



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
23.03.2011 Bulletin 2011/12

(51) Int Cl.:
F28D 1/053 (2006.01) F28F 9/02 (2006.01)

(21) Application number: **10009474.7**

(22) Date of filing: **13.09.2010**

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

(30) Priority: **18.09.2009 CN 200910173434**

(71) Applicant: **Danfoss Sanhua (Hangzhou) Micro Channel Heat Exchanger Co., Ltd.**
Hangzhou
Zhejiang 310018 (CN)

(72) Inventors:
• **Jianlong, Jiang**
Hangzhou
Zhejiang 310018 (CN)
• **Feng, Wang**
Hangzhou
Zhejiang 310018 (CN)
• **Huazhao, Liu**
Hangzhou
Zhejiang 310018 (CN)
• **Huang, Lin-jie**
East Amherst, NY 14051 (US)

(74) Representative: **Knoblauch, Andreas**
Patentanwälte Dr. Knoblauch
Schlosserstrasse 23
60322 Frankfurt am Main (DE)

(54) **Heat exchanger with headers and distribution tube**

(57) A heat exchanger is provided, comprising:
an inlet header (2) defining a refrigerant chamber therein;
an outlet header (6) spaced apart from the inlet header (2);
a plurality of tubes (3), two ends of each tube (3) being connected and communicated with the inlet and outlet

headers (2, 6) respectively;
a plurality of fins (7), each of which is interposed between adjacent tubes (3), and
a distribution tube (1) disposed outside the refrigerant chamber and formed with a distribution opening, through which the distribution tube is communicated with the refrigerant chamber.

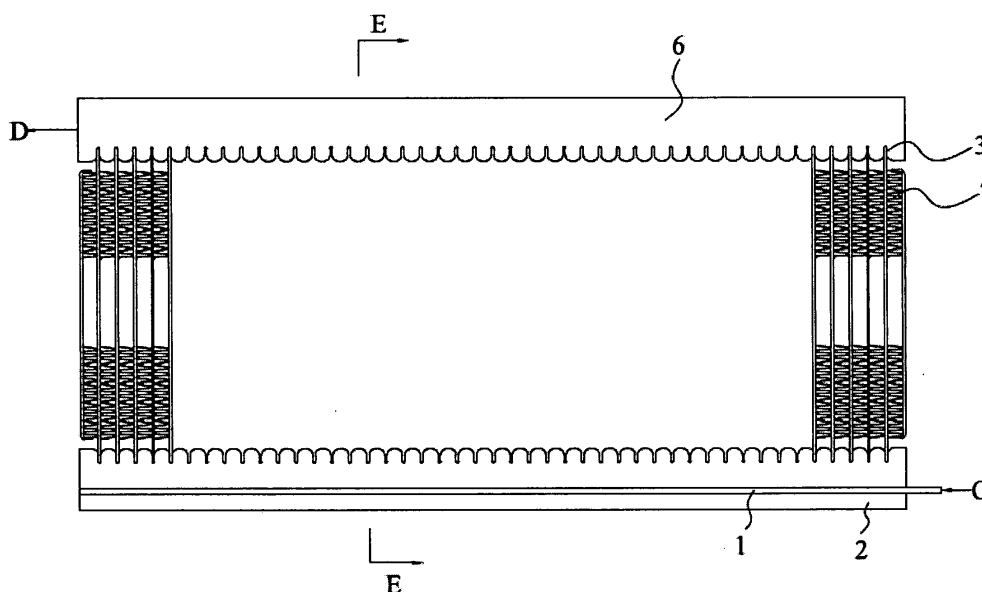


Fig.1

Description

BACKGROUND

Technical Field

[0001] The present invention relates to a heat exchanger.

Description of the Related Art

[0002] A heat exchanger generally comprises an inlet header, an outlet header, tubes and fins. In order to eliminate the separation of vapor refrigerant and liquid refrigerant in the two-phase flow in the inlet header, a tubular distributor is generally inserted into the inlet header. The refrigerant enters into the distributor from a refrigerant source and then is distributed into the interior of the header.

[0003] As shown in Fig. 7, the distributor 1' of a conventional heat exchanger is inserted into the refrigerant within the inlet header 2', so that the distributor 1' is difficult to assemble and disassemble. In addition, 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 the distributor 1' disposed in the inlet header 2' is limited, so that the distributed amount of the refrigerant is difficult to control.

SUMMARY

[0004] The present invention is directed to solve at least one of the problems existing in the prior art.

[0005] Accordingly, an object of the present invention is to provide a heat exchanger, in which the assembling and disassembling of the distribution tube of the heat exchanger is simple, the distribution tube is easy to maintain, and the refrigerants in the inlet header and the distribution tube do not affect disadvantageously each other.

[0006] 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 communicated 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 is communicated with the refrigerant chamber.

[0007] With the heat exchanger according to the embodiment of the present invention, since the distribution tube is not inserted into the refrigerant within the inlet header, the distribution tube is easy to assemble, disassemble and maintain, the refrigerant in the inlet header

and the distribution tube do not affect disadvantageously each other, thus enhancing distribution of the refrigerant.

[0008] Additionally, the distribution tube is mounted onto an outer wall of the inlet header. Therefore, it is easier to assemble, disassemble and maintain the distribution tube.

[0009] Further, 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.

10 [0010] Further, 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.

15 [0011] The interior of the inlet header is divided into two portions by the partition, resulting in reduction of volume of the refrigerant chamber, which can further enhance distribution of the refrigerant.

[0012] Additionally, 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 - about 0.79.

20 [0013] It is proved by experiments that the ratio of an inner diameter of the distribution tube to a hydraulic inner diameter of the refrigerant chamber within such a range can enhance distribution of the refrigerant.

[0014] Further, the distribution tube is disposed inside the cavity.

[0015] The heat exchanger according to the embodiment of the present invention further comprises 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 is communicated with the refrigerant chamber.

35 [0016] Further, the distribution opening comprises a plurality of orifices formed in the distribution tube and separated from each other.

[0017] Alternatively, the distribution opening comprises a single slot formed in the distribution tube.

40 [0018] The distribution opening is circular and a hydraulic diameter thereof is in a range of about 0.2- about 4mm.

[0019] A ratio of an area of the distribution opening to a cross sectional area of the refrigerant chamber is within a range of from about 0.3to about 2.

45 [0020] It is proved by experiments that the setting of such parameters can further enhance distribution of the refrigerant.

[0021] Further, a plurality of the distribution tubes are disposed.

50 [0022] Since the distribution tube may be plural, by controlling individual distribution tubes, it is easy to control the distribution amount of the refrigerant and satisfy the different requirements for the amount of the refrigerant.

55 [0023] Particularly, a flow direction of a refrigerant in the tubes is at an angle of about 45°-about 315°with an opposite direction to an outflow direction of the refrigerant discharged from the distribution opening, thus enhancing

distribution of the refrigerant.

[0024] The above summary of the present invention is not intended to describe each disclosed embodiment or every implementation of the present invention. The Figures and the detailed description which follow more particularly exemplify illustrative embodiments.

BRIEF DESCRIPTION OF DRAWINGS

[0025] 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:

Fig. 1 is a schematic view of a heat exchanger according to an embodiment of the present invention; Fig. 2 is a partially cross-sectional view of the heat exchanger taken along line E-E in Fig. 1;

Figs. 3a and 3b show different types of the distribution opening in the distribution tube of the heat exchanger;

Fig. 4 is a partially cross-sectional view of a heat exchanger according to another embodiment of the present invention;

Fig. 5 is a partially cross-sectional view of a heat exchanger according to still another embodiment of the present invention;

Fig. 6 is a partially cross-sectional view of a heat exchanger according to still further another embodiment of the present invention; and

Fig. 7 is a partially cross-sectional view of a conventional heat exchanger.

DETAILED DESCRIPTION

[0026] 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 descriptions.

[0027] In the description, relative terms such as "longitudinal" as well as derivative 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" and "communicated", 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.

[0028] The heat exchanger according to an embodi-

ment of the present invention will be described in detail with reference to the drawings below.

[0029] 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.

[0030] As shown in Fig. 2, the inlet header 2 defines a refrigerant chamber S1 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 S1. Alternatively, as shown in Figs. 5 and 6, a partition is disposed inside the inlet header so as to divide an interior of the inlet header into the refrigerant chamber S1 and a cavity S2 isolated from each other (which will be described below).

[0031] 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 are connected and communicated with the inlet and outlet headers 2, and 6 respectively, for example by welding, such that the inlet header 2 is communicated 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 this. Each fin is disposed between adjacent tubes so as to enhance the effect of heat transfer.

[0032] As shown in Figs. 1-2 and Figs. 3a-3b, a distribution opening 14 is formed in the distribution tube 1. As shown in Fig. 1, the distribution tube 1 is disposed outside the refrigerant chamber S1, and an inner chamber 13 of the distribution tube 1 is communicated with the refrigerant chamber S1 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 S1.

[0033] With the heat exchanger according to some embodiments of the present invention, the distribution tube 1 is not disposed in the refrigerant chamber S1 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 disadvantageously each other, thus enhancing distribution of the refrigerant.

[0034] 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 S1 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 dis-

tribution tube 1 to a hydraulic inner diameter of the refrigerant chamber S1 is within a range of about 0.17 - about 0.79.

[0035] In order to enhance the convenience of mounting, in an embodiment 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 is penetrated through the mounting foot 12 and corresponded to the through hole 21.

[0036] In an example of the present invention, as shown in Fig. 3a, 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. 3b, 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 S1 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.

[0037] 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 the distribution tube 1 is easy to change. For example, the number of the inlet header 2 may be several so as to satisfy the requirements of the heat exchanger for different amount of refrigerant, and the distribution of the refrigerant is easy to control by controlling individual distribution tubes 1.

[0038] 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° - 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.

[0039] 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 S1 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 tube 14, and a second end thereof is extended into the refrigerant chamber S1 penetrated through the wall of the inlet header 2. Of course, the joint of the communi-

cation 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.

[0040] 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 S1 and a cavity S2 isolated from each other. There will be no refrigerants in the cavity S2, and the distribution tube 1 is fixed onto the outer wall of the inlet header 2 and communicated with the refrigerant chamber S1 via the distribution opening 14 and the through hole 21. The provision of the partition 4 reduces the volume of the refrigerant chamber S1, thus further enhancing distribution of the refrigerant.

[0041] In the embodiment shown in Fig. 5, the distribution tube 1 is formed with the mounting foot, so that the distribution tube 1 may be fixed conveniently onto the outer wall of the inlet header 2.

[0042] 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 S2 rather than fixed onto the outer wall of the inlet header 2 and communicated with the refrigerant chamber S1 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 S1 is reduced, thus improving the distributing effect of the refrigerant and improving the aesthetics of the heat exchanger.

[0043] The operation of the heat exchanger according to an example of the present invention will be described below.

[0044] As shown in Fig. 1, the refrigerant enters into the distribution tube 1 along the direction C, and then sprays into the refrigerant chamber S1 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.

[0045] Since the distribution tube 1 is not inserted into the refrigerant within the inlet header 2, the refrigerant in the inlet header 2 and the distribution tube 1 will not disturb disadvantageously each other, and the distribution tube 1 is easy to assemble, disassemble and maintain. Meanwhile, the distribution tube 1 may be disposed in plural, such that the heat exchanger can satisfy different requirements for the amount of the refrigerant by controlling individual distribution tubes 1.

[0046] 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.

[0047] 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.

Claims

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 and communicated 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 is communicated 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 - 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 any one of claims 1-6, 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 is communicated 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- 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- about 2.

12. The heat exchanger according to claim 1, wherein a plurality of distribution tubes are disposed.

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 °- about 315 °with an opposite direction to an outflow direction of the refrigerant discharged from the distribution opening.

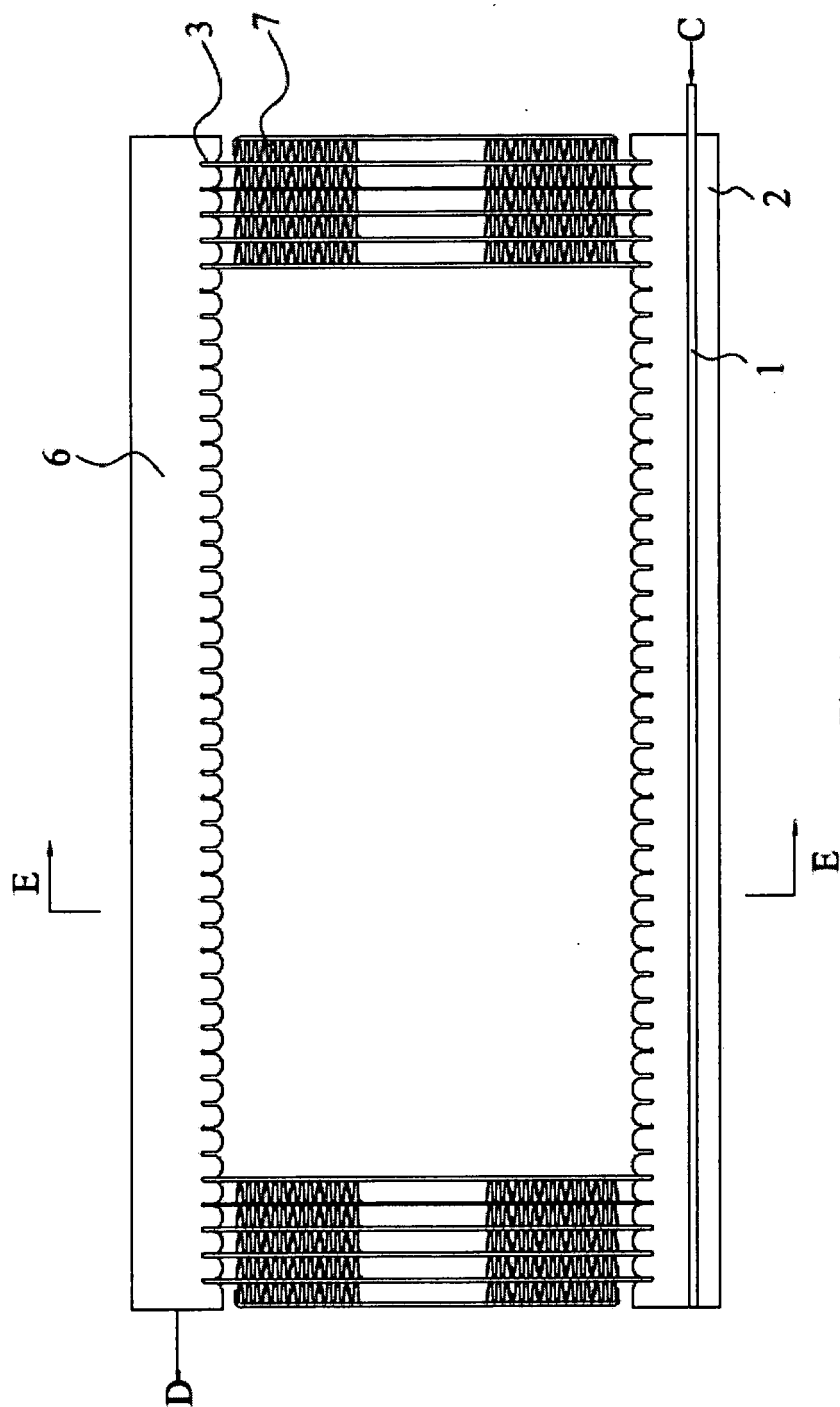


Fig.1

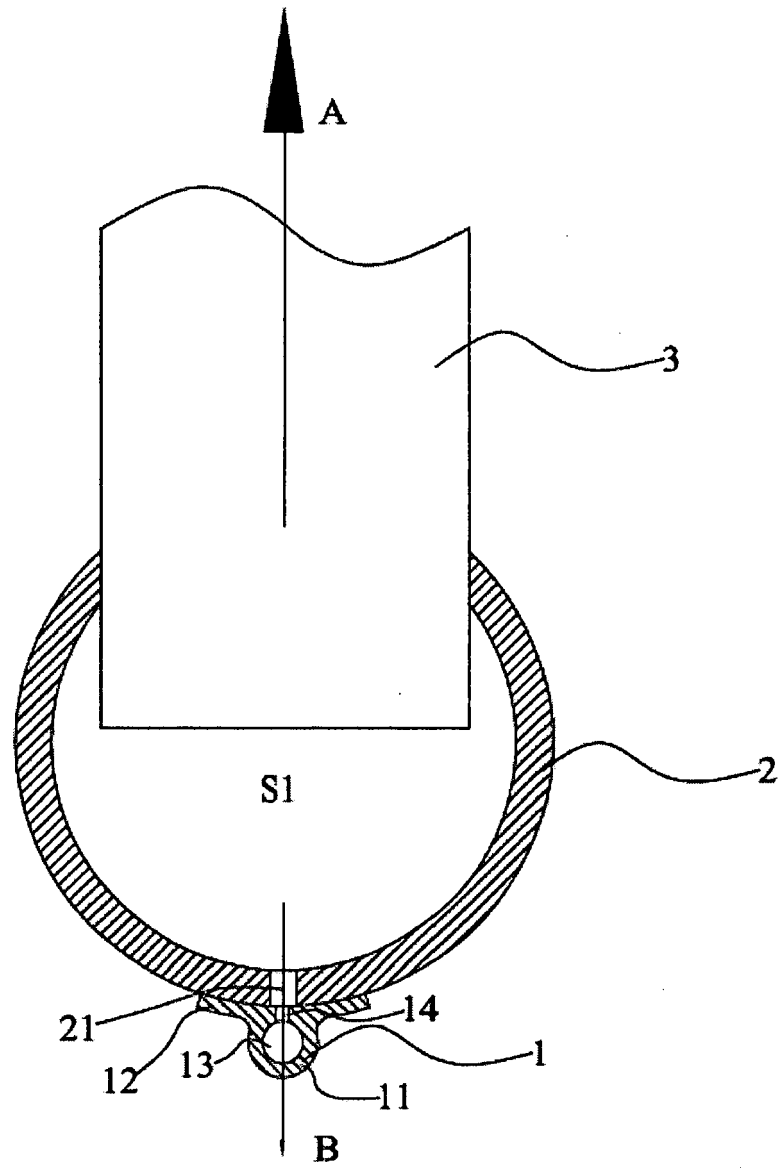


Fig.2

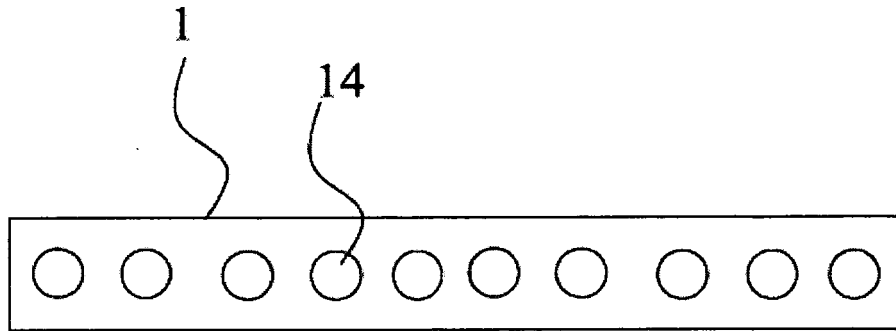


Fig.3a

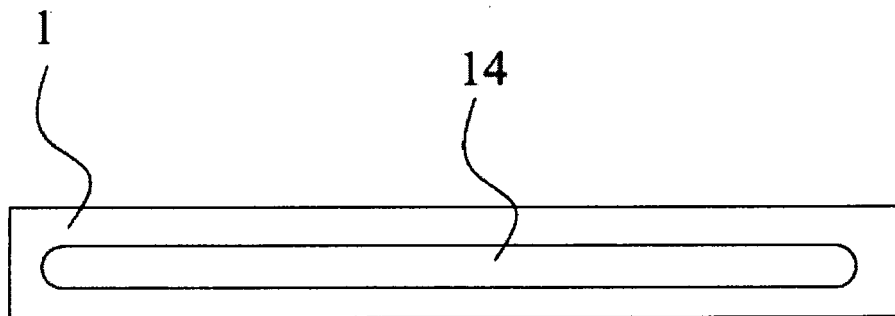


Fig.3b

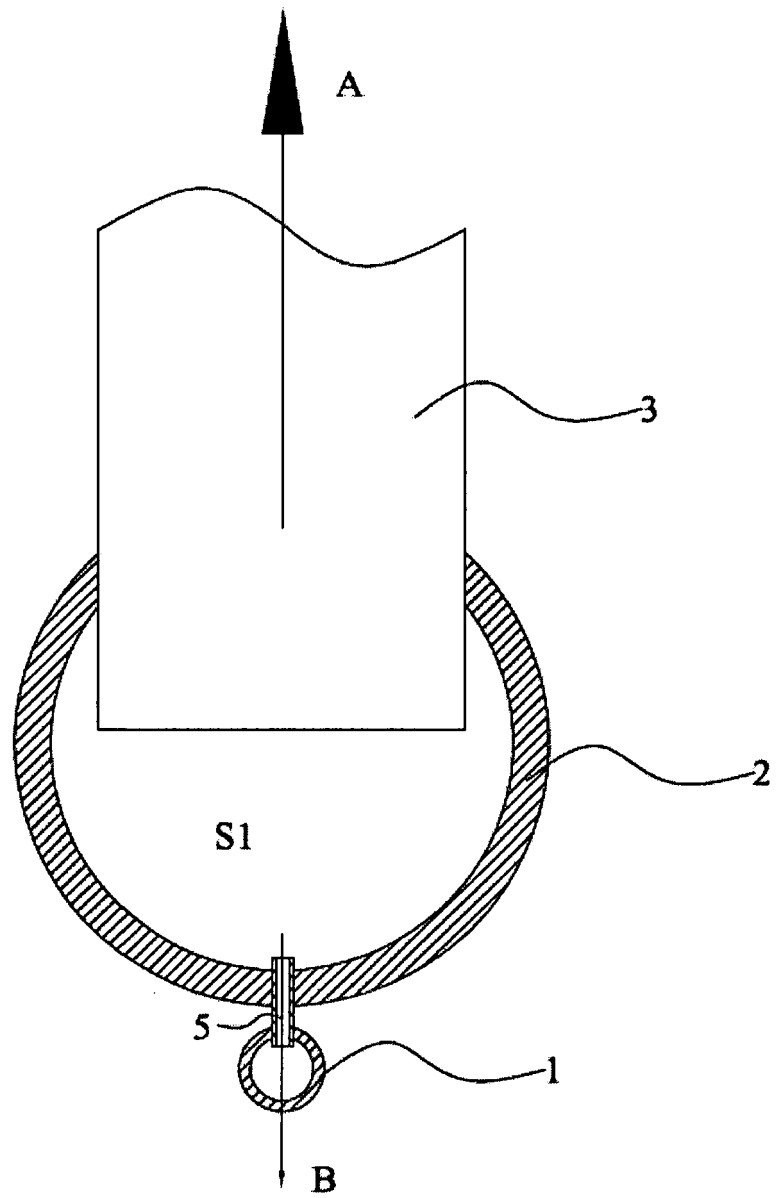


Fig.4

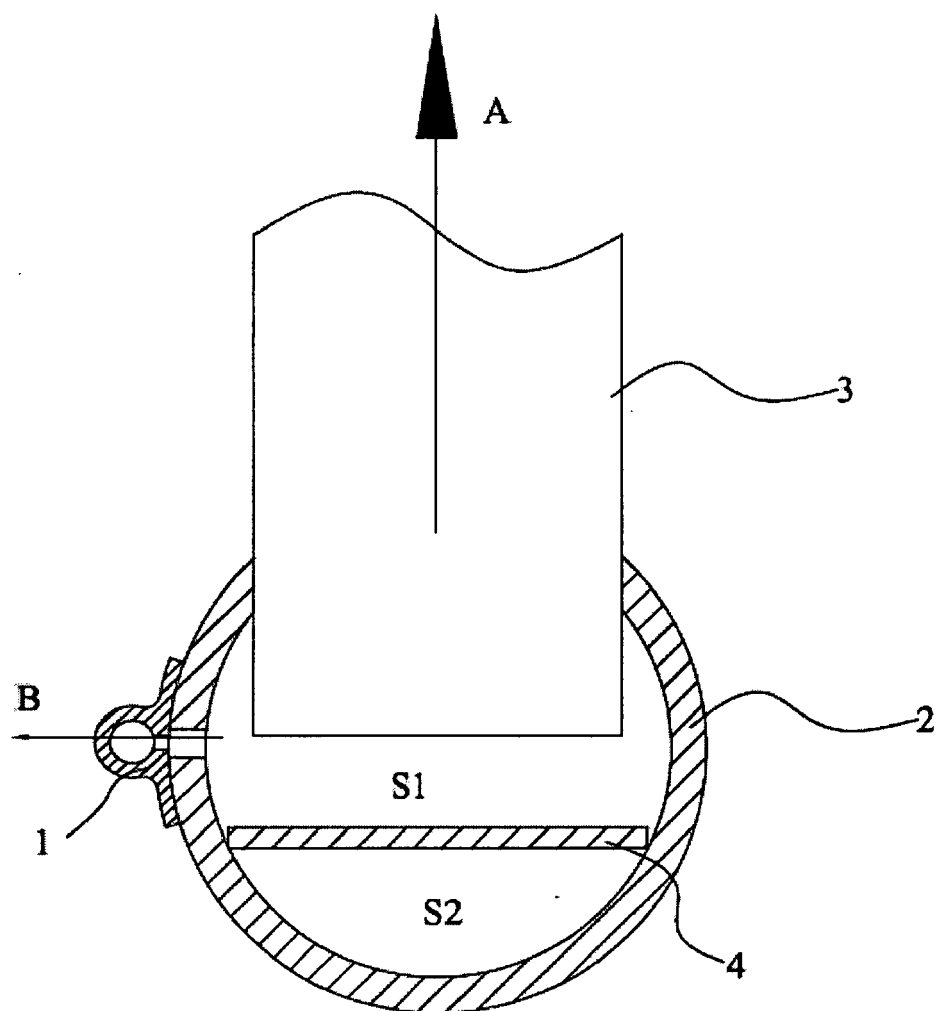


Fig.5

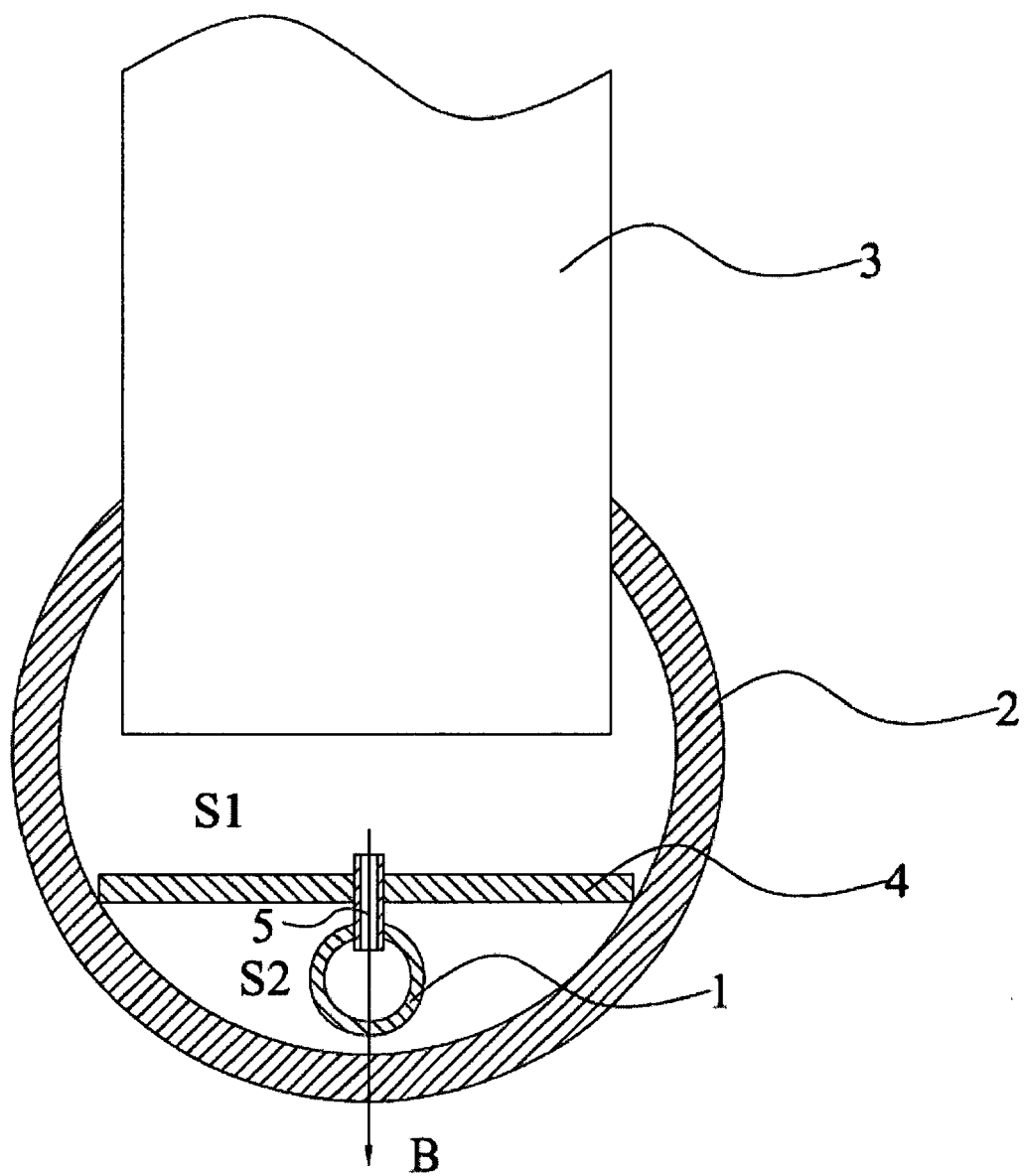


Fig.6

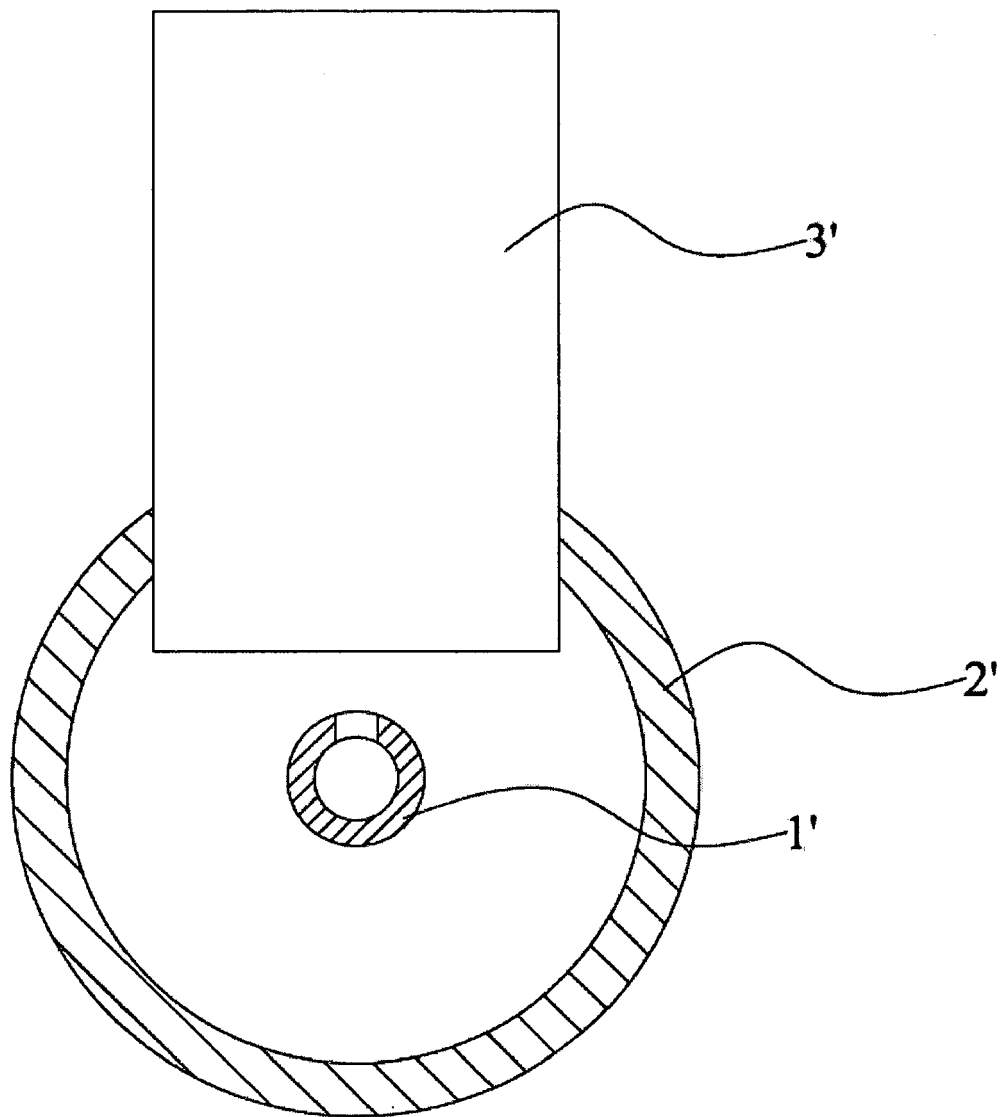


Fig.7