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[Continued on next page]

(54) Title: HEAT-SINK DEVICE AND MANUFACTURING METHOD THEREOF

(57) Abstract: The present invention relates to a heat-sink device, which comprises a first heat-sink structure (A) in thermal contact with an object from which heat to be dissipated and a second heat-sink structure (B), wherein the first heat-sink structure (A) is composed of a plurality of first heat-sink fins (1) and the second heat-sink structure (B) is composed of a plurality of second heat-sink fins (2), wherein the first heat-sink fins (1) are inserted into cavities (3) formed in the second heat-sink fins (2). In addition, the present invention also relates to a method for manufacturing the above type of heat-sink device.

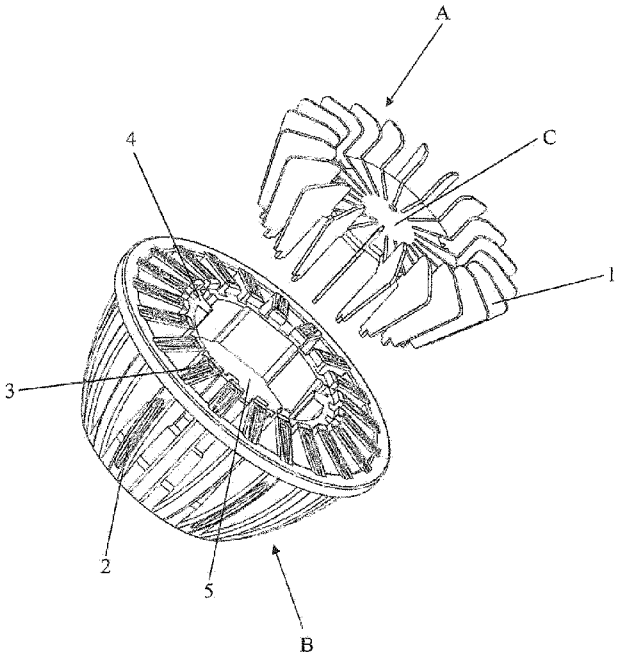

Figure 1

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Description

Heat-sink Device and Manufacturing Method Thereof

Technical Field

The present invention relates to a heat-sink device. In addition, the present invention also relates to a method of manufacturing the above type of heat-sink device.

Background Art

In the current illumination systems, an illumination system with a LED module as a light source has found more and more applications. The LED module has high requirements for heat dissipation since the heat dissipation directly affects the performance and the service life of the LED module. Accordingly, heat-sink devices of various materials and shapes have been used in the prior art, such as a heat-sink device made of aluminum, which has good heat dissipation performance but has a relatively large weight. Therefore, at present, a heat-sink device made of thermally conductive plastic has found more and more applications. In order to improve the heat dissipation performance of such a type of heat-sink device, a plurality of heat-sink fins distributed uniformly are provided on the circumference of the heat-sink device, and on the contact surface between the heat-sink device and the printed circuit board of the LED module there is provided with a metal plate or a bucket-shaped metal insert, said metal plate or said bucket-shaped metal insert being generally molded into a thermally conductive plastic body of the heat-sink device during a process of manufacturing the heat-sink device. However, in terms of the heat dissipation performance of the heat-sink device, what plays a decisive role

is the heat dissipation performance of respective heat-sink fins of the heat-sink device. The existing types of plastic heat-sink device fail to substantively improve the heat dissipation performance of the whole heat-sink device.

Summary of the Invention

Therefore, the object of the present invention is to provide a heat-sink device with improved heat dissipation performance. Said heat-sink device has good heat dissipation performance and a relatively small weight, and is lower in cost as compared with the traditional full metal heat-sink device. Another object of the present invention is to provide a method of manufacturing the above type of heat-sink device.

The first object of the present invention is realized by a heat-sink device, viz. the heat-sink device comprises a first heat-sink structure in thermal contact with an object from which heat to be dissipated and a second heat-sink structure, wherein the first heat-sink structure is composed of a plurality of first heat-sink fins and the second heat-sink structure is composed of a plurality of second heat-sink fins, wherein the first heat-sink fins are inserted into cavities formed in the second heat-sink fins. The heat-sink device according to the present invention is generally applied in illumination systems, especially in a LED illumination system. The heat generated by the chip of the LED module acting as a light source is transferred to the first heat-sink structure and the second heat-sink structure of the heat-sink device via a printed circuit board carrying the LED chip. The heat-sink device according to the present invention can decrease rapidly the junction temperature of the LED chip, thereby improving significantly the lumen efficiency of the LED chip and prolonging the service life of the LED mod-

ule.

It is provided according to the present invention that the first heat-sink fins have higher thermal conductivity than the second heat-sink fins. In the design solution of the present invention, the first heat-sink fins are generally made of pure metal such as copper, aluminum, etc. and are also, of course, made of other metal with high thermal conductive performance, while the second heat-sink fins are made of thermally conductive plastic. The first heat-sink fins are inserted into the cavities of the second heat-sink fins and the first heat-sink fins have higher thermal conductive performance, which improve significantly the heat dissipation performance of the second heat-sink fins, further improve the heat dissipation performance of the whole heat-sink device, accelerate the heat dissipation of the LED chip, and achieve the purpose of decreasing rapidly the junction temperature of the LED chip.

According to one preferred design solution of the present invention, the first heat-sink structure also has a support component, the support component supporting the object from which heat to be dissipated, which is generally designed as a LED module, and being connected to each of the first heat-sink fins for heat conduction. By using said support component, the heat from the LED module is allowed to be transferred uniformly to each of the first heat-sink fins so as to dissipate heat uniformly.

Preferably, the second heat-sink structure also has a base, the base having a receiving part for receiving the support component. The support component is stably received in the base, such that the object from which heat to be dissipated, acting as a LED module, can also be held in the base. And

the LED module is enclosed as much as possible by the heat-sink device, which is more beneficial for the heat dissipation of the LED module.

Preferably, the support component comprises a thermal conduction plate and a mounting plate superimposing together, wherein the first heat-sink fins are embedded into the thermal conduction plate and the mounting plate, respectively, and the mounting plate makes each of the first heat-sink fins connected into one entirety. One surface of the thermal conduction plate is in close contact with the object from which heat to be dissipated and the other surface is supported by the mounting plate, and the mounting plate abuts against the corresponding bottom surface of the receiving part of the base. Each of the first heat-sink fins are embedded into the lateral sides of the thermal conduction plate and the mounting plate. By using such a structure, each of the first heat-sink fins can be favorably held in the mounting plate and can make the heat from the thermal conduction plate dissipate uniformly.

Further preferably, the thermal conduction plate and the mounting plate are respectively provided with a plurality of grooves, and the first heat-sink fins are inserted into the grooves, respectively, so as to ensure a thermally conductive connection between the thermal conduction plate and the first heat-sink fins and a fixed connection between the mounting plate and the first heat-sink fins.

It is provided according to the present invention that the second heat-sink fins and the base are made of thermally conductive plastic in one piece having a thermal conductivity between 1 to 4 W/m·k. In a preferred design solution of the present invention, the thermally conductive plastic could be

PP, PPS, PA or ABS etc., which reduces significantly the weight of the whole heat-sink device and simplifies a manufacturing process.

Preferably, like the first heat-sink fins, the thermal conduction plate is also made of metal material having thermal conductivity higher than 4 W/m·k. In a preferred design solution of the present invention, the first heat-sink fins, the thermal conduction plate could also be made of copper- or aluminum-based materials, or the like and is also, of course, made of other metal with high thermal conductive performance. The heat from the LED chip can be transferred rapidly to the first heat-sink fins via the thermal conduction plate.

Another object of the present invention lies in providing a method for manufacturing a heat-sink device, said method comprising the following steps: a) providing a first heat-sink structure with a plurality of first heat-sink fins; b) providing a second heat-sink structure made of thermally conductive plastic, the second heat-sink structure comprising a base and second heat-sink fins extending outward in a radial direction on an outer surface of the base, wherein cavities are formed in the second heat-sink fins; c) inserting the first heat-sink fins into the cavities of the second heat-sink fins; and d) packaging by plastic injection the first heat-sink fins and the second heat-sink fins using thermally conductive plastic. The heat-sink device manufactured using said method has good heat dissipation performance and a relatively small weight, and is lower in cost as compared with the traditional full metal heat-sink device.

Preferably, in the step a) there further includes a process of connecting the plurality of first heat-sink fins into one entirety via a mounting plate. The respective first heat-

sink fins are firmly connected together by the mounting plate, which makes a process of inserting the first heat-sink fins into the cavities of the second heat-sink fins more simple.

Further preferably, in the step a) there further includes a process of providing a thermal conduction plate for supporting an object from which heat to be dissipated on the mounting plate so as to connect the thermal conduction plate to each of the first heat-sink fins for heat conduction. By setting the thermal conduction plate, the heat from the object from which heat to be dissipated can be more favorably transferred to each of the first heat-sink fins.

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:

Fig. 1 is an exploded perspective view of a heat dissipation device according to the present invention;

Fig. 2 is an exploded perspective view of a first heat-sink structure of a heat-sink device according to the present invention; and

Fig. 3a to Fig. 3c are flow charts of assembling according to a manufacturing method of the present invention.

Detailed Description of the Embodiments

Fig. 1 is an exploded perspective view of a heat dissipation device according to the present invention. From Fig. 1, it can be seen that the heat-sink device comprises a first heat-sink structure A and a second heat-sink structure B, wherein the first heat-sink structure A has a plurality of independent first heat-sink fins 1 which are made of metal, especially made of copper or aluminum. In addition, the first heat-sink structure A also has a support component C which supports an object from which heat to be dissipated not shown, which is a LED module, and the support component C is connected to each of the first heat-sink fins 1. In a specific embodiment of the present invention, the support component C is designed as a circular disk, and each of the first heat-sink fins 1 are uniformly inserted into the circumference of the circular disk-shaped support component C.

From Fig. 1, it can be seen that the heat-sink device according to the present invention also comprises the second heat-sink structure B which has a base 4. The base 4 is designed as a cylindrical shape and a plurality of second heat-sink fins 2 integrated with the base 4 are formed on the outer surface of the base 4. In addition, a receiving part 5 is formed in the base 4. In the design solution of the present invention, the base 4 and the second heat-sink fins 2 are formed into one entirety by a process of plastic injection using thermally conductive plastic. From the figure, it can be seen that a cavity 3 is formed on each second heat-sink fin 2, and the first heat-sink fins 1 of the first heat-sink structure A are inserted into the cavities 3 to form an integral heat-sink device. In order to make the first heat-sink fins 1 in better contact with the second heat-sink fins 2, the molten thermally conductive plastic, after completion of

assembling, can be filled into the gaps between the first heat-sink fins 1 and the second heat-sink fins 2 and is then cured. In the heat-sink device having been assembled, the first heat-sink fins 1 are completely inserted into the cavities 3 of the second heat-sink fins 2 and the support component C is received in the receiving part 5.

Fig. 2 is an exploded perspective view of the first heat-sink structure A of the heat-sink device according to the present invention. From the figure, it can be seen that the first heat-sink structure A comprises a plurality of the first heat-sink fins 1 as well as the thermal conduction plate 6 and mounting plate 7 constituting the support component C. In the design solution of the present invention, the thermal conduction plate 6 is made of copper or aluminum, and the mounting plate 7 is made of thermally conductive plastic. A plurality of grooves 8 are provided on the circumference of the thermal conduction plate 6 and the mounting plate 7. The first heat-sink fins 1 are inserted into the grooves (8), respectively, which makes the plurality of first heat-sink fins 1 held stably in the mounting plate 7 so as to facilitate assembling. In the final state of assembling, the mounting plate 7 abuts against the bottom surface of the receiving part 5 of the base 4, while one surface of the thermal conduction plate 6 abuts against the mounting plate, and the other surface thereof abuts against the object from which heat to be dissipated, that is a LED module. Moreover, the thermal conduction plate 6 is also in contact with the first heat-sink fins 1, such that the heat of the LED module is transferred to the second heat-sink structure B.

Fig. 3a to Fig. 3c are flow charts of assembling according to a manufacturing method of the present invention. First, in the step a) there is provided the first heat-sink structure

A. In said step, first, there are provided the plurality of first heat-sink fins 1, the thermal conduction plate 6, and the mounting plate 7 (see Fig. 3a); second, these first heat-sink fins 1 are inserted into the corresponding grooves 8 of the mounting plate 7 to form a stable integral structure (see Fig. b); finally, the thermal conduction plate 6 is placed above the mounting plate 7, and the respective first heat-sink fins 1 engages with the grooves 8 of the thermal conduction plate 6 so as to form a good thermally conductive connection with the thermal conduction plate (see Fig. 3c). In the step b), there is provided the second heat-sink structure B made of thermally conductive plastic, and the second heat-sink structure comprises the base 4 and the second heat-sink fins 2 extending outward in a radial direction on the outer surface of the base, wherein the cavities 3 are formed in the second heat-sink fins 2 (see Fig. 3d). In the step c), the first heat-sink fins 1 are inserted into the cavities 3 of the second heat-sink fins 2, and in the step d), the first heat-sink fins 1 and the second heat-sink fins 2 are packaged by plastic injection using thermally conductive plastic so as to form the heat-sink device according to the present invention (see Fig. 3e).

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	first heat-sink fins
2	second heat-sink fins
3	cavities
4	a base
5	a receiving part
6	a thermal conduction plate
7	a mounting plate
8	grooves
A	a first heat-sink structure
B	a second heat-sink structure
C	a support component

Patent claims

1. A heat-sink device, characterized in that, the heat-sink device comprises a first heat-sink structure (A) in thermal contact with an object which heat to be dissipated and a second heat-sink structure (B), wherein the first heat-sink structure (A) is composed of a plurality of first heat-sink fins (1) and the second heat-sink structure (B) is composed of a plurality of second heat-sink fins (2), wherein the first heat-sink fins (1) are inserted into cavities (3) formed in the second heat-sink fins (2).

2. The heat-sink device according to Claim 1, characterized in that, the first heat-sink fins (1) have higher thermal conductivity than the second heat-sink fins (2).

3. The heat-sink device according to Claim 1, characterized in that, the first heat-sink structure (A) also has a support component (C), the support component (C) supporting the object from which heat to be dissipated and being connected to each of the first heat-sink fins (1) for heat conduction.

4. The heat-sink device according to Claim 3, characterized in that, the second heat-sink structure (B) also has a base (4), the base (4) having a receiving part (5) for receiving the support component (C).

5. The heat-sink device according to Claim 4, characterized in that, the support component (C) comprises a thermal conduction plate (6) and a mounting plate (7) superimposing together, wherein the first heat-sink fins (1) are embedded into the thermal conduction plate (6) and the mounting plate (7), respectively, and the mounting plate (7) makes each of the first heat-sink fins (1) connected into one entirety.

6. The heat-sink device according to Claim 5, characterized in that, the thermal conduction plate (6) and the mounting plate (7) are respectively provided with a plurality of grooves (8), and the first heat-sink fins (1) are inserted into the grooves (8), respectively.

7. The heat-sink device according to Claim 4, characterized in that, the second heat-sink fins (2) and the base (4) are made of thermally conductive plastic in one piece having a thermal conductivity between 1 to 4 W/ m·k.

8. The heat-sink device according to Claim 7, characterized in that, the thermally conductive plastic is PP, PPS, PA or ABS.

9. The heat-sink device according to Claim 5, characterized in that, the first heat-sink fins (1) and the thermal conduction plate (6) are made of metal material having thermal conductivity higher than 4 W/ m·k.

10. The heat-sink device according to Claim 9, characterized in that the first heat-sink fins (1) and the thermal conduction plated (6) are made of copper- or aluminum-based materials.

11. A method for manufacturing a heat-sink device, characterized by the following steps:
a) providing a first heat-sink structure (A) with a plurality of first heat-sink fins (1);
b) providing a second heat-sink structure (B) made of thermally conductive plastic, the second heat-sink structure (B) comprising a base (4) and second heat-sink fins (2) extending outward in a radial direction on an outer surface of the base

(4), wherein cavities (3) are formed in the second heat-sink fins (2);

c) inserting the first heat-sink fins (1) into the cavities (3) of the second heat-sink fins (2); and

d) packaging by plastic injection the first heat-sink fins (1) and the second heat-sink fins (2) using thermally conductive plastic.

12. The manufacturing method according to Claim 11, characterized in that, in the step a) there further includes a process of connecting the plurality of first heat-sink fins (1) into one entirety via a mounting plate (7).

13. The manufacturing method according to Claim 12, characterized in that, in the step a) there further includes a process of providing a thermal conduction plate (6) for supporting an object from which heat to be dissipated on the mounting plate (7) so as to connect the thermal conduction plate (6) to each of the first heat-sink fins (1) for heat conduction.

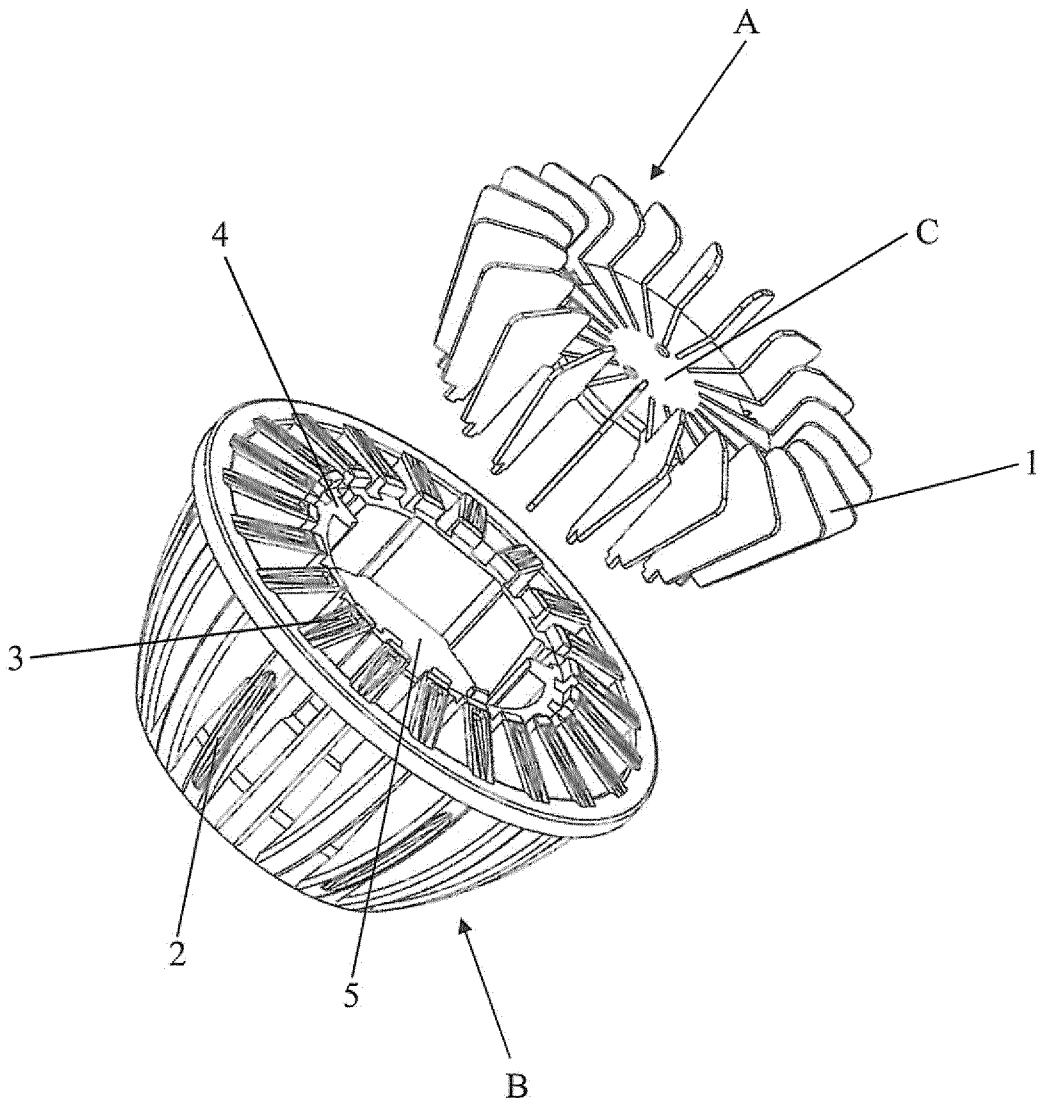

Figure 1

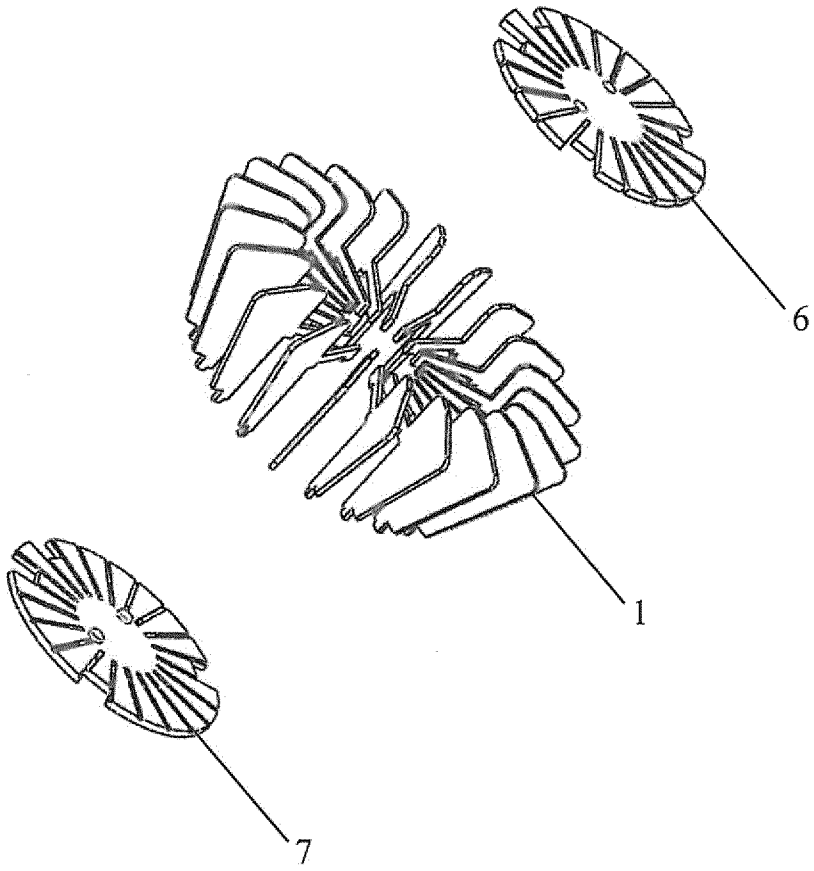

Figure 2

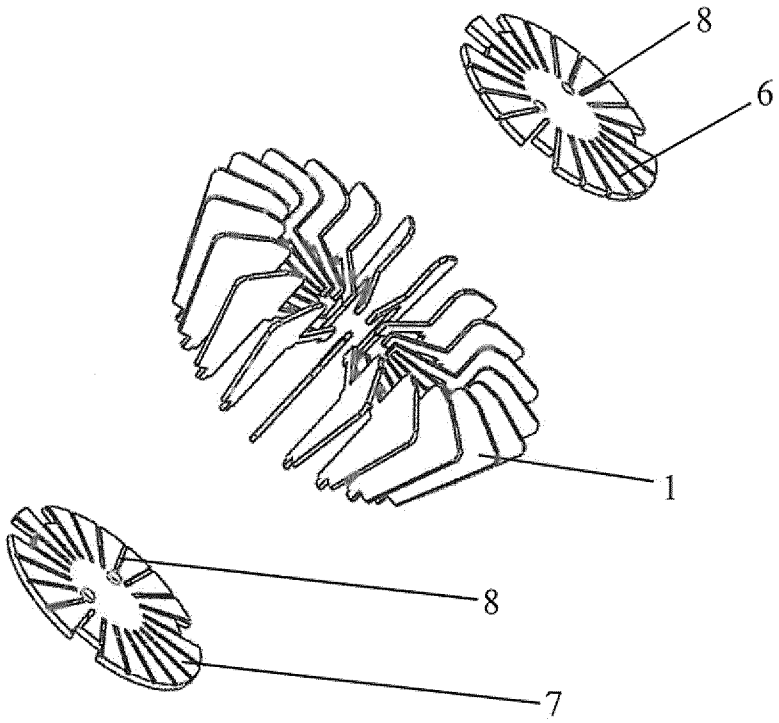

Figure 3a

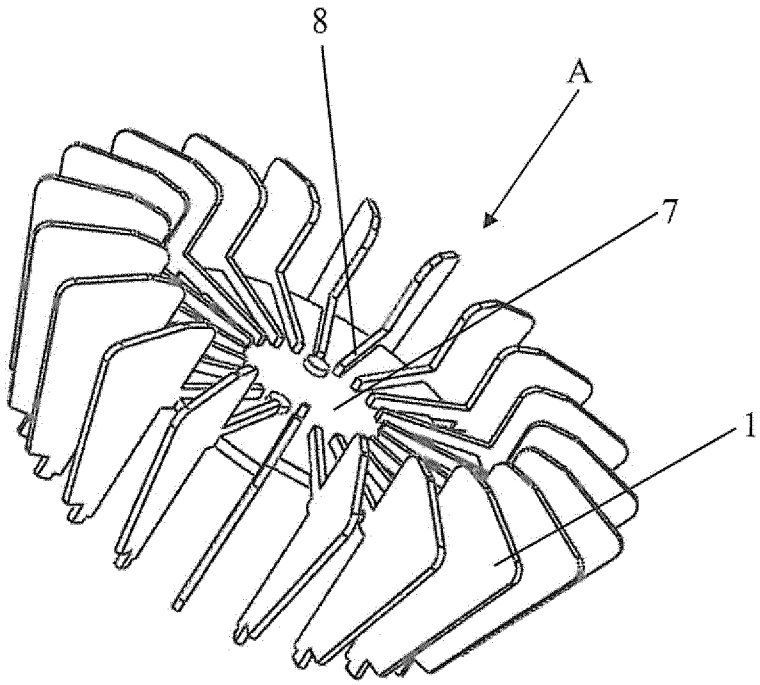

Figure 3b

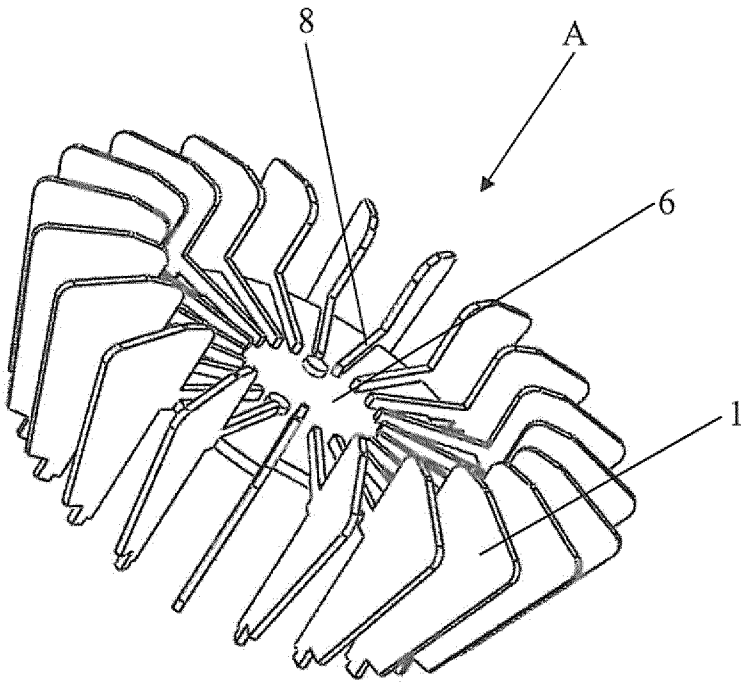

Figure 3c

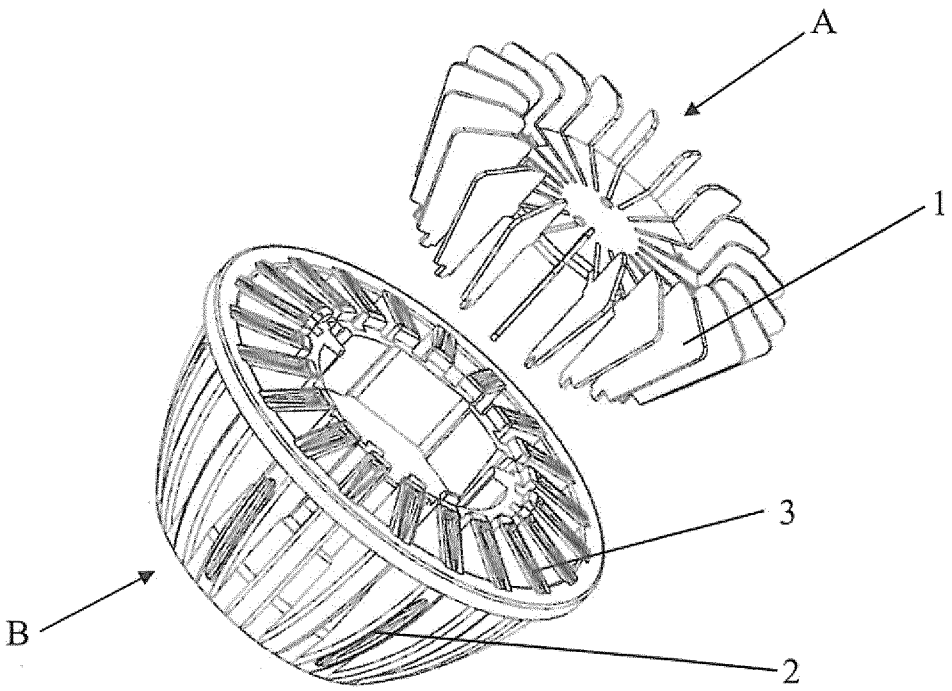

Figure 3d

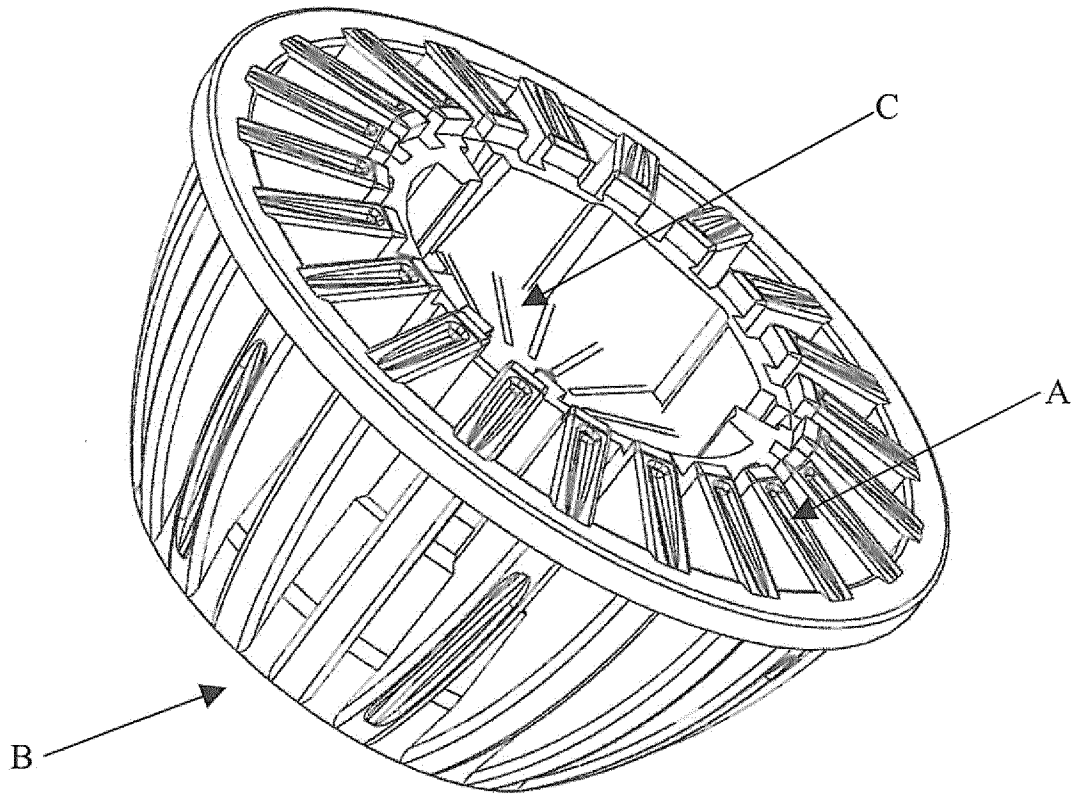

Figure 3e

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/059427

A. CLASSIFICATION OF SUBJECT MATTER
INV. F21V29/00
ADD. F21Y101/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F21V

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 2 081 220 A2 (NENG TYI PREC IND CO LTD [TW]) 22 July 2009 (2009-07-22) paragraph [0015] - paragraph [0025]; figures 3-5,8	1-13
A	US 2010/044009 A1 (CHEN SHYH-MING [TW]) 25 February 2010 (2010-02-25) paragraph [0022] - paragraph [0025]; figures 1-4	1-13

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
19 September 2012	27/09/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Schmid, Klaus

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2012/059427

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