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Zhao et al.

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(45) Date of Patent: Aug. 19, 2025

(54) AIR CONDITIONER

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Related U.S. Application Data

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Jul. 26, 2021 (CN) 202110845581.9

(51) **Int. Cl.**
F24F 1/0063 (2019.01)
F24F 1/0068 (2019.01)
(Continued)

(52) **U.S. Cl.**
CPC ***F24F 1/0063*** (2019.02); ***F24F 1/0068*** (2019.02); ***F25B 39/00*** (2013.01);
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(58) **Field of Classification Search**
CPC F24F 1/0063; F24F 1/0068; F28D 1/0476; F28D 1/05391; F28F 1/128; F28F 1/325;
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(56) **References Cited**

U.S. PATENT DOCUMENTS

2016/0223265 A1 8/2016 Jindou et al.
2016/0327343 A1 11/2016 Hwang et al.
(Continued)

FOREIGN PATENT DOCUMENTS

CN 101619912 A 1/2010
CN 201680652 U 12/2010
(Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion dated Jun. 9, 2022 in corresponding International Application No. PCT/CN2022/081815, translated, 19 pages.
(Continued)

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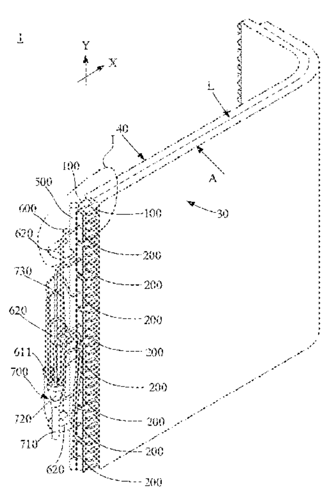
(57) **ABSTRACT**

An air conditioner includes a compressor and a heat exchanger. The heat exchanger includes a first heat exchanger, a second heat exchanger, a plurality of connectors, at least one first header, a second header, and a main air pipe assembly. A plurality of flat pipes in the second heat exchanger correspond to a plurality of flat pipes in the first heat exchanger. The plurality of connectors are arranged corresponding to the plurality of flat pipes in the first heat exchanger. The at least one first header is connected to first ends of the plurality of flat pipes in the first heat exchanger. The second header is connected to first ends of the plurality
(Continued)



of flat pipes in the second heat exchanger. The main air pipe assembly makes the second header communicated with the compressor.

18 Claims, 18 Drawing Sheets

(51) **Int. Cl.**

F25B 39/00	(2006.01)
F25B 39/02	(2006.01)
F28D 1/047	(2006.01)
F28D 1/053	(2006.01)
F28F 9/02	(2006.01)

(52) **U.S. Cl.**
CPC ***F25B 39/028*** (2013.01); *F28D 1/0476* (2013.01); *F28D 1/05391* (2013.01); *F28F 9/0275* (2013.01)

(58) **Field of Classification Search**
CPC F28F 9/0275; F25B 13/00; F25B 39/00; F25B 39/028
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2018/0010857	A1	1/2018	Yang et al.
2019/0234626	A1	8/2019	Onaka et al.
2022/0243988	A1	8/2022	Yamada et al.

FOREIGN PATENT DOCUMENTS

CN	202166234	U	3/2012	
CN	204085299	U	1/2015	
CN	104764255	A	7/2015	
CN	104764256	A	7/2015	
CN	205718555	U	11/2016	
CN	108088121	A	5/2018	
CN	108797048	A	11/2018	
CN	109990627	A	7/2019	
CN	211695162	U	10/2020	
CN	211926198	U	11/2020	
CN	112413932	A	2/2021	
CN	213178905	U	5/2021	
CN	214010051	U	8/2021	
CN	113587250	A	11/2021	
CN	113587251	A	11/2021	
JP	H0468297	A	3/1992	
JP	2013002688	A	1/2013	
WO	WO-2016174830	A1 *	11/2016	.... F24F 5/00
WO	2018040037	A1	3/2018	
WO	2020230737	A1	11/2020	

OTHER PUBLICATIONS

Chinese First Office Action dated May 31, 2022 in corresponding Chinese Application No. 202110845573.4, translated, 13 pages.
Chinese Second Office Action dated Oct. 9, 2022 in corresponding Chinese Application No. 202110845573.4, translated, 10 pages.
Chinese Decision of Rejection dated Feb. 3, 2023 in corresponding Chinese Application No. 202110845573.4, translated, 11 pages.
Chinese First Office Action dated May 7, 2022 in corresponding Chinese Application No. 202110845581.9, translated, 18 pages.
Chinese Notification to Grant Patent Right for Invention dated Oct. 10, 2022 in corresponding Chinese Application No. 202110845581.9, translated, 9 pages.

* cited by examiner

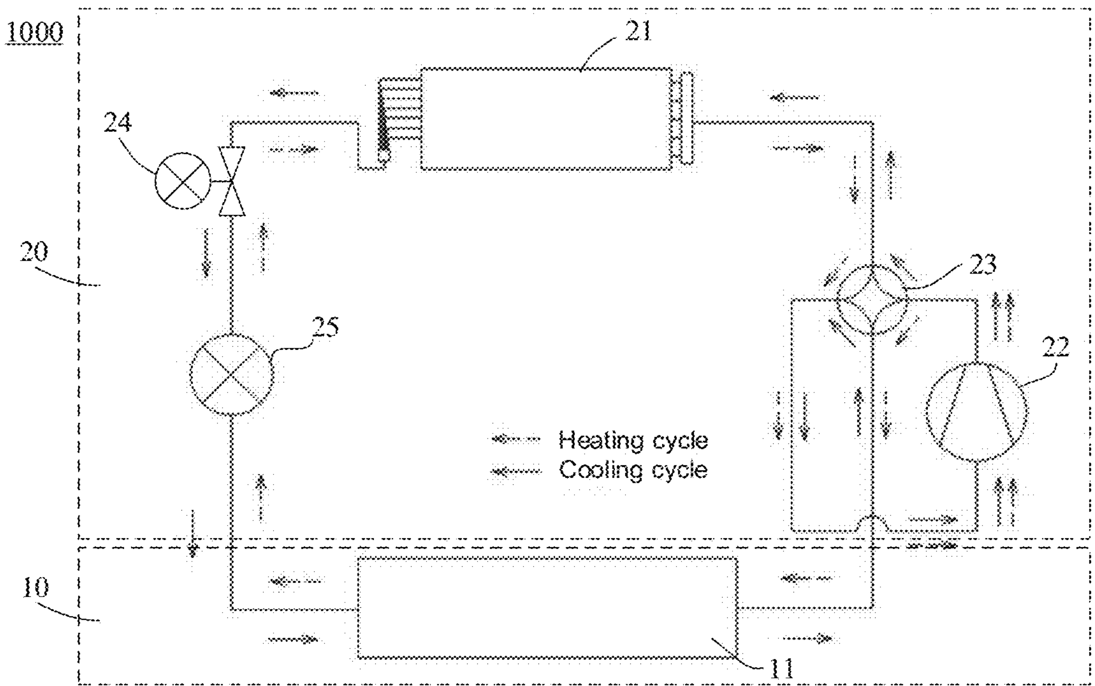

1000
21
24
20
23
25
22
Heating cycle
Cooling cycle
10
11

FIG. 1

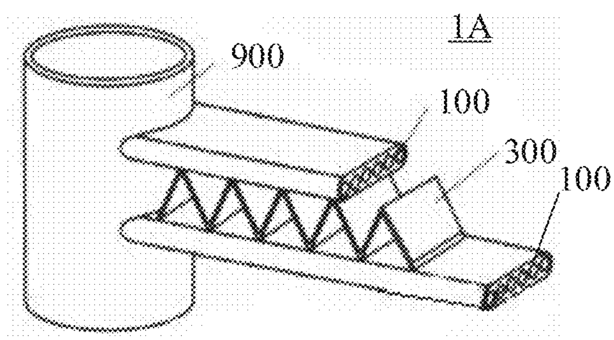

1A
900
100
300
100

FIG. 2

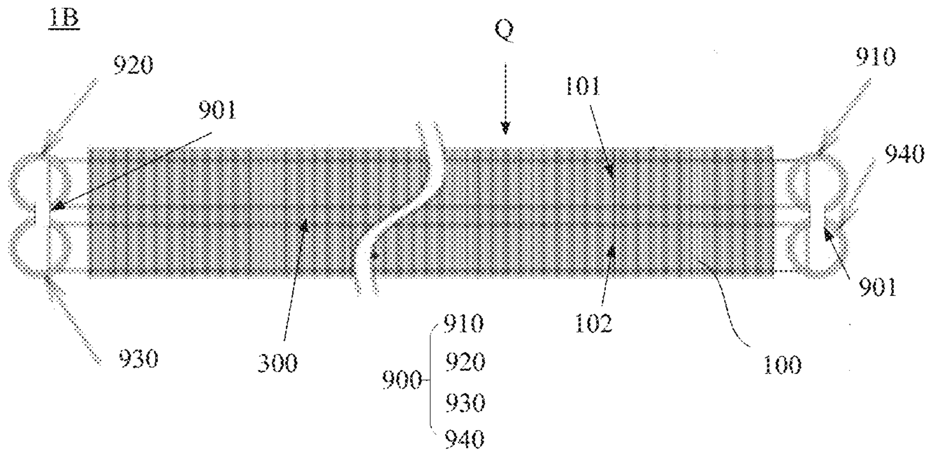

1B
Q
920
901
910
101
940
901
930
300
910
920
930
940
900
102
100

FIG. 3

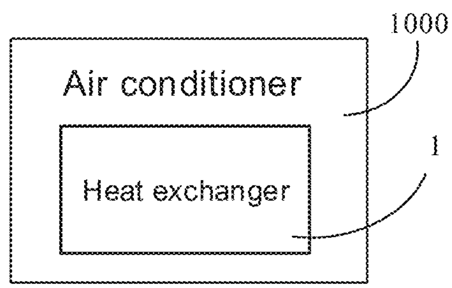

1000
Air conditioner
1
Heat exchanger

FIG. 4

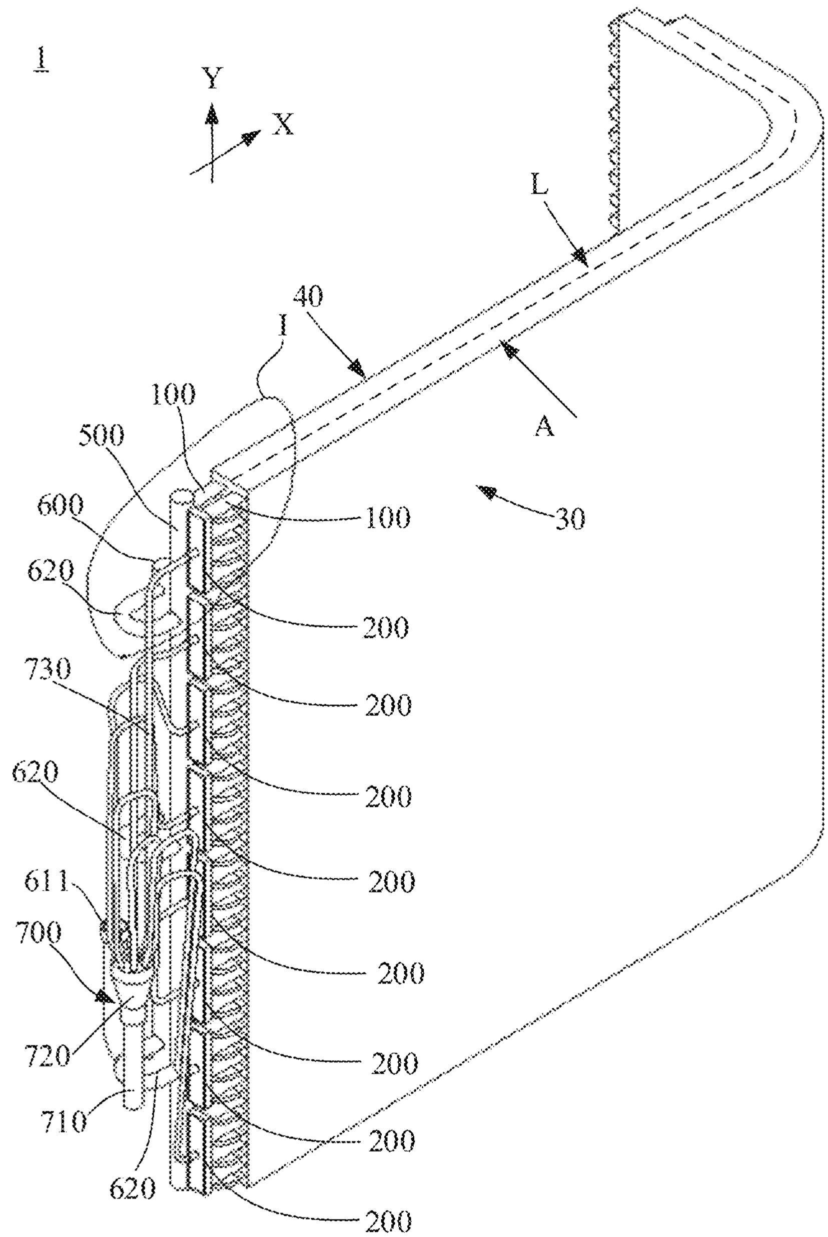

1
Y
X
L
40
I
A
100
500
100
30
600
620
200
730
200
620
200
200
611
700
200
720
200
710
200
620
200

FIG. 5

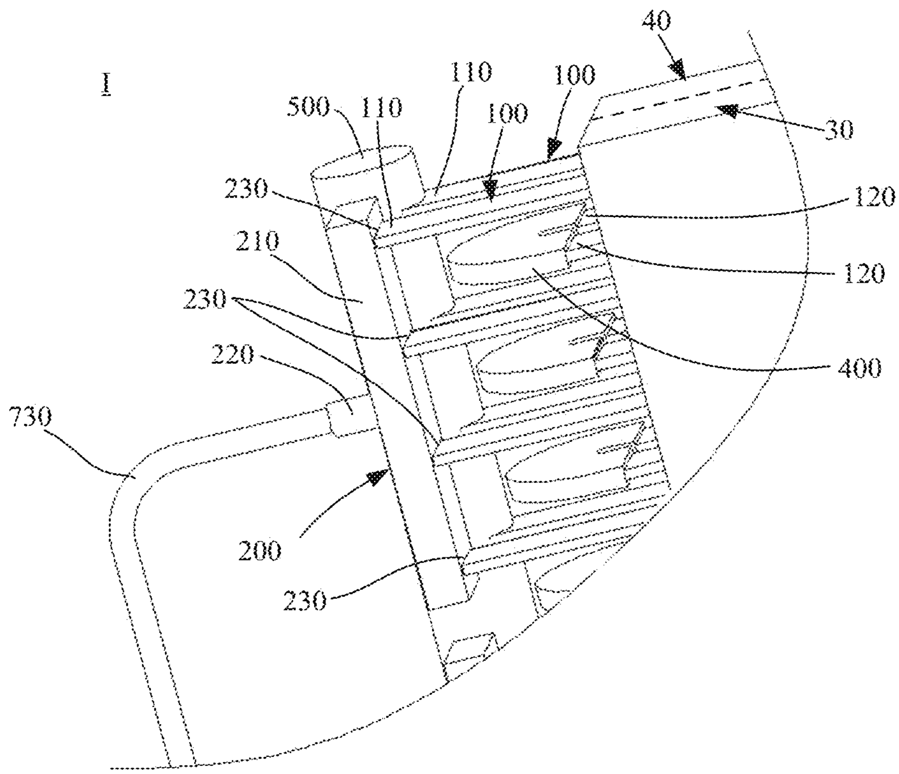

I
40
110
100
500
110
100
30
230
120
210
120
230
400
220
730
200
230

FIG. 6

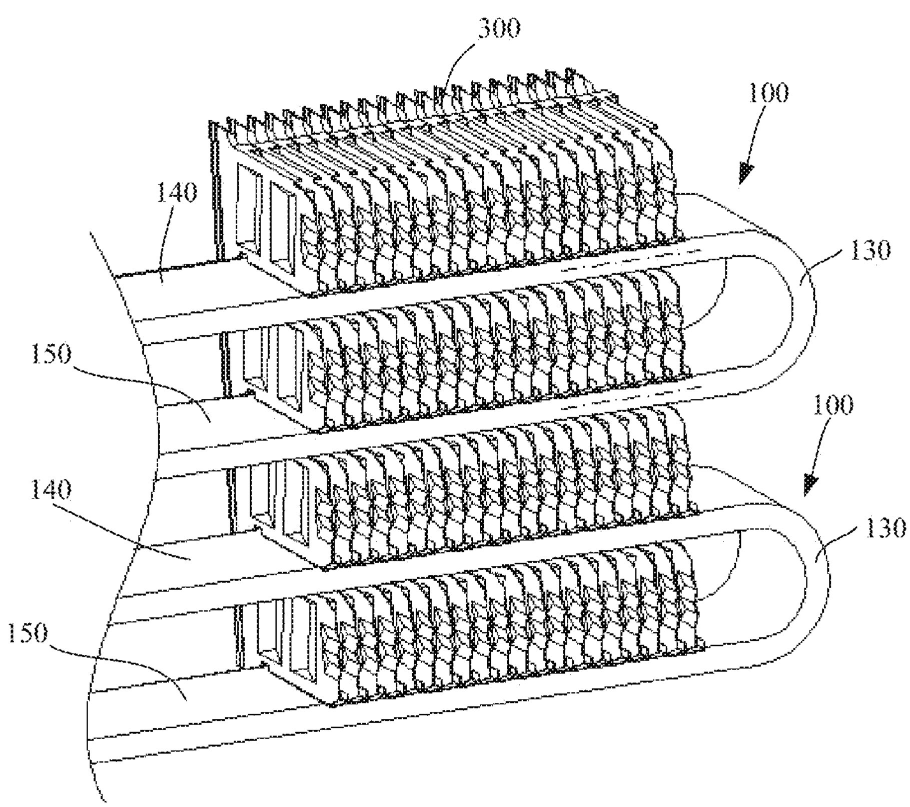


FIG. 7

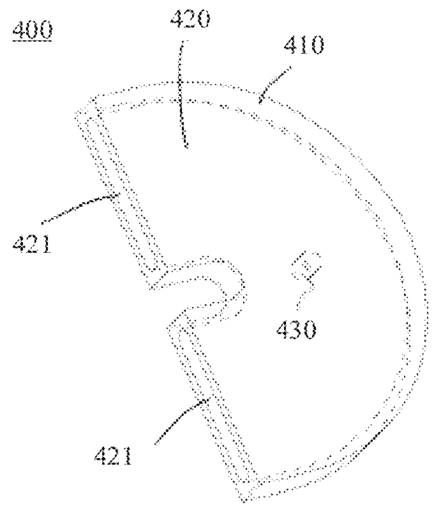


FIG. 8

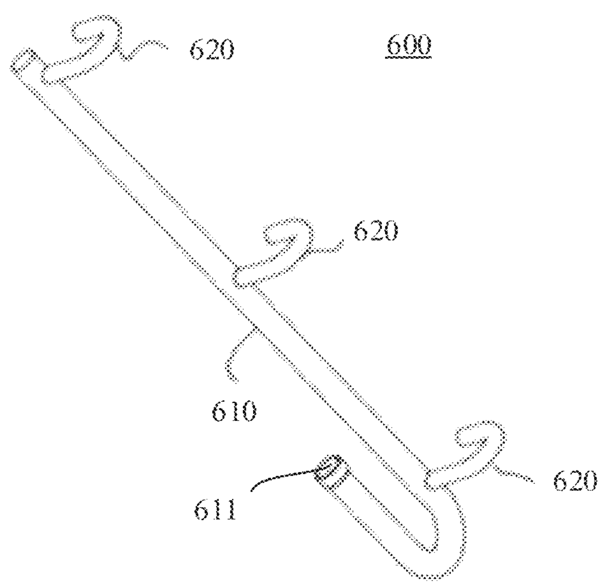


FIG. 9

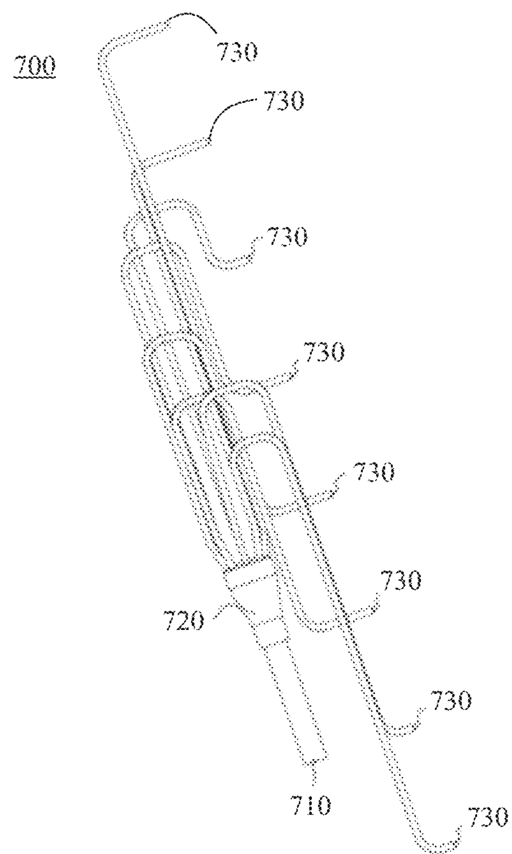


FIG. 10

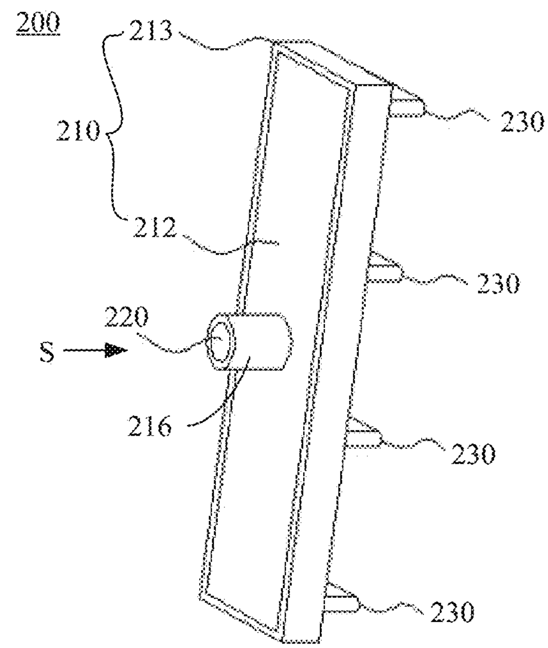

200
213
210
212
220
S
216
230
230
230
230

FIG. 11

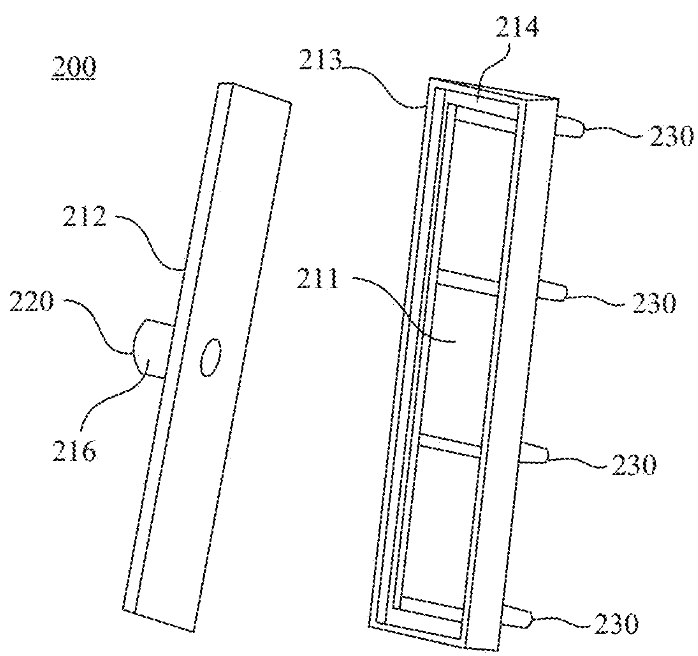

200
214
213
212
211
220
216
230
230
230
230

FIG. 12

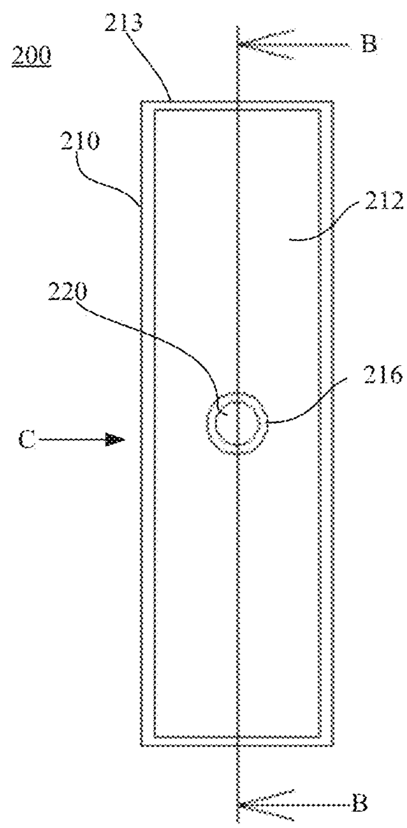


FIG. 13

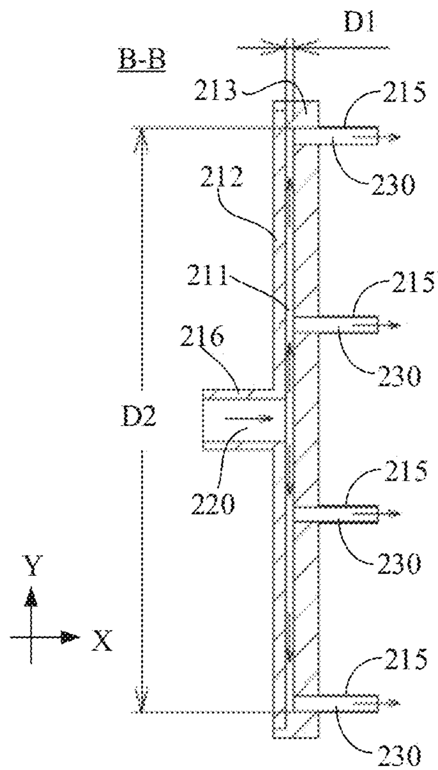


FIG. 14

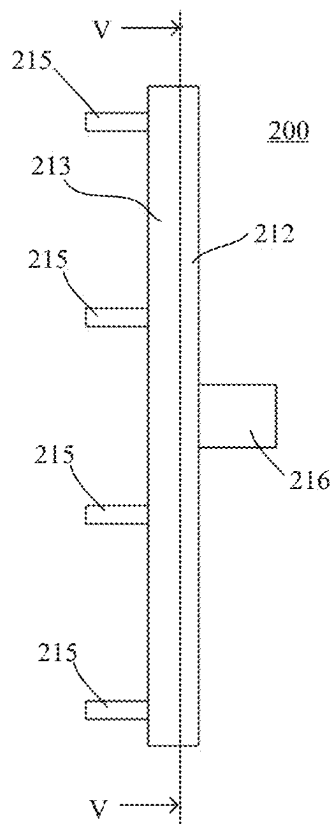


FIG. 15

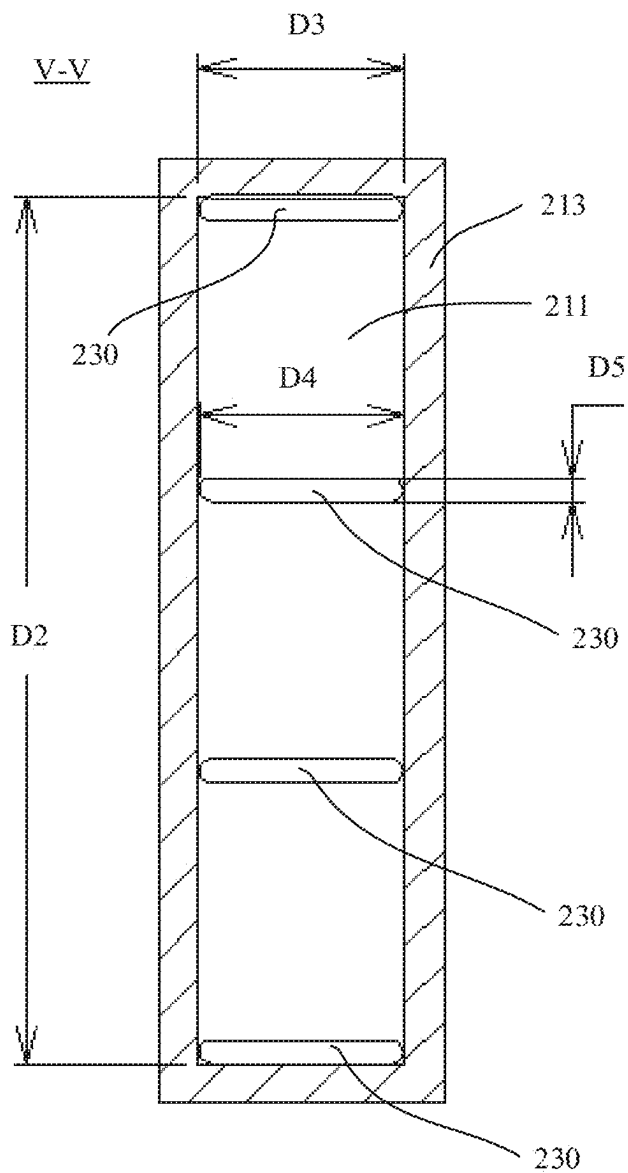


FIG. 16

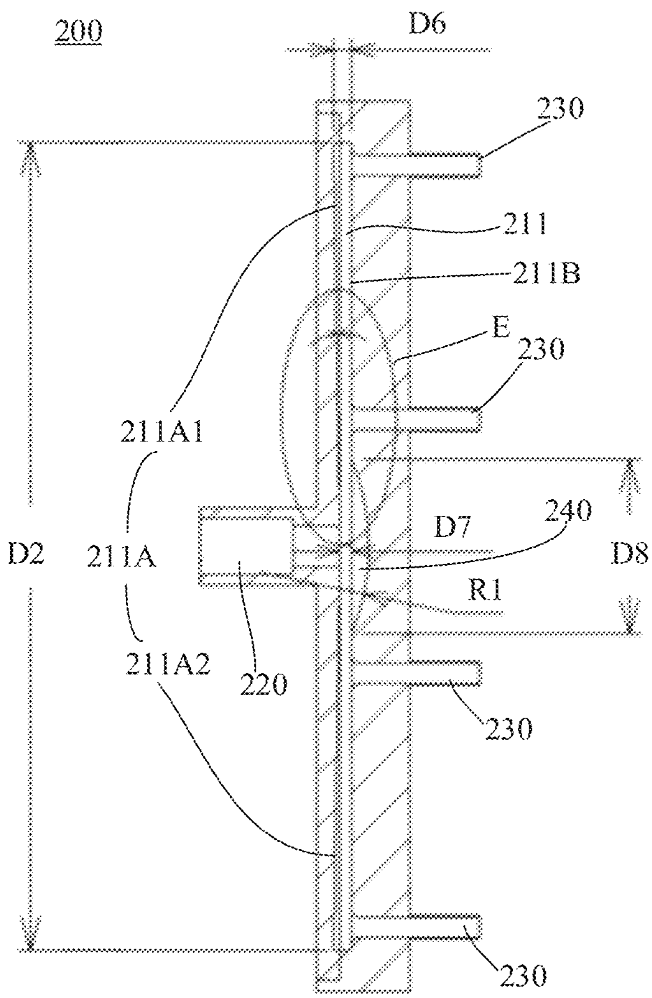

200
D6
230
211
211B
E
230
211A1
240
D7
D8
D2
211A
R1
211A2
220
230
230

FIG. 17

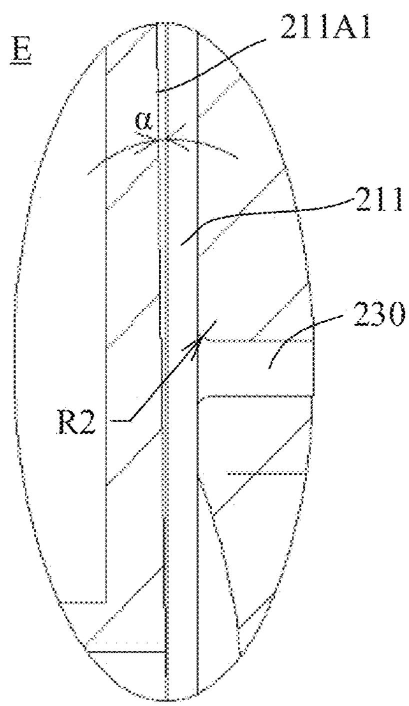


FIG. 18

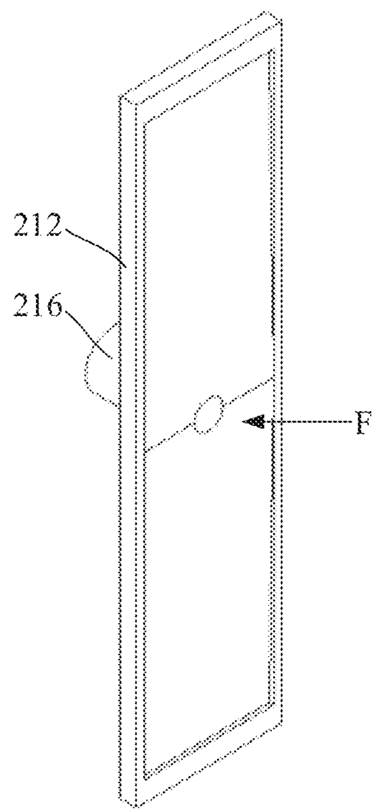


FIG. 19

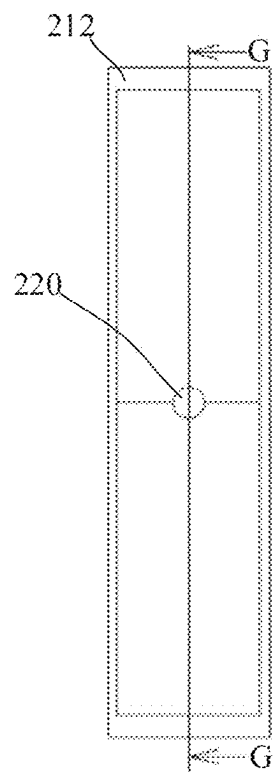


FIG. 20

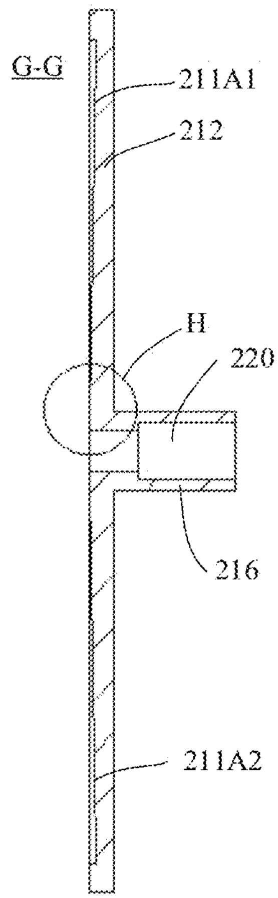


FIG. 21

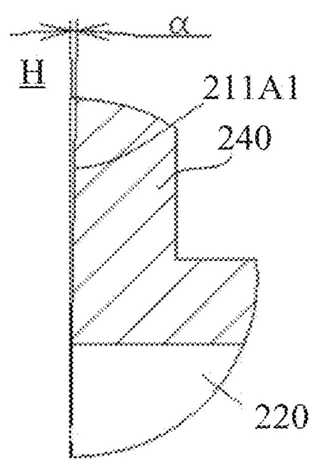


FIG. 22

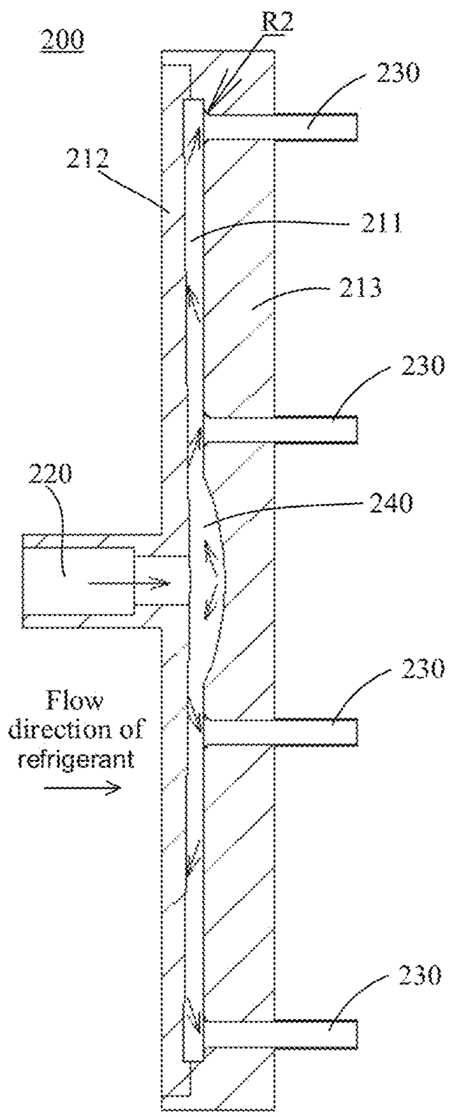

200
R2
230
212
211
213
230
220
240
230
Flow direction of refrigerant
230

FIG. 23

AIR CONDITIONER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation application of International Patent Application No. PCT/CN2022/081815, filed on Mar. 18, 2022, which claims priority to Chinese Patent Application No. 202110845573.4, filed on Jul. 26, 2021, and Chinese Patent Application No. 202110845581.9, filed on Jul. 26, 2021, which are incorporated herein by reference in their entireties.

TECHNICAL FIELD

The present disclosure relates to the field of air conditioning technologies, and in particular, to an air conditioner.

BACKGROUND

The air conditioner is a commonly used family household appliance, and may adjust temperature and humidity of indoor air. The air conditioner includes a heat exchanger that exchanges heat with air, and the heat exchanger is an important component of the air conditioner and may be used as an evaporator or a condenser.

Generally, the heat exchanger may adopt a finned heat exchanger, and the finned heat exchanger includes fins, a heat exchange pipe group passing through the fins, and the like. The heat exchange performance of the heat exchanger is directly related to the connection mode between a plurality of heat exchange pipes in the heat exchange pipe group.

SUMMARY

An air conditioner is provided. The air conditioner includes a compressor and a heat exchanger. The heat exchanger includes a first heat exchanger, a second heat exchanger, a plurality of connectors, at least one first header, a second header, and a main air pipe assembly. The first heat exchanger includes a plurality of flat pipes, and the second heat exchanger includes another plurality of flat pipes. The another plurality of flat pipes in the second heat exchanger correspond to the plurality of flat pipes in the first heat exchanger. Each flat pipe in both the another plurality of flat pipes in the second heat exchanger and the plurality of flat pipes in the first heat exchanger includes a first straight pipe section, a second straight pipe section, and a bent section. The second straight pipe section is parallel to the first straight pipe section. The bent section is located on a same side of the first straight pipe section and the second straight pipe section and connected to an end of the first straight pipe section and an end of the second straight pipe section. Another end of the first straight pipe section is a first end of the flat pipe, and another end of the second straight pipe section is a second end of the flat pipe. The plurality of connectors are arranged corresponding to the plurality of flat pipes in the first heat exchanger, and any connector in the plurality of connectors is configured to connect a second end of a flat pipe in the first heat exchanger to a second end of a flat pipe in the second heat exchanger. The at least one first header is connected to first ends of the plurality of flat pipes in the first heat exchanger. The second header is connected to first ends of the another plurality of flat pipes in the second heat exchanger. The main air pipe assembly includes a main air pipe, a plurality of branch air pipes, and a connecting pipe. An end of the main air pipe is closed. The plurality of branch air pipes are arranged at intervals in an extending direction of the main air pipe. An end of any branch air pipe in the plurality of branch air pipes communicates with the main air pipe, and another end thereof communicates with the second header. Another end of the main air pipe is connected to an end of the connecting pipe, and another end of the connecting pipe is connected to the compressor.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to describe technical solutions of the present disclosure more clearly, accompanying drawings to be used in the description of some embodiments of the present disclosure will be introduced briefly below. However, the accompanying drawings to be described below are merely accompanying drawings of some embodiments of the present disclosure, and a person of ordinary skill in the art may obtain other drawings according to these drawings. In addition, the accompanying drawings to be described below may be regarded as schematic diagrams and are not limitations on an actual size of a product, an actual process of a method, and an actual timing of a signal to which the embodiments of the present disclosure relate.

FIG. **1** is a schematic diagram of an air conditioner, in accordance with some embodiments;

FIG. **2** is a three-dimensional view of a first micro-channel heat exchanger, in accordance with some embodiments;

FIG. **3** is a structural diagram of a multi-row micro-channel heat exchanger, in accordance with some embodiments;

FIG. **4** is a block diagram of an air conditioner, in accordance with some embodiments;

FIG. **5** is a three-dimensional view of a heat exchanger, in accordance with some embodiments;

FIG. **6** is a partial enlarged view of a circle area I in FIG. **5** from another perspective;

FIG. **7** is a diagram showing a partial structure of fins matched with flat pipes in a heat exchanger, in accordance with some embodiments;

FIG. **8** is a three-dimensional view of a connector, in accordance with some embodiments;

FIG. **9** is a three-dimensional view of a main air pipe assembly, in accordance with some embodiments;

FIG. **10** is a structural diagram of a liquid pipe assembly, in accordance with some embodiments;

FIG. **11** is a three-dimensional view of a first header, in accordance with some embodiments;

FIG. **12** is an exploded diagram of a first header, in accordance with some embodiments;

FIG. **13** is a front view in an S direction in FIG. **11**;

FIG. **14** is a cross-sectional view taken along a line B-B in FIG. **13**;

FIG. **15** is a front view in a C direction in FIG. **13**;

FIG. **16** is a cross-sectional view taken along a line V-V in FIG. **15**;

FIG. **17** is a sectional view of another first header, in accordance with some embodiments;

FIG. **18** is a partial enlarged view of a circle area E in FIG. **17**;

FIG. **19** is a three-dimensional view of an end cover portion of another first header, in accordance with some embodiments;

FIG. **20** is a front view in an F direction of an end cover portion of a first header in FIG. **19**;

FIG. **21** is a cross-sectional view taken along a line G-G in FIG. **20**;

FIG. **22** is a partial enlarged view of a circle area H in FIG. **21**; and

FIG. **23** is a cross-sectional view of yet another first header, in accordance with some embodiments.

DETAILED DESCRIPTION

Some embodiments of the present disclosure will be described clearly and completely with reference to the accompanying drawings below. Obviously, the described embodiments are merely some but not all embodiments of the present disclosure. All other embodiments obtained by a person of ordinary skill in the art based on the embodiments of the present disclosure shall be included in the protection scope of the present disclosure.

Unless the context requires otherwise, throughout the description and the claims, the term "comprise" and other forms thereof such as the third-person singular form "comprises" and the present participle form "comprising" are construed as open and inclusive, i.e., "including, but not limited to." In the description of the specification, the terms such as "one embodiment," "some embodiments," "exemplary embodiments," "example," "specific example," or "some examples" are intended to indicate that specific features, structures, materials, or characteristics related to the embodiment(s) or example(s) are included in at least one embodiment or example of the present disclosure. Schematic representations of the above terms do not necessarily refer to the same embodiment(s) or example(s). In addition, the specific features, structures, materials, or characteristics described herein may be included in any one or more embodiments or examples in any suitable manner.

Hereinafter, the terms such as "first" and "second" are used for descriptive purposes only, and are not to be construed as indicating or implying the relative importance or implicitly indicating the number of indicated technical features. Thus, features defined with "first" or "second" may explicitly or implicitly include one or more of the features. In the description of the embodiments of the present disclosure, the term "a plurality of" or "the plurality of" means two or more unless otherwise specified.

In the description of some embodiments, the expressions "coupled" and "connected" and derivatives thereof may be used. For example, the term "connected" may be used in the description of some embodiments to indicate that two or more components are in direct physical or electrical contact with each other. For another example, the term "coupled" may be used in the description of some embodiments to indicate that two or more components are in direct physical or electrical contact. However, the term "coupled" or "communicatively coupled" may also mean that two or more components are not in direct contact with each other but still cooperate or interact with each other. The embodiments disclosed herein are not necessarily limited to the content herein.

The phrase "at least one of A, B and C" has a same meaning as the phrase "at least one of A, B, or C," and they both include the following combinations of A, B, and C: only A, only B, only C, a combination of A and B, a combination of A and C, a combination of B and C, and a combination of A, B, and C.

The phrase "A and/or B" includes following three combinations: only A, only B, and a combination of A and B.

The phrase "applicable to" or "configured to" as used herein indicates an open and inclusive expression, which does not exclude apparatuses that are applicable to or configured to perform additional tasks or steps.

The term "about," "substantially," and "approximately" as used herein includes a stated value and an average value within an acceptable range of deviation of a particular value. The acceptable range of deviation is determined by a person of ordinary skill in the art in consideration of measurement in question and errors associated with measurement of a particular quantity (i.e., limitations of a measurement system).

The term such as "parallel," "perpendicular," or "equal" as used herein includes a stated condition and a condition similar to the stated condition. A range of the similar condition is within an acceptable range of deviation. The acceptable range of deviation is determined by a person of ordinary skill in the art in view of measurement in question and errors associated with the measurement of a particular quantity (i.e., limitations of the measurement system). For example, the term "parallel" includes absolute parallelism and approximate parallelism, and an acceptable range of deviation of the approximate parallelism may be a deviation within 5°; the term "perpendicular" includes absolute perpendicularity and approximate perpendicularity, and an acceptable range of deviation of the approximate perpendicularity may also be a deviation within 5°: and the term "equal" includes absolute equality and approximate equality, and an acceptable range of deviation of the approximate equality may be a difference between two equals being less than or equal to 5% of either of the two equals.

FIG. **1** is a schematic diagram of an air conditioner in accordance with some embodiments.

An air conditioner is provided. As shown in FIG. **1**, the air conditioner **1000** includes an air conditioner indoor unit **10** and an air conditioner outdoor unit **20**. The air conditioner indoor unit **10** and the air conditioner outdoor unit **20** are connected by a pipe to convey a refrigerant.

The air conditioner indoor unit **10** includes an indoor heat exchanger **11**.

The air conditioner outdoor unit **20** includes an outdoor heat exchanger **21**, a compressor **22**, a four-way valve **23**, an expansion valve **24**, and a throttle mechanism **25**. In some embodiments, the expansion valve **24** may also be provided in the air conditioner indoor unit **10**. The throttle mechanism **25** may be a throttle valve or a capillary.

The compressor **22**, the outdoor heat exchanger **21**, the expansion valve **24**, and the indoor heat exchanger **11** that are connected in sequence form a refrigerant loop.

The refrigerant circulates in the refrigerant loop and exchanges heat with air through the outdoor heat exchanger **21** and the indoor heat exchanger **11**, so as to implement a cooling mode or a heating mode of the air conditioner **1000**.

The compressor **22** is configured to compress the refrigerant, so that a low-pressure refrigerant is compressed to be a high-pressure refrigerant.

The outdoor heat exchanger **21** is configured to perform heat-exchange between outdoor air and the refrigerant conveyed in the outdoor heat exchanger **21**. For example, the outdoor heat exchanger **21** operates as a condenser in a cooling mode of the air conditioner **1000**, so that the refrigerant compressed by the compressor **22** dissipates heat into the outdoor air through the outdoor heat exchanger **21** to be condensed; and the outdoor heat exchanger **21** operates as an evaporator in a heating mode of the air conditioner **1000**, so that the decompressed refrigerant absorbs heat from the outdoor air through the outdoor heat exchanger **21** to be evaporated.

Generally, the outdoor heat exchanger **21** further includes heat exchange fins, so as to expand a contact area between the outdoor air and the refrigerant conveyed in the outdoor heat exchanger **21**, thereby improving heat exchange efficiency between the outdoor air and the refrigerant.

The expansion valve **24** is connected between the outdoor heat exchanger **21** and the indoor heat exchanger **11**. A pressure of the refrigerant flowing between the outdoor heat exchanger **21** and the indoor heat exchanger **11** is adjusted by an opening degree of the expansion valve **24**, so as to adjust the flow of the refrigerant flowing between the outdoor heat exchanger **21** and the indoor heat exchanger **11**. The flow and the pressure of the refrigerant flowing between the outdoor heat exchanger **21** and the indoor heat exchanger **11** will affect the heat exchange performance of the outdoor heat exchanger **21** and the indoor heat exchanger **11**. The expansion valve **24** may be an electronic valve. The opening degree of the expansion valve **24** is adjustable, and thus the flow and the pressure of the refrigerant flowing through the expansion valve **24** may be controlled.

The four-way valve **23** is connected in the refrigerant loop and is configured to switch a flow direction of the refrigerant in the refrigerant loop, so as to cause the air conditioner **1000** to perform the cooling mode or the heating mode.

The throttle mechanism **25** is connected between the expansion valve **24** and the indoor heat exchanger **11**. In a case where the air conditioner **1000** operates in the cooling mode, the throttle mechanism **25** is configured to throttle a supercooled liquid refrigerant flowing out of the outdoor heat exchanger **21** into a gas-liquid two-phase refrigerant with low temperature and low pressure, and the flow direction of the refrigerant is shown by solid arrows in FIG. **1**. In a case where the air conditioner **1000** operates in the heating mode, the throttle mechanism **25** is configured to throttle a supercooled liquid refrigerant flowing out of the indoor heat exchanger **11** into a gas-liquid two-phase refrigerant with low temperature and low pressure, and the flow direction of the refrigerant is shown by dashed arrows in FIG. **1**.

The indoor heat exchanger **11** is configured to perform heat-exchange between indoor air and the refrigerant conveyed in the indoor heat exchanger **11**. For example, the indoor heat exchanger **11** operates as an evaporator in a cooling mode of the air conditioner **1000**, so that the refrigerant, which has dissipated heat through the outdoor heat exchanger **21**, absorbs heat from the indoor air through the indoor heat exchanger **11** to be evaporated: and the indoor heat exchanger **11** operates as a condenser in a heating mode of the air conditioner **1000**, so that the refrigerant, which has absorbed heat through the outdoor heat exchanger **21**, dissipates heat into the indoor air through the indoor heat exchanger **11** to be condensed.

Generally, the indoor heat exchanger **11** further includes heat exchange fins, so as to expand a contact area between the indoor air and the refrigerant conveyed in the indoor heat exchanger **11**, thereby improving heat exchange efficiency between the indoor air and the refrigerant.

Operation manners of the cooling mode and the heating mode of the air conditioner **1000** will be described below with reference to FIG. **1**.

As shown in FIG. **1**, in a case where the air conditioner **1000** operates in the cooling mode, the refrigerant is compressed by the compressor **22** to become a superheated gaseous refrigerant with high-temperature and high-pressure, and the superheated gaseous refrigerant is discharged into the outdoor heat exchanger **21** for condensation. In this case, since the refrigerant is in the superheated gas phase, there is no flow-dividing problem, and the refrigerant may be evenly distributed when entering the outdoor heat exchanger **21**. In the outdoor heat exchanger **21**, the superheated gaseous refrigerant is cooled into a supercooled liquid refrigerant, and the supercooled liquid refrigerant flows into the throttle mechanism **25**. The throttle mechanism **25** may throttle the supercooled liquid refrigerant into a gas-liquid two-phase refrigerant with low temperature and low pressure, and the gas-liquid two-phase refrigerant with low temperature and low pressure flows into the indoor heat exchanger **11** for evaporation and heat absorption. In the indoor heat exchanger **11**, the refrigerant is evaporated into superheated gas again and returns to a suction end of the compressor **22**, so as to accomplish a cycle. In the case where the air conditioner **1000** operates in the cooling mode, the flow direction of the refrigerant is shown by the solid arrows in FIG. **1**.

As shown in FIG. **1**, in a case where the air conditioner **1000** operates in the heating mode, a gaseous refrigerant with high-temperature and high-pressure passes through the four-way valve **23** and is directly discharged into the indoor heat exchanger **11** for heating. After the refrigerant is cooled to a supercooled liquid refrigerant in the indoor heat exchanger **11**, the supercooled liquid refrigerant flows into the throttle mechanism **25** and is throttled by the throttle mechanism **25** to become gas-liquid two-phase refrigerant with low temperature and low pressure. The gas-liquid two-phase refrigerant with low temperature and low pressure flows into the outdoor heat exchanger **21** for evaporation and heat absorption. In a case where the gas-liquid two-phase refrigerant with low temperature and low pressure is in a large space or in a case where the flow rate thereof decreases, in order to avoid uneven flow-dividing caused by gas-liquid phase separation, a liquid separation mechanism may be provided on a side of a liquid inlet of the outdoor heat exchanger **21** (such as a first header **200** in the following text), so as to ensure substantially the same flow rates of the refrigerants entering all heat exchange pipes (such as flat pipes **100** in the following text) of the outdoor heat exchanger **21**, thereby maximizing the effectiveness of the heat exchanger.

In the case where the air conditioner **1000** operates in the heating mode, the flow direction of the refrigerant is shown by the dashed arrows in FIG. **1**.

FIG. **2** is a three-dimensional view of a first micro-channel heat exchanger in accordance with some embodiments.

Some embodiments of the present disclosure provide an air conditioner **1000**, which includes a first micro-channel heat exchanger **1**A shown in FIG. **2**. For example, the first micro-channel heat exchanger **1**A is a micro-channel parallel flow heat exchanger. The first micro-channel heat exchanger **1**A includes a header **900**, flat pipes **100**, and fins **300**. The first micro-channel heat exchanger **1**A includes the flat pipes **100** arranged in an axial direction of the header **900**, and the flat pipes **100** are connected through the header **900**. The fins **300** are disposed between two adjacent flat pipes **100**, and the fins **300** are configured to enhance a heat exchange effect between the first micro-channel heat exchanger **1**A and air.

For example, the first micro-channel heat exchanger **1**A is an all-aluminum heat exchanger.

In some embodiments, in order to improve heat exchange efficiency, the air conditioner **1000** may include a multi-row of micro-channel heat exchanger. The multi-row micro-channel heat exchanger includes a plurality of micro-channel heat exchangers (e.g., the first micro-channel heat exchanger **1**A), and the plurality of micro-channel heat exchangers are arranged in a flow direction of air (a Q direction shown in FIG. **3**). For example, the plurality of micro-channel heat exchangers included in the multi-row micro-channel heat exchanger are arranged in the flow direction of air, so that the multi-row micro-channel heat exchanger includes a plurality of rows of flat pipes **100** arranged at intervals in the axial direction of the header **900**.

FIG. **3** is a structural diagram of a multi-row micro-channel heat exchanger in accordance with some embodiments.

For example, as shown in FIG. **3**, the multi-row micro-channel heat exchanger is a second micro-channel heat exchanger **1**B, such as a double-row micro-channel heat exchanger. The second micro-channel heat exchanger **1**B includes a first header **910**, a second header **920**, a third header **930**, a fourth header **940**, fins **300**, a second flat pipe **102**, and a first flat pipe **101**. For example, the first flat pipe **101** is a flat pipe located in an outer row (i.e., an outer-row flat pipe), and the second flat pipe **102** is a flat pipe located in an inner row (i.e., an inner-row flat pipe). Both ends of the first flat pipe **101** communicate with the first header **910** and the second header **920**. Both ends of the second flat pipe **102** communicate with the third header **930** and the fourth header **940**.

The first flat pipe **101** and the second flat pipe **102** are connected together by the same group of fins **300**, so that the heat exchange effect between the second micro-channel heat exchanger **1**B and air may be enhanced.

It will be noted that, in the second micro-channel heat exchanger **11**, the refrigerant will flow across rows. For example, in the case where the air conditioner **1000** operates in the heating mode, the refrigerant flows into a plurality of flat pipes **100** (e.g., **6** flat pipes) in the first flat pipe **101** through the first header **910**, and enters the second header **920** from the plurality of flat pipes **100**, and then flows out from the second header **920**. According to different flow paths, the refrigerant, after flowing out of the second header **920**, will have two flow ways.

One flow way is that the refrigerant still flows in the first flat pipe **101**. For example, the refrigerant flows into the flat pipes **100** from the second header **920** and returns to the first header **910** from the flat pipes **100**. The refrigerant may enter the fourth header **940** from the first header **910**. The flow manner of the refrigerant in the fourth header **940** is similar to that of the refrigerant in the first header **910**, and details will not be repeated here.

Another flow way is that the refrigerant flows from the second header **920** to the third header **930**. In this case, the second micro-channel heat exchanger **1**B further includes connecting pipes **901**, and the connecting pipe **901** is configured to allow the refrigerant to flow across rows.

FIG. **4** is a block diagram of an air conditioner in accordance with some embodiments. FIG. **5** is a three-dimensional view of a heat exchanger in accordance with some embodiments.

Some embodiments of the present disclosure provide another air conditioner **1000**. As shown in FIG. **4**, the air conditioner **1000** includes a heat exchanger **1**.

In some embodiments, the heat exchanger **1** is a multi-flat-pipe parallel flow heat exchanger.

As shown in FIG. **5**, the heat exchanger **1** includes a first heat exchanger **30** and a second heat exchanger **40** that are arranged in the flow direction of air (a direction A shown in FIG. **5**). For example, the first heat exchanger **30** is an outer-row heat exchanger, and the second heat exchanger **40** is an inner-row heat exchanger. In FIG. **5**, a dotted line L is a dividing line between the first heat exchanger **30** and the second heat exchanger **40**.

The first heat exchanger **30** and the second heat exchanger **40** each include a plurality of flat pipes **100**. The plurality of flat pipes **100** in the first heat exchanger **30** correspond to the plurality of flat pipes **100** in the second heat exchanger **40**, respectively. The first heat exchanger **30** and the second heat exchanger **40** each further include fins **300** (referring to FIG. **7**).

The plurality of flat pipes **100** in the first heat exchanger **30** and the plurality of flat pipes **100** in the second heat exchanger **40** are arranged, in their respective rows, at intervals up and down in a height direction of the heat exchanger **1** (i.e., a Y direction in FIG. **5**). That is, the plurality of flat pipes **100** in the first heat exchanger **30** are arranged at intervals up and down in a height direction of the first heat exchanger **30** (i.e., the Y direction in FIG. **5**), and the plurality of flat pipes **100** in the second heat exchanger **40** are arranged at intervals up and down in a height direction of the second heat exchanger **40** (i.e., the Y direction in FIG. **5**). A distance between two vertically adjacent flat pipes **100** is in a range of 10 mm to 18 mm (e.g., 10 mm, 13 mm, 15 mm or 18 mm). The flat pipe **100** includes a plurality of micro-channels configured to allow the refrigerant to flow.

A part of the flat pipe **100** is inserted in the fins **300**. The flow direction of air flowing through the fins **300** (the direction A shown in FIG. **5**) and a flow direction of the refrigerant in the flat pipe **100** (an X direction shown in FIG. **5**) are perpendicular to each other. The heat or cooling released by the refrigerant in the flat pipe **100** is taken away by the fins **300** through heat dissipation and air flowing, which may enhance the heat exchange between the heat exchanger **1** and the air.

In some embodiments, the flat pipe **100** adopts porous micro-channel aluminum alloy, and the fin **300** is made of aluminum alloy with a brazing composite layer on the surface, which may be light in weight and high in heat exchange efficiency.

FIG. **6** is a partial enlarged view of a circle area I in FIG. **5** from another perspective. FIG. **7** is a diagram showing a partial structure of fins matched with flat pipes in a heat exchanger in accordance with some embodiments.

In some embodiments, as shown in FIGS. **6** and **7**, the plurality of flat pipes **100** in the first heat exchanger **30** and the plurality of flat pipes **100** in the second heat exchanger **40** are each bent into a "U" shape. The flat pipe **100** includes a first straight pipe section **140**, a second straight pipe section **150**, and a bent section **130**. The first straight pipe section **140** and the second straight pipe section **150** are parallel to each other. The bent section **130** is located on the same side of the first straight pipe section **140** and the second straight pipe section **150**, and an end of the first straight pipe section **140** and an end of the second straight pipe section **150** are connected by the bent section **130**. Ends of the flat pipe **100** away from the bent section **130** have a first end **110** and a second end **120**, another end of the first straight pipe section **140** is the first end **110** of the flat pipe **100**, and another end of the second straight pipe section **150** is the second end **120** of the flat pipe **100**.

In some embodiments, the heat exchanger **1** further includes first header(s) **200**, a plurality of connectors **400**, and a second header **500**. The heat exchanger **1** includes a single first header **200**; alternatively, the heat exchanger **1** includes a plurality of first headers **200**.

The first header **200** is configured to evenly distribute the gas-liquid two-phase refrigerant into each flat pipe **100** in the first heat exchanger **30**, and the first end **110** of each flat pipe **100** in the first heat exchanger **30** is connected to the first header **200**.

FIG. **11** is a three-dimensional view of a first header in accordance with some embodiments. FIG. **12** is an exploded diagram of a first header in accordance with some embodiments. FIG. **13** is a front view in an S direction in FIG. **11**. FIG. **14** is a cross-sectional view taken along a line B-B in FIG. **13**.

In some embodiments, as shown in FIG. **11**, the first header **200** includes a first header main body **210**, a refrigerant inlet **220**, and a plurality of refrigerant outlets **230**.

As shown in FIGS. **12** and **14**, the first header main body **210** has a hollow structure, and a flat flow channel **211** exists inside the first header main body **210**. The flat flow channel **211** has a small depth D**1** (referring to FIG. **14**), and the flat flow channel **211** extends in the arrangement direction of the plurality of flat pipes **100** in the first heat exchanger **30**. That is, the flat flow channel **211** extends in the Y direction shown in FIG. **5** or FIG. **14**.

In some embodiments, as shown in FIGS. **11**, **12**, and **14**, the first header main body **210** is in a shape of a rectangle, and a length direction of the first header main body **210** is consistent with an extension direction (i.e., a length direction) of the flat flow channel **211**. The first header main body **210** includes an end cover portion **212** and a main body portion **213**. An inner side wall of the main body portion **213** is provided with a positioning portion **214** matched with the end cover portion **212**, and the end cover portion **212** is adapted to be embedded in the positioning portion **214** to be sealed and connected with the main body portion **213**. After sealing connection, an outer surface of the end cover portion **212** is flush with an outer side edge of the main body portion **213**, and the end cover portion **212** cooperates with the main body portion **213** to define the flat flow channel **211**. For example, the positioning portion **214** is an annular groove.

It will be noted that the outer surface of the end cover portion **212** refers to a surface of the end cover portion **212** away from the flat pipe **100**, and the outer side edge of the main body portion **213** refers to a circumference edge on a side of the main body portion **213** away from the flat pipe **100**.

In some embodiments, as shown in FIG. **14**, the refrigerant inlet **220** is disposed on a side of the end cover portion **212** away from the main body portion **213** and communicates with the flat flow channel **211**. The plurality of refrigerant outlets **230** are disposed on a side of the main body portion **213** away from the end cover portion **212**.

For example, as shown in FIG. **14**, an inlet pipe **216** is provided on the side of the end cover portion **212** away from the main body portion **213**. The inlet pipe **216** is integrally formed with the end cover portion **212**, and the refrigerant inlet **220** is formed in the inlet pipe **216**.

A plurality of outlet pipes **215** are further provided on the side of the main body portion **213** away from the end cover portion **212**. The refrigerant outlet **230** is formed in the outlet pipe **215**, and the outlet pipes **215** are connected to the flat pipes **100**, respectively.

The plurality of refrigerant outlets **230** are spaced apart in the length direction (i.e., the Y direction) of the main body portion **213**. The plurality of refrigerant outlets **230** are configured to be correspondingly connected to a plurality of flat pipes **100** in the first heat exchanger **30**, so that the gas-liquid two-phase refrigerant evenly distributed by the first header **200** flows into corresponding flat pipes **100**.

It can be understood that the high-speed gas-liquid two-phase refrigerant flows into the flat flow channel **211** from the refrigerant inlet **220**. Since the flat flow channel **211** is a flat space, when a fluid of the gas-liquid two-phase refrigerant is in contact with a surface (i.e., a right side face of the flat flow channel **211** in the perspective of FIG. **14**) of the flat flow channel **211** away from the refrigerant inlet **220** in the width direction of the flat flow channel **211**, the fluid of the gas-liquid two-phase refrigerant will spread out quickly. Since the space of the flat flow channel **211** is small, the refrigerant may still maintain a high flow rate after spread out. The high flow rate may greatly suppress the influence of gravity, so that the gas-liquid two-phase refrigerant has no chance of generating gas-liquid phase separation. Therefore, the gas-liquid two-phase refrigerant flowing dispersedly around the refrigerant inlet **220** with the refrigerant inlet **220** as the center has almost the equal flow distribution, thereby flowing into each refrigerant outlet **230** uniformly.

FIG. **15** is a front view in a C direction in FIG. **13**. FIG. **16** is a cross-sectional view taken along a line V-V in FIG. **15**.

In some embodiments, as shown in FIGS. **14** and **16**, the depth D**1** of the flat flow channel **211** in a thickness direction (i.e., the X direction) of the first header main body **210** is in a range from 1 mm to 3 mm, a width D**3** of the flat flow channel **211** in a width direction of the first header main body **210** is in a range from 10 mm to 22 mm, and a length D**2** of the flat flow channel **211** in a length direction of the first header main body **210** is in a range from 50 mm to 100 mm.

For example, the depth D**1** of the flat flow channel **211** may be 1 mm, 2 mm, or 3 mm, the width D**3** of the flat flow channel **211** may be 10 mm, 15 mm, 18 mm, or 22 mm, and the length D**2** of the flat flow channel **211** may be 50 mm, 70 mm, 90 mm, or 100 mm.

In some embodiments, as shown in FIG. **16**, an orthographic projection of the refrigerant outlet **230** on the main body portion **213** is approximately in a shape of a rectangle, a length D**4** of the rectangle is in a range of 10 mm to 22 mm, and a width D**5** of the rectangle is in a range of 1.5 mm to 3 mm.

For example, the length D**4** of the rectangle is 10 mm, 15 mm, 18 mm, or 22 mm, and the width D**5** of the rectangle is 1.5 mm, 2.5 mm, or 3 mm.

In some embodiments, as shown in FIG. **16**, a width direction of the orthographic projection (i.e., a width direction of the rectangle) of the refrigerant outlet **230** on the main body portion **213** is parallel to the extension direction of the flat flow channel **211**, and a length direction thereof (i.e., a length direction of the rectangle) is parallel to the width direction of the flat flow channel **211** (i.e., a direction of the width D**3**). That is, the direction of the width D**5** of the rectangle is parallel to the direction of the length D**2** of the flat flow channel **211**, and the direction of the length D**4** of the rectangle is parallel to the direction of the width D**3** of the flat flow channel **211**. Therefore, by arranging the plurality of refrigerant outlets **230** in the extending direction of the flat flow channel **211**, a length and a volume of the first header **200** may be reduced in a case where the number of the flat pipes **100** remains unchanged.

In addition, in order to prevent the refrigerant flowing at a high speed from directly entering the refrigerant outlet **230** directly opposite thereto after entering the flat flow channel **211** from the refrigerant inlet **220**, which will affect the uniform tiling of the refrigerant, the refrigerant outlets **230** and the refrigerant inlet **220** may be disposed in a staggered manner (referring to FIG. **15**). Moreover, refrigerant outlets **230** are respectively provided on both ends of the flat flow channel **211** in the extension direction thereof, so as to avoid presence of flow dead angles of the refrigerant at both ends of the flat flow channel **211** in the extension direction.

In some embodiments, as shown in FIGS. **13** and **14**, the refrigerant inlet **220** is directly opposite to the center of the flat flow channel **211**. That is, the refrigerant inlet **220** is disposed at a center position of the first header main body **210**. As shown in FIG. **14**, the plurality of refrigerant outlets **230** are arranged at equal intervals in the extension direction of the flat flow channel **211**, so that the structure of the first header **200** may be symmetrical. Thus, it may not only realize fool-proofing, but also facilitate the even distribution of refrigerant.

In some embodiments, the heat exchanger **1** has a large volume and a high height. Therefore, the plurality of flat pipes **100** need to be provided. In this case, the heat exchanger **1** may include the plurality of first headers **200**. The first header **200** includes a plurality of refrigerant outlets **230** for being connected with a plurality of flat pipes **100** in the first heat exchanger **30**. In this way, it is possible to improve stability of the connection between the flat pipes **100** and the first header **200**.

For example, the first header **200** includes four or six refrigerant outlets **230** for being connected with four or six flat pipes **100** in the first heat exchanger **30**.

The plurality of connectors **400** are arranged corresponding to the plurality of flat pipes **100** in the first heat exchanger **30**. The connector **400** is configured to make the flat pipes **100** in the first heat exchanger **30** communicate with the flat pipes **100** in the second heat exchanger **40**. The second end **120** of the flat pipe **100** in the first heat exchanger **30** is connected to the connector **400**, and the second end **120** of the flat pipe **100** in the second heat exchanger **40** is also connected to the connector **400**. Therefore, the connector **400** may realize cross-row flow of the refrigerant between the first heat exchanger **30** and the second heat exchanger **40**.

FIG. **8** is a three-dimensional view of a connector in accordance with some embodiments.

For example, as shown in FIGS. **6** and **8**, the connector **400** includes a housing **410** and a flow channel **420** formed in the housing **410**. For example, the flow channel **420** is a flat communication flow channel. The flow channel **420** penetrates the housing **410** and has two openings **421**. One of the two openings **421** communicates with a second end **120** of a flat pipe **100** in the first heat exchanger **30**, and the other of the two openings **421** communicates with a second **120** of a flat pipe **100** in the second heat exchanger **40**.

It will be noted that the cross-sectional size of each opening of the flow channel **420** matches the cross-sectional size of the flat pipe **100** communicated thereto.

In some embodiments, an increase in pressure of a refrigeration system (such as the aforementioned refrigerant loop) will lead to an increase in pressure in the connector **400**. In order to prevent the connector **400** from being deformed due to insufficient pressure, as shown in FIG. **8**, the connector **400** further includes a reinforcing rib **430**, and the reinforcing rib **430** is disposed in the flow channel **420**, so as to prevent the connector **400** from being deformed.

In some embodiments, the first end **110** of the flat pipe **100** in the first heat exchanger **30** is an inlet end of the refrigerant, and the second end **120** of the flat pipe **100** in the first heat exchanger **30** is an outlet end of the refrigerant. The second end **120** of the flat pipe **100** in the second heat exchanger **40** is an inlet end of the refrigerant, and the first end **110** of the flat pipe **100** in the second heat exchanger **40** is an outlet end of the refrigerant. The first ends **110** of the flat pipes **100** in the second heat exchanger **40** are connected to the second header **500**.

The second header **500** is a pipe with both ends closed and hollow interior, and the second header **500** includes a plurality of connection openings. The plurality of connection openings are arranged in a pipe body of the second header **500**, and the plurality of connection openings are respectively connected to first ends **110** of a plurality of flat pipes **100** in the second heat exchanger **40**. The second header **500** is a gathering pipe of the whole refrigerant flowing out from the flat pipes **100**. In a case where the air conditioner **1000** operates in the cooling mode, the second header **500** is connected to the compressor **22** to discharge gas, and the gaseous refrigerant with high-temperature and high-pressure may be evenly distributed from the plurality of connection openings of the second header **500** to the flat pipes **100** in the second heat exchanger **40**.

It can be understood that in the heat exchanger **1**, the flat pipes **100** in the second heat exchanger **40** and the flat pipes **100** in the first heat exchanger **30** are each U-shaped. Therefore, only a single second header **500** cooperated with first header(s) **200** is required for achieving the communication between the second heat exchanger **40** and the first heat exchanger **30** and the uniform distribution of the gas-liquid two-phase refrigerant, thereby simplifying the structure of the heat exchanger **1**. In addition, since the first header **200** may evenly distribute the gas-liquid two-phase refrigerant into the flat pipes **100** in the first heat exchanger **30**, compared with the use of the header **900** (as shown in FIG. **2** or FIG. **3**) in the above embodiments, the interior of the second header **500** does not need to use partitions to divide the flow path, and thus the solder joints and refrigerant leakage points in the heat exchanger **1** may be reduced, and the structure and the manufacturing process of the heat exchanger **1** may be simplified.

It will be noted that the second header **500** extends through the whole heat exchanger **1** in the height direction (i.e., the Y direction shown in FIG. **5**), and limited by its own frame structure, the heat exchanger **1** has no additional space for the second header **500** to be directly connected to the compressor **22**. Therefore, in some embodiments, the heat exchanger **1** further includes a main air pipe assembly **600**. The main air pipe assembly **600** serves as a transitional connection pipe between the compressor **22** and the heat exchanger **1** and is configured to realize the connection between the second header **500** and the compressor **22**.

FIG. **9** is a three-dimensional view of a main air pipe assembly in accordance with some embodiments.

In some embodiments, as shown in FIG. **9**, the main air pipe assembly **600** includes a main air pipe **610**, a plurality of branch air pipes **620**, and a connecting pipe **611**. An end of a branch air pipe **620** directly communicates with the main air pipe **610**, and another end of the branch air pipe **620** communicates with the second header **500**. The plurality of branch air pipes **620** are arranged at intervals in an extending direction (i.e., a length direction) of the main air pipe **610**. The extending direction of the main air pipe **610** is substantially the same as the extending direction of the second header **500**. An end of the main air pipe **610** is closed, and another end of the main air pipe **610** communicates with the connecting pipe **611**. The connecting pipe **611** is configured to connect the main air pipe **610** to the compressor **22**. In this way, the second header **500** and the compressor **22** may be connected by the main air pipe assembly **600**.

In some embodiments, limited by its own frame structure, the heat exchanger **1** has no additional space for the first header **200** to be directly connected to the throttle mechanism **25**. Therefore, in some embodiments, the heat exchanger **1** further includes a liquid pipe assembly **700**. The liquid pipe assembly **700** serves as a transitional connection pipe assembly between the throttle mechanism **25** and the heat exchanger **1** and is configured to realize the connection between the throttle mechanism **25** and the first header **200**.

FIG. **10** is a structural diagram of a liquid pipe assembly in accordance with some embodiments. For example, as shown in FIG. **10**, the liquid pipe assembly **700** includes a main liquid pipe **710**, a flow dividing portion **720**, and a plurality of branch liquid pipes **730**. An end of the main liquid pipe **710** communicates with the throttle mechanism **25**, and another end of the main liquid pipe **710** is connected with the flow dividing portion **720**. The inlet ends of the plurality of branch liquid pipes **730** are each connected to the flow dividing portion **720**, and the outlet ends of the plurality of branch liquid pipes **730** are respectively connected to the refrigerant inlets **220** of the plurality of first headers **200**.

In some embodiments, in a case where the air conditioner **1000** operates in the heating mode, the refrigerant becomes a gas-liquid two-phase refrigerant with low-temperature and low-pressure after being throttled by the throttle mechanism **25** in the refrigeration system. When the gas-liquid two-phase refrigerant enters the liquid pipe assembly **700**, due to a small cross-sectional area of a flow channel in the branch liquid pipe **730**, it is difficult to generate gas-liquid separation. Therefore, the gas-liquid two-phase refrigerant may uniformly pass through each branch liquid pipe **730** to enter a corresponding first header **200** and are evenly distributed by the first header **200** to flat pipes **100** in the first heat exchanger **30**.

The gas-liquid two-phase refrigerant flows, in the flat pipe **100** in the first heat exchanger **30**, from a flow dividing side of the heat exchanger **1** (e.g., a side of the heat exchanger **1** provided with the first header **200**) to a tail side (e.g., a side where the bending section **130** of the flat pipe **100** is located), and passes through the bending section **130** at the tail side and flows to the flow dividing side again. After reaching the flow dividing side again, the gas-liquid two-phase refrigerant may flow into the flat pipe **100** in the second heat exchanger **40** through the connector **400**.

Similarly, the gas-liquid two-phase refrigerant flows, in the flat pipe **100** in the second heat exchanger **40**, from the flow dividing side of the heat exchanger **1** to the tail side, passes through the bending section **130** of the flat pipe **100** at the tail side of the heat exchanger **1** and returns again, and flows into the second header **500** from the first end **110** of the flat pipe **100** in the second heat exchanger **40** and further into the main air pipe assembly **600**. Then, the gas-liquid two-phase refrigerant flows into the suction end of the compressor **22** in the refrigeration system through the main air pipe assembly **600**, so as to complete a heating process.

As the refrigerant starts to flow from the first end **110** of the flat pipe **100** in the first heat exchanger **30**, the refrigerant continuously absorbs heat. As the flow proceeds, the refrigerant gradually vaporizes and the dryness degree increases continuously. When reaching the outlet of the main air pipe assembly **600**, the refrigerant will be heated into a superheated gas.

In some embodiments, in a case where the air conditioner **1000** operates in the cooling mode, the compressor **22** discharges superheated gaseous refrigerant with high-temperature and high-pressure into the main air pipe assembly **600**. In this case, since the refrigerant is in a gaseous state, the pressure distribution is relatively uniform, and thus the refrigerant may be evenly distributed into each branch air pipe **620**, and further evenly distributed into the second header **500**. In the second header **500**, the state of the refrigerant remains unchanged. Therefore, the refrigerant is evenly distributed to the flat pipes **100** in each second heat exchanger **40**. In this case, the refrigerant will flow in an opposite process as the operation in the heating mode of the air conditioner **1000** and exchange heat with the air to be gradually cooled by the air to a supercooled liquid. In the case where the air conditioner **1000** operates in the cooling mode, the refrigerant is mostly gas with high-temperature and high-pressure, so the distribution of the refrigerant is relatively uniform.

FIG. **17** is a sectional view of another first header in accordance with some embodiments.

In some embodiments, as shown in FIG. **17**, the flat flow channel **211** in the first header **200** includes a first side face **211**A and a second side face **211**B. The first side face **211**A and the second side face **211**B are two opposite side faces of the flat flow channel **211** in the depth direction, and the first side face **211**A is closer to the refrigerant inlet **220** than the second side face **211**B.

The main difference between FIG. **17** and FIG. **14** is that, along the extending direction of the flat flow channel **211**, the first side face **211**A includes a first side sub-face **211A1** and a second side sub-face **211A2**. The first side sub-face **211A1** and the second side sub-face **211A2** are symmetrical about the refrigerant inlet **220**, and the first side sub-face **211A1** and the second side sub-face **211A2** are each inclined in a direction from a side away from the refrigerant inlet **220** to a side proximate to the refrigerant inlet **220**. That is, a distance between the side away from the refrigerant inlet **220** and the second side face **211**B is greater than a distance between the side proximate to the refrigerant inlet **220** and the second side face **211**B.

It will be noted that when the high-speed gas-liquid two-phase refrigerant flows into the flat flow channel **211** through the refrigerant inlet **220** and is in contact with the second side face **211**B, the flow direction of the refrigerant turns by 90°, and the refrigerant flows in a tiling manner in all directions. This will cause a significant pressure loss in the heat exchanger **1** and cause flash evaporation of the refrigerant, so that the gas phase ratio of the refrigerant increases, and further aggravate the pressure loss. As a result, the refrigeration performance of the air conditioner **1000** may be affected.

In order to avoid the occurrence of the above situation, in some embodiments, the first side sub-face **211A1** and the second side sub-face **211A2** of the flat flow channel **211** are each inclined in the direction from the side away from the refrigerant inlet **220** to the side proximate to the refrigerant inlet **220**, so that the flow cross-sectional area of the flat flow channel **211** changes. In this way, when the refrigerant enters the flat flow channel **211** from the refrigerant inlet **220** and flows in all directions, the flow cross-sectional area of the refrigerant increases continuously, and thus the on-way resistance in the flow direction of the refrigerant may be balanced, so that the amount of the refrigerant flowing through the refrigerant outlets **230** at both ends of the flat flow channel **211** in the extension direction thereof is substantially equal to the amount of the refrigerant passing through the refrigerant outlets **230** proximate to the refrigerant inlet **220**.

FIG. **19** is a three-dimensional view of an end cover portion of another first header in accordance with some embodiments. FIG. **20** is a front view in an F direction of an end cover portion of a first header in FIG. **19**. FIG. **21** is a cross-sectional view taken along a line G-G in FIG. **20**.

In some embodiments, as shown in FIGS. **19** to **21**, the end cover portion **212** of the first header **200** may be partially thinned to form the flat flow channel **211** in the first header **200**.

For example, a center of the end cover portion **212** is not thinned, but the end cover portion **212** is thinned along the center of the end cover portion **212** towards both ends in a length direction thereof. That is, a surface on a side of the end cover portion **212** away from the refrigerant inlet **220** is inclined in a direction from a side proximate to the second side face **211**B to a side away from the second side face **211**B. In this way, the flat flow channel **211** with changed cross-section may be formed by the cooperation of the end cover portion **212** and the main body portion **213**, and the structure of the main body portion **213** is simple, which is convenient for processing and assembly.

FIG. **22** is a partial enlarged view of a circle area H in FIG. **21**.

In some embodiments, as shown in FIGS. **17** and **22**, after the end cover portion **212** and the main body portion **213** are assembled, a minimum depth of the flat flow channel **211** is D**7**, a maximum depth of the flat flow channel **211** is D**6**, and a total extension length of the flat flow channel **211** is D**2**. The inclination angle of each of the first side sub-face **211A1** and the second side sub-face **211A2** is a. Therefore, there is a relationship of $\alpha=\arctan 2(D6-D7)/D2$, where the angle α is in a range of 0.7° to 2°. For example, the angle α may be 0.7°, 1.0°, 1.5°, 2°, or the like.

In some embodiments, as shown in FIGS. **14** and **15**, for convenience of processing, an axis of the refrigerant inlet **220** and an axis of the refrigerant outlet **230** are each perpendicular to the second side face **211**B.

FIG. **23** is a cross-sectional view of yet another first header in accordance with some embodiments.

In some embodiments, as shown in FIGS. **17** and **23**, a buffer portion **240** is provided at a position, opposite to the refrigerant inlet **220**, of the second side face **211**B of the flat flow channel **211**. The buffer portion **240** is recessed towards a direction away from the first side face **211**A. The longitudinal section of the buffer portion **240** is in a shape of a circular arc, a chord length is D**8**, and a radius of a circle where the circular arc is located is R**1**.

The buffer portion **240** may make the high-speed refrigerant disperse having entered the refrigerant inlet **220** rather evenly. Moreover, the concave curved surface of the buffer portion **240** provided on the main body portion **213** may effectively buffer the refrigerant entering the flat flow channel **211**, which is conducive to reduce of pressure loss and may make the refrigerant spread out quickly. The concave curved surface of the buffer portion **240** provided on the main body portion **213** may also make the refrigerant flow in a varying direction in the flat flow channel **211**, which is conducive to the mixing of the refrigerant and may further reduce the possibility of the gas-liquid separation of the refrigerant. The flow direction of the refrigerant in the flat flow channel **211** may refer to the pointing directions of arrows in FIG. **23**.

FIG. **18** is a partial enlarged view of a circle area E in FIG. **17**.

In some embodiments, in order to reduce the flow resistance caused by the eddy flow inside the flat pipe **100**, as shown in FIGS. **17**, **18** and **23**, the refrigerant outlet **230** and the flat flow channel **211** have transition rounded corners at connection positions therebetween. That is, an inlet end of the refrigerant outlet **230** is provided with rounded corners, and a radius R**2** of a rounded corner is in a range of 0.5 mm to 2 mm. For example, the radius R**2** may be 0.5 mm, 1.0 mm, 1.5 mm, or 2 mm.

The foregoing descriptions are merely specific implementations of the present disclosure, but the protection scope of the present disclosure is not limited thereto. Changes or replacements that any person skilled in the art could conceive of within the technical scope of the present disclosure shall be included in the protection scope of the present disclosure. Therefore, the protection scope of the present disclosure shall be subject to the protection scope of the claims.

It will be appreciated by those skilled in the art that the scope of disclosure involved in the present disclosure is not limited to technical solutions formed by particular combinations of the above technical features, but shall also encompass other technical solutions formed by any combination of the above technical features or equivalents thereof without departing from the concept of present disclosure, for example, the technical solutions formed by replacing the above features with technical features having similar functions disclosed in some embodiments (but not limited thereto).

What is claimed is:

1. An air conditioner, comprising:

a compressor; and

a heat exchanger, including:

- a first heat exchanger including a plurality of flat pipes;
- a second heat exchanger including another plurality of flat pipes, wherein the another plurality of flat pipes in the second heat exchanger correspond to the plurality of flat pipes in the first heat exchanger, and each flat pipe in both the another plurality of flat pipes in the second heat exchanger and the plurality of flat pipes in the first heat exchanger includes:
  - a first straight pipe section;
  - a second straight pipe section parallel to the first straight pipe section; and
  - a bent section located on a same side of the first straight pipe section and the second straight pipe section and connected to an end of the first straight pipe section and an end of the second straight pipe section; another end of the first straight pipe section being a first end of the flat pipe, and another end of the second straight pipe section being a second end of the flat pipe;
- a plurality of connectors disposed corresponding to the plurality of flat pipes in the first heat exchanger, any connector in the plurality of connectors being configured to make a second end of a flat pipe in the first heat exchanger connected to a second end of a flat pipe in the second heat exchanger;
- at least one first header connected to first ends of the plurality of flat pipes in the first heat exchanger;
- a second header connected to first ends of the another plurality of flat pipes in the second heat exchanger; and
- a main air pipe assembly, including:
  - a main air pipe with an end closed;
  - a plurality of branch air pipes arranged at intervals in an extending direction of the main air pipe, an end of any branch air pipe in the plurality of branch air pipes communicating with the main air pipe, and another end thereof communicating with the second header; and
  - a connecting pipe, another end of the main air pipe being connected to an end of the connecting pipe, and another end of the connecting pipe being connected to the compressor.

2. The air conditioner according to claim **1**, wherein any first header in the at least one first header includes:

a first header main body including an end cover portion and a main body portion, the end cover portion and the main body portion cooperating to define a flat flow channel;

a refrigerant inlet disposed on a side of the end cover portion away from the main body portion and communicating with the flat flow channel; and

a plurality of refrigerant outlets disposed on a side of the main body portion away from the end cover portion and being spaced apart in a length direction of the main body portion, the plurality of refrigerant outlets communicating with the flat flow channel, wherein

refrigerant outlets of the at least one first header are respectively connected to the first ends of the plurality of flat pipes in the first heat exchanger.

3. The air conditioner according to claim **2**, wherein

the flat flow channel has a first side face and a second side face, the first side face and the second side face are disposed oppositely in a depth direction of the flat flow channel, and the first side face is closer to the refrigerant inlet than the second side face;

the first header main body further includes a buffer portion; the buffer portion is located at a position of the second side face opposite to the refrigerant inlet, and is recessed towards a direction away from the first side face.

4. The air conditioner according to claim **3**, wherein

in a length direction of the flat flow channel, the first side face includes a first side sub-face and a second side sub-face; the first side sub-face and the second side sub-face are symmetrical about the refrigerant inlet, and the first side sub-face and the second side sub-face are each inclined in a direction from a side away from the refrigerant inlet to a side proximate to the refrigerant inlet in the length direction of the flat flow channel.

5. The air conditioner according to claim **2**, wherein an orthographic projection of a refrigerant outlet on the main body portion is substantially in a shape of a rectangle; a width direction of the rectangle is parallel to a length direction of the flat flow channel, and a length direction of the rectangle is parallel to a width direction of the flat flow channel.

6. The air conditioner according to claim **5**, wherein the plurality of refrigerant outlets and the refrigerant inlet in the any first header are disposed in a staggered manner, and both ends of the flat flow channel in the length direction thereof are each provided a refrigerant outlet in the plurality of refrigerant outlets.

7. The air conditioner according to claim **6**, wherein the refrigerant inlet is located at a center of the end cover portion, and the plurality of refrigerant outlets are disposed at equal intervals in the length direction of the flat flow channel.

8. The air conditioner according to claim **7**, wherein an axis of the refrigerant inlet and axes of the plurality of refrigerant outlets are each parallel to a thickness direction of the first header main body.

9. The air conditioner according to claim **5**, wherein a length of the rectangle is in a range of 10 mm to 22 mm, inclusive, and a width of the rectangle is in a range of 1.5 mm to 3 mm, inclusive.

10. The air conditioner according to claim **2**, wherein the at least one first header includes a plurality of first headers, any first header in the plurality of first headers includes a plurality of refrigerant outlets, and the plurality of refrigerant outlets are connected to flat pipes in the first heat exchanger, respectively.

11. The air conditioner according to claim **2**, wherein

in a length direction of the flat flow channel, a depth of the flat flow channel in a middle thereof is equal to a depth of the flat flow channel at both ends thereof; or

in the length direction of the flat flow channel, the depth of the flat flow channel in the middle thereof is smaller than the depth of the flat flow channel at the both ends thereof.

12. The air conditioner according to claim **2**, wherein

a depth of the flat flow channel in a thickness direction of the first header main body is in a range of 1 mm to 3 mm, inclusive;

a width of the flat flow channel in a width direction of the first header main body is in a range of 10 mm to 22 mm, inclusive; and

a length of the flat flow channel in a length direction of the first header main body is in a range of 50 mm to 100 mm, inclusive.

13. The air conditioner according to claim **2**, wherein the refrigerant outlet and the flat flow channel have a transition rounded corner at a connection position therebetween.

14. The air conditioner according to claim **1**, wherein the plurality of connectors include:

a housing; and

a flow channel provided in the housing and including two openings, wherein

one of the two openings communicates with the second end of the flat pipe in the first heat exchanger, and another of the two openings communicates with the second end of the flat pipe in the second heat exchanger.

15. The air conditioner according to claim **14**, wherein a cross-sectional size of each opening of the flow channel matches a cross-sectional size of a flat pipe communicated thereto.

16. The air conditioner according to claim **14**, wherein the plurality of connectors further include a reinforcing rib disposed inside the flow channel.

17. The air conditioner according to claim **2**, further comprising a throttle mechanism, wherein

the at least one first header includes a plurality of first headers; the heat exchanger further includes a liquid pipe assembly, and the liquid pipe assembly is configured to make the plurality of first headers connected with the throttle mechanism.

18. The air conditioner according to claim **17**, wherein the liquid pipe assembly includes:

a main liquid pipe, an end of the main liquid pipe being connected to the throttle mechanism;

a flow dividing portion, another end of the main liquid pipe being connected to the flow dividing portion; and

a plurality of branch liquid pipes, inlet ends of the plurality of branch liquid pipes being each connected to the flow dividing portion, and outlet ends of the plurality of branch liquid pipes being respectively connected to refrigerant inlets of the plurality of first headers.

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