The micro-channel heat exchanger of claim 4, wherein the height of the first protruding portion protruding out of the inner surface of corresponding one of the plurality of adapters is defined as H_3 , a height of the plurality of flat tube is defined as H_1 , each of the plurality of adapters comprises a first inner surface and a second inner surface opposite to each other, the first protruding portion is disposed on the first inner surface and/or the second inner surface, a distance between the first inner surface and the second inner surface is defined as H_2 , and the height H_3 of the first protruding portion protruding out of the

inner surface of corresponding one of the plurality of adapters, the distance H_2 between the first inner surface and the second inner surface and the height H_1 of the plurality of flat tubes satisfy the following formula:

$$0.2 \text{ mm} \leq [H_3 - (H_2 - H_1)] \leq 3 \text{ mm}.$$

8. The micro-channel heat exchanger of claim 4, wherein a distance between the first protruding portion and an end surface of the first tube orifice is defined as L_1 , and the distance L_1 between the first protruding portion and the end surface of the first tube orifice satisfies the following formula: $2 \text{ mm} \leq L_1 \leq 10 \text{ mm}$.

9. The micro-channel heat exchanger of claim 1, wherein a height of the plurality of flat tubes is defined as H_1 , each of the plurality of adapters comprises a first inner surface and a second inner surface opposite to each other, a distance between the first inner surface and the second inner surface is defined as H_2 , and the distance H_2 between the first inner surface and the second inner surface and the height H_1 of the plurality of flat tubes satisfy the following formula:

$$0.02 \text{ mm} \leq (H_2 - H_1) \leq 0.4 \text{ mm}.$$

10. The micro-channel heat exchanger of claim 3, each of the plurality of adapters comprises a second tube orifice, the second tube orifice is located at an end of the each of the plurality of adapters away from the first tube orifice, and the second tube orifice is circle-shaped; or, the plurality of adapters are a curve-shaped and the first tube orifice is located at both ends of each of the plurality of adapters.
11. The micro-channel heat exchanger of claim 1, the micro-channel heat exchanger further comprises a shrinking tube and a flared tube,

the flared tube is connected to and in communication with corresponding one of the plurality of adapters, and the shrinking tube is connected to and in communication with corresponding one of the plurality of flat tubes, or, the shrinking tube is connected to and in communication with the corresponding one of the plurality of adapters, and the flared tube is connected to and in communication with corresponding one of the plurality of flat tubes; and, the shrinking tube is sleeved with a welding ring, and the shrinking tube penetrates into the flared tube and is connected to the flared tube by weld-

ing.

12. The micro-channel heat exchanger of claim 11, wherein the shrinking tube comprises a first section and a second section connected to each other, an outer size of the first section gradually decreases along a direction from the first section to the second section, the welding ring is sleeved outside the first section, a length of the first section is defined as L_1 along an axis of the shrinking tube, and a dimension of a cross section of the welding ring is defined as D_1 , and the dimension D_1 of the cross section of the welding ring and the length L_1 of the first section satisfy the following formula:

$$D_1 \leq L_1 \leq 1.2D_1.$$

13. The micro-channel heat exchanger of claim 12, wherein a length of the second section is defined as L_2 , and the length L_2 of the second section satisfies the following formula: $3 \text{ mm} \leq L_2 \leq 5 \text{ mm}$.
14. The micro-channel heat exchanger of claim 12, wherein the first section is connected to corresponding one of the plurality of flat tubes, a width of the plurality of flat tubes is defined as W_1 , a width of the second section is defined as W_2 , the welding ring is elliptical ring-shaped, and a long axis of an inner ring of the welding ring is defined as D , and the width W_1 of the plurality of flat tubes, the width W_2 of the second section and the long axis D of the inner ring of the welding ring satisfy the following formula: $W_2 \leq D \leq W_1$.
15. The micro-channel heat exchanger of claim 12, wherein the first second is connected to corresponding one of the plurality of flat tubes, and a width of the plurality of flat tubes is defined as W_1 , and the dimension D_1 of the cross section of the welding ring and the width W_1 of the plurality of flat tubes satisfy the following formula: $D_1 = 0.06W_1$.
16. The micro-channel heat exchanger of claim 12, wherein the first section is connected to corresponding one of the plurality of flat tubes, an inner width of the shrinking tube is defined as W_3 , and an inner width of each of the plurality of adapters is defined as W_4 , and the inner width W_3 of the shrinking tube and the inner width W_4 of each of the plurality of adapters satisfy the following formula: $0.8W_4 < W_3 \leq 1.2W_4$.
17. The micro-channel heat exchanger of claim 11, wherein an outer surface of the shrinking tube is in clearance fit with an inner surface of the flared tube and a gap is defined between the outer surface of the shrinking tube and the inner surface of the flared

tube, the gap between the outer surface of the shrinking tube and the inner surface of the flared tube is defined as H , and the gap H between the outer surface of the shrinking tube and the inner surface of the flared tube satisfies the following formula: $0.1 \text{ mm} \leq H \leq 0.35 \text{ mm}$.

18. The micro-channel heat exchanger of claim 11, wherein the shrinking tube is connected and in communication with corresponding one of the plurality of adapters, the flared tube is connected to and in communication with the corresponding one of the plurality of adapters, and the shrinking tube is formed by a part of corresponding one of the plurality of flat tubes shrinking, and the flared tube is formed by a part of corresponding one of plurality of adapters flaring; or, the flared tube is connected to and in communication with the plurality of adapters, the shrinking tube is connected to and in communication with the adapter, flared tube is formed by a part of corresponding one of plurality of flat tubes flaring, and the shrinking tube is formed by a part of corresponding one of the plurality of adapters shrinking.
19. The micro-channel heat exchanger of claim 11, wherein the micro-channel heat exchanger comprises a plurality of columns of flat tubes, and adjacent two of the plurality of columns of flat tubes are connected and in communication with each other by the adapter, the shrinking tube and the flared tube.
20. The micro-channel heat exchanger of claim 1, wherein the micro-channel heat exchanger comprises at least two columns of flat tubes, the micro-channel heat exchanger further comprises a plurality of bending pipes, adjacent two of the at least two columns of flat tubes are connected to and in communication with each other via the plurality of bending pipes, and the plurality of bending pipes and the at least two columns of flat tubes are disposed separately; and/or, flat tubes in the same column of the at least two columns of flat tubes are connected to and in communication with each other via the plurality of bending pipes, and the plurality of bending pipes and the at least two columns of flat tubes are disposed separately.
21. The micro-channel heat exchanger of claim 1, wherein the plurality of flat tubes are disposed at intervals, each of the plurality of fins is provided with a plurality of insertion slots, the plurality of insertion slots are disposed at intervals along a direction each of the plurality of fins;

a shape of each of the plurality of insertion slots correspondingly matches with a shape of each of the plurality of flat tubes, allowing the plurality of fins to insert on the plurality of flat tubes via the plurality of insertion slots; and the micro-channel heat exchanger further comprises a bending pipe, the bending pipe comprises two connecting sections and a bending section, the two connecting sections are disposed at both ends of the bending sections respectively, the two connecting sections and the bending section are connected to and in communication with each other to define a U-shaped tube structure, and the two connecting sections are connected to and in communication with two of the plurality of flat tubes, respectively, wherein a depth of the connecting section being sleeved on the flat tube is defined as P , and the depth P of the connecting section being sleeved on the flat tube satisfies the following formula: $2 \text{ mm} \leq P \leq 20 \text{ mm}$.

22. The micro-channel heat exchanger of claim 21, wherein the inner surface of the connecting section is consisted of a top surface, a first side surface, a bottom surface and a second side surface in order, both the top surface and the bottom surface are planes;

both the first side surface and the second side surface are arc-shaped surfaces; or, both the first side surface and the second side surface are planes, an arc-shaped transition surface is defined between top surface and the first side surface and between the bottom surface and the first side surface, respectively, and an arc-shaped transition surface is defined between top surface and the second side surface and between the bottom surface and the second side surface, respectively; or, both the first side surface and the second side surface are ellipsoid-shaped surfaces; or, both the first side surface and the second side surface are bended surfaces.

23. The micro-channel heat exchanger of claim 21, wherein each of the two connecting sections of the bending pipe has an axisymmetric structure, symmetry centers of the two connecting sections define a connecting axis, an angle between the connecting axis and a length of a orifice of the bending pipe is defined as α , and the angle α between the connecting axis and the length of the orifice of the bending pipe satisfies the following formula: $0 \leq \alpha \leq 90^\circ$.

24. The micro-channel heat exchanger of claim 21, wherein a width of the insertion slot is defined as Gw , a height of the insertion slot is defined as Gt , and the

width Gw of the insertion slot and the height Gt of the insertion slot satisfy the a following formula: $1.5 \leq Gw/Gt \leq 10$.

25. The micro-channel heat exchanger of claim 1, wherein the plurality of fins are provided with a plurality of first protrusions and the plurality of first protrusions are round-shaped, crescent-shaped, triangle-shaped, square-shaped, S-shaped or corrugation-shaped.

26. The micro-channel heat exchanger of claim 25, wherein the plurality of first protrusions are provided with a stripe-shaped slot, and an air passage is defined by the stripe-shaped slot that penetrates through a surface of the plurality of fins.

27. The micro-channel heat exchanger of claim 1, wherein the plurality of fins comprises a first side and a second side, the plurality of fins are provided with a plurality of second protrusions on a side of the plurality of fins adjacent to the first side, the plurality of second protrusions are disposed in sequence along a width direction of the plurality of fins and form a corrugation-shaped structure, both ends of the corrugation structure extend along a length direction of the plurality of fins and penetrate through both ends of corresponding one of the plurality of fins.

28. The micro-channel heat exchanger of claim 1, wherein each of the plurality of fins comprise a body portion and a flanging structure connected to each other, the plurality of insertion slots are disposed on the body portion, and the flanging structure is disposed adjacent to the plurality of inserting slots, the flanging structure protrudes out of the body portion, and at least a part of the flanging structure abuts against a side surface of corresponding one of the plurality of flat tubes.

29. The micro-channel heat exchanger of claim 21, wherein the plurality of fins comprise a body portion and a flanging structure connected to each other, the plurality of insertion slots are disposed on the body portion, the flanging structure is disposed adjacent to the plurality of inserting slots, the flanging structure protrudes out of the body portion, and the flanging structure is configured for matching with the plurality of flat tubes.

30. The micro-channel heat exchanger of claim 29, wherein the flanging structure comprises a first flanging, and the first flanging is disposed along a peripheral circumference of corresponding one of the plurality of inserting slots and defines a shape matching with the plurality of flat tubes.

31. The micro-channel heat exchanger of claim 30,

wherein a height of the first flanging is defined as H_1 , and the height H_1 of the first flanging satisfies the following formula: $0 < H_1 \leq 1 \text{ mm}$.

32. The micro-channel heat exchanger of claim 30, wherein the flanging structure further comprises a plurality of second flangings, the plurality of second flangings are disposed on the first flanging at intervals along the peripheral circumference of the insertion slot, and a plane defined by the plurality of second flangings coincides with a plane defined by the first flanging.
33. The micro-channel heat exchanger of claim 32, wherein a height of the second flanging is defined as H_2 , and a height of the insertion slot is defined as Gt , and the H_2 height of the second flanging and height Gt of the insertion slot satisfy the following formula: $0.25 < H_2/Gt < 1$.
34. The micro-channel heat exchanger of claim 32, wherein the flanging structure further comprises a plurality of third flangings, the plurality of third flangings are disposed corresponding to the plurality of second flangings, each of the plurality of third flanging is disposed at a side of corresponding one of the plurality of second flangings away from the first flanging, a preset angle is defined between one of the plurality of second flangings and corresponding one of the plurality of third flangings, and the plurality of third flangings are capable of giving way to the plurality of insertion slots.
35. The micro-channel heat exchanger of claim 21, wherein a minimum distance between the plurality of fins and the two connecting sections is defined as C , and the minimum distance C between the plurality of fins and the two connecting sections satisfy the following formula: $0 \leq C \leq 80 \text{ mm}$.
36. The micro-channel heat exchanger of claim 1, wherein the plurality of fins are arranged as at least two columns of fins, and each of the at least two columns of fins comprises a plurality of rows of fins disposed at intervals, fins in the same row of the at least two columns of fins are separately disposed, and insertion slots in the same row of the at least two columns of fins are interlaced disposed; and/or, insertion slots in the same column of the at least two columns of fins are interlaced disposed.
37. The micro-channel heat exchanger of claim 1, wherein the micro-channel heat exchanger comprises a collecting pipe, the plurality of flat tubes comprises at least a first column of flat tubes and a second column of flat tubes parallel to each other, the first column of flat tubes are connected to and in communication with corresponding one of the plurality of

adapters, the second column of flat tubes are connected to and in communication with the collecting pipe; or, the plurality of flat tubes is arranged in one column, an end of each of the plurality of flat tubes is connected to and in communication with corresponding one of the plurality of adapters, the other end of each of the plurality of flat tubes is connected to and in communication with the collecting pipe.

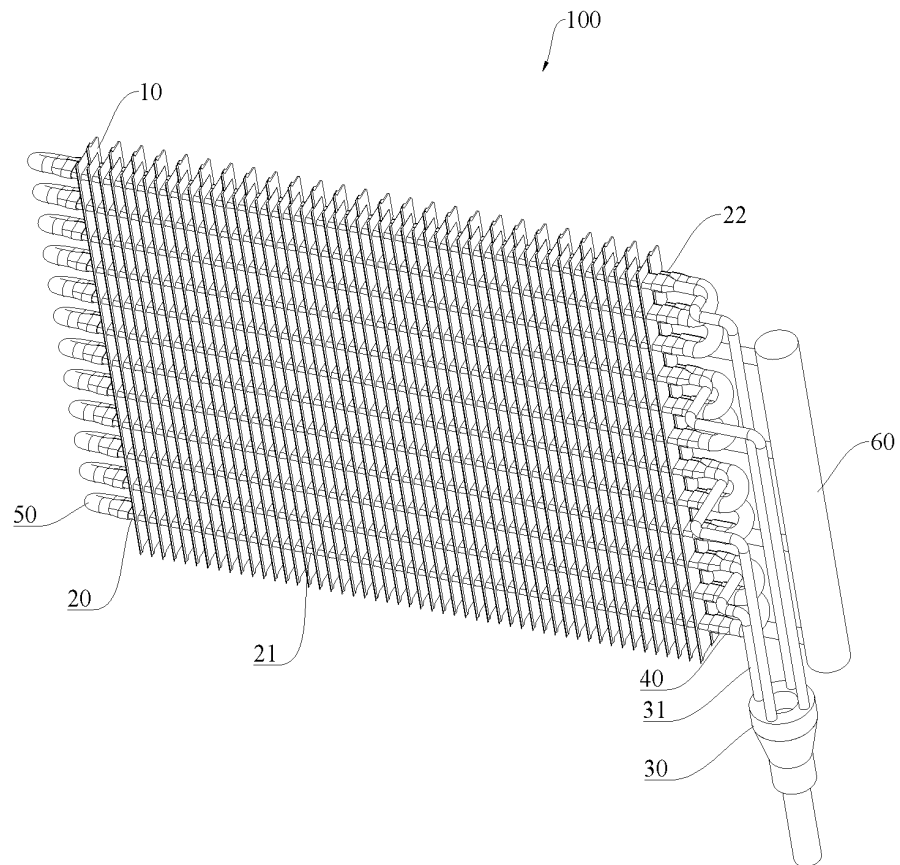


FIG. 1

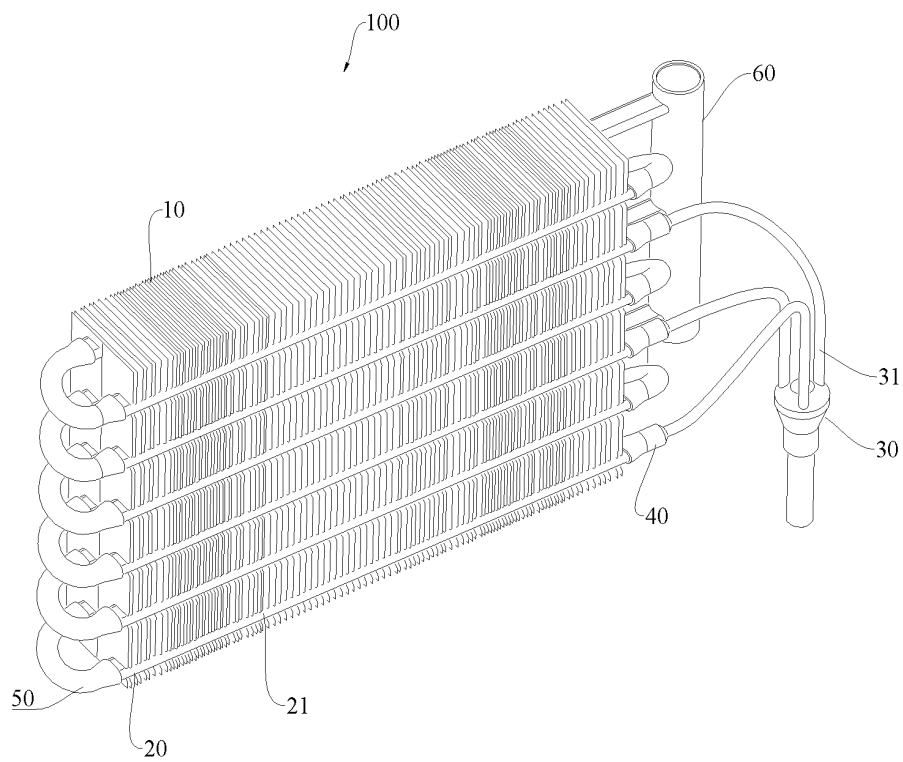


FIG. 2

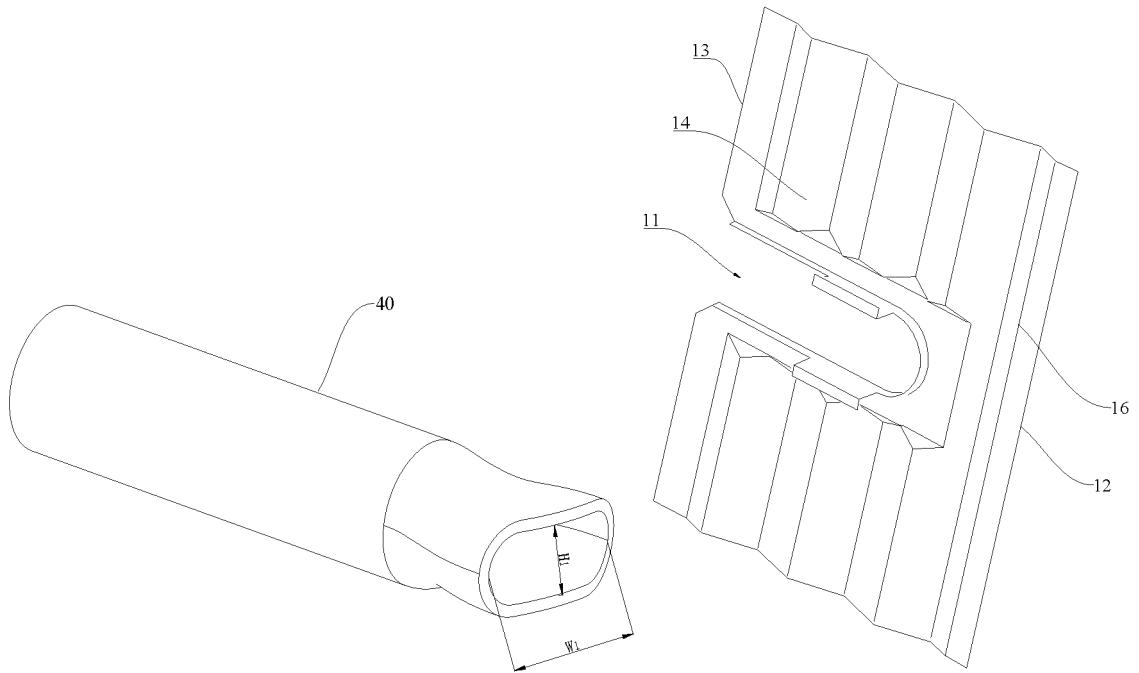


FIG. 3

FIG. 4

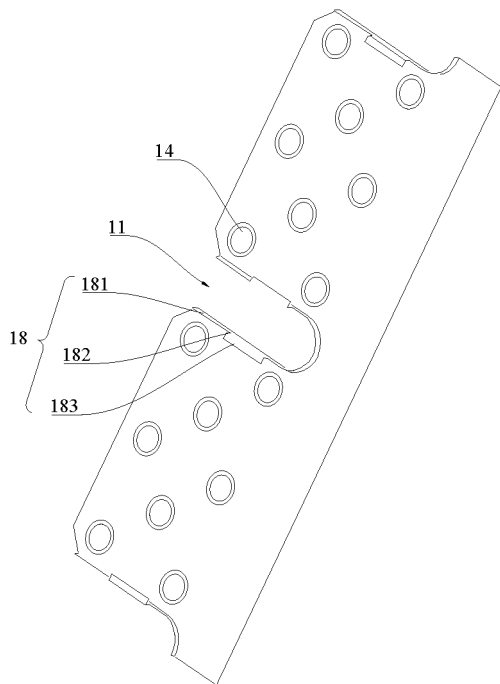


FIG. 5

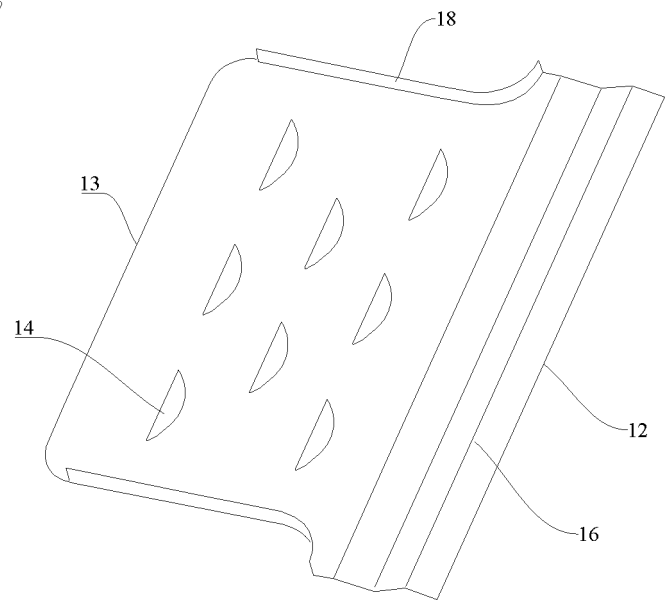


FIG. 6

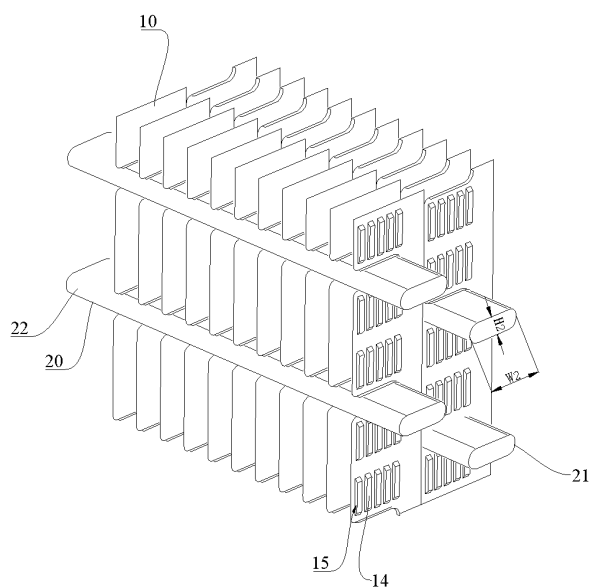


FIG. 7

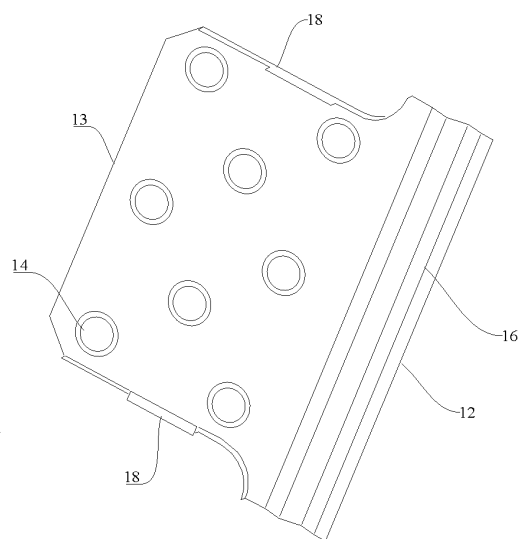


FIG. 8

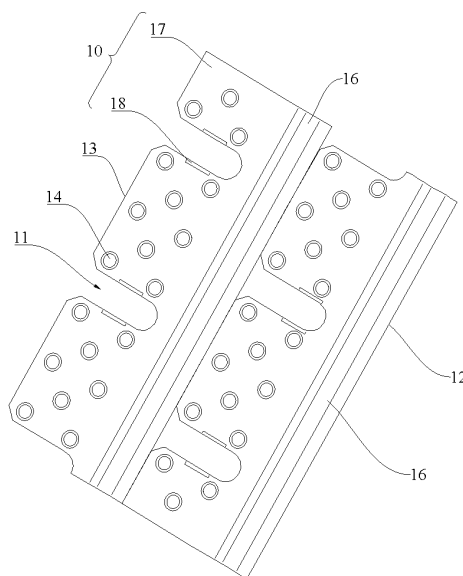


FIG. 9

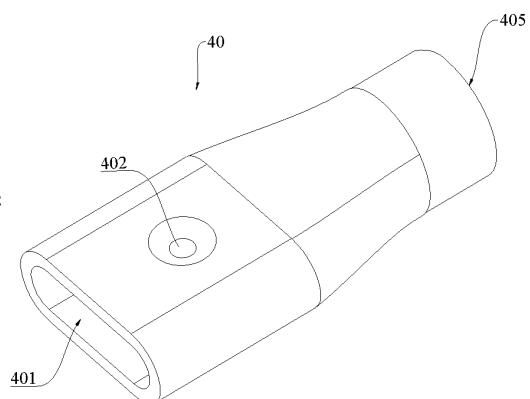


FIG. 10

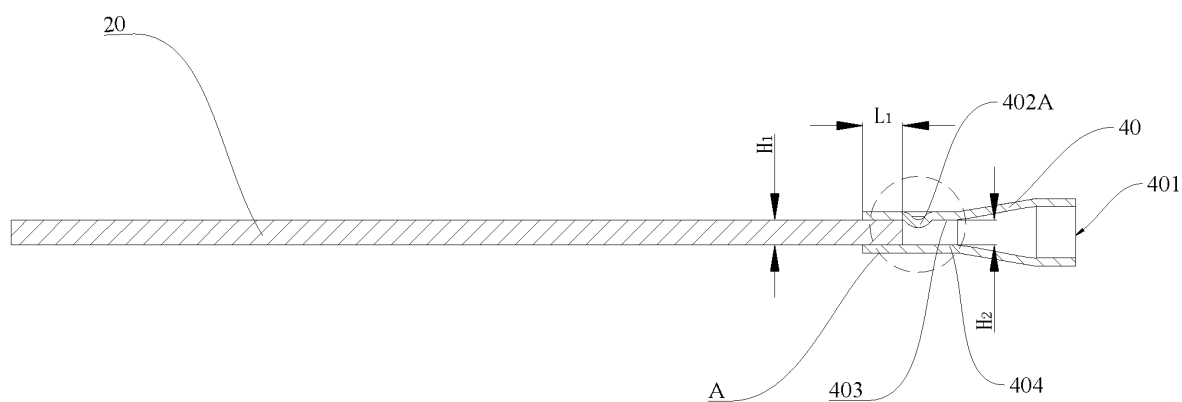


FIG. 11

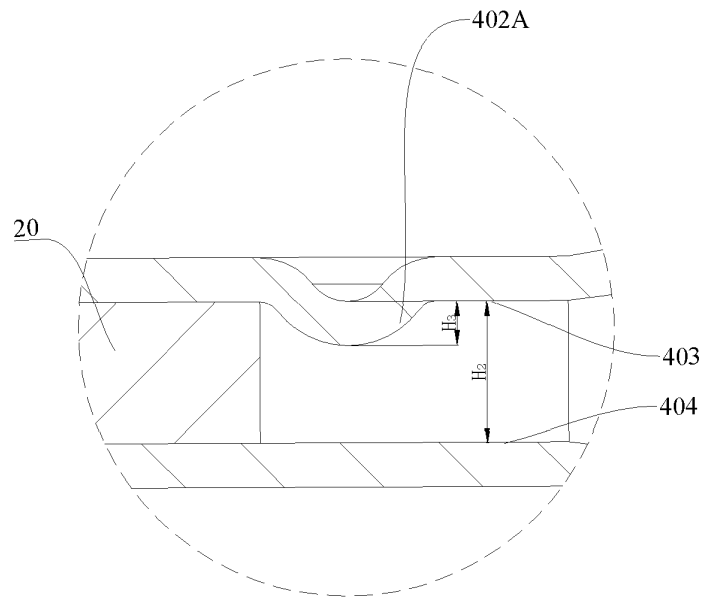


FIG. 12

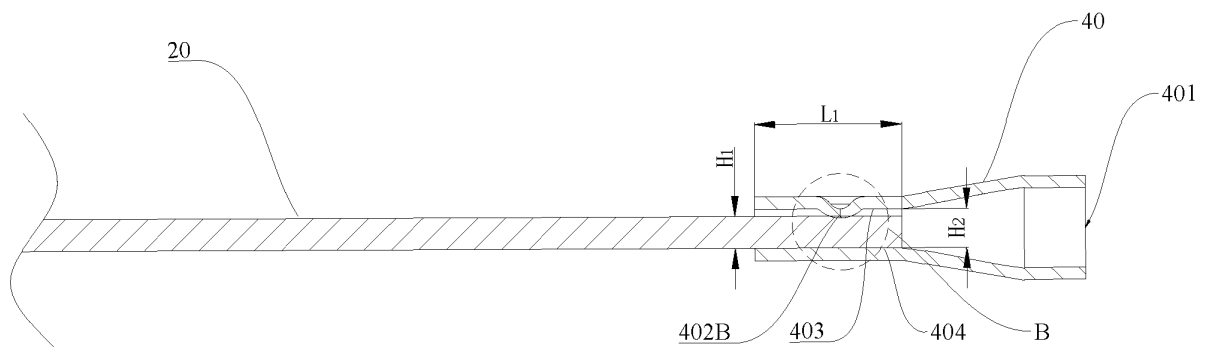


FIG. 13

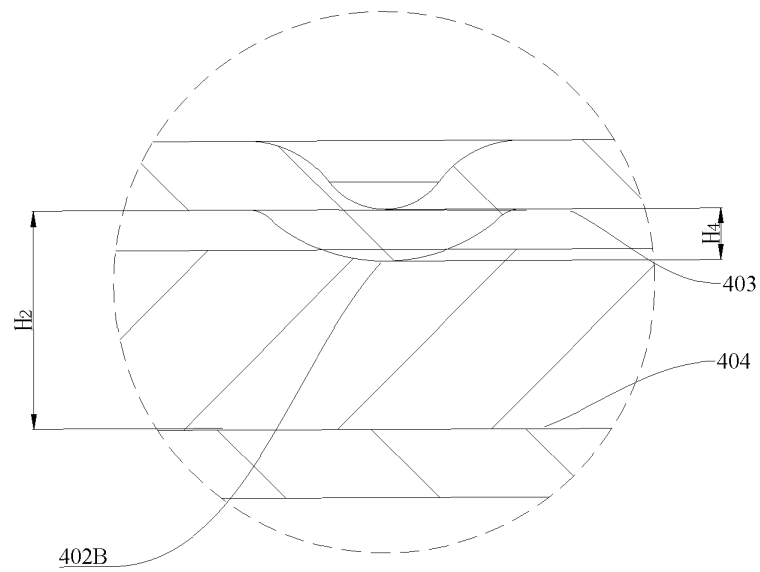


FIG. 14

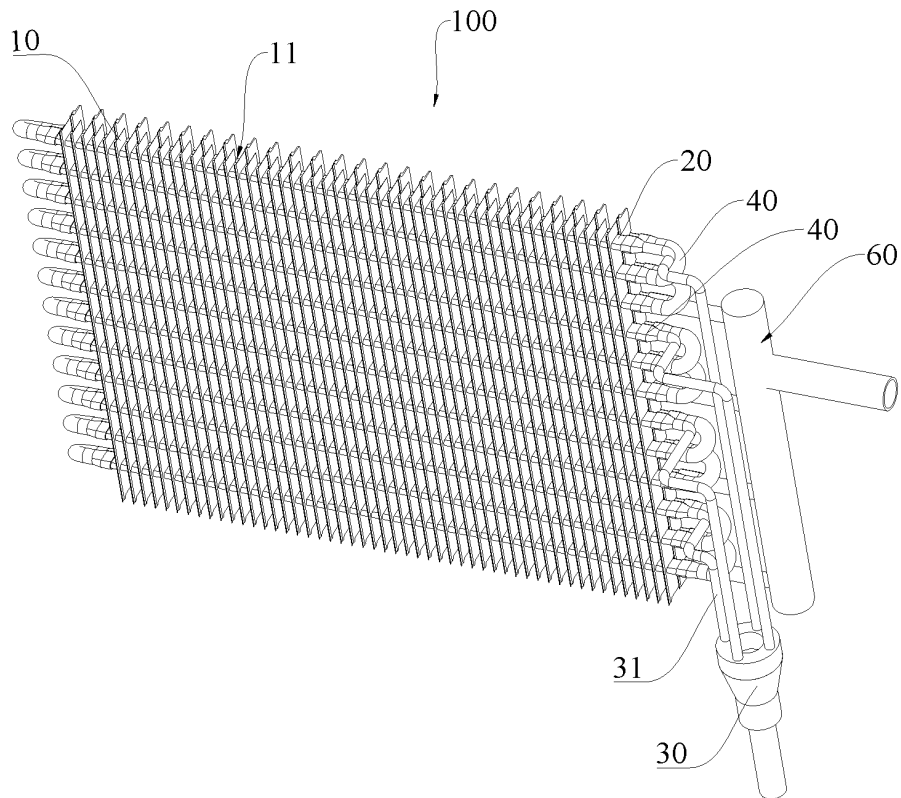


FIG. 15

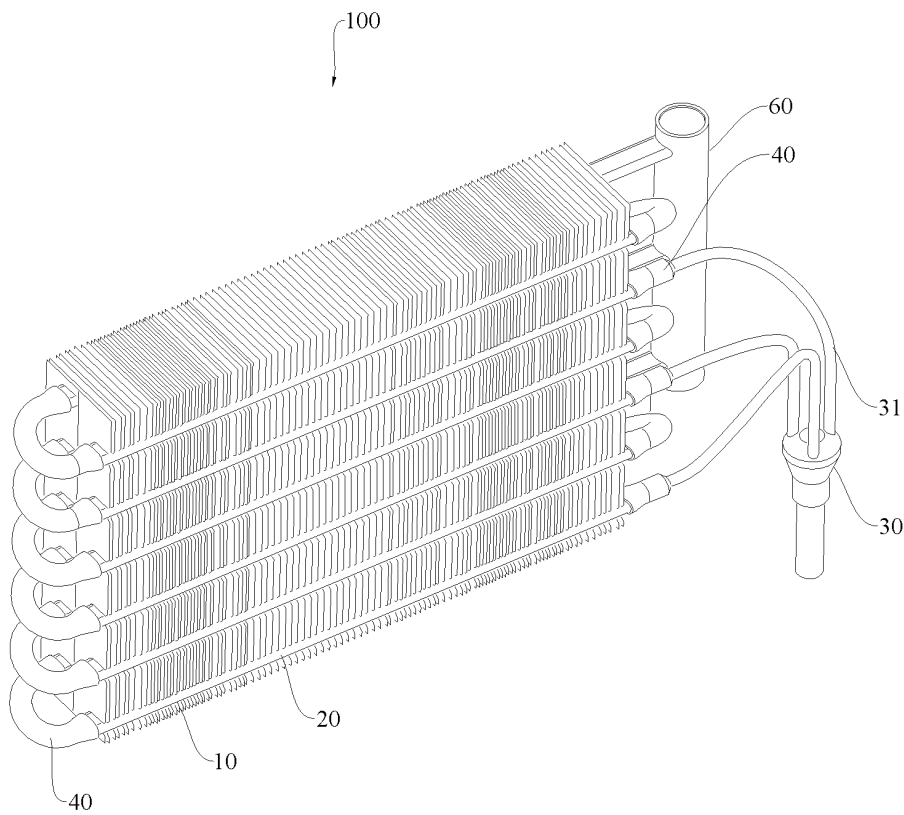


FIG. 16

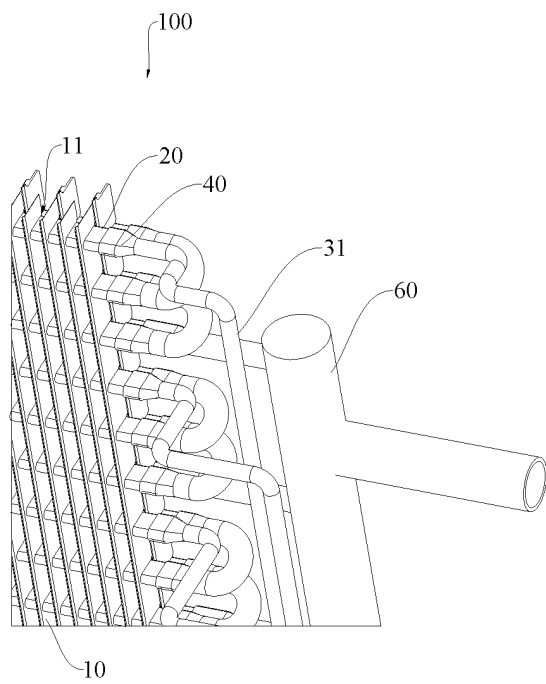


FIG. 17

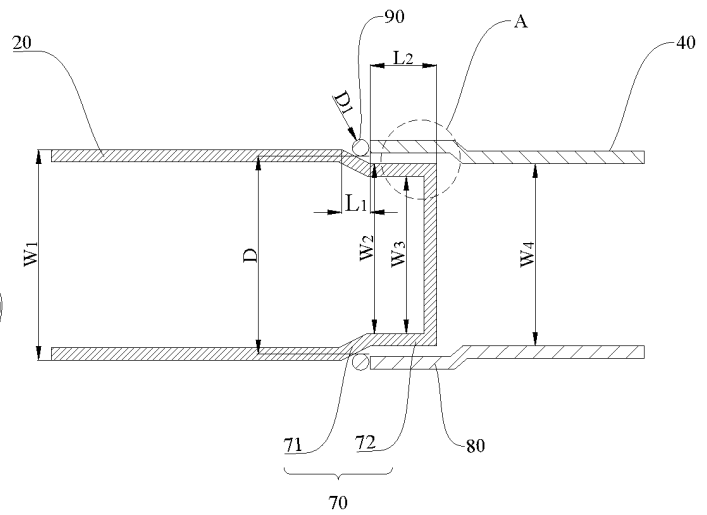


FIG. 18

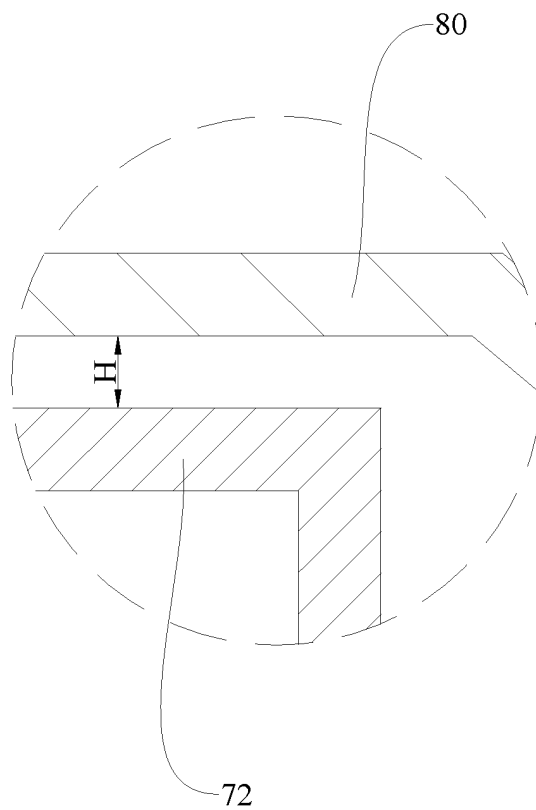


FIG. 19

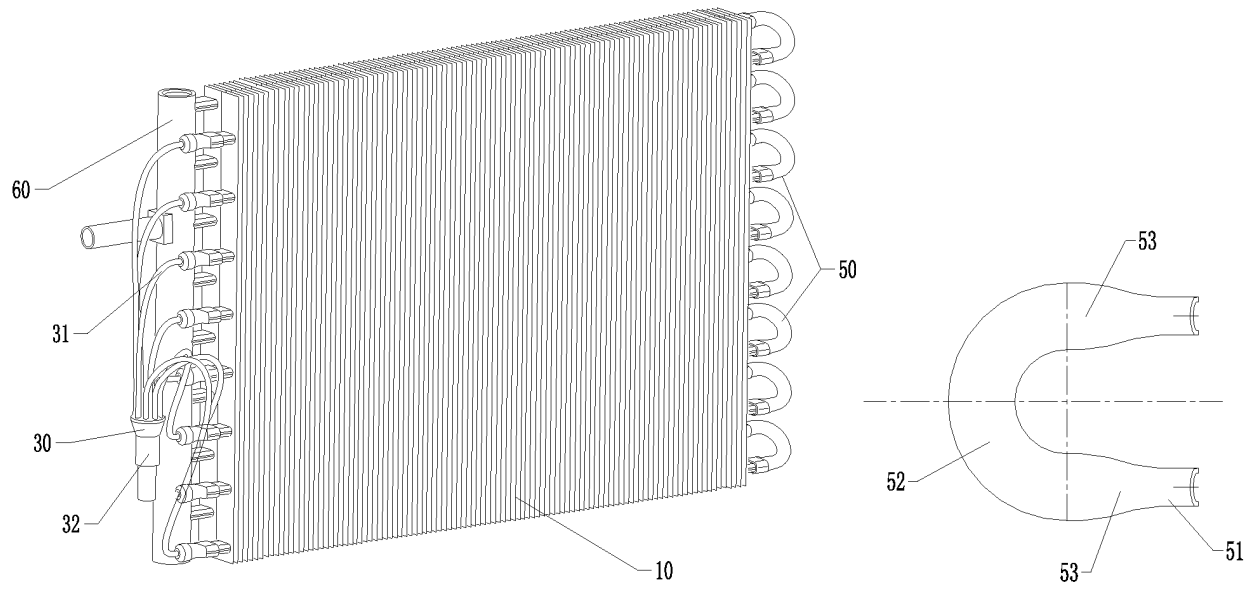


FIG. 20

FIG. 21

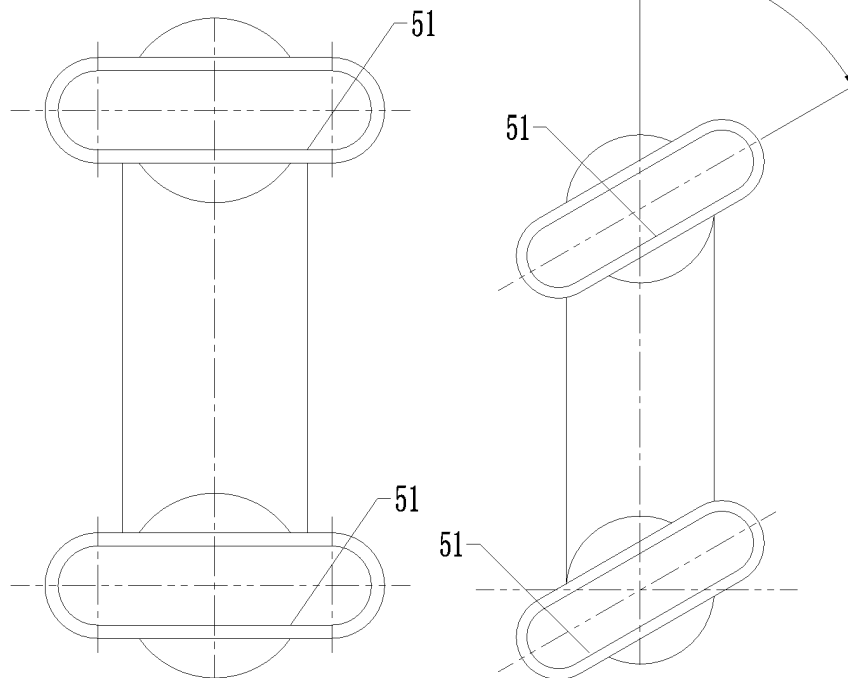


FIG. 22

FIG. 23

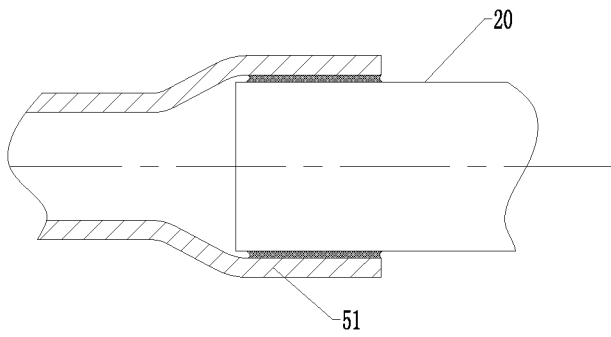


FIG. 24

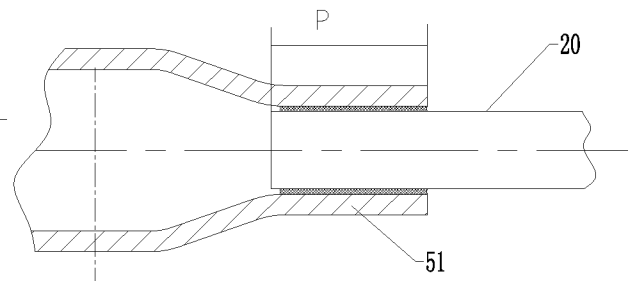


FIG. 25

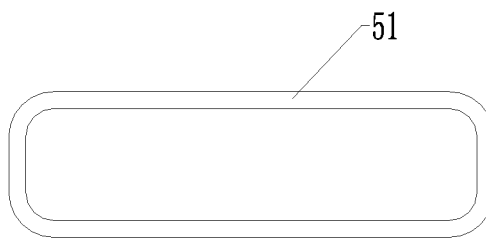


FIG. 26

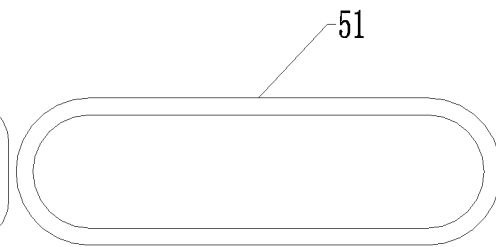


FIG. 27

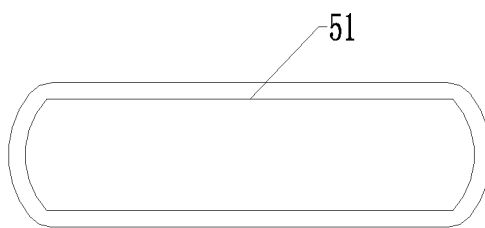


FIG. 28

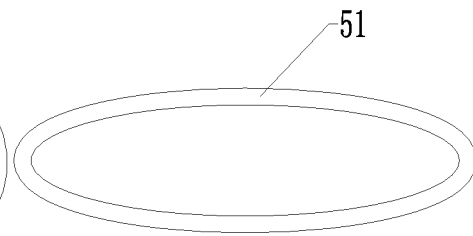


FIG. 29

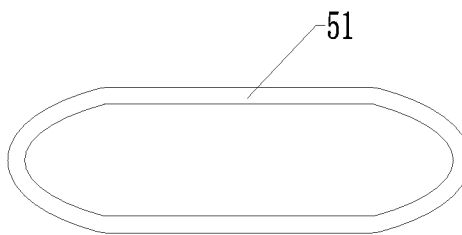


FIG. 30

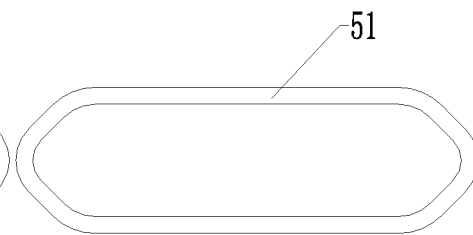


FIG. 31

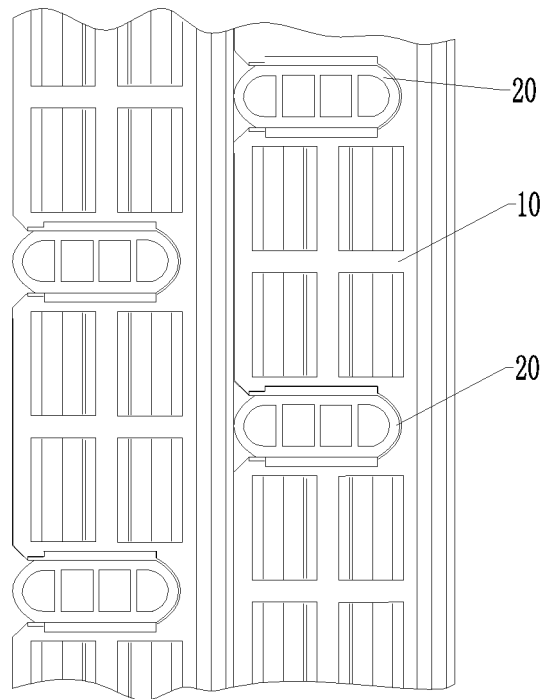


FIG. 32

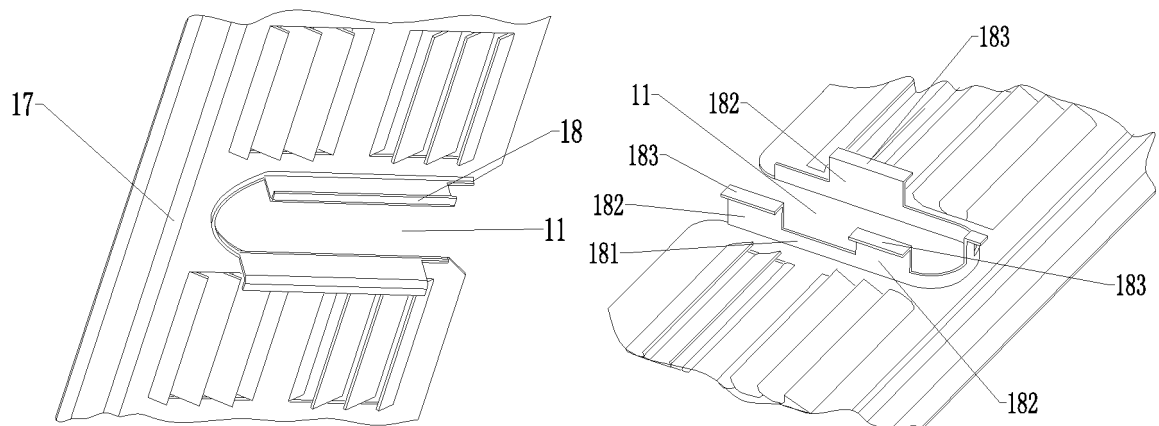


FIG. 33

FIG. 34

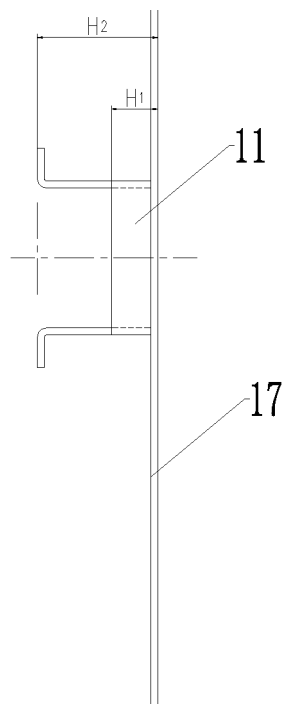


FIG. 35

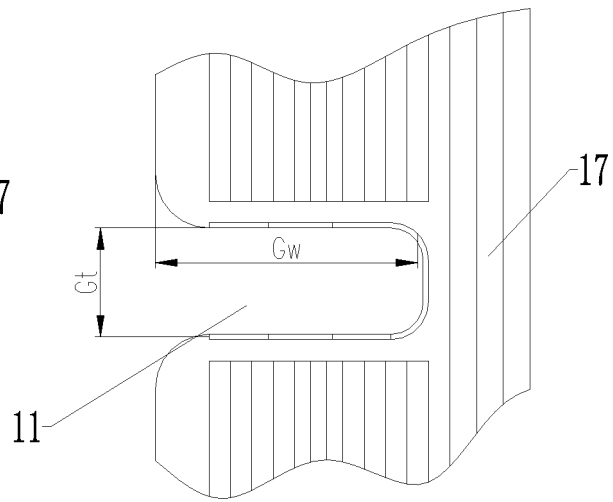


FIG. 36

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2022/129911

A. CLASSIFICATION OF SUBJECT MATTER

F28D 7/00(2006.01)i; F28D 1/04(2006.01)i; F28F 9/26(2006.01)i; F28F 1/12(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F28D;F28F

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)

CNTXT, ENTXTC, VEN, CNKI: 分配器, 分流器, 接头, 接管, 限位, 凸, 翅片, 翻边, distributor, divider, connecting, pipe, tube, adapter, connector, joint, limit, stop, inhibit, projection, bulge, protrusion, fin, collar, flang+, turnup

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 216205497 U (ZHEJIANG DUNAN THERMAL TECHNOLOGY CO., LTD.) 05 April 2022 (2022-04-05) description, paragraphs [0037]-[0060], and figures 1-17	1-2, 11-37
PX	CN 217383869 U (ZHEJIANG DUNAN THERMAL TECHNOLOGY CO., LTD.) 06 September 2022 (2022-09-06) description, paragraphs [0032]-[0059], and figures 1-4	1-2, 11-26, 35-37
PX	CN 217383880 U (ZHEJIANG DUNAN THERMAL TECHNOLOGY CO., LTD.) 06 September 2022 (2022-09-06) description, paragraphs [0043]-[0081], and figures 1-9	1-2, 11-37
X	JP 2012032089 A (MITSUBISHI ELECTRIC CORP.) 16 February 2012 (2012-02-16) description, paragraphs [0010]-[0030], and figures 1-8	1-2, 20-26, 35-37
Y	JP 2012032089 A (MITSUBISHI ELECTRIC CORP.) 16 February 2012 (2012-02-16) description, paragraphs [0010]-[0030], and figures 1-8	3-19, 27-34
Y	FR 2285953 A1 (CREUSOT LOIRE) 23 April 1976 (1976-04-23) description, page 1, line 5-page 5, line 30, and figures 1-3	3-10
Y	CN 208579665 U (MITSUBISHI ELECTRIC CORP.) 05 March 2019 (2019-03-05) description, paragraphs [0032]-[0065], and figures 1-10	11-19

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

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search

02 January 2023

Date of mailing of the international search report

09 January 2023

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/129911

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 207365784 U (BERGSTROM (CHANGZHOU) HEAT EXCHANGER CO., LTD.) 15 May 2018 (2018-05-15) description, paragraphs [0027]-[0056], and figures 1-5	27-34
A	CN 212931129 U (ZHEJIANG SUNCO HEAT EXCHANGE SYSTEM CO., LTD.) 09 April 2021 (2021-04-09) entire document	1-37
A	CN 201954845 U (GUANGDONG MIDEA ELECTRIC APPLIANCES CO., LTD.) 31 August 2011 (2011-08-31) entire document	1-37

INTERNATIONAL SEARCH REPORT
Information on patent family members

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CN 201954845 U	31 August 2011	None	

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REFERENCES CITED IN THE DESCRIPTION

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- US 202221483863 **[0001]**
- US 202122706128 **[0001]**