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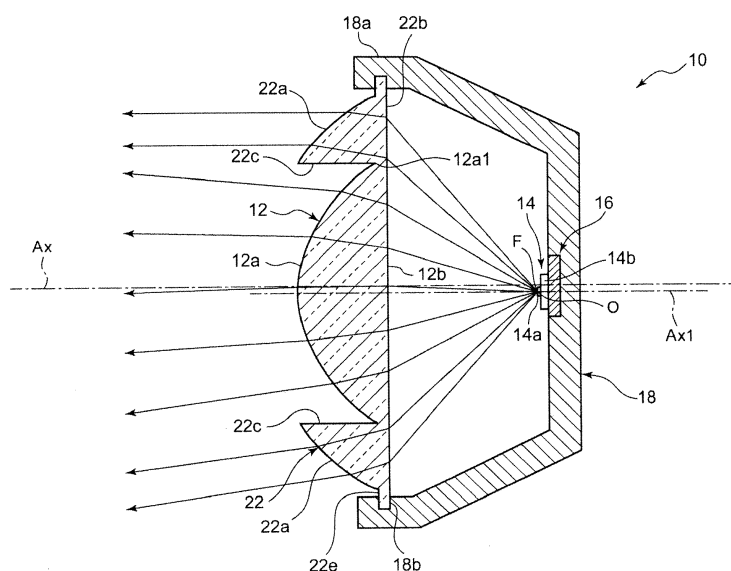
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(54) **Vehicle lamp**

(57) A vehicle lamp (10) includes a light source (14, 14') having a light emitting-surface (14a, 14'A), a first lens (12) configured to deflect a first part of direct light from the light source (14, 14') to form a first light distribution pattern (PC) having a horizontal and oblique cutoff lines (CL1, CL2) on an upper side of the first light distribution pattern (PC), and a second lens (22) configured to horizontally diffuse a second part of the direct light from the light source (14, 14') to form a second light distribution pattern (PB1, PB2) that overlaps the first light distribution pattern (PC). The first lens (12) is a convex lens, and is disposed on an optical axis (Ax) extending in a front-rear direction of the vehicle lamp (10). The light

source (14, 14') is arranged such that the light emitting-surface (14a, 14'A) faces forward in the front-rear direction, and such that a bottom side (14a1, 14'A1) of the light emitting-surface (14a, 14'A) is disposed on a plane including the optical axis (Ax) and has an end point located at a rear focal point (F) of the first lens (12). The second lens (22) has a shape of a portion of a convex lens other than a central portion of the convex lens. The first lens (12) and the second lens (22) are formed as a single unitary piece such that the second lens (22) extends around the first lens (12). The first lens (12) and the second lens (22) have substantially the same maximum thickness in the front-rear direction.

FIG. 2



Description

[0001] The present invention relates to a vehicle lamp having a surface light source such as a light-emitting device.

[0002] In recent years, light-emitting devices such as light-emitting diodes are being used as a light source of a vehicle lamp.

[0003] JP2009-146665A discloses a vehicle lamp including a convex lens disposed on an optical axis extending in the front-rear direction of the vehicle, and a light-emitting device disposed adjacent to the rear focal point of the convex lens. The convex lens deflects direct light from the light-emitting device to form a light distribution pattern having horizontal and oblique cutoff lines along its upper side. The vehicle lamp further includes an auxiliary lens disposed around the convex lens. The auxiliary lens has an annular shape that surrounds the convex lens. The convex lens and the auxiliary lens are formed as a single unitary piece. The auxiliary lens has a cylindrical surface portion having a center axis that is parallel to the optical axis and extending at the light emission center of the light-emitting device.

[0004] The auxiliary lens is configured and arranged such that the light from the light-emitting device directed toward a region outside the convex lens enters the cylindrical surface portion. The light that has entered auxiliary lens is then reflected by a reflecting surface of the auxiliary lens, and is output in a forward direction from a light exit surface of the auxiliary lens. The light output from the auxiliary lens forms an auxiliary light distribution pattern in addition to a basic light distribution pattern formed by light that is output from the convex lens. Thus, a light beam emitted by the light source can be used effectively.

[0005] However, the auxiliary lens having the cylindrical surface portion increases the entire thickness of the lens member, and is difficult to mold, thus resulting in high cost.

[0006] The present invention has been made in view of the above, and an object of the present invention is to provide a vehicle lamp having a simplified structure of a single unitary piece including a convex lens and an auxiliary lens surrounding the convex lens.

[0007] According to an illustrative aspect of the present invention, a vehicle lamp includes a light source having a light emitting-surface, a first lens configured to deflect a first part of direct light from the light source to form a first light distribution pattern having a horizontal and oblique cutoff lines on an upper side of the first light distribution pattern, and a second lens configured to horizontally diffuse a second part of the direct light from the light source to form a second light distribution pattern that overlaps the first light distribution pattern. The first lens is a convex lens, and is disposed on an optical axis extending in a front-rear direction of the vehicle lamp. The light source is arranged such that the light emitting-surface faces forward in the front-rear direction, and such

that a bottom side of the light emitting-surface is disposed on a plane including the optical axis and has an end point located at a rear focal point of the first lens. The second lens has a shape of a portion of a convex lens other than a central portion of the convex lens. The first lens and the second lens are formed as a single unitary piece such that the second lens extends around the first lens. The first lens and the second lens have substantially the same maximum thickness in the front-rear direction.

[0008] Other aspects and advantages of the invention will be apparent from the following description, the drawings and the claims.

[0009] Fig. 1 is a front view of a vehicle lamp according to an exemplary embodiment of the present invention.

[0010] Fig. 2 is a sectional view of the vehicle lamp taken along the line II-II of Fig. 1.

[0011] Fig. 3A is a horizontal sectional view illustrating optical paths of light output from an auxiliary lens of the vehicle lamp.

[0012] Fig. 3B is a vertical sectional view illustrating optical paths of light output from an auxiliary lens of the vehicle lamp.

[0013] Fig. 4 is an enlarged view of Fig. 1, illustrating a convex lens and a light-emitting chip of the vehicle lamp.

[0014] Fig. 5 is a diagram illustrating a basic light distribution pattern PC formed on a virtual vertical screen by light that is projected forward by the vehicle lamp.

[0015] Fig. 6 is a diagram illustrating an upper auxiliary light distribution pattern formed on the virtual vertical screen.

[0016] Fig. 7 is a diagram illustrating a lower auxiliary light distribution pattern formed on the virtual vertical screen.

[0017] Fig. 8A illustrates another exemplary embodiment in which the light-emitting device is arranged such that the bottom side of the light-emitting device extends horizontally.

[0018] Fig. 8B illustrates a basic light distribution pattern formed on a virtual vertical screen by the light-emitting device of Fig. 8A.

[0019] Fig. 9A illustrates yet another exemplary embodiment in which a laterally elongated pentagonal light-emitting device is used.

[0020] Fig. 9B illustrates a basic light distribution pattern formed on a virtual vertical screen by the light-emitting device of Fig. 9A.

[0021] Hereinafter, exemplary embodiments of the present invention will be described with reference to the drawings.

[0022] Figs. 1 and 2 illustrate a vehicle lamp 10 according to an exemplary embodiment of the present invention. As shown in Figs. 1 and 2, the vehicle lamp 10 includes a convex lens 12 (a first lens) disposed on an optical axis Ax extending in the front-rear direction of the lamp 10, an auxiliary lens 22 (a second lens) having an annular shape that extends around the entire circumference of the convex lens 12, a light-emitting device 14 (a

surface light source) and disposed adjacent to the rear focal point F of the convex lens 12, a metal plate 16 on which the light-emitting device 14 is supported, and a metal support member 18 on which the metal plate 16 and the auxiliary lens 22 are supported and positioned. The convex lens 12 and the auxiliary lens 22 are formed as a single unitary piece. The vehicle lamp 10 is used as a lamp unit of a vehicle headlamp, and may be attached to a lamp body of the vehicle headlamp such that its optical axis is adjustable.

[0023] The optical axis Ax of the vehicle lamp 10 is adjusted such that the optical axis Ax is directed downward by about 0.5° to 0.6° with respect to the front-rear direction of the vehicle.

[0024] The convex lens 12 has a shape like a plano-convex aspherical lens, and has a convex front surface 12a and a flat rear surface 12b. The sectional shape of the front surface 12a of the convex lens 12 taken along the vertical plane including the optical axis Ax has a sectional shape of the front surface of the planoconvex aspherical lens, but other sectional shapes of the front surface 12a of the convex lens 12 are somewhat deformed versions of the sectional shape of the front surface of the planoconvex aspherical lens. The rear focal point F of the convex lens 12 is the rear focal point of the convex lens 12 that is within the vertical plane including the optical axis Ax. The details of the front surface 12a of the convex lens 12 will be described later.

[0025] The light-emitting device 14 is, for example, a white light-emitting diode including a light-emitting chip 14a having a laterally elongated rectangular light-emitting surface (e.g., 1 mm by 2 mm) and a substrate 14b on which the light-emitting chip 14a is supported. The light-emitting chip 14a is sealed by a thin film which is formed so as to cover the light-emitting surface. The light-emitting device 14 may be a light source other than a light-emitting diode as long as it has a flat light-emitting surface.

[0026] The light-emitting device 14 is arranged to face forward such that a bottom side 14a1 of the light-emitting chip 14a is disposed within an inclined plane that is inclined upward toward the self-lane side from the horizontal plane including the optical axis Ax by an angle θ (e.g., 15°), and that the end point of the bottom side 14a1 is located at the rear focal point F of the convex lens 12.

[0027] The auxiliary lens 22 has an annular shape obtained by removing a central portion of a convex lens having a center axis Ax1 that is parallel to the optical axis Ax and extending at the emission center O of the light-emitting device 14 (i.e., the center of the light-emitting chip 14a in a front view of the vehicle lamp 10). The auxiliary lens 22 has a light entrance surface 22b which refracts light coming directly from the light-emitting device 14 so that it is directed away from the axis Ax1 and a light exit surface 22a which outputs forward light coming from the light entrance surface 22b.

[0028] The maximum thickness of the auxiliary lens 22 in the front-rear direction (i.e., the direction of the optical

axis Ax) is substantially the same as the maximum thickness of the convex lens 12. The diameter of the front edge of the light exit surface 22a, i.e., the front end of the inner circumferential surface 22c, of the auxiliary lens 22 is substantially the same as the diameter of a boundary 12a1 between the front surface 12a of the convex lens 12 and the auxiliary lens 22.

[0029] The light entrance surface 22b of the auxiliary lens 22 is flush with the light entrance surface 12b of the convex lens 12. That is, the surface, opposed to the light-emitting device 14, of the lens piece is flat as a whole.

[0030] A flange 22e is provided to protrude in a direction perpendicular to the axis Ax1 from the outer circumference of the light exit surface 22a of the auxiliary lens 22.

[0031] The metal plate 16 is positioned and supported by the support member 18 disposed behind the convex lens 12 and the auxiliary lens 22. The support member 18 is arranged to surround the convex lens 12 and the auxiliary lens 22. A front end portion of the support member 18 is a ring portion 18a which surround the auxiliary lens 22 along its entire circumference. The ring portion 18a is formed with a positioning groove 18b in a prescribed angular range with the optical axis Ax as the center line.

[0032] The flange 22e of the auxiliary lens 22 is fitted into the positioning groove 18b, whereby the convex lens 12 and the auxiliary lens 22 are positioned with respect to and supported by the support member 18. The convex lens 12 and the auxiliary lens 22 are positioned not only in the front-rear direction but also in the vertical direction, the horizontal direction, and the rotation direction in a plane that is perpendicular to the front-rear direction.

[0033] Fig. 2 also illustrates optical paths of light emitted from the emission center O of the light-emitting device 14. Light emitted by the light-emitting device 14 and entered the convex lens 12 exits the convex lens 12 as parallel light that is directed slightly downward with respect to the vertical direction, and as rightwardly diffused light and upwardly and leftwardly diffused light with respect to the horizontal direction.

[0034] Figs. 3A and 3B show optical paths of light rays that are emitted by the light-emitting device 14 and passing through the auxiliary lens 22.

[0035] The auxiliary lens 22 is configured such that the portion above the optical axis Ax and the portion below the optical axis Ax output light in a different manner as shown in Figs. 3A and 3B. Fig. 3A is a sectional view taken along the horizontal plane including the optical axis Ax of the vehicle lamp 10, and Fig. 3B is a sectional view taken along the vertical plane including the optical axis Ax of the vehicle lamp 10.

[0036] As shown in Fig. 3A, in the horizontal direction, the auxiliary lens 22 is configured so as to refract by its light entrance surface 22b and then again refract resulting light by its light exit surface 22a which is shaped like a peripheral portion of a convex lens. In this manner, the auxiliary lens 22 outputs light that is diffused on the left

side and the right side more than light that is output from the convex lens 12.

[0037] On the other hand, as shown in Fig. 3B, in the vertical direction, the auxiliary lens 22 outputs light that is directed a little more downward than light that is output from the convex lens 12. The auxiliary lens 22 is designed so that light that is output from a light exit surface 22a1 located over the optical axis Ax is diffused less in the vertical direction than light that is output from a light exit surface 22a2 located under the optical axis Ax. Furthermore, a light distribution pattern (an upper auxiliary light distribution pattern) that is formed on a virtual vertical screen by the light emitted from the light exit surface 22a1 is concentrated in a region that is closer to the optical axis than a region where a light distribution pattern (a lower auxiliary light distribution pattern) that is formed on the virtual vertical screen by the light emitted from the light exit surface 22a2 is concentrated.

[0038] The upper auxiliary light distribution pattern and the lower auxiliary light distribution pattern are superimposed on a light distribution pattern of the convex lens 12.

[0039] Fig. 4 is an enlarged view of Fig. 1, illustrating the convex lens 12 and the light-emitting chip 14a.

[0040] As shown in Fig. 4, the front surface 12a of the convex lens 12 includes a horizontal diffusion region Z1 on the opposing-lane side of the vertical plane including the optical axis Ax, and an oblique diffusion region Z2 on the self-lane side of the vertical plane including the optical axis Ax.

[0041] The horizontal diffusion region Z1 is divided into a plurality of cells C1, and light exit directions are set for the respective cells C1.

[0042] More specifically, as indicated by arrows in Fig. 4, leftward light exit directions having somewhat large angles are set for cells C1 located close to a boundary line B. Rightward light exit directions having somewhat large angles are set for cells C1 located close to the outer periphery of the convex lens 12. Intermediate light exit directions are set for middle cells C1. In each horizontal row, the light exit direction is varied gradually in the horizontal plane from the cell C1 adjacent to the boundary line B to the cell C1 adjacent to the outer periphery of the convex lens 12.

[0043] The oblique diffusion region Z2 is divided into a plurality of cells C2, and light exit directions are set for the respective cells C2.

[0044] More specifically, as indicated by arrows in Fig. 4, leftward light exit directions that are parallel with curves L2c and have small angles are set for cells C2 located close to the boundary line B. Leftward light exit directions that are parallel with the curves L2c and have somewhat large angles are set for cells C2 located close to the outer periphery of the convex lens 12. Intermediate light exit directions are set for middle cells C2. In the exemplary embodiment, leftward light exit directions that are parallel with curves L2c and have small angles are set also for cells C2 located in a fan-shaped region enclosed by the boundary line B and a curve L2m that extends obliquely

downward from the optical axis Ax. In each row, the light exit direction is varied gradually within the plane inclined from the horizontal plane by an angle θ from the cell C2 adjacent to the boundary line B to the cell C2 adjacent to the outer periphery of the convex lens 12.

[0045] The oblique diffusion region Z2 has a top region Z2a and a bottom region Z2b, illustrated as hatched regions in Fig. 4. These regions Z2a, Z2b are configured such that the light from the light-emitting device 14 that has reached the regions Z2a, Z2b is output as downwardly diffused light, more specifically, downwardly diffused with respect to the inclined plane described above. The downward deflection amount of the output light is increased as the cell C2 becomes closer to the top end of the boundary line B or the bottom end of the curve L2m that extends obliquely downward from the optical axis Ax.

[0046] In Fig. 4, the arrow extending from the center of each cell C1 or C2 indicates an exit direction of light that originates from the opposing-lane side end point of the bottom side 14a1 of the light-emitting chip 14a (i.e., the rear focal point F of the convex lens 12), shines on the convex lens 12, and exits from the cell C1 or C2.

[0047] The front surface 12a of the convex lens 12 is discontinuous at the boundary line B between the horizontal diffusion region Z1 and the oblique diffusion region Z2 such that the boundary line B is formed as a ridge line.

[0048] Figs. 5 to 7 illustrate a basic light distribution pattern PC, an upper auxiliary light distribution pattern PB1, and a lower auxiliary light distribution pattern PB2, respectively, that are formed on a virtual vertical screen disposed 25 m ahead of the vehicle lamp 10 by light that is projected forward by the vehicle lamp 10.

[0049] The basic light distribution pattern PC is formed by light that is output from the convex lens 12 (see Fig. 5). The upper auxiliary light distribution pattern PB1 is formed by light that is output from the upper light exit surface 22a1 of the auxiliary lens 22 (see Fig. 6). The lower auxiliary light distribution pattern PB2 is formed by light that is output from the lower light exit surface 22a2 of the auxiliary lens 22 (see Fig. 7). A low-beam light distribution pattern PL2 is a combined light distribution pattern of the basic light distribution pattern PC, the upper auxiliary light distribution pattern PB1, the lower auxiliary light distribution pattern PB2, and one or more light distribution patterns that is formed by light that is projected forward by one or more other lamp units (not shown).

[0050] This low-beam light distribution pattern PL2 is a left-hand traffic low-beam light distribution pattern, and has a horizontal cutoff line CL1 and an oblique cutoff line CL2 on its upper side. The horizontal cutoff line CL1 is formed on the opposing-lane side of a vertical line V-V which passes a forward vanishing point H-V, and the oblique cutoff line CL2 is formed on the self-lane side of the vertical line V-V. An elbow point E which is the intersecting point of the cutoff lines CL1, CL2 is located below the forward vanishing point H-V by about 0.5° to 0.6° . In this low-beam light distribution pattern PL2, a hot zone HZ

(high luminance region) is formed so as to surround the elbow point E with its center deviated leftward from the elbow point E.

[0051] The basic light distribution pattern PC is a combined light distribution pattern of a light distribution pattern PC1 and a light distribution pattern PC2. The light distribution pattern PC1 is formed by light that is output from the horizontal diffusion region Z1 such that its upper side forms a portion of the horizontal cutoff line CL1. The light distribution pattern PC2 is formed by light that is output from the oblique diffusion region Z2 such that its upper side forms a portion of the oblique cutoff line CL2. The hot zone HZ of the low-beam light distribution pattern PL2 is mainly formed by an overlap portion of the light distribution patterns PC1, PC2.

[0052] The upper auxiliary light distribution pattern PB1 is laterally diffused such that its upper side approximately coincides with the horizontal cutoff line CL1. The lower auxiliary light distribution pattern PB2 is laterally diffused so as to irradiate a lower region than the upper auxiliary light distribution pattern PB1.

[0053] As described above, according to the vehicle lamp 10, the basic light distribution pattern PC (a first light distribution pattern) having the horizontal cutoff line CL1 and the oblique cutoff line CL2 on its upper side is formed as a combined light distribution pattern of the light distribution patterns PC1, PC2.

[0054] Further, the auxiliary lens 22 surrounding the convex lens 12 and formed as a single unitary piece with the convex lens 12 forms the auxiliary light distribution patterns PB1, PB2 (a second light distribution pattern) that are laterally diffused below the horizontal cutoff line CL1 and the oblique cutoff line CL2.

[0055] In the exemplary embodiment, the convex lens 12 and the auxiliary lens 22 have substantially the same maximum thickness in the front-rear direction of the vehicle. Therefore, the lens can be made thinner as a whole than the vehicle lamp disclosed in JP2009-146665A. Further, in the exemplary embodiment, since the rear surfaces of the convex lens 12 and the auxiliary lens 22, that is, the light entrance surfaces 12b, 22b, are flush with each other, the lens piece can be molded easily, reduced in manufacturing cost, and stored and handled easily.

[0056] In the exemplary embodiment, the auxiliary lens 22 outputs forward light from the light-emitting device 14 merely by refracting the light. That is, the light can be controlled easily without using total reflection.

[0057] While the present invention has been described with reference to a certain exemplary embodiment thereof, the scope of the present invention is not limited to the embodiment described above, and it will be understood by those skilled in the art that various changes and modifications may be made therein without departing from the scope of the present invention as defined by the appended claims.

[0058] For example, while the light-emitting device 14 is inclined so as to be high on the self-lane side, as shown in Fig. 8A the light-emitting device 14 may be disposed

such that its bottom surface lies horizontally. More specifically, the light-emitting device 14 may be arranged such that the bottom side 14a1 of the light-emitting chip 14a is disposed within the horizontal plane including the optical axis Ax and such that the end point of the bottom side 14a1 on the self-lane-side (i.e., the left end point, or the right end point in the front view) is located at the rear focal point F of the convex lens 12.

[0059] Fig. 8B shows a basic light distribution pattern PC which is formed on a virtual vertical screen when the light-emitting device 14 is disposed as shown in Fig. 8A. This basic light distribution pattern PC is different from the one shown in Fig. 5 in that an oblique cutoff line CL2 is formed by an upper right corner of the light distribution pattern PC2, rather than the upper side of the light distribution pattern PC2.

[0060] The light-emitting surface of the light-emitting device need not be rectangular. For example, according to yet another exemplary embodiment shown in Fig. 9A, a light-emitting device 14' having a laterally elongated pentagonal light-emitting surface 14'A may be used. The light-emitting device 14' is arranged to face forward such that a first side 14'A1 of the bottom side of the light-emitting surface 14'A is disposed within the horizontal plane including the optical axis Ax and such that the intersecting point of the first side 14'A1 and a second side 14'A2 is located at the rear focal point F of the convex lens 12. The second side 14'A2 extends in an oblique direction that is inclined by a prescribed angle θ so as to be high on the self-lane side (left-hand side (as viewed from the rear side)).

[0061] Fig. 9B illustrates a basic light distribution pattern PC formed on a virtual vertical screen when the light-emitting device 14' is arranged as shown in Fig. 9A. In this case, light distribution patterns PC1, PC2 that form the basic light distribution pattern PC have trapezoidal shapes. A is formed by the top side of the trapezoidal pattern PC1 forms a horizontal cutoff line CL21, and an oblique side of the trapezoidal pattern PC2 forms an oblique cutoff line CL2.

Claims

1. A vehicle lamp (10) comprising:

- a light source (14, 14') having a light emitting-surface (14a, 14'A);
- a first lens (12) configured to deflect a first part of direct light from the light source (14, 14') to form a first light distribution pattern (PC) having a horizontal and oblique cutoff lines (CL1, CL2) on an upper side of the first light distribution pattern (PC); and
- a second lens (22) configured to horizontally diffuse a second part of the direct light from the light source (14, 14') to form a second light distribution pattern (PB1, PB2) that overlaps the

first light distribution pattern (PC),
 wherein the first lens (12) is a convex lens, and
 is disposed on an optical axis (Ax) extending in
 a front-rear direction of the vehicle lamp (10),
 the light source (14, 14') is arranged such that 5
 the light emitting-surface (14a, 14'A) faces forward in the front-rear direction, and such that a
 bottom side (14a1, 14'A1) of the light emitting-surface (14a, 14'A) is disposed on a plane including the optical axis (Ax) and has an end point 10
 located at a rear focal point (F) of the first lens (12),
 the second lens (22) has a shape of a portion of
 a convex lens other than a central portion of the
 convex lens, 15
 the first lens (12) and the second lens (22) are
 formed as a single unitary piece such that the
 second lens (22) extends around the first lens
 (12), and
 the first lens (12) and the second lens (22) have 20
 substantially the same maximum thickness in
 the front-rear direction.

2. The vehicle lamp (10) according to claim 1, wherein
 a rear surface (12b) of the first lens (12) and a rear 25
 surface (22b) of the second lens (22) are flush with
 each other.
3. The vehicle lamp (10) according to claim 1 or 2,
 wherein the rear surface (22b) of the second lens 30
 (22) refracts the second part of the direct light, that
 has entered the second lens (22) from the rear surface (22b), toward a convex light exit surface (22a)
 of the second lens (22), and
 the convex light exit surface (22a) further refracts 35
 the second part of the direct light in a horizontally
 diffusing manner.
4. The vehicle lamp (10) according to any one of the
 preceding claims, wherein the second lens (22) is 40
 configured such that an upper portion of the second
 part of the direct light that is output from an upper
 portion (22a1) of the second lens (22) above the optical axis (Ax) is more concentrated near the optical
 axis (Ax) than a lower portion of the second part of 45
 the direct light that is output from a lower portion
 (22a2) of the second lens (22) below the optical axis
 (Ax).
5. The vehicle lamp (10) according to any one of the 50
 preceding claims, wherein the diameter of the front
 edge of the light exit surface (22a) of the second lens
 (22) is substantially the same as the diameter of a
 boundary (12a1) between the front surface (12a) of
 the first lens (12) and the light exit surface (22a) of 55
 the second lens (22).

FIG. 1

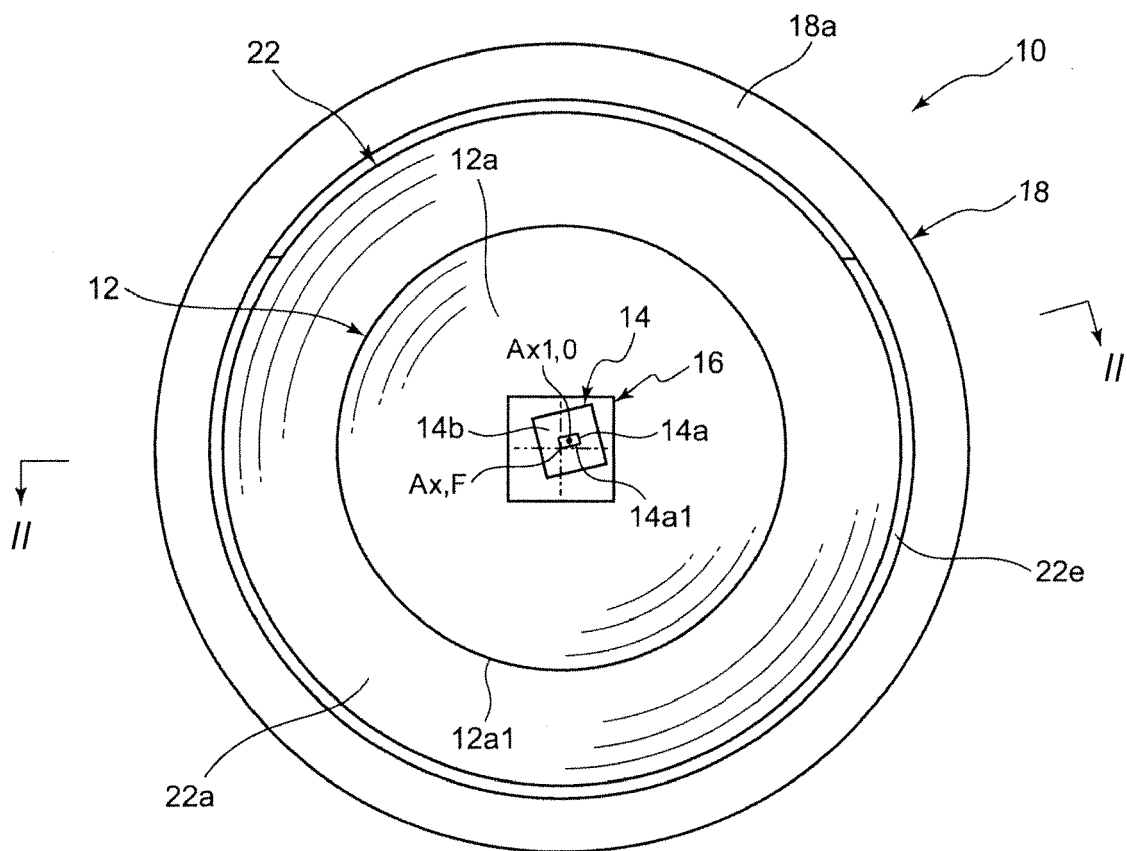


FIG. 2

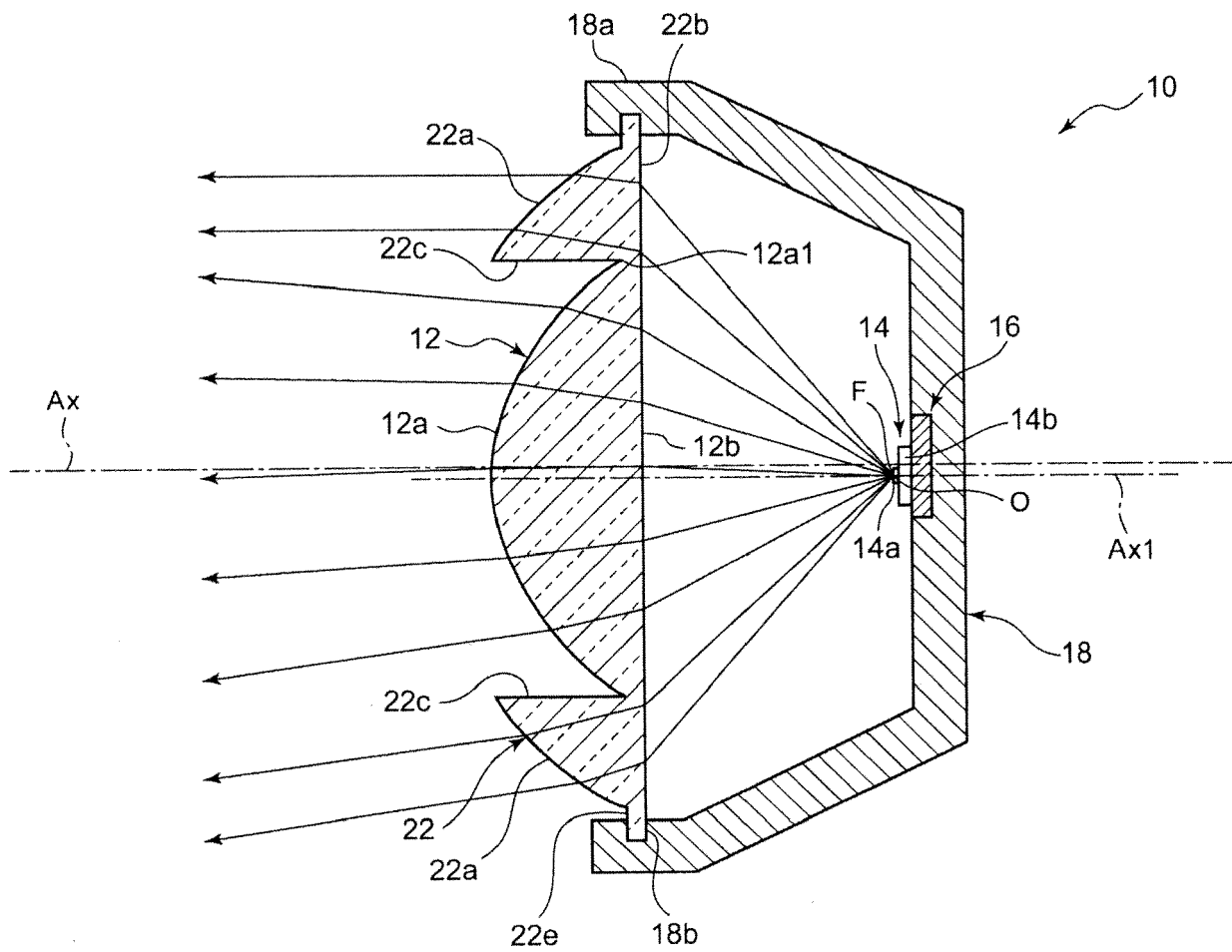


FIG. 3A

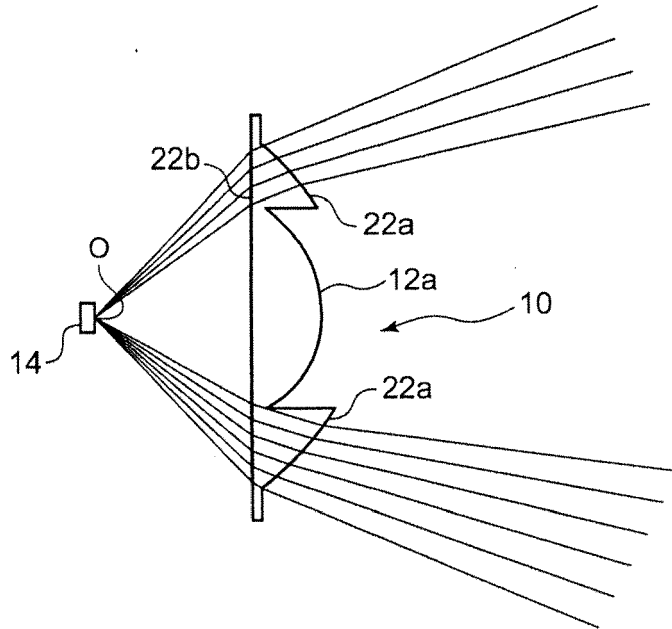


FIG. 3B

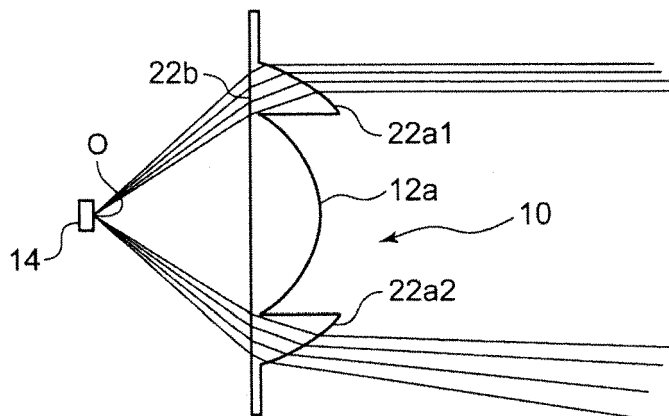


FIG. 4

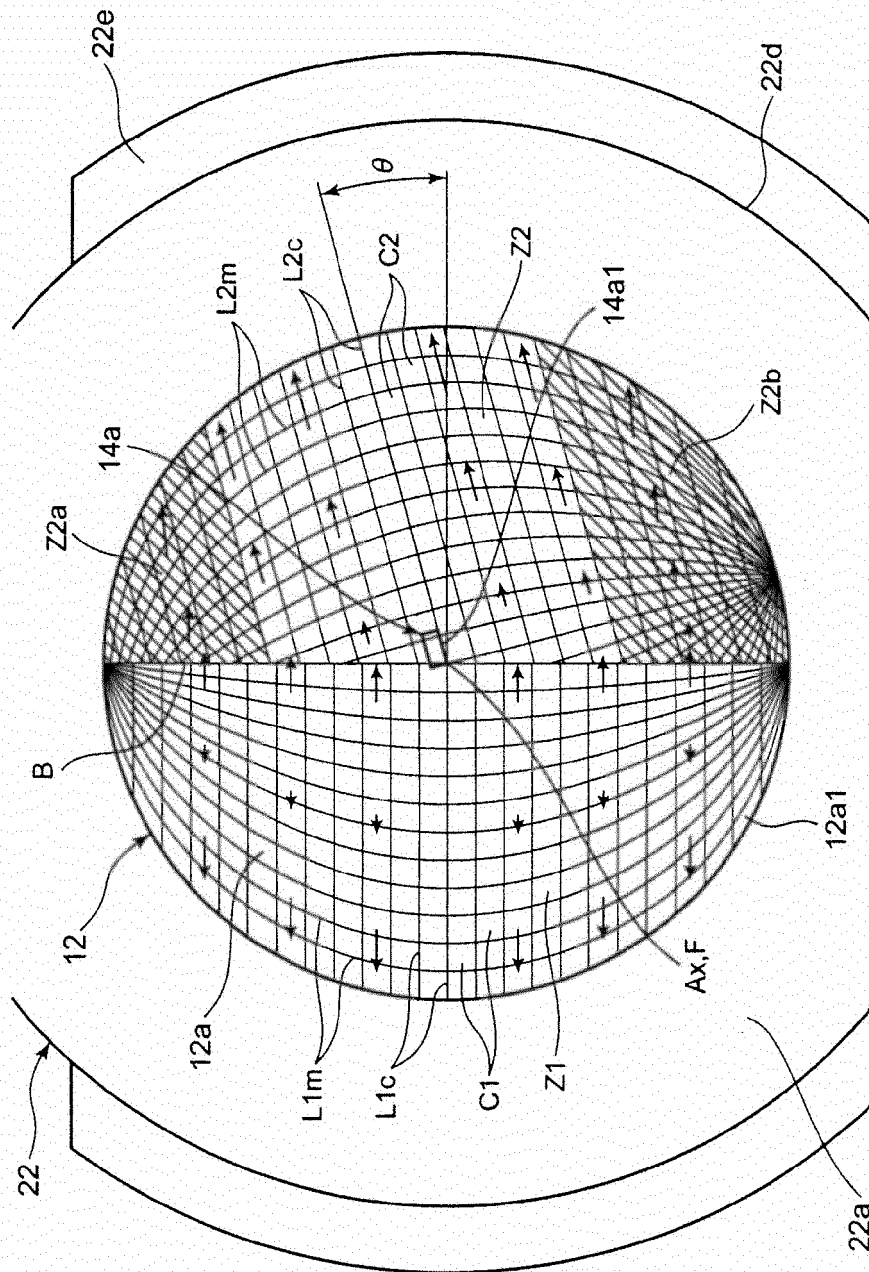


FIG. 5

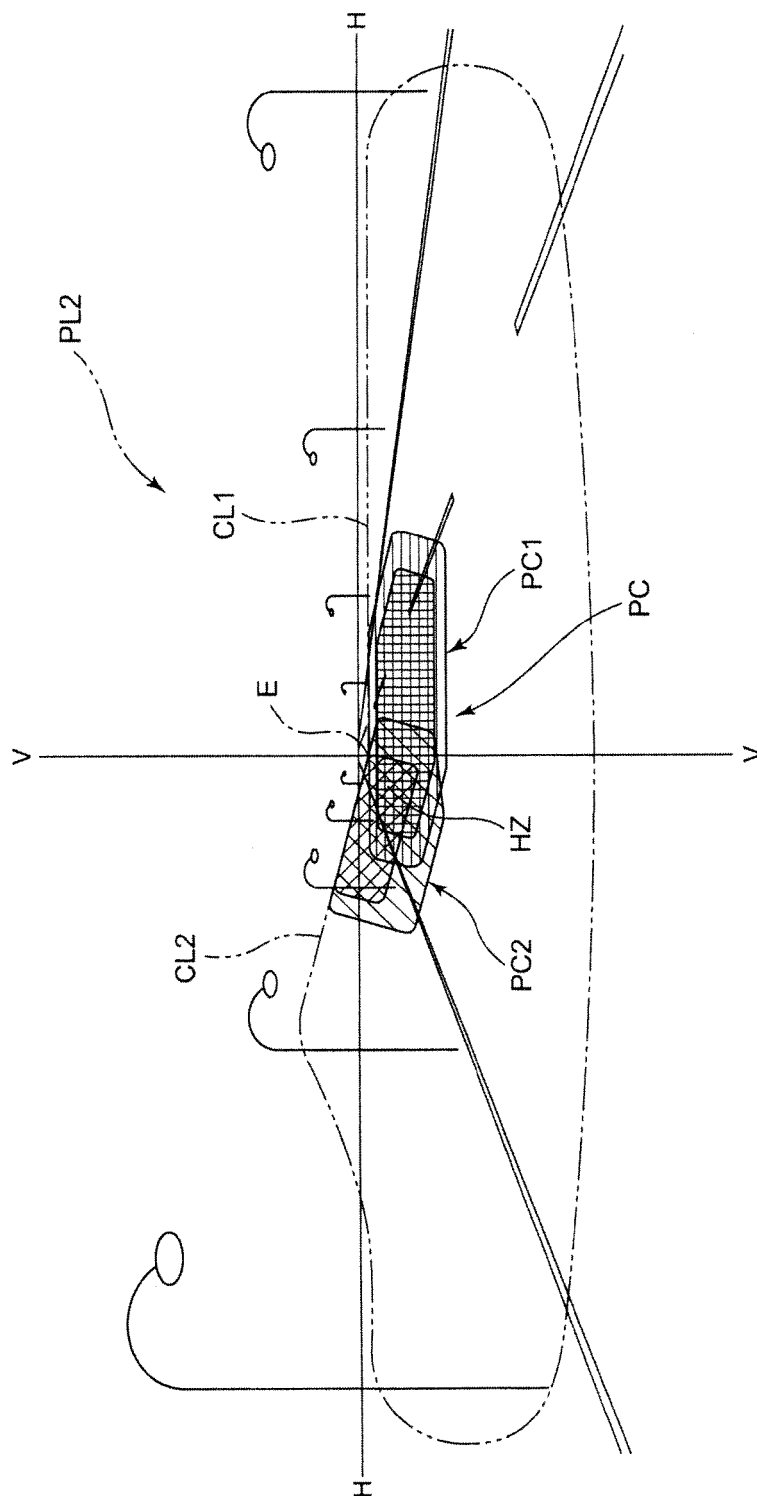


FIG. 6

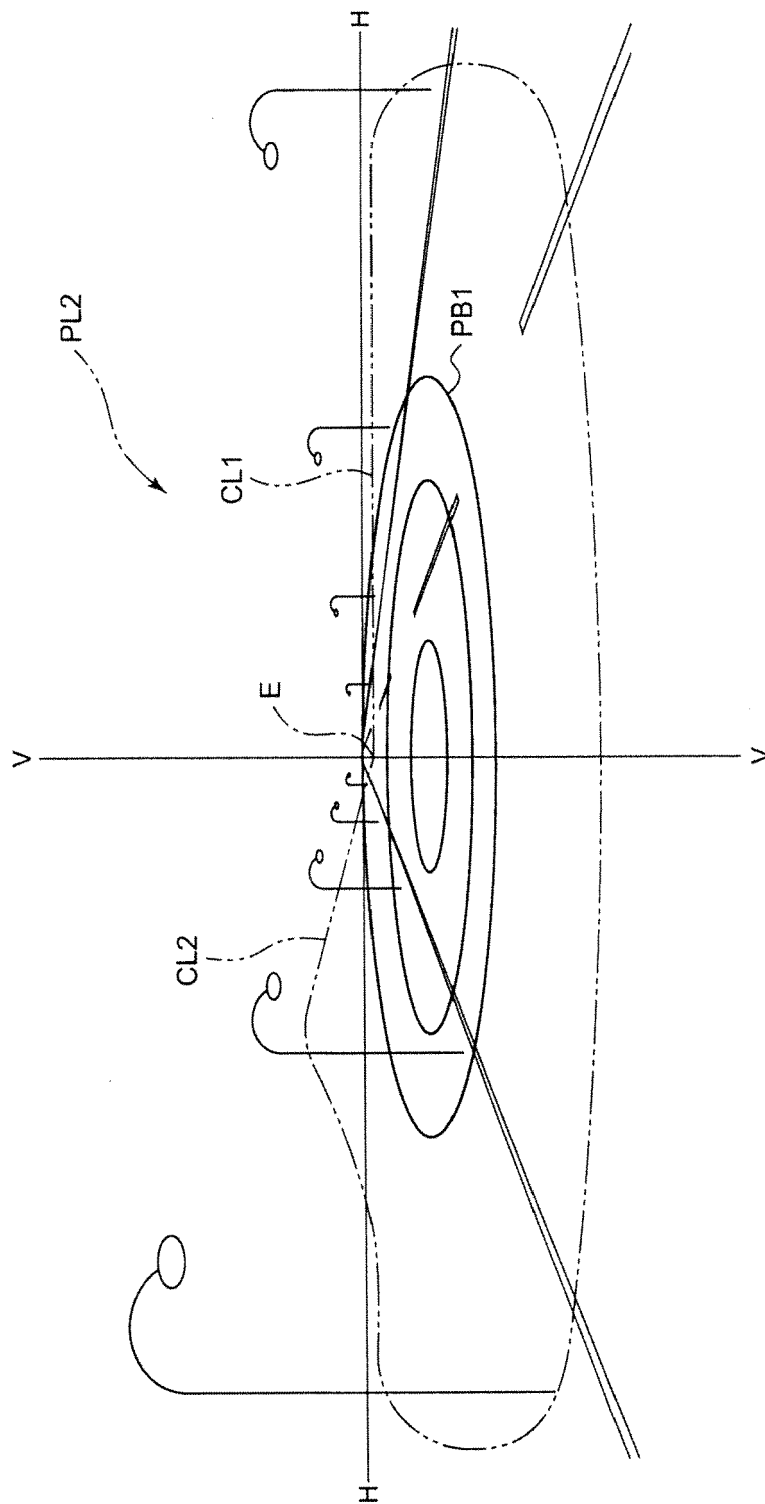
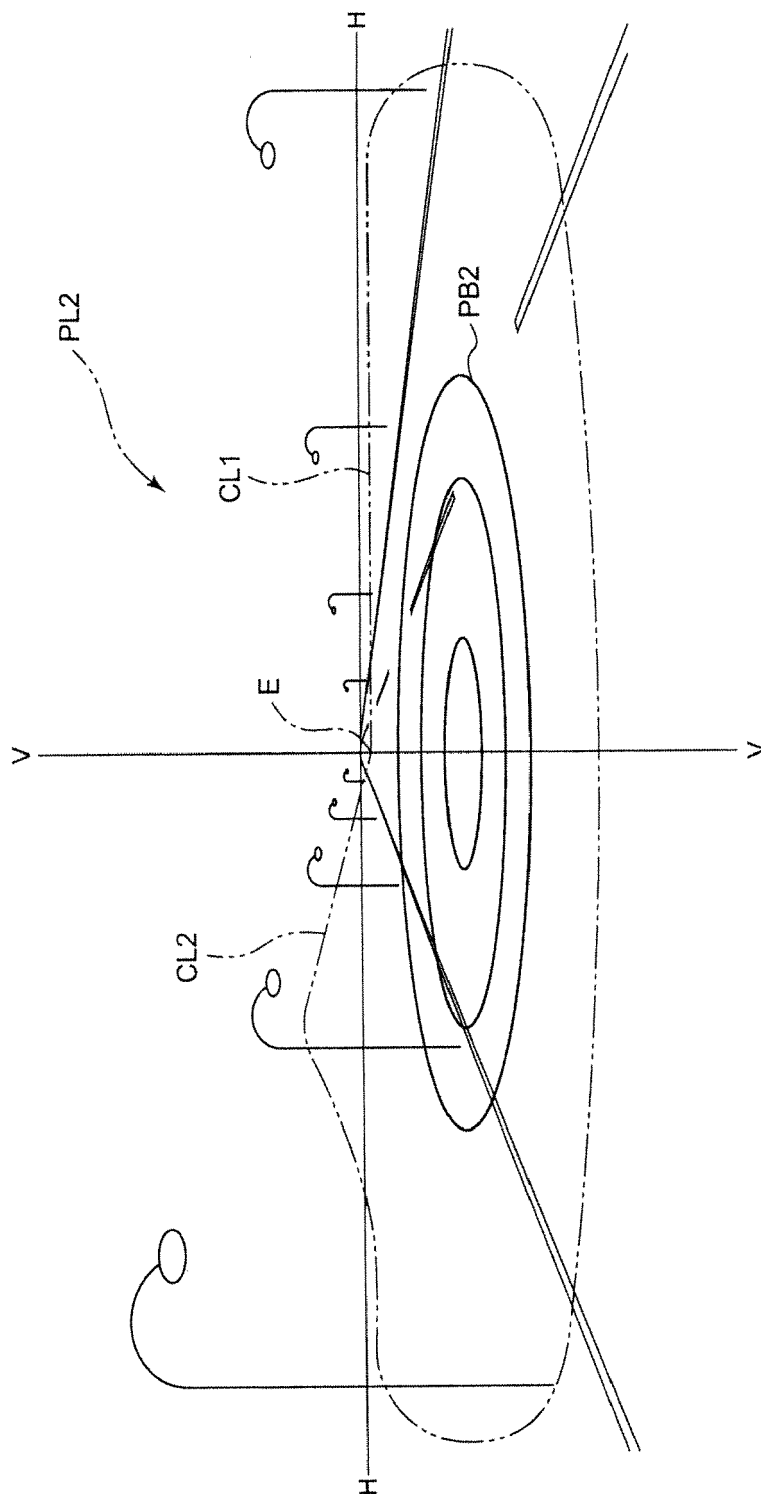


FIG. 7



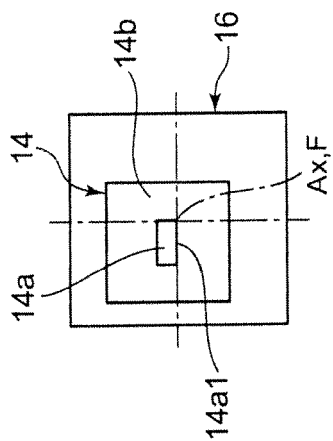


FIG. 8A

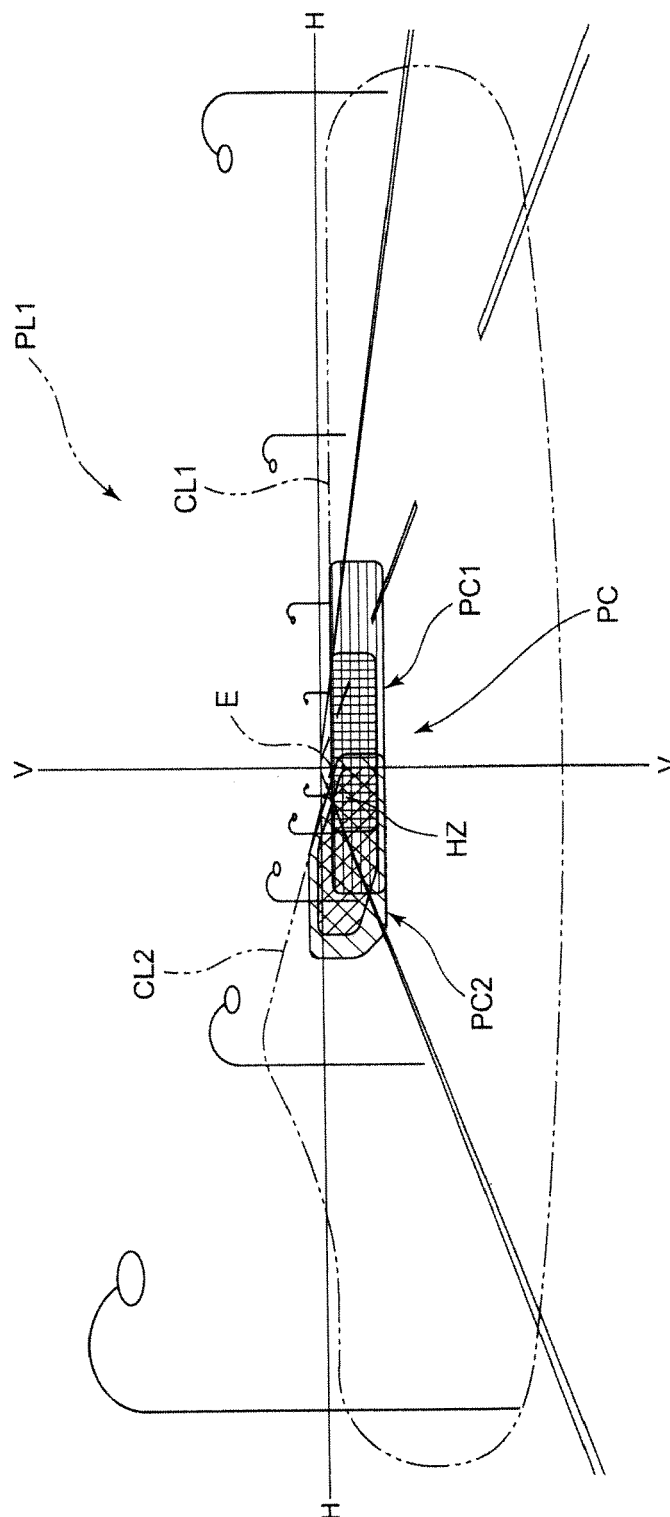


FIG. 8B

FIG. 9A

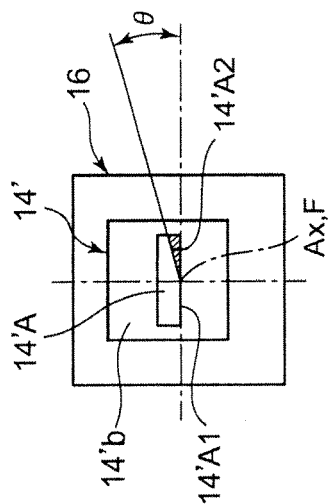
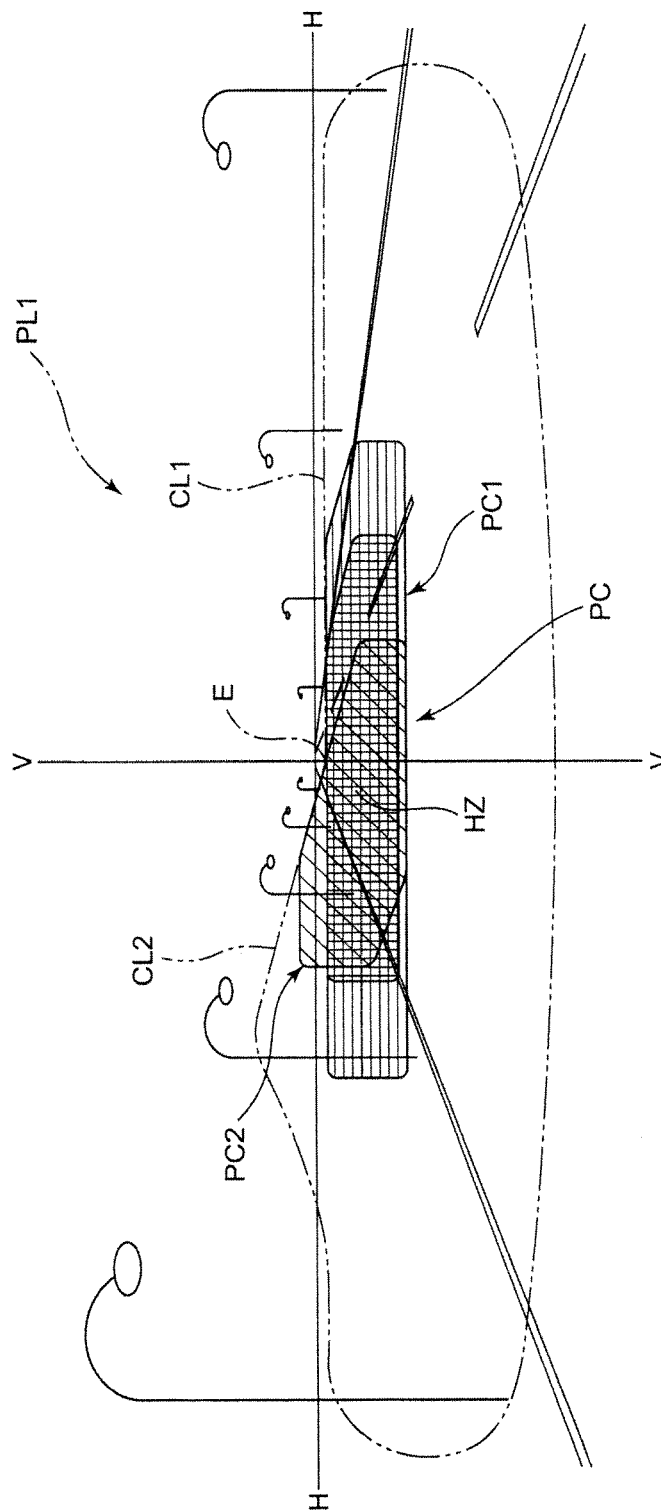


FIG. 9B





EUROPEAN SEARCH REPORT

Application Number
EP 12 15 6688

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y,D	US 2009/154185 A1 (YAGI TAKAYUKI [JP]) 18 June 2009 (2009-06-18) * the whole document *	1-5	INV. F21V5/00 F21V5/04
Y	EP 1 686 313 A2 (ICHIKOH INDUSTRIES LTD [JP]) 2 August 2006 (2006-08-02) * the whole document *	1-5	
A	DE 10 2004 041233 A1 (HELLA KGAA HUECK & CO [DE]) 23 March 2006 (2006-03-23) * abstract; figure 2 *	1-5	
A	DE 298 13 531 U1 (DOCTER OPTICS GMBH [DE]) 5 November 1998 (1998-11-05) * abstract; figures *	1-5	
A	FR 2 799 153 A1 (VALEO VISION [FR]) 6 April 2001 (2001-04-06) * abstract; figure 1 *	1-5	
			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 2 May 2012	Examiner Panatsas, Adam
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

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

EP 12 15 6688

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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02-05-2012

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2009154185 A1	18-06-2009	CN 101457889 A	17-06-2009
		DE 102008061619 A1	25-06-2009
		JP 2009146665 A	02-07-2009
		US 2009154185 A1	18-06-2009

EP 1686313 A2	02-08-2006	EP 1686313 A2	02-08-2006
		JP 2006210294 A	10-08-2006

DE 102004041233 A1	23-03-2006	NONE	

DE 29813531 U1	05-11-1998	NONE	

FR 2799153 A1	06-04-2001	NONE	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2009146665 A [0003] [0055]