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(54) Title: A COOLING DEVICE AND LED LIGHTING APPARATUS COMPRISING THE SAME AND A METHOD OF MANUFACTURING THE COOLING DEVICE

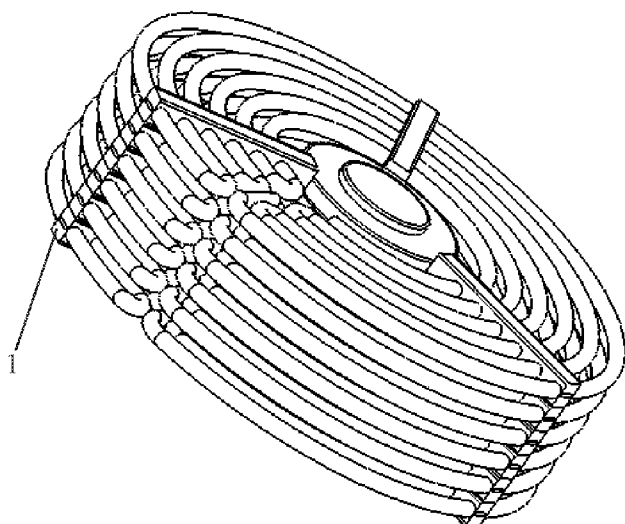


FIG.4

(57) Abstract: The present invention relates to a cooling device for the electric heating element, comprising a plurality of cooling units (1), wherein, each cooling unit (1) possesses a defined heat dissipation performance, the number of the cooling units is determined according to the power of the electric heating element, and the cooling units (1) of the determined number can be stacked together. By the cooling device constructed by the stackable cooling units (1) according to the present gets variable heat dissipation capacities so as to meet the heat dissipation requirements of LED lighting apparatus with different powers. In addition, the present invention also relates to LED lighting apparatus having the cooling device of the above type.

Description

A Cooling Device and LED Lighting Apparatus Comprising the Same and a Method of manufacturing the Cooling Device

Technical Field

The present invention relates to a cooling device used for cooling the electric heating element. In addition, the present invention also relates to LED Lighting apparatus comprising the cooling device.

Background Art

Current LED lighting technologies become more and more mature, in which the constant current input is applied to LED lamps or luminaires in different fields. Usually, different exterior drivers can be used to get different current inputs so as to get different optical performances in multifunctional application. However, it also brings some problems with the heat dissipation, for instance, LED lighting apparatus with difference powers require cooling devices with different heat dissipation performances. Then, more different types of cooling devices are demanded to be designed so as to be adapted to different LED lighting apparatus, which necessarily increases the costs. Moreover, the assembling of different types of cooling devices is relatively complicated.

Summary of the Invention

Therefore, the objective of the present invention is to put forward a cooling device for the electric heating element. The cooling device is capable of being more effectively adapted to the heat dissipation requirements of the electric heating elements with different powers, has variable heat dissipation capabilities and is easy to be assembled.

The objective of the present invention is realized in such a way that the cooling device comprises a plurality of cooling units, each cooling unit possesses a defined heat dissipation performance, the number of the cooling units is determined according to the power of the electric heating element, and the cooling units of the determined number can be stacked together. By this stackable manner, the number

of the cooling units can be determined according to the heat dissipation requirements of the electric heating elements with different powers, and the cooling units are stacked together so as to be flexibly matched with the electric heating element in order to get variable heat dissipation capabilities.

- 5 According to a preferred solution of the present invention, each cooling unit possesses the same heat dissipation performance. This reduces the number of different parts to be manufactured and/or held in stock in order to build cooling devices of different cooling ability. The determination of the number and type of needed cooling units is also easier, if there is only one type available.
- 10 According to a preferred solution of the present invention, each cooling unit comprises at least one cooling body constructed by a bendable wire-shaped body. Different shapes of the cooling body can be obtained by bending the cooling body so as to be better matched with the LED Lighting apparatus and to get optimal heat dissipation effect.
- 15 According to a preferred improved solution of the present invention, the wire-shaped body is metal wire, metal pipe or heat pipe. Since the metal pipe, especially the heat pipe, possesses splendid heat dissipation capacity, the heat conductivity and heat dissipation capacity of the cooling device are further improved. Moreover, since the metal pipe or the heat pipe is used, it is lighter than the heat
- 20 dissipation fin in the prior art, and is able to be better adapted to the electric heating elements of different types.

- According to a preferred solution of the present invention, each cooling unit further comprises the bracket and at least one holder radially outwardly extending from the bracket, the wire-shaped body is supported on the holder. The holder of such type
- 25 steadily supports the wire-shaped body.

- According to another solution of the present invention, each cooling unit comprises at least one cooling body constructed by the grating-shaped metal plate, and each cooling unit further comprises the bracket formed in one piece with the grating-shaped metal plate. In the practical manufacturing procedure, a portion of
- 30 the metal plate can be trenched to form the convective tank, while the other portion is retained to form the bracket. The cooling unit of such type does not require the holder, so that it is quite simple to manufacture the grating-shaped metal plate, and the costs are low; moreover, the one-piece structure of the bracket and the

grating-shaped metal plate simplifies the manufacturing procedure, therefore, the design of the cooling device is simplified to a great extent and the costs are reduced.

5 According to another solution of the present invention, each cooling unit comprises at least one cooling body which is a mesh-shaped metal plate with a central assembly hole, and each cooling unit further comprises the bracket punched into the central assembly hole. Since the metal plate of this type is provided with a large amount of mesh holes, it notably improves the convective capacity of air. Moreover, the structure of the metal plate of this type is relatively simple, which also reduces
10 the costs and the manufacturing difficult to a great extent.

Preferably, each bracket is provided with the concave portion and the convex portion respectively on two side faces toward adjacent cooling units. The stacking is realized by punching the convex portion of one bracket into the concave portion of the adjacent bracket. The simple punching connection greatly simplifies the
15 assembling of the cooling units, and can select the number of the cooling units simply according to the power of the electric heating element, so as to realize the objective of getting variable heat dissipation capacities.

The other objective of the present invention is accomplished by LED lighting apparatus which has the cooling device of the above type. By the use of such
20 stackable cooling device, the LED lighting apparatus gets variable heat dissipation capacities, moreover, the costs are lower and the assembling is quite easier.

Another objective of the present invention is accomplished by a process of manufacturing a cooling device, comprising the steps of

- determining the power of the electric heating element,
- 25 -choosing the number and type of cooling units according to the power of the power of the electric heating element
- stacking the choosen cooling units together in a an appropriate sequence.

This means that the cooling device can be made of defined cooling units which can be chosen according to the requirements of the electric heating element, which
30 helps to reduce the number of necessary parts to be kept in stock for supplying

different electric heating elements with appropriate cooling devices.

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

5 **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. These 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 by the same reference signs. In the drawings:

Figure 1 is a schematic view of the bracket and holder of the cooling unit according to the first embodiment of the present invention;

Figure 2 is a schematic view of the cooling body of the cooling unit according to the first embodiment of the present invention;

Figure 3a and 3b are schematic views of two different side faces of the cooling unit according to the first embodiment of the present invention;

Figure 4 is a schematic view of the cooling device constructed by a plurality of cooling units according to the first embodiment of the present invention;

Figure 5 is a schematic view of the cooling unit according to the second embodiment of the present invention; and

Figure 6 is a schematic view of the cooling device constructed by a plurality of cooling units according to the third embodiment of the present invention.

Detailed Description of the Embodiments

Figure 1 shows the schematic view of the bracket 3 and the holder 4 of the cooling unit 1 according to the first embodiment of the present invention. From the figure it can be seen that the cooling unit has one bracket 3 and three holders 4, wherein, the three holders 4 are uniformly distributed around the bracket 3 and radially

outwardly extending from the bracket 3, so as to form a star-shaped structure. Of course, the number of the holders 4 also can be other than 3, for instance, 5 or 6. Moreover, the holders 4 are further provided with a plurality of accommodation throughholes 5 therein through which the cooling body 2 bent into a disk shape can pass to be firmly retained in the holders 4.

Figure 2 shows the schematic view of the cooling body of the cooling device according to the first embodiment of the present invention. In the figure, the reference sign 2 shows the cooling body constructed by the metal wire, metal pipe or heat pipe. The cooling body is bent into a disk shape.

In an especially preferred embodiment of the present invention, the metal pipe is used as the cooling body, wherein, the cooling body 2 is manufactured by copper, aluminum or other metals having favorable heating conducting performance. In the cooling body 2 a vacuum sealing chamber is defined by the pipe wall, wherein, the pipe wall does not need to be provided with thereon such capillary structures as the heat pipe. The cooling medium is directly filled in the vacuum sealing chamber. Pure water, ether or other liquids having a high specific heat capacity can act as the cooling medium. Further, the heat capacity is also improved by enlarging the volume of the cooling medium. The cooling medium fills 20% to 80% of the volume of the vacuum sealing chamber. Of course, the filling extent of the cooling medium in the vacuum sealing chamber is freely selected from the above range according to the different powers of the LED lighting apparatus. In addition, the cooling medium in the cooling body 2 is at least in a low pressure (close to vacuum) or vacuum state, according to the present invention, the cooling medium is under the atmospheric pressure of 1/1011 MPa or less, the boiling point of the cooling medium under this pressure is relatively lowered and is easily vaporized, so that the cooling device gets a favorable heating conductivity.

Figure 3a and 3b show two different side faces of the cooling unit 1 according to the first embodiment of the present invention. From the figures it can be seen that the cooling body 2 is already fixed in the holders 4 so as to construct a cooling unit 1 in a disk shape. From Figure 3a one side of the cooling unit 1 can be seen, on which the bracket 3 has the concave portion 6. From Figure 3b the other side of the cooling unit 1 can be seen, on which the bracket 3 has the convex portion 7 matched with the shape of the concave portion 6. The convex portion 7 of one cooling unit 1 can be punched into the concave portion 6 of another cooling unit 1, so as to construct a stackable cooling device. The outermost bracket 3 of the cooling

unit is provided with the thermal plate (not shown) on which the electric heating element, i.e. LED lighting apparatus (not shown), is mounted.

Figure 4 shows the schematic view of the cooling device constructed by a plurality of cooling units 1 according to the first embodiment of the present invention. Figure 4 shows a cooling device constructed by six cooling units 1. Of course, according to the different powers of the LED lighting apparatus, the cooling units 1 of different numbers, such as 4, 3 or less, or 7, 8 or more, can be stacked.

Figure 5 shows the schematic view of the cooling unit 1 according to the second embodiment of the present invention. From the figure it can be seen that the cooling unit 1 is constructed by the grating-shaped metal plate 8 and the bracket 3' disposed in the center of the grating-shaped metal plate 8, wherein, the bracket 3' and the grating-shaped metal plate 8 are formed in one piece. The bracket 3' is similar to the bracket 3 in the first embodiment of the present invention in structure, and merely distinguishes in that the bracket 3' according to the second embodiment of the present invention has two concave portions 6 and two convex portions 7. In this embodiment, the stacked cooling device constructed by a plurality of cooling units 1 also can be obtained by punching the convex portion 7 of one cooling unit 1 into the accommodation portion 6 of another cooling unit 1.

Figure 6 is the schematic view of the cooling device constructed by a plurality of cooling units 1 according to the third embodiment of the present invention. From the figure it can be seen that the cooling device is stacked by a plurality of cooling units 1. The third embodiment distinguishes from the first embodiment in that the cooling body is constructed by the mesh-shaped metal plate 10 which has the central assembly hole 11 into which the bracket 3'' can be punched, so that the bracket 3'' directly supports the metal plate 10.

The descriptions above are only preferred embodiments of the present invention and are not used to restrict the present invention. For the person 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.

Claims:

1. A cooling device for an electric heating element, comprising a plurality of cooling units (1), characterized in that, each cooling unit (1) possesses a defined heat dissipation performance, number of the cooling units is determined according to power of the electric heating element, and the cooling units (1) of a determined number can be stacked together.
2. A cooling device according to claim 1, characterized in that, each cooling unit (1) possesses the same heat dissipation performance.
3. The cooling device according to Claim 2, characterized in that, each of the cooling units (1) comprises at least one cooling body (2) constructed by a bendable wire-shaped body.
4. The cooling device according to Claim 3, characterized in that, the wire-shaped body is metal wire, metal pipe or heat pipe.
5. The cooling device according to Claim 4, characterized in that, each of the cooling units (1) further comprises a bracket (3) and at least one holder (4) radially outwardly extending from the bracket (3), and the wire-shaped body is supported on the holder (4).
6. The cooling device according to Claim 1, characterized in that, each of the cooling units (1) comprises at least one cooling body (2) constructed by a grating-shaped metal plate.
7. The cooling device according to Claim 6, characterized in that, each of the cooling units (1) further comprises a bracket (3') formed in one piece with the grating-shaped metal plate.
8. The cooling device according to Claim 1, characterized in that, each of the cooling units (1) comprises at least one cooling body (2) which is a mesh-shaped metal plate with a central assembly hole (11).
9. The cooling device according to Claim 8, characterized in that, each of the cooling units (1) further comprises a bracket (3'') punched into the central assembly hole (11).
10. The cooling device according to any one of Claims 1 to 9, characterized in that, each of the brackets (3, 3', 3'') is provided with a concave portion (6) and a convex portion (7) respectively on two side faces toward adjacent cooling units (1), and a stacking is realized by punching the convex portion of one bracket into the concave portion of adjacent bracket.

11. LED lighting apparatus, characterized in that the LED lighting apparatus have the cooling device according to any one of Claims 1 to 10.

- 5 12. A method of manufacturing a cooling device according to any one of the previous claims, comprising the steps of
- determining the power of the electric heating element,
 - choosing the number and type of cooling units according to the power of
 - 10 the power of the electric heating element,
 - stacking the chosen cooling units together in an appropriate sequence.

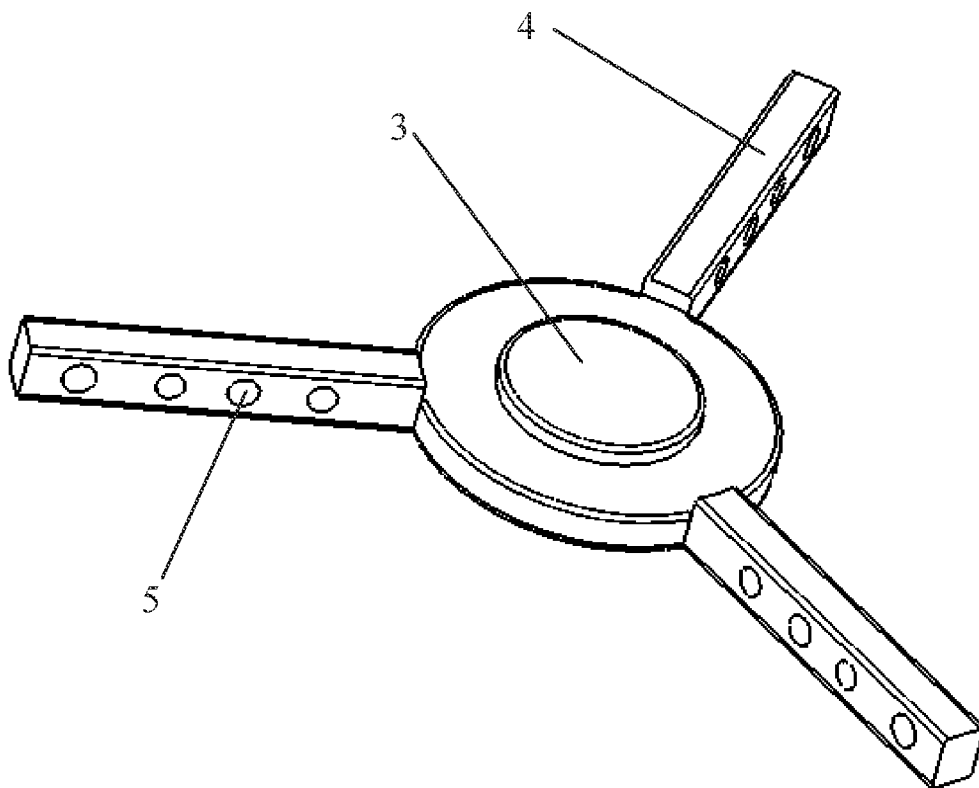
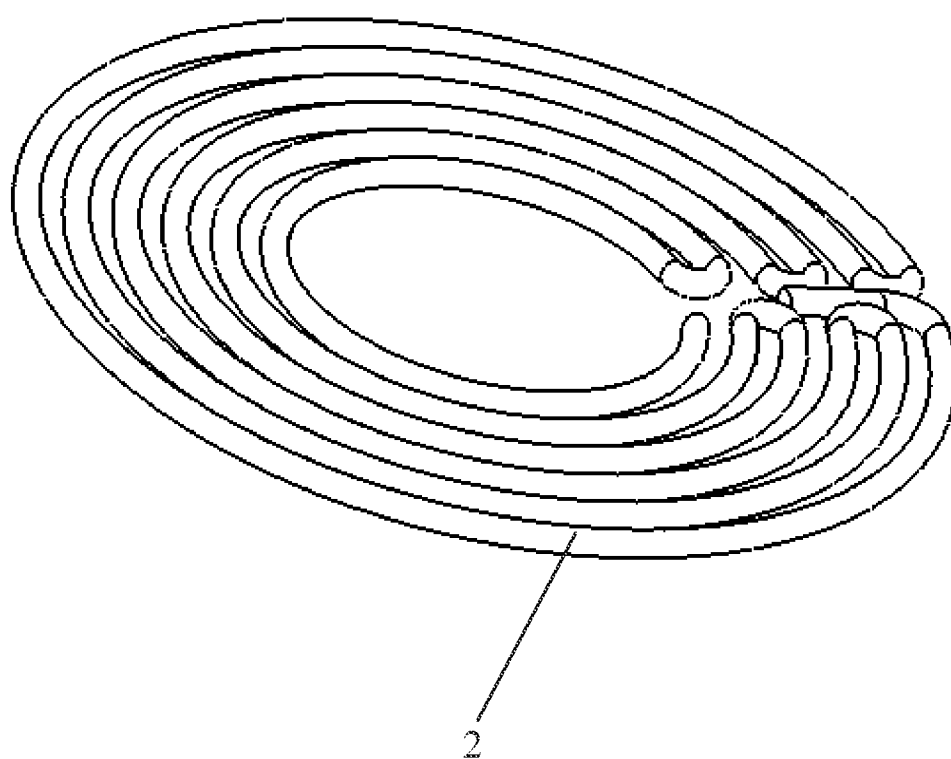


FIG.1

**FIG. 2**

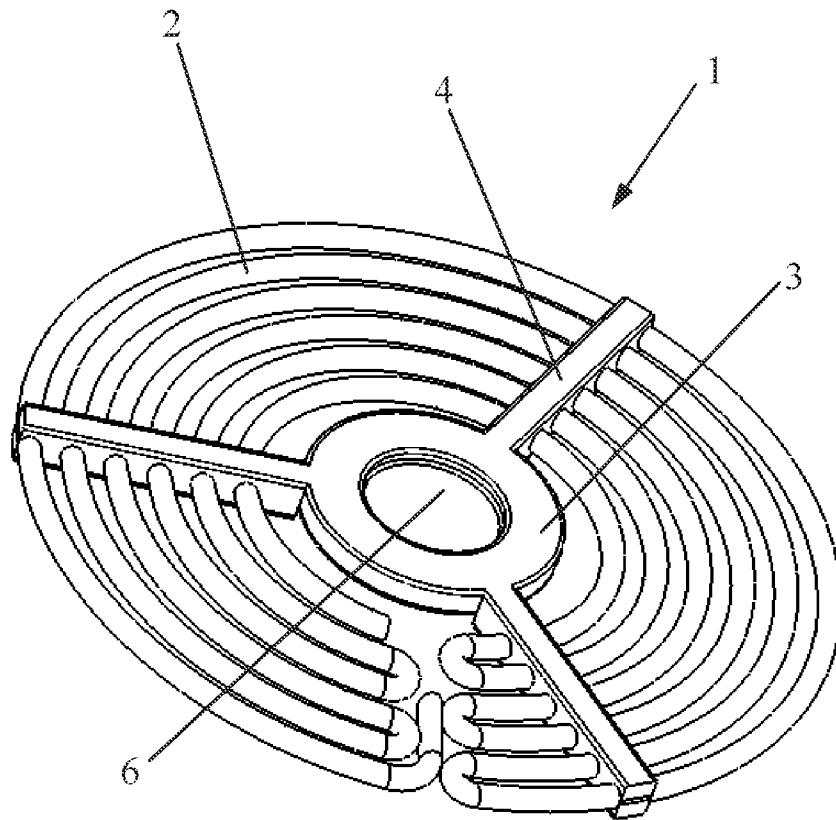


FIG.3a

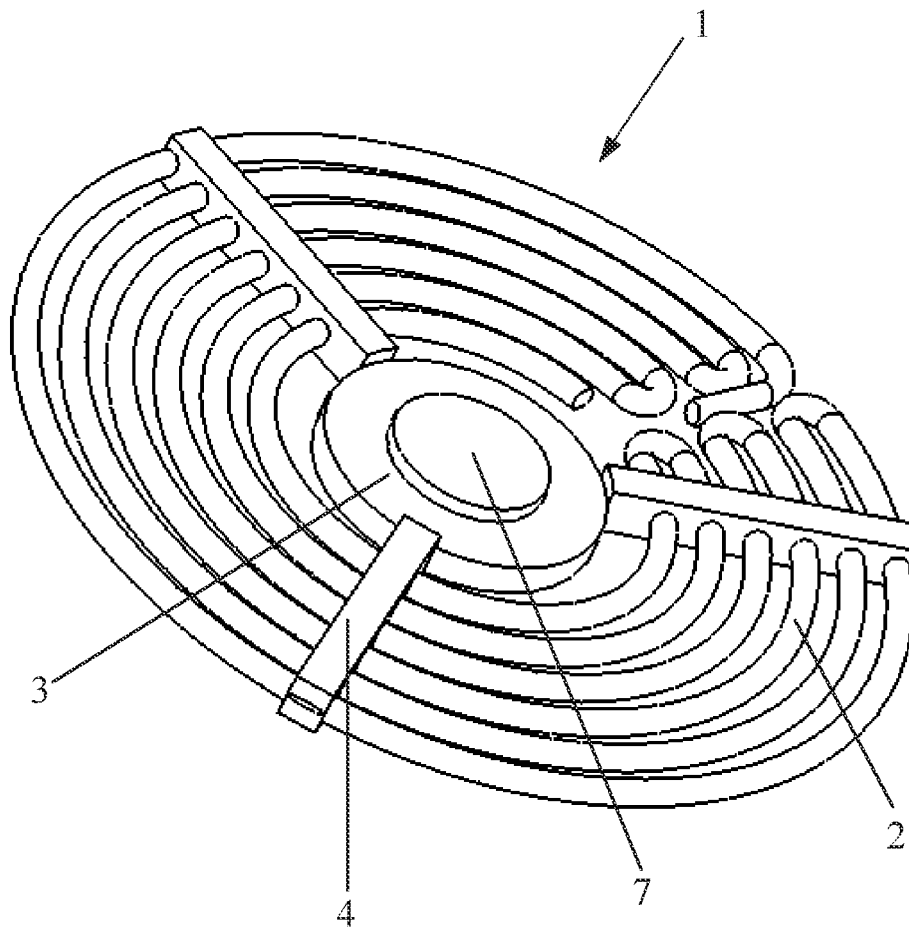


FIG.3b

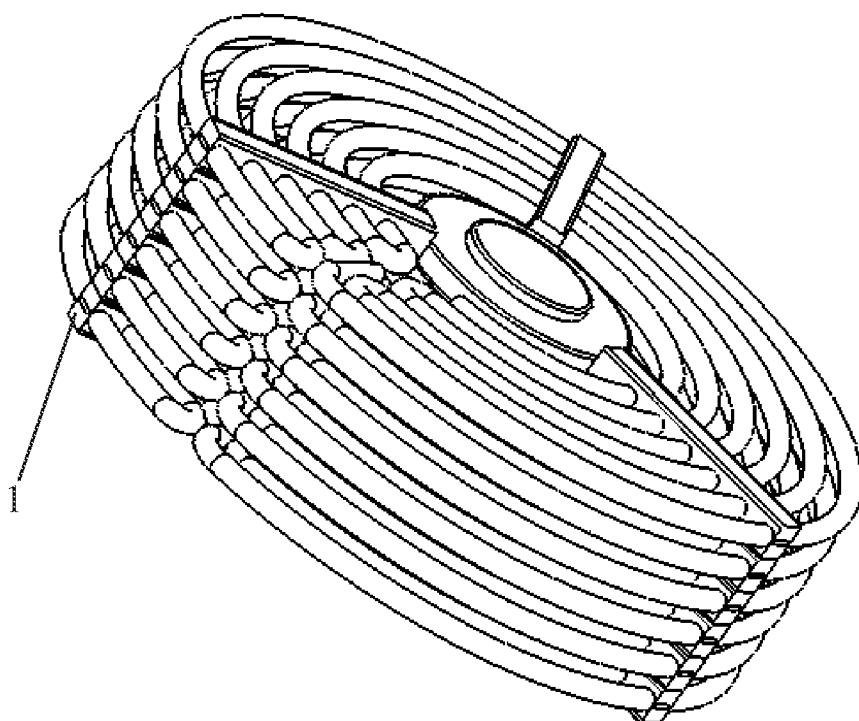


FIG.4

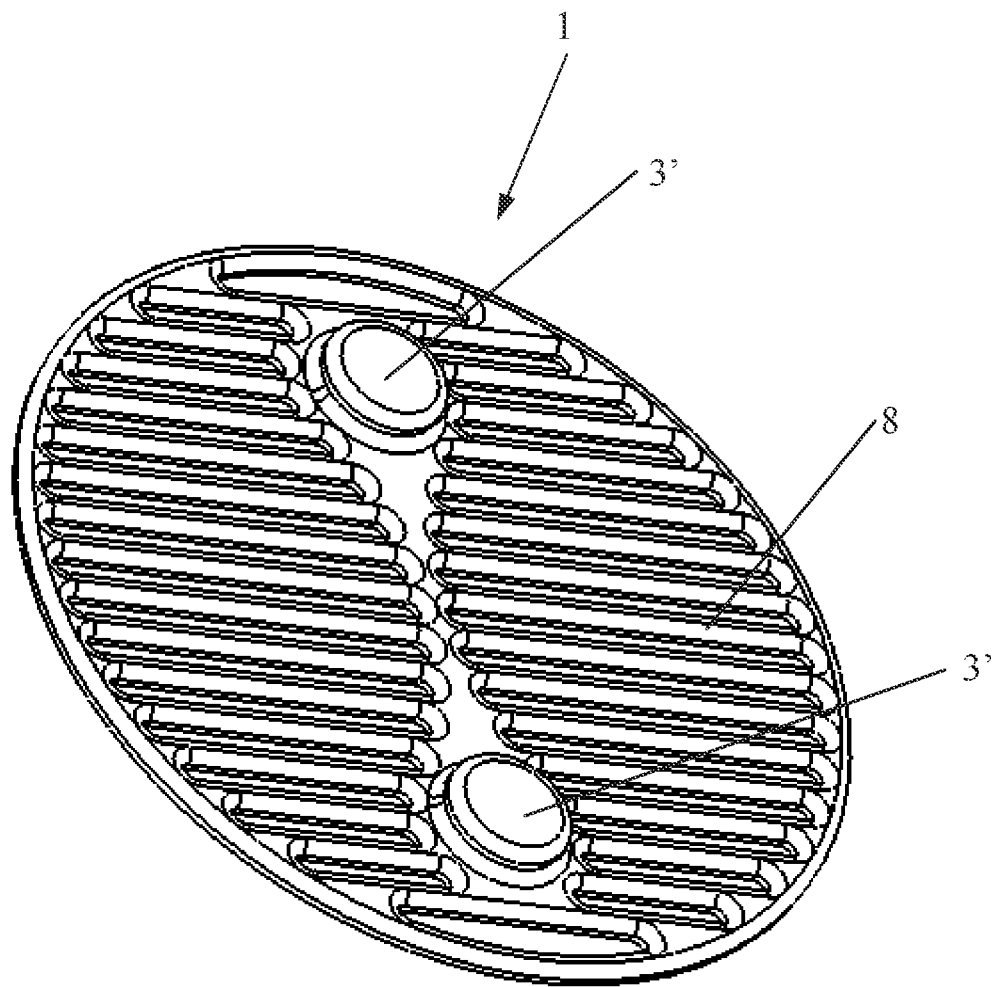


FIG.5

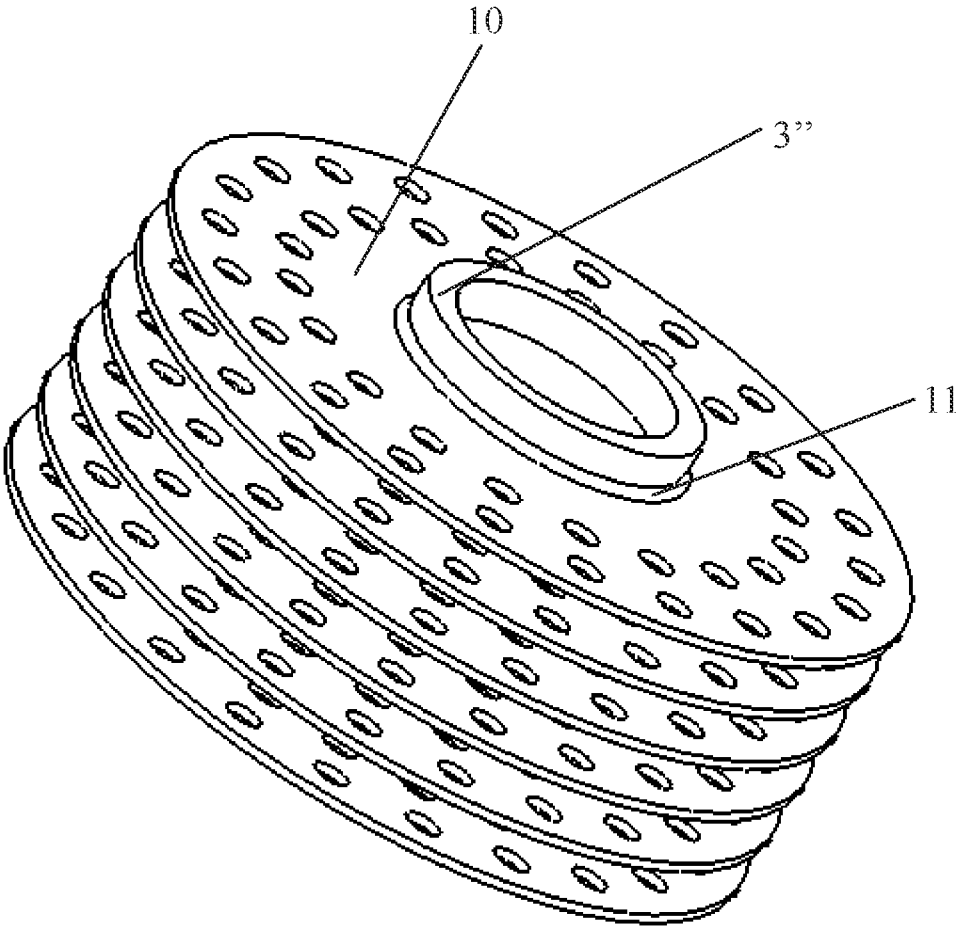


FIG.6