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(54) Title: LIGHTING DEVICE

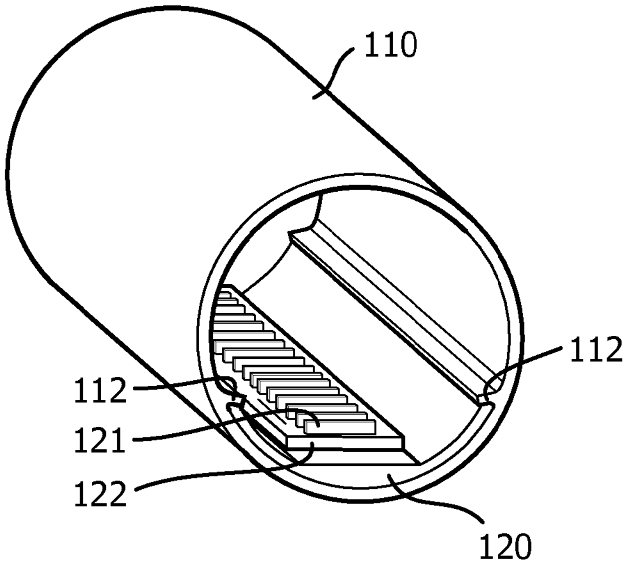

FIG. 1

(57) Abstract: There is provided a lighting device comprising an elongated hollow tubular member (110) which has a light exit window; a heat sink (120); and at least one light emitting element (121) for providing light, which is thermally coupled to the heat sink. The heat sink and the at least one light emitting element are located in the tubular member; and at least a portion of a first surface of the heat sink is geometrically matched with an inner wall of the tubular member. The tubular member comprises at least one connecting element (112) to accommodate the heat sink.

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LIGHTING DEVICE

FIELD OF THE INVENTION

The invention relates generally to lighting devices, and more specifically to a lighting device comprising at least one light source for providing light arranged in an elongated hollow, tubular member.

BACKGROUND OF THE INVENTION

Lighting devices comprising light emitting diodes (LEDs) are used as replacement of traditional lighting devices such as conventional light bulbs. Recently they are also targeted at application of fluorescent tubes. US Patent Application No. 2010 / 0033964 A1 discloses such a LED light tube, which is formed by a semi-circular plastic housing and a semi-circular heat sink comprises an elongated hollow rigid tube into which a plurality of LEDs are inserted. A plurality of LEDs is inserted on the PCB mounted in the middle of the tube. To achieve uniformity and stability of light output, lots of LEDs are used. However, these LEDs account for a large percentage of the bill of material. It's difficult to decrease the number of LED substantially to obtain the same light performance, for the spottiness of light output will be a big issue by doing this.

When lots of LEDs are used to replace fluorescent tubes, there is severe thermal issue to be solved. The heat generated by LEDs should be dissipated as quick as possible, otherwise the lighting devices will be failure when the temperature rises to a certain level. Many attemptions are presently available, such as the exposed heat sink in the above mentioned patent application. However, there can be potential safety risk as the user may access the electrical circuits within the tube. Simply putting the heat sink in the tube can solve the safety issue, but can not have good heat dissipation, because the diametral clearance between the heat sink and the inner wall of the tube forms a thermal barrier. As there is difference on coefficient of thermal expansion between the materials of the tube and the heat sink, the diametral clearance will increase when the rised temperature causes miss-matching deformations of the tube and the heat sink. This further leads to low thermal efficiency under operational conditions of the lighting devices.

SUMMARY OF THE INVENTION

It is an objective of the invention, among others, to achieve a lighting device which can replace fluorescent tubes with good thermal efficiency.

To better address one or more of these concerns, in a first aspect of the invention, a lighting device comprises an elongated hollow tubular member has a light exit window; a heat sink; and at least one light emitting element for providing light, which is thermally coupled to the heat sink. The heat sink and the at least one light emitting element are located in the tubular member; and at least a portion of a first surface of the heat sink is geometrically matched with an inner wall of the tubular member, in order to have sufficient contact area between the first surface and the inner wall for effective heat transfer. The tubular member comprises at least one connecting element to accommodate the heat sink. This allows the first surface of the heat sink to have a minimum distance to the inner wall of the tubular member under various operation conditions of the lighting device. The connecting element keeps the heat sink attached to the inner wall within the tubular member under various operational conditions, e.g., when the heat sink is heated up and extended in size during operation, and allows good heat dissipation.

The lighting device preferably comprises multiple light emitting elements. The light emitting elements can comprise one or more light emitting diodes (LED) or LED dies.

According to an embodiment of the lighting device, the at least one connecting element comprises a protrusion from the inner wall. Preferably, the protrusion can be finger-shaped, dovetail-shaped, mushroom-shaped or T-shaped in cross-section. The protrusion can be cost effectively manufactured with extrusion, injection, molding or other known techniques within the field. And it allows easy assembly of the lighting device or easy disassembly at the end-of-life, so that the tubular member can be recycled after removing the heat sink.

According to an embodiment of the lighting device, the tubular member can further comprise a second connecting element. Preferably, the heat sink is sized to be accommodated in the space defined by the connecting elements. Alternatively, the connecting elements are configured inclined to the heat sink and formed wedge-shaped spaces between the connecting elements and the inner wall. Preferably, the connecting elements are deformable to open the wedge-shaped spaces upon a thermal expansion force of the heat sink. This allows the heat sink to keep good contact with the inner wall within the tubular member under various operational conditions, e.g., when the heat sink is heated up and extended in size during operation, and allows good heat dissipation.

According to an embodiment of the lighting device, the heat sink is rigid or has a thermal stable shape by using a carefully selected material. This allows the heat sink to be in good contact with the inner wall of the tubular member even when the heat sink is heated up during operation, and allows good heat dissipation. A rigid heat sink can be slidely inserted into the tubular member easily. Therefore it provides an additional advantage of allowing easy assembly of the lighting device or easy disassembly at the end-of-life, as the tubular member can be recycled after removing the heat sink.

According to an embodiment of the lighting device, a first thickness of the heat sink between a position where the light emitting element is located and the first surface is relatively small compared to a second thickness of the heat sink being remote from the position of the light emitting element. In other words, the thickness of the heat sink between a position where the light emitting element is located and the first surface is configured to be minimum, but is sufficient so that the heat sink has enough mechanical strength. This allows the light emitting elements be located near the inner wall of the tubular member, and allows a maximum distance between the light emitting elements and the light exit window on the tubular member. A large distance between the light emitting elements and the light exit window allows better light mixing and recycling, which lead to a good light output uniformity. As a result, less LEDs can be used in the tube with similar optical performance. The optical performance includes brightness and light distribution uniformity. Thus there is provided a tube shaped lighting device which has much less number of LEDs comparing to a known Tube Light Emitting Diode Lamp (TLED) for balanced performance of light distribution and thermal transfer. The decreased number of LEDs together with the saved energy advantageously brings the benefit of cost saving while keeping the same light performance. Alternatively, in embodiments of the lighting device according to the present invention, higher light output brightness can be achieved with a similar level of energy input as the known TLED by using fewer but higher power LEDs.

According to an embodiment of the lighting device, the lighting device further comprises a printed circuit board (PCB) arranged between the light emitting element(s) and the heat sink. This allows the electrical connection of driving circuits to the LEDs.

According to an embodiment of the lighting device, wherein at least a portion of a second surface of the heat sink, which is opposite to the first surface, is reflective. The surface can either be specular reflective or diffusive reflective. The reflective or scattering surface portion further allows better light mixing and recycling, which lead to a good light output uniformity. In a further embodiment of the lighting device, the heat sink can have two portions of the second surface extending oppositely from the position where the light emitting element is located. These two portions of the second surface can be symmetric or asymmetric with respect to the position where the light emitting element is located. This benefits the light distribution desired.

Preferably, the heat sink further comprises at least one fin and/or at least one cavity. The fin and/or cavity further enlarge the contact area between the heat sink and air. This is advantageous for increasing the heat dissipation capability of the heat sink.

As explained, the connecting element can be a protrusion from the inner wall of the tubular member. The protrusion can extend along the generatrix direction on the inner wall of the tubular member. There can be more than one protrusion on the inner wall of the tubular member for steadily accommodating the heat sink. In an alternative embodiment of the lighting device, the at least one connecting element of the tubular member comprises a recession in the inner wall of the tubular member. By matching the recession with a protrusion on the heat sink, the heat sink can also be accommodated along the inner wall of the tubular member.

According to an embodiment of the lighting device, the tubular member can be made of plastic. The light exit window of the tubular member can further has one of a transparent layer, a diffusive layer, a semi-transparent layer, and a layer with reflective pattern, or comprises reflective or diffuse particles. Plastic tubes with reflective or diffusive feature can be advantageous in cost and light output performance.

It is noted that the invention relates to all possible combinations of features recited in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the lighting device, according to the invention will become apparent from and will be elucidated with respect to the implementations and embodiments described hereinafter and with reference to the accompanying drawings.

Fig. 1 shows a structure of an embodiment of a lighting device according to the present invention;

Fig. 2 is a schematic cross-sectional side view of a lighting device of Fig 1;

Fig. 3 is a schematic cross-sectional side view of an alternative embodiment of heat sink of a lighting device according to the present invention;

Fig. 4 is a schematic cross-sectional side view of another alternative embodiment of heat sink of a lighting device according to the present invention;

Fig. 5 is a schematic cross-sectional side view of an alternative embodiment of a lighting device according to the present invention with one rail-type connecting element;

Fig. 6 is a schematic cross-sectional side view of a further alternative embodiment of a lighting device according to the present invention with one rail-type connecting element;

Fig. 7 is a schematic cross-sectional side view of another alternative embodiment of a lighting device according to the present invention;

Fig. 8 is a schematic cross-sectional side view of a further alternative embodiment of a lighting device according to the present invention;

Fig. 9 is a schematic cross-sectional side view of the embodiment of Fig. 8 when the lighting device is heated up during operation.

DETAILED DESCRIPTION

A lighting device according to the present inventive concept is illustrated in Fig. 1. The lighting device comprises a tube 110, a heat sink 120 and a linear array of light emitting diodes (LED) 121 for light generation.

The LEDs 121 are mounted on the heat sink 120 for heat dissipation. Preferably, the LEDs 121 are mounted on a substrate or PCB 122 and the PCB 122 is mounted on the flat surface portion 124 of the heat sink 120 through mechanical connection, such as using adhesive layer or screws. The PCB 122 is for an easy electrical connection between the driving circuits and the LEDs. A person skilled of the art can understand that, there can be multiple PCBs for LED mounting, and the linear array can be composed of a PCB with chip-board LEDs, or be a linear lead frame with LED-dies and wirebonds that in addition may be silicone overmoulded locally or over the full length. The LEDs or LED-dies can be combined with wavelength conversion material. The linear assembly may also be based on a foil with an electrically conductive surface. LEDs in a linear array are suitable for the present inventive concept, but other arrangements are applicable as well. The linear array is in embodiments of the invention equipped with separate lenses or a common linear lens. The mounting method includes approaches to have good thermal engagement between the LEDs, the PCB and the heat sink.

As shown in Fig. 2, the tube 110 has two protrusions or ribs 112 extending along the generatrix direction on the inner wall 116 of the tube 110. The ribs 112 are finger-shaped in a cross-sectional view. The heat sink 120 is arc-shaped in a cross-sectional view, with a curved surface 126 opposite to the flat surface portion 124. The curved surface 126 is geometrically matched with the inner wall 116. The heat sink 120 is sized to be accommodated in the space defined by the two protrusions 112. In other words, the arcuation distance between the two edges 128 of the heat sink 120 is a little smaller than the arcuation distance between the two protrusions 112, so that the heat sink 120 can be slidely inserted into the tube 110, and can be in good contact with the inner wall 116 of the tube 110, even when the heat sink is heated up during operation. This good contact under various conditions is advantageous for heat dissipation.

The tube 110 is made of plastic, and in alternative embodiments, the tube 110 is provided with wavelength conversion material, such as phosphorus material, or another additional optical layer, such as a diffusive layer, a semi-transparent layer, or a layer with reflective pattern, or comprises reflective or diffuse particles in the tube wall, etc., by means of deposition, lamination, extrusion or co-extrusion according to known techniques within the field. Thus, a number of different optical functionalities can advantageously be integrated in the tube 110, including the improvement of output light distribution and/or providing light recycling within the tube 110. The plastic tube 110 with ribs 112 can be cost effectively manufactured with extrusion, injection, molding or other known techniques within the field. A person skill in the art can understand that, the tube 110 can also formed with individual knobs on the inner wall 116 to act as the protrusions 112 defining the space for the heat sink 120. The tube 110 can also be made of glass or other at least partly transparent, diffusive or translucent material. The protrusions 112 can also be discrete knobs attached to the inner wall of the tube with glue, adhesive or by means of melting, or with other known mechanical methods, such as screws or bolts.

The tube 110 provides a light mixing chamber for light generated by the LEDs 121. The tube 110 can be transparent or translucent as a whole, or a transparent portion 111 is arranged on an opposite side of the tube with respect to the LEDs 121. The transparent (or alternatively translucent) portion 111, provides a light exit window on the tube.

The thickness between the flat surface portion 124 and the curved surface 126 of the heat sink 120 is configured to minimum, as long as the heat sink 120 has enough mechanical strength, so as to allow the LEDs 121 be close to the inner wall 116 of the tube 110. This allows a maximum distance between the LEDs 121 and the light exit window on the tube 110, in turn allows a desired light recycling within the cavity of tube 110. The light recycling can help to improve light mixing, which is advantageous for to prevent getting visible spots at the light exit window.

In an embodiment of the invention as shown in Fig. 2, there are two second surface portions 125, in addition to the flat surface portion 124 at the same side of the heat sink 120. The second surface portions 125 can be reflective or scattering, or integrates a reflective or scattering functionality by coating, laminating, plating, polishing or other known techniques within the field.

The profile of the second surface portions 125 can be linear, parabolic or other configuration based on the optical consideration. Although it is shown in Fig. 2 that the two second surface portions 125 are symmetric, an asymmetric structure is also possible. In an alternative embodiment, only one second surface portion 125 is configured to meet the desired light output distribution.

Since the LEDs 121 are positioned close to the inner wall 116 of the plastic tube 110, it will reduce spottiness if decreasing the number of LEDs 121 largely. In an experimental test with a commercial available 4 feet TLED, which has 256 pieces of LED, the output light distribution profile keeps the same, without issue of spottiness when the number of LED decrease to 64~80 with the structure according to the invention.

Various embodiments of heat sink 220 and 320 are illustrated in Fig. 3 and Fig. 4, for better thermal dissipation, together with additional advantages on mechanical properties and/or optical properties.

As shown in Fig. 3, the heat sink 220 is configured with two fins 223 which enlarge the volume of the heat sink 220 for improved heat transfer performance. The heat sink 220 can be accommodated in the tube 110 by the two edges 228. The curved surface 226 is geometrically matched with the inner wall 116 of the tube 110. The LEDs are mounted in the flat surface portion 224, and the two second surface portions 225 are reflective.

As shown in Fig. 4, the heat sink 320 is configured with two fins 323. The heat sink 320 can be accommodated in the tube 110 by the two edges 328. The curved surface 326 is geometrically matched with the inner wall 116 of the tube 110. The LEDs are mounted in the flat surface portion 324, and the two second surface portions 325 are reflective. The fins are thinned and extended to form two cavities 327 which further enlarge the contact area between the heat sink 320 and air for better heat transfer performance.

Embodiments of various modifications to the connecting element between the tube 510, 610, 710 and 810 and the heat sink 520, 620, 720 and 810 are exemplarily illustrated in Fig. 5 to Fig. 9 for improvements to keep the tube and heat sink in good contact.

As shown in Fig. 5, the tube 510 has a protrusion or rail 519, which is dovetail-shaped in cross sectional view, extending along the generatrix direction on the inner wall 516. The heat sink 520 has a curved surface 526 which is geometrically matched with the inner wall 516. Accordingly, the heat sink 520 is configured with a dovetail groove 529. The heat sink 520 can be easily slided into the tube 510 with the rail-groove engagement. During the lamp operation, the rail-groove engagement attaches the heat sink 520 to the inner wall 516 of the tube 510, regardless the thermal expansion of the heat sink 520, and allows a good heat transfer.

As shown in Fig. 6, the protrusion or rail 619 of tube 610 is mushroom-shaped in cross sectional view, which engages with the mushroom-shaped groove 629 in heat sink 620 to allow the curved surface 626 of the heat sink 620 keep good contact with the inner wall 616 of the tube 610.

As shown in Fig. 7, the protrusion or rail 719 of tube 710 is T-shaped in cross sectional view, which engages with the T-shaped groove 729 in heat sink 720 to allow the curved surface 726 of the heat sink 720 keep good contact with the inner wall 716 of the tube 710. In addition to the rail 719, the tube 710 is further configured with two protrusions 712 defining the space to accommodate the heat sink 720 by the two edges 728.

Although Fig. 5 to Fig. 7 show protrusions from the tube to the heat sink, the connecting element of alternative embodiments can be at reversed way, in other words, the grooves can be in the tube while the rails are configured on the curved surface of the heat sink. And a person skill in the art can understand that, the shapes of the rail-groove engagement can be revised according to known techniques within the field. The protrusions 112, 712 on the inner wall in Fig 1, 2 and 7 can also be reversed to recessions in the inner wall and engage with protrusions or ribs on the heat sink.

As shown in Fig. 8 and Fig. 9, the tube 810 has two protrusions or ribs 812 extending along the generatrix direction on the inner wall 816 of the tube 810. The ribs 812 are configured inclined to the heat sink 820 and formed wedge-shaped space 818 between the ribs 812 and the inner wall 816. Fig. 8 and the dash line in Fig. 9 shows the initial state of the lighting device when the cool heat sink 820 is accommodated by the two ribs 812 and has the curved surface 826 attached to the inner wall 816. When the lighting device is in operation state and the heat sink 820 is heated up, the edges 828 are forced into the wedge-shaped space 818, as the solid line shown in Fig. 9. The plastic material of the tube 810 has certain elasticity which enables the ribs 812 to deform slightly and open the wedge-shaped space 818 upon the thermal expansion force of the heat sink 820. Therefore, this allows good contact between the curved surface 826 and the inner wall 816 during the life time of the lighting device.

While the invention has been illustrated and described in detail in the drawings and foregoing description as one, two or three connecting elements for a better contact between the heat sink and the inner wall of the tube, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiments. A person skill in the art can understand that, more connecting elements can be implemented to achieve the contact for heat dissipation.

At the position(s) where the heat sink keeps contact with the tube, the matched shape of the surfaces, the contacting area and the close connection therebetween leads to the good thermal transfer. Therefore, it would be advantageous to have a substantial portion of the first surface (shown as 126, 226, 326, 526, 626, 726 and 826 in the figures) of the heat sink in good contact with the inner wall of the tube, to achieve a good thermal efficiency. In other words, a sufficient contact area between the heat sink and the tube will help the heat dissipation. The tube material can be a thermal conductive plastic which brings more advantage in heat transfer.

In embodiments, after assembly of the heat sink and the tube, the lighting device cavity can be evacuated or filled with a gas and sealed. Alternatively, the lighting device cavity can be filled with a liquid or a solidifying material like silicones.

A person skilled in the art realizes that the present invention by no means is limited to the preferred embodiments described above. On the contrary, many modifications and variations are possible within the scope of the appended claims. It should be noted that the above-mentioned embodiments illustrate rather than limit the invention and that those skilled in the art will be able to design alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be constructed as limiting the claim. The word ‘comprising’ does not exclude the presence of elements or steps not listed in a claim. The word “a” or “an” preceding an element does not exclude the presence of a plurality of such elements. The usage of the words first, second and third, etc., do not indicate any ordering. These words are to be interpreted as names. No specific sequence of acts is intended to be required unless specifically indicated.

CLAIMS:

1. A lighting device comprising:

an elongated hollow tubular member (110; 510; 610; 710; 810) which has a light exit window (111);

a heat sink (120; 220; 320; 520; 620; 720; 820); and

at least one light emitting element (121) for providing light, which is thermally coupled to the heat sink (120; 220; 320; 520; 620; 720; 820);

the heat sink (120; 220; 320; 520; 620; 720; 820) and the at least one light emitting element (121) being located in the tubular member (110; 510; 610; 710; 810); and

at least a portion of a first surface (126; 226; 326; 526; 626; 726; 826) of the heat sink (120; 220; 320; 520; 620; 720; 820) being geometrically matched with an inner wall (116; 516; 616; 716; 816) of the tubular member (110; 510; 610; 710; 810); wherein,

the tubular member (110; 510; 610; 710; 810) comprises at least one connecting element (112; 519; 619; 719, 712; 812) to accommodate the heat sink (120; 220; 320; 520; 620; 720; 820).

2. A lighting device according to claim 1, wherein the connecting element (112; 519; 619; 719, 712; 812) comprises a protrusion from the inner wall (116; 516; 616; 716; 816).

3. A lighting device according to claim 2, wherein the protrusion is finger-shaped, dovetail-shaped, mushroom-shaped or T-shaped, in cross-section.

4. A lighting device according to claim 1, wherein the tubular member (110; 510; 610; 710; 810) further comprises a second connecting element (112; 712, 719; 812).

5. A lighting device according to claim 4, wherein the heat sink (120) is sized to be accommodated in the space defined by the connecting elements (112).

6. A lighting device according to claim 4, wherein the connecting elements (812) are configured inclined to the heat sink (820) and formed wedge-shaped spaces (818) between the connecting elements (812) and the inner wall (816).

7. A lighting device according to claim 6, wherein the connecting elements (812) are deformable to open the wedge-shaped spaces (818) upon a thermal expansion force of the heat sink (820).

8. A lighting device according to any of the preceding claims, wherein the heat sink (120; 220; 320; 520; 620; 720; 820) is rigid or has a thermal stable shape.

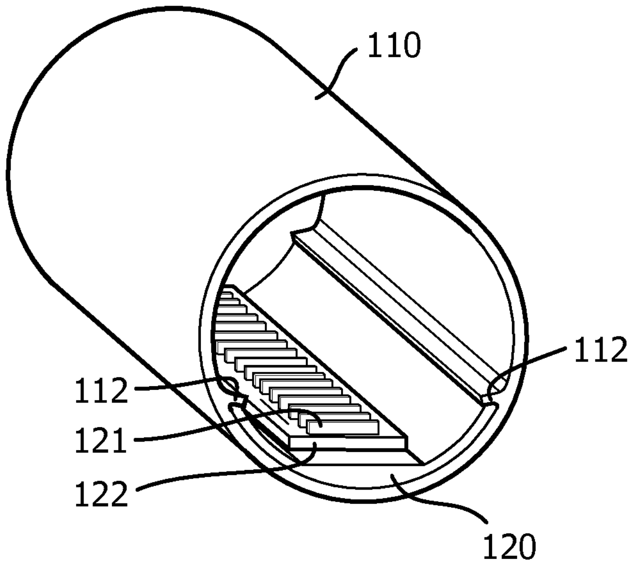
9. A lighting device according to any of the preceding claims, wherein a first thickness of the heat sink (120; 220; 320; 520; 620; 720; 820) between a position where the light emitting element (121) is located and the first surface (126; 226; 326; 526; 626; 726; 826) is relatively small compared to a second thickness of the heat sink (120; 220; 320; 520; 620; 720; 820) being remote from the position of the light emitting element (121).

10. A lighting device according to any of the preceding claims, further comprising a printed circuit board (122) arranged between the at least one light emitting element (121) and the heat sink (120; 220; 320; 520; 620; 720; 820).

11. A lighting device according to any of the preceding claims, wherein at least a portion of a second surface (125; 225; 325) of the heat sink (120; 220; 320; 520; 620; 720; 820), which is opposite to the first surface (126; 226; 326; 526; 626; 726; 826), is reflective.

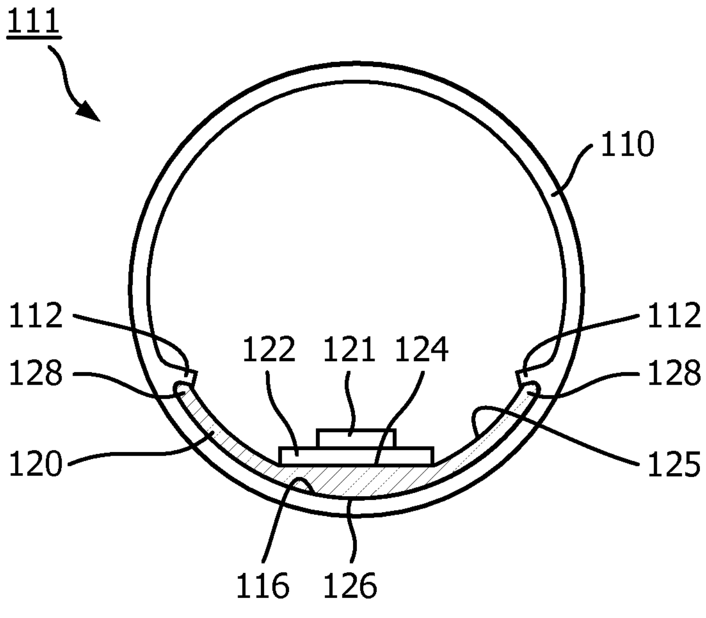
12. A lighting device according to any of the preceding claims, wherein the heat sink (120; 220; 320; 520; 620; 720; 820) further comprises at least one fin (223; 323) and/or at least one cavity (327).

13. A lighting device according to any one of claims 1 - 12, wherein the light exit window (111) has one of a transparent layer, a diffusive layer, a semi-transparent layer, and a layer with reflective pattern, or comprises reflective or diffuse particles.



110
112
112
121
122
120

FIG. 1



111
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112
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122
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124
128
128
120
125
116
126

FIG. 2

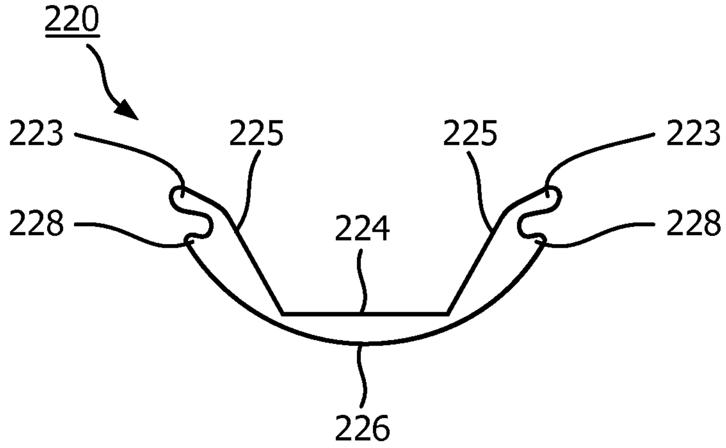

FIG. 3

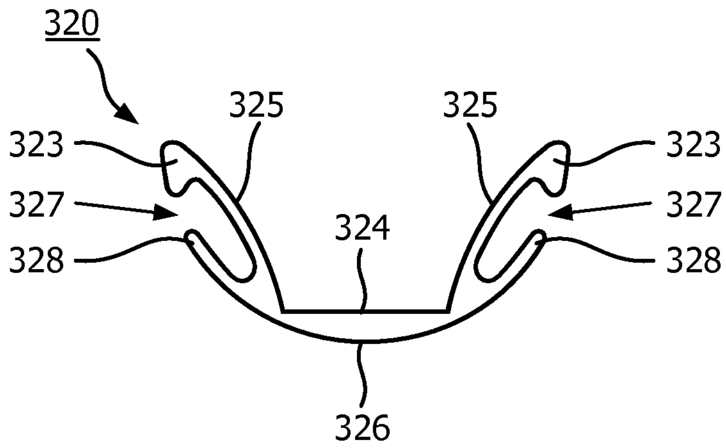

FIG. 4

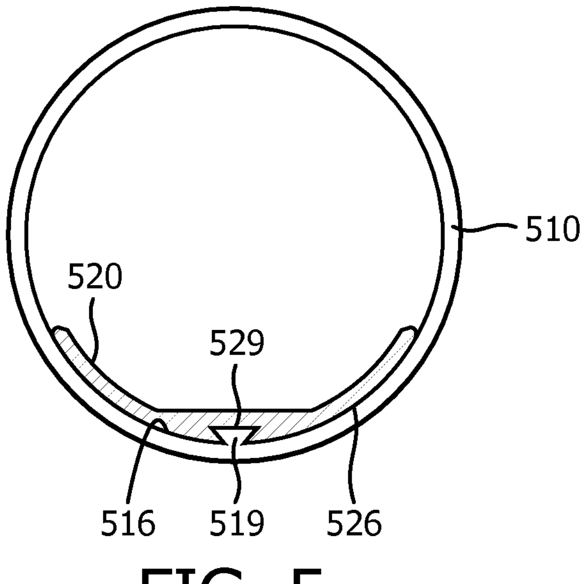

FIG. 5

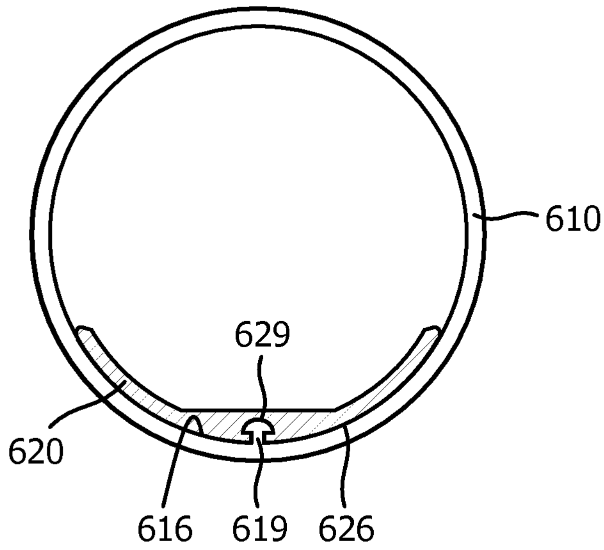

FIG. 6

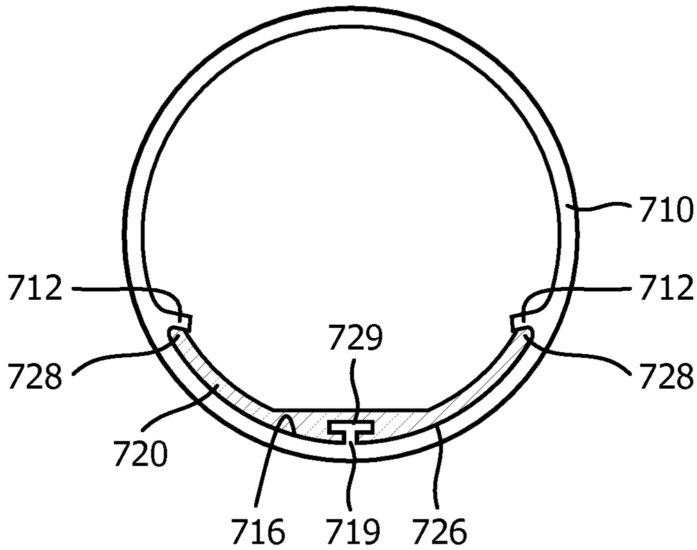

FIG. 7

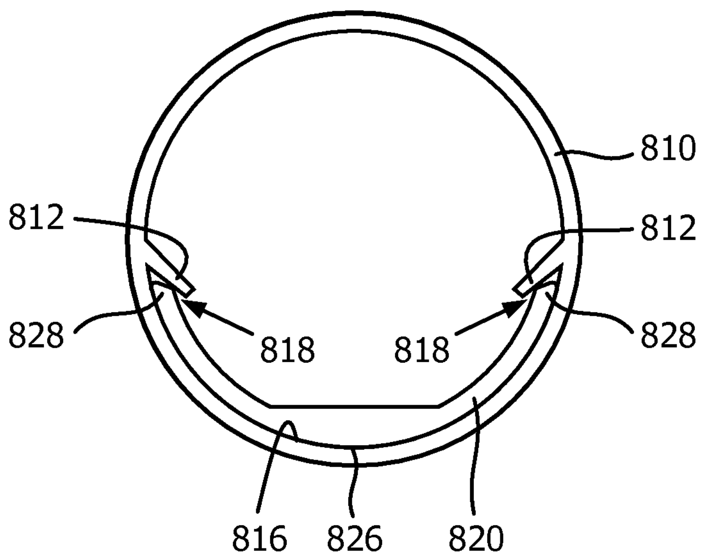
810
812
812
828
818
818
828
816
826
820

FIG. 8

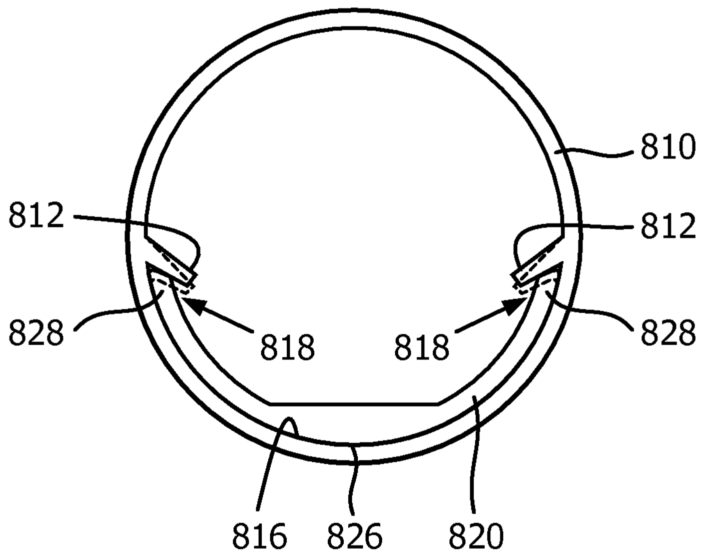
810
812
812
828
818
818
828
816
826
820

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2013/051511

A. CLASSIFICATION OF SUBJECT MATTER
INV. F21V29/00 F21K99/00 F21V17/10 F21V17/16 F21V3/00
F21V7/20
ADD. F21Y101/02 F21Y103/00 F21V3/04

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 F21K F21Y F21S

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.
X	WO 2009/143047 A2 (ALTAIR ENG INC [US]; IVEY JOHN [US]; SIEMIET DENNIS [US]) 26 November 2009 (2009-11-26) figures 9, 10 paragraph [0038] - paragraph [0041] paragraph [0035] -----	1-5,8-13
X	JP 2010 198927 A (SSEC KK) 9 September 2010 (2010-09-09) abstract; figures 1,4,7,10,15,19,22 -----	1-8, 10-13
X	US 2011/303928 A1 (KAWABATA YUSAKU [JP]) 15 December 2011 (2011-12-15) figures 1, 2 paragraph [0094] - paragraph [0095] paragraph [0110] - paragraph [0113] -----	1-6,8, 10,13
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 June 2013	17/06/2013

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	Thibaut, Arthur

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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X	JP 2010 165647 A (MOMO ALLIANCE CO LTD) 29 July 2010 (2010-07-29) abstract; figures 4,5 -----	1-5,8, 10,13
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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