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(54) **ILLUMINATION DEVICE AND VEHICLE LAMP**

(57) The present application relates to the technical field of vehicle lamps, and provides an illumination device and a vehicle lamp. An optical lens in the illumination device is improved, such that the optical lens has a first total reflection surface. The first total reflection surface can be used to replace an incident surface in an existing optical lens to realize unidirectional collimation and total reflection of light from a light source, so that the position of an incident surface of the optical lens can be changed while the illumination effect is ensured, and components provided for cooperating with the optical lens can also be arranged in other directions perpendicular to a front-rear direction instead of being arranged in the front-rear direction, thereby preventing the illumination device from being too large in the front-rear direction, and reducing the limitation on the arrangement of the illumination device.

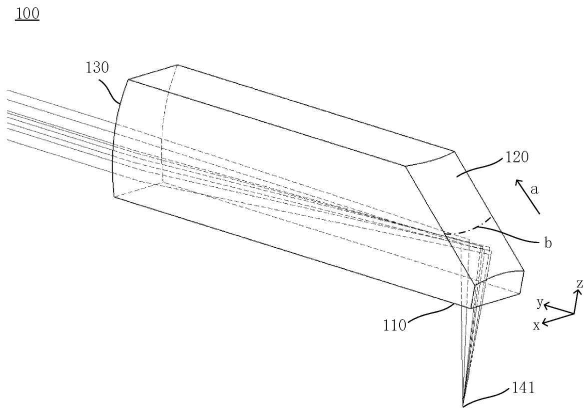

FIG. 1

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present disclosure claims the priority to the Chinese patent application with the filling No. 2023100638505 filed with the Chinese Patent Office on January 11, 2023, and entitled "ILLUMINATION DEVICE AND VEHICLE LAMP", the contents of which are incorporated herein by reference in entirety.

TECHNICAL FIELD

[0002] The present disclosure relates to the technical field of vehicle lamps, and specifically relates to a lighting apparatus and a vehicle lamp.

BACKGROUND ART

[0003] With the development of the social economy, the automobile industry has also developed accordingly. With the continuous advancement of automotive lighting technology, more requirements have been proposed for the functions of vehicle lamps. A lighting apparatus for achieving the lighting function of a vehicle lamp is typically provided with an optical element having a collimation function to obtain approximately parallel emitted light rays, thereby achieving a better lighting effect.

[0004] An existing optical lens with a collimation function generally comprises a light-entering portion and a light-emitting portion located on opposite sides of the optical lens. The light-entering portion enables unidirectional collimation in the horizontal direction, and the light-emitting portion enables unidirectional collimation in the vertical direction. This configuration also restricts other components arranged in cooperation with the optical lens to be distributed only on opposite sides of the optical lens, thereby forming an optical system arranged in a front-and-rear manner. Therefore, the dimension of the entire lighting apparatus in the front-rear direction becomes excessively large, which is unfavorable for the arrangement of the lighting apparatus and the vehicle lamp.

SUMMARY

[0005] The objective of the present disclosure is to address the deficiencies in the prior art and provide a lighting apparatus and a vehicle lamp.

[0006] In order to achieve the above objective, the technical solution adopted in the embodiments of the present disclosure is as follows.

[0007] One aspect of an embodiment of the present disclosure provides a lighting apparatus, including a light source and an optical lens provided on a light-emitting side of the light source. The optical lens includes a light-incidence surface, a first total reflection surface configured to collimate light rays in a first direction, and a light-emitting surface configured to collimate light rays in a second direction, wherein the light-incidence surface, the first total reflection surface, and the light-emitting surface are sequentially arranged along a light path. The first direction and the second direction are perpendicular or approximately perpendicular to each other. Light rays emitted by the light source and entering through the light-incidence surface are reflected by the first total reflection surface to the light-emitting surface for collimated emission.

[0008] Optionally, a cut-off line of the first total reflection surface in the first direction is a curved line, and a cut-off line of the first total reflection surface in the second direction is a straight line or an approximately straight line.

[0009] Optionally, a surface shape of the first total reflection surface is a cylindrical surface or a quasi-cylindrical surface.

[0010] Optionally, the optical lens further includes a primary reflection surface located between the light-incidence surface and the first total reflection surface along the light path, wherein the light rays emitted by the light source and entering through the light-incidence surface are reflected by the primary reflection surface to the first total reflection surface.

[0011] Optionally, the primary reflection surface is a total reflection surface or a reflective mirror surface having a reflective layer.

[0012] Optionally, the lighting apparatus further includes a primary reflector having the primary reflection surface, wherein the primary reflector is located between the light source and the optical lens, and the primary reflector is configured to reflect light rays emitted by the light source to the light-incidence surface of the optical lens.

[0013] Optionally, the lighting apparatus further includes a cut-off line structure provided on the light-emitting side of the light source, wherein the cut-off line structure is located at or near a focus of the optical lens, and the cut-off line structure is configured to form a light-emitting pattern with a cut-off line.

[0014] Optionally, when the lighting apparatus further includes the primary reflection surface, the cut-off line structure is provided at or near a boundary of the primary reflection surface on a side close to the light source.

[0015] Optionally, the optical lens further includes at least one second total reflection surface located on the light path, wherein the at least one second total reflection surface is configured to adjust the light path of light rays emitted by the light source within the optical lens.

[0016] Optionally, a surface shape of the primary reflection surface is a parabolic surface, a quasi-parabolic surface, an ellipsoidal surface, or a quasi-ellipsoidal surface.

[0017] Another aspect of the embodiments of the present disclosure provides a vehicle lamp, which includes any one of the aforementioned lighting apparatuses.

[0018] The present disclosure includes the following beneficial effects.

[0019] The present disclosure provides a lighting apparatus and a vehicle lamp. An optical lens in the illumination device is improved, such that the optical lens has a first total reflection surface. The first total reflection surface can be used to replace a light-incidence surface in an existing optical lens to realize unidirectional collimation and total reflection of light rays emitted from a light source, so that the position of a light-incidence surface of the optical lens can be changed while the illumination effect is ensured, and components provided for cooperating with the optical lens can also be arranged in other directions perpendicular to a front-rear direction instead of being arranged in the front-rear direction, thereby preventing the illumination device from being too large in the front-rear direction, and reducing the limitation on the arrangement of the lighting apparatus.

BRIEF DESCRIPTION OF DRAWINGS

[0020] To more clearly illustrate the technical solutions of the embodiments of the present disclosure, the following will briefly introduce the drawings used in the embodiments. It should be understood that the following drawings only show some embodiments of the present disclosure, and therefore they should not be regarded as a limitation on the scope. Those ordinary skilled in the art can also obtain other related drawings based on these drawings without inventive effort.

FIG. 1 is a schematic structural diagram of one example of an optical lens provided in the embodiments of the present disclosure;

FIG. 2 is a schematic structural diagram of another example of an optical lens provided in the embodiments of the present disclosure;

FIG. 3 is a schematic structural diagram of yet another example of an optical lens provided in the embodiments of the present disclosure;

FIG. 4 is a schematic structural diagram of yet one example of an optical lens provided in the embodiments of the present disclosure;

FIG. 5 is a schematic structural diagram of one example of a lighting apparatus provided in the embodiments of the present disclosure;

FIG. 6 is a schematic structural diagram of another example of a lighting apparatus provided in the embodiments of the present disclosure;

FIG. 7 is a schematic structural diagram of a light path of a lighting apparatus provided in the embodiments of the present disclosure;

FIG. 8 is a schematic structural diagram of one example of another lighting apparatus provided in the embodiments of the present disclosure;

FIG. 9 is a schematic structural diagram of another example of another lighting apparatus provided in the embodiments of the present disclosure;

FIG. 10 is a schematic structural diagram of another light path of a lighting apparatus provided in the embodiments of the present disclosure;

FIG. 11 is a schematic structural diagram of another optical lens provided in the embodiments of the present disclosure;

FIG. 12 is a schematic structural diagram of another light path of a lighting apparatus provided in the embodiments of the present disclosure;

FIG. 13 is a schematic structural diagram of yet another optical lens provided in the embodiments of the present disclosure;

FIG. 14 is a schematic structural diagram of yet another light path of a lighting apparatus provided in the embodiments of the present disclosure;

FIG. 15 is a schematic structural diagram of an optical lens and a primary reflection surface being separately arranged in a lighting apparatus provided in an embodiment of the present disclosure;

FIG. 16 is a schematic structural diagram of a lighting apparatus comprising a low-beam module and a high-beam module, as provided in an embodiment of the present disclosure; and

FIG. 17 is a schematic diagram of a low-beam light pattern formed when a lighting apparatus is used as a low-beam module, as provided in an embodiment of the present disclosure.

[0021] Reference numerals: 10 - lighting apparatus; 11 - high-beam module; 12 - low-beam module; 100 - optical lens; 110 - light-incidence surface; 120 - first total reflection surface; 130 - light-emitting surface; 140 - cut-off line structure; 141 - focal position; 150 - primary reflection surface; 160 - second total reflection surface; 200 - heat sink; 210 - circuit board; 220 - light source.

DETAILED DESCRIPTION OF EMBODIMENTS

[0022] In order to make the objective, technical solutions, and advantages of the embodiments of the present disclosure clearer, the following description will provide a clear and comprehensive explanation of the technical solutions in the embodiments of the present disclosure with reference to the drawings of the present disclosure. Clearly, the described embodiments are part of the embodiments of the present disclosure and not the entire embodiments. It should be noted that, without conflicts, various features in the embodiments of the present disclosure can be combined with each other, and the combined embodiments still fall within the protection scope of the present disclosure.

[0023] In the description of the present disclosure, the terms "first", "second", "third" and the like are only used for distinguishing descriptions, and cannot be understood as indicating or implying relative importance.

[0024] In the description of the present disclosure, it is further important to note that unless otherwise clearly stipulated and limited, the terms "provide", "mount", "interconnect", and "connect" should be understood in a broad sense, for example, it can be a fixed connection, a detachable connection, or an integral connection; it can be a mechanical connection, or an electrical connection; and it can be a direct connection, an indirect connection through an intermediary, or an internal communication between two components. Those of ordinary skill in the art can understand the meanings of the above terms in the present disclosure according to specific situations.

[0025] It should be understood that, for ease of description and to simplify the explanation of the present disclosure, the terms "front" and "rear" refer to the front-rear direction of the lighting apparatus along the light-emitting direction, the terms "left" and "right" refer to the left-right direction of the lighting apparatus itself, and the terms "upper" and "lower" refer to the up-down direction of the lighting apparatus itself, which generally correspond to the front-rear, left-right, and up-down directions of the vehicle. These terms are based on the orientations or positional relationships shown in the drawings and do not indicate or imply that the referred device or component must have a specific orientation or be constructed and operated in a particular orientation. Therefore, they should not be construed as limitations on the present disclosure. Furthermore, the orientation terms of the lighting apparatus in the present disclosure should be understood in conjunction with the actual mounting state.

[0026] In the present disclosure, the light pattern refers to the projection shape of the light rays from the vehicle lamp onto the vertical-plane light distribution screen located 25 m directly in front of the vehicle. The cut-off line refers to the boundary where the light rays are projected onto the light distribution screen and the visual perception of the light changes significantly. The primary low-beam light pattern is the central region of the low-beam light pattern with high illuminance, and the auxiliary low-beam light pattern is the widened region of the low-beam light pattern, thus ensuring that the left and right illumination range of the low-beam light pattern meets the requirements. A total reflection surface refers to a reflection surface capable of causing as much total reflection as possible for the light ray incident on the reflection surface.

[0027] In one aspect of an embodiment of the present disclosure, a lighting apparatus is provided. The lighting apparatus includes a light source and an optical lens arranged on a light-emitting side of the light source. The optical lens is an integrally molded component, which is made of a transparent material. The optical lens is capable of performing bidirectional collimation on light rays emitted by the light source (i.e., collimating the light rays emitted by the light source in two mutually perpendicular or approximately perpendicular directions). Therefore, the light rays, which are converged and approximately parallel emitted, can be obtained, thereby achieving a better lighting effect. Approximately perpendicular refers to an included angle between the two directions being 90° ± 10°.

[0028] Referring to FIG. 1 and FIG. 2, the optical lens 100 includes a light-incidence surface 110, a first total reflection surface 120, and a light-emitting surface 130, which are sequentially arranged along an optical path. The first total reflection surface 120 is configured to achieve collimation of light rays emitted by the light source 220 in a first direction. The light-emitting surface 130 is configured to achieve collimation of light rays emitted by the light source 220 in a second direction. The first direction and the second direction are mutually perpendicular or approximately perpendicular. By means of the first total reflection surface 120 and the light-emitting surface 130, the optical lens 100 achieves a bidirectional collimation function. Therefore, the light rays, which are converged and approximately parallel emitted, can be obtained, thereby achieving a better lighting effect.

[0029] During actual use, light rays emitted by the light source 220 enter the optical lens 100 through the light-incidence surface 110 of the optical lens 100 and propagate to the first total reflection surface 120. The first total reflection surface 120 not only performs collimation on the incident light rays in the first direction but also enables a total reflection of the incident light rays at the first total reflection surface 120. This reduces light loss. After undergoing total reflection at the first total reflection surface 120, the light rays emitted by the light source 220 propagate to the light-emitting surface 130, and then the light-emitting surface 130 performs collimation on the light rays in the second direction. Consequently, after collimation in both the first direction and the second direction, the light rays emitted by the light source 220 are ultimately emitted from the light-emitting surface 130, thereby forming a light-emitting pattern of the lighting apparatus 10.

[0030] Since the first total reflection surface 120 is capable of achieving collimation in the first direction, the first total reflection surface 120 can replace the light-incidence surface in existing optical lenses that achieves unidirectional collimation. On this basis, given the total reflection function of the first total reflection surface 120, the position of the light-incidence surface 110 on the optical lens 100 can be changed. That is, the relative position of the light-incidence surface 110 with respect to the light-emitting surface 130 can be changed. Therefore, the light-incidence surface 110 and the light-emitting surface 130 are no longer necessarily located on opposite sides of the optical lens 100. In other words, due to the total reflection function of the first total reflection surface 120, the light-entering direction can be changed, allowing components arranged in conjunction with the optical lens 100 to be arranged not only in the front-rear direction but also in other directions besides the front-rear direction. For ease of understanding, referring to the directions shown in FIG. 1, the light-incidence surface and the light-emitting surface of an existing optical lens are arranged along the y direction (front-rear direction), thereby constraining light rays to enter the optical lens from the y direction. Consequently, other components must also be arranged in the y direction in conjunction with the optical lens, leading to an excessive overall size of the lighting apparatus 10 in the y direction, which in turn imposes many limitations on the arrangement of the lighting apparatus. As shown in FIG. 1 and FIG. 2, the optical lens 100 of the present disclosure, due to the presence of the first total reflection surface 120, allows the position of the light-incidence surface 110 to be changed so that the light-incidence surface 110 is located on the bottom surface of the optical lens 100. Accordingly, during the arrangement, components located on the light-emitting side of the optical lens 100 can be arranged along the y direction with the optical lens 100, and components located on the light-entering side of the optical lens 100 can be arranged along the z direction with the optical lens 100. Therefore, an excessive size of the lighting apparatus 10 in the y direction can be avoided.

[0031] It should be noted that the first direction can be a horizontal direction, and the second direction can be a vertical direction. Of course, in other embodiments, the first direction can also be a vertical direction, and the second direction can be a horizontal direction.

[0032] The first total reflection surface 120 can achieve collimation of light rays in the first direction, i.e., unidirectional collimation. This can be understood as follows: as shown in FIG. 1, when the first direction is the x direction and the second direction is the z direction, the cut-off line of the first total reflection surface 120 in the first direction is a curved line, more specifically, a convex curve (where "convex" refers to protruding outward relative to the optical lens 100). It converges incident light rays and also provides a certain degree of collimation for divergent light rays. The cut-off line of the first total reflection surface 120 in the second direction is a straight line or an approximately straight line, and thus, the first total reflection surface 120 does not perform collimation in the second direction. Therefore, the first total reflection surface 120 can achieve unidirectional collimation of the light rays emitted from the light source 220 in the first direction.

[0033] Similarly, since the light-emitting surface 130 can achieve collimation of the light rays emitted from the light source 220 in the second direction, i.e., unidirectional collimation. It can be understood as follows: as shown in FIG. 1, when the first direction is the x direction and the second direction is the z direction, the cut-off line of the light-emitting surface 130 in the second direction is a curved line, more specifically, a convex curve (where "convex" refers to protruding outward relative to the optical lens 100). It converges incident light rays, but in this case, the light rays undergo refraction at the light-emitting surface 130. Therefore, "converge" here means that the degree of deflection of light rays is greater. It also provides a certain degree of collimation for divergent light rays. The cut-off line of the light-emitting surface 130 in the first direction is a straight line or an approximately straight line, and as a result, the ability of the light-emitting surface 130 to deflect light rays in the first direction is far inferior to the ability to deflect light rays in the second direction. Consequently, the light-emitting surface 130 has no or substantially no ability to change the degree of light deflection in the first direction. At the same time, it does not have a collimating effect on the light rays, that is, the light rays are relatively divergent in the first direction. Therefore, the light-emitting surface 130 can achieve unidirectional collimation of the light rays emitted from the light source 220 in the second direction.

[0034] Optionally, as shown in FIGS. 1 to 16, a surface shape of the first total reflection surface 120 is a cylindrical surface or a quasi-cylindrical surface. For ease of understanding, the formation of the first total reflection surface 120 can be regarded as a curve obtained by unidirectional stretching. Specifically, as shown in FIG. 1, curve b is unidirectionally stretched along the stretching direction a to form a cylindrical surface or a quasi-cylindrical surface. Additionally, it should be understood that to ensure that the light rays emitted from the light source 220 undergo total reflection at the first total reflection surface 120, the angle between the normal at any point on the first total reflection surface 120 and the incident light must satisfy the law of total reflection. The formation of the light-emitting surface 130 can also refer to the formation of the first total reflection surface 120, except that the curve stretching direction is different.

[0035] Optionally, the present disclosure can also include a primary reflective element, with the light source 220 positioned at or near the focus of the primary reflective element. Given the function of the first total reflection surface 120, the primary reflective element and the first total reflection surface 120 can be arranged along a non-front-rear direction. Thus, the issue of excessive size in the front-rear direction of the lighting apparatus 10 can be avoided. The primary reflective element can perform primary modulation of the light rays emitted from the light source 220, thereby achieving a better lighting effect. When arranging the primary reflective element, the primary reflective element can be integrated with the optical lens 100. On the one hand, the volume of the lighting apparatus 10 can be effectively reduced, and on the other hand, the integrated arrangement can effectively save the dimming step of the primary reflective element in the light distribution process. Further, the integrated arrangement allows the light rays to undergo only one incidence (entering through the light-incidence surface 110 of the optical lens 100) and one emission (exiting through the light-emitting surface 130 of the optical lens 100), thereby effectively reducing light loss and improving the performance of the lighting apparatus 10. Of course, in other embodiments, the primary reflective element and the optical lens 100 can also be separately arranged, and this arrangement can reduce the complexity of manufacturing the optical lens 100 and improve the yield rate of the optical lens 100. The following will describe the integrated arrangement and separate arrangement with reference to the drawings.

[0036] When the primary reflective element is integrated with the optical lens 100, it can be understood that a primary reflective surface 150 is provided on the optical lens 100 to achieve the function of primary modulation. For example,

[0037] in one embodiment, as shown in FIGS. 3 and 4, the optical lens 100 includes the primary reflection surface 150, and the primary reflection surface 150 is arranged along the light path direction between the light-incidence surface 110 and the first total reflection surface 120. The primary reflection surface 150 is positioned closer to the light-emitting surface 130 relative to the light-incidence surface 110.

[0038] Correspondingly, the light source 220 is positioned on one side of the light-incidence surface 110 of the optical lens 100. As shown in FIGS. 5, 6, and 7, the light source 220 is arranged on one side of the light-incidence surface 110 of the optical lens 100, and the light source 220 can be located at or near the focus of the primary reflection surface 150. Thus, as shown in FIG. 7, under the action of the first total reflection surface 120, the primary reflection surface 150 and the first total reflection surface 120 can also be arranged in an up-down direction. This arrangement can help prevent the size of the lighting apparatus 10 from being too large in the front-rear direction.

[0039] In addition, a circuit board 210 carrying the light source 220 can also be provided. To improve the heat dissipation of light source 220, a heat sink 200 can also be arranged on the side of the circuit board 210 that is away from light source 220. In this way, the heat sink 200 effectively dissipates heat from the light source 220. The present disclosure imposes no limitation on the type of light source 220, the structure of heat sink 200, or the material thereof.

[0040] As shown in FIG. 7, the light path of the light rays emitted by the light source 220 when the lighting apparatus 10 operates in the embodiment is illustrated. The light rays emitted by the light source 220 are incident into optical lens 100 through the light-incidence surface 110 of the optical lens 100, propagate to the primary reflection surface 150, and are reflected to the first total reflection surface 120. After total reflection and unidirectional collimation occur at first total reflection surface 120, the light rays propagate to light-emitting surface 130, and then the light rays are subjected to unidirectional collimation in another direction by the light-emitting surface 130, and then emitted to form the light-emitting pattern of the lighting apparatus 10. Therefore, approximately parallel emitted light rays are obtained, achieving a better illumination effect.

[0041] In another embodiment, as shown in FIGS. 8, 9, and 10, the optical lens 100 includes the primary reflection surface 150, and the primary reflection surface 150 is arranged along the light path direction between the light-incidence surface 110 and the first total reflection surface 120. The difference from the previous embodiment lies in that the primary reflection surface 150 is arranged farther away from the light-emitting surface 130 relative to the light-incidence surface 110. In this way, the light source 220, the circuit board 210, and the heat sink 200 can fully utilize the space below the optical lens 100 for arrangement, thereby further reducing the size of the lighting apparatus 10.

[0042] As shown in FIG. 10, the light path of the light rays emitted by the light source 220 when the lighting apparatus 10 operates in the embodiment is illustrated. The light rays emitted by the light source 220 are incident into optical lens 100 through the light-incidence surface 110 of the optical lens 100, propagate to the primary reflection surface 150, and are reflected to the first total reflection surface 120. After total reflection and unidirectional collimation occur at first total reflection surface 120, the light rays propagate to light-emitting surface 130, and then the light rays from the light source 220 are subjected to unidirectional collimation in another direction by the light-emitting surface 130, and then emitted to form the light-emitting pattern of the lighting apparatus 10. Therefore, approximately parallel emitted light rays are obtained, achieving a better illumination effect.

[0043] From the embodiments shown in FIG. 7 and FIG. 10, it can be seen that during arrangement, the position of the primary reflection surface 150 can be flexibly selected according to the requirements of lighting apparatus 10, thereby enabling the lighting apparatus 10 to have different structural forms and meet different requirements for arrangement.

[0044] In another embodiment, as shown in FIGS. 11 and 12, the optical lens 100 includes the primary reflection surface 150, and the primary reflection surface 150 is arranged along the light path direction between the light-incidence surface 110 and the first total reflection surface 120. The difference from the previous embodiment lies in that a second total reflection surface 160 is further added between the primary reflection surface 150 and the first total reflection surface 120. By means of the second total reflection surface 160, the light path of the light rays inside the optical lens 100 can be changed, thereby facilitating modifications to the structural form of optical lens 100.

[0045] As shown in FIG. 12, the light path of the light rays emitted by the light source 220 when the lighting apparatus 10 operates in the embodiment is illustrated. The light rays emitted by the light source 220 are incident through the light-incidence surface 110 of the optical lens 100, propagate to the primary reflection surface 150, and are reflected to the second total reflection surface 160. After reflection by the second total reflection surface 160, the light rays are incident onto the first total reflection surface 120. After total reflection and unidirectional collimation occur at first total reflection surface 120, the light rays propagate to light-emitting surface 130, and then the light rays are subjected to unidirectional collimation in another direction by the light-emitting surface 130, and then emitted to form the light-emitting pattern of the lighting apparatus 10. Therefore, approximately parallel emitted light rays are obtained, achieving a better illumination effect.

[0046] In another embodiment, as shown in FIGS. 13

and 14, the optical lens 100 includes the primary reflection surface 150, and the primary reflection surface 150 is arranged along the light path direction between the light-incidence surface 110 and the first total reflection surface 120. The second total reflection surface 160 is further added between the primary reflection surface 150 and the first total reflection surface 120. The difference from the previous embodiment lies in that the second total reflection surface 160 is further added between the first total reflection surface 120 and the light-emitting surface 130. By means of the two second total reflection surfaces 160, the light path inside the optical lens 100 can be changed, thereby facilitating modifications to the structural form of optical lens 100. As shown in FIG. 13 and FIG. 14, the bottom surface c of the optical lens 100 is a flat surface, thereby reducing the difficulty of processing and manufacturing the optical lens 100 and improving the yield rate.

[0047] As shown in FIG. 14, the light path of the light rays emitted by the light source 220 when the lighting apparatus 10 operates in the embodiment is illustrated. The light rays emitted by the light source 220 are incident into optical lens 100 through the light-incidence surface 110 of the optical lens 100, propagate to the primary reflection surface 150, and are reflected to the second total reflection surface 160. After reflection by the second total reflection surface 160, the light rays are incident onto the first total reflection surface 120. After being reflected and unidirectionally collimated by the first total reflection surface 120, the light rays propagate to another second total reflection surface 160, and then are reflected by the second total reflection surface 160 and propagate to the light-emitting surface 130. Then, the light rays are subjected to unidirectional collimation in another direction by the light-emitting surface 130, and then emitted to form the light-emitting pattern of the lighting apparatus 10. Therefore, approximately parallel emitted light rays are obtained, achieving a better illumination effect.

[0048] Optionally, as shown in FIG. 3 to FIG. 14, a surface shape of the primary reflection surface 150 is a parabolic surface, a quasi-parabolic surface, an ellipsoidal surface, or a quasi-ellipsoidal surface. By means of the primary reflection surface 150, the light rays emitted by the light source 220 can be subjected to primary modulation, such that the light rays of the light source 220 reflected by the primary reflection surface 150 can be irradiated onto the first total reflection surface 120 or the second total reflection surface 160 as nearly parallel light rays, thereby improving the illumination effect of the lighting apparatus 10.

[0049] Optionally, as shown in FIG. 3 to FIG. 14, in an embodiment where the optical lens 100 is provided with a primary reflection surface 150, that is, where the primary reflective element and the optical lens 100 are integrally provided, the primary reflection surface 150 can be a total reflection surface or a reflective mirror surface having a reflective layer. In this way, the primary reflection surface 150 can be used for modulating the light rays and preventing light loss. A total reflection surface refers to a surface on which the light rays emitted by the light source 220 are reflected by means of total reflection upon incident on the total reflection surface. A reflective mirror surface having a reflective layer refers to a specific region of the outer surface of the optical lens 100 that is coated with a reflective layer, such that light rays emitted by the light source 220 are reflected by means of mirror reflection upon incidence on the reflective mirror surface having a reflective layer.

[0050] Optionally, as shown in FIGS. 3 to 14, in an embodiment where the optical lens 100 is provided with a primary reflection surface 150, i.e., an embodiment in which the primary reflection element is integrally provided with the optical lens 100, the optical lens 100 can integrate a cut-off line structure 140, meaning that the cut-off line structure 140 is integrally provided with the optical lens 100. Specifically, as shown in FIGS. 3 to 14, the cut-off line structure 140 is provided at the boundary of the primary reflection surface 150 on the side close to the light source 220 or near the boundary. The cut-off line structure 140 can correspondingly enable the light-emitting pattern of the lighting apparatus 10 to have a cut-off line, thereby conforming to light pattern standards. The cut-off line structure 140 can be located at the focus of the optical lens 100. For example, as shown in FIGS. 3 and 4, parallel light enters the optical lens 100 from the light-emitting surface 130 and is reflected by the first total reflection surface 120 to converge at a point, where the point is the focal position 141 of the optical lens 100. The cut-off line structure 140 can be arranged near the point, so that when light rays from the light source 220 are projected onto the cut-off line structure 140, an image is formed and emitted through the optical lens 100 so as to form an image on the light distribution screen, i.e., the formation of the light-dark cut-off line of the light-emitting pattern. The term "near the boundary" refers to a range within 2 mm around the boundary.

[0051] When the primary reflective element is separately arranged from the optical lens 100, it can be understood that a primary reflector is independently arranged outside the optical lens 100 to reflect light rays emitted by the light source 220 toward the light-incidence surface 110 of the optical lens 100, thereby achieving primary modulation. For example,

[0052] as shown in FIG. 15, a primary reflector is arranged between the light source 220 and the optical lens 100. Under the effect of the first total reflection surface 120, the light-incidence surface 110 of the optical lens 100 can be positioned at the bottom surface, and the primary reflector is arranged below the optical lens 100, which can form an arrangement with the first total reflection surface 120 in an up-down direction. This arrangement can help prevent the size of the lighting apparatus 10 from being too large in the front-rear direction.

[0053] Similarly, in the embodiment, a circuit board 210 carrying the light source 220 can also be provided. To improve the heat dissipation of light source 220, a heat sink 200 can also be arranged on the side of the circuit board 210 that is away from light source 220. In this way, the heat sink 200 effectively dissipates heat from the light source 220. The present disclosure imposes no limitation on the type of light source 220, the structure of heat sink 200, or the material thereof.

[0054] The light path of the light rays emitted by the light source 220 when the lighting apparatus 10 operates in the embodiment is illustrated as follows (not shown in the figure). The light source 220 emits the light rays and the light rays are incident on the primary reflector. Under the reflection effect of the primary reflector, the light rays are incident on the light-incidence surface 110 of the optical lens 100 and propagate to the first total reflection surface 120. After total reflection and unidirectional collimation occur at first total reflection surface 120, the light rays propagate to light-emitting surface 130, and then the light rays are subjected to unidirectional collimation in another direction by the light-emitting surface 130, and then emitted to form the light-emitting pattern of the lighting apparatus 10. Therefore, approximately parallel emitted light rays are obtained, achieving a better illumination effect.

[0055] Of course, in the embodiment, at least one second total reflection surface 160 can also be provided inside the optical lens 100, which can modify the light path inside the optical lens 100, thereby enabling the optical lens 100 to have a specific external shape that meets the arrangement requirements of other components.

[0056] Optionally, as shown in FIG. 15, a surface shape of the primary reflection surface 150 of the primary reflector can be a parabolic surface, a quasi-parabolic surface, an ellipsoidal surface, or a quasi-ellipsoidal surface. The quasi-parabolic surface refers to a curved surface approximating a parabolic surface, and the quasi-ellipsoidal surface refers to a curved surface approximating an ellipsoidal surface, where they have similar optical performance. By means of the primary reflection surface 150, the light rays of the light source 220 can be subjected to primary modulation, such that the light rays of the light source 220 reflected by the primary reflection surface 150 can be irradiated onto the first total reflection surface 120 or the second total reflection surface 160 as nearly parallel light rays, thereby improving the illumination effect of the lighting apparatus 10.

[0057] Optionally, as shown in FIG. 15, in an embodiment where the primary reflection element is separately arranged from the optical lens 100, the primary reflector can integrate a cut-off line structure 140, meaning that the cut-off line structure 140 is integrally provided with the primary reflector. Specifically, as shown in FIG. 15, the cut-off line structure 140 is provided at the boundary of the primary reflection surface 150 of the primary reflector on the side close to the light source 220 or near the boundary. The cut-off line structure 140 can correspondingly enable the light-emitting pattern of the lighting apparatus 10 to have a cut-off line, thereby conforming to light pattern standards. The cut-off line structure 140 can be located at the focus of the optical lens 100. For example, as shown in FIGS. 1 and 2, parallel light enters the optical lens 100 from the light-emitting surface 130 and is reflected by the first total reflection surface 120 to converge at a point outside the optical lens 100, where the point is the focal position 141 of the optical lens 100. The cut-off line structure 140 can be arranged at the point or near the point, so that when light rays from the light source 220 are projected onto the cut-off line structure 140, an image is formed and emitted through the optical lens 100 so as to form an image on the light distribution screen, i.e., the formation of the light-dark cut-off line of the light-emitting pattern.

[0058] Of course, as shown in FIGS. 1 and 2, in other embodiments, the cut-off line structure 140 cannot be integrally provided with the optical lens 100 or the primary reflector. Instead, it can be formed by a separate light-blocking member, a light-shielding plate, or a concentrator, with no limitations imposed by the present disclosure. During arrangement, the cut-off line structure 140 needs to be positioned at or near the focal position 141 of the optical lens 100, as shown in FIG. 1 or FIG. 2. The term "near the focal position" refers to a range within 2 mm around the focus.

[0059] It should be understood that the lighting apparatus 10 in the present disclosure can include a low-beam module 12 for forming a low-beam light pattern. As shown in FIGS. 5 to 15, the lighting apparatus 10 can be configured to form a low-beam light pattern. Of course, the lighting apparatus 10 in the present disclosure can also include a high-beam module 11 for forming a high-beam light pattern. As shown in FIGS. 5 to 15, the lighting apparatus 10 can be configured to form a high-beam light pattern. Alternatively, the lighting apparatus 10 in the present disclosure can include both a low-beam module 12 for forming a low-beam light pattern and a high-beam module 11 for forming a high-beam light pattern. For example, as shown in FIG. 16, a dashed line in FIG. 16 is a boundary (where the boundary is a virtual line, included only for ease of understanding and does not exist in the actual structure). The structure above the boundary can be the high-beam module 11, which is configured for forming a high-beam light pattern. The structure below the boundary can be the low-beam module 12, which is configured for forming a low-beam light pattern. Of course, in different embodiments, the low-beam module 12 and the high-beam module 11 can be arranged separately or integrally. For example, as shown in FIG. 16, the optical lens 100 of the low-beam module 12 and the high-beam module 11 can be integrally provided, with the optical surfaces of the optical lens 100 for the low-beam module 12 and the high-beam module 11 symmetrically arranged. The first total reflection surface 120 of the low-beam module 12 is connected to the first total reflection surface 120 of the high-beam module 11, and the light-emitting surface 130 of the low-beam module 12 is connected to the light-emitting surface 130 of the high-beam module 11. In one embodiment, the low-beam module 12 and the high-beam module 11 can share a common light-emitting surface 130. This further enhances the integration of the lighting apparatus 10, simplifies light distribution, and reduces the volume of the lighting apparatus 10.

[0060] FIG. 17 shows a low-beam light pattern formed on the light distribution screen when the lighting apparatus 10 in the present disclosure is a low-beam module 12. The low-beam light pattern is enabled to have a light-dark cut-off line by means of the cut-off line structure 140, thereby meeting low-beam illumination requirements.

[0061] Another aspect of the embodiments of the present disclosure provides a vehicle lamp, which includes any one of the aforementioned lighting apparatuses 10. By improving the optical lens 100 in the lighting apparatus 10 so that the optical lens 100 is provided with the first total reflection surface 120, the position of the light-incidence surface 110 of the optical lens 100 can be adjusted through the first total reflection surface 120. Thus, it is possible to prevent the size of the lighting apparatus 10 in the front-rear direction from being too large, effectively prevent the size of the vehicle lamp in the front-rear direction from being too large, and reduce the restrictions on the vehicle lamp when it is mounted on the vehicle.

[0062] The above is only a preferred embodiment of the present disclosure, which is not intended to limit, and the present disclosure may have various changes and variations for those skilled in the art. Any modification, equivalent substitution, improvement, etc. made within the spirit and principles of the present disclosure shall be included in the scope of protection of the present disclosure.

INDUSTRIAL PRACTICALITY

[0063] The present disclosure provides a lighting apparatus and a vehicle lamp. An optical lens in the illumination device is improved, such that the optical lens has a first total reflection surface. The first total reflection surface can be used to replace a light-incidence surface in an existing optical lens to realize unidirectional collimation and total reflection of light rays emitted from a light source, so that the position of a light-incidence surface of the optical lens can be changed while the illumination effect is ensured, and components provided for cooperating with the optical lens can also be arranged in other directions perpendicular to a front-rear direction instead of being arranged in the front-rear direction, thereby preventing the illumination device from being too large in the front-rear direction, and reducing the limitation on the arrangement of the illumination device.

Claims

1. A lighting apparatus, comprising a light source and an optical lens provided on a light-emitting side of the light source, wherein the optical lens comprises a light-incidence surface, a first total reflection surface configured to collimate light rays in a first direction, and a light-emitting surface configured to collimate light rays in a second direction, wherein the light-incidence surface, the first total reflection surface, and the light-emitting surface are sequentially arranged along a light path; the first direction and the second direction are perpendicular or approximately perpendicular to each other; and light rays, emitted by the light source and entering through the light-incidence surface, are reflected by the first total reflection surface to the light-emitting surface for collimated emission.

2. The lighting apparatus according to claim 1, wherein a cut-off line of the first total reflection surface in the first direction is a curved line, and a cut-off line of the first total reflection surface in the second direction is a straight line or an approximately straight line.

3. The lighting apparatus according to claim 2, wherein a surface shape of the first total reflection surface is a cylindrical surface or a quasi-cylindrical surface.

4. The lighting apparatus according to claim 1, wherein the optical lens further comprises a primary reflection surface located between the light-incidence surface and the first total reflection surface along the light path, and the light rays emitted by the light source and entering through the light-incidence surface are reflected by the primary reflection surface to the first total reflection surface.

5. The lighting apparatus according to claim 4, wherein the primary reflection surface is a total reflection surface or a reflective mirror surface having a reflective layer.

6. The lighting apparatus according to claim 1, wherein the lighting apparatus further comprises a primary reflector having a primary reflection surface, the primary reflector is located between the light source and the optical lens, and the primary reflector is configured to reflect the light rays emitted by the light source to the light-incidence surface of the optical lens.

7. The lighting apparatus according to any one of claims 1 to 6, wherein the lighting apparatus further comprises a cut-off line structure located on a light-emitting side of the light source, the cut-off line structure is located at or near a focus of the optical lens, and the cut-off line structure is configured to form a light-emitting pattern with a cut-off line.

8. The lighting apparatus according to claim 7, wherein when the lighting apparatus further comprises a primary reflection surface, the cut-off line structure

is provided at or near a boundary of the primary reflection surface on a side close to the light source.

9. The lighting apparatus according to any one of claims 1 to 6, wherein the optical lens further comprises at least one second total reflection surface located on the light path, and the at least one second total reflection surface is configured to adjust a light path of the light rays emitted by the light source within the optical lens.

10. The lighting apparatus according to any one of claims 4 to 6, wherein a surface shape of the primary reflection surface is a parabolic surface, a quasi-parabolic surface, an ellipsoidal surface, or a quasi-ellipsoidal surface.

11. A vehicle lamp, comprising the lighting apparatus according to any one of claims 1 to 10.

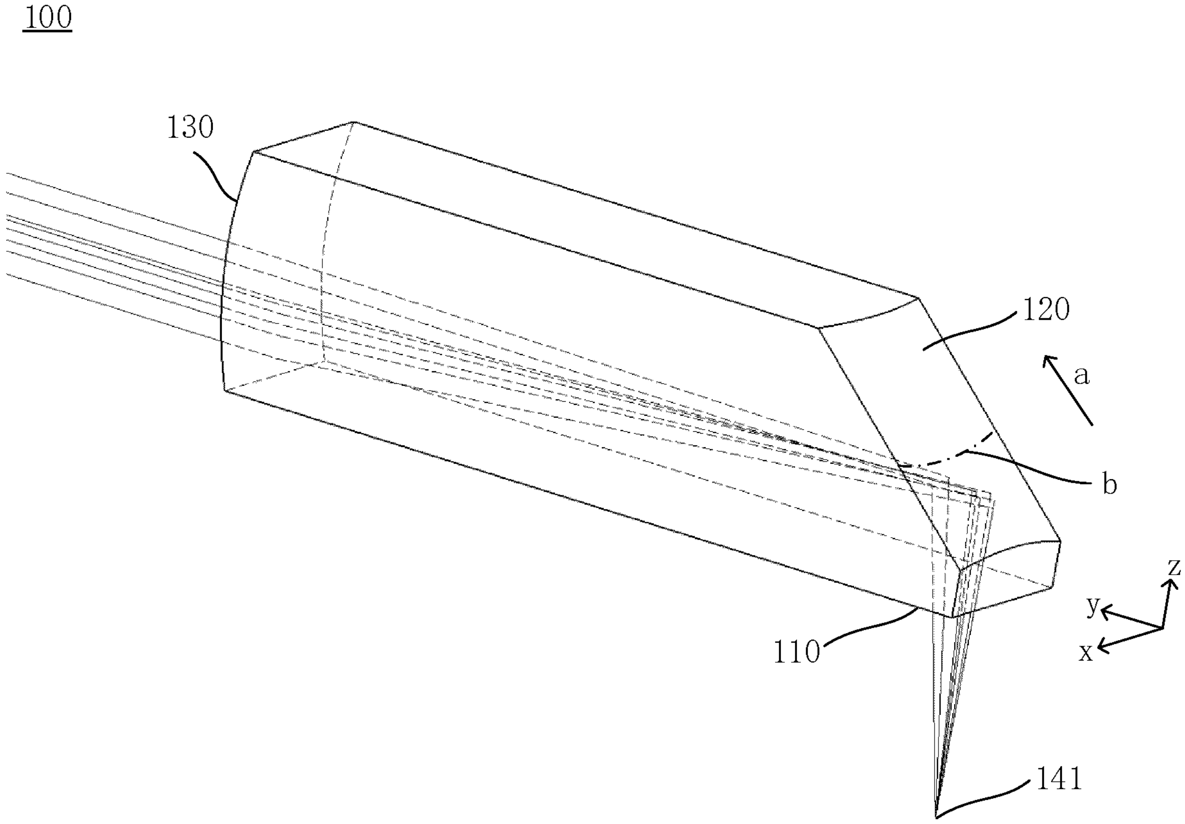

FIG. 1

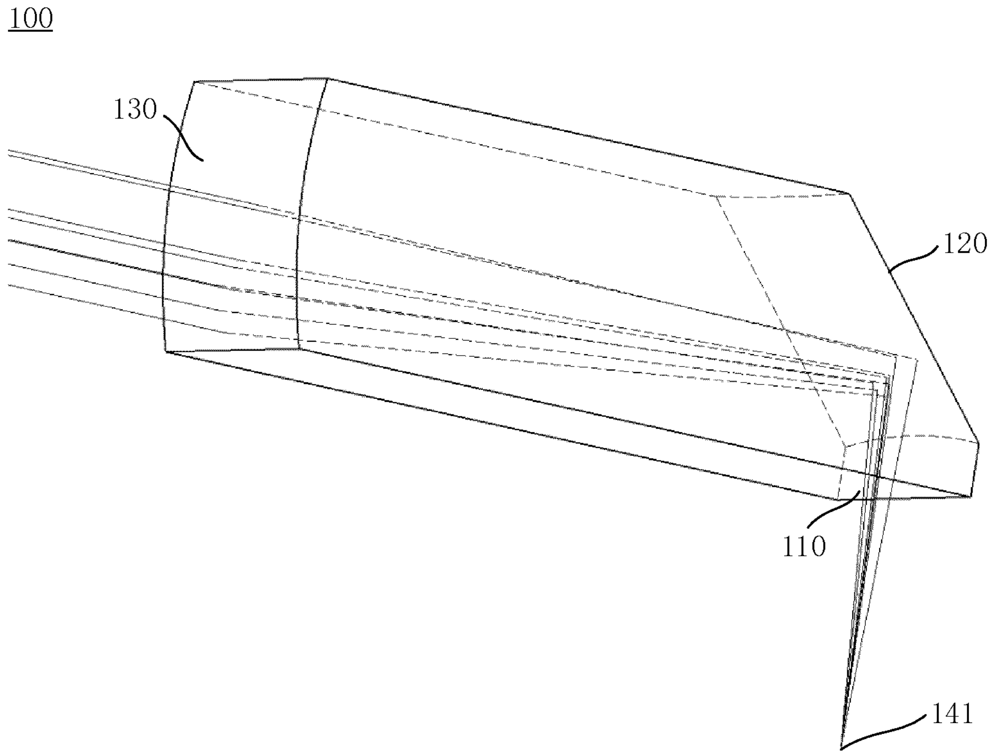

FIG. 2

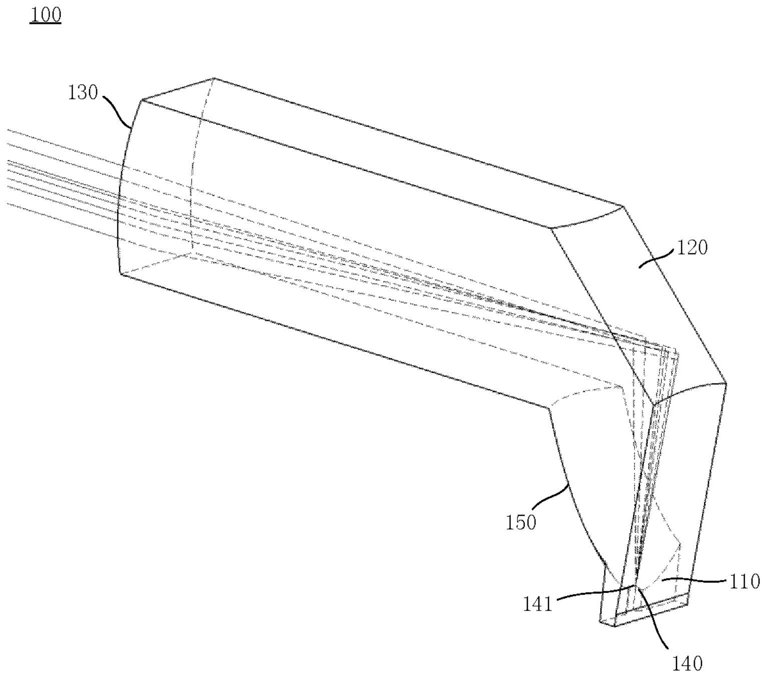

FIG. 3

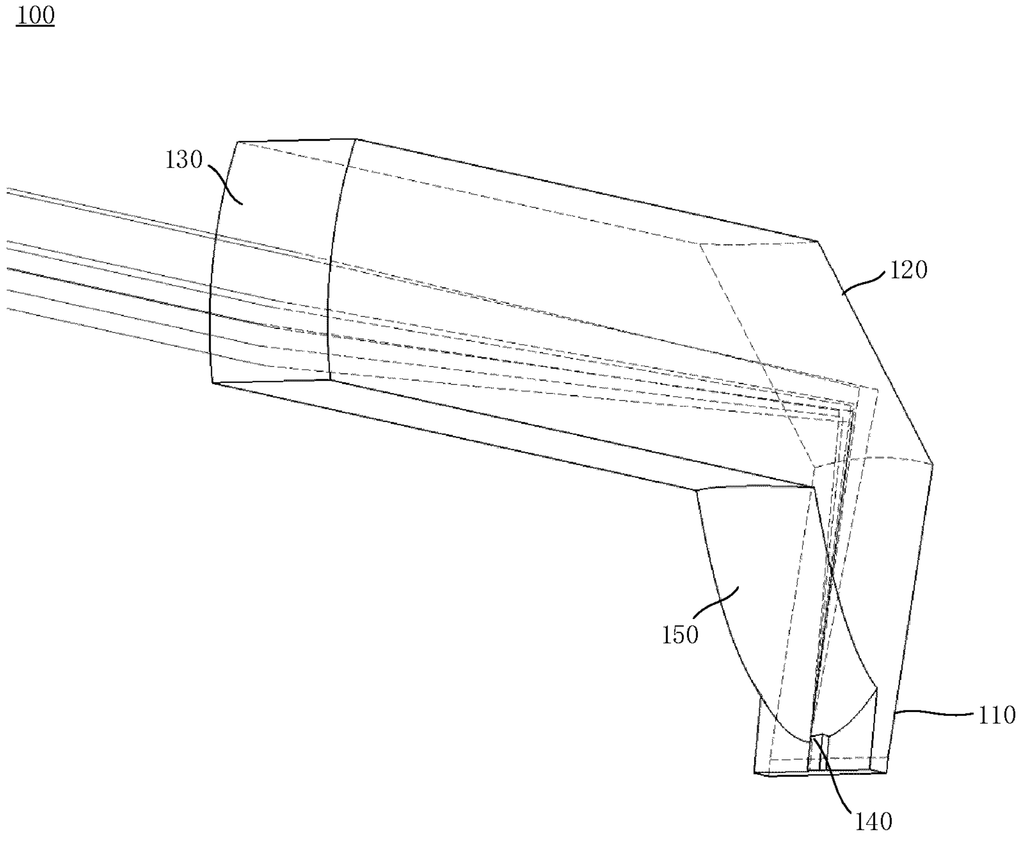

FIG. 4

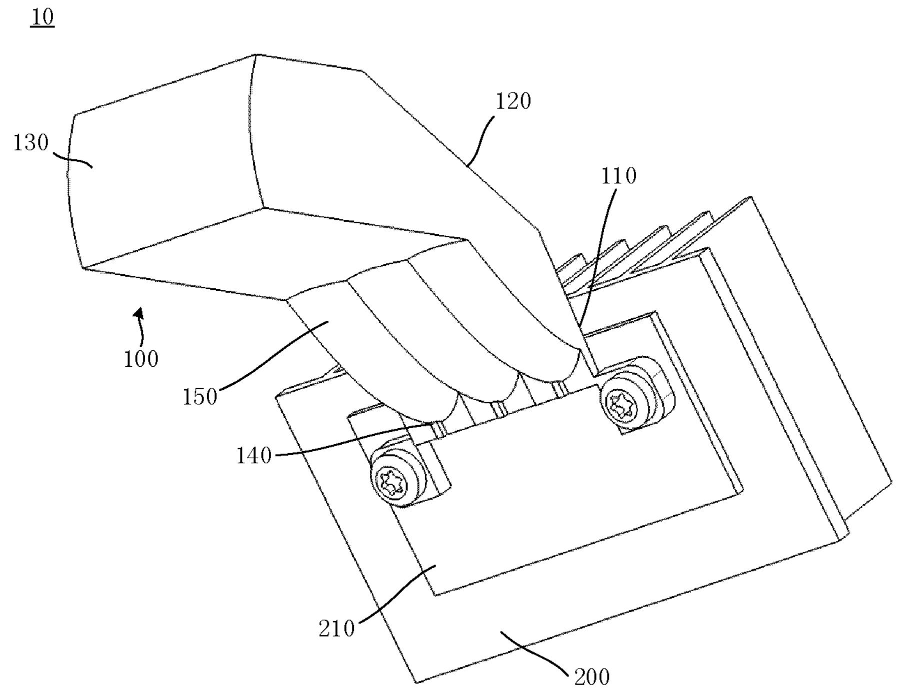

FIG. 5

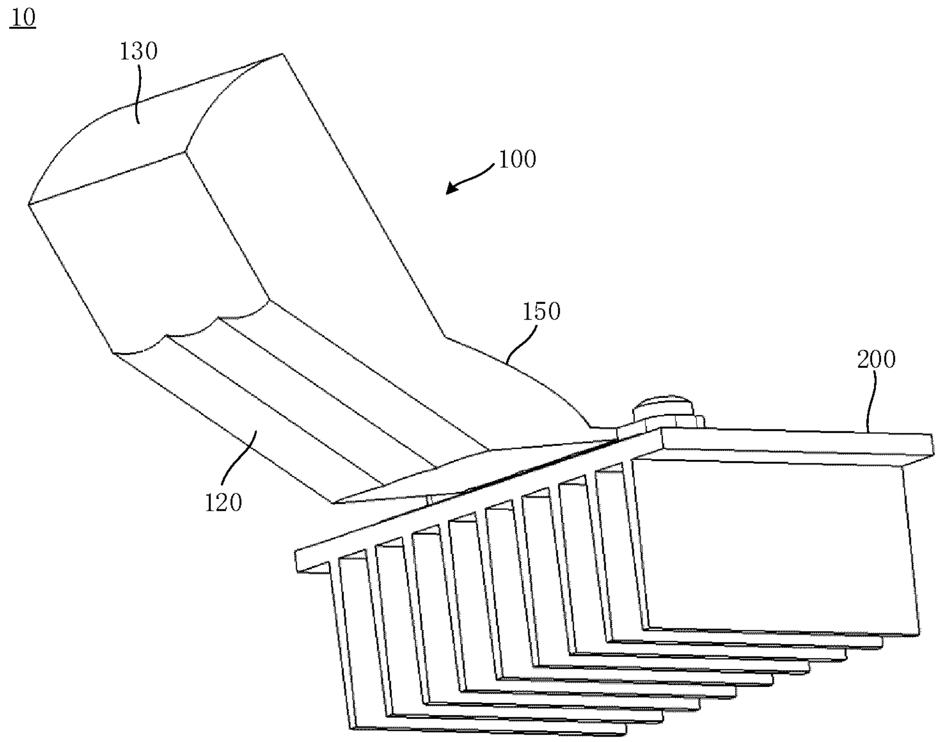

FIG. 6

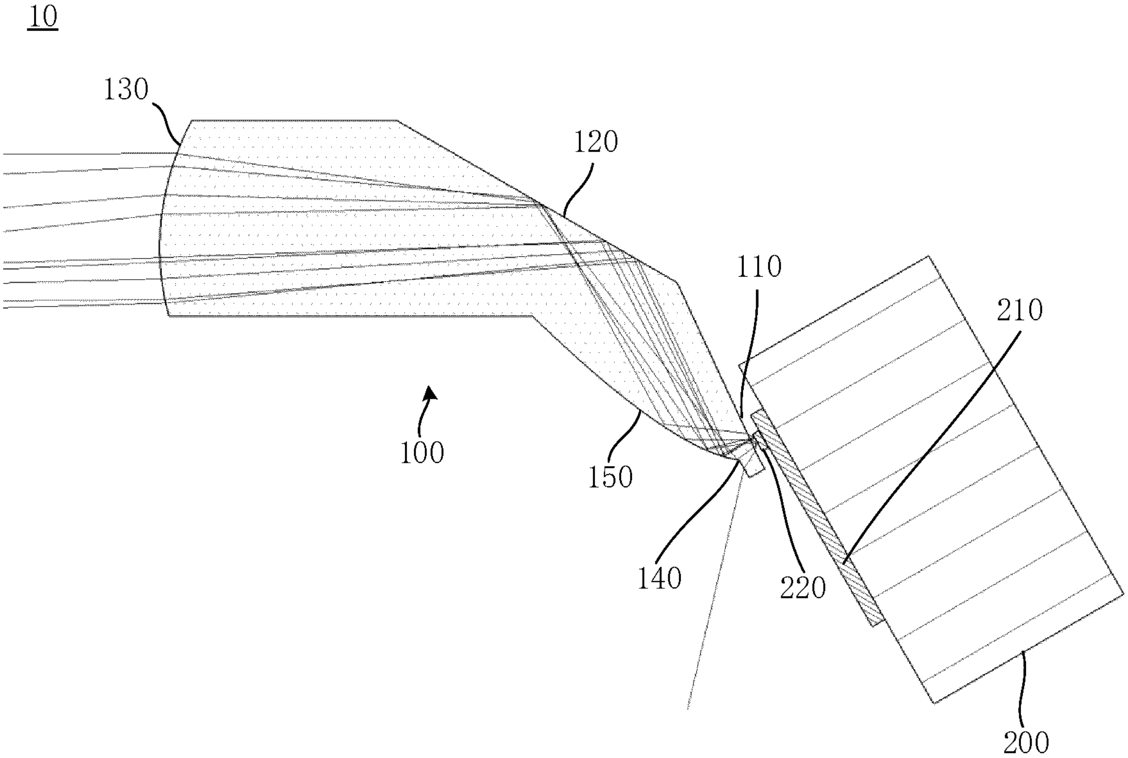

FIG. 7

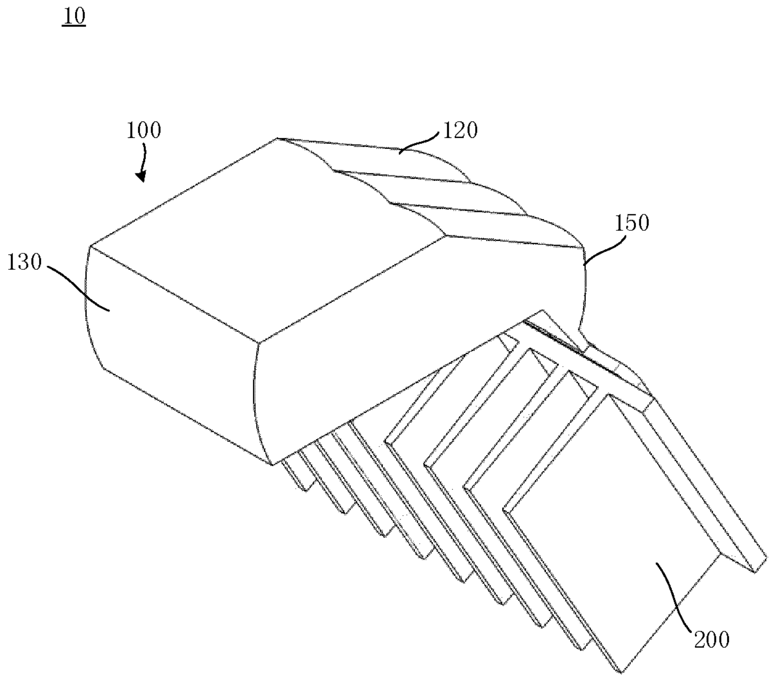

FIG. 8

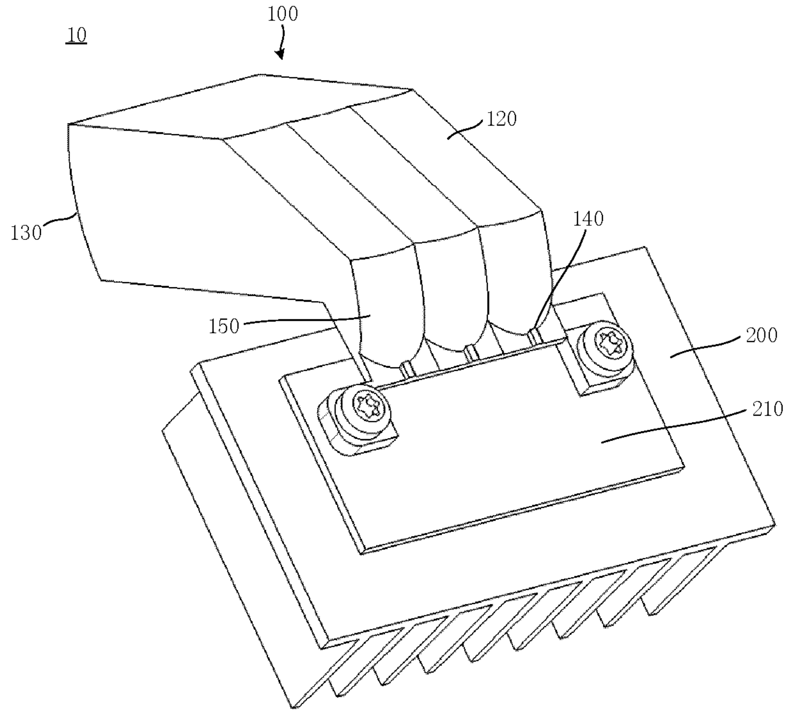
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FIG. 9

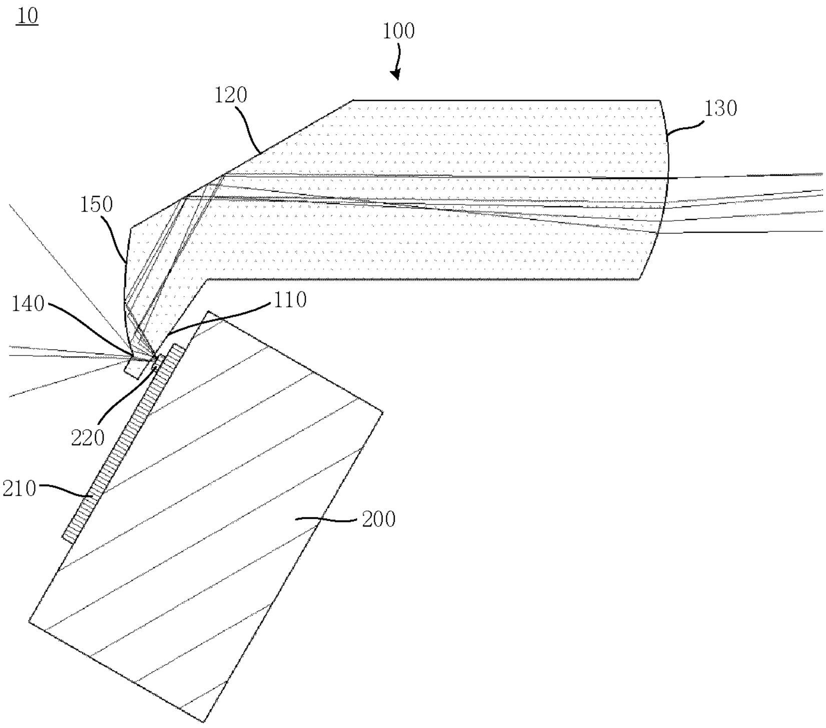
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FIG. 10

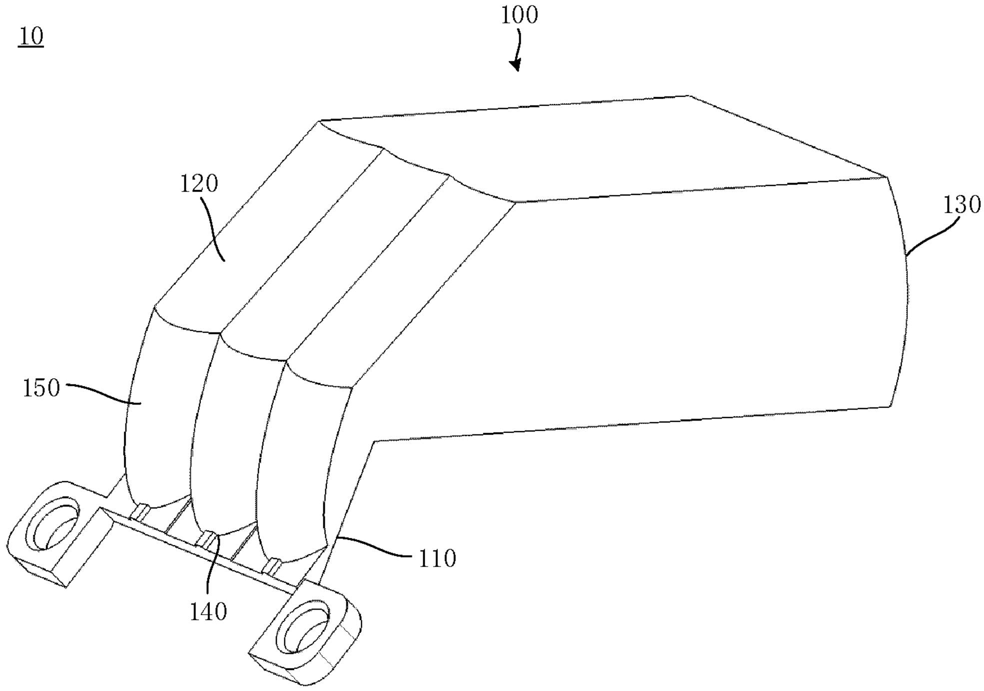

FIG. 11

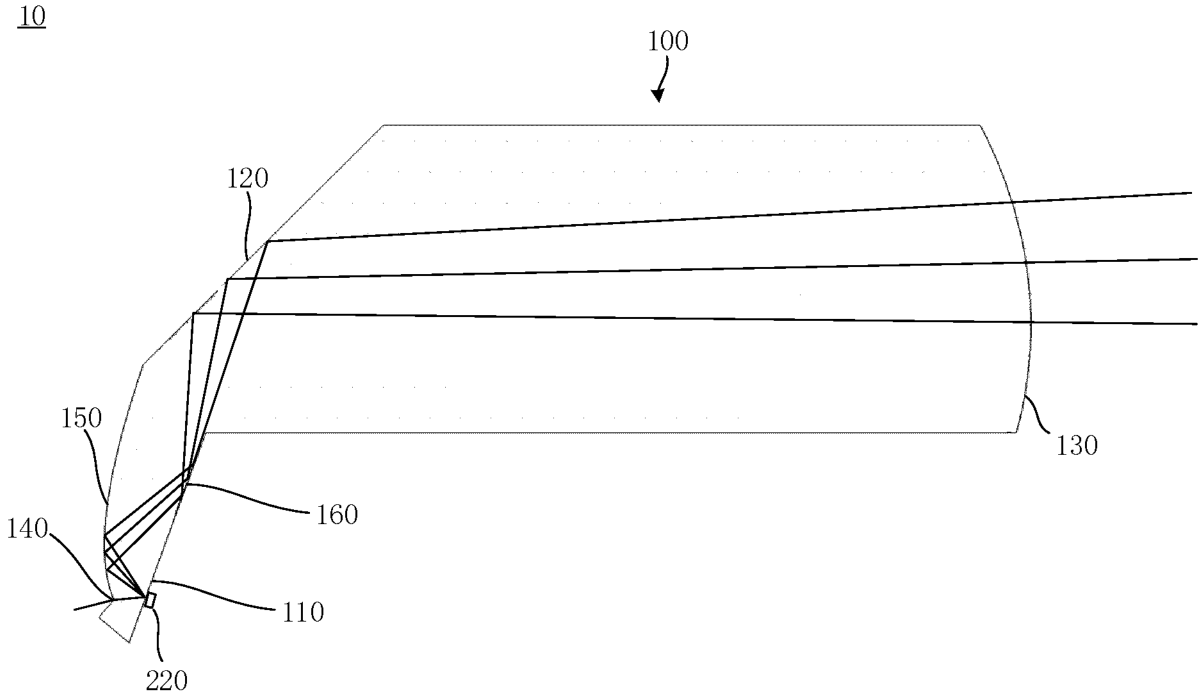

FIG. 12

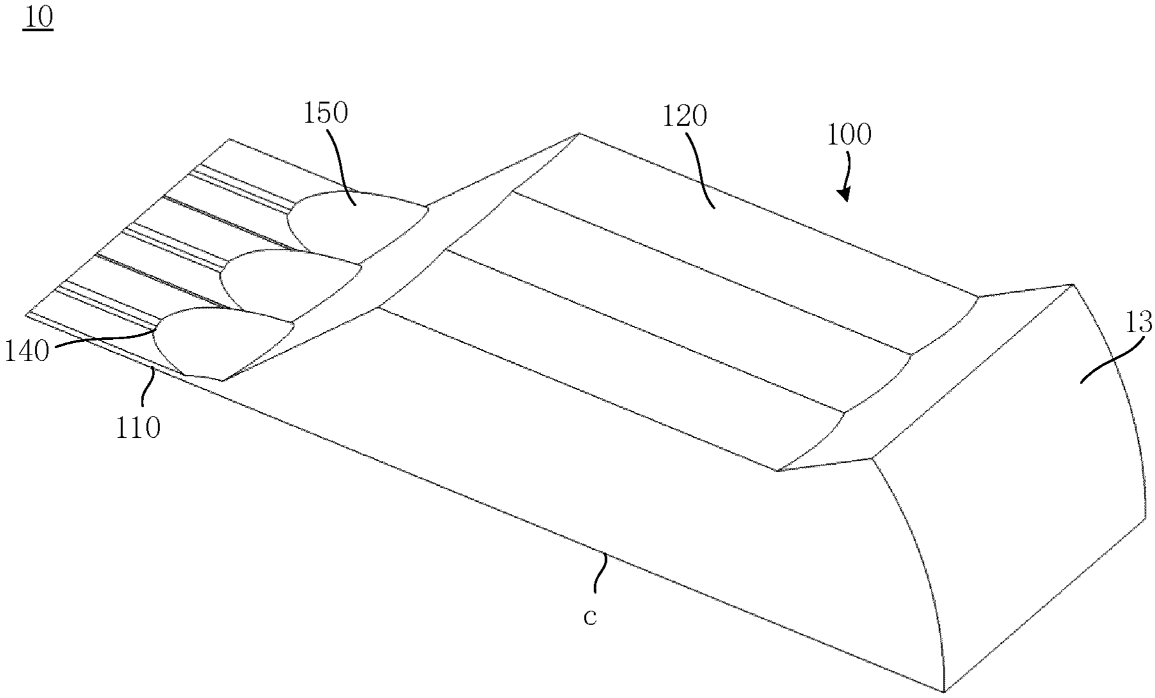

FIG. 13

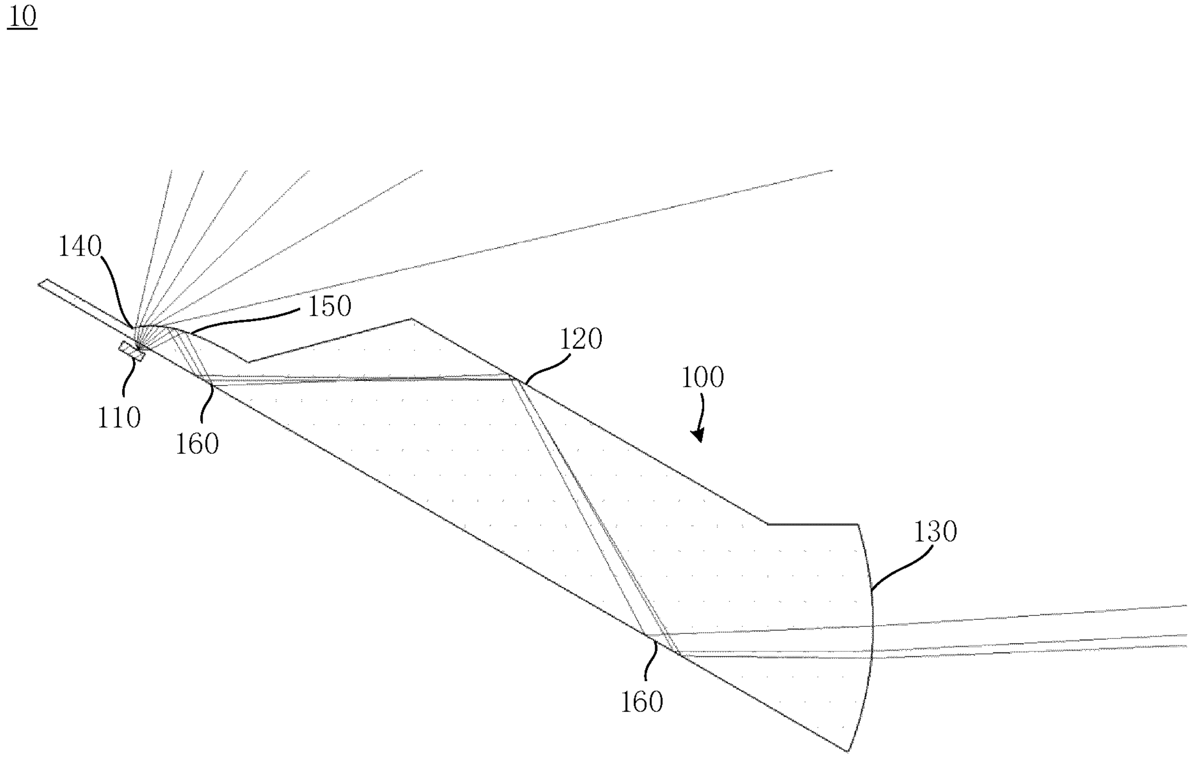

FIG. 14

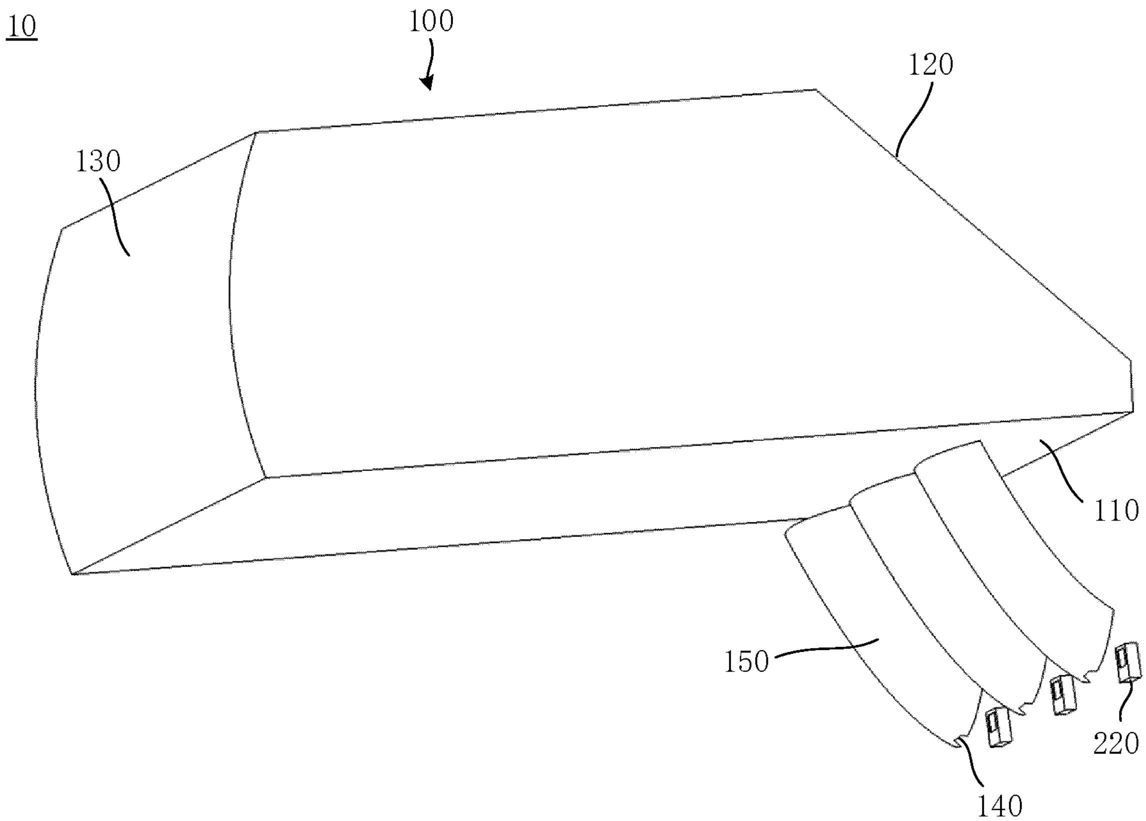

FIG. 15

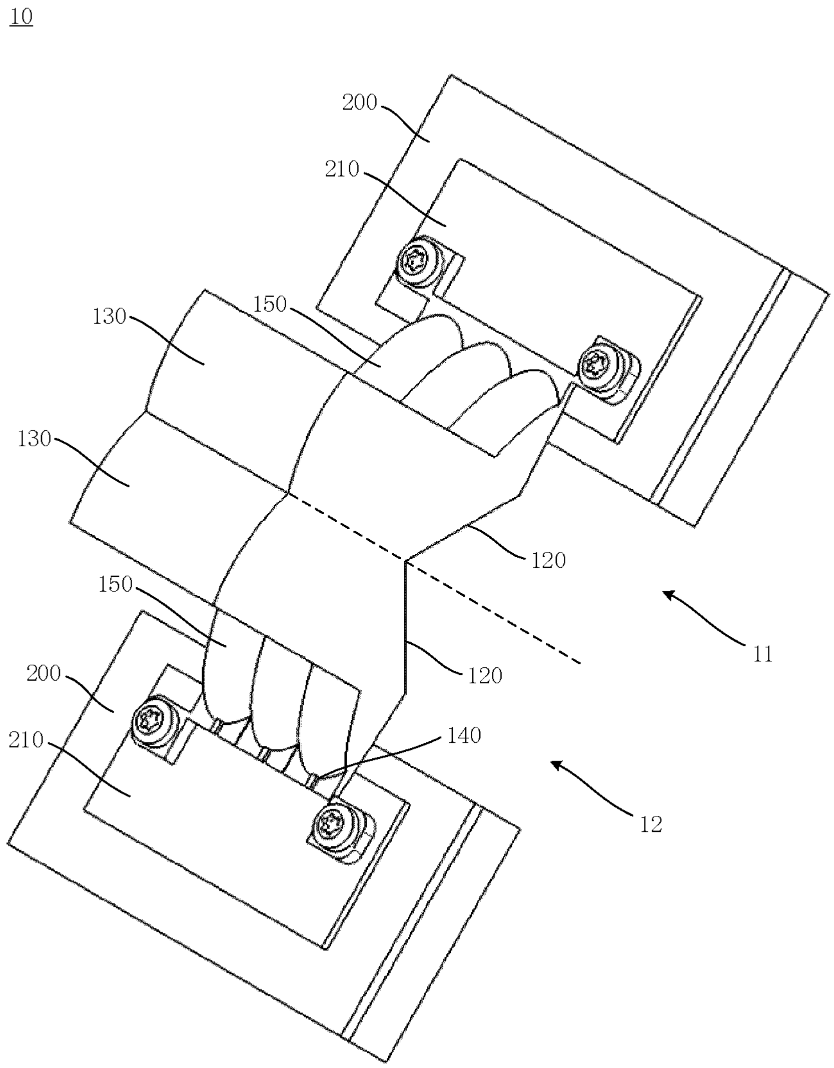

FIG. 16

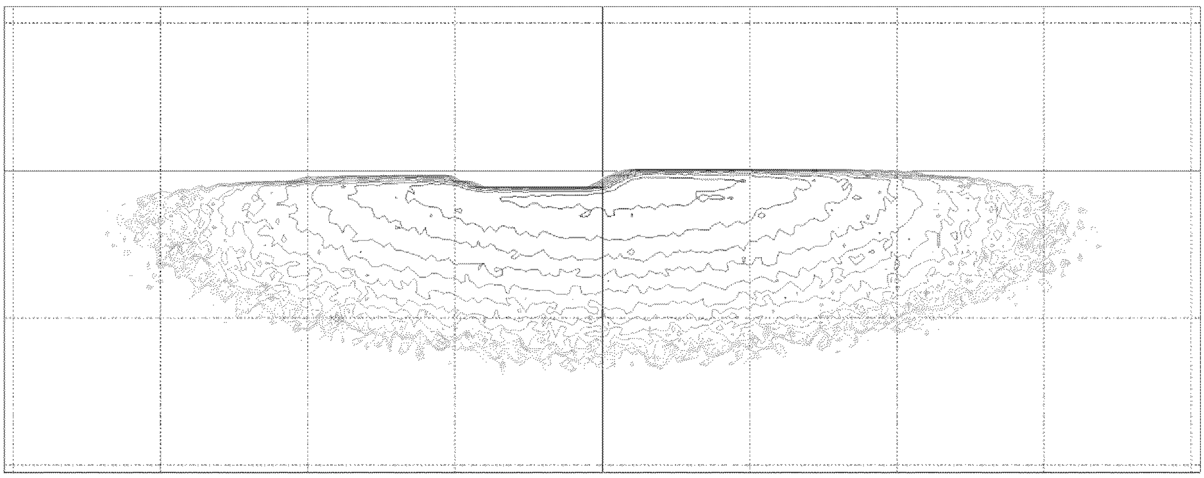

FIG. 17

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2023/116983

A. CLASSIFICATION OF SUBJECT MATTER

F21S 41/25(2018.01)i; F21S41/32(2018.01)i; F21W102/13(2018.01)i; F21W107/10(2018.01)i

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)

IPC: F21S F21W

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)

CNTXT; WPABSC; ENTXTC; CNKI; VEN; WPABS; ENTXT: 全反射, 透镜, 光导, 导光, 准直, 截止, total, reflect+, lens, light, guide, cutoff, line, collimation

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 219510649 U (HASCO VISION TECHNOLOGY (SHANGHAI) CO., LTD.) 11 August 2023 (2023-08-11) description, paragraphs [0006]-[0077], and figures 1-17	1-11
Y	CN 108800052 A (CHANGCHUN HELLA AUTOMOTIVE LIGHTING LTD.) 13 November 2018 (2018-11-13) description, paragraphs [0032]-[0055], and figures 1-13	1-11
Y	CN 113531477 A (HASCO VISION TECHNOLOGY (SHANGHAI) CO., LTD.) 22 October 2021 (2021-10-22) description, paragraphs [0064]-[0087], and figures 1-28	1-11
A	CN 108474534 A (ZKW GROUP GMBH) 31 August 2018 (2018-08-31) entire document	1-11
A	JP 2021185558 A (STANLEY ELECTRIC CO., LTD.) 09 December 2021 (2021-12-09) entire document	1-11

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

* Special categories of cited documents:
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"P" document published prior to the international filing date but later than the priority date claimed
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 November 2023	**24 November 2023**

Name and mailing address of the ISA/CN	Authorized officer
China National Intellectual Property Administration (ISA/CN) **China No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088**	Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2023/116983

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN	219510649	U	11 August 2023	None	
CN	108800052	A	13 November 2018	None	
CN	113531477	A	22 October 2021	None	
CN	108474534	A	31 August 2018	None	
JP	2021185558	A	09 December 2021	None	

Form PCT/ISA/210 (patent family annex) (July 2022)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 2023100638505 **[0001]**