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(54) **LIGHT-EMITTING DEVICE AND SURGICAL LAMP**

(57) A light-emitting device (100), comprising: a light source (1), a light deflection element (2) and a reflective shade (3); the reflective shade (3) comprises a top end (301), a bottom end (302) which is provided with an annular opening, and a reflector body (303) which gradually expands from the top end (301) to the bottom end (302), the reflector body (303) being symmetrical about a central axis; the light source (1) is located at the top end (301) of the reflective shade (3) and faces the bottom end (302) of the reflective shade (3), and may emit forward light and side light; the light deflection element (2) is located between the light source (1) and the reflective shade (3), and the light deflection element (2) is used for collecting the forward light and the side light, adjusting the deflection direction of the forward light and the side light such that the forward light and the side light which emerge from the light deflection element (2) are projected to an inner side of the reflector body (303) of the reflective shade (3); the reflective shade (3) then mixes and reflects a light beam, and finally light rays from different positions of the reflective shade (3) are superposed at a desired position to form a desired light spot. By using such the light-emitting device (100), a surgical lamp having no shadow effect may be made.

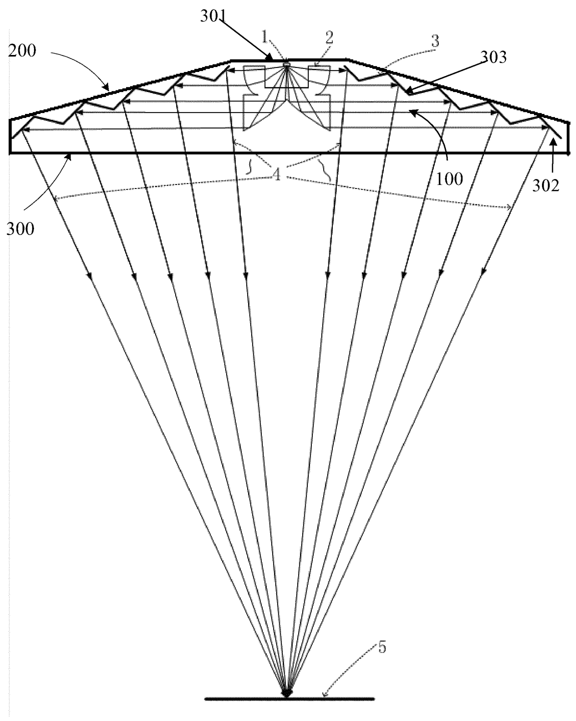

Fig. 1

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Description

Technical Field

[0001] The present invention relates to the field of lighting, and in particular to a light-emitting device and a surgical lamp using the light-emitting device.

Background Art

[0002] Surgical lamps, as special lamps used in an operating room, need to achieve a shadowless effect in addition to meeting the requirements of brightness. Therefore, the surgical lamp is generally large in size, and the size of a lamp head may reach 600-700 mm, and a plurality of light beams converge into a desired light spot to illuminate a surgical fields of surgical operation.

[0003] A commonly used surgical lamp generally adopts the technical solution of Gypsophila. In this solution, an LED light source is placed in a reflective shade or lens to form a separate lighting unit. A plurality of lighting units are distributed inside the lamp head and their irradiation directions are directed to a surgical region, and finally an area light source with a certain direction and converging light rays is formed to achieve a shadowless effect. In this solution, when the size of the light spot formed by the surgical lamp in the surgical region is adjusted, the method of changing the irradiation angle of the lighting unit to change the light intensity distribution of the surgical region, or the method of changing the relative intensity of light rays output by the lighting unit that are irradiated at different positions in the surgical region to change the light intensity distribution of the surgical region, is generally used.

[0004] Another variant of the solution of Gypsophila is to distribute the plurality of above-mentioned lighting units composed of LED light sources and lenses to the periphery of the lamp head, a large reflective shade is placed in the middle of the lamp head, and the light rays emitted by these lighting units are directly or indirectly directed towards the center of the lamp head and are irradiated on the reflective shade, which in turn reflects the light rays to the surgical region. In this solution, the method of changing the size of the light spot in the surgical region is to use two groups (or more groups) of lighting units, and the positions and irradiation angles of multiple groups of lighting units in the lamp head are different, so that the directions of the light rays after reflected by the reflective shade are also different, forming different light intensity distributions in the surgical region, and the light intensity distribution of the surgical region is changed by changing the relative intensity of output of the two groups of lighting units.

[0005] Many lighting units are required in the above solution. In this solution, on the one hand, the weight, the material cost and the installation time of the lamp head are increased because of the large number of lighting units, and on the other hand, because of high requirements on the irradiation angle of the lighting unit, the requirements on positioning and installation structure thereof are high.

Technical Problem

[0006] The main technical problem to be solved by the present invention is to provide a technical solution different from that of Gypsophila, which method does not require multiple lighting units, and may make full use of light emitted by the light source.

Solution to the Problem

Technical Solution

[0007] According to a first aspect, an embodiment provides a light-emitting device, comprising:

a reflective shade, which comprises a top end, a bottom end having an annular opening, and a reflector body gradually expanding from the top end to the bottom end, causing light projected to an inner side of the reflector body to converge into a light spot of a predetermined size after reflection;
a light source, which is located in a top area of the reflective shade and faces the bottom end of the reflective shade, and at least emits forward light and lateral light; and
a light deflection element, which is located on light paths of the forward light and the lateral light to collect the forward light and the lateral light, and adjusts deflection directions of the forward light and the lateral light, such that the forward light and the lateral light exited from the light deflection element are projected to the inner side of the reflector body of the reflective shade.
According to a third aspect, an embodiment may further provide a light-emitting device, comprising:
a reflective shade, which comprises a top end, a bottom end, and a reflector body extending from the top end to the bottom end;
a light source, which is located in a top area of the reflective shade and faces the bottom end of the reflective shade, and at least emits lateral light; and
a light deflection element, which is located on a light path of the lateral light to collect the lateral light;
wherein the light deflection element adjusts the light propagation direction of the lateral light projected on the light deflection element, such that the lateral light exited from the light deflection element is projected onto the reflector body, the reflector body reflects the lateral light projected on the reflector body, and the lateral light exited from the reflector body converges into a light spot of a predetermined size.

[0008] According to a second aspect, an embodiment further provides a surgical lamp using the light-emitting device described above.

Beneficial Effects of the Invention

Beneficial Effects

[0009] In the embodiment of the present invention, a lateral light beam emitted by the light source is collected by a profiled optical element that causes light rays to deflect in varying degrees, thereby changing an exit direction of the light beam to cause the light beam to be directed towards the reflective shade disposed on the periphery, then the reflective shade mixes and reflects the light beam, and finally the light rays at different positions of the reflective shade are superimposed at a desired position (e.g. the surgical region) and form a desired light spot.

[0010] The surgical lamp made by using the light-emitting device of the present invention may increase the light-emitting area of the entire surgical lamp by making larger the transverse dimension of the reflective shade, thereby avoiding a shadow zone caused by obstruction of an object (such as a doctor's head) under the surgical lamp, and thus achieving a good shadowless effect.

Brief Description of the Drawings

Description of the Drawings

[0011]

- Fig. 1 is a sectional diagram of a surgical lamp in an axial direction;
- Figs. 2A-2H show schematic diagrams of a light source according to various embodiments;
- Figs. 3A-3C show schematic diagrams of a light deflection element according to various embodiments;
- Fig. 4 is a structural schematic diagram of a fold line reflective shade in an embodiment;
- Fig. 5 is a structural schematic diagram of the reflective shade using the principle of total reflection in another embodiment;
- Fig. 6 is a schematic diagram of adjusting a light spot by changing the light source in an embodiment;
- Fig. 7 is a structural schematic diagram of a light-emitting device in an embodiment of adjusting the light spot by a light spot adjustment assembly;
- Figs. 8A-8F show schematic diagrams of a light spot adjustment process of the embodiment shown in Fig. 7;
- Fig. 9 is a structural schematic diagram of the light-emitting device in another embodiment of adjusting the light spot by the light spot adjustment assembly;
- Fig. 10 is a structural schematic diagram of the light-emitting device in still another embodiment of adjusting the light spot by the light spot adjustment assembly;
- Fig. 11 is a structural schematic diagram of the light-emitting device added with an optical filter.

Best Mode for Carrying out the Invention

Best Mode of the Invention

[0012] The paragraph describing the best mode of the present invention is entered here.

Embodiments of the Invention

Particular Embodiments of the Invention

[0013] The present invention will be further described in detail below in conjunction with the accompanying drawings and specific embodiments. Similar elements in various embodiments use associated similar element reference signs. In the following embodiments, many details are described for the purpose of facilitating better understanding of the present application. However, it would be effortlessly appreciated by those skilled in the art that some features may be omitted or may be substituted by other elements, materials and methods in a different situation. In certain cases, some operations relevant to the present application are not displayed or described in the description, and this is to prevent the core part of the present application from being obscured by too much description. Moreover, for those skilled in the art, describing these relevant operations in detail is not necessary, and they may completely understand relevant operations according to the description and general technical knowledge in the art.

[0014] In addition, the characteristics, operations or features described in the description may be combined in any appropriate manner to form various embodiments. Moreover, the steps or actions in the method description may also be changed or adjusted in sequence in a way that would be obvious to those skilled in the art. Therefore, the various sequences in the description and drawings are only for the purpose of clearly describing a certain embodiment and are not meant to be a necessary sequence that must be followed, unless otherwise specified.

[0015] The serial numbers themselves for the components herein, for example, "first", "second", etc., are only used to distinguish the described objects, and do not have any sequential or technical meaning. As used in the present application, "connect" or "couple", unless otherwise specified, includes both direct and indirect connections (coupling).

[0016] The light-emitting device disclosed in an embodiment of the present invention no longer adopts the solution of Gypsophila composed of a plurality of small lighting units, but one or more light sources share an optical system, which collects light emitted by the light source, and after reflection, the light will converge into a desired light spot. Hereinafter, an example in which the light-emitting device is applied to a surgical lamp will be described.

[0017] Referring to Fig. 1, Fig. 1 is a sectional diagram of a surgical lamp in an axial direction. The surgical lamp comprises a lamp head, and the lamp head further comprises a light-emitting device 100, a lamp head rear shade 200 and a lamp head front shade 300, wherein the light-emitting device 100 is mounted on the lamp head rear shade 200, the lamp head rear shade 200 and the lamp head front shade 300 enclose an accommodating chamber, and the light-emitting device 100 is enclosed in the accommodating chamber. The light-emitting device 100 comprises a light source 1, a light deflection element 2 and a reflective shade 3, wherein the reflective shade 3 comprises a top end 301, a bottom end 302 and a reflector body 303, the reflector body gradually expands from the top end to the bottom end, the bottom end is provided with an annular opening, the top end may also be provided with a small annular opening, and a shape of the annular opening may be circular, elliptic or polygonal. In other particular embodiments, the top end may also be enclosed, for example as a tip or a platform. As a whole, the reflective shade 3 is umbrella-shaped, and is fixed to the lamp head rear shade. The light source 1 is located in a top area of the reflective shade, and a light exit surface faces the bottom end of the reflective shade, the light source 1 is preferably mounted on a circuit board (not shown in the figures), and the circuit board is fixed on the lamp head rear shade, which is equivalent to the case where the light source 1 is placed near the top of the center of the surgical lamp, so that heat generated by the light source may be quickly transmitted to the lamp head rear shade through a large area heat conduction pathway. The light deflection element 2 is located between the light source 1 and the reflective shade 3, and the light deflection element 2 is mounted on the lamp head rear shade or at the top end of the reflective shade 3 or on the circuit board.

[0018] The various parts of the light-emitting device and its optical processing idea are described below.

[0019] In this embodiment, the light source 1 uses a forward light-emitting light source, the forward light-emitting light source is characterized in that light rays are emitted substantially in the range of 0-180 degrees, and therefore, light emitted by the light source 1 includes forward light and lateral light. In other embodiments, the light source 1 may also be a light source that shines around. The included angle between a light beam and an optical axis is defined herein as the angle of divergence, the forward light refers to a light beam with the angle of divergence being less than or being less than or equal to a certain value, and the lateral light refers to a light beam with the angle of divergence being greater than or equal to or being greater than a certain value and being less than the maximum divergence. For example, for a light source that emits light in the range of 180 degrees, a light beam with the angle of divergence being less than or being less than or equal to 40 degrees, 45 degrees or 50 degrees is referred to as forward light, and correspondingly, a light beam with the angle of divergence being greater than or equal to or being greater than 40 degrees, 45 degrees or 50 degrees and being less than 90 degrees is referred to as lateral light. For a light source that emits light in the range of 90 degrees, a light beam with the angle of divergence being less than or equal to 30 degrees or 35 degrees is referred to as forward light, and correspondingly, a light beam with the angle of divergence being greater than 30 degrees or 35 degrees and being less than 45 degrees is referred to as lateral light. It may be seen that no matter what kind of light source, the angle of divergence of the lateral light is greater than the angle of divergence of the forward light.

[0020] In this embodiment, the light source 1 may be one light source or a combination of a plurality of light sources, and types of light source include but are not limited to an LED, an OLED, a laser, an optical fiber, an optical fiber bundle, fluorescent powder, a light guide tube, etc. The optical fiber, the optical fiber bundle, the light guide tube, etc. may be collectively referred to herein as a light guide for introducing light rays from a light source outside the lamp head that would otherwise be energy to the position of the light source of the light-emitting device for use as a light source within the light-emitting device. When the light source 1 uses the combination of a plurality of light sources, the combination of different types of light sources may be used to change the spatial distribution characteristics, spectral characteristics, strength characteristics and other parameters of the entire light source to meet different clinical needs. When the combination of a plurality of light sources is used, the degree of mixing of different light sources after reflection may be changed by controlling the size of the light-emitting area of the light source and the parameters of the reflective shade, thereby achieving uniform mixing of light. For example, as shown in Fig. 2, and in Fig. 2A, an LED light source 101 is used as the light source 1; in Fig. 2B, two light sources, i.e. a high color temperature LED 102 and a low color temperature LED 103, are combined to form the light source 1 to realize a color temperature adjustment function of the surgical lamp by adjusting their relative brightness; in Fig. 2C, an OLED area light source 104 is used as the light source 1; in Fig. 2D, an optical fiber, an optical fiber bundle or a light conduit 105 is used to introduce light rays from the light source 106 outside the lamp head of the surgical lamp into the position of the light source of the lamp head of the surgical lamp to form the light source 1; in Fig. 2E, a lens 107 is used to cooperate with the optical fiber (bundle) 108 to form the light source 1, to further expand the angle of divergence of the light rays emitted by the optical fiber (bundle); in Fig. 2F, the light emitted from the head end of the optical fiber (bundle) further excites the fluorescent powder 109 to form the light source 1, which may realize the conversion of the wavelength of the light rays; in Fig. 2G, various fluorescent powder or optical fibers (bundles) of light sources are combined to form the light source 1, for example, high color temperature fluorescent powder and low color temperature fluorescent powder are used to achieve a color temperature adjustment function; and Fig. 2H is an example of the combination of different types of light sources.

[0021] For a light source with light ray distribution in the range of 0° to 180°, how to collect and utilize light rays as much as possible is crucial. In the absence of the light deflection element 2, the lateral light emitted by the light source 1 has a large angle of divergence, and thus part, most or all of the lateral light may be emitted to the inside of the reflective shade. However, since the forward light emitted by the light source 1 has a small angle of divergence, and the reflective shade is restricted by the longitudinal dimension and cannot be made too large in the longitudinal direction, the forward light cannot be irradiated to the inside of the reflective shade, causing that the light emitted by the light source cannot be fully utilized. However, if it is considered that the reflective shade is disposed on a light path of the forward light to collect the forward light, the lateral light cannot be collected because the surgical lamp is spatially constrained by the design of the reflective shade. To this end, in an embodiment of the present invention, a light deflection element 2 is used to collect light rays in the range of 0° to 180° (i.e., the range in which the angle of divergence is greater than or equal to 0° and less than 90°). The light deflection element 2 is located between the light source 1 and the reflective shade 3, specifically on light paths of the forward light and the lateral light, to collect the forward light and the lateral light, and adjust deflection directions of the forward light and the lateral light, such that both the forward light and the lateral light exited after the adjustment may be projected to the inside of the reflector body of the reflective shade. In particular embodiments, the light deflection element 2 may adjust the light propagation directions of the forward light and the lateral light by the combination of one or more of refraction, reflection and total reflection, such that both the forward light and the lateral light exited from the light deflection element are propagated towards the direction of the reflective shade. In some embodiments, the light propagation directions of the forward light and the lateral light exited from the light deflection element are adjusted to be close to or consistent with each other, as shown in Fig. 3. In order to compress the thickness of the reflective shade in the longitudinal direction as much as possible, a small deflection of the lateral light may be performed, and a large deflection of the forward light may be performed.

[0022] In order to make full use of the lateral light emitted by the light source, the light deflection element 2 performs at most twice reflections and/or total reflections on the lateral light, that is, the total number of reflections and/or total reflections of the lateral light by the light deflection element 2 is at most two. When the light rays are reflected, the energy of the light rays will be lost, and multiple reflections will cause cascaded loss, resulting in ineffective use of light energy. The reflection or total reflection of the light rays is limited by the manufacturing process and assembly and other factors of an optical element. The reflected or totally reflected light ray has a certain angle deviation from a theoretical reflection angle. The deviation of the reflection angle will affect the size or location of the light spot formed by the convergence of the reflection shade, and multiple reflections or total reflections further magnify the reflection angle deviation. In view of the above, the light deflection element 2 of the solution of the present application performs at most two reflections and/or total reflections of the lateral light.

[0023] To improve the rational use of the forward light, and based on the reasons as described above, the total number of reflections and/or total reflections of the forward light may also be set to be at most two.

[0024] The specific structure of the light deflection element 2 is exemplified in Figs. 3A-3C, the light deflection elements 2 in these examples are symmetrical about their central axes, the light source 1 emits light rays in the range of 180°, and the direction indicated by 90° is an optical axis (i.e. the center), 0° and 180° indicate edges.

[0025] In an embodiment shown in Fig. 3A, the light deflection element 2 collects lateral light near the edge by refraction (e.g. light rays with the angle of divergence being between 60 degrees and 90 degrees, 60° < the angle of divergence < 90°), and collects forward light near the center by total reflection (e.g. light rays with the angle of divergence being between 0 degrees and 60 degrees, 0° ≤ the angle of divergence ≤ 60°). The light deflection element 2 comprises a refraction 201 and a total reflection portion 202, the refraction portion 201 and the total reflection portion 202 are transparent medium, the refraction portion 201 is disposed on a light path of lateral light to collect the lateral light, and the total reflection portion 202 is disposed on a light path of the forward light to collect the forward light. Fig. 3A shows a sectional diagram of the light deflection element 2 along a central axis, and the light deflection element 2 is shown by the figure shown in Fig. 3A to rotate around the central axis. The refraction portion 201 is in a shape of a bowl with a bowl opening facing upwards and is fixed to the rear of the lamp head, the refraction portion 201 comprises an outer surface 2011 and an inner surface 2012, the inner surface 2012 encloses a square groove with an upper opening forming the bowl opening, and the light source 1 is disposed at a bowl opening area of the refraction portion 201. The lateral light emitted by the light source 1 is incident to the inner surface 2012, and the lateral light is refracted and then exited from the outer surface 2011. The outer surface 2011 is a convex surface, which is referred to as a first convex surface for the convenience of description. The curvature of the first convex surface 2011 changes with the angle of divergence of the lateral light, such that the light propagation direction of the lateral light refracted by the first convex surface is close or consistent. The total reflection portion 202 is located below the refraction portion 201, specifically on the light path of the forward light. The total reflection portion 202 comprises a light incident surface 2021, a total reflection surface 2022 and a light exit surface 2023, wherein the incident surface 2021 and the light exit surface 2023 may be planes, the total reflection surface 2022 is a convex surface which is referred to herein as a second convex surface, and the second convex surface extends downwards obliquely from the central axis. The forward light emitted by the light source 1 is incident from the incident surface 2021 and then irradiated to the second convex surface 2022, the curvature of the second convex surface 2022 changes with the angle of divergence of the forward light, such that the angle of incidence of the forward light on an inner side face of the second convex surface is greater than or equal to a critical angle, and thus the forward light is totally reflected on the second convex surface 2022; and such that the light propagation direction of the forward light after reflected by the second convex surface is close or consistent, and the forward light after total reflection is exited from the light exit surface 2023. In the embodiment shown in Fig. 3A, propagation directions of light rays of the lateral light and the forward light after passing through the light deflection element 2 are substantially parallel, and the light rays are irradiated to the reflective shade 3 in a horizontal direction.

[0026] In a preferred embodiment, the refraction portion 201 and the total reflection portion 202 of the light deflection element 2 may be integrated together and integrally formed using a mold during fabrication.

[0027] In an embodiment shown in Fig. 3B, the light deflection element 2 collects light rays of all angles by two total reflections. The light deflection element is a transparent medium, and comprises a third convex surface 203, a fourth convex surface 204 and a light exit surface 205, wherein the third convex surface 203 and the fourth convex surface 204 are opposite each other, the third convex surface 203 extends downwards obliquely from the plane of the light source and is located on a light path of the lateral light to collect the lateral light, and the curvature of the third convex surface 203 changes with the angle of incidence of the lateral light, such that the lateral light is totally reflected on an inner side face of the third convex surface 203 and is reflected to an inner side of the fourth convex surface 204. The fourth convex surface 204 extends downwards obliquely from the central axis and is located on a light path of the forward light to collect totally reflected light of the forward light and the lateral light, and the curvature of the fourth convex surface changes with the angle of incidence of the totally reflected light of the forward light and the lateral light, such that the angle of incidence of the totally reflected light of the forward light and the lateral light on an inner side face of the fourth convex surface is greater than or equal to the critical angle of total reflection, and the light propagation directions of the totally reflected light of the forward light and the lateral light after reflected by the fourth convex surface are close to or consistent with each other. Fig. 3B shows a sectional diagram of the light deflection element 2 along the central axis, the light exit surface 205 is a plane connecting edges of the third convex surface 203 and the fourth convex surface 204, and the solid of the light deflection element 2 is formed by the figure shown in Fig. 3B to rotate around the central axis. In the embodiment shown in Fig. 3B, propagation directions of light rays of the lateral light and the forward light after passing through the light deflection element 2 are substantially parallel, and the light rays are irradiated to the reflective shade 3 in the horizontal direction.

[0028] In an embodiment shown in Fig. 3C, the light deflection element 2 collects edge light rays by refraction of a separate element, and collects light rays near the center by reflection of another element. The deflection element 2 comprises a refraction portion 206 and a reflection portion 207. The refraction portion 206 is a transparent medium, the refraction portion 206 is disposed on a light path of the lateral light to collect the lateral light, and the refraction portion 206 is composed of a light incident surface 2061, a fifth convex surface 2062 as a light exit surface, and a top face 2063. The top face 2063 is fixed to the rear of the lamp head, the light incident surface 2061 may be formed into a plane and is located on the side face of the refraction portion 206, and the curvature of the fifth convex surface 2062 changes with the angle of divergence of the lateral light, such that the light propagation direction of the lateral light refracted by the fifth convex surface is close or consistent. The reflection portion 207 is a concave mirror located below the refraction portion 206, and the concave mirror extends downwards obliquely from the central axis and the concave mirror is symmetrical mirror about the central axis. Fig. 3C shows a sectional diagram of the light deflection element 2 along the central axis, and the solid of the light deflection element 2 is formed by the figure shown in Fig. 3C to rotate around the central axis. In the embodiment shown in Fig. 3C, light rays of the lateral light and the forward light after passing through the light deflection element 2 are irradiated to the reflective shade 3 in the horizontal direction, and propagation directions of the light rays are substantially parallel, and the light rays. In actual production, the refraction portion 206 and the reflection portion 207 use independent elements, the refraction portion 206 is fixed to the rear of the lamp head, and the reflection portion 207 may be fixed to a supporting frame which is fixed to the interior of the lamp head.

[0029] Figs. 3A-3C mentioned above are merely exemplary embodiments of the light deflection element 2. Based on the transmission (especially refraction), reflection or total reflection treatment of the lateral light and the forward light by the light deflection element 2, other shapes of the light deflection element 2 may also be designed to adjust the light propagation directions of the lateral light and the forward light.

[0030] In an embodiment, on the basis of the light deflection element 2 of Fig. 3A, an optical element may be added, which is located on a light path between the light deflection element 2 and the reflective shade. The optical element is used for further shaping the lateral light and the forward light that are adjusted via the light deflection element 2, for example, being able to perform further refraction such that the light propagation directions of the lateral light and the forward light are close to or consistent with each other.

[0031] In an embodiment, the light deflection element 2 comprises a refraction portion, which is made of a transparent material and comprises a first curved surface located on the light path of the lateral light, and the curvature of the first curved surface changes with the angle of divergence of the lateral light. The first curved surface refracts the lateral light projected on the first curved surface, and the refracted lateral light is exited from the light deflection element onto the reflector body of the reflective shade.

[0032] In an embodiment, the light deflection element 2 comprises a first non-transmission portion, which refers to that incident light will not penetrate and exit, but does not limit whether it is transparent. For example, the first non-transmission portion may be a total reflection portion made of a transparent material, or a non-transparent reflection portion coated with a reflective coating. The first non-transmission portion comprises a second curved surface located on the light path of the lateral light, and the curvature of the second curved surface changes with the angle of incidence of the lateral light. When the first non-transmission portion is the total reflection portion, the second curved surface totally reflects the lateral light projected on the second curved surface, and the totally reflected lateral light is exited from the light deflection element onto the reflector body of the reflective shade. When the first non-transmission portion is the reflection portion, the second curved surface reflects the lateral light projected on the second curved surface, and the reflected lateral light is exited from the light deflection element onto the reflector body of the reflective shade.

[0033] In an embodiment, the light deflection element 2 may further comprise a second non-transmission portion, which is similar to the first non-transmission portion, and may be a total reflection portion made of a transparent material or a non-transparent reflection portion coated with a reflective coating. The second non-transmission portion comprises a third curved surface located on the light path of the lateral light, and the curvature of the third curved surface changes with the angle of incidence of the lateral light. When the second non-transmission portion is the total reflection portion, the third curved surface totally reflects the lateral light projected on the third curved surface, the totally reflected lateral light is projected onto the first non-transmission portion, and the first non-transmission portion performs a secondary total reflection on the totally reflected light of the lateral light; and In this case, the lateral light projected onto the reflector body is the lateral light after the secondary total reflection. When the second non-transmission portion is the reflection portion, the third curved surface reflects the lateral light projected on the third curved surface, the reflected lateral light is projected onto the first non-transmission portion, and the first non-transmission portion performs a secondary reflection on the reflected light of the lateral light; and In this case, the lateral light projected onto the reflector body is the lateral light after the secondary reflection.

[0034] In the above embodiment, after the light deflection element 2 refracts, reflects, and/or totally reflects the lateral light, the light propagation direction of the lateral light may be adjusted to be projected onto the reflector body, for example, for the light source disposed on the optical axis, the light propagation direction of the lateral light may be adjusted to be projected in an approximately parallel manner to different positions on the reflector body. In the above embodiment, the first curved surface may be, for example, the first convex surface or the fourth convex surface in Figs. 3A-3C; the second curved surface may be, for example, the third convex surface of a total reflection type, the fourth convex surface of a total reflection type or the concave mirror of a reflection type in Figs. 3A-3C; the third curved surface may be, for example, the second convex surface of a total reflection type or a composite curved surface in Figs. 3A-3C; and alternatively, the first curved surface, the second curved surface and the third curved surface may be a composite curved surface fitted in a concave and convex manner.

[0035] In a specific example, as shown in Fig. 1, the reflective shade 3 may be composed of a reflective mirror using the principle of reflection, and light rays irradiated on the reflective mirror are reflected, superimposed and then converged in a surgical region 5. In order to reduce the height of the reflective shade such that the lamp head of the surgical lamp looks lighter and more beautiful, the cross section of the reflective shade may be in the form similar to a fold line. Referring to Fig. 1, the cross section of the reflective mirror along the central axis is a fold line. As shown in Fig. 4, each bend on the reflector body forms an annular reflector band 304, and the radius of the reflector band increases along the direction from the top end to the bottom end in a stepwise manner.

[0036] The reflector band may be enclosed by a plurality of planes, which is referred to herein as scalewise of the reflector band in an embodiment, and the planes may be trapezoidal planes, triangular planes, etc. As shown in Fig. 4, the trapezoidal planes 305 are connected end to end to form the annular reflector band, and with this structure, the cross section of the reflector band in a radial direction is polygonal.

[0037] In a further specific example, as shown in Fig. 5, the reflective shade may also be composed of a total reflection transparent element 6 using the principle of total reflection. Light rays pass through a first surface of the reflective shade and are transmitted into its interior, and when the light rays reach a reflection surface, if the angle of incidence of the light rays is greater than a total reflection angle, a total reflection is formed, and the reflected light rays are refracted by a lower surface and then are exited, superimposed and converged in the surgical region 5. The cross section of the transparent element 6 in Fig. 5 may also be in the form similar to the fold line in the figure in order to reduce the weight and the height.

[0038] Generally, the production process of the reflective shade determines that the reflective surface of the reflective shade is susceptible to environment, wiping and other factors; and therefore, in the surgical lamp using the reflective shade, the lamp head of the surgical lamp further comprises a lamp head rear shade, a light-transmitting lamp head front shade and other elements, and the reflective shade is protected between the lamp head rear shade and the lamp head front shade. The transparent element in the solution of total reflection, is generally processed by an injection molding or mold pressing process and does not require a reflective film layer, the surface of the transparent element has good weather resistance and wiping resistance, so the transparent element may be directly presented to a user without the protection of the lamp head rear shade and/or the lamp head front shade. Therefore, the use of the solution of total reflection may reduce the elements of the surgical lamp, and makes the surgical lamp more beautiful, have more design sense and high-end.

[0039] When the light-emitting device is in operation, the light rays 4 emitted by the light source 1 are collected through the light deflection element 2, the transmission, reflection or total reflection are utilized and exit directions of the light rays are deflected, and the light rays, after deflected by a large angle, are directed to the periphery of the lamp head in a nearly horizontal direction. The light rays that are directed towards the periphery are then collected by the reflective shade 3 and reflected to the surgical region 5, and the reflected light rays 4 are superimposed to each other in the surgical region 5, finally forming a surgical lamp which has a certain lamp head area and a good shadowless effect.

[0040] In this embodiment, by the cooperation of the light deflection element and the reflective shade, light rays of various angles that are emitted by the light source may be effectively utilized, and when the surgical lamp is installed, the size of the formed light spot may be changed by changing the distance from the surgical lamp to the surgical region.

[0041] Since the geometry of the reflective shade in this solution is much larger than the size of a combined light source, for example, when the surgical lamp uses only one large reflective shade, the diameter of the circular large reflective shade is generally 400-750 mm, and the size of the LED light source, the optical fiber, the optical fiber bundle, etc. is generally 0.01-20 mm, these combined light sources may be regarded as an approximate small light source with respect to the reflective shade; and sub-light sources of this small light source are reflected by the reflective shade and then form superimposed diffusion spots in the surgical region, so the large reflective shade in this solution is very beneficial for uniform mixing of light from the combined light sources. Moreover, by further scalewise of the reflective shade, the uniformity of mixing of light will be further enhanced, so that the light rays emitted by all the different types of light sources may be uniformly irradiated to the surgical region after reflected, mixed and superimposed by the reflective shade, thus non-uniformity in spectral spatial distribution of the light spot in the surgical region may be avoided or reduced.

[0042] At the same time, when a plurality of light sources are provided, since the light rays of different light sources are first mixed at the reflective shade within the lamp head and then reflected to the surgical region, which is equivalent to emitting the light rays through one lighting unit, and therefore, when an object such as a doctor's head, arm, hand obstructs between the lamp head and the surgical region, no distinct colored stripes appear in the surgical region.

[0043] Usually, the distance from the surgical lamp to the surgical region during operation is adjusted according to the height of the doctor and then keeps constant, however, during the use of the surgical lamp, different surgical procedures and types may require different surgical fields of surgical operation, and at this time, it is necessary to adjust the size of the light spot of the surgical lamp. In the case of a plurality of light sources, the size of the light spot may be changed by adjusting the lighting of different light sources.

[0044] As shown in Fig. 1, the light source 1 is located in the center of the surgical lamp, that is, the optical axis of the light source 1 coincides with the central axis of the surgical lamp, and after the light rays 4 are collected and deflected by the light deflection element 2 and reflected by the reflective shade, the converging light spot is located in the central axis of the surgical lamp. In this embodiment, the solution of a plurality of light sources is used, and the plurality of light sources may be arranged in a square array or may be arranged in a plurality of concentric circles. When it is necessary to change the size of the light spot, a peripheral light source of a central light source or a combined light source of the central light source and the peripheral light source may be employed. When the peripheral light source or the combined light source is in operation, the light rays emitted by the peripheral light source or the combined light source are collected by the reflective shade and reflected to the surgical region. Since the optical axis of the light source deviates from the central axis, at this time the light rays cannot be completely converged by the reflective shade, a large light spot is formed in the surgical region. As shown in Fig. 6, the light rays emitted by the peripheral light source 7 that is off-center are deflected by the light deflection element 2 and then produce light rays in different directions, said light rays are no longer horizontal with respect to the light rays in Fig. 1, have a large deviation angle, are reflected by the reflective shade 3 and then produce divergent light rays 8 having different irradiation directions and positions, and finally form a large area illumination light spot in the surgical region 5, and the illumination light spot deviates from the optical axis of the light source. Therefore, when the surgical lamp of the embodiment of the present invention is used, if the size of the illumination light spot in the surgical region needs to be adjusted to adapt to the operation of different incision sizes, it may be achieved by adjusting the light-emitting area of the combination of light sources; when a small light spot is required, only the light source near the center is used to emit light; and When a large light spot is required, the intensity of the light source away from the center may be increased. In this way, the size of the light spot may be adjusted quickly and quietly, which is beneficial to the user's clinical experience.

[0045] The size of the light spot may be adjusted by means of a light spot adjustment assembly, and Figs. 7-9 show examples of the light spot adjustment assembly. As shown in Fig. 7, the light spot adjustment assembly comprises a first column cylinder 9 and a second column cylinder 10, wherein the column cylinder may be a cylindrical cylinder or a prismatic cylinder, the first column cylinder 9 is nested inside the second column cylinder 10, the first column cylinder 9 and the second column cylinder 10 surround the outside of the light deflection element 2 and are disposed on light paths between the light deflection element 2 and the reflective shade 3, an interval is provided between the first column cylinder 9 and the second column cylinder 10 to form an air gap, and when the shape of at least one of the first column cylinder and the second column cylinder is changed, the shape of the air gap is changed, and the size of the light spot is adjusted by changing the shape of the air gap. The shape of the first column cylinder and the second column cylinder referred to herein includes the shape and state, and the state includes change of position. The change of form of the first column cylinder and the second column cylinder may be adjusted by an adjusting device, which will be described in detail below; and the change of form of the first column cylinder and the second column cylinder may also be achieved by the structural or material characteristics of the first column cylinder and the second column cylinder. For example, an outer surface of the first column cylinder and an inner surface of the second column cylinder may be deformed by contraction and/or expansion, to thus change the shape of the air gap between the first column cylinder and the second column cylinder.

[0046] Referring to Fig. 8A, the outer surface of the first column cylinder 9 is provided with a first concave-convex surface structure 9a, the inner surface of the second column cylinder 10 is provided with a second concave-convex surface structure 10a, the first concave-convex surface structure and the second concave-convex surface structure may be directly shaped on the outer surface of the first column cylinder and the inner surface of the second column cylinder, respectively, or a layer of concave-convex structure may be attached to the outer surface of the first column cylinder and the inner surface of the second column cylinder. An air gap 12 is provided between the first concave-convex surface structure and the second concave-convex surface structure, the first column cylinder 9 and the second column cylinder 10 may move relative to each other, and the shape of the air gap 12 is changed by movement.

[0047] In this embodiment, the first concave-convex surface structure 9a has a first wavy surface structure, and the second concave-convex surface structure 10a has a second wavy surface structure. In other embodiments, the first concave-convex surface structure and the second concave-convex surface structure may also be a pit or bump structure, or a groove or rib structure. The first wavy surface structure and the second wavy surface structure fluctuate in a circumferential direction, the first column cylinder and the second column cylinder may be controlled by the adjusting device to move relative to each other in the circumferential direction, thus changing the shape of the air gap 12, and the adjustment principle is as follows:

[0048] the light source is placed in the center, a certain interval of air gap is formed between two cylinder waves, and the two waves are similar in shape. Fig. 8A shows a horizontal cross-sectional diagram of relative positions of the two cylinders in the state of a small light spot, a peak point of the first column cylinder 9 corresponds to a valley point of the second column cylinder 10 on an outer ring, and an approximately parallel air gap 12 is formed between the first column cylinder 9 and the second column cylinder 10, as shown in Fig. 8D. Fig. 8D shows the direction of the light rays in the horizontal cross section of the small light spot, the light rays pass through the parallel air gap 12, the included angle 13 between two edges of the air gap 12 is zero, so that the light rays pass through the parallel air gap 12 which is equivalent to a plate of glass, and therefore, the exit direction of the light ray 14 passing through the two cylinders does not change, is deviated by a small displacement but remains parallel to an incident direction; and thus the light rays remain substantially in their original states after passing through the cylinders. After the first column cylinder 9 is rotated, the peak point of the first column cylinder 9 and the valley point of the second column cylinder 10 on the outer ring are staggered at a certain distance, as shown in Fig. 8B; wedged air gaps 12 of different sizes are formed between the first column cylinder 9 and the second column cylinder 10, as shown in Fig. 8E; and the included angle between the two edges of the air gap 12 is not zero, which is equivalent to the air gap 12 gradually becoming an air convex lens, the refractive index of the cylinder material is higher than the refractive index of air, and then the air convex lens has a diverging effect, so the light rays pass through the wedged air gap 12 and then diverge outwards, making the size of the light spot become large. When the first column cylinder rotates at a small angle and the light rays pass through the gap 12, part of the air gap has a small wedge angle 15, through which the light rays 16 are deflected at a small angle;

part of the air gap has a large wedge angle 17, through which the light rays 18 are deflected at a large angle; therefore, after the light rays pass through the first and second column cylinders, some of the light rays are deflected less and some are deflected more, some of the light rays after reflected by the reflective shade are closer to the central axis and some are far away, and finally the light rays are superimposed and combined to form a light field having a certain light intensity distribution; when there are more light lays that are closer to the central axis, the light intensity is more concentrated on the optical axis, and the user will see and feel a small light spot; and when there are more light rays that are far away from the central axis, the light intensity increases around, and the user will see and feel a large light spot. Therefore, with the rotation of the first column cylinder, the light spot gradually changes from small to large. With continuous rotation of the first column cylinder 9, the peak point of the first column cylinder 9 corresponds to the peak point of the second column cylinder 10 on the outer ring, and the valley point of the first column cylinder and the valley point of the second cylinder correspond to each other. Fig. 8C is a horizontal cross-sectional diagram of relative positions of the two cylinders in the state of the maximum light spot, and a complete wedged air gap 12 is formed between the first column cylinder 9 and the second column cylinder 10. Fig. 8F shows the directions of the light rays of the maximum light spot, the light rays pass through the wedged air gap 12, all of the air gaps have the maximum wedge angle 19, at this time, the deflection angle 20 of the light rays is the maximum deflection angle, and therefore, the light rays after reflected by the reflective shade form the maximum light spot.

[0049] It can be seen that, when the air gap is in a parallel state, the angles of the light rays passing through the two cylinders to the reflective shade do not change the angle, and are reflected by the reflective shade and then form a small light spot in the surgical region. When it is necessary to increase the size of the light spot, one of the cylinders is rotated to change the shape of the air gap to form wedge-shaped air, such that the light rays are deflected left and right when passing through the two cylinders, the angle of divergence of the light rays after reflected by the reflective shade is further increased, and a large light spot is formed in the surgical region.

[0050] In another embodiment, as shown in Fig. 9, the first wavy surface structure and the second wavy surface structure fluctuate in the axial direction, and the first column cylinder 21 and the second column cylinder 22 may move relative to each other in the axial direction. When the first column cylinder 21 and the second column cylinder 22 move relative to each other in the axial direction, the corresponding positions of the peak points and the valley points of the first wavy surface structure and the second wavy surface structure are changed, thereby changing the wedge angle of the air gap, and similarly being able to change the size of the light spot.

[0051] Fig. 10 discloses another solution of the light spot adjustment assembly, as shown in Fig. 10, the light spot adjustment assembly comprises a first light-transmitting plate 24 and a second light-transmitting plate 25, the first light-transmitting plate 24 and the second light-transmitting plate 25 are disposed opposite each other, for example, the first light-transmitting plate 24 and the second light-transmitting plate 25 are disposed parallel to each other, and the first light-transmitting plate 24 and the second light-transmitting plate 25 are located on a light path of the light rays after reflected by the reflective shade; and the first light-transmitting plate 24 and the second light-transmitting plate 25 may move relative to each other, a third concave-convex surface structure is provided on the surface of the first light-transmitting plate 24 that faces the second light-transmitting plate, a fourth concave-convex surface structure is provided on the surface of the second light-transmitting plate 25 that faces the first light-transmitting plate, and an air gap 26 is provided between the third concave-convex surface structure and the fourth concave-convex surface structure. Based on the same principle as in the third embodiment, when the relative positions of the first light-transmitting plate 24 and the second light-transmitting plate 25 are adjusted by the adjusting device, the shape of the air gap 26 may be changed, and based on the same principle as in the third embodiment, the size of the light spot may be changed.

[0052] As shown in Fig. 11, in the above embodiment, an optical filter 23 may be added between the light source 1 and the light deflection element 2 for filtering or reducing unwanted wavelength energy to modulate the light source spectrum. For example, an infrared cut optical filter is added for reducing near-infrared light to improve the cold light performance of the surgical lamp; in another example, an optical filter modulated for a visible light band is added to improve the color temperature or color rendering index of the light source; and in still another example, a blue light cut optical filter is added to improve the blue light characteristics of a white LED light source and reduce the blue light hazard of the surgical lamp, etc. In this solution, the surface of the light deflection element may also be directly coated with an optical thin film to filter or reduce the unwanted wavelength energy.

[0053] In some embodiments, the lamp head of the surgical lamp includes a plurality of light-emitting modules, each light-emitting module comprises one light-emitting device described above, the plurality of light-emitting modules may be separately or integrally mounted and tilted at a predetermined angle, such that the respective light-emitting devices are tilted at a predetermined angle, and central axes of light-emitting devices intersect at one point. In this case, the light emitted by the plurality of light sources is reflected by the respective reflective shade, and then the light rays may be concentrated on a light spot.

[0054] The present invention has been described with reference to specific examples, which are merely for the purpose of facilitating understanding of the present invention and are not intended to limit the present invention. It will be apparent to those skilled in the art that changes may be made to the specific embodiments described above in accordance with the teachings of the present invention.

Claims

1. A light-emitting device, comprising:

a reflective shade, which comprises a top end, a bottom end having an annular opening, and a reflector body gradually expanding from the top end to the bottom end, causing light projected to an inner side of the reflector body to converge into a light spot of a predetermined size after reflection;

a light source, which is located at the top end of the reflective shade and faces the bottom end of the reflective shade, and at least emits forward light and lateral light; and

a light deflection element, which is located between the light source and the reflective shade, is located on light paths of the forward light and the lateral light to collect the forward light and the lateral light, and adjusts light propagation directions of the forward light and the lateral light, such that the forward light and the lateral light exited from the light deflection element are projected to the inner side of the reflector body of the reflective shade.

2. The light-emitting device of claim 1, wherein the light deflection element adjusts the light propagation directions of the forward light and the lateral light by a combination of one or more of refraction, reflection and total reflection, such that the light propagation directions of the forward light and the lateral light exited from the light deflection element are close to or consistent with each other; and the light deflection element performs at most two reflections and/or total reflections on the lateral light.

3. The light-emitting device of claim 2, wherein the light deflection element comprises a refraction portion and a total reflection portion, the refraction portion and the total reflection portion are transparent medium, the refraction portion is disposed on the light path of the lateral light to collect the lateral light, the refraction portion comprises a first convex surface for exiting light, and a curvature of the first convex surface changes with an angle of divergence of the lateral light, such that the light propagation direction of the lateral light refracted by the first convex surface is close or consistent; and the total reflection portion comprises a second convex surface, which is disposed on the light path of the forward light to collect the forward light, a curvature of the second convex surface changes with an angle of divergence of the forward light, such that the angle of incidence of the forward light on an inner side face of the second convex surface is greater than or equal to a critical angle, and the light propagation direction of the forward light reflected by the second convex surface is close or consistent.

4. The light-emitting device of claim 3, wherein the refraction portion and the total reflection portion are integrated together.

5. The light-emitting device of claim 3, wherein the refraction portion is in a shape of a bowl with a bowl opening facing upwards, the light source is disposed at the bowl opening of the refraction portion, and the second convex surface of the total reflection portion extends downwards obliquely from a central axis.

6. The light-emitting device of claim 2, wherein the light deflection element is a transparent medium, the light deflection element comprises a third convex surface and a fourth convex surface, the third convex surface is located on the light path of the lateral light to collect the lateral light, and a curvature of the third convex surface changes with an angle of incidence of the lateral light, such that the lateral light is totally reflected on an inner side face of the third convex surface and is reflected to an inner side of the fourth convex surface; and the fourth convex surface is located on the light path of the forward light to collect totally reflected light of the forward light and the lateral light, and a curvature of the fourth convex surface changes with an angle of incidence of the totally reflected light of the forward light and the lateral light, such that the angle of incidence of the totally reflected light of the forward light and the lateral light on the inner side face of the fourth convex surface is greater than or equal to a critical angle, and the light propagation directions of the totally reflected light of the forward light and the lateral light reflected by the fourth convex surface are close to or consistent with each other.

7. The light-emitting device of claim 2, wherein the light deflection element comprises a refraction portion and a reflection portion, the refraction portion is a transparent medium, the refraction portion is disposed on the light path of the lateral light to collect the lateral light, the refraction portion comprises a fifth convex surface for exiting light, and a curvature of the fifth convex surface changes with an angle of divergence of the lateral light, such that the light propagation direction of the lateral light refracted by the fifth convex surface is close or consistent; and the reflection portion is a concave mirror extending downwards obliquely from a central axis.

8. A light-emitting device, comprising:

a reflective shade, which comprises a top end, a bottom end, and a reflector body extending from the top end to the bottom end;
a light source, which is located at the top end of the reflective shade and faces the bottom end of the reflective shade, and at least emits lateral light; and
a light deflection element, which is located on a light path of the lateral light to collect the lateral light;
wherein the light deflection element adjusts the light propagation direction of the lateral light projected on the light deflection element, such that the lateral light exited from the light deflection element is projected onto the reflector body, the reflector body reflects the lateral light projected on the reflector body, and the lateral light exited from the reflector body converges into a light spot of a predetermined size.

9. The light-emitting device of claim 8, wherein the light deflection element adjusts the light propagation direction of the lateral light by one or more of refraction, reflection and total reflection, and the light deflection element performs at most two reflections and/or total reflections on the lateral light.

10. The light-emitting device of claim 8, wherein the light deflection element comprises a refraction portion, which comprises a first curved surface located on the light path of the lateral light, and a curvature of the first curved surface changes with an angle of divergence of the lateral light; and the first curved surface refracts the lateral light projected on the first curved surface, and the refracted lateral light is exited from the light deflection element onto the reflector body of the reflective shade.

11. The light-emitting device of claim 8, wherein the light deflection element comprises a first non-transmission portion, which comprises a sixth curved surface located on the light path of the lateral light, and a curvature of the sixth curved surface changes with an angle of incidence of the lateral light; and the sixth curved surface totally reflects or reflects the lateral light projected on the sixth curved surface, and the totally reflected or reflected lateral light is exited from the light deflection element onto the reflector body of the reflective shade.

12. The light-emitting device of claim 11, wherein the light deflection element further comprises a second non-transmission portion, which comprises a seventh curved surface located on the light path of the lateral light, and a curvature of the seventh curved surface changes with an angle of incidence of the lateral light; and the seventh curved surface totally reflects or reflects the lateral light projected on the seventh curved surface, and the totally reflected or reflected lateral light is projected onto the first non-transmission portion and is further totally reflected or reflected by the first non-transmission portion.

13. The light-emitting device of any of claims 8-12, wherein the lateral light exited from the light deflection element has a close or consistent light propagation direction.

14. The light-emitting device of any of claims 8-12, wherein the light source further emits forward light, and the light deflection element is further located on a light path of the forward light to collect the forward light; the light deflection element adjusts the light propagation direction of the forward light projected on the light deflection element, such that the forward light exited from the light deflection element is projected onto the reflector body, the reflector body reflects the forward light projected on the reflector body, and the forward light and the lateral light exited from the reflector body converge into a light spot of a predetermined size; and the light propagation directions of the forward light and the lateral light exited from the light deflection element are close to or consistent with each other.

15. The light-emitting device of claim 1 or 14, wherein the light deflection element adjusts the light propagation direction of the forward light by one or more of refraction, reflection and total reflection, and the light deflection element performs at most two reflections and/or total reflections on the forward light.

16. The light-emitting device of claim 14, wherein the light deflection element further comprises a total reflection portion, which comprises a second curved surface located on the light path of the forward light, and a curvature of the second curved surface changes with an angle of incidence of the forward light; the second curved surface totally reflects the forward light projected on the second curved surface, and the totally reflected forward light is projected onto the reflector body of the reflective shade; and/or
the light deflection element further comprises a reflection portion, which comprises a fifth curved surface located on the light path of the forward light; and the fifth curved surface reflects the forward light projected on the fifth curved surface, and the reflected forward light is projected onto the reflector body of the reflective shade.

17. The light-emitting device of claim 1 or 8, wherein the reflector body is a reflective mirror or a total reflection transparent element, a cross section of the reflector body along a central axis is in a shape of a fold line, each bend on the reflector body forms an annular reflector band, and a radius of the reflector band increases along the direction from the top end to the bottom end in a stepwise manner.

18. The light-emitting device of claim 17, wherein the reflector band is enclosed by a plurality of planes.

19. The light-emitting device of claim 1 or 8, wherein one or more light sources are provided, and the light sources are arranged on a central axis or distributed near the central axis.

20. The light-emitting device of claim 19, wherein a plurality of light sources are provided, the plurality of light sources include a central light source disposed on the central axis, and a peripheral light source disposed around the central light source; the light emitted by the central light source forms a first light spot, and the light emitted by the peripheral light source forms a second light spot; and a center of the first light spot is located on the central axis, and the second light spot is eccentrically disposed with respect to the central axis.

21. The light-emitting device of claim 19, wherein a plurality of light sources are provided:
the plurality of light sources comprise a combination of one or more selected from the group consisting of an LED light source, an OLED light source, a laser light source, a fluorescent light source and a light guide; and/or, the plurality of light sources include a first light source emitting first color temperature light and a second light source emitting second color temperature light.

22. The light-emitting device of any of claims 1-7 and 8-12, further comprising a first column cylinder and a second column cylinder that allow light transmission, wherein the first column cylinder is nested inside the second column cylinder, the first column cylinder and the second column cylinder are disposed on the light paths between the light deflection element and the reflective shade, an interval is provided between the first column cylinder and the second column cylinder to form an air gap, and when the shape of at least one of the first column cylinder and the second column cylinder is changed, the shape of the air gap is changed.

23. The light-emitting device of claim 22, wherein an outer surface of the first column cylinder is provided with a first concave-convex surface structure, an inner surface of the second column cylinder is provided with a second concave-convex surface structure, an air gap is provided between the first concave-convex surface structure and the second concave-convex surface structure, and the first column cylinder is capable of moving relative to the second column cylinder.

24. The light-emitting device of claim 23, wherein the first concave-convex surface structure is a first wavy surface structure, and the second concave-convex surface structure is a second wavy surface structure.

25. The light-emitting device of claim 24, wherein the first wavy surface structure and the second wavy surface structure fluctuate in an axial direction, and the first column cylinder and the second column cylinder is capable of moving relative to each other in the axial direction; or the first wavy surface structure and the second wavy surface structure fluctuate in a circumferential direction, and the first column cylinder and the second column cylinder is capable of move relative to each other in the circumferential direction.

26. The light-emitting device of any of claims 1-7 and 8-12, further comprising a first light-transmitting plate and a second light-transmitting plate, wherein the first light-transmitting plate and the second light-transmitting plate are disposed opposite to each other and located on light paths of light rays reflected by the reflective shade, the first light-transmitting plate is capable of move relative to the second light-transmitting plate, a third concave-convex surface structure is provided on a surface of the first light-transmitting plate that faces the second light-transmitting plate, a fourth concave-convex surface structure is provided on a surface of the second light-transmitting plate that faces the first light-transmitting plate, and an air gap is provided between the third concave-convex surface structure and the fourth concave-convex surface structure.

27. A surgical lamp, comprising a lamp head, wherein the lamp head comprises the light-emitting device of any of claims 1-26.

28. The surgical lamp of claim 27, wherein the lamp head further comprises a lamp head rear shade, and the light-emitting device is fixed to the lamp head rear shade.

29. The surgical lamp of claim 28, wherein the lamp head further comprises a transparent lamp head front shade, the lamp head rear shade and the lamp head front shade enclose an accommodating chamber, and the light-emitting device is mounted inside the accommodating chamber.

30. The surgical lamp of any of claims 27 to 29, wherein a plurality of light-emitting devices are provided, and the plurality of light-emitting devices are provided with a tilt of a predetermined angle, such that central axes of the light-emitting devices intersect at one point.

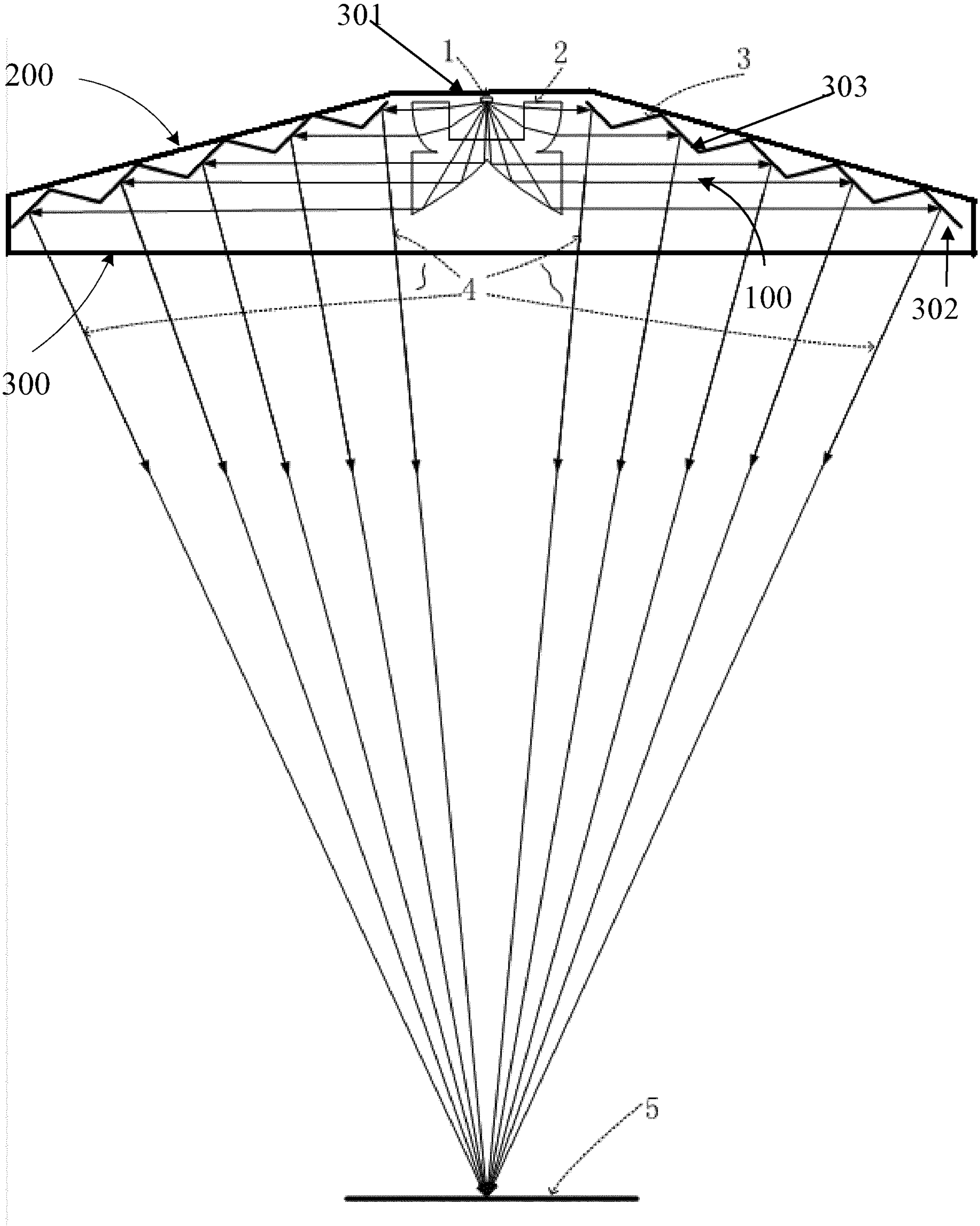

Fig. 1

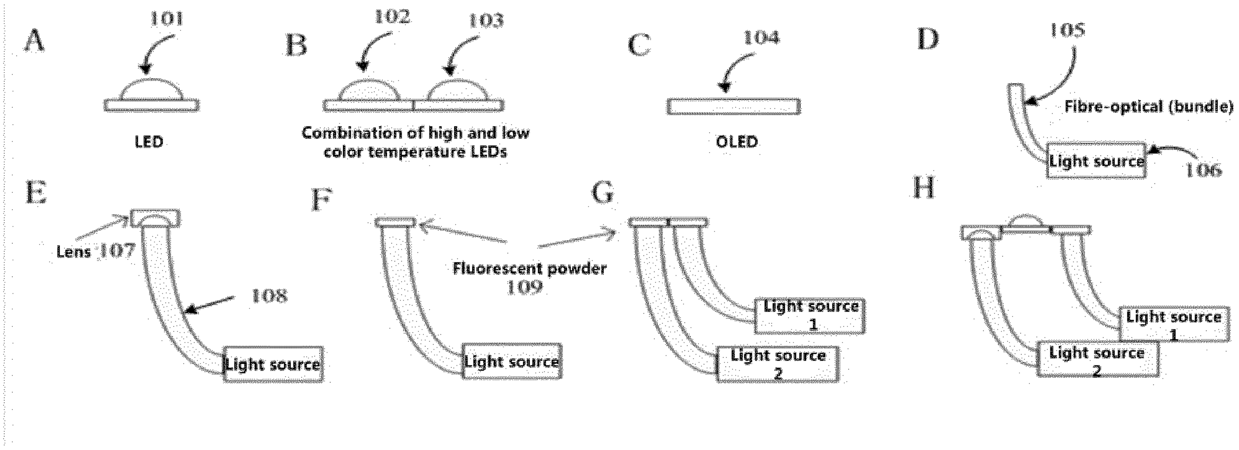
A
101
LED
B
102
103
Combination of high and low color temperature LEDs
C
104
OLED
D
105
Fibre-optical (bundle)
Light source
106
E
Lens 107
108
Light source
F
Fluorescent powder 109
Light source
G
Light source 1
Light source 2
H
Light source 1
Light source 2

Fig. 2

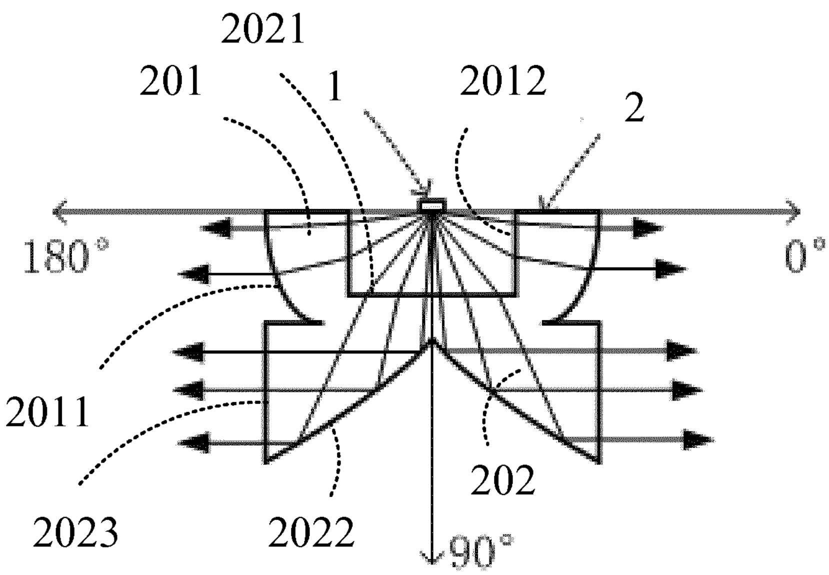
2021
201
1
2012
2
180°
0°
2011
2023
2022
202
90°

Fig. 3A

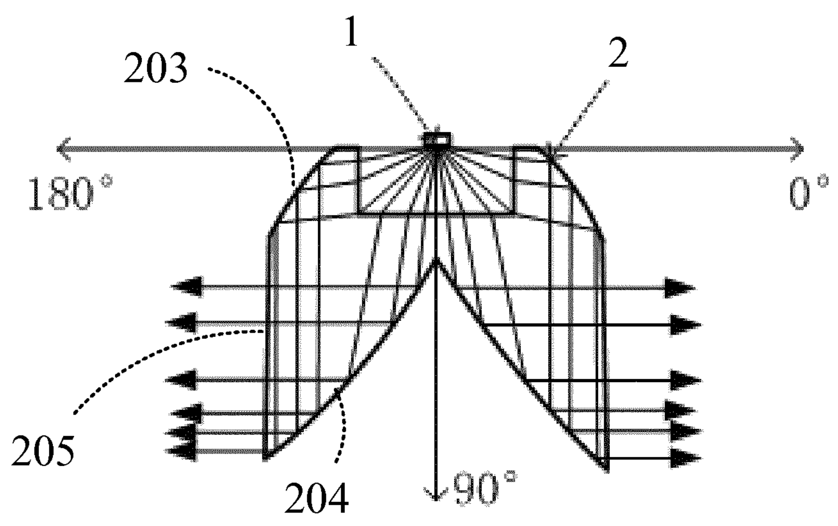

Fig. 3B

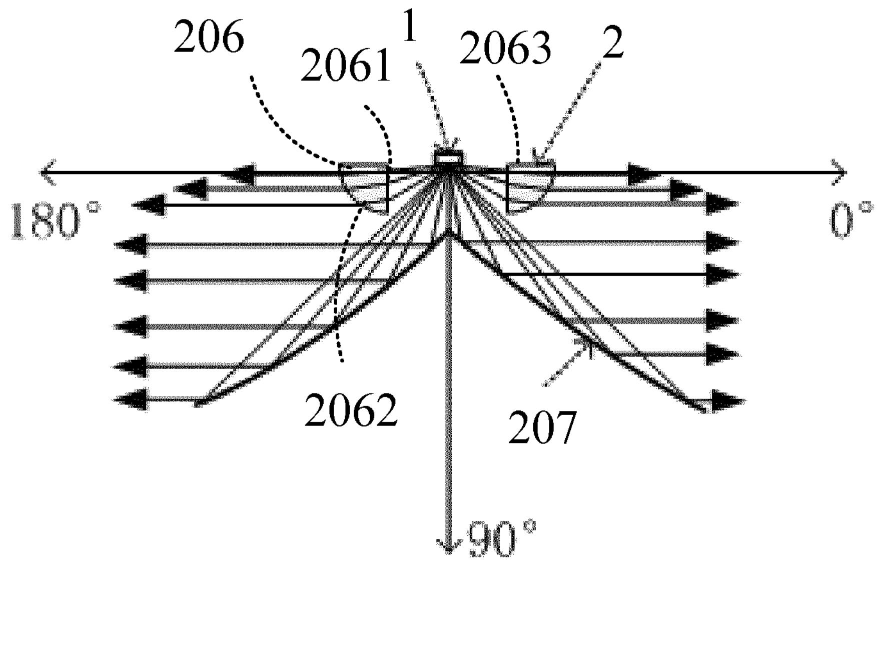

Fig. 3C

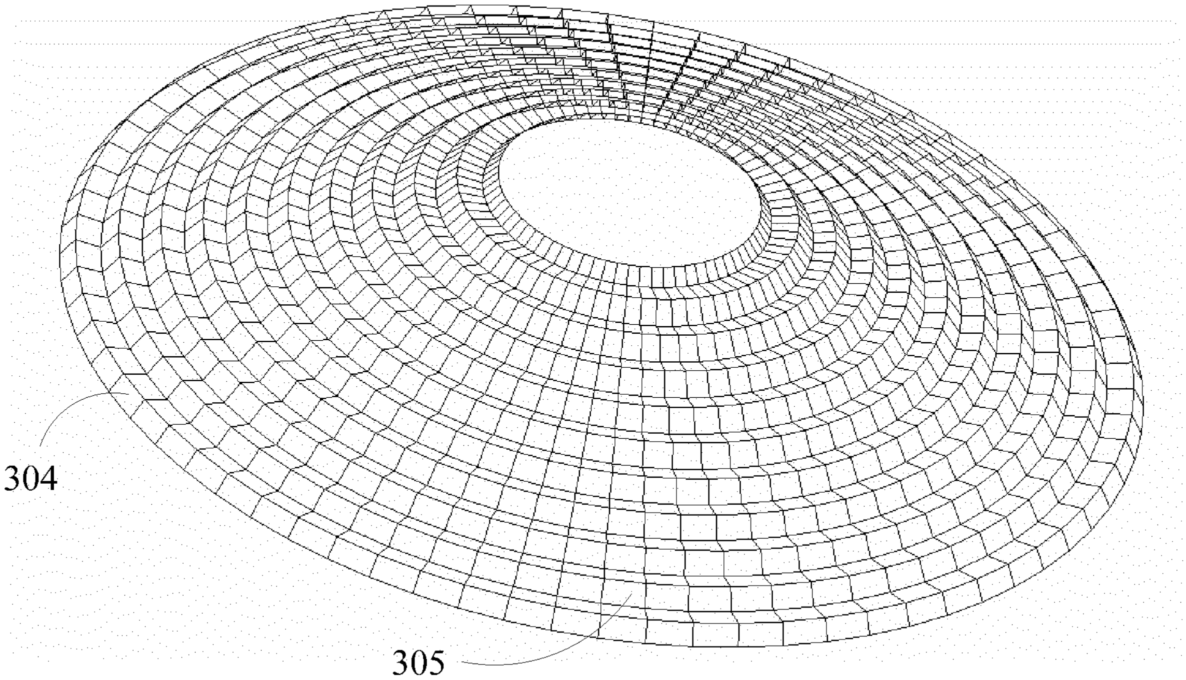

Fig. 4

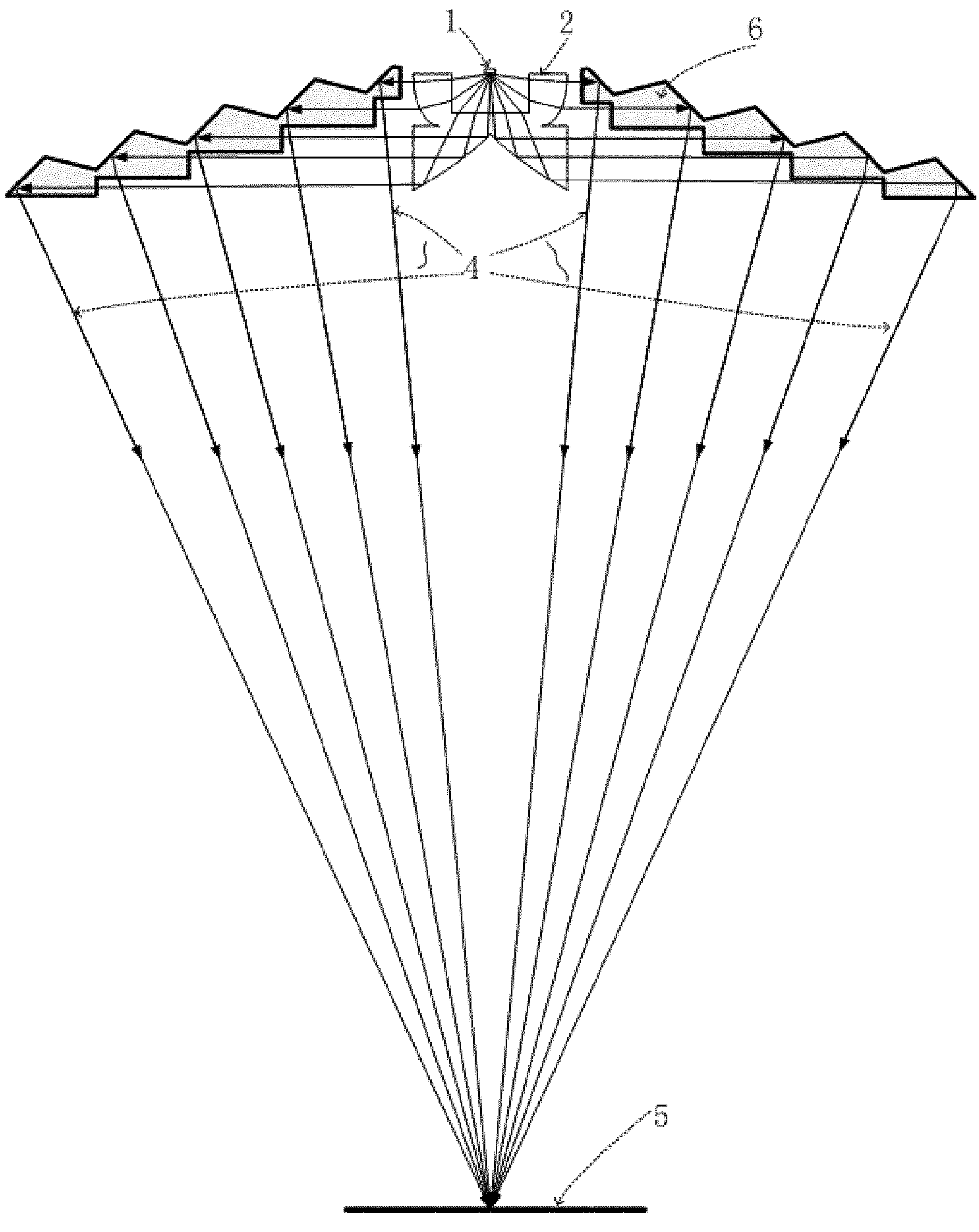

Fig. 5

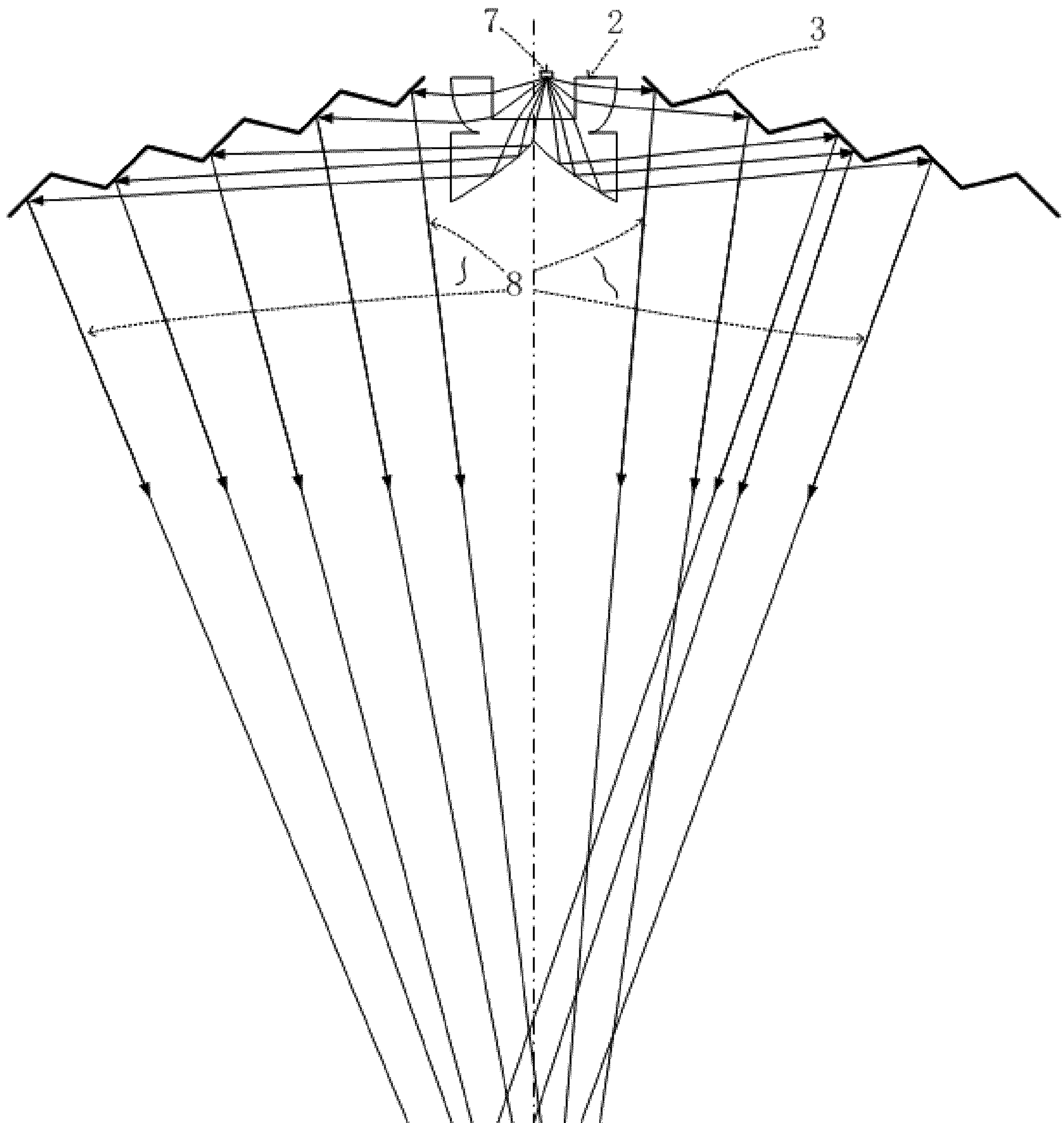

Fig. 6

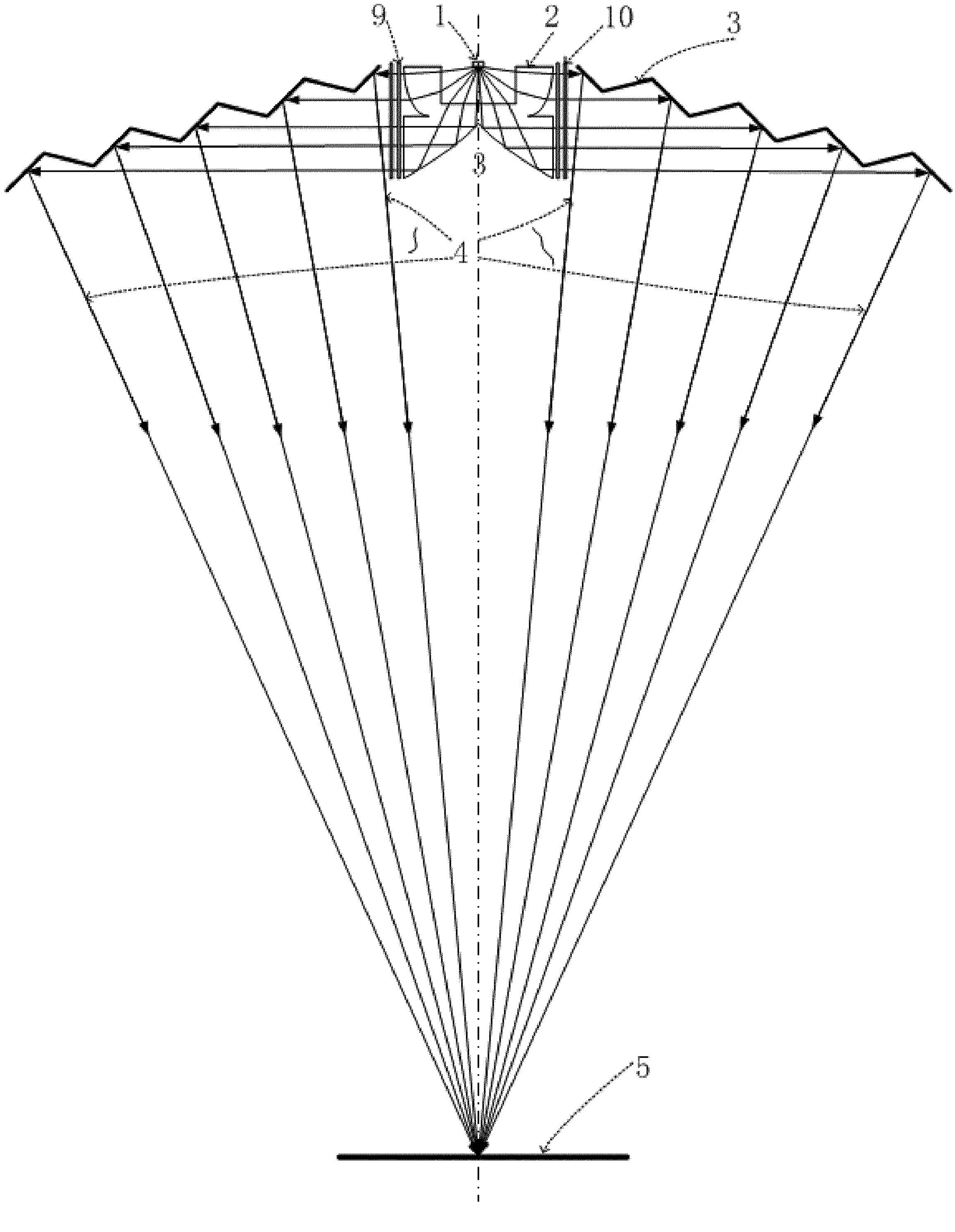

Fig.7

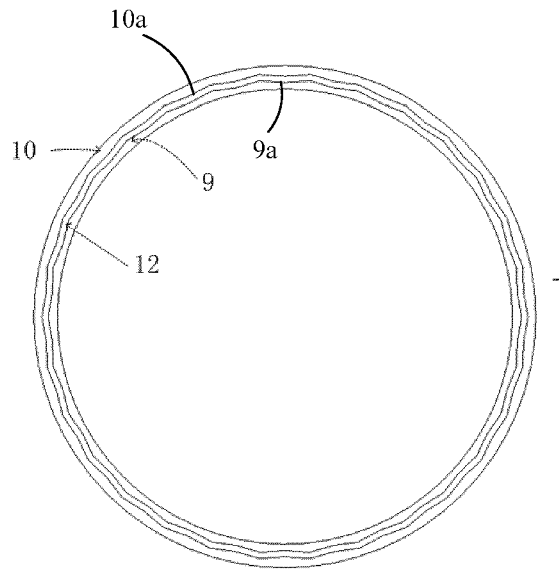

Fig. 8A

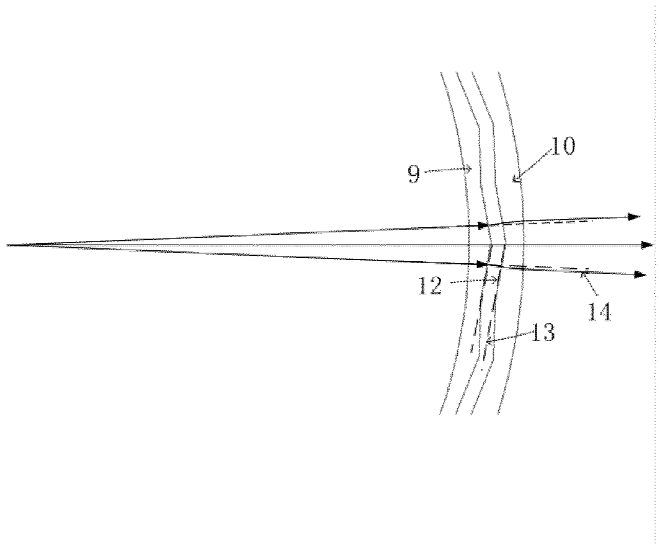

Fig. 8D

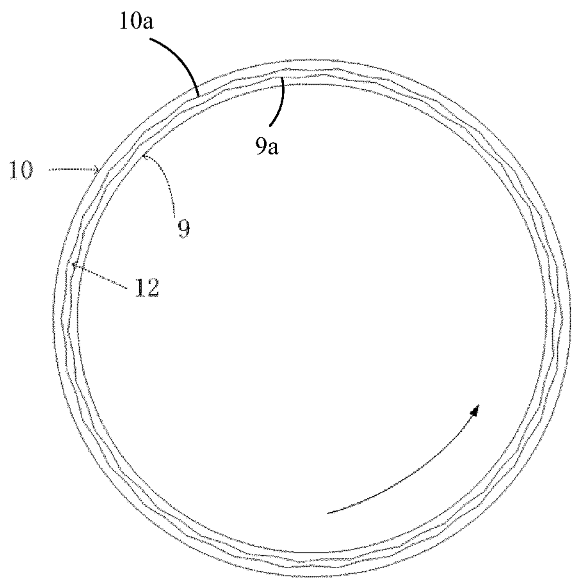

Fig. 8B

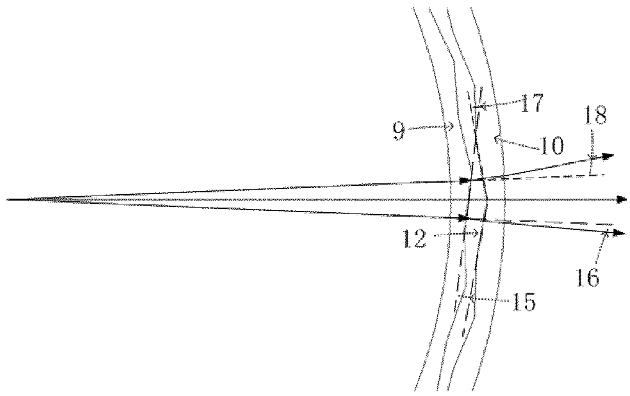

Fig. 8E

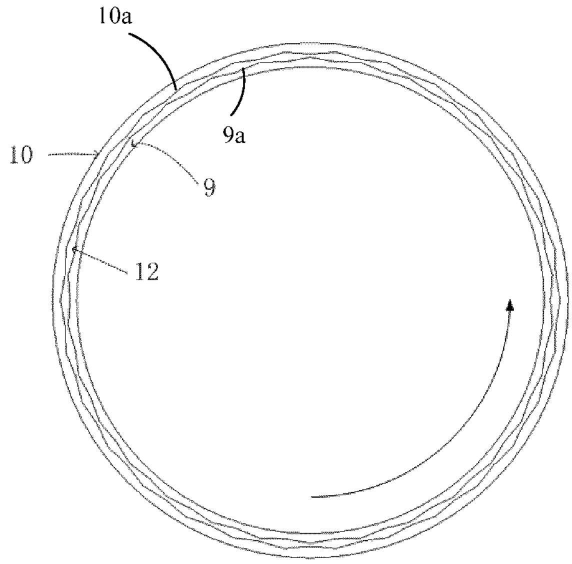

Fig. 8C

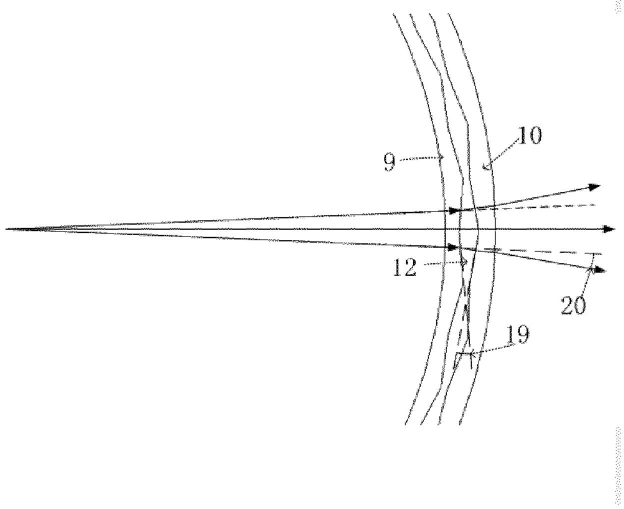

Fig. 8F

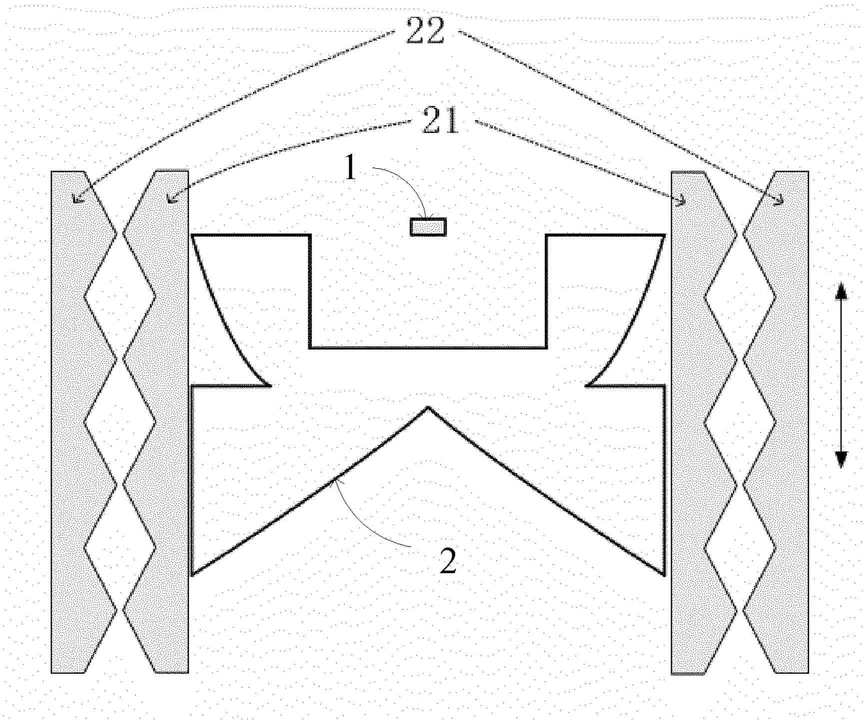

Fig. 9

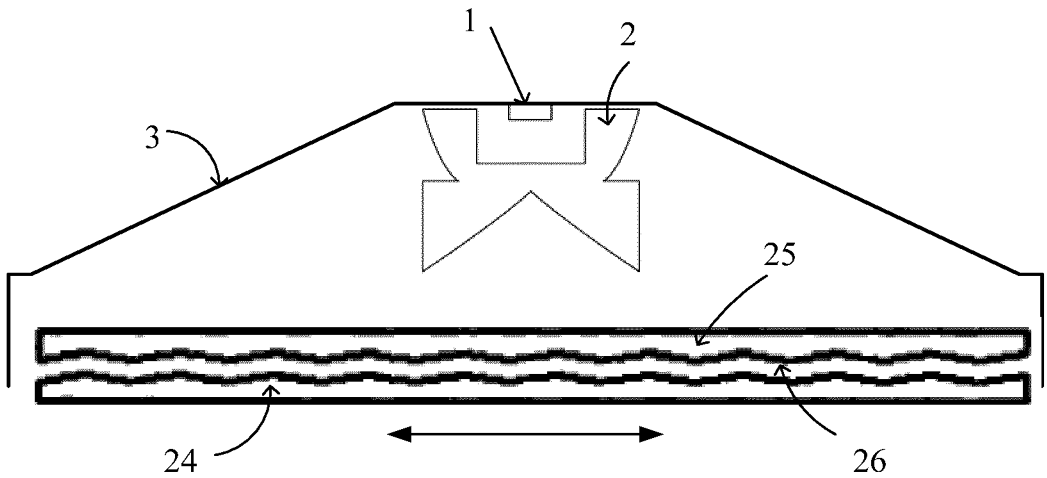

Fig. 10

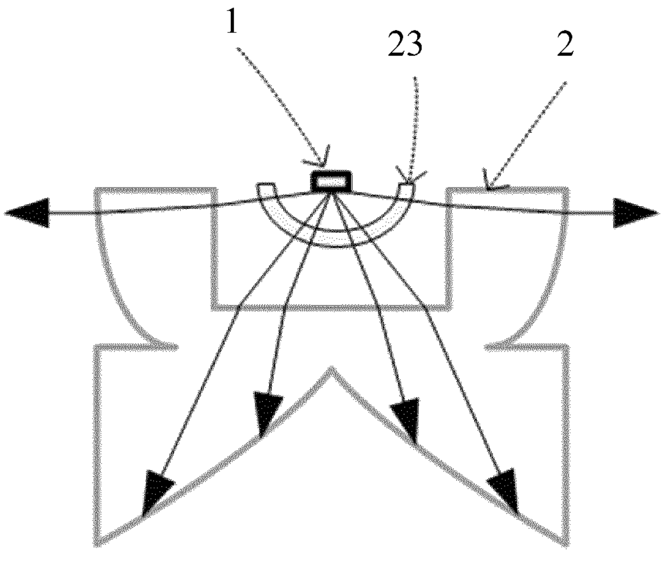

Fig. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/076685

A. CLASSIFICATION OF SUBJECT MATTER

F21V 13/00 (2006.01) i; F21V 7/00 (2006.01) i; F21V 5/00 (2015.01) i; F21W 131/205 (2006.01) n

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)

F21

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)

CNABS, CPRSABS, VEN, CNTXT, CNKI: 手术, 无影, 反射, 折射, 全反射, 内反射, 偏转, 偏折, 透镜, 发光二极管, operation, shadow+, less, reflect+, refract+, TIR, lens+, light, emitting, diode?, deflect+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 103062641 A (OSRAM GMBH.) 24 April 2013 (24.04.2013), description, paragraphs [0002], [0003] and [0029]-[0041], and figures 5-7c	1, 8, 19, 21, 27
Y	CN 103062641 A (OSRAM GMBH.) 24 April 2013 (24.04.2013), description, paragraphs [0002], [0003] and [0029]-[0041], and figures 5-7c	17, 18
Y	CN 1353268 A (YAMADA MEDICAL LIGHTING CO., LTD.) 12 June 2002 (12.06.2002), description, page 3, line 24 to page 6, line 23, and figures 2-8	17, 18
A	DE 202013006570 U1 (CIVAL MEDICAL GMBH) 07 August 2013 (07.08.2013), entire document	1-30
A	CN 204164948 U (ZENG, Linyong) 18 February 2015 (18.02.2015), entire document	1-30
A	US 6572234 B1 (HERAEUS MED GMBH) 03 June 2003 (03.06.2003), entire document	1-30

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"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

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"&"document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 December 2017	27 December 2017

Name and mailing address of the ISA
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/076685

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 105333318 A (ZHANGZHOU LEEDARSON OPTOELECTRONICS TECHNOLOGY CO., LTD.) 17 February 2016 (17.02.2016), entire document	1-30
A	CN 202629823 U (NANCHANG MICARE MEDICAL APPARATUS AND INSTRUMENTS CO., LTD.) 26 December 2012 (26.12.2012), entire document	1-30

Form PCT/ISA /210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2017/076685

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		EP 1103761 A2	30 May 2001
		EP 1103761 A3	02 May 2003
CN 105333318 A	17 February 2016	None	
CN 202629823 U	26 December 2012	None	

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