(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
12 June 2014 (12.06.2014)

WIPO | PCT

(10) International Publication Number
WO 2014/086782 A1

(51) International Patent Classification:
F21V 5/04 (2006.01) *F21K 99/00* (2010.01)
F21V 7/04 (2006.01) *F21Y 101/02* (2006.01)

(21) International Application Number: PCT/EP2013/075395

(22) International Filing Date: 3 December 2013 (03.12.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
201210513341.X 4 December 2012 (04.12.2012) CN

(71) Applicant: **OSRAM GMBH** [DE/DE]; Marcel-Breuer-Straße 6, 80807 München (DE).

(72) Inventors: **LIN, XueQin**; 28/F, Harbour Ring Plaza, 18 Xi Zang (M.) Road, Shanghai 200001 (CN). **CHENG, YingJun**; 28/F, Harbour Ring Plaza, 18 Xi Zang (M.) Road, Shanghai 200001 (CN).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) Title: LENS, OMNIDIRECTIONAL ILLUMINATING DEVICE HAVING THE LENS AND RETROFIT LAMP

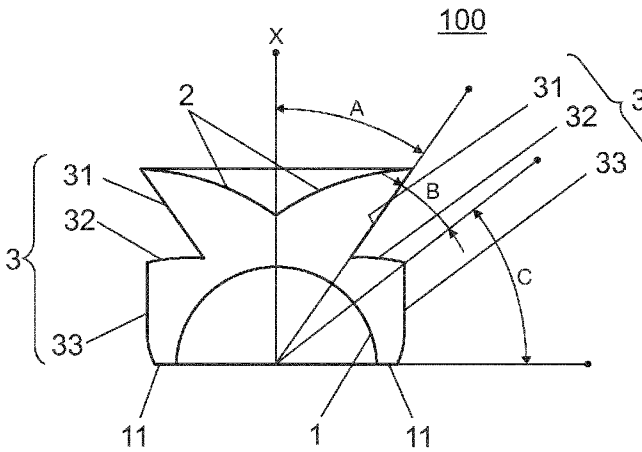

Figure 1

(57) Abstract: The present invention relates to a lens (100) for an omnidirectional illuminating device, characterized in that the lens (100) is rotationally symmetrical about a central axis (X) and comprises an incident surface (1), a reflection surface (2) and an emergent surface (3) that are rotationally symmetrically configured, respectively, wherein a first part of light (A) from a light source of the omnidirectional illuminating device forms first emergent light (A') after being incident through the incident surface (1) and reflected by the reflection surface (2), and emerging through the emergent surface (3), a second part of light (B) from the light source forms second emergent light (B') after being incident through the incident surface (1) and emerging through the emergent surface (3), and a third part of light (C) from the light source forms third emergent light (C') after being incident through the incident surface (1) and emerging through the emergent surface (3), wherein the first emergent light (A'), the second emergent light (B') and the third emergent light (C') jointly form omnidirectional illumination. In addition, the present invention also relates to an omnidirectional illuminating device having the lens and also a retrofit lamp.

WO 2014/086782 A1

Description

Lens, Omnidirectional Illuminating device Having the Lens and Retrofit Lamp

Technical Field

The present invention relates to a lens for an omnidirectional illuminating device. In addition, the present invention further relates to an omnidirectional illuminating device having the lens and a retrofit lamp.

Background Art

With the advantages of long life, energy saving, environmental friendliness and shake-resistance, the LED light sources can be applied in a wide area. With the continuous development of manufacture technology, the cost of the LEDs becomes back and back, and the optical efficiency is also increased. It has been a trend that solid-state lighting (SSL) replaces the traditional lighting devices.

The US Energy Star Standard has certain requirements for omnidirectional SSL replacement lamps. Within a 0°-135° zone, luminous intensity at any angle shall not differ from the mean luminous intensity for the 0°-135° zone by more than 20%. Luminous flux within 135°-180° zone shall occupy at least 5% of the total luminous flux. Measurement results should be the same in vertical planes at 45° and 90° from the initial plane. Most of the LED intensity distribution is lambertian rather than uniform, so secondary optical design is indispensable. For SSL replacement lamps, in order to meet those requirements, it usually needs to design optical components to redistribute light.

In the prior art, there are many solutions to get light source redistribution for LED lamps. The first solution is optimizing LED array, and the second solution is using reflector to redistribute light.

In the field of illuminating device, an omnidirectional illuminating device can realize an illumination effect in a large area, and thus has a large prospect of application. A class of illuminating devices among the prior omnidirectional illuminating devices has a three-dimensional light source such as an array of LED chips directly arranged at the center of a lamp housing, and such light sources arranged in a cylindrical or disc array can illuminate in a circumferential direction of 360°. Light emitted from the light source directly emerges through the lamp housing, thus simple omnidirectional illumination effect is realized. Such omnidirectional illuminating device is, for example, disclosed by EP2180234A1 and WO2009/091562A2. However, when one or more light sources of the light source array are broken, the omnidirectional illumination effect cannot be realized any more. Since it is necessary to mount a plurality of light sources in the illuminating device and electrically connect each of these light sources to a circuit board, the illuminating device consumes a large amount of electric energy and correspondingly generates too much heat. In order to improve the effect of radiating heat from the cylindrical light source array, it is for example possible to arrange, on an outer circumferential surface of the cylindrical light source array, a heat sink such as a plurality of heat sink ribs, which is, for example, disclosed in WO2010/058325A1. However, it requires high cost in both the manufacture or assembling and the use or maintenance of the above illuminative device. Another kind of omnidirectional illuminating device realizes the omnidirectional illumination effect by using the reflection principle. Patent Document WO2009/059125A1 discloses an illuminating device, in which a single light source is arranged in a bottom region of a basin-shaped reflector so that light can be reflected by means of a reflective surface of the reflector toward an area as large as possible, while the reflector must be ensured to have a large enough reflective surface. Hence, such illuminating device has a large volume.

Summary of the Invention

In order to solve the above technical problems, the present invention provides a lens for an omnidirectional illuminating device. With use of the lens, omnidirectional illumination can be realized using a single light source, and the lens according to the present invention has a low manufacturing cost, a simple manufacturing process and uniform light distribution. In addition, the present invention further provides an omnidirectional illuminating device having the lens of such type and a retrofit lamp.

The first object of the present invention is accomplished via a lens for an omnidirectional illuminating device. The lens is rotationally symmetrical about a central axis and comprises an incident surface, a reflection surface and an emergent surface that are rotationally symmetrically configured, respectively, wherein a first part of light from a light source of the omnidirectional illuminating device forms first emergent light after being incident through the incident surface and reflected by the reflection surface, and emerging through the emergent surface, a second part of light from the light source forms second emergent light after being incident through the incident surface and emerging through the emergent surface, and a third part of light from the light source forms third emergent light after being incident through the incident surface and emerging through the emergent surface, wherein the first emergent light, the second emergent light and the third emergent light jointly form omnidirectional illumination. In solutions of the present invention, the light source of the omnidirectional illuminating device is configured as a point light source. In a hemispherical region in the light emission direction, three emission areas are divided at one side of the optical axis. With the lens according to the present invention, light in the three emission areas is refracted to three corresponding illuminated target areas, and the three target areas jointly form one illuminated region. As a result, viewed from the whole, light emitted emerging through the lens realizes the omnidirectional illumination in a three-dimensional space.

According to the present invention, the emergent surface comprises a first emergent surface, a second emergent surface and a third emergent surface, wherein the first emergent light is formed after refracted by the first emergent surface, the second emergent light is formed after refracted by the second emergent surface and the third emergent light is formed after refracted by the third emergent surface. In solutions of the present invention, the emergent surface plays an important role in angle distribution of light, and the emergent light can be adjusted by modifying the emergent surface so as to light a predetermined area.

Preferably, the first emergent light illuminates part of a region of a back hemisphere of a illuminated space, at least the second emergent light illuminates part of regions of an front hemisphere and the back hemisphere of a illuminated space, and at least the third emergent light illuminates part of a region of the front hemisphere of a illuminated space. The so-called omnidirectional illumination is a type of illumination in a three-dimensional space of 360°, thus the three-dimensional space is divided into two hemispheres of

180°. The light source is located in sphere centers of the two hemispheres, and the hemisphere of 180° corresponding to light emergent direction of the light source is set as the front hemisphere and the opposite hemisphere back to the light source is set as the back hemisphere. In solutions of the present invention, the first emergent light, the second emergent light and the third emergent light illuminate different areas of the front and back hemispheres, respectively, and even partially overlap so as to realize omnidirectional illumination in the three-dimensional space.

Advantageously, the lens comprises a bottom surface, a top surface and a side surface joining the top surface and the bottom surface, the top surface is formed by the reflection surface, the bottom surface comprises the incident surface located in a center of the bottom surface and a support surface surrounding the incident surface, and the side surface is formed by the first emergent surface, the second emergent surface and the third emergent surface.

Further according to the present invention, the first emergent surface, the second emergent surface and the third emergent surface are connected in sequence in a direction from the top surface to the bottom surface. The first emergent surface extends from an edge of the top surface to the bottom surface in a direction close to the central axis, and cooperates with the reflection surface so as to enable the light emerging from the first emergent surface to illuminate the area of the back hemisphere. The second emergent surface extends from the first emergent surface in a direction away from the central axis. It should be noted herein that attention should be paid, when configuring dimensions and profiles of the first emergent surface and the second emergent surface, that light emerging from the first emergent surface should not be blocked by the second emergent surface so as not to affect the omnidirectional illumination effect. In addition, the third emergent surface extends from the second emergent surface to the bottom surface.

According to the present invention, the reflection surface forms a region recessed towards the bottom surface, and a curve of the reflection surface in cross section is bent in a direction away from the bottom surface. Viewed from the whole, the reflection surface is formed into a shape of funnel, while a circumferential wall of the funnel is not straight but bent in a direction away from the bottom surface. Such bent reflection surface makes sure that incident light, as reflected thereby and emerging through the first emergent surface, can illuminate towards the direction of the back hemisphere.

Preferably, the reflection surface, the second emergent surface and the third emergent surface in cross sections are defined by spline curves. The reflection surface, the second emergent surface and the third emergent surface are formed by rotating spline curved. According to requirements of light distribution, simulated reflection surface, second emergent surface and third emergent surface are generated with an existing computer, and then a plurality of points which are taken from the simulated surfaces are connected with smooth curves to form the spline curves.

Further preferably, the incident surface is configured as a hemispherical surface, wherein a sphere center of the hemispherical surface is configured as a mounting point of the light source of the omnidirectional illuminating device. Therefore, each beam of light emitted from the light source, after being incident on the incident surface, can propagate inside the lens without changing direction.

Advantageously, the first emergent surface in cross section is defined by a straight line. In other solutions of the present invention, the first emergent surface in cross section also can be defined by a curve. However, no matter in the case of the curve or the straight line, cooperation between the first emergent surface and the reflection surface should be ensured to guarantee generation of the first emergent light illuminating the back hemisphere.

Advantageously, the support surface in cross section is defined by a straight line. The lens according to the present invention is usually fabricated on a circuit board which often has a flat surface, thus, the support surface configured in such a manner is favorable for fixation on the circuit board. In other embodiments of the present invention, a lock structure also can be configured on the support surface to be engaged with a groove or a notch correspondingly configured on the circuit board.

Preferably, the reflection surface is configured as a total internal reflection surface. The total internal reflection surface reduces the light loss to the greatest extent and the manufacture cost of the lens significantly. Of course, optionally, the reflection surface is formed by coating a mirror reflection material on the top surface.

According to a second aspect of the present invention, an omnidirectional illuminating device comprising a directional light source and a lens having the above features is provided, so as to omnidirectionally distribute light from the directional light source by using the lens.

Preferably, the heat sink comprises a body and a plurality of fins extending from the body, the body has one end carrying the light source, and the lens covers the light source. The body is designed, for example, as a hollow cylinder in which other members can be contained. The fins can be arranged, in one piece or as additional members, on the body. The fins also may be formed as structures for supporting and/or limiting the lens or the light source in a circumferential direction.

Preferably, the bulb and the heat sink are in fixed connection and jointly define a cavity for accommodating the light source and the lens.

Preferably, the body has the other end in connection with the lamp holder. Thus, a current can be supplied to the light source.

Besides, the present invention further relates to a retrofit lamp characterized by comprising the omnidirectional illuminating device as described above, wherein a light source of the omnidirectional illuminating device is an LED chip. The retrofit lamp according to the present invention has the advantages of a low manufacturing cost, a simple manufacturing process, uniform light distribution, and omnidirectional illumination realized at the same time.

It should be understood that the general descriptions above and detailed descriptions below are only illustrative for the purpose of further explaining the claimed present invention.

Brief Description of the Drawings

The accompanying drawings constitute a part of the present 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 by the same reference numbers. In the drawings,

Fig. 1 is a cross sectional view of a lens according to the present invention;

Fig. 2 is a spatial distribution diagram of light emitted from a light source;

Fig. 3 is a spatial distribution diagram of light emitted from the lens according to the present invention in a target area illuminated;

Fig. 4 is a schematic diagram of the lens according to the present invention viewed in a first direction;

Fig. 5 is a schematic diagram of the lens according to the present invention viewed in a second direction;

Fig. 6 is an optical path diagram of first emergent light emitted from the lens according to the present invention;

Fig. 7 is an optical path diagram of second emergent light emitted from the lens according to the present invention;

Fig. 8 is an optical path diagram of third emergent light emitted from the lens according to the present invention;

Fig. 9 is an optical path diagram of light emitted from one side of the lens according to the present invention;

Fig. 10 is an overall optical path diagram of light emitted from the lens according to the present invention;

Fig. 11 is a distribution chart of light intensity of light emitted from the lens according to the present invention; and

Fig. 12 is a cross sectional view of an illuminating device according to the present invention.

Detailed Description of the Embodiments

In the following detailed description, reference is made to the accompanying drawings, which form a part hereof, and in which is shown by way of illustration specific embodiments in which the invention may be practiced. In this regard, directional terminology, such as "top", "bottom", "front", "back", "left", "right", is used in reference to the orientation of the figures being described. Because components of embodiments of the present invention can be positioned in a number of different orientations, the directional terminology is used for purposes of illustration and is in no way limiting. It is to be understood that other embodiments may be utilized and structural or logical changes may made without departing from the scope of the present invention. The following detailed description, therefore, is not to be taken in a limiting sense, and the scope of the present invention is defined by the appended claims.

Fig. 1 is a cross sectional view of a lens 100 according to the present invention. It can be seen from the figure that the lens 100 is rotationally symmetrical about a central axis X and comprises an incident surface 1, a reflection surface 2 and an emergent surface 3 that are rotationally symmetrically configured, respectively. It can be seen further from Fig. 1 that the emergent surface 3 comprises a first emergent surface 31, a second emergent surface 32 and a third emergent surface 33.

As shown in Fig. 1, the lens 100 can comprise a bottom surface, a top surface and a side surface joining the top surface and the bottom surface, and the top surface is formed by the reflection surface 2. The bottom surface comprises the incident surface 1 located in a center of the bottom surface and a support surface 11 surrounding the incident surface 1. The side surface is formed by the first emergent surface 31, the second emergent surface 32 and the third emergent surface 33, and the first emergent surface 31, the second emergent surface 32 and the third emergent surface 33 are connected in sequence in a direction from the top surface to the bottom surface, wherein the first emergent surface 31 extends from an edge of the top surface to the bottom surface in a direction close to the central axis X, the second emergent surface 32 extends from the first emergent surface 31 in a direction away from the central axis X, and the third emergent surface 33 extends from the second emergent surface 32 to the bottom surface.

Besides, it can be seen from Fig. 1 that the reflection surface 2, the second emergent surface 32 and the third emergent surface 33 in cross sections are defined by spline curves. The incident surface 1 is configured as a hemispherical surface, wherein a sphere center of the hemispherical surface is configured as a mounting point of a light source, and the first emergent surface 31 and the support surface 11 in cross sections are defined by straight lines. In the present embodiment, the reflection surface 2 is configured as a total internal reflection surface. Of course, in other embodiments of the present invention, the reflection surface 2 is formed by coating a mirror reflection material on the top surface.

Furthermore, at the right side of the central axis X of the lens 100 shown in Fig. 1, the lens 100 is divided into three areas corresponding to light in three areas at the right side of an optical axis of the light source shown in Fig. 2, respectively. It should be emphasized herein that only areas at the right side of the central axis X are explained herein, while since the lens 100 according to the present invention is configured to be rotationally symmetrical, areas at the left side of the lens 100 are the same as that at the right side, and further illustration will not be made.

In conjunction with the spatial distribution diagram of light emitted from the light source shown in Fig. 2 and the spatial distribution diagram of light emitted from the lens 100 according to the present invention in a target area illuminated, a first part of light A from the light source forms first emergent light A' after being incident through the incident surface 1 and reflected by the reflection surface 2, and emerging through the emergent surface 3. A second part of light B from the light source forms second emergent light B' after being incident through the incident surface 1 and emerging through the emergent surface 3. A third part of light C from the light source forms third emergent light C' after being incident through the incident surface 1 and emerging through the emergent surface 3, wherein the first emergent light A', the second emergent light B' and the third emergent light C' jointly form omnidirectional illumination.

Fig. 4 is a schematic diagram of the lens 100 according to the present invention viewed in a first direction. The incident surface 1 of the lens cannot be observed in the angle shown in the figure. It can be seen from the figure that the lens 100 is formed by two parts in appearance, namely, a back lens region having a basically cylindrical profile located in a back part and an front lens region having a truncated conical shape located in an front part, wherein the front lens region having the truncated conical shape (i.e. top surface using a small area) is inverted over one end surface of the back lens region. In combination with Fig. 1, it can be seen that the top surface of the lens 100 forms the reflection surface 2 which forms a region recessed towards the bottom surface, and a curve of the reflection surface 2 in cross section is bent in a direction away from the bottom surface. Viewed from the whole, the reflection surface 2 is formed into a shape of funnel, while a circumferential wall of the funnel is not straight but bent in a direction away from the bottom surface. Such bent reflection surface 2 makes sure that incident light, as reflected thereby and emerging through the first emergent surface 31, can illuminate back sides of the lens.

Fig. 5 is a schematic diagram of the lens 100 according to the present invention viewed in a second direction. The incident surface 1 of the lens 100 can be seen from the figure, while the reflection surface 2 and the second emergent surface 32 of the lens 100 cannot be observed. In this figure, the back lens region is more similar to a hollow cylinder, but essentially, only a hemispherical cavity is formed in the back lens region. In addition, it also can be seen from the figure the support surface 11 formed in a circumferential direction of the hemispherical cavity. In practical assembling, the support surface 11 abuts against a circuit board or other flat mounting surface.

In the present embodiment, the first emergent light A′ is formed after refracted by the first emergent surface 31. Referring to the optical path diagram of the first emergent light A′ emitted from the lens 100 according to the present invention shown in Fig. 6, the first emergent light A′ illuminates part of a region of a back hemisphere. The second emergent light B′ is formed after refracted by the second emergent surface 32. In reference to the optical path diagram of the second emergent light B′ emitted from the lens 100 according to the present invention shown in Fig. 7, the second emergent light B′ illuminates part of regions of an front hemisphere and the back hemisphere. In addition, the third emergent light C′ is formed after refracted by the third emergent surface 33. Referring to the optical path diagram of the third emergent light C′ emitted from the lens 100 according to the present invention shown in Fig. 8, the third emergent light C′ illuminates part of the region of the front hemisphere. It should be indicated herein that the so-called omnidirectional illumination is a type of illumination in a three-dimensional space of 360°, thus the three-dimensional space is divided into two hemispheres of 180°. The light source is located in sphere centers of the two hemispheres, and the hemisphere of 180° corresponding to light emergent direction of the light source is set as the front hemisphere and the opposite hemisphere back to the light source is set as the back hemisphere. In solutions of the present invention, the first emergent light, the second emergent light and the third emergent light illuminate different areas of the front and back hemispheres, respectively, and even partially overlap so as to realize omnidirectional illumination in the three-dimensional space.

Fig. 9 is an optical path diagram of light emitted from one side of the lens 100 according to the present invention. It can be seen from the figure that the first emergent light A′, the second emergent light B′ and the third emergent light C′ have covered a large area at the right side of the central axis X.

Fig. 10 is an overall optical path diagram of light emitted from the lens 100 according to the present invention. It can be seen from the figure that most areas at both sides of the central axis X of the lens 100 are covered by emergent light. Fig. 11 is a distribution chart of light intensity of light emitted from the lens 100 according to the present invention. It can be seen from the figure that the lens 100 according to the present invention substantially covers a spatial area of 280°, which has met requirements of omnidirectional illumination in the conventional sense. In addition, it can be seen from the figure that areas covered by the light have substantially consistent light intensity, and only the light intensities in the area of -80° to -110° and the area of 80° to 110° are slightly strong, while such light intensities are not greater than that in other areas by 20%, which conforms to related criteria.

Fig. 12 is a cross sectional view of an omnidirectional illuminating device 200 according to the present invention. The omnidirectional illuminating device 200 is especially configured as a retrofit lamp. It can be seen from the figure that the omnidirectional illuminating device 200 comprises a bulb 2, a light source 5, a heat sink 6, a lamp holder 7 and the lens 100 of the above-mentioned type. It can be seen further from the figure that the heat sink 6 comprises a body 61 and a plurality of fins 62 extending from the body 61, wherein the body 61 has one end carrying the light source 5 and the other end in connection with the lamp holder 7, and the lens 100 covers the light source 5. In the retrofit lamp according to the present invention, the light source 5 is particularly configured as a single high-power LED chip.

The above is merely preferred embodiments of the present invention but not to limit the present invention. For the person skilled in the art, the present invention may have various alterations and changes. Any alterations, equivalent substitutions, improvements, within the spirit and principle of the present invention, should be covered in the protection scope of the present invention.

List of reference signs

1	incident surface
11	support surface
2	reflection surface
3	emergent surface
31	first emergent surface
32	second emergent surface
33	third emergent surface
4	bulb
5	light source, LED chip
6	heat sink
61	body
62	fin
7	lamp holder
A	first part of light
A'	first emergent light
B	second part of light
B'	second emergent light
C	third part of light
C'	third emergent light
100	lens
200	omnidirectional illuminating device, retrofit lamp

Patent claims

1. A lens (100) for an omnidirectional illuminating device, characterized in that the lens (100) is rotationally symmetrical about a central axis (X) and comprises an incident surface (1), a reflection surface (2) and an emergent surface (3) that are rotationally symmetrically configured, respectively, wherein a first part of light (A) from a light source of the omnidirectional illuminating device forms first emergent light (A’) after being incident through the incident surface (1) and reflected by the reflection surface (2), and emerging through the emergent surface (3), a second part of light (B) from the light source forms second emergent light (B’) after being incident through the incident surface (1) and emerging through the emergent surface (3), and a third part of light (C) from the light source forms third emergent light (C’) after being incident through the incident surface (1) and emerging through the emergent surface (3), wherein the first emergent light (A’), the second emergent light (B’) and the third emergent light (C’) jointly form omnidirectional illumination.

2. The lens (100) according to Claim 1, characterized in that the emergent surface (3) comprises a first emergent surface (31), a second emergent surface (32) and a third emergent surface (33), wherein the first emergent light (A’) is formed after refracted by the first emergent surface (31), the second emergent light (B’) is formed after refracted by the second emergent surface (32) and the third emergent light (C’) is formed after refracted by the third emergent surface (33).

3. The lens (100) according to Claim 2, characterized in

that at least the first emergent light (A’) illuminates part of a region of a back hemisphere of a illuminated space, at least the second emergent light (B’) illuminates part of regions of an front hemisphere and the back hemisphere of the illuminated space, and at least the third emergent light (C’) illuminates part of a region of the front hemisphere of the illuminated space.

4. The lens (100) according to Claim 2, characterized in that the lens (100) comprises a bottom surface, a top surface and a side surface joining the top surface and the bottom surface, and the top surface is formed by the reflection surface (2).

5. The lens (100) according to Claim 4, characterized in that the bottom surface comprises the incident surface (1) located in a center of the bottom surface and a support surface (11) surrounding the incident surface (1).

6. The lens (100) according to Claim 4, characterized in that the side surface is formed by the first emergent surface (31), the second emergent surface (32) and the third emergent surface (33).

7. The lens (100) according to Claim 6, characterized in that the first emergent surface (31), the second emergent surface (32) and the third emergent surface (33) are connected in sequence in a direction from the top surface to the bottom surface.

8. The lens (100) according to Claim 7, characterized in that the first emergent surface (31) extends from an edge of the top surface to the bottom surface in a direction close to the central axis (X), the second emer-

gent surface (32) extends from the first emergent surface (31) in a direction away from the central axis (X), and the third emergent surface (33) extends from the second emergent surface (32) to the bottom surface.

9. The lens (100) according to Claim 7, characterized in that the reflection surface (2) forms a region recessed towards the bottom surface.

10. The lens (100) according to Claim 9, characterized in that a curve of the reflection surface (2) in cross section is bent in a direction away from the bottom surface.

11. The lens (100) according to any of Claims 2-10, characterized in that the reflection surface (2), the second emergent surface (32) and the third emergent surface (33) in cross sections are defined by spline curves.

12. The lens (100) according to any of Claims 1-9, characterized in that the incident surface (1) is configured as a hemispherical surface, wherein a sphere center of the hemispherical surface is configured as a mounting point of the light source of the omnidirectional illuminating device.

13. The lens (100) according to any of Claims 2-9, characterized in that the first emergent surface (31) in cross section is defined by a straight line.

14. The lens (100) according to Claim 5, characterized in that the support surface (11) in cross section is defined by a straight line.

15. The lens (100) according to any of Claims 1-9, characterized in that the reflection surface (2) is configured as a total internal reflection surface.

16. The lens (100) according to any of Claims 4-9, characterized in that the reflection surface (2) is formed by coating a mirror reflection material on the top surface.

17. An omnidirectional illuminating device (200), comprising a bulb (4), a light source (5), a heat sink (6) and a lamp holder (7), characterized by further comprising the lens (100) according to any of Claims 1-16.

18. The omnidirectional illuminating device (200) according to Claim 17, characterized in that the heat sink (6) comprises a body (61) and a plurality of fins (62) extending from the body (61), the body (61) has one end carrying the light source (5), and the lens (100) covers the light source (5).

19. The omnidirectional illuminating device (200) according to Claim 18, characterized in that the bulb (4) and the heat sink (6) are in fixed connection and jointly define a cavity for accommodating the light source (5) and the lens (100).

20. The omnidirectional illuminating device (200) according to Claim 18, characterized in that the body (61) has the other end in connection with the lamp holder (7).

21. A retrofit lamp, characterized by comprising the omnidirectional illuminating device (20) according to any of Claims 17-20, wherein the light source (5) of the omnidirectional illuminating device (200) is an LED chip.

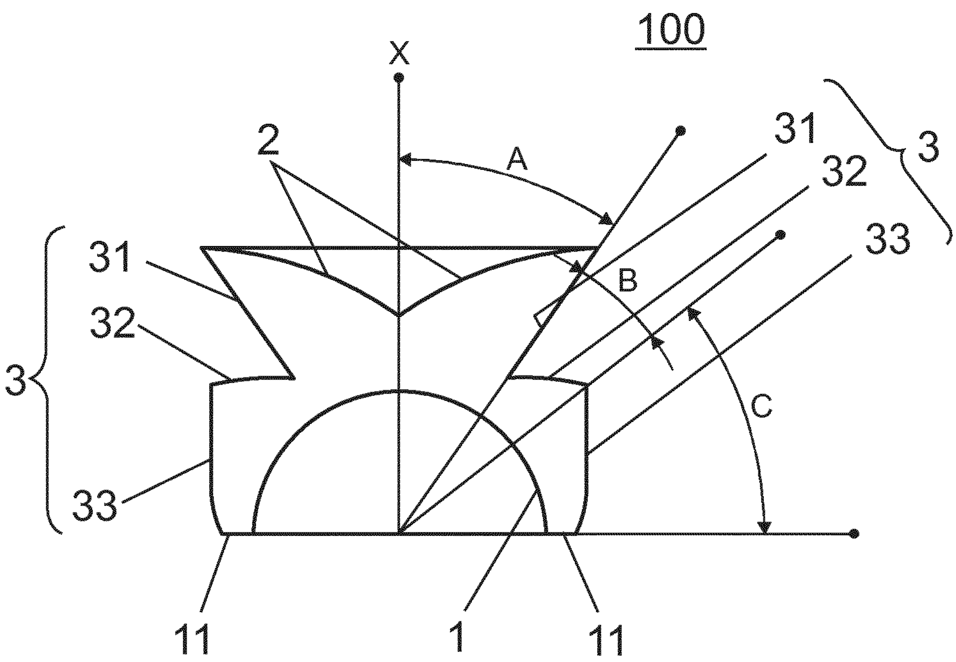

Figure 1

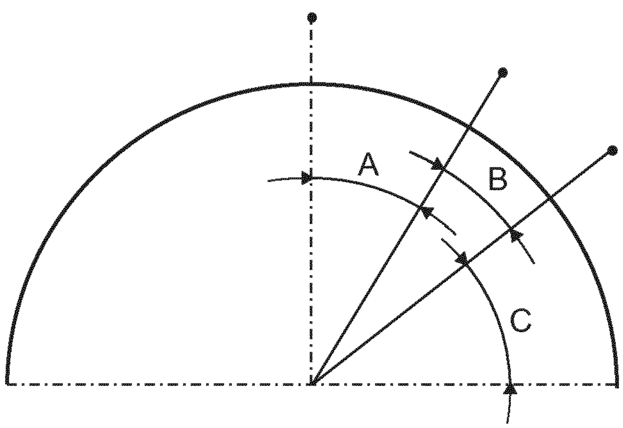

Figure 2

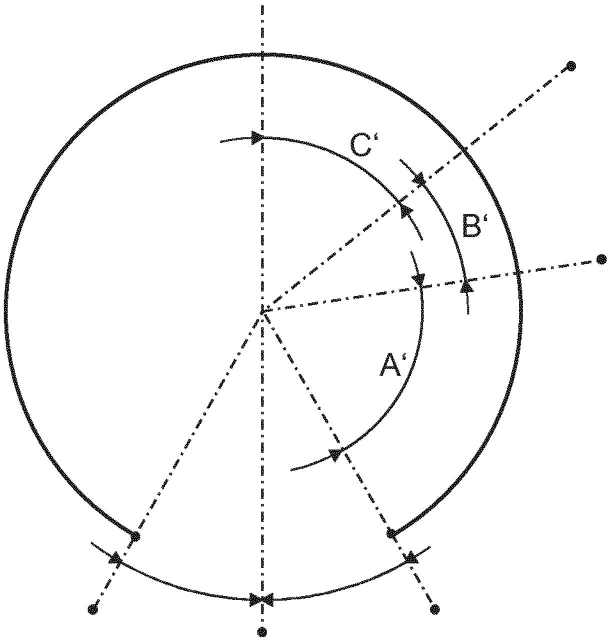

Figure 3

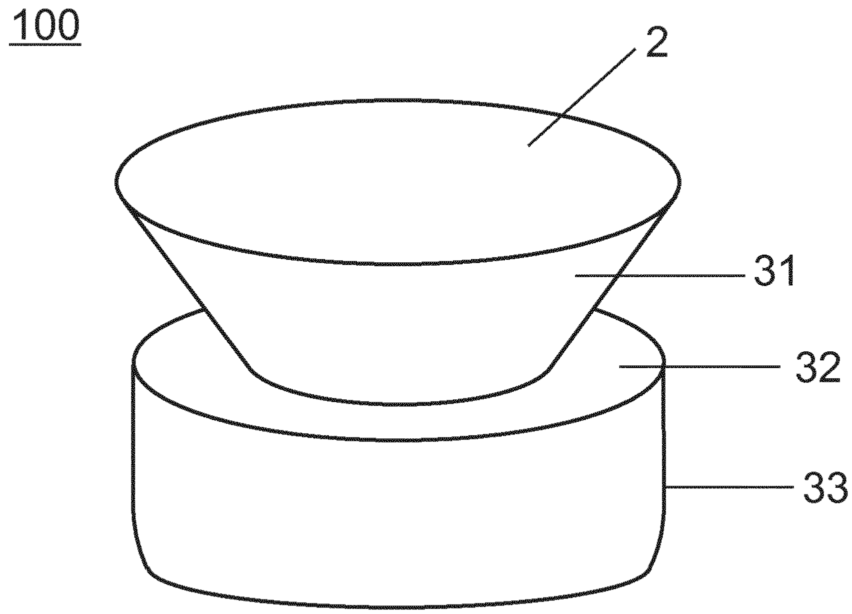

Figure 4

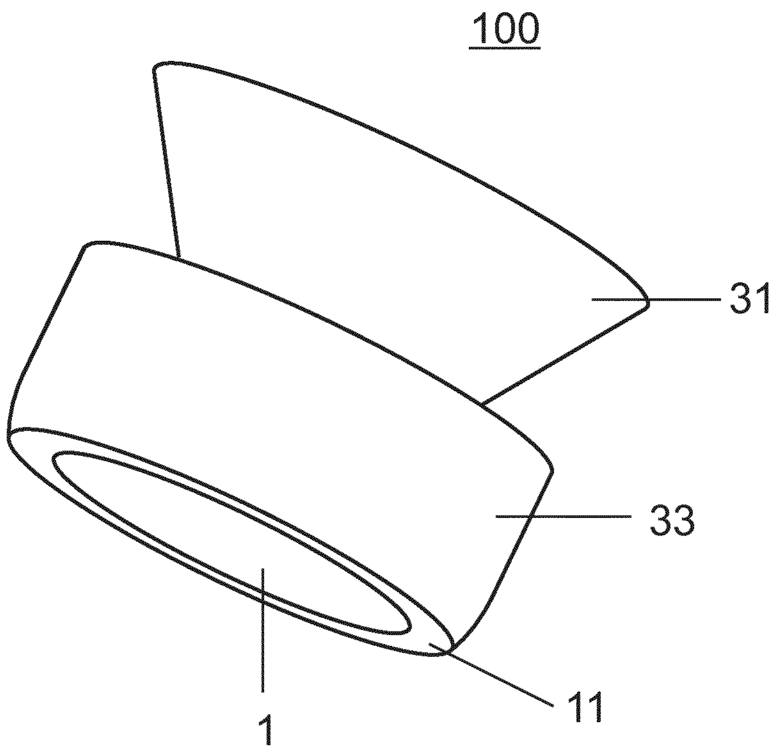

Figure 5

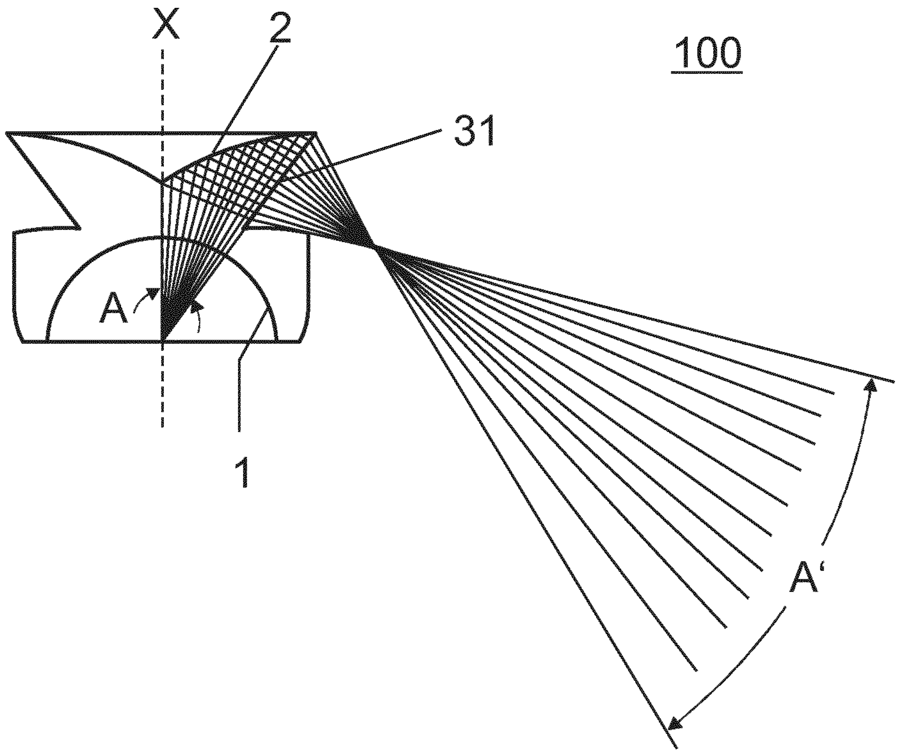

Figure 6

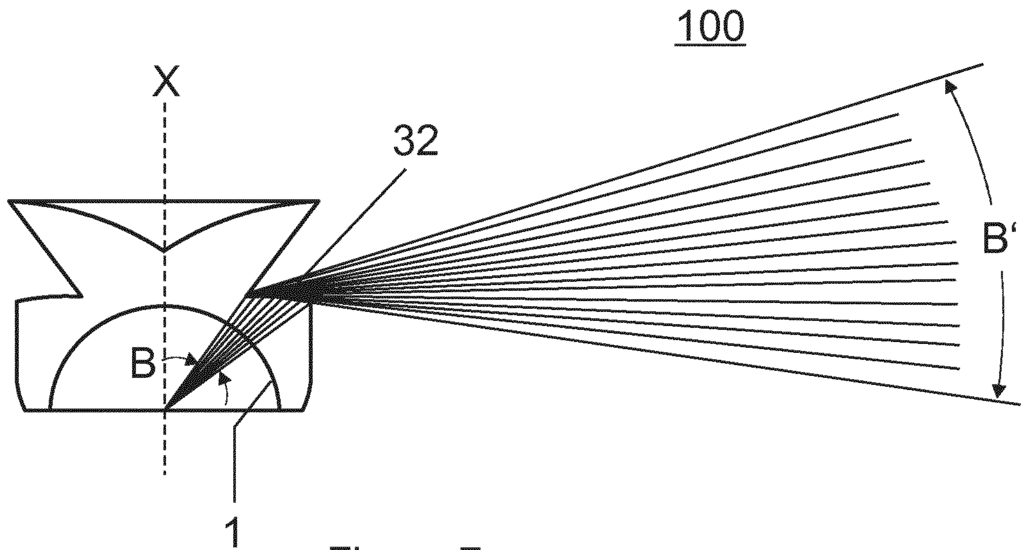

Figure 7

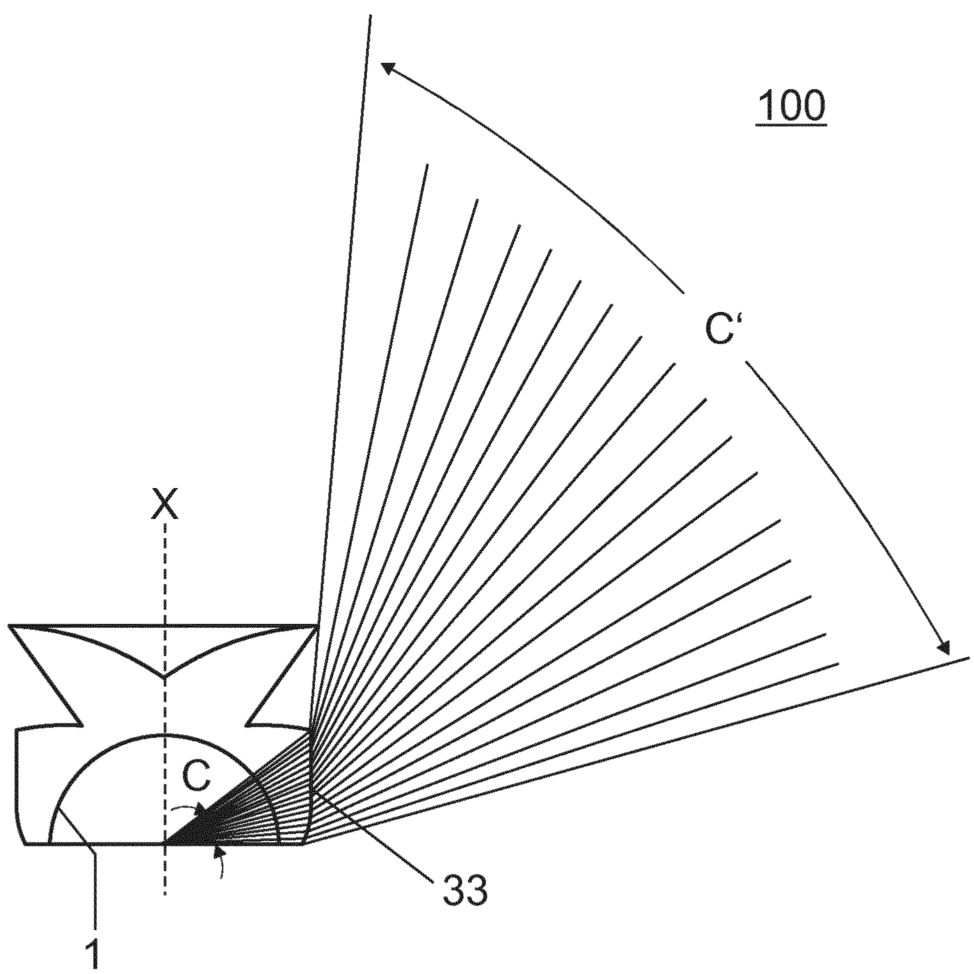

Figure 8

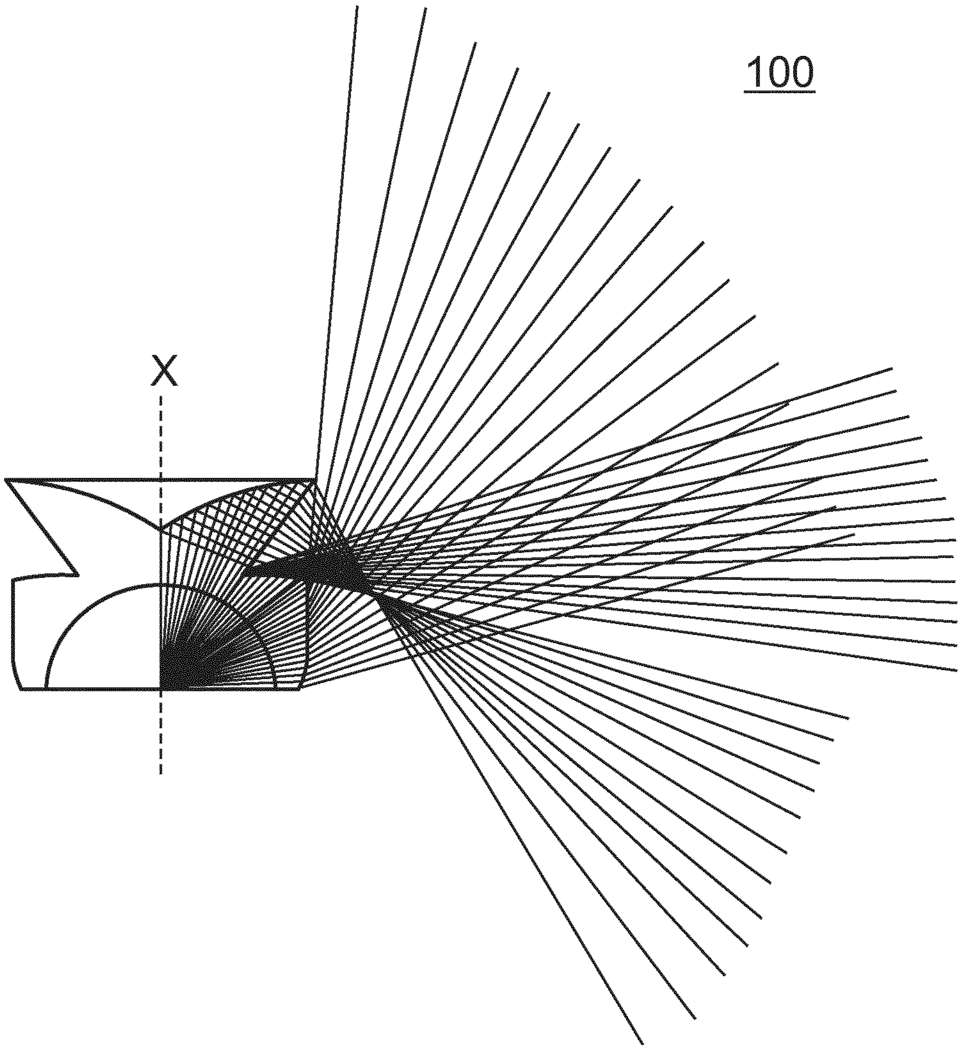

Figure 9

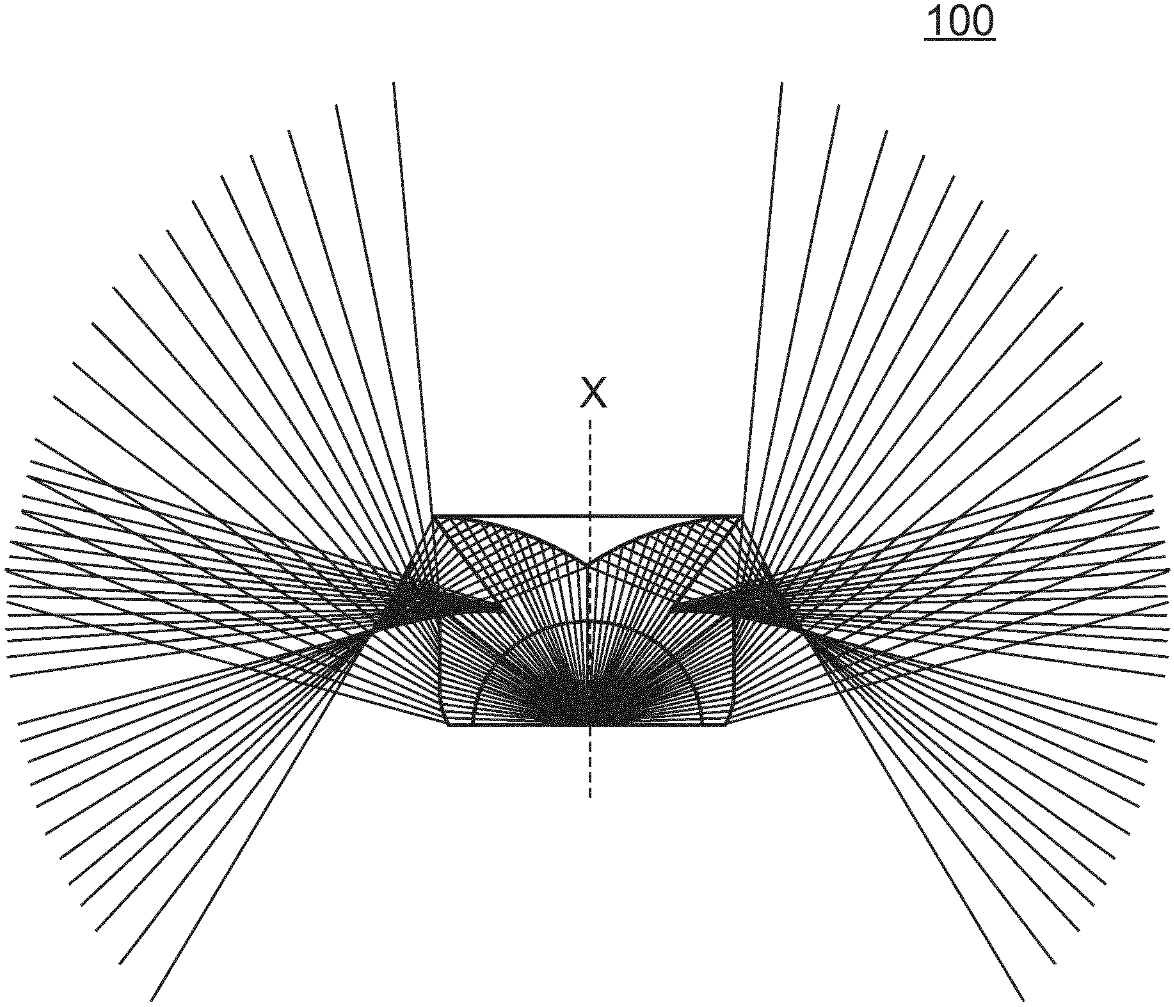

Figure 10

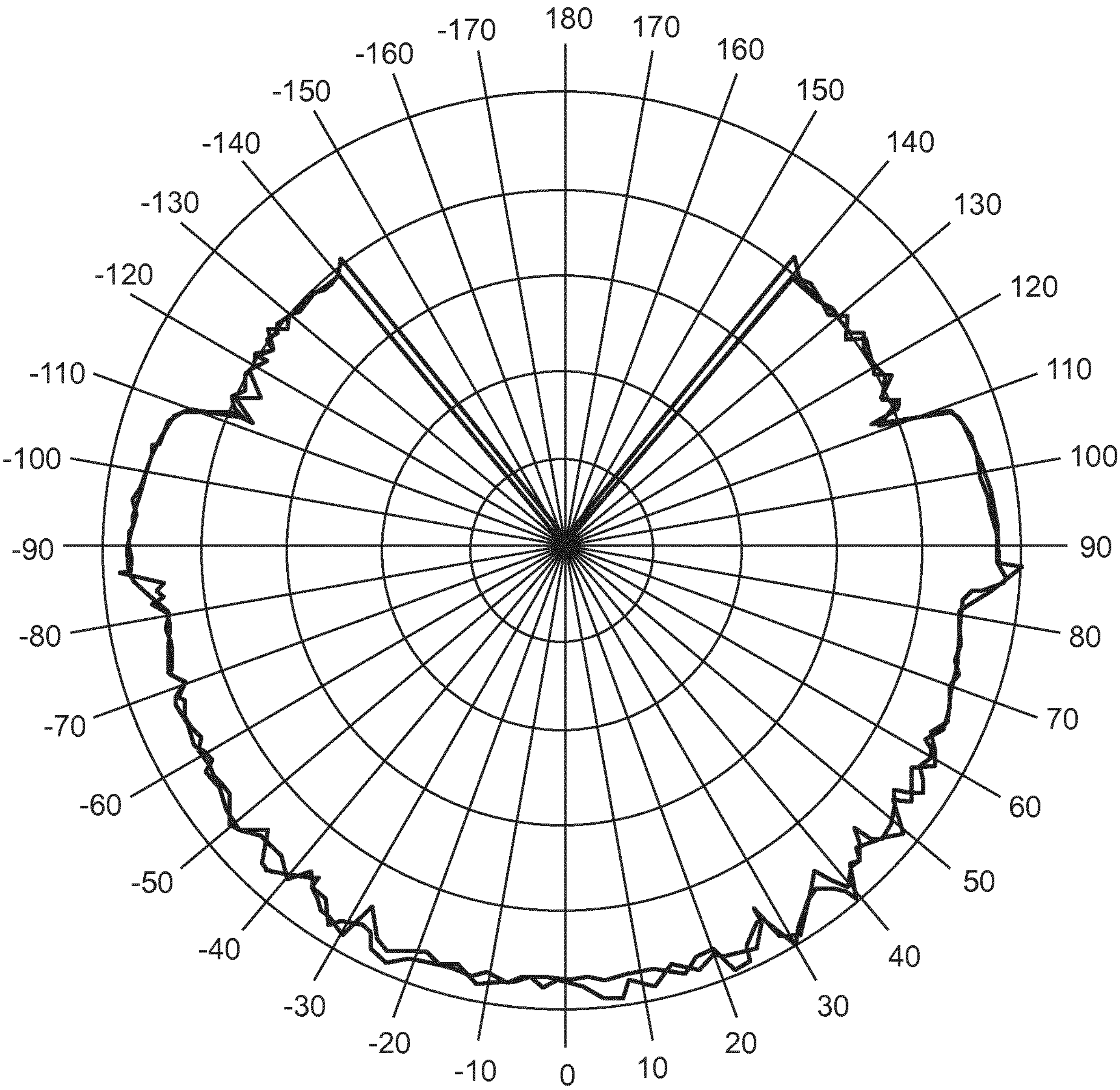
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170

Figure 11

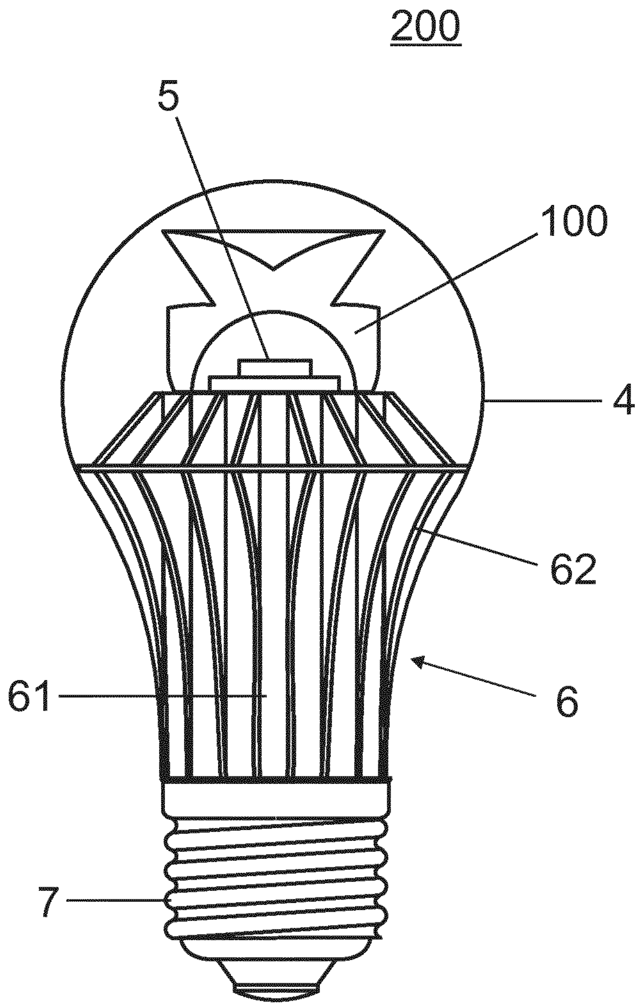

Figure 12

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/075395

A. CLASSIFICATION OF SUBJECT MATTER
INV. F21V5/04 F21V7/04 F21K99/00
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 F21K F21Y G02B

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	TW M 429 802 U (CHICONY POWER TECH CO LTD [TW]) 21 May 2012 (2012-05-21) the whole document	1-21
X,P	& US 2013/083555 A1 (CHEN SHIH-PIN [TW] ET AL) 4 April 2013 (2013-04-04) paragraph [0035] - paragraph [0044] figures 2,3 -----	1-21
X	US 2011/305026 A1 (MOCHIZUKI KEIICHI [JP]) 15 December 2011 (2011-12-15) paragraph [0057] - paragraph [0061] figure 7 paragraph [0048] -----	1-15, 17-21
X	US 2012/044700 A1 (CHEN SHIH-FENG [TW] ET AL) 23 February 2012 (2012-02-23) paragraph [0036] - paragraph [0040] figures 3-6 -----	1-5,14, 17-21
	-/--	

[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

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"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
19 February 2014	26/02/2014

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	Demirel, Mehmet

1

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/075395

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/140486 A1 (CHOU YEN-CHUN [TW]) 7 June 2012 (2012-06-07) paragraph [0020] - paragraph [0031] paragraph [0046] figures 3,4,5,9 -----	1-5, 14-21

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2013/075395

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
TW M429802 U	21-05-2012	TW M429802 U	21-05-2012
		US 2013083555 A1	04-04-2013
US 2011305026 A1	15-12-2011	JP 2012003845 A	05-01-2012
		US 2011305026 A1	15-12-2011
US 2012044700 A1	23-02-2012	NONE	
US 2012140486 A1	07-06-2012	CN 102486267 A	06-06-2012
		JP 2012119304 A	21-06-2012
		US 2012140486 A1	07-06-2012