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(54) **HEAT EXCHANGER**

(57) A heat exchanger (100) is provided. The heat exchanger (100) includes a plurality of fin units (10), a first pipeline unit (2), and a second pipeline unit (3); the plurality of fin units (10) is spaced apart from each other and arranged side by side; the first pipeline unit (2) penetrates through the fin units (10), and includes a plurality of first pipelines (201) distributed at intervals in the length direction of the fin units (10); the second pipeline unit (3) penetrates through the fin units (10); the second pipeline unit (3) and the first pipeline unit (2) are arranged at intervals in the width direction of the fin units (10); the second pipeline unit (3) includes a plurality of second pipelines (301) distributed at intervals in the length direction of the fin units (10); and the pipeline structures of the second pipelines (301) and the first pipelines (201) are different.

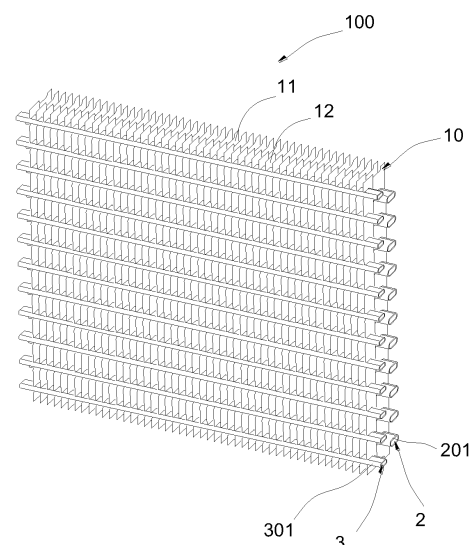


FIG. 1

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to Chinese patent application No. 202221016299.6, filed on April 28, 2022, and titled "HEAT EXCHANGER", and 202221057985.8, filed on April 28, 2022, and titled "HEAT EXCHANGER", the contents of which are hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The present invention relates to the field of heat exchange technology, and in particular to a heat exchanger.

BACKGROUND

[0003] The main components of an air conditioning system include a compressor, a condenser, a throttling device and a heat exchanger. The heat exchanger is configured to exchange heat between the air conditioning system and the outside world, and the heat exchange is mainly accomplished via fins of the heat exchanger.

[0004] In related technology, in order to achieve the refrigeration requirement with a relatively small box body, a double-row parallel-flow heat exchanger is generally adopted. Currently, in the double-row parallel-flow heat exchanger, a front row of the pipeline and a rear row of the pipeline have the same structure, which cannot meet heat exchange requirement in different working conditions. For example, when the heat exchanger is used as an evaporator, a medium is liquid when it enters the front row of the pipeline, and with the heat exchange process, the medium is gradually evaporated from liquid to gas. In the process, a flow rate of the medium becomes faster, resulting in insufficient heat exchange between the medium and the rear row of the pipeline. Thus, the heat exchange effect of the front row of pipeline is good, while the heat exchange effect of the rear row of the pipeline is relatively worse, not give full play to the heat transfer effect of the double-row parallel-flow heat exchanger, affecting the heat exchange effect.

SUMMARY

[0005] On the basis of embodiments of the present invention, a heat exchanger is provided. The heat exchanger includes a plurality of fin units, a first pipeline unit and a second pipeline unit. The plurality of fin units are spaced from each other and arranged side by side; the first pipeline unit penetrates through the plurality of fin units, in which the first pipeline unit includes a plurality of first pipelines arranged at intervals along a length direction of the plurality of fin units; and the second pipeline unit penetrates through the plurality of fin units, in which the second pipeline unit and the first pipeline unit are

spaced from each other along a width direction of the plurality of fin units, and the second pipeline unit includes a plurality of second pipelines arranged at intervals along the length direction of the plurality of fin units. A pipeline structure of the plurality of second pipelines is different from a pipeline structure of the plurality of first pipelines.

[0006] In some embodiments, the first pipeline unit is a first flat pipe unit, the first flat pipe unit includes a plurality of first flat pipes arranged at intervals along the length direction of the plurality of fin units, the second pipeline unit is a second flat pipe unit, and the second flat pipe unit includes a plurality of second flat pipes arranged at intervals along the length direction of the plurality of fin units. The plurality of first flat pipes and the plurality of second flat pipes are interlaced and a cross sectional area of each of the plurality of first flat pipes is greater than a cross sectional area of each of the plurality of second flat pipes.

[0007] In some embodiments, a length of each of the plurality of first flat pipes is equal to a length of each of the plurality of second flat pipes, and a pipe thickness of the plurality of first flat pipes is equal to a pipe thickness of each of the plurality of second flat pipes; a width of each of the plurality of first flat pipes is defined as $L1$, a width of each of the plurality of second flat pipes is defined as $L2$, and the width $L1$ of each of the plurality of first flat pipes and the width $L2$ of each of the plurality of second flat pipes satisfy a following formula: $6\text{ mm} \leq L2 < L1 \leq 20\text{ mm}$. Optionally, a length of each of the plurality of first flat pipes is equal to a length of each of the plurality of second flat pipes, and a width of the plurality of first flat pipes is equal to a width of each of the plurality of second flat pipes; a pipe thickness of each of the plurality of first flat pipes is defined as $H1$, a pipe thickness of each of the plurality of second flat pipes is defined as $H2$, and the pipe thickness $H1$ of each of the plurality of first flat pipes and the pipe thickness $H2$ of each of the plurality of second flat pipes satisfy a following formula: $1\text{ mm} \leq H2 < H1 \leq 5\text{ mm}$.

[0008] In some embodiments, one of the plurality of first flat pipes and adjacent two of the plurality of second pipes are arranged in an equilateral triangle-shape; a vertical distance between a central plane of one of the plurality of first flat pipes along the length direction of the plurality of fin units and a central plane of an adjacent second pipe along the length direction of the plurality of fin units is defined as S , and the vertical distance S between the central plane of one of the plurality of first flat pipes along the length direction of the plurality of fin units and the central plane of the adjacent second pipe along the length direction of the plurality of fin units satisfy a following formula: $12\text{ mm} \leq S \leq 25\text{ mm}$.

[0009] In some embodiments, the heat exchanger further includes a distributor and an adapting unit, the distributor includes a first capillary pipe and a second capillary pipe, a pipe size of the first capillary pipe is greater than a pipe size of the second capillary pipe. The first capillary pipe is connected to and in communication with one of the plurality of first flat pipes via the

adapting unit, and the second capillary pipe is connected to and in communication with one of the plurality of second flat pipes via the adapting unit.

[0010] In some embodiments, the adapting unit includes a first adapter and a second adapter, one end of the first adapter fits with the first capillary pipe, the other end of the first adapter fits with a corresponding first flat pipe of the plurality of first flat pipes; and one end of the second adapter fits with the second capillary pipe, and the other end of the second adapter fits with a corresponding second flat pipe of the plurality of second flat pipes.

[0011] In some embodiments, the first pipeline unit is a first flat pipe unit, the first flat pipe unit includes a plurality of first flat pipes arranged at intervals along the length direction of the plurality of fin units, the second pipeline unit is a circular pipe unit, and the circular pipe unit includes a plurality of circular pipes arranged at intervals along the length direction of the plurality of fin units. The heat exchanger further includes a bending connector, one end of the bending connector is connected to and in communication with a corresponding circular pipe of the plurality of circular pipes, and the other end of the bending connector is connected to and in communication with a corresponding first flat pipe of the plurality of first flat pipes.

[0012] In some embodiments, the bending connector includes a first connecting portion, a second connecting portion and a twisting portion, in which one end of the first connecting portion is connected to and in communication with a corresponding first flat pipe of the plurality of first flat pipes; one end of the second connecting portion is connected to and in communication with the corresponding circular pipe of the plurality of circular pipe; and one end of the twisting portion is connected to and in communication with one end of the first connecting portion away from the corresponding first flat pipe of the plurality of first flat pipes, and the other end of the twisting portion is connected to and in communication with one end of the second connecting portion away from the corresponding circular pipe of the plurality of circular pipes.

[0013] In some embodiments, the first connecting portion fits with the corresponding first flat pipe of the plurality of first flat pipes, and at least part of the corresponding first flat pipe of the plurality of first flat pipes penetrates into the first connecting portion; and the second connecting portion fits with the corresponding circular pipe of the plurality of circular pipes, and at least part of the corresponding circular pipe of the plurality of circular pipes penetrates into the second connecting portion. The twisting portion is U-shaped, the twisting portion is U-shaped, and a cross section of one end of the twisting portion is kidney-shaped, a cross section of the other end of the twisting portion is circular-shaped, and the one end of the twisting portion with the kidney-shaped cross section is in a smooth transition to the other end of the twisting portion with the circular-shaped cross section.

[0014] In some embodiments, the plurality of first flat

pipes and the plurality of circular pipes are interlaced, and one of the plurality of first flat pipes is connected to and in communication with an adjacent circular pipe of the plurality of circular pipes.

[0015] In some embodiments, the heat exchanger further includes a plurality of bending pipes, and ends of the adjacent two of the plurality of first flat pipes away from the bending connector are connected to and in communication with each other via corresponding one of the plurality of bending pipes.

[0016] In some embodiments, the heat exchanger further includes a distributor and a collecting pipe, an end of one of adjacent two of the plurality of circular pipes away from the bending connector is connected to and in communication with the distributor, and an end of the other of the adjacent two of the plurality of circular pipes away from the bending connector is connected to and in communication with the collecting pipe.

[0017] In some embodiments, a bending portion is defined by an end of each of the plurality of circular pipes away from the bending connector bending, and the bending portion is connected to and in communication with the distributor.

[0018] In some embodiments, the plurality of fin units includes a first fin and a second fin, the first pipeline unit penetrates through the first fin, and the second pipeline unit penetrates through the second fin. The second fin is located at a side of the first fin adjacent to the first pipeline unit and abuts against the first fin.

[0019] In some embodiments, a width of the first fin is defined as $W1$, a width of the second fin is defined as $W2$, and the width $W1$ of the first fin and the width $W2$ of the second fin satisfy with a following formula: $W2 < W1$.

[0020] Details of one or more embodiments of the present application are presented in the following accompanying drawings and description in order to make other features, purposes and advantages of the present application more concise and understandable.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] In order to better describe and illustrate the embodiments and/or examples of the present application disclosed herein, reference may be made to one or more of the accompanying drawings. 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 applications, the embodiments and/or examples currently described, and the best mode of these applications as currently understood.

FIG. 1 is a structural schematic diagram of part of a heat exchanger in some embodiments.

FIG. 2 is a front view of part of a heat exchanger in some embodiments.

FIG. 3 is a front view of part of a heat exchanger in some embodiments.

FIG. 4 is a front view of part of a heat exchanger in

some embodiments.

FIG. 5 is a structural schematic diagram of part of a heat exchanger in some embodiments.

FIG. 6 is a structural schematic diagram of a distributor in some embodiments.

FIG. 7 is a structural schematic diagram of a first adapter in some embodiments.

FIG. 8 is a structural schematic diagram of a second adapter in some embodiments.

FIG. 9 is a structural schematic diagram of a bending pipe in some embodiments.

FIG. 10 is a structural schematic diagram of a heat exchanger in some embodiments.

FIG. 11 is a side view of a heat exchanger in some embodiments.

FIG. 12 is a structural schematic diagram of part of a heat exchanger in some embodiments.

FIG. 13 is a structural schematic diagram of part of a heat exchanger in some embodiments.

FIG. 14 is a bending connector of a heat exchanger in some embodiments.

[0022] In the figures, 100 represents a heat exchanger; 10 represents a fin unit; 11 represents a first fin; 12 represents a second fin; 2 represents a first pipeline unit; 201 represents a first pipeline; 20 represents a first flat pipe unit; 21 represents a first flat pipe; 3 represents a second pipeline unit; 301 represents a second pipeline; 31 represents a second flat pipe unit; 311 represents a second flat pipe; 32 represents a circular pipe unit; 321 represents a circular pipe; 322 represents a bending portion; 40 represents a bending connector; 41 represents a first connecting portion; 42 represents a second connecting portion; 43 represents a twisting portion; 50 represents a bending pipe; 60 represents a distributor; 6 represents a capillary pipe; 61 represents a first capillary pipe; 62 represents a second capillary pipe; 70 represents a collecting pipe; 80 represents an adapting unit; 81 represents a first adapter; and 82 represents a second adapter.

DETAILED DESCRIPTION

[0023] In order that the foregoing purposes, features and advantages of the present invention may be made more apparent and understandable, specific embodiments of the present invention 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 invention. However, the present invention 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 invention, and thus the present invention is not limited by the specific embodiments disclosed below.

[0024] 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 centred component. When a component is said to be "connected" to another component, it may be directly connected to the other component or there may be both centred components. The terms "vertical", "horizontal", "up", "down", "left", "right" and similar expressions used in the specification of the present invention are for illustrative purposes only and are not meant to be exclusive.

[0025] Furthermore, the terms "first", "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 technical features indicated. Thus, a feature defined with the terms "first", "second" may include at least one such feature, either explicitly or implicitly. In the description of the present invention, "plurality" means at least two, e.g., two, three, etc., unless otherwise expressly and specifically limited.

[0026] In the present invention, unless otherwise expressly specified and limited, the first feature "on" or "under" the second feature may be that the first feature is in direct contact with the second feature, or that the first feature is in indirect contact with 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 it may simply mean that the first feature is horizontally higher than the second feature. The first feature being "below", "under" or "beneath" the second feature may be that the first feature is directly below or diagonally below the second feature, or it may simply mean that the first feature is horizontally smaller than the second feature.

[0027] Unless otherwise defined, all technical and scientific terms used in the specification of the present invention have the same meaning as commonly understood by those skilled in the art to which the present invention belongs. Terms used in the specification of the present invention are used only for the purpose of describing specific embodiments and are not intended to limit the present invention. The term "and/or" as used in the specification of the present invention includes any and all combinations of one or more of the relevant listed items.

[0028] Referring to FIG. 1, FIG. 5 and FIG. 10, a heat exchanger 100 is provided in the present invention, and the heat exchanger 100 is disposed in an air conditioning system.

[0029] The main components of the air conditioning system include a compressor, a condenser, a throttling device and a heat exchanger. The heat exchanger is configured to exchange heat between the air conditioning system and the outside world, and the heat exchange is mainly accomplished via fins of the heat exchanger.

[0030] In related technology, in order to achieve the refrigeration requirement with a relatively small box body, a double-row parallel-flow heat exchanger is generally adopted. Currently, in the double-row parallel-flow heat

exchanger, a front row of the pipeline and a rear row of the pipeline have the same structure, which cannot meet heat exchange requirement in different working conditions. For example, when the heat exchanger is used as an evaporator, a medium is liquid when it enters the front row of the pipeline, and with the heat exchange process, the medium is gradually evaporated from liquid to gas. In the process, a flow rate of the medium becomes faster, resulting in insufficient heat exchange between the medium and the rear row of the pipeline. Thus, the heat exchange effect of the front row of pipeline is good, while the heat exchange effect of the rear row of the pipeline is relatively worse, not give full play to the heat transfer effect of the double-row parallel-flow heat exchanger, affecting the heat exchange effect.

[0031] In order to solve the problem above, referring to FIG. 1, a heat exchanger 100 is provided in the present invention. The heat exchanger 100 includes a plurality of fin units 10, a first pipeline unit 2 and a second pipeline unit 3. The plurality of fin units 10 are spaced from each other and arranged side by side; the first pipeline unit 2 penetrates through the plurality of fin units 10, in which the first pipeline unit 2 includes a plurality of first pipelines 201 arranged at intervals along a length direction of the plurality of fin units 10; and the second pipeline unit 3 penetrates through the plurality of fin units 10, in which the second pipeline unit 3 and the first pipeline unit 2 are spaced from each other along a width direction of the plurality of fin units 10, and the second pipeline unit 3 includes a plurality of second pipelines 301 arranged at intervals along the length direction of the plurality of fin units 10. A pipeline structure of the plurality of second pipelines 301 is different from a pipeline structure of the plurality of first pipelines 201.

[0032] In the present invention, by providing two rows of pipelines having different pipeline structures, the heat exchanger 100 can meet different heat exchange requirement according to actual working conditions. In the heat exchange process, when a medium in the pipeline of the heat exchanger 100 should be subjected to sufficient heat exchange, a pipe size of the first pipeline 201 or a pipe size of the second pipeline 301 can be enlarged to properly reduce a flow rate of the medium, thereby improving a heat exchange effect. On the contrary, when the flow rate of the medium in the pipeline should be increased, the pipe size of the first pipeline 201 or the pipe size of the second pipeline 301 can be decreased. In some embodiments, in order to improve the flow rate of the medium, improve discharge effect or adapt to a pipeline of the air conditioning system, a pipeline structure of the second pipeline 301 and a pipeline structure of the first pipeline 201 can be different structures, such as a circular pipe, a flat pipe, a snake-shaped pipe and the like, which are not limited in the present invention.

[0033] In some embodiments, the first pipeline unit 2 is a first flat pipe unit 20, the first flat pipe unit 20 includes a plurality of first flat pipes 21 arranged at intervals along

the length direction of the plurality of fin units 10, the second pipeline unit 3 is a second flat pipe unit 31, and the second flat pipe unit includes a plurality of second flat pipes 311 arranged at intervals along the length direction of the plurality of fin units 10. The plurality of first flat pipes 21 and the plurality of second flat pipes 311 are interlaced and a cross sectional area of each of the plurality of first flat pipes 21 is greater than a cross sectional area of each of the plurality of second flat pipes 311.

[0034] In the heat exchanger 100 of the present invention, by providing two rows of flat pipes having different cross sectional areas, different heat exchange requirements can be met. Besides, firstly, the medium flows into the second flat pipe 311 having a relatively small cross sectional area and is subjected to a preliminary heat exchange process. Then, the medium flows into the first flat pipe 21 having a relatively great cross sectional area and is subjected to a further heat exchange process. Since the cross sectional area of the first flat pipe 21 is greater, when the medium flows into the first flat pipe 21, the flow rate of the medium decreases, so that the medium can be subjected to sufficient heat exchange with the first flat pipe 21, improving heat exchange performance of the heat exchanger 100. The plurality of first flat pipes 21 and the plurality of second flat pipes 311 are interlaced, which further improves the heat exchange performance of the heat exchanger 100.

[0035] At the same time, since the plurality of first flat pipes 21 and the plurality of second flat pipes 311 are interlaced, the heat exchange performance of the heat exchanger 100 is further improved. Since the plurality of first flat pipes 21 and the plurality of second flat pipes 311 are interlaced, a side of one of the plurality of first flat pipes 21 faces the plurality of fin units. Therefore, the medium in the first flat pipe 21 can not only exchange heat via fin structures at both sides of the first flat pipe 21 along the length direction of the fin unit 10, but also exchange heat via fin structures at a side of the second flat pipe 211 along the width direction of the fin unit 10, so as to make full use of the plurality of fin units 10 to exchange heat, thereby further improving the heat exchange performance.

First embodiment

[0036] Referring to FIG. 2, a length of the first flat pipe 21 is equal to a length of the second flat pipes 311, and a pipe thickness of the first flat pipe 21 is equal to a pipe thickness of the second flat pipe 311. A width of the first flat pipe 21 is defined as $L1$, a width of the second flat pipe 311 is defined as $L2$, and the width $L1$ of the first flat pipe 21 and the width $L2$ of the second flat pipe 311 satisfy a following formula: $L1 > L2$. In this way, since the cross sectional area of the first flat pipe 21 is greater than the cross sectional area of the second flat pipes 311, a contact area between the first flat pipe 21 and the fin unit 10 is increased. In addition, when the heat exchanger is in operation, since the cross sectional area of the first flat

pipe 21 is greater, the flow rate of the medium becomes slower, and the medium contact more sufficiently with the first flat pipe 21, which improve the heat exchange performance of the heat exchanger 100.

[0037] In some embodiments, the width $L1$ of the first flat pipe 21 and the width $L2$ of the second flat pipe 311 satisfy a following formula: $6\text{ mm} \leq L2 < L1 \leq 20\text{ mm}$. By properly setting the width $L1$ of the first flat pipe 21 and the width $L2$ of the second flat pipe 311, a discharging performance of the heat exchanger 100 and the heat exchange performance of the heat exchanger 100 can be balanced. When the heat exchanger is used as an evaporator, the second flat pipe 311 is located at a windward side of the heat exchanger 100, and the first flat pipe 21 is located at a leeward side of the heat exchanger 100. The second flat pipe 311 located at the windward side of the heat exchanger 100 will contact the outside air first, condensing a great amount of water. At this time, the second flat pipe 311 with a smaller cross sectional area can facilitate discharging of the condensate water, thereby improving discharging performance of the heat exchanger 100. If both the width of the first flat pipe 21 and the width of the second flat pipe 311 are greater than 20 mm, the width of the first flat pipe 21 and the width of the second flat pipe 311 are unduly great. When the heat exchanger 100 is used as the evaporator, water may easily accumulate on the first flat pipe 21 and the second flat pipe 311. The heat exchange performance of the heat exchanger 100 may be influenced if the water is not timely discharged. If both the width of the first flat pipe 21 and the width of the second flat pipe 311 are smaller than 6 mm, the width of the first flat pipe 21 and the width of the second flat pipe 311 are unduly small, and a contact area between the first flat pipe 21 and the fin unit 10 and a contact area between the second flat pipe 311 and the fin unit 10 become smaller, which reduces the heat exchange performance of the heat exchanger 100.

[0038] In some embodiments, the width of the first flat pipe 21 and the width of the second flat pipe 311 can be adjusted according to actual needs. For example, the width of the first flat pipe 21 and the width of the second flat pipe 311 can be independently selected from 10 mm, 12 mm, 14 mm or 16 mm, as long as the width of the first flat pipe 21 and the width of the second flat pipe 311 satisfy the range of the width of the first flat pipe 21 and the range of the width of the second flat pipe 311 described above.

Second embodiment

[0039] Referring to FIG. 3, a length of the first flat pipe 21 is equal to a length of the second flat pipes 311, and a width of the first flat pipe 21 is equal to a width of the second flat pipe 311. A pipe thickness of the first flat pipe 21 is defined as $H1$, a pipe thickness of the second flat pipe 311 is defined as $H2$, and the pipe thickness $H1$ of the first flat pipe 21 and the pipe thickness $H2$ of the second flat pipe 311 satisfy a following formula: $H1 > H2$. In this

way, since the cross sectional area of the first flat pipe 21 is greater than the cross sectional area of the second flat pipes 311, a contact area between the first flat pipe 21 and the fin unit 10 is increased. In addition, when the heat exchanger is in operation, since the cross sectional area of the first flat pipe 21 is greater, the flow rate of the medium becomes slower, and the medium contact more sufficiently with the first flat pipe 21, which improve the heat exchange performance of the heat exchanger 100.

[0040] In some embodiments, the pipe thickness $H1$ of the first flat pipe 21 and the pipe thickness $H2$ of the second flat pipe 311 satisfy a following formula: $1\text{ mm} \leq H2 < H1 \leq 5\text{ mm}$. If both the pipe thickness $H1$ of the first flat pipe 21 and the pipe thickness $H2$ are greater than 5 mm, the first flat pipe 21 and the second flat pipe 311 are compactly disposed, which leads to reduce of heat exchange area of the fin unit 10, so that the heat exchange efficiency of the fin unit is lowered and the heat exchange performance of the heat exchanger 100 is lowered. If both the pipe thickness $H1$ of the first flat pipe 21 and the pipe thickness $H2$ are smaller than 1 mm, the medium flowing through the first flat pipe 21 and the second flat pipe 311 reduces and the medium cannot exchange heat sufficiently. In addition, the amount of the material consumed by the fin unit 10 increases, leading to increase of the cost.

[0041] In some embodiments, the pipe thickness of the first flat pipe 21 and the pipe thickness of the second flat pipe 311 can be adjusted according to actual needs. For example, the pipe thickness of the first flat pipe 21 and the pipe thickness of the second flat pipe 311 can be independently selected from 2 mm, 3 mm or 4 mm, as long as the pipe thickness of the first flat pipe 21 and the pipe thickness of the second flat pipe 311 satisfy the range of the pipe thickness of the first flat pipe 21 and the range of the pipe thickness of the second flat pipe 311 described above.

Third embodiment

[0042] Referring to FIG. 4, a length of the first flat pipe 21 is equal to a length of the second flat pipes 311, a range of a width of the first flat pipe 21 and a range of a width of the second flat pipe 311 are the same as the range of the width of the first flat pipe 21 and the range of the width of the second flat pipe 311 in the first embodiment, and a range of a pipe thickness of the first flat pipe 21 and a range of a pipe thickness of the second flat pipe 311 are the same as the range of the pipe thickness of the first flat pipe 21 and the range of the pipe thickness of the second flat pipe 311 in the second embodiment, which will not be repeated herein. The difference between the present embodiment and the first embodiment and the third embodiment are described herein. The width of the first flat pipe 21 is different from the width of the second flat pipe 311, the pipe thickness of the first flat pipe 21 is different from the pipe thickness of the second flat pipe 311, and a cross sectional area of the first flat pipes 21 is greater than

a cross sectional area of the second flat pipes 311. In this way, a contact area between the first flat pipe 21 and the fin unit 10 is increased. In addition, when the heat exchanger is in operation, since the cross sectional area of the first flat pipe 21 is greater, the flow rate of the medium becomes slower, and the medium contact more sufficiently with the first flat pipe 21, which improve the heat exchange performance of the heat exchanger 100 and the discharge effect of the heat exchanger 100.

[0043] Referring to FIG. 4, in the present invention, the first flat pipe 21 and adjacent two second pipes 311 are arranged in an equilateral triangle-shape, which facilitates assembly of the first flat pipe 21 and the second flat pipe 311, and can ensure that heat exchange at both sides of the first flat pipe 21 can be improved via the fin unit 10, so that the heat exchange efficiency of the fin unit 10 can be improved, thereby improving a cost performance of the heat exchanger 100.

[0044] Furthermore, referring to FIG. 4, a vertical distance between a central plane of one of the plurality of first flat pipes 21 along the length direction of the plurality of fin units 10 and a central plane of an adjacent second pipe 311 along the length direction of the plurality of fin units 10 is defined as S, and the vertical distance S between the central plane of one of the plurality of first flat pipes 21 along the length direction of the plurality of fin units 10 and the central plane of the adjacent second pipe 311 along the length direction of the plurality of fin units 10 satisfy a following formula: $12\text{ mm} \leq S \leq 25\text{ mm}$. By properly disposing the flat pipes, the heat exchange efficiency of the fin unit 10 is improved, so that the heat exchange performance of the heat exchanger 100 can be improved. When the vertical distance S between the central plane of one of the plurality of first flat pipes 21 along the length direction of the plurality of fin units 10 and the central plane of the adjacent second pipe 311 along the length direction of the plurality of fin units 10 is smaller than 12 mm, the wind drag increases and the heat exchange efficiency is improved. When the vertical distance S between the central plane of one of the plurality of first flat pipes 21 along the length direction of the plurality of fin units 10 and the central plane of the adjacent second pipe 311 along the length direction of the plurality of fin units 10 is greater than 25 mm, the material of the fin unit 10 wastes. In some embodiments, the vertical distance S between the central plane of one of the plurality of first flat pipes 21 along the length direction of the plurality of fin units 10 and the central plane of the adjacent second pipe 311 along the length direction of the plurality of fin units 10 can be adjusted according to actual needs. For example, the vertical distance S between the central plane of one of the plurality of first flat pipes 21 along the length direction of the plurality of fin units 10 and the central plane of the adjacent second pipe 311 along the length direction of the plurality of fin units 10 can be 16 mm, 18 mm, 20 mm or 22 mm.

[0045] Referring to FIG. 6, FIG. 7 and FIG. 8, the heat exchanger 100 further includes a distributor 60 and an

adapting unit 80, the distributor 60 includes a plurality of capillary pipes 6. The plurality of capillary pipes 6 includes a first capillary pipe 61 and a second capillary pipe 62, a pipe size of the first capillary pipe 61 is greater than a pipe size of the second capillary pipe 62. The first capillary pipe 61 is connected to and in communication with one of the plurality of first flat pipes via the adapting unit 80, and the second capillary pipe 62 is connected to and in communication with one of the plurality of second flat pipes 311 via the adapting unit 80. Since the distributor 60 includes pipes having different sizes and is connected to and in communication with different flat pipes via the adapting unit 80, a refrigerant can be distributed to different flat pipes, so that the refrigerant can be evenly distributed.

[0046] In some embodiments, the adapting unit 80 includes a first adapter 81 and a second adapter 82, one end of the first adapter 81 fits with the first capillary pipe 61, the other end of the first adapter 81 fits with a corresponding first flat pipe 21 of the plurality of first flat pipes 21; and one end of the second adapter 82 fits with the second capillary pipe 62, and the other end of the second adapter 82 fits with a corresponding second flat pipe 311 of the plurality of second flat pipes 311. In this way, a connecting strength between the adapting unit 80 and the distributor 60, the first flat pipe 21 or the second flat pipe 311 can be improved.

[0047] In some embodiments, at least part of an end of the first capillary pipe 61 penetrates into the first adapter 81, and at least part of an end of the first flat pipe 21 penetrates into the first adapter 81; and at least part of an end of the second capillary pipe 62 penetrates into the second adapter 82, and at least part of an end of the second flat pipe 311 penetrates into the second adapter 82. Thus, the connecting strength can be further improved.

[0048] In some embodiments, referring to FIG. 5, the heat exchanger 100 further includes a collecting pipe 70. One end of the first flat pipe 21 is connected to and in communication with the distributor 60 via the adapting unit 80, and the other end of the first flat pipe 21 is connected to and in communication with the collecting pipe 70; and one end of the second flat pipe 311 is connected to and in communication with the distributor 60 via the adapting unit 80, and the other end of the second flat pipe 311 is connected to and in communication with the collecting pipe 70.

[0049] When the heat exchanger 100 is in operation, the medium flows into the heat exchanger 100 via the distributor 60, flows into the first flat pipe 21 via the first capillary pipe 61, exchanges heat with the outside world via the first fin 11, and then centralizes and flows out from the collecting pipe 70 after the heat exchange process. Besides, the medium flows into the heat exchanger 100 from the distributor 60, flows into the second flat pipe 311 via the second capillary pipe 62, exchanges heat with the outside world via the second fin 12, and then centralizes and flows out from the collecting pipe 70 after the heat

exchange process.

[0050] In some embodiments, referring to FIG. 9 and FIG. 13, the heat exchanger 100 further includes a plurality of bending pipes 50, and adjacent two first flat pipes 21 are connected to and in communication with each other via the bending pipe 50; optionally, a first flat pipe 21 is connected to and in communication with an adjacent second flat pipe 311 via the bending pipe 50, so as to realize different circulation. Since the adjacent two first flat pipes 21 are connected to or in communication with each other via the bending pipe 50 or the first flat pipe 21 is connected to or in communication with the adjacent second flat pipe 311 via the bending pipe 50, the number of flowing paths of the medium increases, and the heat exchange efficiency of the heat exchanger 100 is improved. The bending pipe 50 is connected to or in communication with the first flat pipe 21 or the second flat pipe 311 by method of welding, so as to reduce bending processes of the flat pipe. It could be understood that in a bending process, the fin may deform. In the present invention, the bending process is not required, and the problem that the fin deforms in the bending process can be solved.

[0051] In the present embodiment, the medium the medium flows into the heat exchanger 100 from the distributor 60, flows into the second flat pipe 311 via the second capillary pipe 62, and is subjected to preliminary heat exchange process. With the heat exchange, part of the liquid medium converts to gas, a flowing resistance of the medium gradually increases and the pressure in the heat exchanger 100 gradually increases. The flow rate of the medium increases, and then the medium flows into the first flat pipe 21 via the bending pipe 50 and is subjected to a further heat exchange process. Since a cross sectional area of the first flat pipe 21 is greater, a flow area of the medium flowing through the first pipe 21 is greater than a flow area of the medium flowing through the second flat pipe 311, that is, an internal volume of the first flat pipe 21 is greater than an internal volume of the second flat pipe 311. In addition, when the medium flows in the first flat pipe 21, the pressure decreases accordingly, so that the flow rate of the medium flowing into the first flat pipe 21 decreases, and the medium sufficiently exchanges heat with the first flat pipe 21, and the heat exchange performance of the heat exchanger 100 is improved. Then, the medium flows into an adjacent first flat pipe 21 via the bending pipe 50, and flows into an adjacent second flat pipe 311 via a bending pipe 50 and is subjected to a following heat exchange process. Finally, the medium flows out from the collecting pipe 70. In this way, a flow distance of the refrigerant in the heat exchanger 100 increases, and a circulation distribution of the refrigerant is more even, so that the heat exchange effect of the heat exchanger 100 significantly increases.

[0052] In the related art, some of the parallel-flow heat exchangers includes a collecting pipe, a fin, a circular pipe and a flat pipe. The collecting pipe is provided with a

plurality of hole slots, and a plurality of spacer plates are provided inside the collecting pipe. The collecting pipe is divided into a plurality of circulation chamber with a plurality of spacer plates. Both the circular pipe and the flat pipe penetrate through the plurality of slot holes, and is in communication with the corresponding circulation chamber. The flat pipe is in communication with the circular pipe by the medium flowing in the collecting pipe. However, the heat exchanger in the related art has a compact structure and is complicated to assemble, and the number of welding spots increases, which increases a risk of leakage of the medium, decreases a structural strength of the heat exchanger, so that the heat exchange efficiency of the heat exchanger is reduced. In addition, if the collecting pipe is provided without the spacer plate, circulation uniformity of the medium in the flat pipe and the circulation pipe will be affected, so that the heat exchange efficiency of the heat exchanger decreases.

[0053] In order to solve the problem above, referring to FIG. 10 to FIG. 12, a heat exchanger 100 is provided in embodiments of the present invention. The first pipeline unit 2 is a first flat pipe unit 20, the first flat pipe unit 20 includes a plurality of first flat pipes 21 arranged at intervals along the length direction of the plurality of fin units 10, the second pipeline unit 3 is a circular pipe unit 32, and the circular pipe unit 32 includes a plurality of circular pipes 321 arranged at intervals along the length direction of the plurality of fin units 10.

[0054] In the heat exchanger 100 of the present invention, by providing the first flat pipe 21 and the circular pipe 321, the heat exchange efficiency of the heat exchanger 100 is improved, while taking into account the drainage efficiency of the heat exchanger 100 at the same time. When the heat exchanger 100 is in operation, the medium flows into the circular pipe 321 first and is subjected to a preliminary heat exchange process, and then the medium flows into a first flat pipe 21 and is subjected to a further heat exchange process. Since the first flat pipe 21 is provided with a plurality of microchannels inside, the medium contacts more sufficiently with the first flat pipe 21. Thus, the exchange heat sufficiently with the first flat pipe 21, thereby improving the heat exchange performance of the heat exchanger 100. When the heat exchanger 100 is used as an evaporator, the circular pipe 321 is located at the windward side of the heat exchanger 100, the first flat pipe 21 is located at the leeward side of the heat exchanger 100. The circular pipe 321 located at the windward side will contact the outside air first, condensing a great amount of water. Due to the structure of the circular pipe 321, water is not easily accumulate on the circular pipe 321, and the condensation water will flow along the periphery wall of the circular pipe 321, which facilitates discharge of the water and improves the discharge efficiency of the heat exchanger 100.

[0055] In some embodiments, referring to FIG. 10, FIG. 11 and FIG. 14, the heat exchanger 100 further includes a bending connector 40, one end of the bending connector 40 is connected to and in communication with a corre-

sponding circular pipe 321 of the plurality of circular pipes 321, and the other end of the bending connector 40 is connected to and in communication with a corresponding first flat pipe 21 of the plurality of first flat pipes 21. By using the bending connector 40 to replace the collecting pipe 70 in the related art to transmit the medium, the hole slot disposed on the collecting pipe 70 and the spacer plates disposed in the collecting pipe 70 can be omitted. Thus, conditions that both the circular pipe 321 and the first flat pipe 21 penetrate through the collecting pipe 70 can be avoided, the number welding spots can be reduced, and the risk of leakage of the medium can be lowered, so that the entire structural strength of the heat exchanger 100 can be improved and the heat exchange efficiency of the heat exchanger 100 can be improved. The bending connector 40 can allow the medium to flow directly from the first flat pipe to the circular pipe 321, optionally, the medium can flow directly from the circular pipe 321 to the first flat pipe 21, so as to ensure that the medium is always in a flow equilibrium and stable state when the medium flows in the circular pipe 321 and the first flat pipe 21. Therefore, the problem of leakage can be avoided, the use ratio of the medium is improved, and uniform of circulation of the medium is improved, so as to improve the heat exchange performance of the heat exchanger 100.

[0056] Referring to FIG. 14, in some embodiments, then bending connector 40 includes a first connecting portion 41, a second connecting portion 42 and a twisting portion 43, in which one end of the first connecting portion 41 is connected to and in communication with a corresponding first flat pipe 21 of the plurality of first flat pipes 21; one end of the second connecting portion 42 is connected to and in communication with the corresponding circular pipe 321 of the plurality of circular pipe 321; and one end of the twisting portion 43 is connected to and in communication with one end of the first connecting portion 41 away from the corresponding first flat pipe 21, and the other end of the twisting portion 43 is connected to and in communication with one end of the second connecting portion 42 away from the corresponding circular pipe 321. Since the circular pipe 321 is connected to and in communication with the first flat pipe 21 via the bending connector 40, circulation between the circular pipe 321 and the first flat pipe 21 is more convenient. At the same time, the medium generates turbulence in the bending connector 40, which makes the refrigerant more even, and the heat exchange efficiency of the heat exchanger 100 is improved.

[0057] The first connecting portion 41 fits with the corresponding first flat pipe 21 of the plurality of first flat pipes 21. Specifically, a cross section of the first connecting portion 41 is kidney-shaped, which facilitates smooth connection between the first connecting portion 41 and the first flat pipe 21. In addition, in the assembling process, at least part of the corresponding first flat pipe 21 of the plurality of first flat pipes 21 penetrates into the first connecting portion 41, which can increase a contact area

between the first connecting portion 41 and the first flat pipe 21 and increase the welding strength between the first connecting portion 41 and the first flat pipe 21.

[0058] The second connecting portion 42 fits with the corresponding circular pipe 321 of the plurality of circular pipes 321. Specifically, a cross section of the circular pipes 321 is circular-shaped, which facilitates smooth connection between the second connecting portion 42 and the first circular pipe 321. In addition, in the assembling process, at least part of the corresponding circular pipe 321 of the plurality of circular pipes 321 penetrates into the second connecting portion 42, which can increase a contact area between the second connecting portion 42 and the circular pipe 321 and increase the welding strength between the second connecting portion 42 and the circular pipe 321.

[0059] In some embodiments, referring to FIG. 14, the twisting portion 43 is U-shaped, the twisting portion is U-shaped, which can play a good role of turning and facilitate connection between the first flat pipe 21 and the circular pipe 321 via the bending connector 40. In addition, and a cross section of one end of the twisting portion 43 is kidney-shaped, a cross section of the other end of the twisting portion 43 is circular-shaped, and the one end of the twisting portion 43 with the kidney-shaped cross section is in a smooth transition to the other end of the twisting portion 43 with the circular-shaped cross section, which can reduce the flow resistance of the medium and facilitate smooth circulation of the medium, thereby improving the heat exchange efficiency of the heat exchanger 100. In some embodiments, the twisting portion 43 can be in other shapes, as long as the twisting portion 43 can play the same role.

[0060] Referring to FIG. 14, in some embodiments, the first connecting portion 41, the second connecting portion 42 and the twisting portion 43 are an integral structure, which facilitates processing and shaping, and effectively improves the entire structural strength of the bending connector 40. At the same time, the time of assembly can be reduced, and the cost of the bending connector 40 can be lowered.

[0061] Furthermore, a material of the bending connector 40 is copper, aluminum or steel. In this way, the bending connector 40 has relatively good strength and corrosion resistance, and hardly deforms in operation. In addition, the bending connector 40 is formed by stamping and stretching using a stamping die, which facilitates industrialized production. In some embodiments, the bending connector 40 may be made of different materials and production processes according to actual needs, as long as the same or similar functional characteristics can be achieved.

[0062] Referring to FIG. 10 to FIG. 12, the plurality of first flat pipes 21 and the plurality of circular pipes 321 are interlaced, and the first flat pipe 21 is connected to and in communication with an adjacent circular pipe 321 via the bending connector 40, which further improves the heat exchange performance of the heat exchanger 100. Since

the plurality of first flat pipes 21 and the plurality of circular pipes 321 are interlaced, a side of one of the plurality of first flat pipes 21 is corresponding to the plurality of fin units 10. Therefore, the medium in the first flat pipe 21 can not only exchange heat via fin structures at both sides of the first flat pipe 21 along the length direction of the fin unit 10, but also exchange heat via fin structures at a side of the circular pipe 321 along the width direction of the fin unit 10, so as to make full use of the plurality of fin units 10 to exchange heat, thereby further improving the heat exchange performance.

[0063] Optionally, the first flat pipe 21 and adjacent two circular pipes 321 are arranged in an equilateral triangle-shape, which can ensure that heat exchange at both sides of the first flat pipe 21 can be improved via the fin unit 10, so that the heat exchange efficiency of the fin unit 10 can be improved, thereby improving a cost performance of the heat exchanger 100.

[0064] Furthermore, referring to FIG. 12, a width of each of the plurality of first flat pipes is defined as $L1$, and the width $L1$ of each of the plurality of first flat pipes satisfies a following formula: $6\text{ mm} < L1 \leq 20\text{ mm}$. By properly setting the width $L1$ of the first flat pipe 21, a discharging performance of the heat exchanger 100 and the heat exchange performance of the heat exchanger 100 can be balanced. If the width of the first flat pipe 21 is greater than 20 mm, the width of the first flat pipe 21 is unduly great. When the heat exchanger is used as an evaporator, water may easily accumulate on the first flat pipe 21. The heat exchange performance of the heat exchanger 100 may be influenced if the water is not timely discharged. If both the width of the first flat pipe 21 is smaller than 6 mm, the width of the first flat pipe 21 is unduly small, and a contact area between the first flat pipe 21 and the fin unit 10 becomes smaller, which reduces the heat exchange performance of the heat exchanger 100.

[0065] In some embodiments, the width of the first flat pipe 21 can be adjusted according to actual needs. For example, the width of the first flat pipe 21 can be selected from 10 mm, 12 mm, 14 mm or 16 mm, as long as the width of the first flat pipe 21 satisfy the range of the width of the first flat pipe 21 described above.

[0066] Referring to FIG. 10 and FIG. 13, in some embodiments, the heat exchanger 100 further includes a collecting pipe 70, an end of one of adjacent two circular pipes 321 away from the bending connector 40 is connected to and in communication with the distributor 60, and an end of the other of the adjacent two circular pipes 321 away from the bending connector 40 is connected to and in communication with the collecting pipe 70. The medium flows into the plurality of circular pipes 321 via the distributor 60. After the heat exchange process, the medium flows into the collecting pipe 70 via the plurality of circular pipes 321, so as to realize distribution and collection of the medium.

[0067] Referring to FIG. 10, a bending portion 322 is defined by an end of the circular pipe 321 away from the

bending connector 40 bending, and the bending portion 322 is connected to and in communication with the distributor 60. Since both the distributor 60 and the collecting pipe 70 are disposed at a side of the heat exchanger 100 away from the bending connector 40, the bending portion 322 formed by bending of the circular pipe 321 connecting to the distributor 60 can facilitate assembly of the heat exchanger 100.

[0068] Specifically, the bending portion 322 is L-shaped, which facilitates assembly of the heat exchanger 100. In some embodiments, the bending portion 322 can be in other shapes, for example, the bending portion 322 can be U-shaped or V-shaped.

[0069] Furthermore, the distributor 60 is provided with a plurality of capillary pipes 6, and the medium flows into the circular pipe 321 via the capillary pipe 6 provided on the distributor 60. By changing a length of the capillary pipe 6, the flow rate of the medium can be controlled to meet different heat exchange requirements.

[0070] Referring to FIG. 4 and FIG. 12, the unit fin 10 includes a first fin 11 and a second fin 12, the first pipeline unit 2 penetrates through the first fin 11, and the second pipeline unit 3 penetrates through the second fin 12. Specifically, the first flat pipe 21 penetrates through the first fin 11, and the second flat pipe 311 or the circular pipe 321 penetrates through the second fin 12. The second fin 12 is located at a side of first fin 11 adjacent to the first flat pipe 21 and abuts against the first fin 11. In this way, the medium in the first flat pipe can not only exchange heat via the first fin 11, but also exchange heat via the second fin 12 at a side of the first flat pipe 21, so that the medium can make full use of the fin unit 10 to exchange heat and the heat exchange performance is enhanced.

[0071] In some embodiments, a width of the first fin 11 is defined as $W1$, and a width of the second fin 12 is defined as $W2$, and the width $W1$ of the first fin 11 and the width $W2$ of the second fin 12 satisfy with a following formula: $W2 < W1$. The first flat pipe 21 having a greater cross section area penetrates through the first fin 11 having a wider width, and the second flat pipe 311 having a smaller cross section area penetrates through the second fin 12 having a narrower width. By choosing proper fin unit 10, the heat exchange efficiency of the heat exchanger 100 can be further improved.

[0072] Specifically, the width $W1$ of the first fin 11 and the width $W2$ of the second fin 12 satisfy with a following formula: $8\text{ mm} < W2 < W1 < 27\text{ mm}$. If both the width $W1$ of the first fin 11 and the width $W2$ of the second fin 12 are greater than 27 mm, the temperature of an end of the first fin 11 away from the flat pipe and the temperature of an end of the second fin 12 away from the flat pipe are lower, leading to a faster frost rate and conditions of frost blockage. If both the width $W1$ of the first fin 11 and the width $W2$ of the second fin 12 are smaller than 8 mm, a heat exchange area of the first fin 11 and a heat exchange area of the second fin 12 are decreased, lowering the heat exchange performance of the heat exchanger 100.

[0073] Furthermore, the first fin 11 is located at the

leeward side of the heat exchanger 100, and the second fin 12 is located at the windward side of the heat exchanger 100, and the structure of the first fin 11 and the structure of the second fin 12 can be chosen according to different heat exchange requirements. For example, since the second fin 12 is located at the windward side of the heat exchanger 100, the second fin can have a structure having a plurality of openings, so as to improve the heat exchange performance of the heat exchanger 100. It facilitates discharge of the condensate water to set the first fin 11 located at the leeward side of the heat exchanger 100 as a plane structure. In this way, not only the heat exchange efficiency of the heat exchanger 100, but also the discharge efficiency of the heat exchanger 100 can be ensured. In some embodiments, the first fin 11 and the second fin 12 can be in other structures, as long as the same or similar effects can be achieved.

[0074] It should be noted that, the structure having a plurality of openings can be a second fin 12 provided with a plurality of openings protruding out from a surface of the fin body; optionally, the structure having a plurality of openings can be a lamina and the second fin 12 is provided with through holes. The through hole penetrates along the length direction of the second fin 12, both ends of the lamina is connected to one of the through holes, and an air outlet is disposed between the lamina and the surface of the second fin 12, so that an air channel is defined by the air outlet and the corresponding through hole.

[0075] Referring to FIG. 10, the heat exchanger 100 includes a plurality of heat exchange loop. In some embodiments, the heat exchange loop includes adjacent two circular pipes 321, two adjacent first flat pipes 21, and two bending connectors 40 and one bending pipe 50 configured for connecting and communicating the two adjacent first flat pipes 21. One of the adjacent two circular pipes 321 is connected and in communication with one of the adjacent two first flat pipes 21 via one of the two bending connectors 40, and the other of the adjacent two circular pipes 321 is connected and in communication with the other of the adjacent two first flat pipes 21 via the other of the two bending connectors 40. An end of one of the adjacent two circular pipes 321 away from the bending connector 40 is connected and in communication with the distributor 60, and an end of the other of the adjacent two circular pipes 321 away from the bending connector 40 is connected and in communication with the collecting pipe 70.

[0076] When the heat exchanger 100 is in operation, the medium flows in the heat exchanger 100 via the distributor 60, flows into the circular pipe 321 connected to and in communication with the distributor 60 via the capillary pipe 6, and exchange heat with the outside world via the second fin 12. Part of the liquid medium converts to gas and the flow rate of the medium increases. Then, the medium flows into an adjacent first flat pipe 21 via the bending connector 40. Since the first flat pipe is provided with a plurality of microchannels, a contact area between

the first flat pipe and the medium increases and the flow rate of the medium decreases, so that the medium exchanges heat sufficiently with the first flat pipe 21. Then the medium flows into another adjacent first flat pipe 21 via the bending pipe 50, flows into another circular pipe 321 via a bending connector 40 connected to the adjacent first flat pipe 21 and is subjected to a following heat exchange process. Finally, the medium flows out of the heat exchanger 100 via the collecting pipe 70. In this way, circulation paths of the medium in the heat exchanger 100 increases, and the use ratio of the medium increases. The medium is distributed more evenly, and the heat exchange performance is significantly improved. In addition, since multipath is achieved by the bending connector 40 and the bending pipe 50, it is only necessary for the collecting pipe 70 to collect the medium at the last, and does not need to take into account diversion of the medium. Thus, spacer plates provided in the collecting pipe 70 can be omitted, so that processing of the collecting pipe 70 can be simplified. In addition, since a plurality of heat exchange loops share on distributor 60 and one collecting pipe 70, the cost of the heat exchanger 100 can be saved.

[0077] In the present embodiment, the number of the heat exchange loop is six. In other embodiments, the number of the heat exchange loop can be decided according to actual heat exchange requirement, e.g., the number of the heat exchange loop can be four, five, seven or eight.

[0078] In some embodiments, in the heat exchange loop, the number of the circular pipe 321, the number of the bending connector 40, the number of the first flat pipe 21 and the number of the bending pipe 50 can be decided according to actual requirements, and the location of the bending connector 40 and the location of the bending pipe 50 can be determined according to actual requirements. For example, the heat exchange loop can include one circular pipe 321, one bending connector 40 and one first flat pipe 21. When the heat exchanger is in operation, a medium enters from the distributor 60, and flows into the circular pipe 321 via the capillary pipe 6, and flows into the first flat pipe via the bending connector 40, and then flows out of the heat exchange loop from the collecting pipe 70.

[0079] 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 invention.

[0080] The above-described embodiments are only several implementations of the present invention, and the descriptions are relatively specific and detailed, but they should not be construed as limiting the scope of the present invention. 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 invention, and all fall within the protection scope of the present invention. Therefore, the patent protection of the present invention shall be defined by the appended claims.

Claims

1. A heat exchanger, comprising

a plurality of fin units, wherein the plurality of fin units are spaced from each other and arranged side by side;

a first pipeline unit penetrating through the plurality of fin units, wherein the first pipeline unit comprises a plurality of first pipelines arranged at intervals along a length direction of the plurality of fin units; and

a second pipeline unit penetrating through the plurality of fin units, wherein the second pipeline unit and the first pipeline unit are spaced from each other along a width direction of the plurality of fin units, and the second pipeline unit comprises a plurality of second pipelines arranged at intervals along the length direction of the plurality of fin units;

characterized in that a pipeline structure of the plurality of second pipelines is different from a pipeline structure of the plurality of first pipelines.

2. The heat exchanger of claim 1, wherein the first pipeline unit is a first flat pipe unit, the first flat pipe unit comprises a plurality of first flat pipes arranged at intervals along the length direction of the plurality of fin units, the second pipeline unit is a second flat pipe unit, and the second flat pipe unit comprises a plurality of second flat pipes arranged at intervals along the length direction of the plurality of fin units; wherein the plurality of first flat pipes and the plurality of second flat pipes are interlaced and a cross sectional area of each of the plurality of first flat pipes is greater than a cross sectional area of each of the plurality of second flat pipes.

3. The heat exchanger of claim 2, wherein a length of each of the plurality of first flat pipes is equal to a length of each of the plurality of second flat pipes, and a pipe thickness of the plurality of first flat pipes is equal to a pipe thickness of each of the plurality of second flat pipes; a width of each of the plurality of first flat pipes is defined as $L1$, a width of each of the plurality of second flat pipes is defined as $L2$, and the width $L1$ of each of the plurality of first flat pipes and the width $L2$ of each of the plurality of second flat pipes satisfy a following formula: $6\text{ mm} \leq L2 < L1 \leq 20\text{ mm}$; optionally,

a length of each of the plurality of first flat pipes is equal to a length of each of the plurality of second flat pipes, and a width of the plurality of first flat pipes is equal to a width of each of the plurality of second flat pipes; a pipe thickness of each of the plurality of first flat pipes is defined as $H1$, a pipe thickness of each of the plurality of second flat pipes is defined as $H2$, and the pipe thickness $H1$ of each of the plurality of first flat pipes and the pipe thickness $H2$ of each of the plurality of second flat pipes satisfy a following formula: $1\text{ mm} \leq H2 < H1 \leq 5\text{ mm}$.

4. The heat exchanger of claim 2, wherein one of the plurality of first flat pipes and adjacent two of the plurality of second pipes are arranged in an equilateral triangle-shape;

a vertical distance between a central plane of one of the plurality of first flat pipes along the length direction of the plurality of fin units and a central plane of an adjacent second pipe along the length direction of the plurality of fin units is defined as S , and the vertical distance S between the central plane of one of the plurality of first flat pipes along the length direction of the plurality of fin units and the central plane of the adjacent second pipe along the length direction of the plurality of fin units satisfy a following formula: $12\text{ mm} \leq S \leq 25\text{ mm}$.

5. The heat exchanger of claim 2, further comprising a distributor and an adapting unit, the distributor comprises a first capillary pipe and a second capillary pipe, a pipe size of the first capillary pipe is greater than a pipe size of the second capillary pipe; wherein the first capillary pipe is connected to and in communication with one of the plurality of first flat pipes via the adapting unit, and the second capillary pipe is connected to and in communication with one of the plurality of second flat pipes via the adapting unit.

6. The heat exchanger of claim 5, wherein the adapting unit comprises a first adapter and a second adapter, one end of the first adapter fits with the first capillary pipe, the other end of the first adapter fits with a corresponding first flat pipe of the plurality of first flat pipes; and one end of the second adapter fits with the second capillary pipe, and the other end of the second adapter fits with a corresponding second flat pipe of the plurality of second flat pipes.

7. The heat exchanger of claim 1, wherein the first pipeline unit is a first flat pipe unit, the first flat pipe unit comprises a plurality of first flat pipes arranged at intervals along the length direction of the plurality of fin units, the second pipeline unit is a circular pipe unit, and the circular pipe unit comprises a plurality of circular pipes arranged at intervals along the length direction of the plurality of fin units;

wherein the heat exchanger further comprises a bending connector, one end of the bending connector is connected to and in communication with a corresponding circular pipe of the plurality of circular pipes, and the other end of the bending connector is connected to and in communication with a corresponding first flat pipe of the plurality of first flat pipes.

8. The heat exchanger of claim 7, wherein the bending connector comprises a first connecting portion, wherein one end of the first connecting portion is connected to and in communication with a corresponding first flat pipe of the plurality of first flat pipes;

a second connecting portion, wherein one end of the second connecting portion is connected to and in communication with the corresponding circular pipe of the plurality of circular pipe; and a twisting portion, wherein one end of the twisting portion is connected to and in communication with one end of the first connecting portion away from the corresponding first flat pipe of the plurality of first flat pipes, and the other end of the twisting portion is connected to and in communication with one end of the second connecting portion away from the corresponding circular pipe of the plurality of circular pipes.
9. The heat exchanger of claim 8, wherein the first connecting portion fits with the corresponding first flat pipe of the plurality of first flat pipes, and at least part of the corresponding first flat pipe of the plurality of first flat pipes penetrates into the first connecting portion; the second connecting portion fits with the corresponding circular pipe of the plurality of circular pipes, and at least part of the corresponding circular pipe of the plurality of circular pipes penetrates into the second connecting portion; and the twisting portion is U-shaped, and a cross section of one end of the twisting portion is kidney-shaped, a cross section of the other end of the twisting portion is circular-shaped, and the one end of the twisting portion with the kidney-shaped cross section is in a smooth transition to the other end of the twisting portion with the circular-shaped cross section.
10. The heat exchanger of claim 7, wherein the plurality of first flat pipes and the plurality of circular pipes are interlaced, and one of the plurality of first flat pipes is connected to and in communication with an adjacent circular pipe of the plurality of circular pipes via the bending connector.
11. The heat exchanger of claim 7, wherein the heat exchanger further comprises a plurality of bending pipes, and ends of the adjacent two of the plurality of first flat pipes away from the bending connector are connected to and in communication with each other

via corresponding one of the plurality of bending pipes.

12. The heat exchanger of claim 7, further comprising a distributor and a collecting pipe, wherein an end of one of adjacent two of the plurality of circular pipes away from the bending connector is connected to and in communication with the distributor, and an end of the other of the adjacent two of the plurality of circular pipes away from the bending connector is connected to and in communication with the collecting pipe.
13. The heat exchanger of claim 12, wherein a bending portion is defined by an end of each of the plurality of circular pipes away from the bending connector bending, and the bending portion is connected to and in communication with the distributor.
14. The heat exchanger of claim 1, wherein the plurality of fin units comprises a first fin and a second fin, the first pipeline unit penetrates through the first fin, and the second pipeline unit penetrates through the second fin;
wherein the second fin is located at a side of the first fin adjacent to the first pipeline unit and abuts against the first fin.
15. The heat exchanger of claim 14, wherein a width of the first fin is defined as $W1$, a width of the second fin is defined as $W2$, and the width $W1$ of the first fin and the width $W2$ of the second fin satisfy with a following formula: $W2 < W1$.

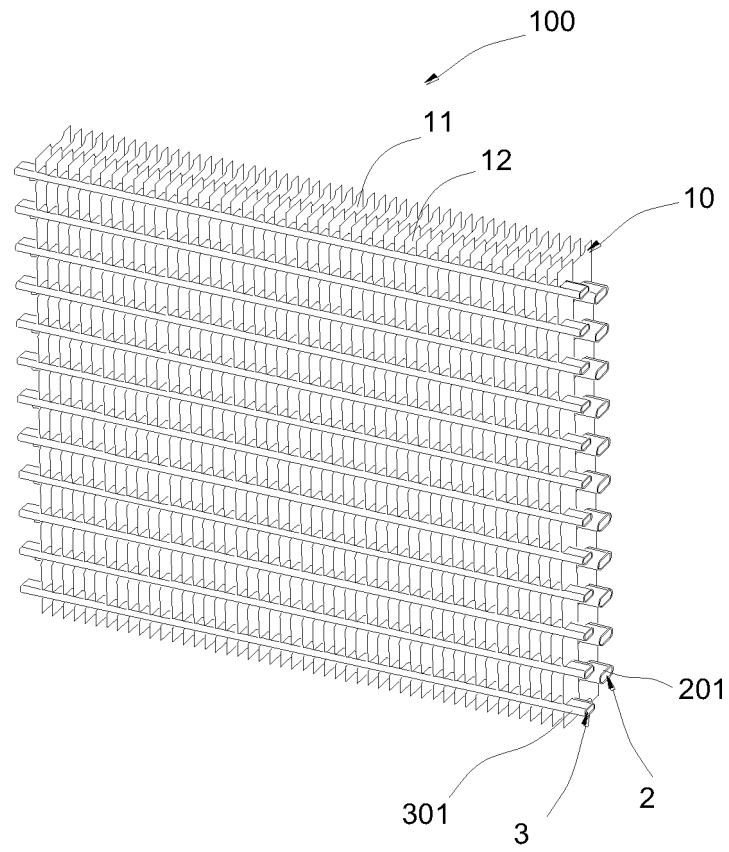


FIG. 1

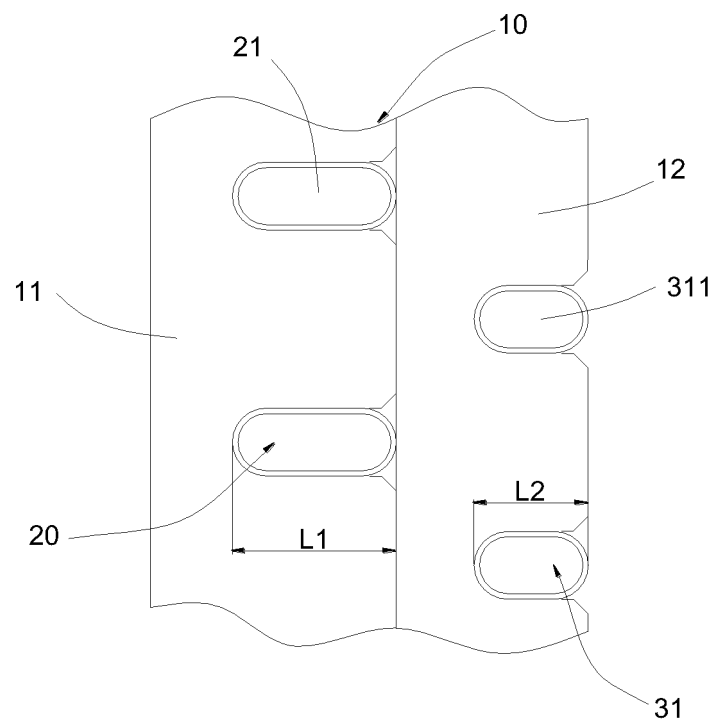


FIG. 2

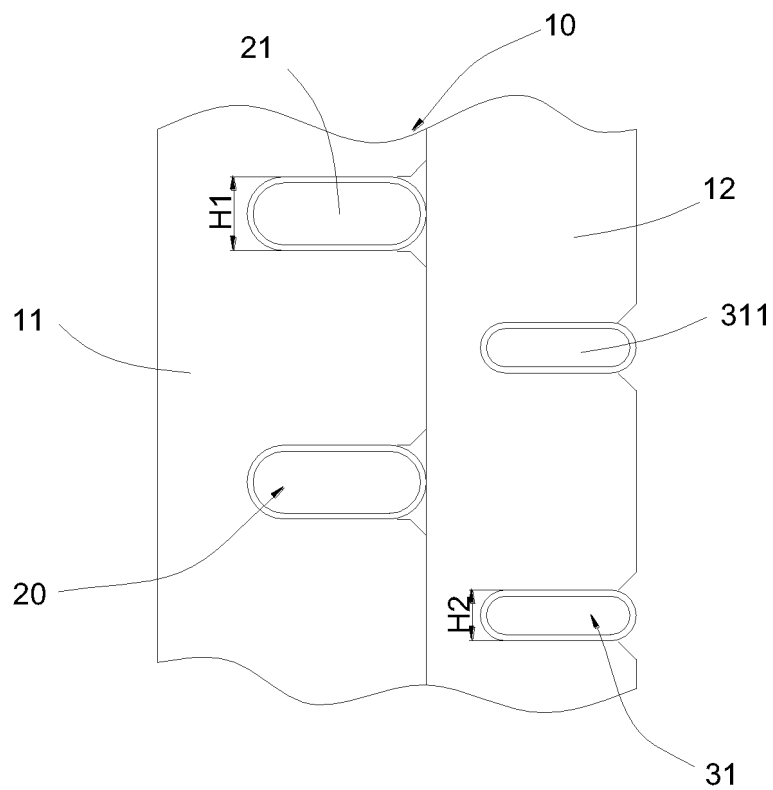


FIG. 3

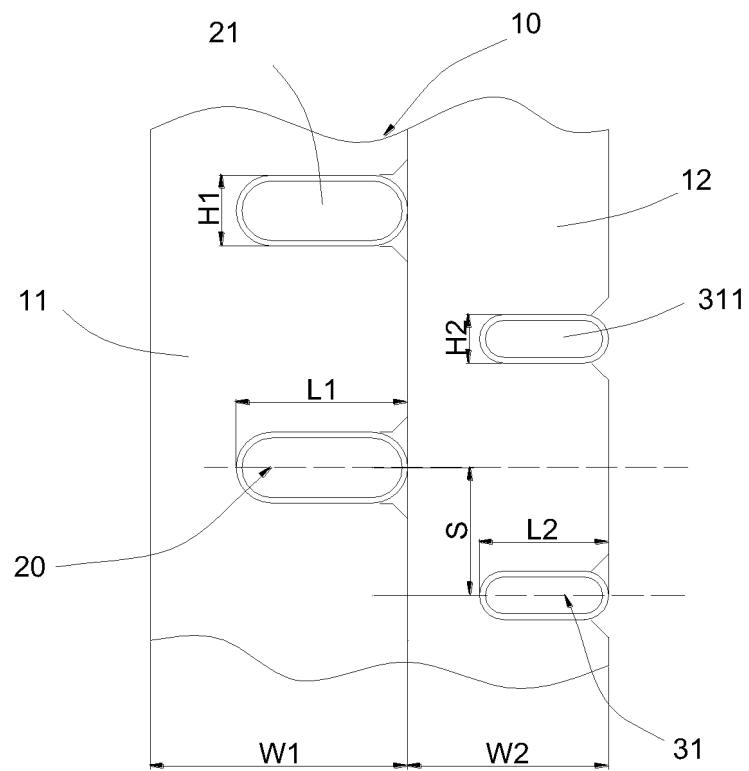


FIG. 4

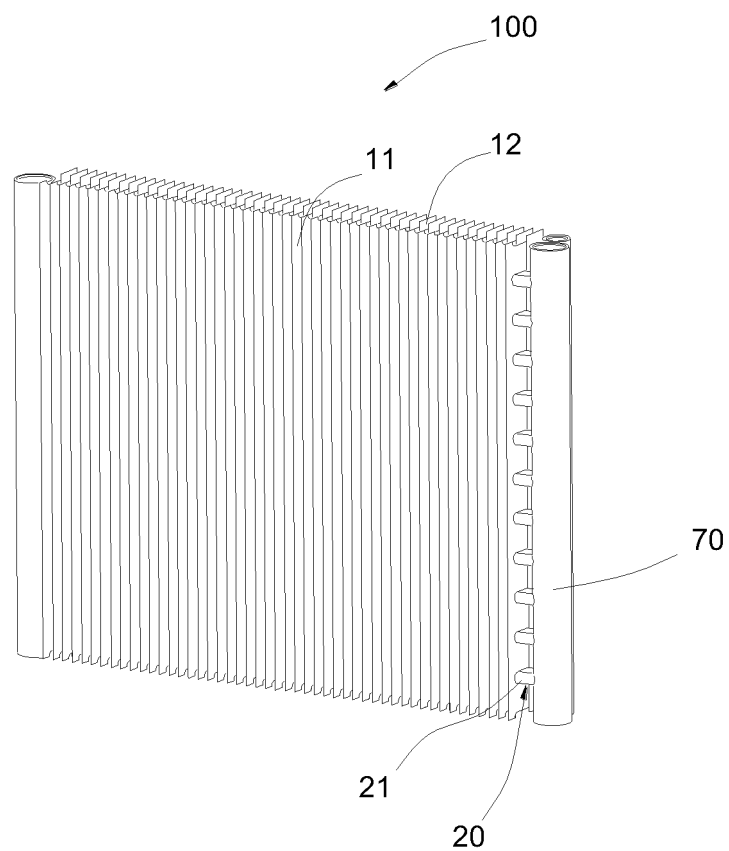


FIG. 5

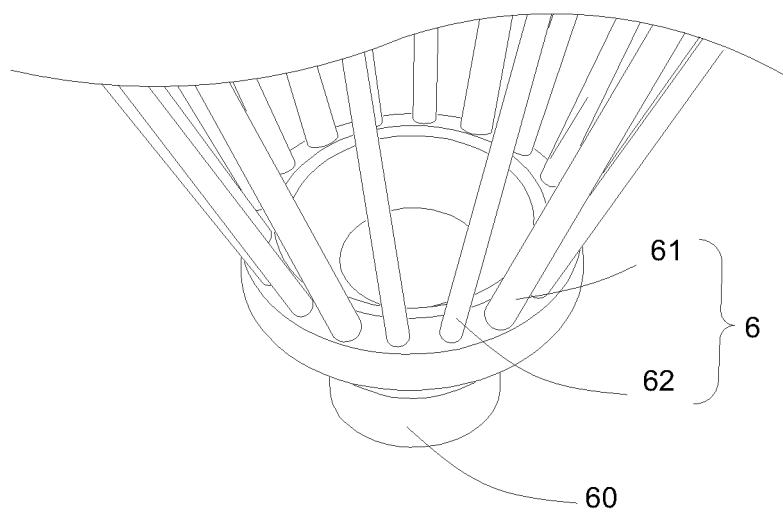


FIG. 6

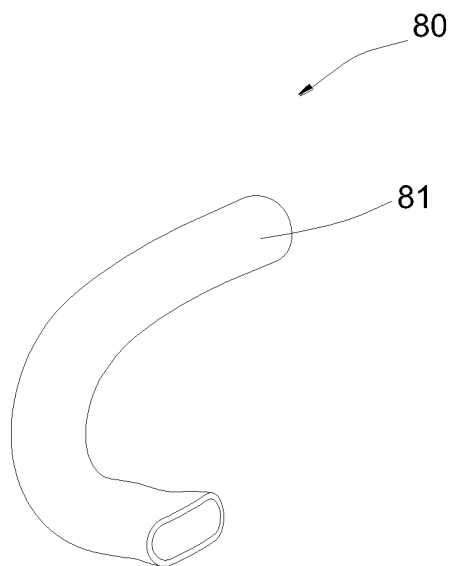


FIG. 7

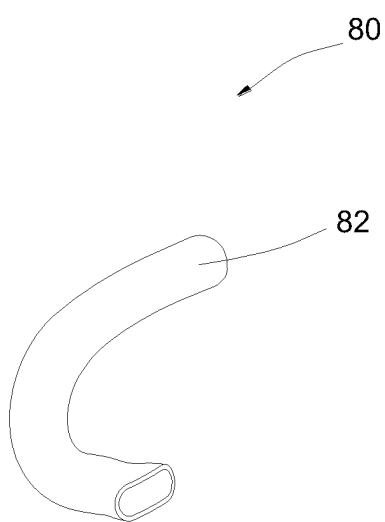


FIG. 8

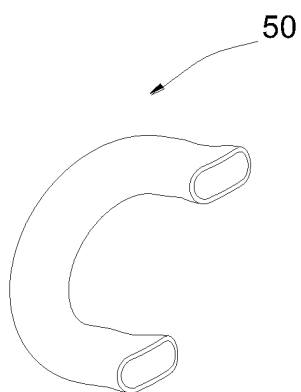


FIG. 9

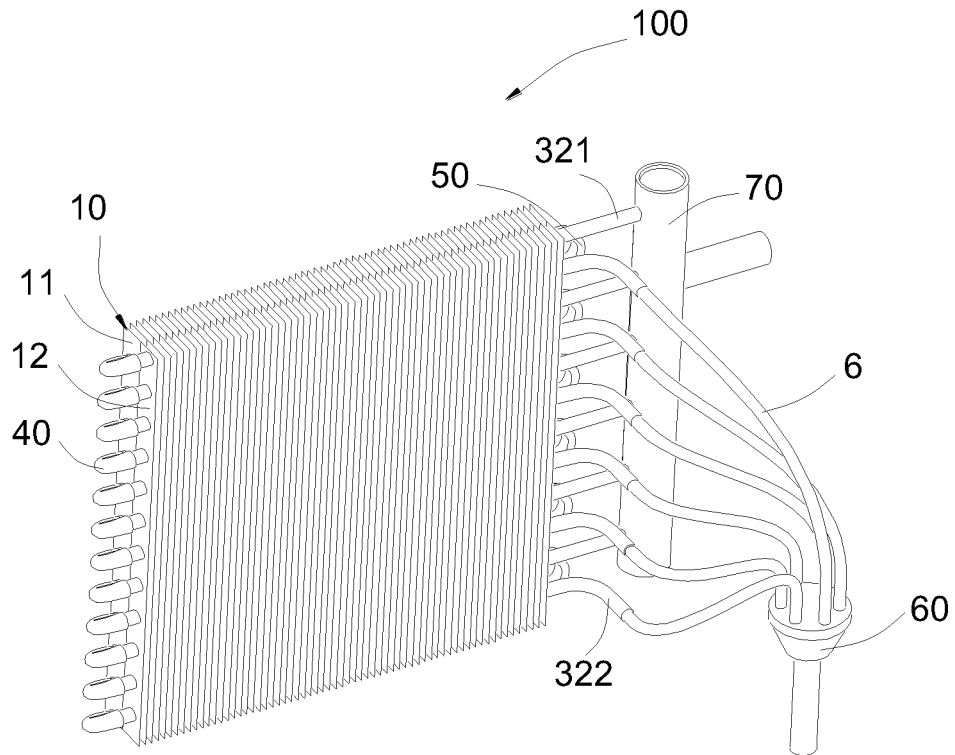


FIG. 10

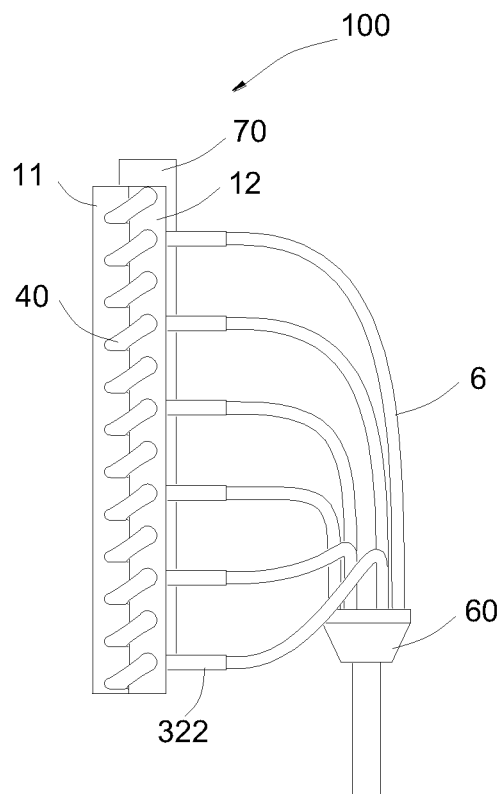


FIG. 11

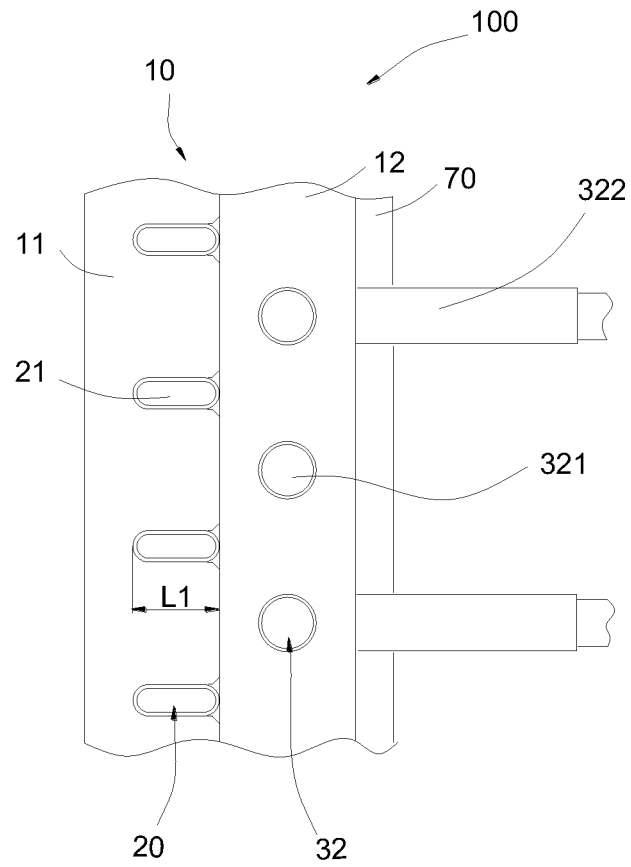


FIG. 12

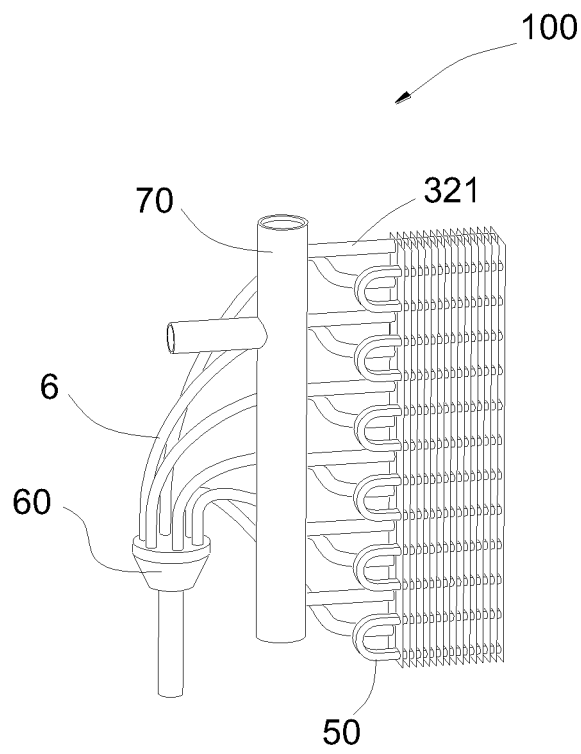


FIG. 13

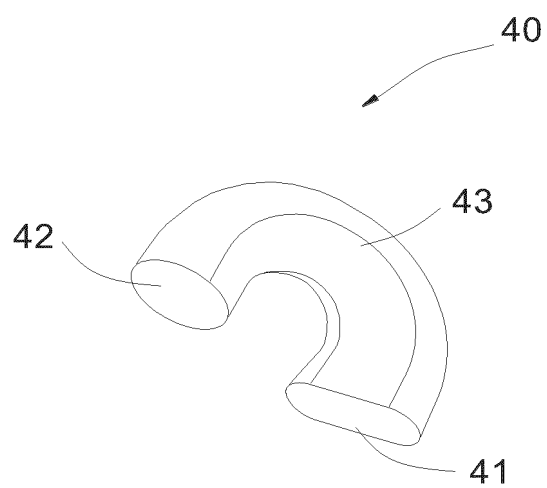


FIG. 14

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2023/090982

A. CLASSIFICATION OF SUBJECT MATTER

F28F1/32(2006.01)i; F28F9/26(2006.01)i; F28D1/053(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)

IPC:F28F; F28D

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)

CNABS; CNTXT; VEN; WPABS; ENTXTC; ENTXT; DWPI; CNKI: 超星读秀: 浙江盾安人工环境, 王炎峰, 王冠军, 丁二刚, 史俊茹, 热交换, 换热, 蒸发器, 冷凝器, 扁管, 圆管, 翅片, 第二, 毛细管, 分配, 分布, 分液, 弯头, heat exchang+, evaporator, condenser, condensator, flat, tube, pipe, round+, circular+, fin?, second+, capillar???, distribut+, divid+, dispens+, shunt, elbow

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 217383369 U (ZHEJIANG DUNAN THERMAL TECHNOLOGY CO., LTD.) 06 September 2022 (2022-09-06) description, paragraphs 45-73, and figures 1-9	1-6, 14-15
PX	CN 217383368 U (ZHEJIANG DUNAN THERMAL TECHNOLOGY CO., LTD.) 06 September 2022 (2022-09-06) description, paragraphs 40-66, and figures 1-5	1, 7-15
X	CN 100513977 C (PANASONIC CORP.) 15 July 2009 (2009-07-15) description, page 7, paragraph 5 to page 10, paragraph 3, and page 16, paragraph 1, and figures 1-2 and 7-8	1-4, 14, 15
Y	CN 100513977 C (PANASONIC CORP.) 15 July 2009 (2009-07-15) description, page 7, paragraph 5 to page 10, paragraph 3, and page 16, paragraph 1, and figures 1-2 and 7-8	5-13
Y	CN 208296385 U (ZHENGZHOU HAIER AIR-CONDITIONER CO., LTD.) 28 December 2018 (2018-12-28) description, paragraphs 33-59, and figures 1-4	5-6



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

12 July 2023

Date of mailing of the international search report

30 July 2023

Name and mailing address of the ISA/CN

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Beijing 100088

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2023/090982

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 5014372 B2 (MITSUBISHI ELECTRIC CORP.) 29 August 2012 (2012-08-29) description, paragraphs 11-21, and figures 1-4	7-13
Y	JP 2010185614 A (MITSUBISHI ELECTRIC CORP.) 26 August 2010 (2010-08-26) description, paragraphs 12-22, and figures 1-8	7-13
X	US 2022065556 A1 (SAMSUNG ELECTRONICS CO., LTD.) 03 March 2022 (2022-03-03) description, paragraphs 75-82, and figures 1 and 13-20	1-4, 14, 15
X	JP 5014372 B2 (MITSUBISHI ELECTRIC CORP.) 29 August 2012 (2012-08-29) description, paragraphs 11-21, and figures 1-4	1, 14, 15
Y	US 2022065556 A1 (SAMSUNG ELECTRONICS CO., LTD.) 03 March 2022 (2022-03-03) description, paragraphs 75-82, and figures 1 and 13-20	5-13
A	JP H08200886 A (YANMAR DIESEL ENGINE CO.) 06 August 1996 (1996-08-06) entire document	1-15

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2023/090982

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CN 217383368 U	06 September 2022	None	
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		JP 2007183088 A	19 July 2007
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		JP 2022040969 A	11 March 2022
JP H08200886 A	06 August 1996	None	

Form PCT/ISA/210 (patent family annex) (July 2022)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 202221016299 [0001]
- CN 202221057985 [0001]