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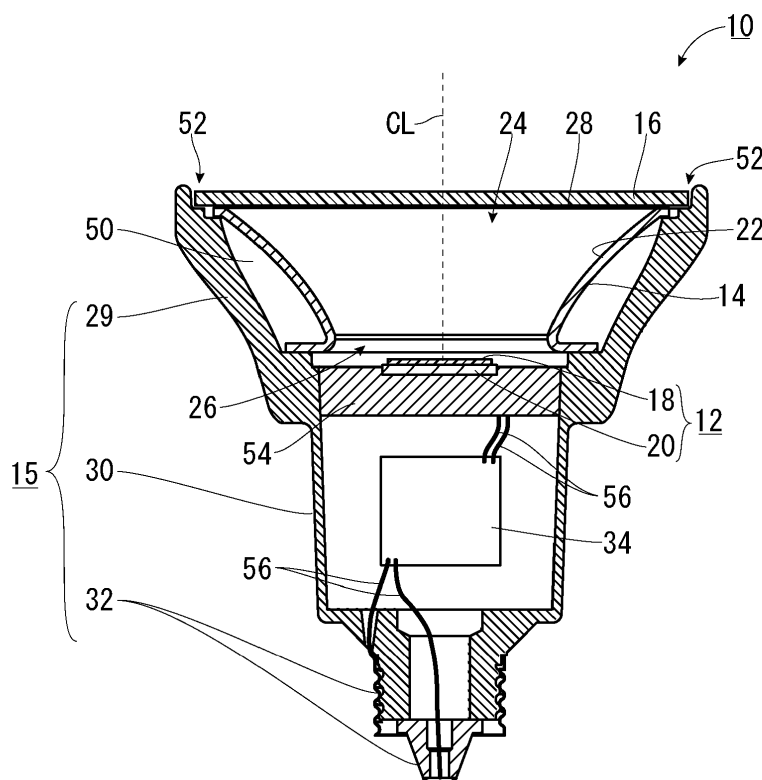
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(54) **Reflector and lamp using the same**

(57) A reflector (14) has a reflective surface (22) for reflecting a light from a light emitter (12). At least an opening part (36) of the reflective surface (22) has a cross-sectional shape formed such that an angle formed by an

optical axis (CL) and a tangent (TL) passing through a given point on the reflective surface (22) is gradually increased as a position of the given point gets closer to an opening end (28) of the reflective surface (22).

FIG. 1



Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a reflector for reflecting a light emitted from a light emitter typified by a light emitting diode in a predetermined direction, and relates to a lamp using the same.

Background Art

[0002] To obtain a desired light distribution profile by controlling a direction of a light emitted from a light emitter typified by an incandescent lamp (e.g., a halogen lamp) or a light emitting diode, a lamp to be used in general is equipped with a reflector (reflection mirror) having a reflective surface for reflecting the aforementioned light in a predetermined direction.

[0003] For example, a lamp described in Japan Laid-open Patent Application Publication No. JP-A-2013-114917 (e.g., FIG 2 in the Publication) is equipped with a reflector having a reflective surface defined by so-called a paraboloid of revolution. The paraboloid of revolution has a single focus. Theoretically, light rays emitted from the focus are reflected by the paraboloid of revolution, and are then changed into light rays parallel to each other (parallel light rays).

[0004] It is obvious that the reflective surface of a well-known reflector is not limited to be defined by the aforementioned paraboloid of revolution and includes a reflective surface defined by an ellipsoid of revolution and that defined by a combination of the paraboloid of revolution and the ellipsoid of revolution. Moreover, the reflective surface of a well-known reflector is not limited to a smooth reflective surface, and includes a reflective surface formed by collecting a plurality of facets.

[0005] However, as shown in FIG 6, a reflective surface 1 of a well-known reflector has a cross-sectional shape that an angle, formed by an optical axis CL and a tangent (CTL1, TL2, TL3) passing through a given point (a, b, c) on the reflective surface 1, is gradually reduced as the position of the given point gets closer to an opening 2 of the reflective surface 1. In other words, the tangents gradually become parallel to the optical axis CL in the order of the tangent TL1, the tangent TL2 and the tangent TL3. That is, the reflective surface 1 is formed in a bowl shape. Alternatively, as shown in FIG 7, a reflective surface 3 is formed such that an angle, formed by the optical axis CL and a tangent TL4 passing through a given point on the reflective surface 3, is constant. In other words, the reflective surface 3 has a linear cross-section.

[0006] Therefore, as shown in FIG 8, most of light rays CTL, emitted from a light emitter 4 and then reflected by the reflective surface 1 (hereinafter referred to as "controlled light rays"), are theoretically supposed to irradiate a range with roughly the same size as an opening side

of the reflective surface 1, where the reflective surface is defined by a paraboloid of revolution. Depending on the shape of the reflective surface 1, the controlled light rays CTL may irradiate a region smaller than the opening side of the reflective surface 1, where the reflective surface 1 is defined by an ellipsoid of revolution. Alternatively, the controlled light rays CTL may irradiate a range slightly larger than the opening side of the reflective surface 1, where the reflective surface is defined by a plane of revolution with a linear cross-section (i.e., the angle formed by the optical axis CL and the tangent TL4 is constant) as shown in FIG 7. The region irradiated by the controlled light rays CTL will be hereinafter referred to as "a bright region" X1. In reality, the controlled light rays CTL will be further expanded than theoretically assumed. This is because in some cases, a light source is not a point and a light is irradiated from a position away from a focus.

[0007] The light rays irradiated from the light emitter 4 include not only the controlled light rays CTL but also light rays (hereinafter referred to as "direct light rays") DL that are directly transmitted through the opening 2 without being reflected by the reflective surface 1. Some of the direct light rays DL irradiate the bright region X1 (i.e., the bright region X1 is irradiated by the controlled light rays CTL and the direct light rays DL), whereas the rest of the direct light rays DL are expanded to the outer peripheral side of the bright region X1 and are thus supposed to irradiate a region that the controlled light rays CTL hardly reach. The region extended to the outer peripheral side of the bright region X1 will be hereinafter referred to as "a dark region" X2.

[0008] Now, consideration will be given to a light irradiated from a single point on the planar light emitter 4 mounted onto the bottom part of the reflective surface 1. The light irradiated from the single point on the planar light emitter 4 has an irradiation angle with a predetermined range based on the shape or so forth of the planar light emitter 4 itself. Thus, some of light rays irradiated from the single point become the controlled light rays CTL, whereas the rest become the direct light rays DL. For example, a light ray L1, irradiated from the single point on the planar light emitter 4 toward the opening edge of the reflective surface, is reflected by the opening edge and becomes the controlled light ray CTL. By contrast, a light ray L2 is irradiated as the direct light ray DL without being reflected by the reflective surface 1. Here, the angle formed by the light ray L2 and the optical axis CL is slightly smaller than that formed by the light L1 and the optical axis CL.

[0009] In this case, the angle formed by the light ray L1 and the light ray L2 is roughly zero (i.e., the light rays L1 and L2 follow roughly the same track) to the position that the light ray L1 is reflected by the reflective surface 1. However, the light rays L1 and L2 are supposed to form an angle A after the light ray L1 is reflected by the reflective surface 1. Further, the angle A is supposed to correspond to the width Y of the dark region X2 on an

irradiated plane. For example, the aforementioned angle A is greater in the reflective surface 1 (defined by, for instance, an ellipsoid of revolution) with a feature of causing convergence of the controlled light rays CTL than in the reflective surface 1 (defined by, for instance, a paraboloid of revolution) with less tendency to cause convergence of the controlled light rays CTL. Accordingly, the width Y of the dark region X2 is also greater in the reflective surface 1 with the feature of convergence of the controlled light rays CTL than in the reflective surface 1 with a tendency to less cause convergence of the controlled light rays CTL.

[0010] Due to the aforementioned reasons, in using a reflector 5 having the well-known reflective surface 1, a tendency has been observed that the intensity of light in the bright region X1 on the irradiated plane becomes too great, while the width Y of the dark region X2 extended to the outer peripheral side of the bright region X1 becomes too wide. In other words, the well-known reflector has been only capable of irradiating a light with a point-like light (a spotlight) distribution profile. Thus, it has been demanded to produce a reflector that can satisfy a demand of not irradiating a range with a point-like light but brightly irradiating a wider range.

[0011] The present invention has been developed in view of the aforementioned drawback of the well-known art. Therefore, it is a main object of the present invention to provide a reflector and a lamp using the same, whereby a wider range can be brightly irradiated by extending the range of the bright region X1 without remarkably reducing the intensity of light in a center part (in the vicinity of the optical axis); a light distribution profile can be formed in a smooth curve by reducing the width of the dark region X2; and a light distribution, less evoking a feeling of strangeness, can be implemented by blurring the contour of an irradiated light.

SUMMARY OF THE INVENTION

[0012] A first aspect of the present invention relates to a reflector with a reflective surface for reflecting a light from a light emitter, and wherein at least an opening part of the reflective surface has a cross-sectional shape formed such that an angle formed by an optical axis and a tangent passing through a given point on the reflective surface is gradually increased as a position of the given point gets closer to an opening end of the reflective surface.

[0013] The cross-sectional shape of the reflective surface may be formed based on a part of a parabola, a part of an ellipse or a part of circle.

[0014] A bottom part formed continuously to the opening part of the reflective surface preferably may have a shape defined by either an ellipsoid of revolution or a paraboloid of revolution.

[0015] Another aspect of the present invention relates to a lamp including a light emitter and the aforementioned reflector.

[0016] According to the present invention, it is possible to provide a reflector and a lamp using the same, whereby a wider range can be brightly irradiated without remarkably reducing the intensity of light in a center part (i.e., the bright region X1).

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] Referring now to the attached drawings which form a part of this original disclosure:

FIG 1 is a cross-sectional view of a lamp according to a practical example to which the present invention is applied;

FIG 2 is a cross-sectional view for explaining a reflector according to the practical example;

FIG 3 is a diagram showing, (a) a part of a parabola, (b) a part of an ellipse and (c) a part of a circle, which are applicable as a shape of a reflective surface of the reflector;

FIG 4 is a schematic diagram of a light distribution profile of a light from the reflector according to the practical example;

FIG 5 is a cross-sectional view for explaining a reflector according to another practical example;

FIG 6 is a cross-sectional view of a shape of a reflective surface of a well-known reflector;

FIG 7 is a cross-sectional view of a shape of a reflective surface of another well-known reflector; and FIG 8 is a schematic view of a light distribution profile of a light from the well-known reflector shown in FIG 6.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0018] With reference to the drawings, explanation will be hereinafter made for a practical example of a lamp 10 to which the present invention is applied. As shown in FIG 1, the lamp 10 mainly comprises a light emitter 12, a reflector 14, a lamp main body 15 and a front cover 16.

[0019] The light emitter 12 is configured to irradiate a predetermined light when receiving a power. In the present practical example, the light emitter 12 comprises a light emitting part 18 and a light emitting part holding member 20. The light emitting part 18 is configured to emit a planar light. The light emitting part holding member 20 serves to hold the light emitting part 18, and a power feed circuit (not shown in the drawings) is printed thereon for supplying a power to the light emitting part 18. For example, a light emitting part herein used as the light emitting part 18 is a light emitting part configured to emit lights from a large number of LED elements aligned on the light emitting part holding member 20 as if the emitted lights were a planar light or a light emitting part represented by an organic EL (Electro-Luminescence) configured to emit a planar light. It is obvious that the light emitter 12 is not limited to a light emitter configured to emit a planar light. Alternatively, a light emitter configured to

emit a light with a roughly point shape may be used as the light emitter 12. Moreover, the light emitter 12 is not limited to the LED or the organic EL. Alternatively, any suitable types of light emitter may be used as the light emitter 12, including an incandescent lamp and a high-pressure discharge lamp.

[0020] The reflector 14 has a reflective surface 22 formed on the inside thereof. The reflective surface 22 reflects a light emitted from the light emitter 12. Glass, aluminum, resin or so forth is used as the material of the reflector 14. When the reflector 14 is made of aluminum, metal evaporation is performed for the reflective surface 22 (alternatively, alumite processing may be performed instead of metal evaporation). On the other hand, when the reflector 14 is made of glass, it is possible to use a visible light reflective film made of a multilayer film coating as well as a metal film made of aluminum or so forth. Further, the reflective surface 22 of the present practical example is made in the form of a smooth surface, but alternatively, may be made in the form of a facet surface.

[0021] The reflective surface 22 has an opening 24 on one end thereof, while having a bottom part 26 on the other end thereof. The bottom part 26 has an area smaller than that of the opening 24. As shown in FIG 2, the reflective surface 22 of the present practical example is made in the form of a surface of revolution about a center axis CL. The cross-sectional shape of the reflective surface 22 is formed such that an angle, formed by the center axis CL and a tangent (TL100, TL102, TL104) passing through a given point (100, 102, 104) on the reflective surface 22, is gradually increased as the position of the given point gets closer to an opening end 28. In short, the reflective surface 22 of the reflector 14 to which the present invention is applied is formed in a shape flexed (curved) oppositely to the reflective surface of a well-known reflector. Alternatively, as shown in FIG 3, the cross-sectional shape of the reflective surface 22 may be formed based on a part of parabola (FIG 3(a)), a part of ellipse (FIG 3(b)) or a part of circle (FIG 3(c)).

[0022] With reference back to FIG 1, the lamp main body 15 is made of material with good thermal conductivity, and comprises a reflector accommodation part 29, a socket 30 and a base 32. It should be noted that the reflector accommodation part 29 and the socket 30 are integrally formed in the present practical example.

[0023] The reflector accommodation part 29 is a part having a recess 50 in which the reflector 14 can be accommodated. Further, the reflector accommodation part 29 has a step 52 formed on the circumferential edge of the opening thereof. The circumferential edge of the opening end of the reflector 14 and the circumferential edge of the front cover 16 are attachable to the step 52.

[0024] The socket 30 is a roughly cylindrical part. One end part of the socket 30 has an opening to which the light emitter 12 is attached, whereas the other end part of the socket 30 has a diameter gradually reduced. In the present practical example, the opening bored in one end part of the socket 30 is larger than the light emitter 12.

Therefore, the light emitter 12 is attached to the opening of the socket 30 together with a light emitter support member 54 formed in a roughly disc shape, while being mounted onto the light emitter support member 54.

[0025] The socket 30 accommodates a power circuit 34 for supplying a light emission power to the light emitter 12 (the light emitting part 18 in the present practical example). The power circuit 34 is not required in using the light emitter 12 of a type (e.g., an incandescent lamp) capable of directly supplying a commercial power. Further, lead wires 56 are provided within the socket 30 in order to establish electrical conduction between the base 32 and the power circuit 34 and that between the power circuit 34 and the light emitter 12.

[0026] The base 32 is a conductive member attached to the tip end of the other end part of the socket 30. The base 32 is molded in a predetermined standard shape such as "E11" or "E17".

[0027] The front cover 16 is a roughly plate-shaped translucent member attached to the opening end 28 of the reflector 14 in order to prevent a user from directly touching the light emitter 12 by the hand or to avoid attachment of raindrops, dust and so forth to the light emitter 12. In general, the front cover 16 is made of glass or resin such as polycarbonate or acrylic. The front cover 16 is not required, for instance, when there is no chance for a user to directly touch the light emitter 12 by the hand or there is no concern for attachment of raindrops, dust and so forth to the light emitter 12.

[0028] Next, explanation will be simply made for a procedure of assembling the lamp 10 to which the present invention is applied. The light emitter 12 is preliminarily assembled by combining the light emitting part 18 and the light emitting part holding member 20 together. Further, the base 32 is preliminarily fixed to the tip end of the other end part of the socket 30, while one ends of some lead wires 56 are preliminarily electrically connected to the base 32.

[0029] The power circuit 34 is accommodated within the socket 30, while the other ends of some lead wires 56 are electrically connected to the power circuit 34. Thereafter, the light emitter 12 (including the light emitter support member 54) is attached to one end part of the socket 30 (it is obvious that the other lead wires 56 are preliminarily connected between the power circuit 34 and the light emitter 12).

[0030] Finally, the reflector 14 is accommodated in and fixed to the reflector accommodation part 29 of the socket 30 such that the light emitter 12 is enclosed by the bottom part 26. The front cover 16 is herein attached to the opening end 28 of the reflector 14 (with use of the step 52 of the reflector accommodation part 29) on an as-needed basis. Thus, assembling of the lamp 10 is completed. In attaching the reflector 14 to the socket 30, the center axis CL of the reflective surface 22 of the reflector 14 is adjusted to be matched with the optical axis CL of the light emitter 12 (the light emitting part 18 in the present practical example).

[0031] The light emitter 12 is configured to emit a light when a power is supplied thereto through the base 32 and the power circuit 34. As shown in FIG 4, some of light rays emitted from the light emitter 12 irradiate an irradiated plane as the controlled light rays CTL reflected by the reflective surface 22 of the reflector 14. On the other hand, the rest of light rays irradiate the irradiated plane as the direct light rays DL.

[0032] Now, consideration will be given to light rays to be irradiated from a single point on the light emitting part 18. A light ray to be irradiated from the single point on a light emitter part 18 has an irradiation angle with a predetermined range based on the shape and so forth of the light emitter part 18 itself. Therefore, some of light rays to be irradiated from the single point become the controlled light rays CTL, whereas the rest of the light rays become the direct light rays DL. For example, a light ray L100, directed from the single point on the light emitting part 18 to the opening end 28 of the reflective surface 22, is reflected by the reflective surface 22 and becomes a controlled light ray CTL100. By contrast, a light ray L102 is irradiated as a direct light ray DL102 without being reflected by the reflective surface 22. It should be noted that the angle formed by the light ray L102 and the optical axis (center axis) CL is herein slightly less than that formed by the light ray L100 and the optical axis CL.

[0033] The cross-sectional shape of the reflective surface 22 of the reflector 14 in the present practical example is herein formed, as described above, such that an angle, formed by the center axis CL and a tangent (TL100, TL102, TL104) passing through a given point (100, 102, 104) on the reflective surface 22, is gradually increased as the position of the given point gets closer to the opening end 28 (see FIG 2). Accordingly, the controlled light ray CTL also has an angle formed in a direction away from the optical axis CL. Thus, the bright region X1 irradiated by the controlled light rays CTL is sufficiently larger than the plane region of the opening 24 of the reflective surface 22. It is thereby possible to avoid a situation that the controlled light rays CTL are excessively converged as with a well-known reflector.

[0034] On the other hand, when consideration is given to the light rays L100 and L102 irradiated from the light emitter 12 roughly in the same direction, an angle B formed by the controlled light ray CTL100 and the direct light ray DL102 will be clearly smaller than the angle A formed in a well-known reflector. The angle B corresponds to the width Y of the dark region X2 on the irradiated plane. Hence, the width Y of the dark region X2 will be smaller where the reflector 14 of the present practical example is used than where a well-known reflector is used.

[0035] Consequently, with use of the reflector 14 of the present practical example, a wider range can be brightly irradiated by extending the range of the bright region X1 without remarkably reducing the intensity of light in the center part (in the vicinity of the optical axis CL); a light distribution profile can be formed in a smooth curve by

reducing the width Y of the dark region X2; and a light distribution, less evoking a feeling of strangeness, can be implemented by blurring the contour of an irradiated light.

(Other Practical Examples)

[0036] In the aforementioned practical example, the cross-sectional shape of the reflective surface 22 of the reflector 14 is entirely formed such that "an angle, formed by the center axis CL and a tangent (TL100, TL102, TL104) passing through a given point (100, 102, 104) on the reflective surface 22, is gradually increased as the position of the given point gets closer to the opening end 28". However, the present invention is not limited to the aforementioned practical example. It is only required to form at least an opening part 36 of the reflective surface 22 in "a flexed (curved) shape". Specifically, as shown in FIG 5, the opening part 36 of the reflective surface 22 may be made in the form of "the flexed (curved) surface" of the present invention, while a bottom part 38 of the reflective surface 22, continued to the opening part 36, may be defined by an ellipsoid of revolution, a paraboloid of revolution, a plane of revolution with a linear cross-section, or so forth that has been employed in a well-known reflector.

[0037] The reflective surface 22 structured as described above is preferred in that theoretically, it is possible to obtain an converging light (where an ellipsoid of revolution is employed) or a parallel light (where a paraboloid of revolution is employed) in the vicinity of the optical axis CL; a distribution profile of a surrounding light can be formed in a smooth curve; and a distribution light, less evoking a feeling of strangeness, can be obtained by blurring the contour of an irradiated light.

[0038] It should be noted that attention is required not to set the region of "the flexed (curved) surface" to be extremely smaller than the region of "a well-known type surface (an ellipsoid of revolution, a paraboloid of revolution, etc.)". This is due to the following reason. When the region of "the flexed (curved) surface" is extremely small, the advantageous effect of forming a distribution light profile in a smooth curve, which is achieved by "the flexed (curved) surface", becomes too weak and will be inevitably almost the same as that achieved by the reflective surface 22 formed by only "the well-known type surface".

[0039] Further, the aforementioned practical example has explained a configuration that the single light emitter 12 and the single reflector 14 are used for the single lamp 10. However, a plurality of light emitters 12 and a plurality of reflectors 14 can be used for the single lamp 10. It is obvious that a single reflector 14 may be used for a single light emitter 12, or alternatively, a single reflector 14 may be used for a plurality of light emitters 12.

Reference Signs List

[0040] 10...Lamp, 12...Light emitter, 14...Reflector, 15...Lamp main body, 16...Front cover, 18...Light emitting part, 20...Light emitting part holding member, 22...Reflective surface, 24...Opening (of reflective surface), 26...Bottom part, 28...Opening end (of reflective surface), 29...Reflector accommodation part, 30...Socket, 32...Base, 34...Power circuit, 36...Opening part (of reflective surface), 38...Bottom part (of reflective surface), 50...Recess, 52...Step, 54...Light emitter support member, 56...Lead wire, CL...Optical axis (Center axis), TL...Tangent

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Claims

1. A reflector (14) with a reflective surface (22) for reflecting a light from a light emitter (12), wherein at least an opening part (36) of the reflective surface (22) has a cross-sectional shape formed such that an angle formed by an optical axis (CL) and a tangent (TL) passing through a given point on the reflective surface (22) is gradually increased as a position of the given point gets closer to an opening end (28) of the reflective surface (22). 20
2. The reflector (14) according to claim 1, wherein the cross-sectional shape of the reflective surface (22) is formed based on a part of a parabola, a part of an ellipse or a part of circle. 30
3. The reflector (14) according to claim 1 or 2, wherein a bottom part (38) formed continuously to the opening part (36) of the reflective surface (22) has a shape defined by either an ellipsoid of revolution or a paraboloid of revolution. 35
4. A lamp (10), comprising: 40
 - a light emitter (12); and
 - the reflector (14) recited in any of claims 1 to 3.

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FIG. 1

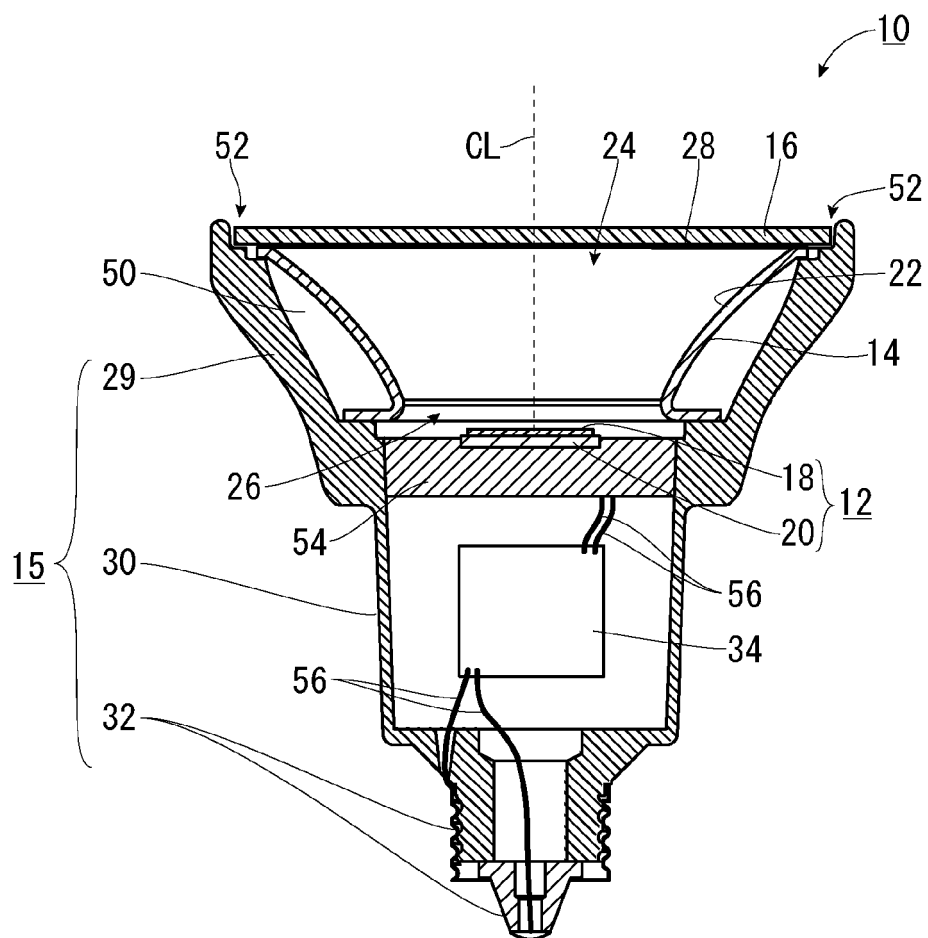


FIG. 2

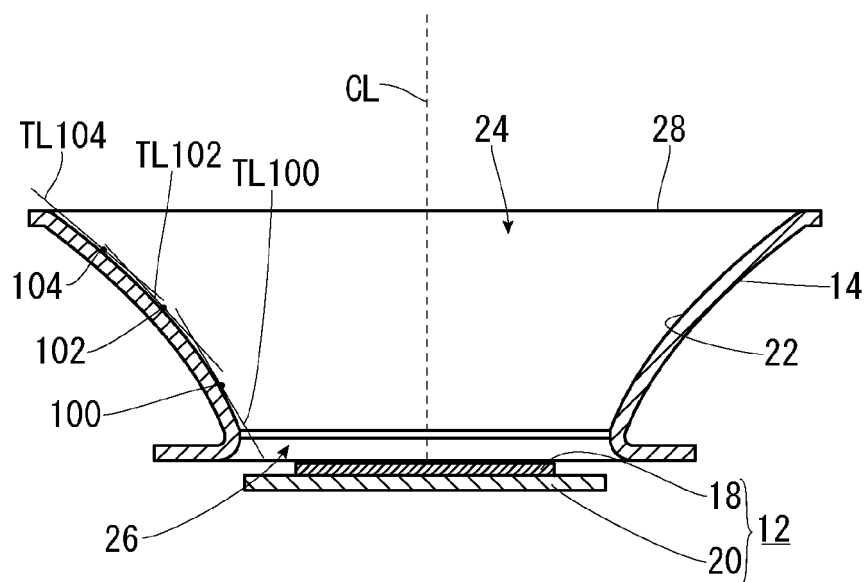
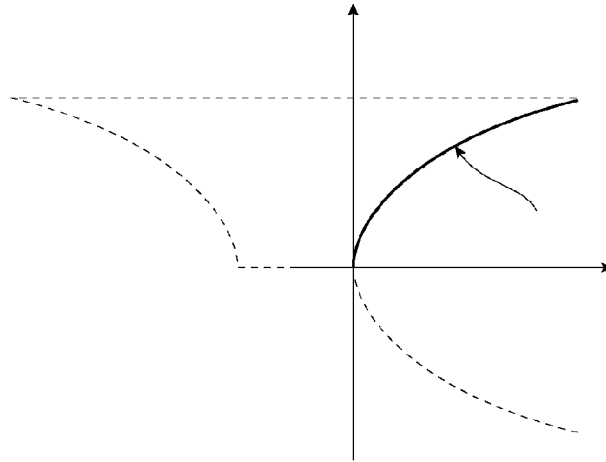
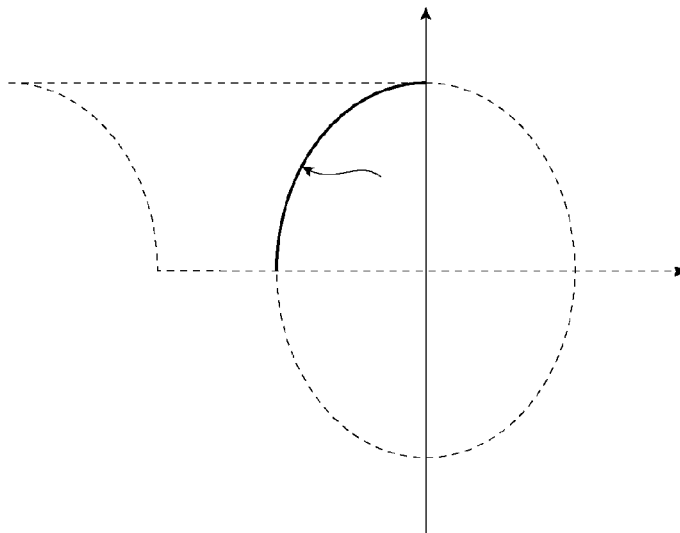


FIG. 3

(a)



(b)



(c)

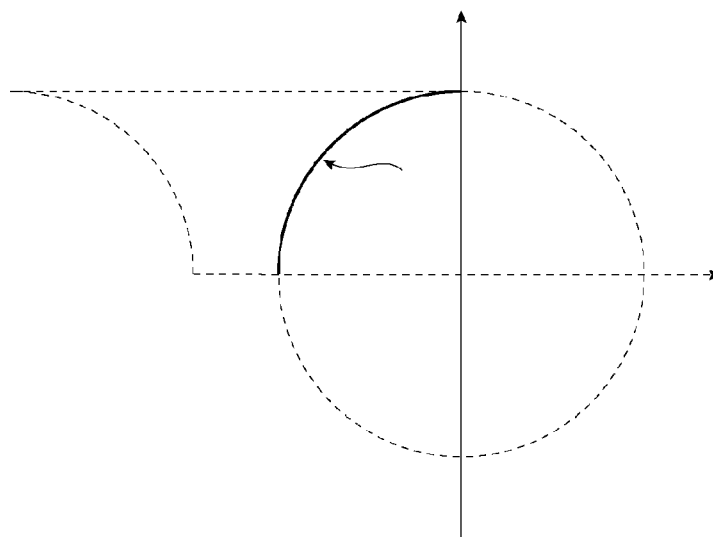


FIG. 4

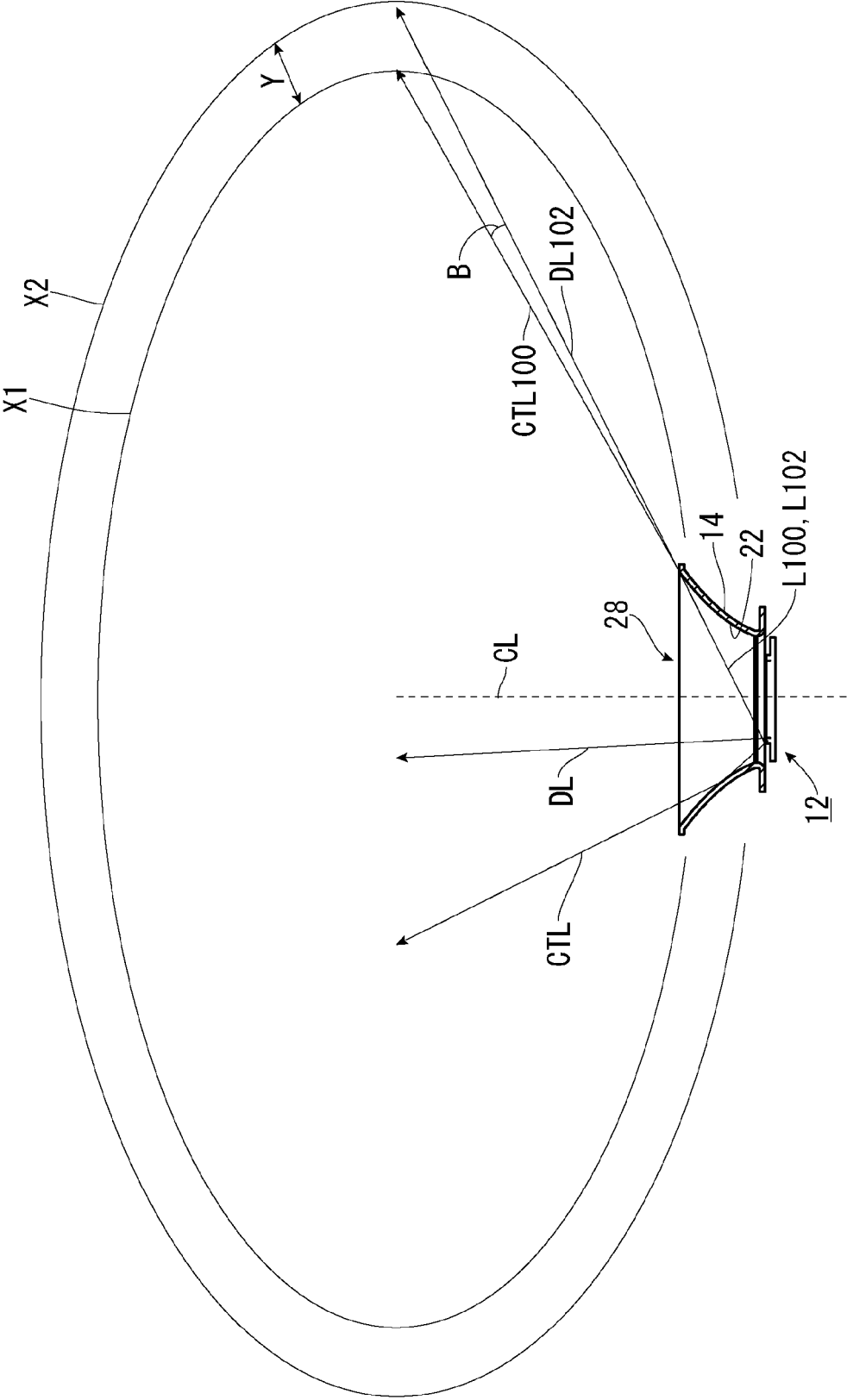


FIG. 5

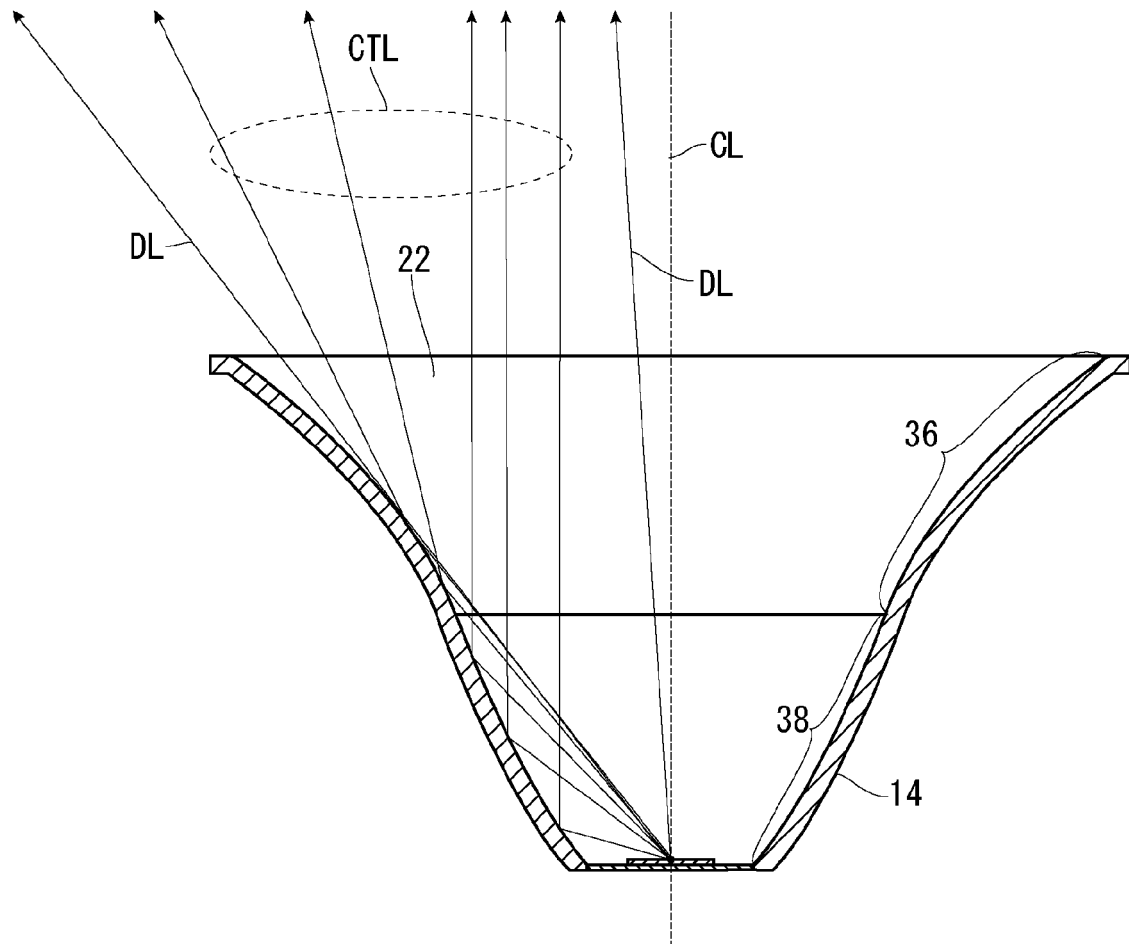


FIG. 6

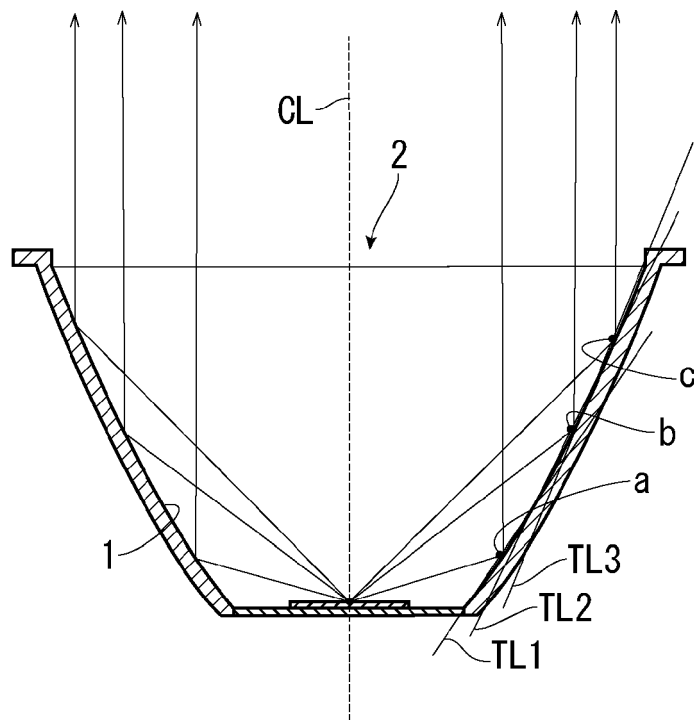


FIG. 7

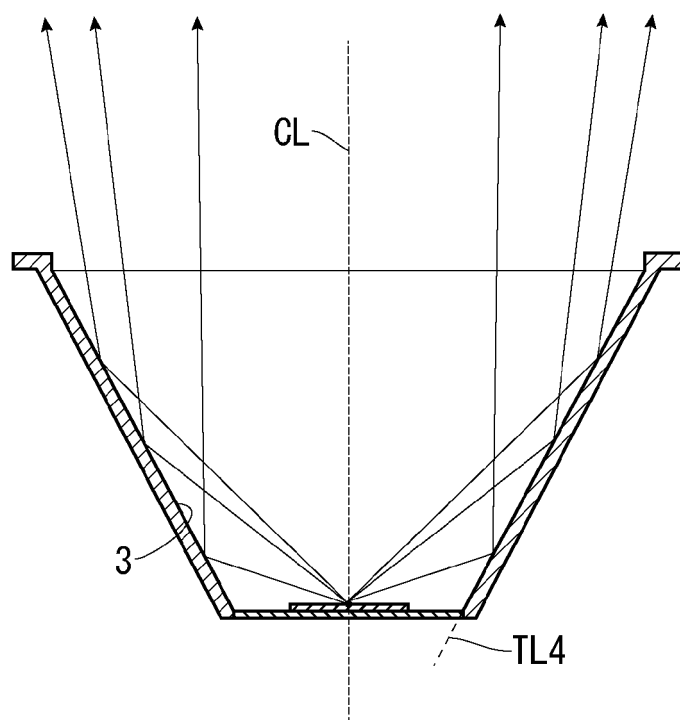
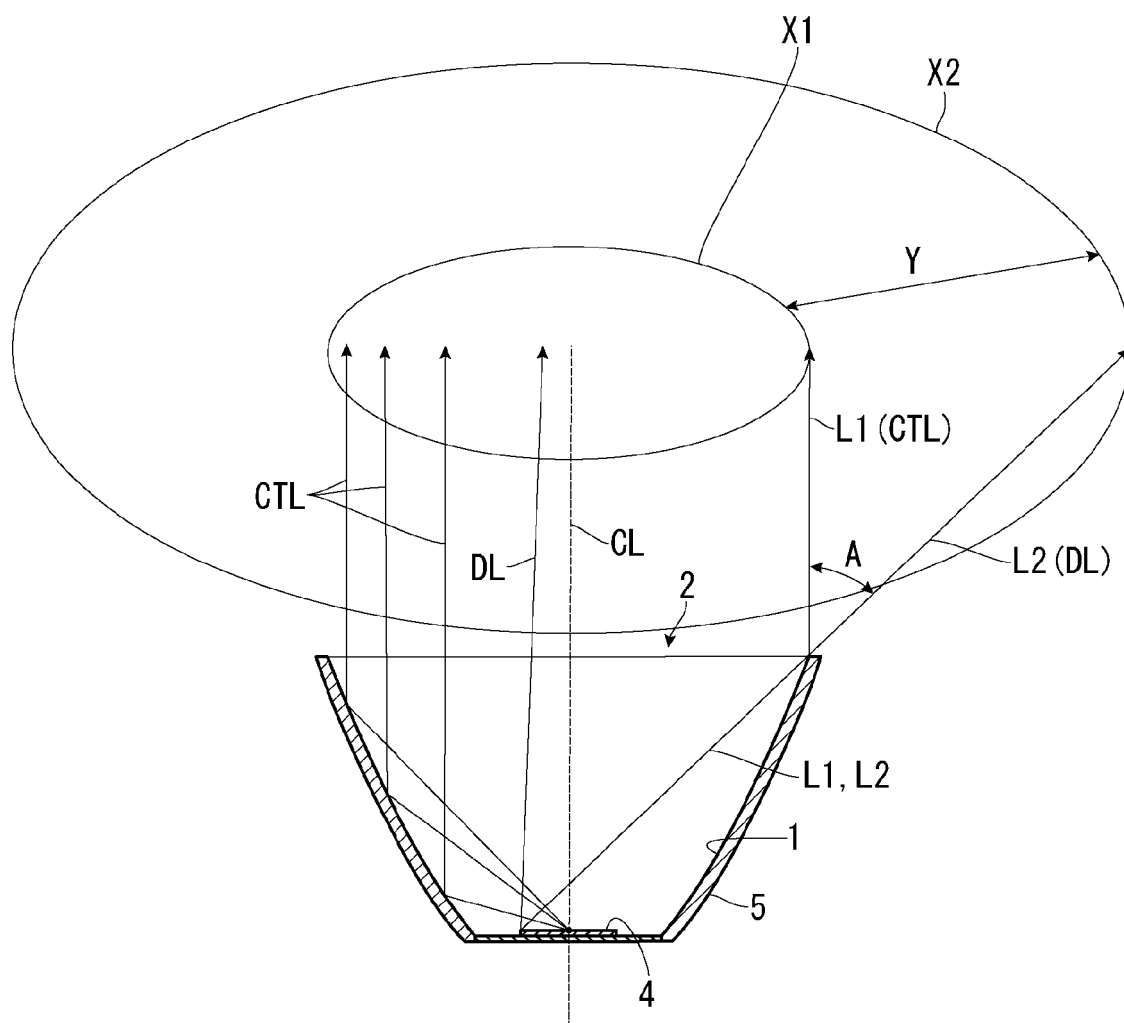


FIG. 8





EUROPEAN SEARCH REPORT

Application Number
EP 14 16 1469

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The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		28 May 2014	Vida, Gyorgy
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 14 16 1469

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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