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(54) **Lamp**

(57) A lamp in an embodiment includes a thermal radiator functioning as a hollow case opened on one end side, a board having a through-hole in the center and provided on the one end side of the thermal radiator, a plurality of semiconductor light-emitting elements provided on one end side of the board and in a circumferential shape to extend along the through-hole, a lighting circuit including a circuit board and circuit components including a heat generating component mounted on the circuit board, the lighting circuit being provided inside the thermal radiator such that the heat generating component is located in an area of the through-hole when the thermal radiator is viewed from the one end side, and a cap provided on the other end side of the thermal radiator.

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is based upon and claims the benefit of priority from the prior Japanese Patent Application No.2014-006376, filed on January 17, 2014, the entire contents of which are incorporated herein by reference.

FIELD

[0002] Exemplary embodiments described herein relate generally to a lamp.

BACKGROUND

[0003] A lamp that makes use of light emission of a semiconductor such as a light-emitting diode is used for, for example, lighting and display. The lamp includes semiconductor light-emitting elements, a lighting circuit that supplies electric power to the semiconductor light-emitting elements, and a member that houses the semiconductor light-emitting elements and the lighting circuit.

[0004] Since the semiconductor light-emitting elements have long life, it is known that the lamp of this type has long life compared with a lamp such as a bulb in the past. However, the lamp sometimes reaches the end of the life when the lighting circuit reaches the end of the life earlier than the semiconductor light-emitting elements. The life of the lighting circuit depends on the temperature of a circuit member of the lighting circuit during lighting. Therefore, it is desired that the temperature of the lighting circuit during the lighting is low.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005]

FIG. 1 is a diagram for explaining a lamp in a first embodiment;
FIG. 2 is a diagram for explaining the external appearance of the lamp;
FIGS. 3A and 3B are diagrams for explaining a state in which the lamp is viewed from one end side of a case; wherein FIG. 3A is a state in which a globe, a board, and a thermal radiation plate are removed and FIG. 3B is a state in which the globe is removed;
FIGS. 4A to 4C are diagrams for explaining a difference between the temperature of the lighting circuit of the lamp and the temperature of a lighting circuit of a lamp in the past;
FIG. 5 is a diagram for explaining a temperature difference of the lighting circuit when the size L of through-holes of the thermal radiation plate and the board and the width W of a circuit board are changed;
FIG. 6 is a diagram for explaining a lamp in a second embodiment;
FIGS. 7A to 7C are diagrams for explaining a temperature change of a lighting circuit when the shape of a cover member is changed in the lamp; and
FIG. 8 is a diagram for explaining another example of the lamp.

DETAILED DESCRIPTION

[0006] In view of the above circumstances, an embodiment provides a lamp capable of reducing the temperature of a lighting circuit.

[0007] The lamp in the embodiment includes: a hollow case opened on one end side; a board having a through-hole in the center and provided on the one end side of the case; a plurality of semiconductor light-emitting elements provided on one end side of the board and in a circumferential shape to extend along the through-hole; a lighting circuit including a circuit board and circuit components including a heat generating component mounted on the circuit board, the lighting circuit being provided inside the case such that the heat generating component is located in an area of the through-hole when the case is viewed from the one end side; and a power-supply section provided on the other end side of the case.

First Embodiment

[0008] A first embodiment is explained with reference to FIG. 1 to FIGS. 3A and 3B.

[0009] FIG. 1 is a diagram for explaining a lamp in the first embodiment. FIG. 2 is a diagram for explaining the external appearance of the lamp. FIGS. 3A and 3B are diagrams for explaining a state in which the lamp is viewed from one end side of a case.

[0010] The lamp in this embodiment is an LED lamp used for lighting and display. The lamp includes a thermal radiator 1, a thermal radiation plate 2, a board 3 (substrate), LEDs 4, a globe 5, a resin case 6 (an insulating case), a lighting circuit 7, a cap 81, and an insulating ring 82. In the explanation in this embodiment, in the center axis of the lamp, a direction in which the globe 5 is located viewed from the cap 81 is referred to as one end side and a direction in which the cap 81 is located viewed from the globe 5 is referred to as the other end side.

[0011] The thermal radiator 1 is a hollow case made of a material excellent in heat conductivity such as aluminum, ceramics, or resin and having an opening on the one end side. A flat board attaching section 11 is formed around the opening on the one end side of the thermal radiator 1. A peripheral wall 12 projecting in one end direction is formed around the board attaching section 11. A ring-like projecting wall 13 projecting in an inner space direction is formed on the peripheral wall 12. A ring-like groove 14 is formed between the projecting wall 13 and the board attaching section 11. On the projecting wall 13, four cutouts 15 are formed at 90-degree intervals. The cutouts 15 are connected to the ring-like groove 14. On an inner space side of the thermal radiator 1, three boss sections 16 projecting in the center direction from the inner wall of the thermal radiator 1 are formed at 120-degree intervals. The boss sections 16 and a surface on the one end side of the board attaching section 11 are formed in a same plane. Screw holes 17 are formed on the one end side of the boss sections 11.

[0012] The thermal radiation plate 2 is a thin plate made of a material excellent in heat conductivity such as aluminum. A through-hole is formed in the center of the thermal radiation plate 2. In an inner wall portion in the through-hole, four projecting sections 21 projecting in the center direction are formed at 90-degree intervals. Screw holes (not shown in the figure) are formed in the projecting sections 21. In the thermal radiation plate 2, screw holes (not shown in the figure) are formed in outer positions corresponding to the screw holes 17 of the thermal radiator 1. The thermal radiation plate 2 is heat-conductively attached to the board attaching section 11 by screwing screws 22 into the screw holes.

[0013] The board 3 is a thin plate made of a material excellent in heat conductivity such as aluminum or ceramics. A through-hole is formed in the center of the board 3. In an inner wall portion in the through-hole, four projecting sections 31 projecting in the center direction are formed at 90-degree intervals like the projecting sections 21 of the thermal radiation plate 2. In the projecting sections 31, cutouts (not shown in the figure) for inserting screws are formed to correspond to the screw holes of the projecting sections 21 of the thermal radiation plate 2. The board 3 is heat-conductively attached to the thermal radiation plate 2 by screwing screws 32 into the cutouts and the screw holes. A connector receiving section 33 is provided on the one end side of the board 3. The through-holes of the board 3 and the thermal radiation plate 2 are, for example, the same diameter and are communicate with the thermal radiator 1, which is the hollow case.

[0014] The LED 4 is a semiconductor light-emitting element called light-emitting diode. Specifically, the LED 4 is a light-emitting diode formed by mounting a light-emitting chip, which emits blue light, in a package of resin or the like and covering the light-emitting chip with a yellow phosphor layer. In this embodiment, twenty-seven LEDs 4 are mounted in a circumferential shape along the through-hole at substantially equal intervals on the one end side of the board 3. The board 3, LEDs 4, wires (not shown) and connector receiving section 33 constitutes a light-emitting module.

[0015] The globe 5 is a transparent or milky-white translucent cover mainly made of polycarbonate. The globe 5 has a spherical shape and is joined in a maximum diameter section thereof. Specifically, a semispherical top section 51 and a diameter-expanded base section 52 are integrated by ultrasonic welding. On the inner side on the other end side of the base section 52 of the globe 5, four protrusions 53 having width slightly smaller than the cutouts 15 of the thermal radiator 1 are formed at 90-degree intervals. By turning the globe 5 in the groove 14 via the cutouts 15, the protrusions 53 are sandwiched by the board attaching section 11 and the projecting wall 13 and the globe 5 is held by the thermal radiator 1.

[0016] The insulating case 6 is a case made of a material excellent in electric insulation and having heat conductivity lower than heat conductivity of metal such as polybutylene terephthalate. The insulating case 6 includes a main body section 61 and a projecting section 62. The main body section 61 includes three concave sections 63 on the inner space side thereof at 120-degree intervals. The concave sections 63 correspond to the boss sections 16. That is, the concave sections 63 fit in the boss sections 16, whereby the main body section 61 is arranged in the inner space of the thermal radiator 1. In the main body section 61, opposed walls 64 are formed in the inner space side thereof. A pair of opposed walls 64 is formed. A line connecting spaces between the opposed walls 64 deviates from the center of the main body section 61. The projecting section 62 is formed on the other end side of the main body section 61 and arranged to project to the outside from the opening on the other end side of the thermal radiator 1. A spiral protrusion 65 is formed in an outer surface portion projecting from the thermal radiator 1.

[0017] The lighting circuit 7 is a circuit for supplying desired electric power to the light-emitting module of the LEDs 4 and is housed on the inside of the insulating case 6. The lighting circuit 7 includes a circuit board 71 in which a predetermined metal wire is provided on a board having electric insulation such as epoxy, circuit components 72 mounted on the circuit board 71, and a connector 73 connected to the connector receiving section 33. The circuit components 72 include a heat generating component 721 such as a switching element such as a transformer or an FET and a non-heat generating component 722 such as a capacitor that generates relatively little heat compared with the heat generating component 721. The circuit board 71 is held by the pair of opposed walls 64 of the insulating case 6, whereby the lighting circuit 7 is arranged on the inside of the insulating case 6 such that a surface thereof on which the circuit components 72 are mounted extends along a lamp axis. In this case, at least the heat generating component 721 is located in the area of the through-hole of the board 3 when the thermal radiator 1 is viewed from the one end side.

[0018] The cap 81 is a power-supply section mounted on a socket of a device. The cap 81 is provided at the other end of the lamp and electrically connected to the lighting circuit 7. The cap 81 includes a spiral section, which is a spiral metal portion formed on the side surface of the cap 81, an eyelet, which is a metal portion formed on the bottom surface of the cap 81, and an insulating section (not shown in the figure), which is a portion provided between the spiral section and the eyelet and electrically insulating the spiral section and the eyelet from each other.

[0019] The insulating ring 82 is a ring-like member made of a member having insulation. The insulating ring

82 is provided in the outer circumferential section of the projecting section 62 of the insulating case 6 to be located between the thermal radiator 1 and the cap 81.

[0020] According to this embodiment, it is possible to reduce the temperature of the lighting circuit.

[0021] In the lamp in this embodiment, when alternating-current power is supplied to the cap 81 by an external power supply, the alternating-current power is rectified and DC-DC converted by the lighting circuit 7. Direct-current power is supplied to the LEDs 4. The LEDs 4 are lit by the supply of the direct-current power. According to the lighting, the LEDs 4 and the lighting circuit 7 generate heat. The heat generated by the LEDs 4 is conducted to the thermal radiator 1 via the board 3 and the thermal radiation plate 2 and radiated. However, since the through-holes are provided in the centers of the thermal radiation plate 2 and the board 3, the heat is conducted only in the outer side direction and is not conducted in the center direction. That is, since the heat generating component 721 of the lighting circuit 7 is located in the area of the through-hole of the board 3 when the thermal radiator 1 is viewed from the one end side, the heat of the LEDs 4 is not conducted to the heat generating component 721 via the board 3 and the heat radiation plate 2. A temperature rise of the heat generating component 721 can be suppressed. Further, since the temperature in the space in the globe 5 is relatively low even during the lighting, the heat generating component 721 can be cooled via the through-holes. Therefore, the temperature of the lighting circuit 7 during the lighting drops and the life of the lighting circuit 7 can be extended.

[0022] FIGS. 4A to 4C are diagrams for explaining a difference between the temperature of the lighting circuit of the lamp in the embodiment and the temperature of a lighting circuit of a lamp in the past. FIG. 4A is a lamp in the past (a past example 1) in which the board 3 mounted with the LEDs 4 is arranged in the center of the thermal radiation plate 2 without a through-hole. FIG. 4B is a lamp in the past (a past example 2) in which the board 3 mounted with the LEDs 4 in a circumferential shape is arranged on the thermal radiation plate 2 without a through-hole. FIG. 4C is a lamp (an example) in this embodiment. The temperature of the lighting circuit 7 during the lighting is indicated by the density of dots. Higher density means higher temperature. Note that the number of mounted LEDs and input power are the same. In all FIGS. 4A to 4C, the width W of the circuit board 71 is 45.6 mm. The size L of the through-hole of the board 3 in FIG. 4C is 43 mm.

[0023] It is seen from a result that, in the lamp of the example, compared with the lamps of the past examples 1 and 2, the temperature of the lighting circuit 7 during the lighting is generally low. Specifically, with respect to the lamp of the past example 1, the temperature at an LED side point A on the lighting circuit 7 was -0.5°C in the past example 2 and was not greatly different from the temperature in the lamp of the past example 1. On the other hand, in the lamp of the example of FIG.4C, the temperature greatly dropped to -7.7°C. The temperature at a cap side point B on the lighting circuit 7 was -0.2°C in the past example 2 and was not greatly different from the temperature in the lamp of the past example 1. On the other hand, in the lamp of the example, the temperature greatly dropped to -4.7°C. This is because, as explained above, since the most part of the lighting circuit 7 is located in the area of the through-holes of the thermal radiation plate 2 and the board 3, the heat of the LEDs 4 was suppressed from being conducted to the lighting circuit 7 via the board 3 and the thermal radiation plate 2 and the lighting circuit 7 was exposed to a relatively low-temperature atmosphere in the globe 5 to be cooled. In this way, when the thermal radiator 1 is viewed from the one end side, the heat generating component 721 of the lighting circuit 7 is arranged in the area of the through-hole of the board 3. Therefore, it is possible to markedly suppress a temperature rise of the lighting circuit 7.

[0024] A temperature difference of the lighting circuit 7 when size L of the through-holes of the thermal radiation plate 2 and the board 3 and width W of the circuit board 71 are changed is explained with reference to FIG. 5. The temperature difference is the difference as compared with the temperatures at points A and B in the lamp shown in FIG. 4B in which through-holes are not formed in the thermal radiation plate 2 and the board 3.

[0025] It is seen from a result that, as L/W is larger, the temperatures drop more at both the points A and B. This is because, if L/W is small, heat is easily conducted to the circuit board 71 via the LEDs 4, the board 3, and the thermal radiation plate 2 and a cooling effect by a relatively low-temperature atmosphere in the globe 5 is deteriorated. If L/W is equal to or larger than 0.6, the temperature difference tends to be larger. Therefore, L/W is desirably equal to or larger than 0.6 and more desirably equal to or larger than 0.75. As L/W is larger, the effect is higher. However, if L/W is too large, a place for arranging the LEDs 4 cannot be secured or the circuit board 71 is reduced in size and the arrangement of the circuit components 72 is made difficult. Therefore, L/W is desirably equal to or smaller than 1.4.

[0026] In the first embodiment, the through-hole is formed in the center of the board 3. The plurality of semiconductor light-emitting elements are provided on the one end side of the board 3 and in the circumferential shape to extend along the through-hole, namely, in the circumferential shape around the through-hole. The lighting circuit 7 including the circuit board 71 and the circuit components 72 including the heat generating component 721 mounted on the circuit board 71 is provided inside the thermal radiator 1 such that the heat generating component 721 is located in the area of the through-hole when the thermal radiator 1 is viewed from the one end side. Consequently, it is possible to suppress a temperature rise of the lighting circuit 7, in particular, the heat generating component 721. When the size of the through-holes is represented as L (mm) and the width of the circuit board 71 is represented as W (mm), the effect can be further improved by setting L/W to be equal to or larger than 0.6. Note that this effect can also be obtained if the thermal radiation plate 2 having the same through-hole is interposed between the thermal radiator 1 and the board 3 or the thermal radiation plate 2 is omitted and the board 3 is directly attached to the board attaching section 11 of the thermal radiator 1 by screws or the like.

Second Embodiment

[0027] FIG. 6 is a diagram for explaining a lamp in a second embodiment of the present invention. Components in the second embodiment same as the components in the first embodiment are denoted by the same reference numerals and signs and explanation of the components is omitted.

[0028] In this embodiment, a cover member 9 is provided in the through-hole of the board 3. The cover member 9 is a member made of resin having heat conductivity lower than the heat conductivity of the thermal radiation plate 2 and the board 3, for example, heat conductivity equal to or lower than 0.5 W/mK. The cover member 9 desirably has high reflectivity. Consequently, whereas a loss of light could occur if the thermal radiation plate 2 and the board 3 are hollow, it is possible to reflect the light on the cover member 9 and improve efficiency of use of the light. Further, it is possible to suppress, even if the lamp is used with the cap 81 faced up, foreign matters from dropping to the globe 5 from the lighting circuit 7 portion to hinder light emission.

[0029] In this embodiment, the cover member 9 includes attaching sections 91 and a convex section 92. The attaching sections 91 are portions including screw holes and screwed by the screws 32 together with the screw holes of the projecting sections 21 of the thermal radiation plate 2 and the projecting sections 31 of the board 3. The convex section 92 is a portion projecting in the direction of the cap 81 from the attaching sections 91. A flat portion, which is the bottom of the convex section 92, is located near the one end side of the lighting circuit 7 through the through-holes of the thermal radiation plate 2 and the board 3. In this shape, since a relatively low-temperature atmosphere in the globe 5 is easily conducted to the lighting circuit 7 by the convex section 92. Therefore, as in the first embodiment, it is possible to suppress a temperature rise of the lighting circuit 7.

[0030] FIGS. 7A to 7C are diagrams for explaining a temperature change of the lighting circuit when the shape of the cover member 9 is changed in the lamp in the second embodiment. In FIG. 7A, the cover member 9 having a flat shape is used. In FIG. 7B, the cover member 9 projecting in the direction of the globe 5 is used. In FIG. 7C, the cover member 9 projecting in the direction of the cap 81 is used.

[0031] As it is seen from the figures, in the lamp shown in FIG. 7C, the temperature of the lighting circuit decreases compared with FIGS. 7A and 7B. Compared with the lamp in FIG. 4C, the temperature at an LED side point A on the lighting circuit 7 was +5°C in FIG. 7A, +4.7°C in FIG. 7B, and +1.8°C in FIG. 7C and the temperature at a cap side point B was +2.7°C in FIG. 7A, +2.7°C in FIG. 7B, and +1.7°C in FIG. 7C. That is, with the shape shown in FIG. 7C, it is possible to suppress a temperature rise of the lighting circuit 7 to the same degree as in the first embodiment. In particular, if a distance D between the convex section 92 and the circuit board 71 is set to be equal to or smaller than 3 mm and, optimally, set to allow the convex section 92 and the circuit board 71 to come into contact with each other, it is possible to reduce the temperature of the lighting circuit 7. As the cover member 9, for example, polycarbonate having thickness of 1 mm was used.

[0032] In the second embodiment, since the cover member 9 is provided in the through-hole of the board 3, it is possible to improve efficiency of use of light. Further, it is possible to suppress adhesion of foreign matters to the globe 5. It is desirable the cover member 9 has heat conductivity lower than the board 3 and/or thermal radiation plate 2.

[0033] The convex section 92 is provided in the cover member 9. The convex section 92 is projected in the direction of the cap 81 and located near the lighting circuit 7. Therefore, in addition to the effects explained above, it is possible to suppress a temperature rise of the lighting circuit 7 to the same degree as in the first embodiment. It is possible to further suppress the temperature rise by setting the distance D between the convex section 92 and the circuit board 71 to be equal to or smaller than 3 mm.

[0034] The present invention is not limited to the embodiments and various modifications are possible.

[0035] For example, the shape of the through-holes of the board 3 and the thermal radiation plate 2 is not limited to a circular shape and may be a polygonal shape.

[0036] Silicone resin may be filled in all or a part of the inside of the insulating case 6 in which the lighting circuit 7 is arranged. Consequently, it is possible to further suppress the temperature rise of the lighting circuit 7. As shown in FIG. 8, silicone resin 74 is filled on the inside of the projecting section 62 of the insulating case 6. Consequently, it is possible to expect a temperature reduction effect of about 5°C compared with a temperature reduction effect attained when the silicone resin is not filled.

[0037] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

Claims

1. A lamp comprising:

    a hollow case opened on one end side;
    a board having a through-hole in a center and provided on the one end side of the case;
    a plurality of semiconductor light-emitting elements provided on one end side of the board and in a circumferential shape to extend along the through-hole;
    a lighting circuit including a circuit board and circuit components including a heat generating component mounted on the circuit board, the lighting circuit being provided inside the case such that the heat generating component is located in an area of the through-hole when the case is viewed from the one end side; and
    a power-supply section provided on the other end side of the case.

2. The lamp according to claim 1, wherein, when size of the through-hole is represented as L (mm) and width of the circuit board is represented as W (mm), L/W is equal to or larger than 0.6.

3. The lamp according to claim 1 or 2, wherein the board is provided on a heat radiation plate, and the heat radiation plate has a through-hole in a center and is provided on the one end side of the case such that the through-hole of the thermal radiation plate and the through-hole of the board communicate with each other.

4. The lamp according to claim 3, wherein a cover member having heat conductivity lower than the board is provided in the through-hole, the cover member includes a convex section, and the convex section projects in a direction of the power-supply section and is located near the lighting circuit.

5. The lamp according to any one of claims 1 to 4, wherein the circuit board is arranged on the inside of the case such that a surface thereof on which the circuit components are mounted extends along a lamp axis, and a distance D between the convex section and the circuit board is equal to or smaller than 3 mm.

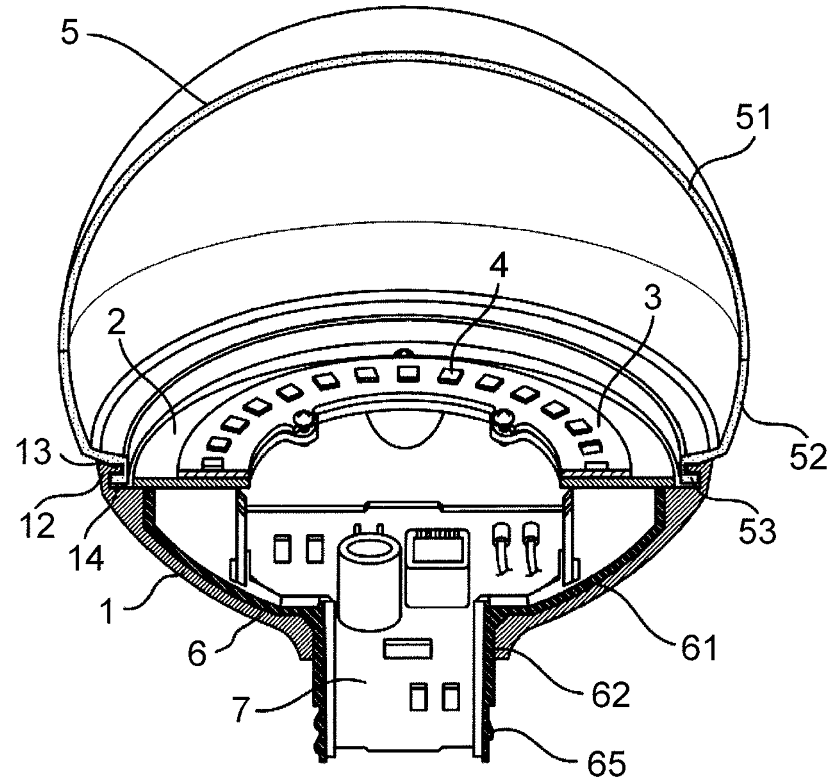


FIG. 1

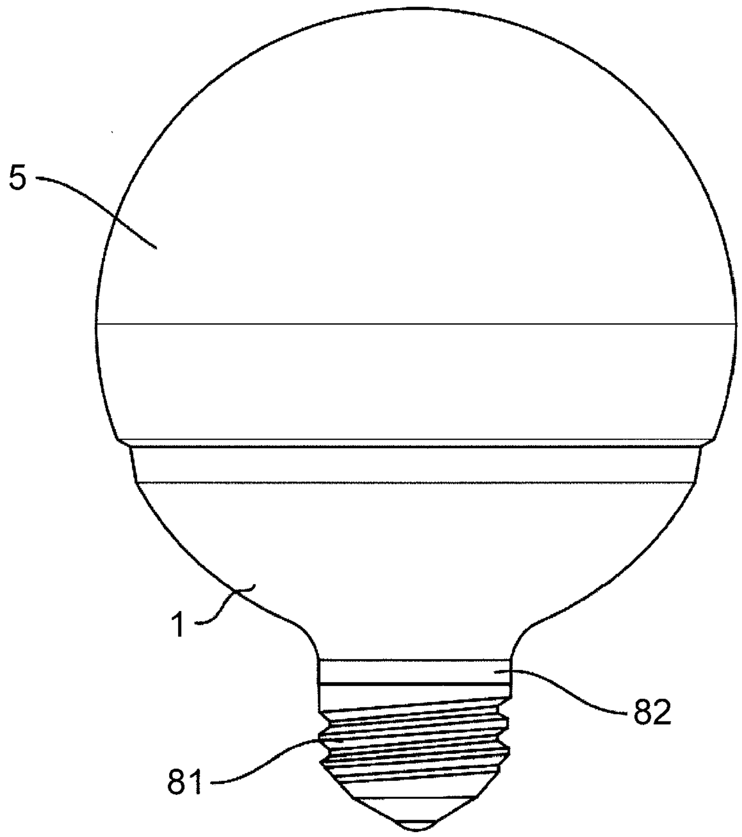
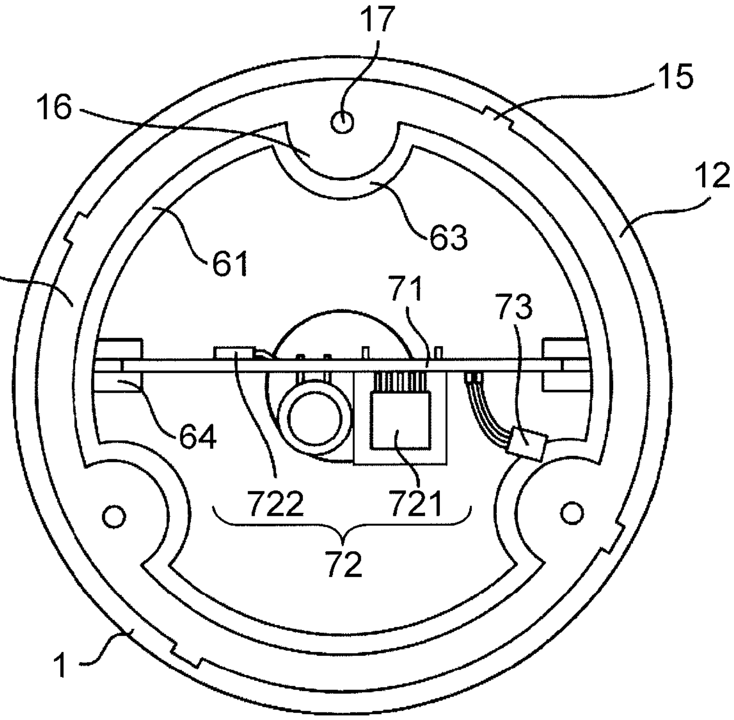


FIG. 2


17
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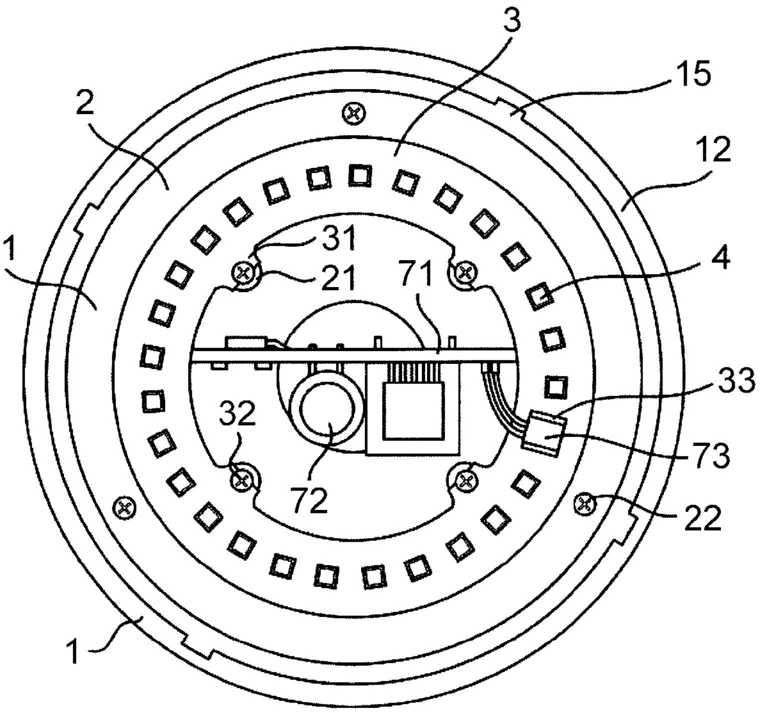
72
1

FIG. 3A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31
21
71
4
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22
1

FIG. 3B

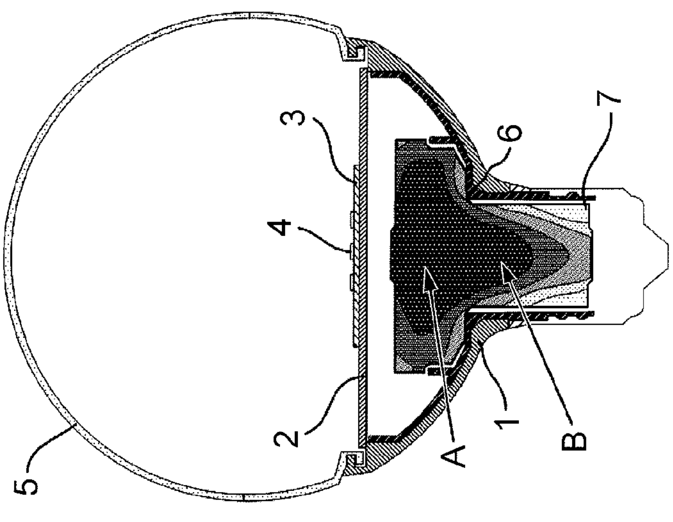

FIG. 4A

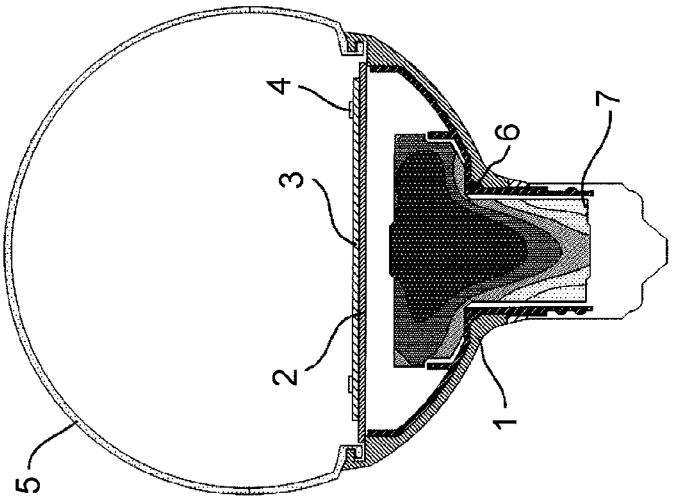

FIG. 4B

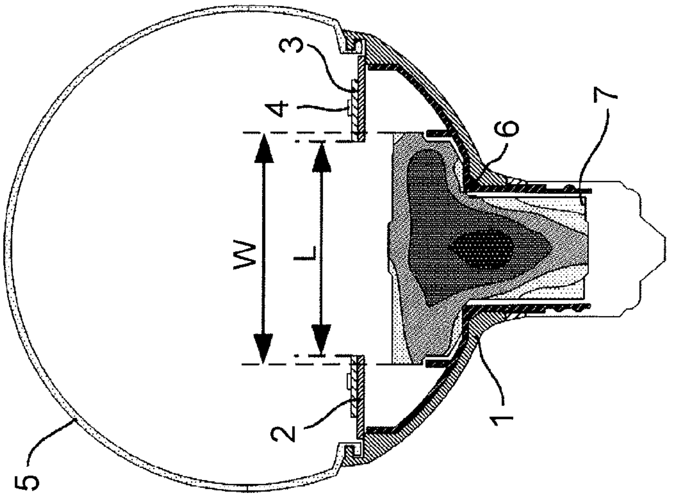

FIG. 4C

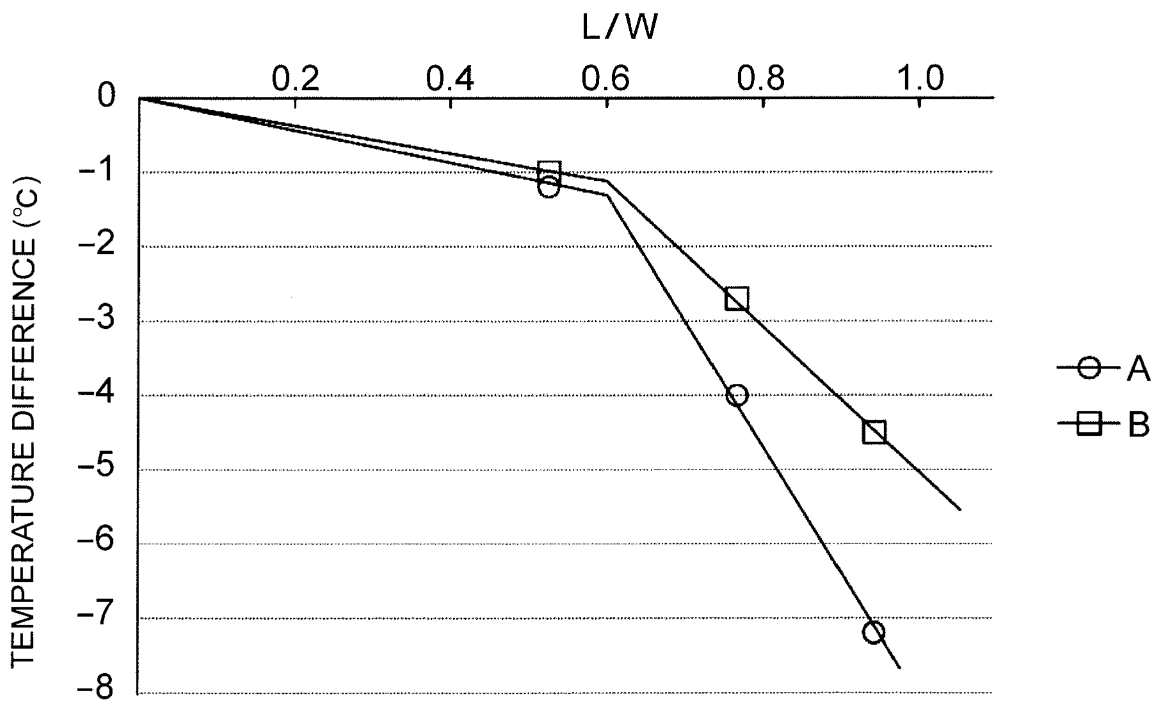

FIG. 5

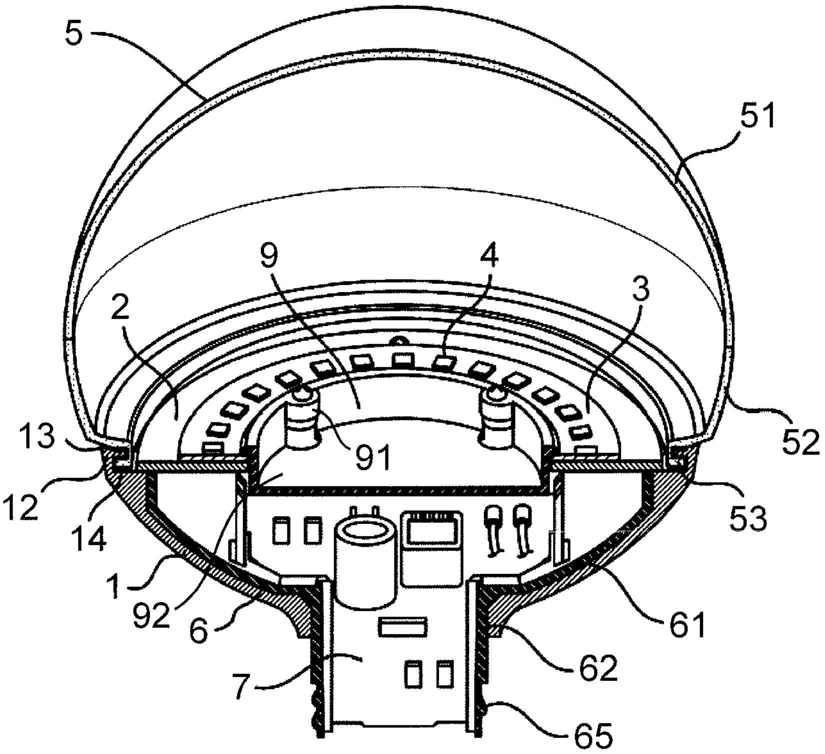

FIG. 6

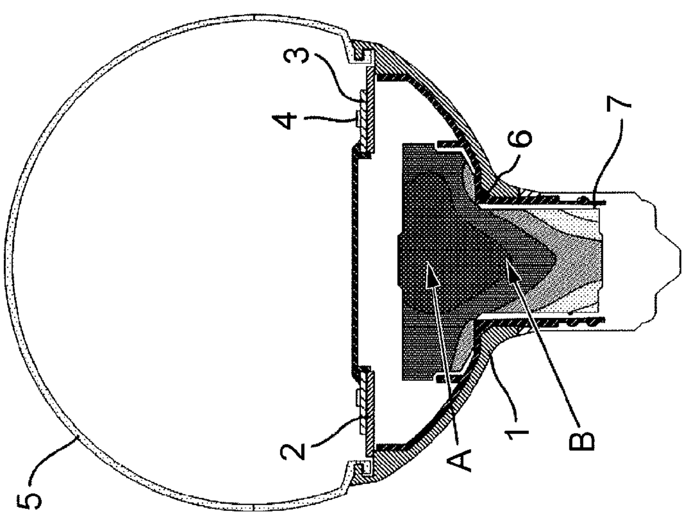

FIG. 7A

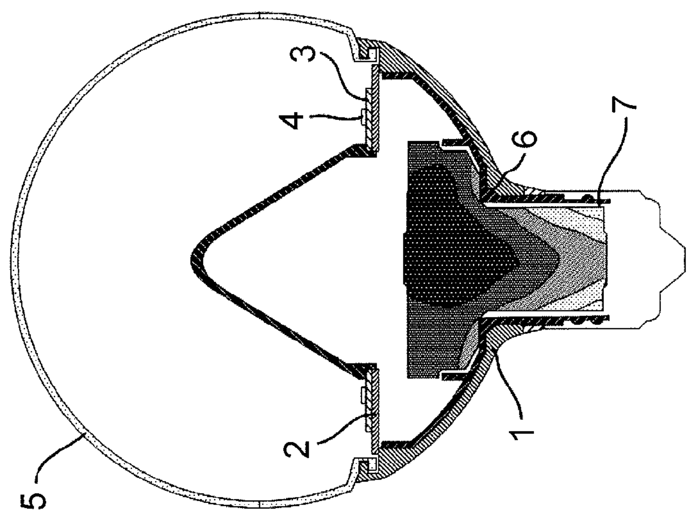

FIG. 7B

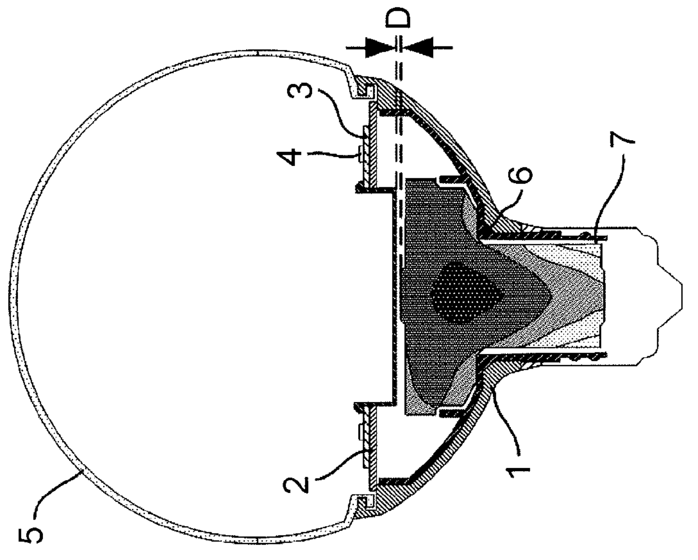

FIG. 7C

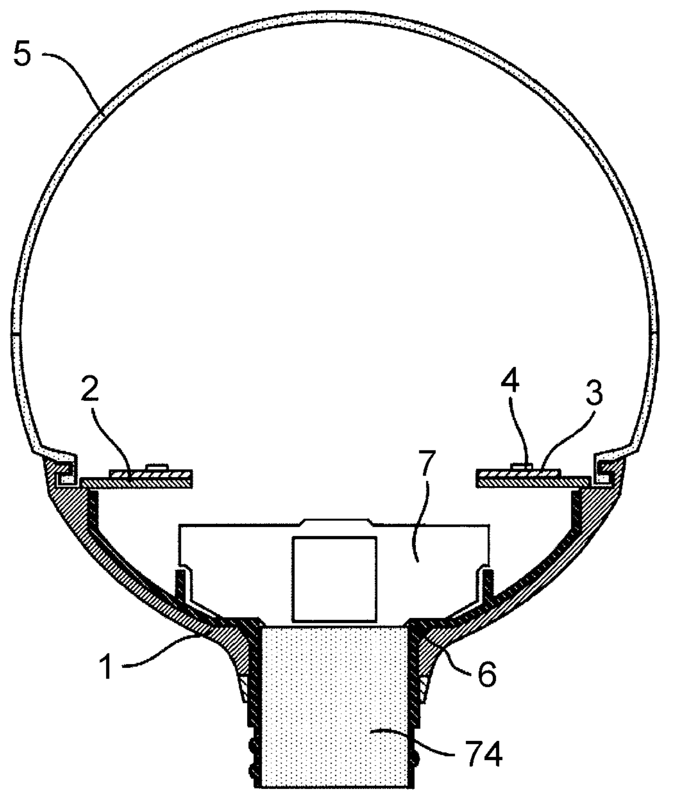

FIG. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 14 18 3423

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2012/287632 A1 (TAKAHASHI KENJI [JP] ET AL) 15 November 2012 (2012-11-15) * paragraph [0045] - paragraph [0074] * * paragraph [0097] - paragraph [0101] * * paragraph [0113] - paragraph [0114] * * paragraph [0117] - paragraph [0120] * * paragraph [0136] - paragraph [0138] * * figures 7, 9, 16 * -----	1-3	INV. F21K99/00 F21V23/00 F21V29/508 ADD. F21Y101/02 F21Y103/02
X	US 2012/025706 A1 (WANG CHUN-YUAN [TW] ET AL) 2 February 2012 (2012-02-02) * paragraph [0026] - paragraph [0034] * * figures 1A, 1B * -----	1,3	
X	DE 10 2011 005597 A1 (OSRAM AG [DE]) 20 September 2012 (2012-09-20) * paragraph [0046] - paragraph [0051] * * figure 1 * -----	1,3	
X	US 8 282 250 B1 (DASSANAYAKE MAHENDRA [US] ET AL) 9 October 2012 (2012-10-09) * column 3, line 7 - column 6, line 9 * * figures 1, 2A, 2B * -----	1,3	TECHNICAL FIELDS SEARCHED (IPC) F21K F21Y F21V

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	3 February 2015	Demirel, Mehmet

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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