US 20110061844A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2011/0061844 A1

(43) Pub. Date: Mar. 17, 2011

Jianlong et al.

(54) **HEAT EXCHANGER**

(75) Inventors: **Jiang Jianlong**, Zhejiang (CN); **Wang Feng**, Zhejiang (CN); **Liu Huazhao**, Zhejiang (CN); **Lin-jie Huang**, East Amherst, NY (US)

(73) Assignee: **Danfoss Sanhua (Hangzhou) Micro Channel Heat Exchanger Co., Ltd.**, Zhejiang (CN)

(21) Appl. No.: **12/872,508**

(22) Filed: **Aug. 31, 2010**

(30) **Foreign Application Priority Data**

Sep. 16, 2009 (CN) 200910173434.0

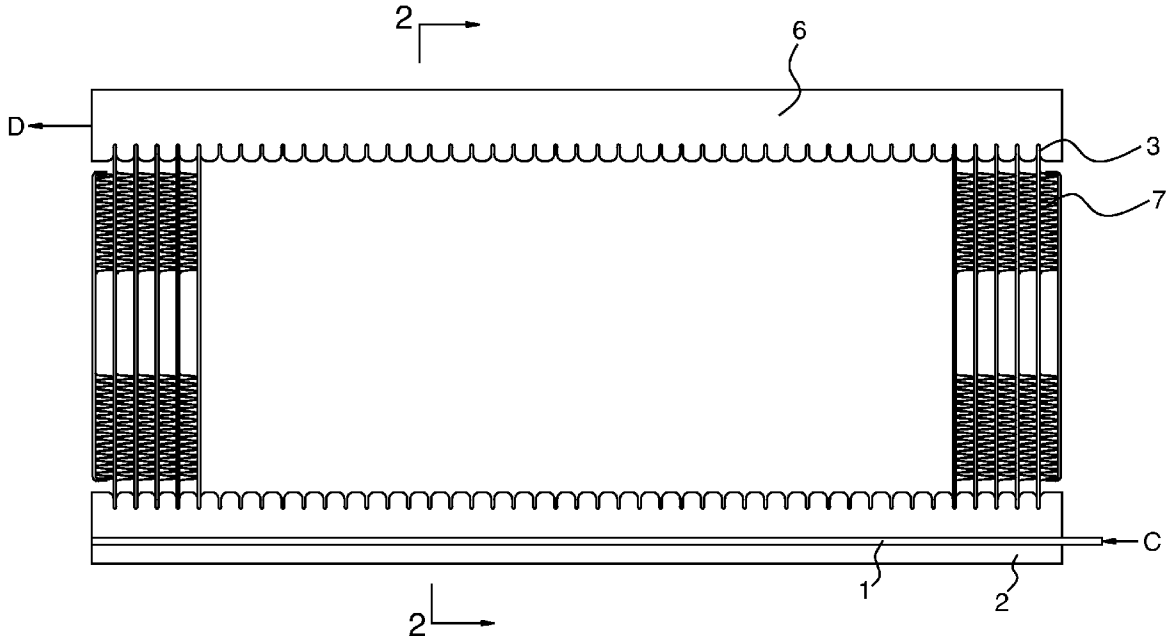
Publication Classification

(51) **Int. Cl.**
F28F 9/02 (2006.01)

(52) **U.S. Cl.** **165/173**

(57) **ABSTRACT**

A heat exchanger is disclosed, which comprises an inlet header defining a refrigerant chamber therein; an outlet header spaced apart from the inlet header; a plurality of tubes, two ends of each tube being connected to and communicating with the inlet and outlet headers respectively; a plurality of fins, each of which is interposed between adjacent tubes; and a distribution tube disposed outside the refrigerant chamber and formed with a distribution opening, through which the distribution tube communicates with the refrigerant chamber. According to the present invention, the distribution tube is easy to assemble, disassemble and maintain. The refrigerants in the inlet header and the distribution tube do not disadvantageously affect each other, thus enhancing distribution of refrigerant.



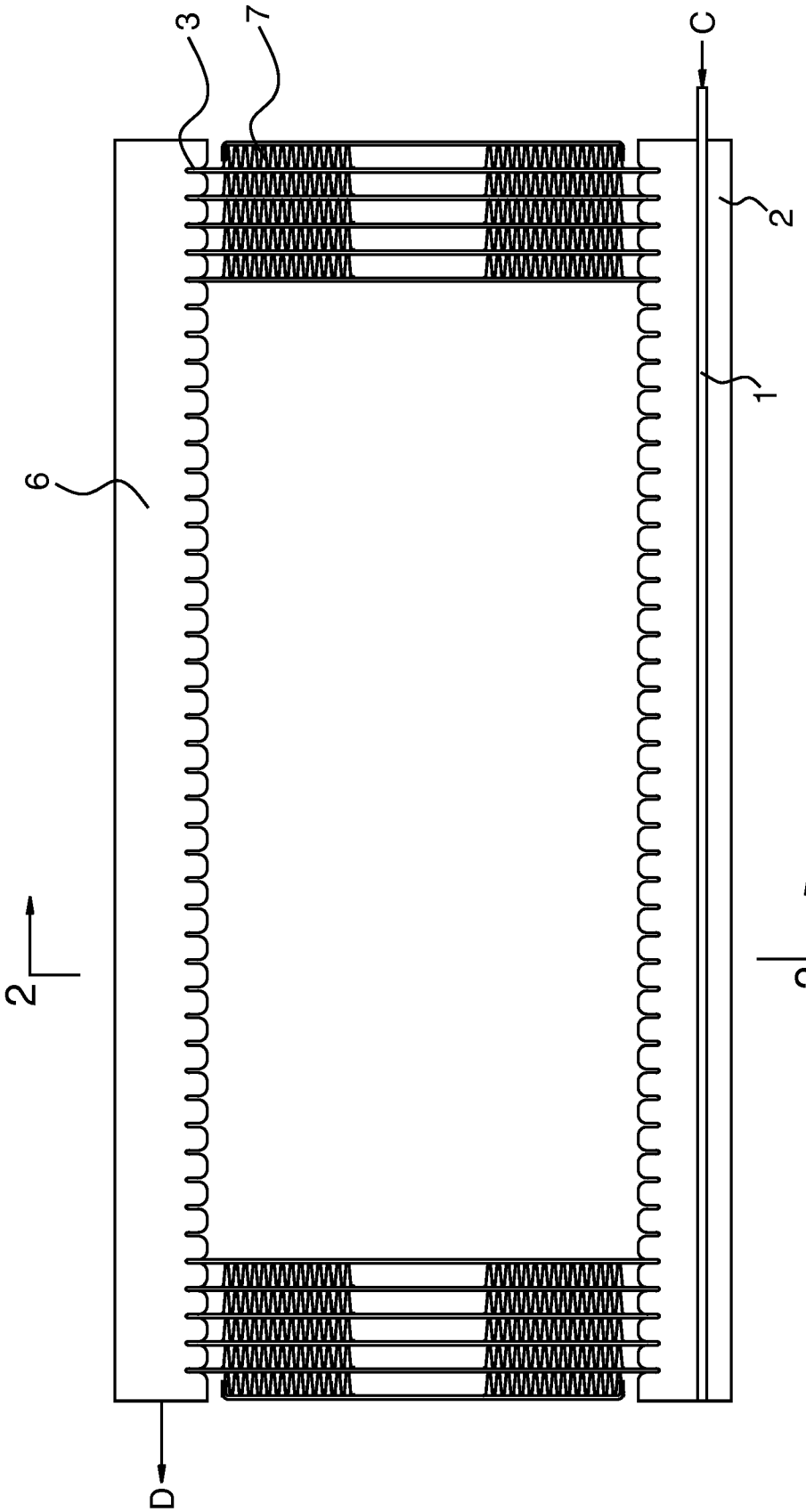


FIG. 1

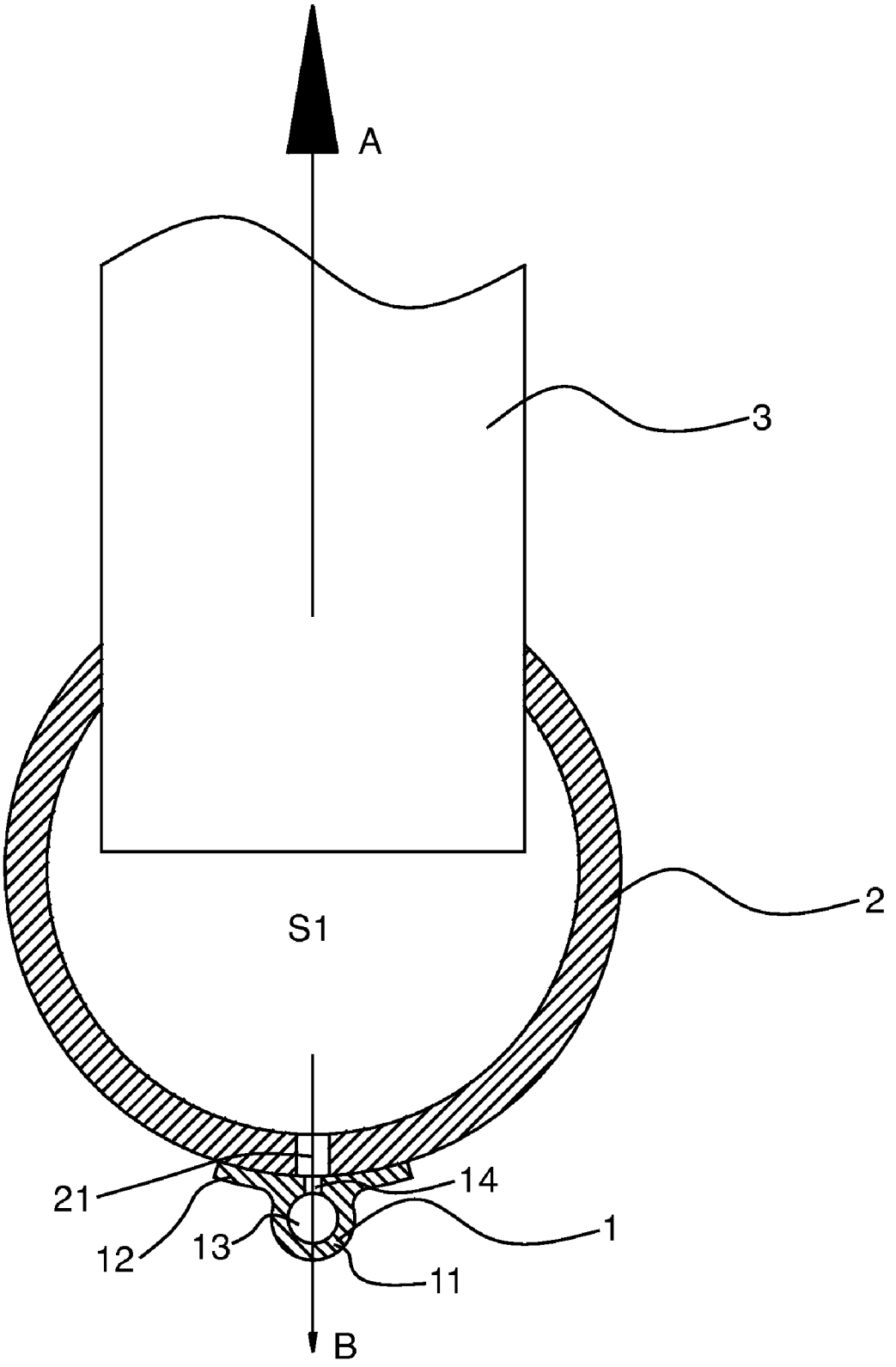


FIG. 2

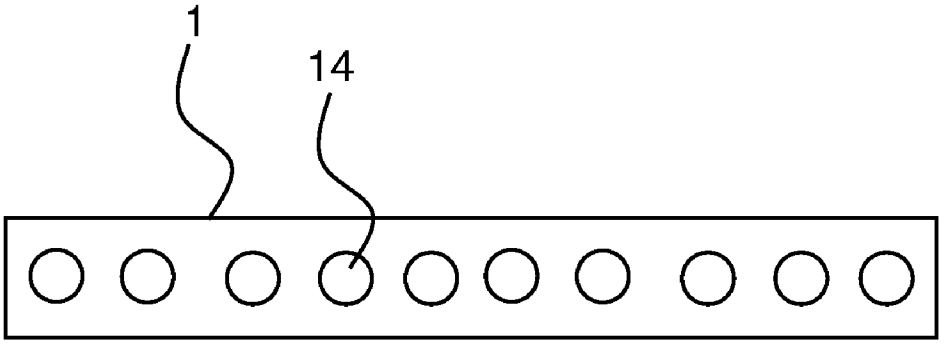


FIG. 3a

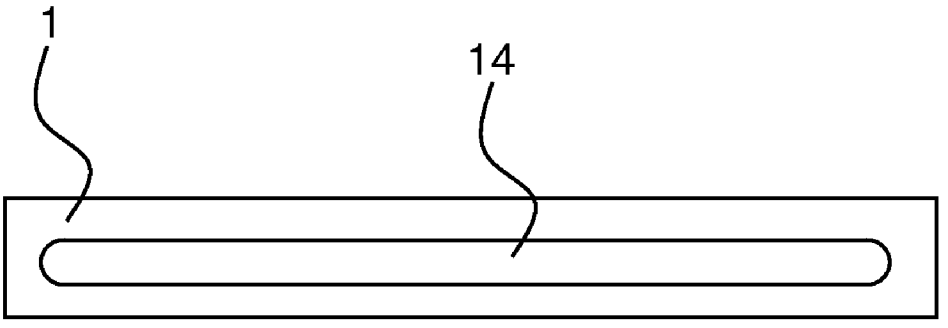


FIG. 3b

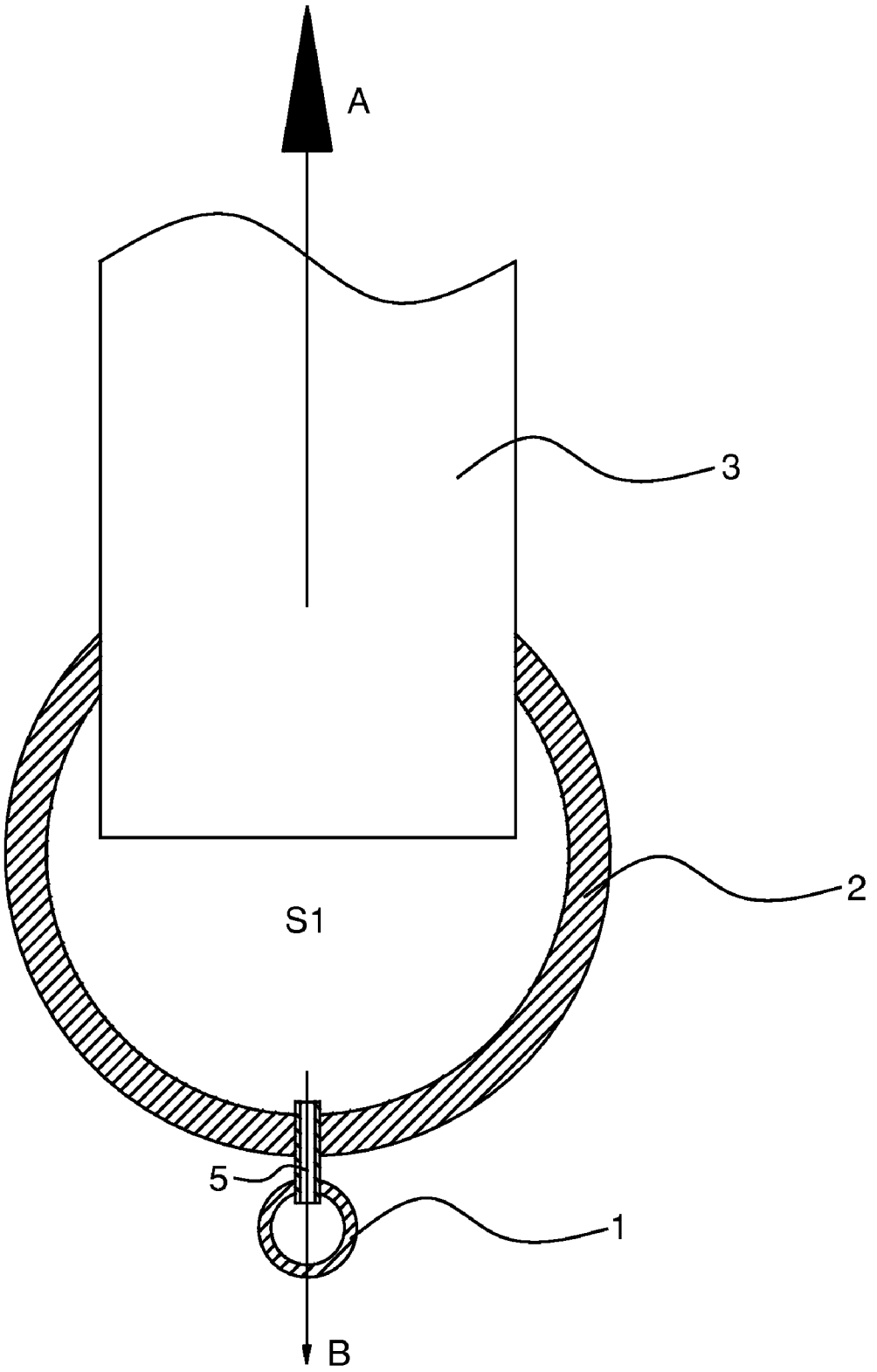


FIG. 4

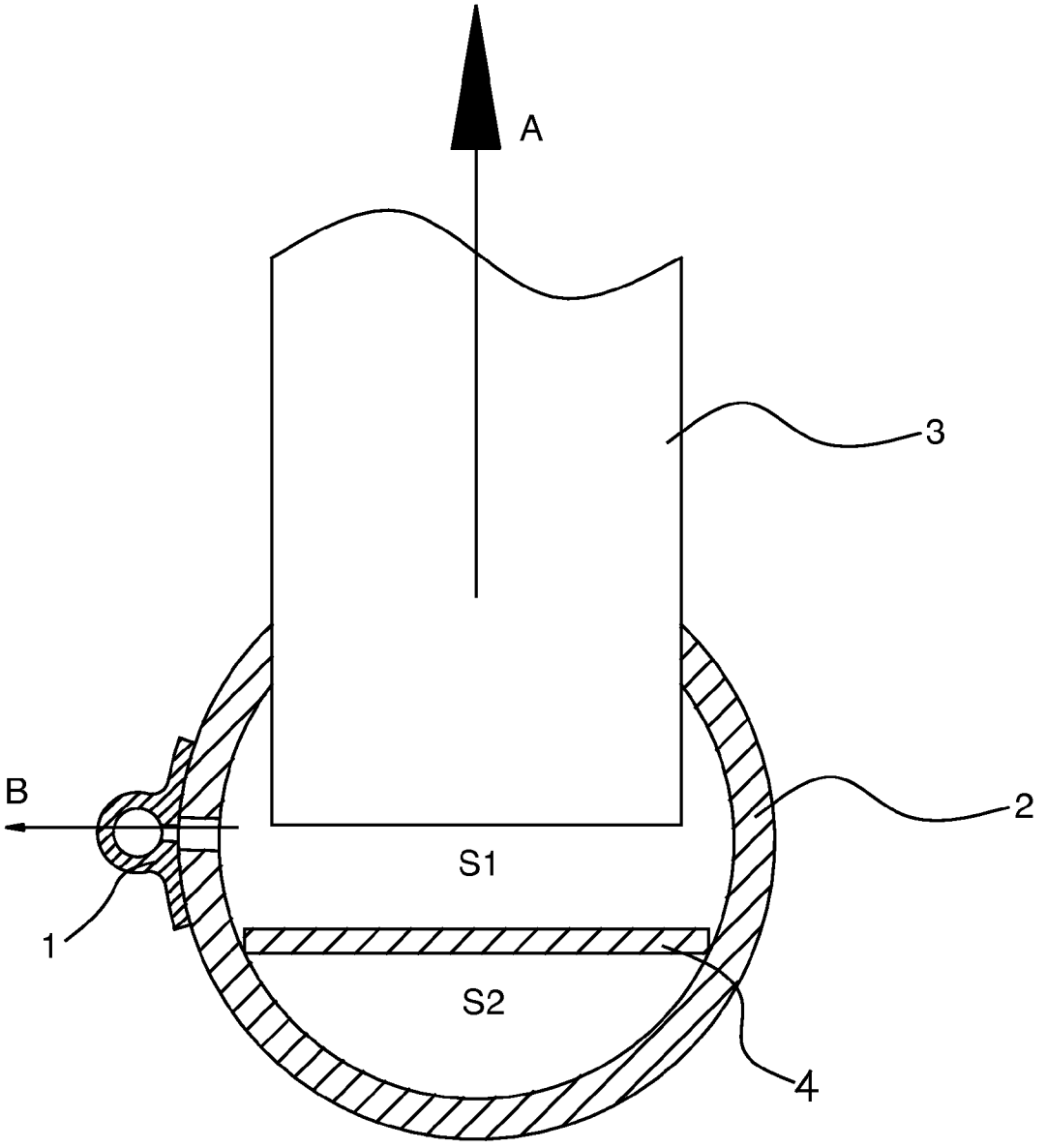


FIG. 5

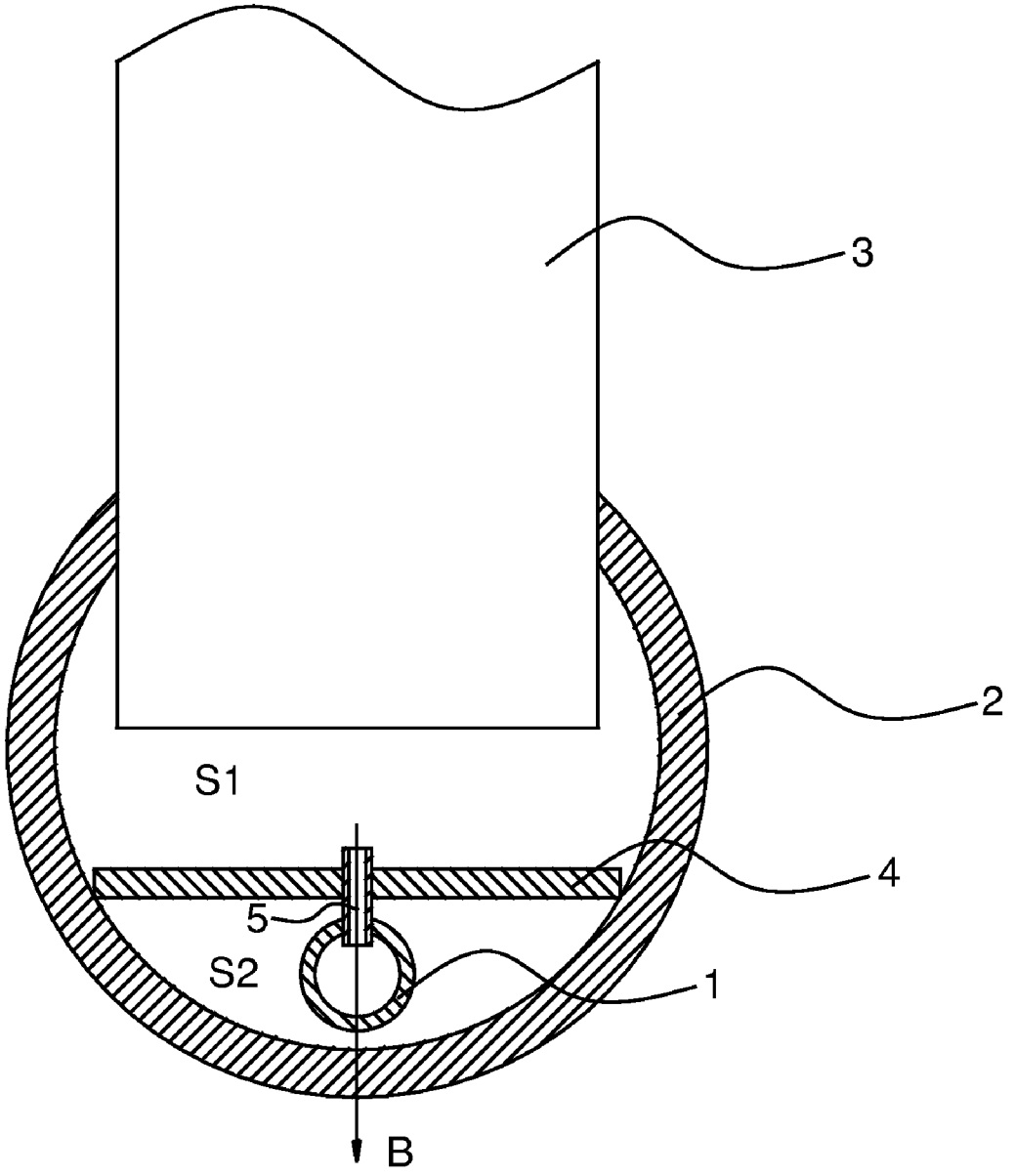


FIG. 6

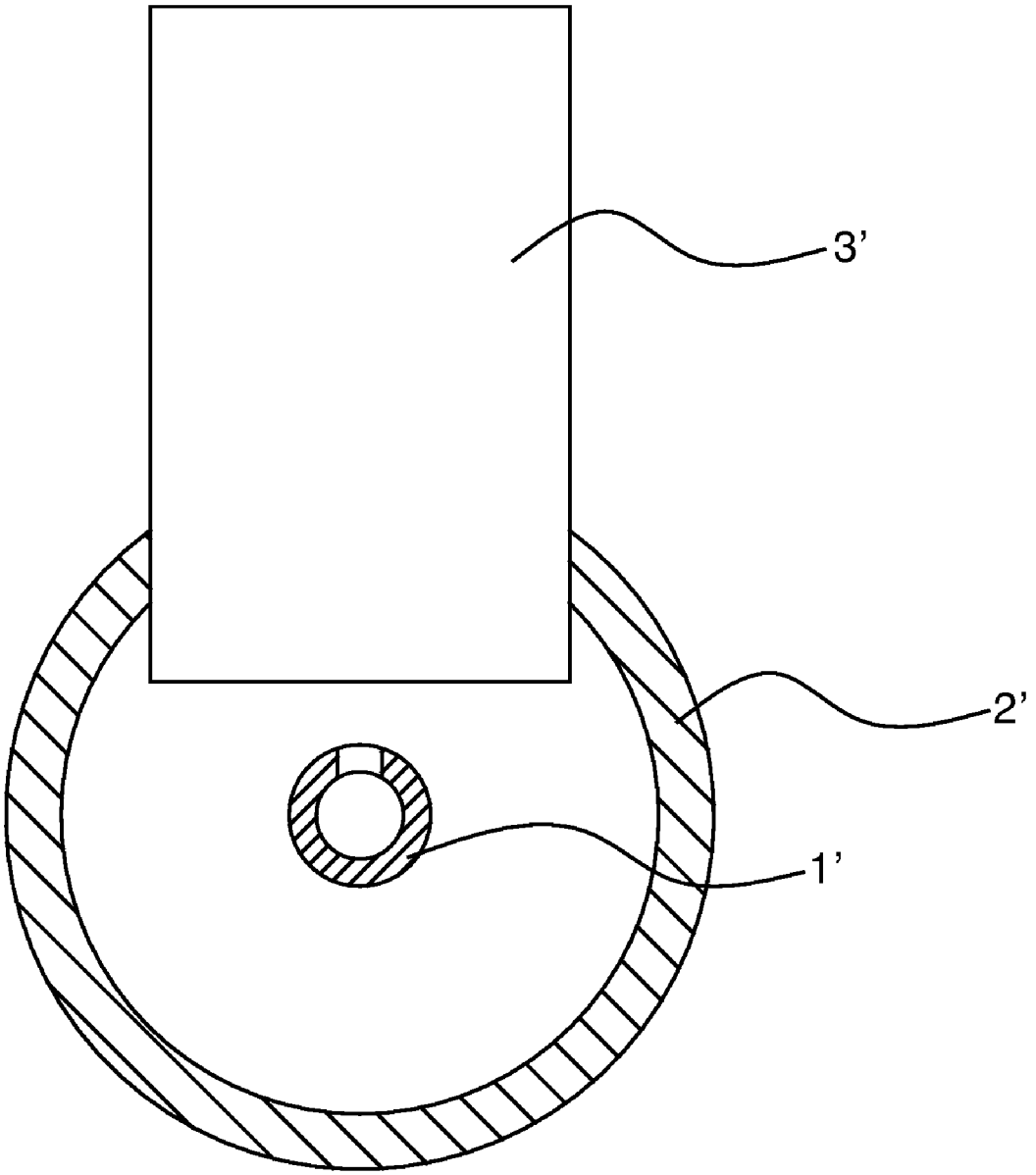


FIG. 7

HEAT EXCHANGER

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is entitled to the benefit of and incorporates by reference essential subject matter disclosed in Chinese Patent Application No. 200910173434.0 filed on Sep. 16, 2009.

BACKGROUND

[0002] 1. Technical Field of the Invention

[0003] The present invention relates to a heat exchanger.

[0004] 2. Background of the Invention

[0005] A heat exchanger generally comprises an inlet header, an outlet header, flat tubes and fins. In order to eliminate the gas-liquid stratification of the refrigerant in the headers, a tubular distributor is generally disposed in the inlet header, the refrigerant is entered into the distributor from a refrigerant source and then the distributor distributes the refrigerant into the interior of the header. Since the distributor is disposed inside the inlet header, the assembling and disassembling of the distributor is complex, the distributor is difficult to maintain, and the refrigerants in the inlet header and the distributor affect each other disadvantageously.

SUMMARY OF THE INVENTION

[0006] The present invention is directed to solve at least one of the problems existing in the prior art.

[0007] Accordingly, an embodiment of the present invention provides a heat exchanger, comprising: an inlet header defining a refrigerant chamber therein; an outlet header spaced apart from the inlet header; a plurality of tubes, two ends of each tube being connected and communicating with the inlet and outlet headers respectively; a plurality of fins, each of which is interposed between adjacent tubes, and a distribution tube disposed outside the refrigerant chamber and formed with a distribution opening through which the distribution tube communicates with the refrigerant chamber.

[0008] With the heat exchanger according to the embodiment of the present invention, since the distribution tube is not inserted into the refrigerant chamber within the inlet header, the distribution tube is easy to assemble, disassemble and maintain, the refrigerants in the inlet header and the distribution tube do not affect each other disadvantageously, thus enhancing distribution of refrigerant.

[0009] The above summary of the present invention is not intended to limit each disclosed embodiment or describe every implementation of the present invention. The Figures and the detailed description which follow more particularly exemplify illustrative embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] These and other aspects and advantages of the invention will become apparent and more readily appreciated from the following descriptions taken in conjunction with the drawings in which:

[0011] FIG. **1** is a schematic view of a heat exchanger according to an embodiment of the present invention;

[0012] FIG. **2** is a partial cross-sectional view of the heat exchanger taken along line E-E in FIG. **1**;

[0013] FIGS. **3***a* and **3***b* show different types of the distribution opening in the distribution tube of the heat exchanger;

[0014] FIG. **4** is a partial cross-sectional view of a heat exchanger according to another embodiment of the present invention;

[0015] FIG. **5** is a partial cross-sectional view of a heat exchanger according to still another embodiment of the present invention;

[0016] FIG. **6** is a partial cross-sectional view of a heat exchanger according to still another embodiment of the present invention; and

[0017] FIG. **7** is a partial cross-sectional view of a conventional heat exchanger.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0018] Reference will be made in detail to embodiments of the present invention. The embodiments described herein with reference to drawings are explanatory, illustrative, and used to generally understand the present invention. The embodiments shall not be construed to limit the present invention. The same or similar elements and the elements having same or similar functions are denoted by like reference numerals throughout the description.

[0019] In the description, relative terms such as "longitudinal" as well as derivatives thereof (e.g., "longitudinally", etc.) should be construed to refer to the orientation as then described or as shown in the drawings under discussion. These relative terms are for convenience of description and do not require that the present invention be constructed or operated in a particular orientation. Terms concerning "connected to" and "communicate with", refer to a relationship wherein structures are secured or attached to one another either directly or indirectly through intervening structures, as well as both movable or rigid attachments or relationships, unless expressly described otherwise.

[0020] FIG. **7** shows a partial cross-sectional view of a conventional heat exchanger. As shown in FIG. **7**, the distributor **1'** of the conventional heat exchanger is inserted into the inlet header **2'**. As so positioned, the distributor **1'** is difficult to assemble and disassemble. In addition, the refrigerant in the distributor **1'** and the refrigerant in the inlet header **2'** disadvantageously disturb each other. When a fault occurs in the distributor **1'**, it is difficult to find the fault and maintain the distributor **1'**. Further, due to the limitation of the size of the interior of the inlet header **2'**, the number of distributors **1'** that can be disposed in the inlet header **2'** is limited, so that the distributed amount of the refrigerant is difficult to control.

[0021] The heat exchanger according to an embodiment of the present invention will be described in detail with reference to the drawings below.

[0022] As shown in FIG. **1**, the heat exchanger according to an embodiment of the present invention comprises an inlet header **2**, an outlet header **6**, tubes **3**, fins **7** and a distribution tube **1**.

[0023] As shown in FIG. **2**, the inlet header **2** defines a refrigerant chamber S**1** therein. Of course, in the examples shown in FIGS. **2** and **4**, the whole inner chamber of the inlet header **2** is the refrigerant chamber S**1**. Alternatively, as shown in FIGS. **5** and **6**, a partition **4** is disposed inside the inlet header **2** so as to divide an interior of the inlet header **2** into the refrigerant chamber S**1** and a cavity S**2** isolated from each other (which will be described below).

[0024] The outlet header **6** and the inlet header **2** are spaced apart from each other, and for example, disposed substantially parallelly to each other. Two ends of each tube **3** are

connected to and communicate with the inlet and outlet headers **2**, and **6** respectively, for example by welding, such that the inlet header **2** communicates with the outlet header **6** via refrigerant channels in tubes **3**. The refrigerant channel of tube **3** may be a micro-channel for instance, therefore the heat exchanger is referred to as a micro-channel heat exchanger. Of course, the present invention is not limited to micro-channel heat exchanger designs. Each fin **7** is disposed between adjacent tubes **3** so as to enhance the effect of heat transfer.

[0025] As shown in FIGS. **1-2** and FIGS. **3***a*-**3***b*, a distribution opening **14** is formed in the distribution tube **1**. As shown in FIGS. **1-2**, the distribution tube **1** is disposed outside the refrigerant chamber S**1**, and an inner chamber **13** of the distribution tube **1** communicates with the refrigerant chamber S**1** via the distribution opening **14**. Of course, a through hole **21** is formed accordingly in a wall of the inlet header **2** defining the refrigerant chamber S**1**.

[0026] With the heat exchanger according to some embodiments of the present invention, the distribution tube **1** is not disposed in the refrigerant chamber S**1** of the inlet header **2**. In other words, the distribution tube **1** is not inserted into the refrigerant within the inlet header **2**. Therefore, assembling and disassembling of the distribution tube **1** are simple, the distribution tube **1** is easy to maintain, and the refrigerants in the inlet header **2** and the distribution tube **1** do not affect each other disadvantageously, thus enhancing distribution of the refrigerant.

[0027] As shown in FIG. **1**, in an embodiment of the present invention, the distribution tube **1** is mounted onto the outer wall of the inlet header **2** and the distribution opening **14** corresponds to the through hole **21**. Therefore, the refrigerant, which enters into the inner chamber **13** of the distribution tube **1** from a refrigerant source (not shown), is sprayed into the refrigerant chamber S**1** via the distribution opening **14** and the through hole **21**, thus eliminating the separation of vapor refrigerant and liquid refrigerant in the inlet header **2** and enhancing the effect of heat transfer. In order to further enhance distribution of the refrigerant, a ratio of an inner diameter of the distribution tube **1** to a hydraulic inner diameter of the refrigerant chamber S**1** is within a range of about 0.17 to about 0.79.

[0028] In order to enhance the convenience of mounting the distribution tube **1** in accordance with embodiments of the present invention, the distribution tube **1** is formed integrally with a mounting foot **12** having a surface adapted to outer surface of inlet header **2**, so that the distribution tube **1** is fixed onto the outer wall of the inlet header **2**, for example, by welding the mounting foot **12** to the outer wall of the inlet header **2**. In this case, the distribution opening **14** penetrates through the mounting foot **12** and corresponded to the through hole **21**.

[0029] In an example of the present invention, as shown in FIG. **3***a*, the distribution opening **14** comprises a plurality of orifices formed in the distribution tube **1** separated from each other. The orifice may be a circular orifice or a slot having any other shapes. Alternatively, as shown in FIG. **3***b*, the distribution opening **14** may be formed as a single slot extending along the longitudinal direction of the distribution tube **1**. The distribution opening **14** is circular and its hydraulic diameter is within a range of from about 0.2 to about 4 mm, thus further improving the heat transfer effect. Alternatively, a ratio of an area of the distribution opening **14** to a cross-sectional area of the refrigerant chamber S**1** is within the range of from about 0.3 to about 2. Experiments conducted by the present inventors prove that the above range can enhance distribution of the refrigerant.

[0030] In some embodiments of the present invention, since the distribution tube **1** is fixed onto the outer wall of the inlet header **2**, the number of distribution tubes **1** is easy to change. For example, the number of inlet headers **2** used may be several so as to satisfy the requirements of the heat exchanger for different amounts of refrigerant, and the distribution of the refrigerant is easy to control by controlling individual distribution tubes **1**.

[0031] In some embodiments of the present invention, an opposite direction B to an outflow direction of the refrigerant discharged from the distribution opening **14** is at an angle of about 45° to about 315° with a flow direction A of a refrigerant in the tubes **3**. The distributing effect of the refrigerant is further enhanced by setting the angle between the direction A and B in the above angle range. For example, as shown in FIG. **2**, the direction B is at an angle of 180° with the direction A. Alternatively, in an example of the present invention shown in FIG. **5**, the direction B is at an angle of 90° with the direction A.

[0032] As shown in FIG. **4**, in some examples of the present invention, the distribution tube **1** without the mounting foot **12** thereon is connected and communicated with the refrigerant chamber S**1** of the inlet header **2** via a communication pipe **5** rather than the mounting foot **12**. A first end of the communication pipe **5** is welded to the distribution tube **1** at the position of the distribution opening **14**, and a second end thereof is extended into the refrigerant chamber S**1** penetrated through the wall of the inlet header **2**. Of course, the joint of the communication pipe **5** and the inlet header **2** is sealed, for example, via welding the communication pipe **5** to the inlet header **2**, that is, the gap between the communication pipe **5** and the inlet header **2** is sealed.

[0033] The heat exchanger according to another embodiment of the invention will be described below. As shown in FIG. **5**, a partition **4** is disposed inside the inlet header **2** so as to divide the interior of the inlet header **2** into the refrigerant chamber S**1** and a cavity S**2** isolated from each other. There will be no refrigerants in the cavity S**2**, and the distribution tube **1** is fixed onto the outer wall of the inlet header **2** and communicates with the refrigerant chamber S**1** via the distribution opening **14** and the through hole **21**. The provision of the partition **4** reduces the volume of the refrigerant chamber S**1**, thus further enhancing distribution of the refrigerant.

[0034] In the embodiment shown in FIG. **5**, the distribution tube **1** is formed with a mounting foot, so that the distribution tube **1** may be fixed conveniently onto the outer wall of the inlet header **2**.

[0035] FIG. **6** shows an alternative embodiment of the present invention. In the embodiment shown in FIG. **6**, the distribution tube **1** is disposed inside the cavity S**2** rather than fixed onto the outer wall of the inlet header **2** and communicates with the refrigerant chamber S**1** via the communication pipe **5**. Therefore, the distribution tube **1** is easy to assemble and disassemble, and is not affected by the refrigerant in the inlet header **2**. Meanwhile, the volume of the refrigerant chamber S**1** is reduced, thus improving the distributing effect of the refrigerant and improving the aesthetics of the heat exchanger.

[0036] The operation of the heat exchanger according to an example of the present invention will be described below.

[0037] As shown in FIG. **1**, the refrigerant enters into the distribution tube **1** along the direction C, and then sprays into the refrigerant chamber S**1** of the inlet header **2** via the distribution opening **14**, thus eliminating the separation of vapor refrigerant and liquid refrigerant in the two-phase flow, and finally the refrigerant flows towards the outlet header **6** along the tubes **3** and exchanges heat during this period. The refrigerant subject to heat exchanging enters into the outlet header **6** and is finally discharged from the outlet header **6** along the direction D.

[0038] Since the distribution tube **1** is not inserted into the refrigerant chamber within the inlet header **2**, the refrigerant in the inlet header **2** and the distribution tube **1** will not disadvantageously disturb each other, and the distribution tube **1** is easy to assemble, disassemble and maintain. Meanwhile, the distribution tube **1** may be disposed in plural numbers, such that the heat exchanger can satisfy different requirements for the amount of the refrigerant by controlling individual distribution tubes **1**.

[0039] Reference throughout this specification to "an embodiment," "some embodiments," "one embodiment", "an example," or "some examples," means that a particular feature, structure, material, or characteristic described in connection with the embodiment or example is included in at least one embodiment or example of the invention. Thus, the appearances of the phrases such as "in some embodiments," "in one embodiment" "in an embodiment", "an example," or "some examples," in various places throughout this specification are not necessarily referring to the same embodiment or example of the invention. Furthermore, the particular features, structures, materials, or characteristics may be combined in any suitable manner in one or more embodiments or examples.

[0040] Although explanatory embodiments have been shown and described, it would be appreciated by those skilled in the art that changes, alternatives, and modifications can be made in the embodiments without departing from spirit and principles of the invention. Such changes, alternatives, and modifications all fall into the scope of the claims and their equivalents.

What is claimed is:

1. A heat exchanger, comprising:

an inlet header defining a refrigerant chamber therein;

an outlet header spaced apart from the inlet header;

a plurality of tubes, two ends of each tube being connected to and communicating with the inlet and outlet headers respectively;

a plurality of fins, each of which is interposed between adjacent tubes, and

a distribution tube disposed outside the refrigerant chamber and formed with a distribution opening, through which the distribution tube communicates with the refrigerant chamber.

2. The heat exchanger according to claim **1**, wherein the distribution tube is mounted onto an outer wall of the inlet header.

3. The heat exchanger according to claim **2**, wherein the distribution tube is formed integrally with a mounting foot, through which the distribution tube is mounted onto the outer wall of the inlet header.

4. The heat exchanger according to claim **1**, wherein a ratio of an inner diameter of the distribution tube to a hydraulic inner diameter of the refrigerant chamber is within a range of about 0.17 to about 0.79.

5. The heat exchanger according to claim **1**, wherein a partition is disposed inside the inlet header so as to divide an interior of the inlet header into the refrigerant chamber and a cavity isolated from each other.

6. The heat exchanger according to claim **5**, wherein the distribution tube is disposed inside the cavity.

7. The heat exchanger according to claim **1**, further comprising a communication pipe, a first end of which is connected to the distribution tube so as to communicate with the distribution tube via the distribution opening and a second end thereof communicates with the refrigerant chamber.

8. The heat exchanger according to claim **1**, wherein the distribution opening comprises a plurality of orifices formed in the distribution tube and separated from each other.

9. The heat exchanger according to claim **1**, wherein the distribution opening comprises a single slot formed in the distribution tube.

10. The heat exchanger according to claim **1**, wherein the distribution opening is circular and a hydraulic diameter thereof is within a range of about 0.2 mm. to about 4 mm.

11. The heat exchanger according to claim **1**, wherein a ratio of an area of the distribution opening to a cross-sectional area of the refrigerant chamber is within a range of about 0.3 to about 2.

12. The heat exchanger according to claim **1**, wherein a plurality of distribution tubes are disposed outside the refrigerant chamber.

13. The heat exchanger according to claim **1**, wherein a flow direction of a refrigerant in the tubes is at an angle of about 45° to about 315° with an opposite direction to an outflow direction of the refrigerant discharged from the distribution opening.

* * * * *