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- (54) **Title:** COOLING DEVICE AND LED LIGHTING DEVICE COMPRISING THE SAME

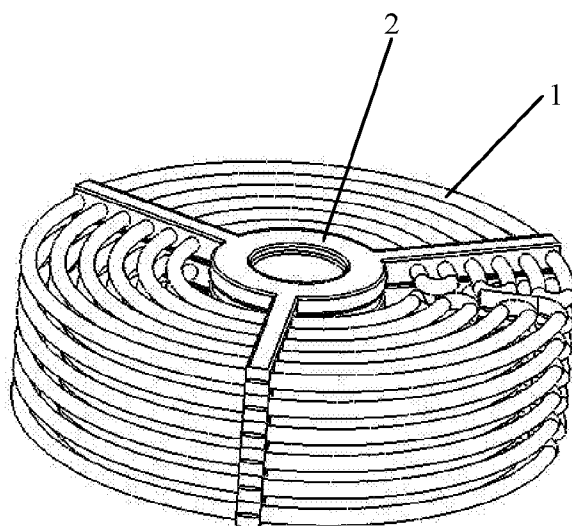


FIG.3b

(57) **Abstract:** The present invention relates to a cooling device, comprising: at least one cooling body (1) each of which is provided with a vacuum sealing chamber (3) therein; and a cooling medium filled in the vacuum sealing chamber (3), wherein the cooling medium has a high heat capacity. The cooling device according to the present invention can provide a high heat capacity, satisfactorily overcome thermal shock, and also has fine thermal conductivity and then can effectively cool devices such as an LED lighting apparatus. Another aspect of the present invention also relates to a cooling device, comprising: at least one cooling body (1), wherein the at least one cooling body comprises an elongated bendable member. The cooling device has fine thermal conductivity and heat dissipation property, and is lighter in weight and more flexible in design. In addition, the present invention also relates to an LED lighting apparatus comprising the above types of cooling devices.

Description

Cooling Device and LED Lighting Device Comprising the Same

5

Technical Field

The present invention relates to a cooling device used for cooling an LED lighting apparatus. In addition, the present invention also relates to an LED lighting apparatus comprising the cooling device.

10 Background Art

Current LED lighting technologies become more and more mature, and heat dissipation technologies for cooling LED lighting apparatuses have also undergone much improvement, especially cooling the LED lighting apparatuses in a manner of natural convection. However, as a large power pump is introduced into the LED lighting apparatuses (generally a heat flux density is more than 50000W/m^2), this puts forward new challenges to designs of passive cooling. In traditional passive cooling designs, metal plate heat sinks such as a finned heat sink are widely used. This type of solutions sometimes cannot provide fine heat dissipation properties and results in big weight. In addition, when the LED lighting apparatuses are used in unstable power consumption, the heat sinks should have a high heat capacity so as to overcome thermal shock (generally an instantaneous heat flux density is more than 100000W/m^2). However, traditional designs cannot satisfactorily overcome the thermal shock, because the metal plate used in the traditional designs does not have a fine specific heat capacity.

25 In the prior art, a heat sink according to a heat-pipe principle is known, and the heat-pipe is composed of a pipe wall, a capillary die and a cooling medium. The cooling medium in the heat-pipe is absorbed into the capillary die so that when the heat-pipe absorbs heat, the cooling medium in the capillary die is quickly vaporized and is condensed at the other end of the heat-pipe, thereby dissipating the heat to realize the object of cooling. However, as known to all, although the heat-pipe has fine cooling effect, it cannot provide a high heat capacity, because although the cooling medium may have a high specific heat capacity, the amount of the cooling medium in the heat-pipe is small, as long as it meets the object of vaporizing, and thus it is relatively weak in anti-thermal shock. In addition, due to the structure of

the heat-pipe, it is relatively complex in construction and is high in cost.

Summary of the Invention

Therefore, a first aspect of the present invention aims to put forward a cooling device, especially for use in cooling LED lighting apparatuses. The cooling device
5 according to the present invention can provide a high heat capacity, satisfactorily overcome thermal shock, and also has fine thermal conductivity and then can effectively cool devices such as an LED lighting apparatus.

The first aspect of the present invention is realized by a cooling device, and the device comprises: at least one cooling body (1) each of which is provided with a
10 vacuum sealing chamber therein; and a cooling medium filled in the vacuum sealing chamber, wherein the cooling medium has a high heat capacity. The cooling body according to the present invention just needs to meet the requirement of obtaining a vacuum sealing chamber therein, and does not need other complex structures such as a capillary structure in the heat-pipe, and the cooling body is very simple in
15 structure. Also, as the cooling medium has a high heat capacity, that is, in the case of the same volume, the heat capacity from using pure water is 2 to 10 times of a general metal, it can satisfactorily resist thermal shock.

According to a preferable design of the present invention, the cooling medium fills
20 20% to 80% of the volume of the vacuum sealing chamber. By enhancing the volume of the cooling medium, the heat capacity can be improved. The above volume of the cooling medium constitutes a substantive difference with respect to the cooling medium in the heat-pipe. In addition, the volume of the cooling medium in the vacuum sealing chamber can be selected for the above value range according to the powers of the LED lighting apparatuses.

25 According to a preferable design of the present invention, a pure liquid having a high specific heat capacity is selected as the cooling medium, and the pure liquid is, for example, pure water or ether, and preferably a pure liquid having a minimum specific heat capacity of 2000 J/kgK is selected, more preferably more than 4000 J/kgK. This pure liquid having the high specific heat capacity notably enhances
30 the heat capacity of the cooling medium.

According to a preferable design of the present invention, the cooling body is designed to be in a tubular shape. The cooling body in this shape can be

processed or obtained more easily. For example, it can be seamless steel pipe and can be easily obtained in the market. In addition, the cooling body in this shape will obtain contact in maximum extent with ambient environment, thereby further improving the heat dissipation effect. Also, it is more suitable to be bent
5 into different shapes.

According to a preferable design of the present invention, the cooling body is made of a metal having a fine heat conducting property, and the metal can be copper, aluminum, and etc.

Advantageously, the at least one cooling body is bendable. In the design of the
10 present invention, according to the differences in powers, volumes, and etc. of the LED lighting apparatuses, the at least one cooling body is bent and forms a shape selected from a group consisting of a double spiral taper shape, a multi-layer disk shape and a lantern shape. Thus, to the maximum extent the cooling device according to the present invention matches the heat dissipation requirement of the
15 LED lighting apparatuses.

Advantageously, the cooling device comprises a heat conducting plate which transmits the heat of an object to be cooled to the at least one cooling body. In the situation of the double spiral taper shape, the multi-layer disk shape and the lantern shape, the heat conducting plate is connected to a converging end of at least one
20 cooling body.

According to a design of the present invention, at least one cooling body is bent and forms a panel-shape cooling body array, and the cooling body array sticks to the surface of the heat conducting plate. This type of panel-shape cooling device can be used to relatively large-sized LED lighting apparatuses and provide fine heat
25 dissipation and cooling effects.

A second aspect of the present invention is realized by an LED lighting apparatus. The LED lighting apparatus comprises the above type of cooling device, and by using this cooling device the heat dissipation of the LED lighting apparatus is notably improved, and as this cooling device has a large heat capacity, the
30 anti-thermal shock ability of the overall LED lighting apparatus is enhanced. Also, due to the hollow structure of the cooling structure, the weights of the overall system together with the LED lighting apparatus and the cooling device are reduced.

A third aspect of the present invention is to put forward a cooling device, especially for use in cooling LED lighting apparatuses. The cooling device according to the present invention can provide better thermal conductivity and heat dissipation ability, and is lighter in weight and can be used more flexibly to LED lighting apparatuses.

The third aspect of the present invention is realized by a cooling device, and the device comprises: at least one cooling body comprising an elongated bendable member. Elongated means that the member has a shape where in one direction the linear dimension (the members length) is substantially larger than in a plane perpendicular to this direction, preferably at least by a factor of 5, more preferably by a factor of more than 10 or even 20. Such members may be completely solid, partially hollow or along the whole length hollow. By bending the cooling body, in the case of occupying a relatively small space, as large a contact area as possible with ambient environment can be obtained, thereby effectively improving the thermal conductivity and the heat dissipation ability.

According to a preferable design of the present invention, the cooling body is a wire, a rod, a metal pipe, or a heat pipe. As the metal pipe, especially the heat pipe, has very good heat dissipation property, this further improves the thermal conductivity and the heat dissipation ability of the cooling device. Also, due to the use of the metal pipe or the heat pipe which is lighter and more flexible with respect to the heat dissipating fins in the prior art, the present invention better suits different types of LED lighting apparatuses. Wire or rod can be bent more easily than a pipe and is easier to produce and to handle. The sectional area perpendicular to the elongated members length may be of circular or square shape for the ease of manufacturing but may also have any other suitable shape.

If the cooling device comprises no more than 5, preferably no more than 2 elongated members the cooling body can be built with little effort.

Advantageously, the cooling device further comprises a heating conducting plate which transmits the heat of an object to be cooled to at least one cooling body.

In the design of the present invention, according to the powers, volumes and etc. of the LED lighting apparatuses, the at least one cooling body is bent and forms a shape selected from a group consisting of a double spiral taper shape, a multi-layer disk shape and a lantern shape, so that the cooling device of the present invention

matches the heat dissipation requirements of the LED lighting apparatuses to the maximum extent.

According to a design of the present invention, the at least one cooling body is bent and forms a panel-shape cooling body array, and the cooling body array sticks to the surface of the heat conducting plate. This type of panel-shape cooling device can be used to relatively large-sized LED lighting apparatuses and provide fine heat dissipation and cooling effects.

The last aspect of the present invention is realized by an LED lighting apparatus which comprises the above types of cooling devices, and use of such cooling devices obviously improves the heat dissipation of the LED lighting apparatus. As the cooling body of the cooling device comprises an elongated bendable member, in the case of occupying a relatively small space, as large a contact area as possible with ambient environment can be obtained, thereby effectively improving the thermal conductivity and the heat dissipation ability, and this satisfactorily improves the heat dissipation effect of the overall LED lighting apparatus. Also, the weight of the overall system together with the LED lighting apparatus and the cooling device is reduced.

It should be understood that the above general description and the following detailed description are for listing and explanation, and aim to provide further explanation of the claimed invention.

Brief Description of the Drawings

The accompanying drawings constitute a part of the Description and are used to provide further understanding of the present invention. Such accompanying drawings illustrate the embodiments of the present invention and are used to describe the principles of the present invention together with the Description. In the accompanying drawings the same components are represented using the same reference. As shown in the drawings:

Figure 1 is a schematic perspective view of the cooling body with the end portion thereof opened;

Figure 2 is a schematic perspective view of the cooling body with the end portion thereof closed;

Figure 3a is a schematic view of the first embodiment of the cooling device according to the present invention;

Figure 3b is a schematic view of the second embodiment of the cooling device according to the present invention;

- 5 Figure 3c is a schematic view of the third embodiment of the cooling device according to the present invention; and

Figure 4 is a sectional view of the cooling device formed in a panel-shape.

Detailed Description of the Embodiments

- 10 Figure 1 illustrates the perspective view of the cooling body 1 of the cooling device according to the present invention. In a preferable design of the present invention, the cooling body 1 is designed to be in a tubular shape, and made of copper, aluminum or other metals having a fine heating conducting property. Of course, the cooling body according to the present invention is not just limited to the tubular shape, and can also be designed to be in other shapes suitable for bending and
15 obtaining a larger heat dissipation area. It may also be made of a solid wire or rod.

- The cooling body 1 with its end portion cut open can be seen from Figure 1, wherein, the cooling body 1 defines a vacuum sealing chamber 3 by way of the pipe wall, wherein, the pipe wall does not need to be provided with therein such capillary structures as the heat-pipe. The cooling medium is directly filled in the vacuum
20 sealing chamber 3. In the design of the present invention, pure water, ether or other pure liquids having a high specific heat capacity can be selected as the cooling medium. Further, the heat capacity can be improved by enlarging the volume of the cooling medium. In the embodiments, the cooling medium fills 20% to 80% of the volume of the vacuum sealing chamber 3. Of course, the filling
25 extent of the cooling medium in the vacuum sealing chamber 3 can be selected freely for the above range according to the powers of the LED lighting apparatuses.

- Figure 2 illustrates the cooling body 1 with its end portion 4 closed, and the cooling medium in the cooling body 1 is at least in a low pressure (close to vacuum) or vacuum state, the boiling point of the cooling medium in this state is relatively
30 lowered and is easily vaporized, so that the cooling device obtains a fine heating conducting property.

Figures 3a-3c illustrate three embodiments of the cooling device, wherein, at least one cooling body 1 in Figure 3c is wound into the double spiral taper shape, at least one tubular cooling body 1 in Figure 3b is formed in the multi-layer disk shape, and at least one cooling body 1 in Figure 3c is bent to the lantern shape. The cooling device also comprises a heat conducting plate 2 which is connected to the converging portion of the at least one cooling body, and the heat conducting plate 2 contacts an LED lighting apparatus that is not shown, so that the heat from the LED lighting apparatus is transmitted to the cooling body 1 and is dissipated into the ambient environment via the cooling body 1.

Figure 4 illustrates the sectional view of the cooling device formed in the panel-shape. In this design, at least one cooling body 1 is bent to be a winding shape in the plane of the heat conducting plate 2, thus forming a cooling body array, and the cooling body array is paved flat on the heat conducting plate 2 and is in close contact with the same, thereby forming a panel-shape cooling device which can also cool a large-sized apparatus according to needs.

Of course, in the above embodiments of the present invention, the heat pipe can be bent and form a shape selected from a group consisting of a double spiral taper shape, a multi-layer disk shape and a lantern shape. However, in view of the structure features of the heat pipe, an overlarge angle in bending the heat pipe should be avoided so as not to damage the internal structure of the heat pipe.

The descriptions above are only preferable embodiments of the present invention and are not used to restrict the present invention. For those skilled in the art, the present invention may have various changes and variations. Any modifications, equivalent substitutions, improvements etc. within the spirit and principle of the present invention shall all be included in the scope of protection of the present invention.

List of reference signs

1 cooling body

2 heat conducting plate

5 3 vacuum sealing chamber

4 end portion

Claims:

- 5 1. A cooling device, characterized by, comprising: at least one cooling body (1) each of which is provided with a vacuum sealing chamber (3) therein; and a cooling medium filled in the vacuum sealing chamber (3), wherein the cooling medium has a high heat capacity.
- 10 2. The cooling device according to claim 1, characterized in that the cooling medium is filled into 20% to 80% of the volume of the vacuum sealing chamber (3).
- 15 3. The cooling device according to claim 1 or 2, characterized in that a pure liquid having a high specific heat capacity is selected as the cooling medium.
4. The cooling device according to claim 3, characterized in that the cooling medium is pure water or ether.
- 20 5. The cooling device according to claim 1 or 2, characterized in that the at least one cooling body (1) is designed to be in a tubular shape.
- 25 6. The cooling device according to claim 1 or 2, characterized in that the at least one cooling body (1) is made of metal.
7. The cooling device according to claim 1 or 2, characterized in that the at least one cooling body (1) is bendable.
- 30 8. The cooling device according to claim 7, characterized in that the cooling device comprises a heat conducting plate (2) which transmits the heat of an object to be cooled to the at least one cooling body (1).
- 35 9. The cooling device according to claim 8, characterized in that the at least one cooling body (1) is bent and forms a shape selected from a group consisting of a double spiral taper shape, a multi-layer disk shape and a lantern shape.
10. The cooling device according to claim 8, characterized in that the at least one cooling body (1) is bent and forms a panel-shape cooling body array, and the cooling body array sticks to the surface of the heat conducting plate (2).
- 40 11. An LED lighting apparatus, characterized in that the LED lighting apparatus comprises the cooling device according to any of claims 1 to 10.
12. A cooling device, characterized by, comprising: at least one cooling body (1), wherein the at least one cooling body comprises an elongated bendable member.
- 45 13. The cooling device according to claim 12, characterized in that the at least one cooling body is a wire, a rod, a metal pipe or a heat pipe.
14. The cooling device according to claim 13, characterized in that the cooling device comprises no more than 5, preferably no more than 2 elongated members.
- 50 15. The cooling device according to claim 13, characterized in that the cooling

device comprises no more than 2 elongated members.

- 5 16. The cooling device according to claim 14 or 15, characterized in that the cooling device comprises a heat conducting plate (2) which transmits the heat of an object to be cooled to the at least one cooling body (1).

- 10 17. The cooling device according to claim 16, characterized in that the at least one cooling body (1) is bent and forms a shape selected from a group consisting of a double spiral taper shape, a multi-layer disk shape and a lantern shape.

18. The cooling device according to claim 16, characterized in that the at least one cooling body (1) is bent and forms a panel-shape cooling body array, and the cooling body array sticks to the surface of the heat conducting plate (2).

- 15 19. An LED lighting apparatus, characterized in that the LED lighting apparatus comprises the cooling device according to any of claims 12 to 18.

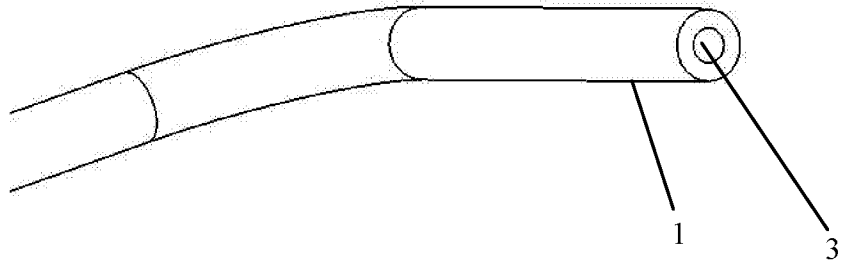


FIG.1

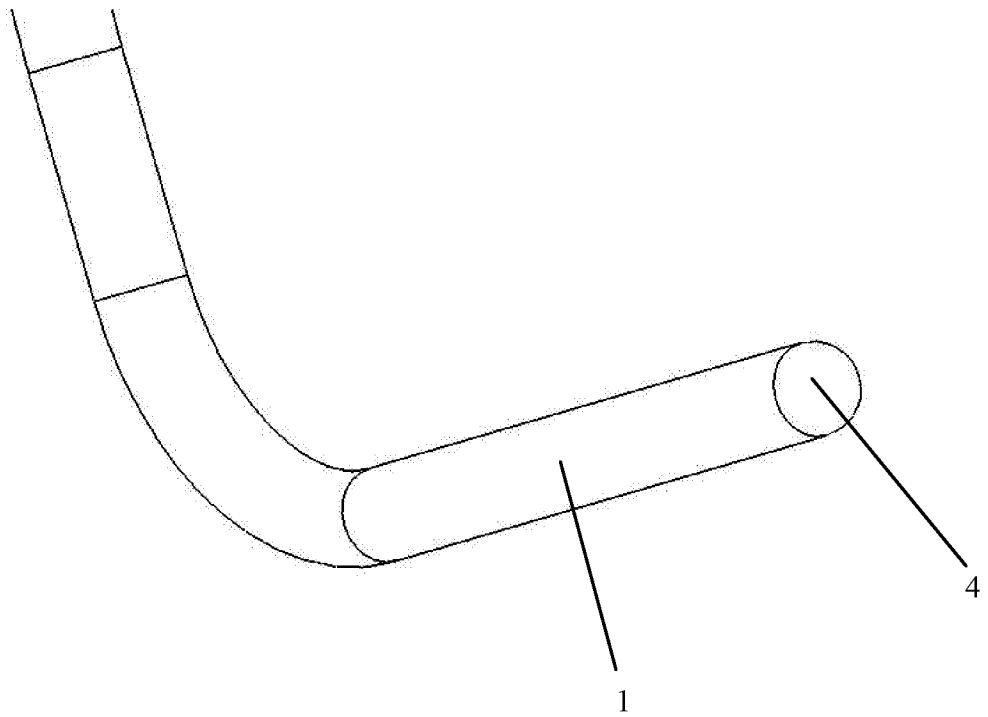


FIG.2

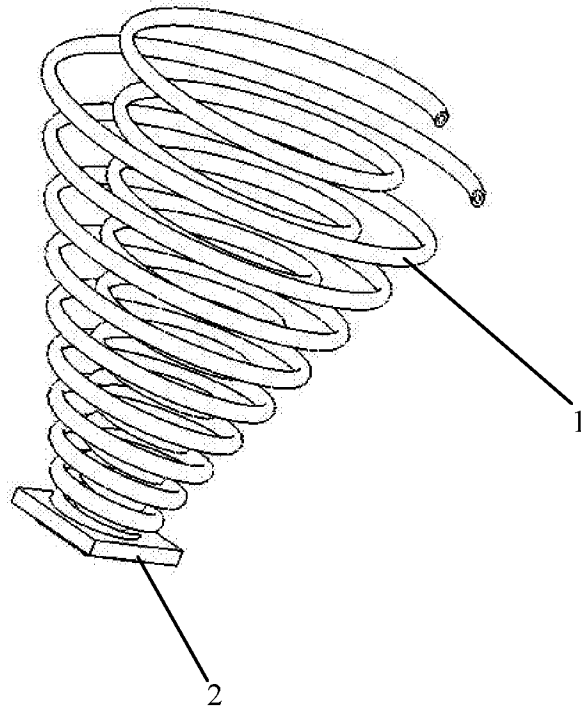


FIG.3a

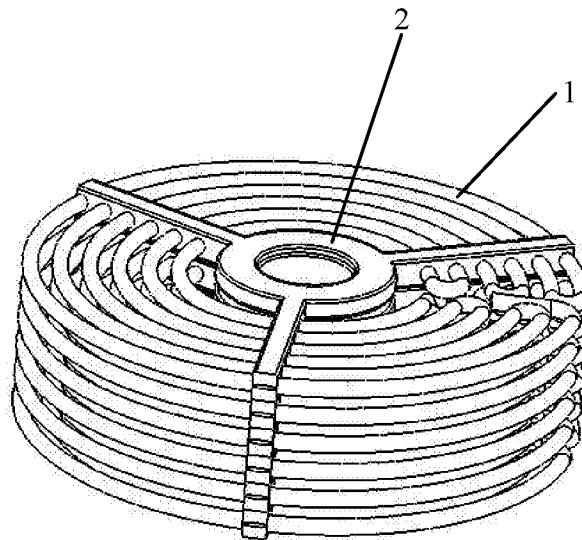


FIG.3b

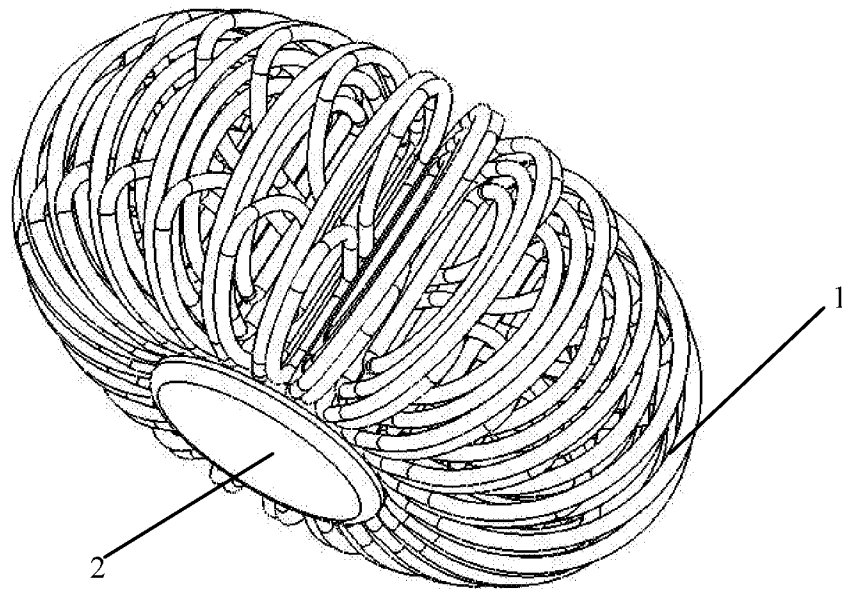


FIG. 3c

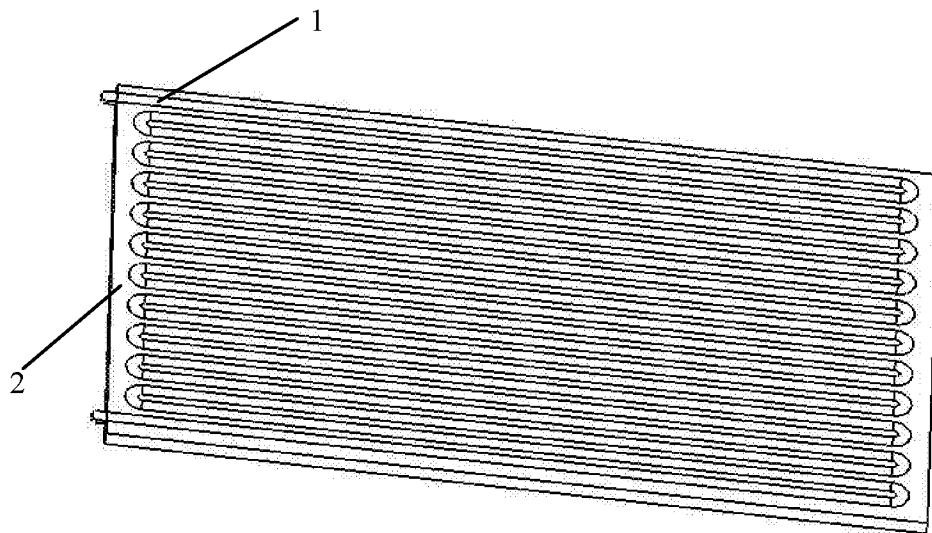


FIG. 4