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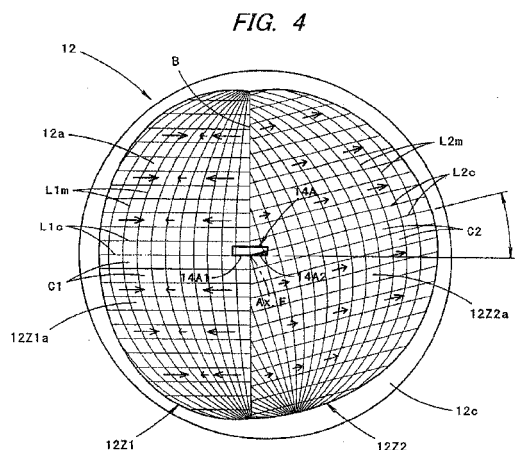
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(54) **VEHICULAR LIGHTING EQUIPMENT**

(57) A vehicle lamp of a direct projection type is configured to control deflection of direct light from a light emitting surface 14A serving as a surface light source using a convex lens 12. A lower end edge of the light emitting surface 14A includes a first side 14A1 and a second side 14A2, each extending linearly so as to form an obtuse angle with each other in a front view of the lamp, a point of intersection thereof is positioned on a rear focal point F of the convex lens 12, and is disposed to face forward such that the first side 14A1 is disposed on a horizontal plane including an optical axis Ax. It is configured such that, using first and second lens portions 12Z1, 12Z2 of the convex lens 12 respectively, the light from the light emitting surface 14A is deflected and/or diffused in directions respectively parallel to the first side 14A1 and the second side 14A2. According to this vehicle lamp, it is possible to form a light distribution pattern having horizontal and oblique cutoff lines on an upper end portion thereof, while providing a degree of freedom for a light intensity distribution on the light distribution pattern and suppressing generation of great unevenness in light distribution on a road surface ahead of a vehicle.



Description

TECHNICAL FIELD

5 **[0001]** The present invention relates to a vehicle lamp including a surface light source such as a light emitting surface of a light emitting device and, in particular, to a vehicle lamp which can form, with irradiation light, a light distribution pattern having horizontal and oblique cutoff lines on an upper end portion thereof.

BACKGROUND ART

10 **[0002]** In recent years, light emitting devices such as light emitting diodes are often used as a light source of a vehicle lamp.

[0003] For example, Patent Document 1 describes a vehicle lamp of a so-called direct projection type, which includes a convex lens disposed on an optical axis extending in a front-rear direction of the lamp and a light emitting device disposed near a rear focal point of the convex lens, and is configured to control a deflection of direct light from the light emitting device using the convex lens.

[0004] The vehicle lamp described in Patent Document 1 can form a light distribution pattern having a horizontal cutoff line and an oblique cutoff line on an upper end portion thereof by shielding a part of the direct light from the light emitting device using a light shield portion disposed in front of and near the light emitting device.

20 **[0005]** Patent Document 2 describes a vehicle lamp including a light guide member in place of the light shield portion described in Patent Document 1. That is, this vehicle lamp is configured such that light from a light emitting device enters the light guide member from a rear side thereof and exits from its front end face toward the convex lens.

[0006] The vehicle lamp described in Patent Document 2 forms a light distribution pattern having a horizontal cutoff line and an oblique cutoff line on an upper end portion thereof by forming the light exit surface of the light guide member to have a shape that corresponds to the cutoff lines of the light distribution pattern.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

30 **[0007]** Patent Document 1: Japanese Patent Application Publication No.2007-87946
Patent Document 2: Japanese Patent Application Publication No. 2006-66399

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0008] Each of the vehicle lamps described above is configured to dispose the light surface light source having the light emitting surface of the shape corresponding to cutoff lines of the light distribution pattern, namely by the light emitting device and the light shield portion in Patent Document 1 and by the light emitting device and the light exit surface of the light guide member in Patent Document 2, on the rear focal plane of the convex lens.

[0009] According to such vehicle lamps, the shape of the surface light source formed on the rear focal plane of the convex lens is projected, as it is, toward the front of the vehicle by the convex lens. Therefore, while it is possible to form a light distribution pattern having horizontal and oblique cutoff lines on an upper end portion, light intensity distribution on the light distribution pattern is inevitably defined by the luminance distribution on the surface light source.

[0010] Therefore, the conventional vehicle lamps described above have a problem in that a degree of freedom for the light intensity distribution on the light distribution pattern is poor.

[0011] Further, the conventional vehicle lamps described above also have a problem in that great unevenness is generated in light distribution on a road surface ahead of a vehicle, because a portion of the outline of the light distribution pattern other than the horizontal and oblique cutoff lines show a relatively clear contour due to the projection of the light from the surface light source.

50 **[0012]** The present invention has been made in view of such circumstances, and it is an object thereof to provide a vehicle lamp of a direct projection type having a surface light source, the vehicle lamp being capable of forming a light distribution pattern having horizontal and oblique cutoff lines on an upper end portion thereof, while providing a degree of freedom for a light intensity distribution on the light distribution pattern without generating great unevenness in light distribution on a road surface ahead of a vehicle.

MEANS FOR SOLVING THE PROBLEMS

[0013] The present invention achieves the above object by devising a lower end edge shape of a surface light source and its arrangement and also by devising a configuration of a convex lens that controls a deflection of direct light from the surface light source.

[0014] That is, a vehicle lamp according to the present invention includes a convex lens disposed on an optical axis extending in a front-rear direction of the lamp, and a surface light source disposed near a rear focal point of the convex lens, the lamp being configured to form a light distribution pattern having horizontal and oblique cutoff lines on an upper end portion by controlling a deflection of direct light from the surface light source using the convex lens, and characterized in that a lower end edge of the surface light source includes a first side and a second side, each extending linearly so as to form an obtuse angle with each other in a front view of the lamp, the surface light source is disposed to face forward such that a point of intersection of the first side and the second side is positioned on the rear focal point of the convex lens and such that the first side is positioned on a horizontal plane including the optical axis, a portion of the convex lens is configured as a first lens portion that deflects and/or diffuses light from the surface light source in a direction parallel to the first side, and at least another portion of the convex lens is configured as a second lens portion that deflects and/or diffuses light from the surface light source in a direction parallel to the second side.

[0015] The "surface light source" is a surface-emitting light source, and a surface shape of the light emitting surface may be a flat surface or a curved surface.

[0016] A specific configuration of the "surface light source" is not particularly limited, and may be, for example, a light emitting surface of a light emitting device such as a light emitting diode, a light exit surface of a light guide member to which light from a primary light source has been guided, or, when a light shield coating is provided on a bulb tube of a discharge bulb so as to leave a given window portion, the window portion.

[0017] With regard to the "first side" and the "second side", a specific value of an angle therebetween is not particularly limited, provided that they respectively extend in straight lines forming an obtuse angle (i.e., an angle larger than 90° and smaller than 180°) with each other.

[0018] The "convex lens" may consist of the first and second lens portions, or may include a portion other than the first and second lens portions.

[0019] The "first lens portion" is not limited to have a specific configuration, provided it is configured such that it deflects and/or diffuses the light from the surface light source in the direction parallel to the first side.

[0020] The "second lens portion" is not limited to have a specific configuration, provided that it is configured such that it deflects and/or diffuses the light from the surface light source in the direction parallel to the second side.

[0021] The phrase "deflects and/or diffuses" means only deflects, only diffuses, or deflects and diffuses.

EFFECTS OF THE INVENTION

[0022] As shown in the structure described above, the vehicle lamp according to the present invention is configured such that the direct light from the surface light source is deflected and controlled using the convex lens to form the light distribution pattern having the horizontal and oblique cutoff lines on the upper end portion. Specifically, the lower end edge of the surface light source includes the first and second sides, each extending in a straight line to form an obtuse angle with each other in the front view of the lamp. The surface light source is disposed to face forward such that the point of intersection of the first and second sides is positioned on the rear focal point of the convex lens and such that the first side is positioned on the horizontal plane including the optical axis. Therefore, the following functions and effects can be obtained.

[0023] That is, since the surface light source is disposed near the rear focal point of the convex lens to face forward, the inverted projection image thereof is formed on a virtual vertical screen ahead of the lamp. The first side of the lower end edge of the surface light source is positioned on the horizontal plane including the optical axis, and the point of intersection of the first and second sides forming an obtuse angle with each other is positioned on the rear focal point of the convex lens. Therefore, if the convex lens is a normal convex lens, the inverted projection image of the surface light source is formed on the virtual vertical screen such that its upper end edge is positioned on a horizontal line passing through the point of intersection of the virtual vertical screen and the optical axis and also on an inclined line inclined with respect to the horizontal line.

[0024] Here, according to the present invention, a portion of the convex lens is configured as the first lens portion that deflects and/or diffuses the light from the surface light source in the direction parallel to the first side. Further, at least another portion of the convex lens is configured as the second lens portion that deflects and/or diffuses the light from the surface light source in the direction parallel to the second side. Accordingly, the outgoing light from the first lens portion forms a first light distribution pattern having the horizontal cutoff line on an upper end portion, and the outgoing light from the second lens portion forms a second light distribution pattern having the oblique cutoff line on the upper end portion. The light distribution pattern having the horizontal and oblique cutoff lines on the upper end portion is formed

as a combined light distribution pattern in which they are combined.

[0025] Light intensity distribution on the first and second light distribution patterns can be adjusted optionally by adjusting the degree of deflection and/or the diffusion of the first and second lens portions as needed, whereby it is possible to provide freedom for the light intensity distribution on the light distribution pattern of the entire of the lamp.

Further, it is possible to prevent a great unevenness from being generated in the light distribution on a road surface ahead of the vehicle, which is caused by clear formation of a contour of the surface light source like in the conventional art.

[0026] Thus, according to the present invention, in a vehicle lamp of a direct projection type having a surface light source, it is possible to form a light distribution pattern having horizontal and oblique cutoff lines on an upper end portion thereof, while providing a degree of freedom for a light intensity distribution on the light distribution pattern and suppressing generation of great unevenness in light distribution on a road surface ahead of a vehicle.

[0027] In the configuration described above, when at least another portion of the convex lens other than the first and second lens portions is configured as a third lens portion that diffuses light from the surface light source in the horizontal direction, thereby diffusing the light from the surface light source more laterally than the lights outgoing from the first and second lens portions respectively, the light outgoing from the third lens portion forms a diffused light distribution pattern having a horizontal cutoff line on an upper end portion as a third light distribution pattern. Therefore, due to the formation of the third light distribution pattern, a widely diffused light distribution pattern having a smooth light intensity distribution can be formed as the light distribution pattern of the entire of the lamp.

[0028] The location of the third lens portion is not particularly limited. However, when the third lens portion is disposed below the first and second lens portions, even when the light from the surface light source and sent out from the third lens portion is diffused downwardly, the output angle of the light from the convex lens can be prevented from becoming excessively large. Accordingly, the third light distribution pattern can be easily formed as a light distribution pattern which is diffused in the horizontal direction and in the downward direction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] Fig. 1 is a front view of a vehicle lamp according to a first embodiment of the present invention.

Fig. 2 is a sectional view taken along the line II-II in Fig. 1.

Fig. 3(a) is a front view illustrating a light emitting device of the vehicle lamp in detail, and (b) is a front view illustrating a modified example thereof.

Fig. 4 is a front view illustrating a convex lens of the vehicle lamp together with a light emitting surface.

Fig. 5 is a perspective view illustrating the convex lens of the vehicle lamp together with the light emitting surface.

Fig. 6 is a perspective view of a light distribution pattern formed on a virtual vertical screen disposed at a position 25 m ahead of the lamp by the forward light irradiation from the vehicle lamp.

Fig. 7(a) is a detailed view of a first light distribution pattern forming a portion of the light distribution pattern, and (b) is a detailed view of a second light distribution pattern forming another portion of the light distribution pattern.

Fig. 8(a) is a perspective view illustrating a modified example of the surface light source of the first embodiment, and (b) is a sectional view of main parts of another modified example of the surface light source of the first embodiment.

Fig. 9 is a perspective view similar to Fig. 5, illustrating main parts of a vehicle lamp according to a second embodiment of the invention.

Fig. 10 is a perspective view of a light distribution pattern formed on the virtual vertical screen by the forward light irradiation from the vehicle lamp according to the second embodiment.

EMBODIMENTS OF THE INVENTION

[0030] Hereinafter, embodiments of the present invention will be described with reference to the drawings.

[0031] First, a first embodiment of the present invention will be described.

[0032] Fig. 1 is a front view of a vehicle lamp 10 according to the first embodiment of the invention, and Fig. 2 is a sectional view taken along the line II-II in Fig. 1.

[0033] As shown in these figures, the vehicle lamp 10 according to the present embodiment includes a convex lens 12 disposed on an optical axis Ax extending in the front-rear direction of a vehicle, a light emitting device 14 disposed near the rear focal point F of the convex lens 12, a metal plate 16 for supporting the light emitting device 14, and a base member 18 for supporting and fixing the metal plate 16 and the convex lens 12. This vehicle lamp 10 is used as a lamp unit of a vehicle headlamp such that it is incorporated in a lamp body (not shown) or the like such that the optical axis thereof can be adjusted.

[0034] The vehicle lamp 10 is disposed such that its optical axis Ax extends in a downward direction at about 0.5 to 0.6° with respect to the front-rear direction of the vehicle at the stage of completion of the optical axis adjustment.

[0035] The convex lens 12 is a convex lens having a shape approximate to a plano-convex aspherical lens, a front

surface 12a of which is a convex surface and a rear surface 12b of which is a flat surface, and is disposed on the optical axis Ax.

[0036] In the convex lens 12, the entire portion on the oncoming lane side with respect to a vertical plane including the optical axis Ax is configured as a first lens portion 12Z1, and the entire portion on the self lane side with respect to the vertical plane including the optical axis Ax is configured as a second lens portion 12Z2.

[0037] With regard to the front surface 12a of the convex lens 12, a sectional shape along a vertical plane including its optical axis Ax has the sectional shape of the front surface of a plano-convex aspherical lens, whereas a sectional shape other than the sectional shape along the vertical plane has a shape which is somewhat modified from the sectional shape of the front surface of the plane-convex aspherical lens. Therefore, the rear focal point F of the convex lens 12, exactly, is a rear focal point in the vertical plane including the optical axis Ax. The details of the front surface 12a of the convex lens 12 will be described later.

[0038] The outer peripheral edge portion of the convex lens 12 is formed to have a flat plate shape, while the convex lens 12 is positioned and fixed to the base member 18 in this ring-shaped flat plate portion 12c.

[0039] The light emitting device 14 is a white light emitting diode which has a light emitting surface 14A of a pentagonal shape long sideways.

[0040] Fig. 3(a) is a front view of the light emitting device 14, showing the details thereof.

[0041] As shown in this drawing, the light emitting device 14 includes four light emitting chips 14a and a substrate 14b for supporting these light emitting chips 14a.

[0042] The four light emitting chips 14a are disposed facing front such that they are in a line and close to each other in the horizontal direction, while their respective outer shapes are about 1 mm square. On the entire area of the surfaces of the four light emitting chips 14a, there is formed a fluorescent thin film 14c. Further, on a portion of the surface of the fluorescent thin film 14c, there is formed a light shield film 14d.

[0043] The light shield film 14c is formed in the right downward corner portions of the four light emitting chips 14a when the lamp is viewed from the front. The upper end edge of the light shield film 14d is a straight line which extends from a point existing centrally in the right and left direction in the lower end edges of the four light emitting chips 14a in an oblique direction inclined upwardly by a given angle θ (specifically, $\theta=15^\circ$) with respect to the lower end edges. That is, the shape of the light shield film 14d, when the lamp is viewed from the front, has an oblong wedge shape.

[0044] The light shield film 14d of an oblong wedge shape is formed in a portion of the surface of the fluorescent thin film 14c having an oblong rectangular shape in this manner, whereby the light emitting surface 14A provides a surface light source of an oblong pentagonal shape. Also, the lower end edges of the light emitting surface 14A, when the lamp is viewed from the front, respectively extend as straight lines with an obtuse angle (specifically, an angle of 165°) between them. That is, such portion of the lower end edge of the light emitting surface 14A as exists in the lower end edge of the fluorescent thin film 14c and extends in the horizontal direction is formed as a first side 14A1, whereas such portion of the lower end edge of the light emitting surface 14A as exists in the upper end edge of the light shield film 14d is formed as a second side 14A2 which extends in an oblique direction inclined facing upward by a given angle θ with respect to the first side 14A1.

[0045] The light emitting device 14 is disposed to face forward such that, as shown in Fig. 1, the first side 14A1 in the lower end edge of the light emitting surface 14A is positioned on a horizontal plane including the optical axis Ax and such that a point of intersection the first side 14A1 and second side 14A2 is positioned on the rear focal point F of the convex lens 12. The second side 14A2 extends in an oblique direction inclined upwardly by a given angle θ toward the self lane (that is, toward the left (toward the right when the lamp is viewed from the front)).

[0046] Fig. 4 is a front view of the convex lens 12 together with the light emitting surface 14A, and Fig. 5 is a perspective view of the convex lens 12.

[0047] The convex lens 12 is configured such that it deflects and/or diffuses the light from the light emitting surface 14A in the horizontal direction in its first lens portion 12Z1 and also that it deflects and/or diffuses the light toward its self lane in an oblique direction inclined upwardly by a given angle θ with respect to the horizontal direction in its second lens portion 12Z2.

[0048] To realize this, such portion of the front surface 12a of the convex lens 12 as exists in the first lens portion 12Z1 is configured as a horizontally diffusing section 12Z1a, and such portion thereof as exists in the second lens portion 12Z2 is configured as an obliquely diffusing section 12Z2a.

[0049] The horizontally diffusing section 12Z1a is a section which sends out the light having reached this section 12Z1a from the light emitting surface 14A as light diffused in the horizontal direction. On the other hand, the obliquely diffusing section 12Z2a is a section which sends out the light having reached this section 12Z2a from the light emitting surface 14A as light diffused in an oblique direction inclined by a given angle θ toward the self lane with respect to the horizontal direction.

[0050] Also, the diffusion control of the outgoing light from the horizontally diffusing section 12Z1 a is carried out by setting the directions of the outgoing lights for each position on the horizontally diffusing section 12Z1a.

[0051] That is, the horizontally diffusing section 12Z1a, as shown in Fig. 4, is divided into multiple cells C1 which are

respectively defined by multiple curved lines L1c extending in the horizontal direction at regular intervals in the vertical direction and multiple curved lines L1m extending in a meridian manner from the upper end point to the lower end point of a boundary line B between the horizontally diffusing section 12Z1a and obliquely diffusing section 12Z2a, and the output directions of the lights are set in the respective cells C1.

[0052] Specifically, as shown by arrow marks in Fig. 4, the direction of the outgoing light passing through the cell C1 near the boundary line B is right, the direction of the outgoing light passing through the cell C1 near the outer peripheral edge of the convex lens 12 is left, and the direction of the outgoing light passing through the cell C1 therebetween is the intermediate direction. The directions of the outgoing light passing through the cells ranging from the cell C1 adjacent to the boundary line B to the cell C1 adjacent to the outer peripheral edge of the convex lens 12 vary gradually within a horizontal plane in the respective stages.

[0053] On the other hand, the diffusion control of the outgoing light from the obliquely diffusing section 12Z2a, similarly to the diffusion control of the outgoing light from the horizontally diffusing section 12Z1a, is also carried out by setting the directions of the outgoing lights in the respective positions of the obliquely diffusing section 12Z2a.

[0054] That is, the obliquely diffusing section 12Z2a, as shown in Fig. 4, is divided into multiple cells C2, while the light output directions are set in the respective cells C2. However, in the obliquely diffusing section 12Z2a, curved lines L2c, L2m defining the multiple cells C2 extend counterclockwise around the optical axis Ax such that they are respectively inclined by an angle θ (when the lamp is viewed from the front) with respect to the curved lines L1c, L1m of the horizontally diffusing section 12Z1a.

[0055] And, as shown by arrow marks in Fig. 4, the direction of the outgoing light passing through the cell C2 near the boundary line B goes slightly to the left along the curved line L2c, the direction of the outgoing light passing through the cell C2 near the outer peripheral edge of the convex lens 12 goes to the left by a slightly larger angle, and the direction of the outgoing light passing through cell C2 therebetween is intermediate the above two directions. Also, the directions of the outgoing lights passing through the respective cells ranging from the cell C2 adjacent to the boundary line B to the cell C2 adjacent to the outer peripheral edge of the convex lens 12, in the respective stages, vary gradually within an inclined plane which is inclined by an angle θ with respect to a horizontal plane.

[0056] Here, arrow marks extending from the center positions of the respective cells C1, C2 in Fig. 4 show directions in which lights entering the convex lens 12 from the point of intersection of the first side 14A1 and second side 14A2 of the lower end edge of the light emitting surface 14A are output from the respective cells C1, C2.

[0057] By forming such front surface 12a in the convex lens 12, this front surface 12a provides a discontinuous surface shape in the boundary line B between the horizontally diffusing section 12Z1a and obliquely diffusing section 12Z2a, and the boundary line B is formed as the ridge of the convex lens 12.

[0058] Fig. 6 is a perspective view of a light distribution pattern PA which is formed on a virtual vertical screen disposed at a position 25 m ahead of the vehicle lamp 10 by the forward light irradiation from the lamp.

[0059] As shown in Fig. 6, this light distribution pattern PA is a light distribution pattern which is formed as part of a low beam light distribution pattern PL1 shown by a two-dot chained line, and the light distribution pattern PA is formed as a combined light distribution pattern in which a first light distribution pattern PA1 and a second light distribution pattern PA2 are combined. When the light distribution pattern PA is combined with a light distribution pattern which is formed by the forward light irradiation from other lamp unit (not shown), there is formed, as a combined light distribution pattern, the low beam light distribution pattern PL1.

[0060] This low beam light distribution pattern PL1 is a left-hand traffic low beam light distribution pattern, and has horizontal and oblique cutoff lines CL1, CL2 on the upper end portion thereof. With respect to the V-V line which is a vertical line passing through a vanishing point H-V in the front direction of the lamp, there is formed the horizontal cutoff line CL1 on the oncoming lane side, while there is formed the oblique cutoff line CL2 on the self lane side, and an elbow point E, which is a point of intersection of the two cutoff lines CL1, CL2, is situated below the vanishing point H-V substantially by an angle of 0.5 to 0.6°. In the low beam light distribution pattern PL1, there is formed a hot zone HZ, which is a high light intensity zone, such that it surrounds the elbow point E leftward.

[0061] The light distribution pattern PA1 is a light distribution pattern which is formed by the light that is output from the horizontally diffusing section 12Z1a of the first lens portion 12Z1, and it is formed such that its upper end edge PA1a is substantially coincident with the horizontal cutoff line CL1. On the other hand, the light distribution pattern PA2 is a light distribution pattern which is formed by the light that is output from the obliquely diffusing section 12Z2a of the second lens portion 12Z2, and is formed such that its upper end edge PA2a is substantially coincident with the oblique cutoff line CL2. The hot zone HZ of the low beam light distribution pattern PL1 is formed mainly in the portion where these two light distribution patterns PA1, PA2 overlap with each other.

[0062] Fig. 7(a) shows the details of the light distribution pattern PA1, and (b) shows the details of the light distribution pattern PA2.

[0063] As shown in these figures, if the convex lens 12 is an ordinary piano-convex aspherical lens, the inverted projection image Io of the light emitting surface 14A is formed such that, on the virtual vertical screen described above, a point of intersection of a horizontal portion Io1 and an inclined portion Io2 respectively forming the upper end edge of

the inverted projection image lo is situated at the position of the elbow point E (that is, the point of intersection of the virtual vertical screen and optical axis Ax). This is because a point of intersection of the first side 14A1 and second side 14A2 of the lower end edge of the light emitting surface 14A is situated at the rear focal point F of the convex lens 12. And, since the first side 14A1 of the lower end edge of the light emitting surface 14A extends in the horizontal direction from the rear focal point F of the convex lens 12, the horizontal portion $lo1$ of the upper end edge of the inverted projection image lo extends in the horizontal direction at a very high light and shade ratio. Also, since the second side 14A2 of the lower end edge of the light emitting surface 14A extends from the rear focal point F of the convex lens 12 toward the self lane side in a direction which is inclined upwardly by a given angle θ from the horizontal plane, the inclined portion $lo2$ of the upper end edge of the inverted projection image lo extends at a very high light and shade ratio from the elbow point E toward the oncoming lane side in a direction which is inclined downwardly by a given angle θ from the horizontal plane.

[0064] In fact, the front surface 12a of the convex lens 12 is configured such that the portion on the oncoming lane side with respect to the vertical plane including the optical axis Ax is the horizontally diffusing section 12Z1a and the portion on the self lane side is the obliquely diffusing section 12Z2a, and therefore, on the virtual vertical screen, the light that is output from the horizontally diffusing section 12Z1a forms the light distribution pattern PA1 which extends in the horizontal direction as a light distribution pattern in which the inverted projection image lo is enlarged in the horizontal direction, and the light that is output from the obliquely diffusing section form the light distribution pattern PA2 which extends in the oblique direction as a light distribution pattern in which the inverted projection image lo is enlarged toward the self lane in an oblique direction inclined upwardly by a given angle θ with respect to the horizontal direction.

[0065] In Fig. 7(a), while overlapping multiple pieces of inverted projection images $lz1$ with each other, there is shown a state in which the light distribution pattern PA1 spreads.

[0066] This light distribution pattern PA1 is formed as a light distribution pattern in which the inverted projection image lo of the light emitting surface 14A is enlarged in both right and left directions with respect to the horizontal direction. In this case, since the extending direction of the horizontal portion $lo1$ of the upper end edge of the inverted projection image lo coincides with the enlarging direction of the inverted projection image lo , the upper end edge PA1a of this light distribution pattern PA1 provides a very high light and shade ratio, whereby the horizontal cutoff line CL1 becomes clear.

[0067] On the other hand, Fig. 7(b) shows the state of spread of the light distribution pattern PA2 while overlapping multiple pieces of inverted projection images $lz2$ with each other.

[0068] This light distribution pattern PA2 is formed as a light distribution pattern in which the inverted projection image lo of the light emitting surface 14A is enlarged in an oblique direction inclined upwardly by a given angle θ toward the self lane. In this case, since the extending direction of the inclined portion $lo2$ of the upper end edge of the inverted projection image lo coincides with the enlarging direction of the inverted projection image lo , the upper end edge PA2a of this light distribution pattern PA2 provides a very high light and shade ratio, whereby the oblique cutoff line CL2 becomes clear.

[0069] As described above in detail, the vehicle lamp 10 according to the present embodiment is configured such that the direct light emitted from the light emitting surface 14A serving as a surface light source is deflected and controlled by the convex lens 12, whereby, as part of the low beam light distribution pattern PL1, there is formed the light distribution pattern PA having the horizontal and oblique cutoff lines CL1, CL2 in the upper end portion thereof. Specifically, the lower end edge of the light emitting surface 14A includes the first side 14A1 and the second sides 14A2, each extending in a straight line so as to form an obtuse angle with each other when the lamp is viewed from the front. The light emitting surface 14A is disposed to face forward such that the point of intersection of the first side 14A1 and the second side 14A2 is positioned on the rear focal point F of the convex lens 12, and such that the first side 14A1 is positioned on the horizontal plane including the optical axis Ax . Therefore, the following functions and effects can be obtained.

[0070] That is, since the light emitting surface 14A is disposed facing front in the vicinity of the rear focal point F of the convex lens 12, the inverted projection image lo thereof is formed on a virtual vertical screen which exists forwardly of the lamp. However, the lower end edge of the light emitting surface 14A is positioned on a horizontal plane including the optical axis Ax , and the point of intersection of the first and second sides 14A1 and 14A2 of the light emitting surface 14A having an obtuse angle between them is situated at the rear focal point F of the projection lens 12. Thus, if the convex lens 12 is a normal convex lens, the inverted projection image lo of the light emitting surface 14A is formed on the virtual vertical screen described above such that the upper end edges $lo1$ and $lo2$ of the inverted projection image lo are positioned on a horizontal line passing through the point of intersection of the virtual vertical screen and optical axis Ax and also on an inclined line inclined upwardly with respect to this horizontal line.

[0071] In this case, according to the present embodiment, such portion of the convex lens 12 as exists on the oncoming lane side with respect to a vertical plane including the optical axis Ax is configured as the first lens portion 12Z1 which deflects and/or diffuses the light from the light emitting surface 14A in a direction parallel to the first side 14A1, and such portion of the convex lens 12 as exists on the self lane side with respect to the vertical plane including the optical axis Ax is configured as the second lens portion 12Z2 which deflects and/or diffuses the light from the light emitting surface 14A in a direction parallel to the first side 14A2. Therefore, the light that is output from the first lens portion 12Z1 forms

the first light distribution pattern PA1 which, in the upper end portion thereof, has an upper end edge PA 1 a serving as the horizontal cutoff line CL1, and the light that is output from the second lens portion 12Z2 forms the second light distribution pattern PA2 which, in the upper end portion thereof, has an upper end edge PA2a serving as the oblique cutoff line CL2. As a combined light distribution pattern in which the above two light distribution patterns are combined, there is formed the light distribution pattern PA which has the horizontal and oblique cutoff lines CL1, CL2 on the upper end portion.

[0072] Further, by adjusting the degree of the deflection and/or the diffusion of the first and second lens portions 12Z1, 12Z2 as needed, the light intensity distributions on the first and second light distribution patterns PA1, PA2 can be adjusted optionally, thereby allowing the light intensity distribution on the light distribution pattern PA of the entire lamp to have degree of freedom. Further, it is possible to prevent a great unevenness from being generated in the light distribution on a road surface ahead of the vehicle, which is caused by clear formation of a contour of the surface light source like in the conventional art. Especially, if the convex lens 12 is a normal convex lens, the two right and left portions of the contour of the inverted projection image Io of the light emitting surface 14A are formed as light-dark sharp line extending substantially in the front-rear direction on the road surface ahead of the vehicle. However, because the light intensity distribution in the right-left direction on the light distribution pattern PA varies smoothly, it is possible to prevent the generation of such light-dark sharp lines.

[0073] As described above, according to the present embodiment, in the vehicle lamp 10 of a direct projection type using the light emitting surface 14A serving as a surface light source, there can be formed the light distribution pattern PA having the horizontal and oblique cutoff lines CL1, CL2 in the upper end portion thereof and, in addition to this, the light intensity distribution on the light distribution pattern PA is allowed to have degree of freedom, and great unevenness in light distribution is prevented from appearing on the road surface ahead of the vehicle.

[0074] According to the present embodiment, while it is configured such that it can form the light distribution pattern PA having the horizontal and oblique cutoff lines CL1, CL2 on the upper end portion, the efficiency of use of the luminous flux of the light source can be enhanced. Further, this can be realized by a compact and simple lamp structure.

[0075] Especially, according to the present embodiment, the portion of the front surface 12a of the convex lens 12 on the oncoming lane side with respect to the vertical plane including the optical axis Ax is configured as the horizontally diffusing section 12Z1a, and the portion on the self lane side is configured as the obliquely diffusing section 12Z2. Therefore, the following effects can be obtained.

[0076] That is, the horizontally diffusing section 12Z1a is configured to diffuse the outgoing light in both right and left directions, while the obliquely diffusing section 12Z2 is configured to diffuse the outgoing light toward the self lane. If the portion on the oncoming lane side with respect to the vertical plane including the optical axis Ax is configured as an obliquely diffusing section, the angle of refraction of the outgoing light at the front surface 12a of the convex lens 12 becomes larger and thus the rate of the light to be internally reflected on the front surface 12a becomes larger, resulting in loss of the luminous flux of the light source accordingly. In this regard, by configuring the portion on the self lane side with respect to the vertical plane including the optical axis Ax as the obliquely diffusing section 12Z2, the angle of refraction of the light outgoing from the front surface 12a of the convex lens 12 is small and thus the rate of the light to be internally reflected on the front surface 12a is small, thereby being able to enhance the efficiency of use of the luminous flux of the light source.

[0077] Next, description will be given below of a modified example of the first embodiment described above.

[0078] In the first embodiment, description has been given of an example in which the oblong pentagonal-shaped light emitting surface 14A is configured such that the fluorescent thin film 14c is formed over the entire area of the surfaces of the four light emitting chips 14a and also the oblong wedge-shaped light shield film 14d is formed in the right lower corner portion of the surface of the fluorescent thin film 14c. However, as shown in Fig. 3(b), in the case that there is formed a fluorescent thin film 114c is formed in the surfaces of the four light emitting chips 14a while the right lower corner portions of these surfaces are left as oblong wedges, there can also be structured a light emitting surface 114A which has a first side 114A1 and a second side 114A2 having an obtuse angle between them.

[0079] Also, instead of structuring the surface light source using the oblong pentagonal-shaped light emitting surface 14A as in the first embodiment, as shown by a perspective view in Fig. 8(a), a surface light source can be structured using the light exit surface 214A of a light guide member 214, or as shown by a main portion sectional view in (b), a surface light source can also be structured using a window portion 314A which is formed in the bulb tube 314 of a discharge bulb 312.

[0080] In this case, in the light guide member 214 shown in (a), a primary light source 212 such as a light emitting device or the like is mounted on the rear end face 214b of the light guide member 214, and the front end face of the light guide member 214 is configured as a light exit surface 214A which has a first side 214A1 and a second side 214A2 that are formed to have an obtuse angle between them. According to the structure of the light guide member 214, the light, which is emitted from the primary light source 212 and entered from the rear end face 214b of the light guide member 214, can be guided to the light exit surface 214A of the light guide member 214 and can be then output from the light exit surface 214A.

[0081] On the other hand, in the discharge bulb 312 shown in (b), the bulb tube 314 defining the discharge chamber of the discharge bulb 312 is configured as a cylindrical tube made of transparent ceramics and, on the outer peripheral surface of the bulb tube 314, there is applied light shield coating except for the oblong pentagonal-shaped window portion 314A. The window portion 314A is configured such that, when the discharge bulb 312 is view from laterally, it includes a first side 314A1 and a second side 314A2 which are formed to have an obtuse angle between them. The discharge bulb 312 is used in a state where it is disposed horizontally such that its bulb axis Ax1 intersects at right angles with the optical axis Ax.

[0082] Next, description will be given below of a vehicle lamp according to the second embodiment of the invention.

[0083] Fig. 9, similarly to Fig. 5, shows the main portions of a vehicle lamp 410 according to the present embodiment.

[0084] As shown in Fig. 9, the vehicle lamp 410 according to the present embodiment is similar in basic structure to the vehicle lamp 10 according to the first embodiment but is different from the first embodiment in the shape of a convex lens 412 thereof.

[0085] The convex lens 412 according to the present embodiment is similar in structure to the convex lens 12 according to the first embodiment in its upper half portion (that is, such portion of the convex lens 412 as exists upwardly of a horizontal plane including the optical axis Ax) but is different from the convex lens 12 according to the first embodiment in the structure of its lower half portion.

[0086] Referring specifically to the structure of the upper half portion of the present convex lens 412, a portion on the oncoming lane side with respect to the vertical plane including the optical axis Ax is configured as a first lens portion 412Z1 which is similar to the first lens portion 12Z1 of the first embodiment, and a portion on the self lane side with respect to the vertical plane including the optical axis Ax is configured as a second lens portion 412Z2 which is similar to the second lens portion 12Z2 of the first embodiment. On the other hand, the lower half portion of the convex lens 412 is configured as a third lens portion 412Z3 which diffuses the light from the light emitting surface 14A in the horizontal direction.

[0087] In this case, the rear surface 412b of the convex lens 412, similarly to the convex lens 12 of the first embodiment, is a flat surface that intersects at right angles with the optical axis Ax, whereas the front surface 412a of the convex lens 412 is different in shape from the convex lens 12 according to the first embodiment.

[0088] That is, a section of the front surface 412a of the convex lens 412 on the third lens portion 412Z3 is configured as a horizontally wider-diffusing section 412Z3a. This horizontally wider-diffusing section 412Z3a, as shown by arrow marks shown in Fig. 9, diffuses the light emitting from the light emitting surface 14A more laterally than lights respectively outgoing from the horizontal direction and obliquely diffusing sections 412Z1a, 412Z2a of the first and second lens portions 412Z1, 412Z2.

[0089] In order to realize this, the horizontally wider-diffusing section 412Z3a is configured such that its sectional shape along the horizontal plane has a substantially arc-shaped curved line the curvature of which is smaller than the front surface of an ordinary plano-convex aspherical lens. Owing to this, the light, which has been emitted from the light emitting surface 14A and has arrived at the horizontally wider-diffusing section 412Z3a, can be output at a horizontal direction deflection angle which increases with respect to the optical axis Ax as it parts away from the optical axis Ax in the right and left directions.

[0090] Further, the third lens portion 412Z3 of the convex lens 412 diffuses the light from the light emitting surface 14A not only in the horizontal direction but also in the downward direction slightly, as shown by arrow marks in Fig. 9.

[0091] In order to realize this, the horizontally wider-diffusing section 412Z3a is configured such that its sectional shape along the horizontal plane has a substantially arc-shaped curved line the curvature of which is smaller than the front surface of an ordinary plano-convex aspherical lens. Owing to this, the light, which has been emitted from the light emitting surface 14A and has arrived at the horizontally wider-diffusing section 412Z3a, can be output at a downward direction deflection angle which increases with respect to the optical axis Ax as it parts away downward from the optical axis Ax.

[0092] [0090] Here, in the upper half portion of the convex lens 412, specifically, in the outer peripheral edge portion thereof, there is formed a ring-shaped flat plate portion 412c, whereas, in the lower half portion of the convex lens 412, there is not formed such flat plate portion 412c but the third lens portion 412Z3 is formed to extend up to the outer-most peripheral edge of the convex lens 412.

[0093] Now, Fig. 10 is a perspective view of a light distribution pattern PB which is formed on a virtual vertical screen disposed at a position 25 m ahead of the lamp by the forward light irradiation from the vehicle lamp 410 according to the present embodiment.

[0094] As shown in Fig. 10, this light distribution pattern PB is a light distribution pattern which is formed as a portion of a low beam light distribution pattern PL2 shown by a two-dot chained line in Fig. 10, and this is formed as a combined light distribution pattern in which a first light distribution pattern PB1, a second light distribution pattern PB2 and a third light distribution pattern PB3 are combined. As a combined light distribution pattern of this light distribution pattern PB and a light distribution pattern formed by the forward light irradiation from another lamp (not shown), there is formed the low beam light distribution pattern PL2.

[0095] The low beam light distribution pattern PL2, similarly to the low beam light distribution pattern PL1 according to the first embodiment, has horizontal and oblique cutoff lines CL1, CL2, and a hot zone HZ is formed to surrounds the elbow point E of the low beam light distribution pattern PL2 rather on the left.

[0096] The light distribution pattern PB1 is a light distribution pattern which is formed by the light output from the horizontally diffusing section 412Z1a of the first lens portion 412Z1, while the light distribution pattern PB1 is formed such that its upper end edge is substantially coincident with the horizontal cutoff line CL1. On the other hand, the light distribution pattern PB2 is a light distribution pattern which is formed by the light output from the obliquely diffusing section 412Z2a of the second lens portion 412Z2, while it is formed such that its upper end edge is substantially coincident with the oblique cutoff line CL2. The hot zone HZ of the low beam light distribution pattern PL2 is formed by a portion where these two light distribution patterns PB 1, PB2 overlap with each other.

[0097] The third light distribution pattern PB3 is a light distribution pattern which is formed by the light output from the horizontally wider-diffusing section 412Z3a of the third lens portion 412Z3, while it is formed such that its upper end edge is substantially coincident with the horizontal cutoff line CL1. In this case, the third light distribution pattern PB3 is formed such that it spreads right and left more widely than the light distribution patterns PB1, PB2 as well as more downwardly than the light distribution patterns PB1, PB2.

[0098] According to the present embodiment as well, as the composite pattern of the light distribution patterns PB1, PB2 and PB3, there is formed the light distribution pattern PB which has the horizontal and oblique cutoff lines CL1, CL2, in the upper end portion thereof.

[0099] In this case, since the first and second lens portions 412Z1, 412Z2 are reduced by half in size when compared with the first and second lens portions 12Z1, 12Z2 according to the first embodiment, the light distribution patterns PB1, PB2 are reduced by half in brightness when compared with the light distribution patterns PA1, PA2 according to the first embodiment. However, due to the light output from the third lens portion 412Z3, there is formed the light distribution pattern PB3 the right and left diffusion angle of which is larger than the light distribution patterns PB1, PB2 and also which can diffuse the light even downwardly. Therefore, as the light distribution pattern PB of the whole lamp, there can be formed a light distribution pattern of a wide diffusion type which has a smooth light intensity distribution, and the light and shade ratio of the lower end edges of the light distribution patterns PB1, PB2 can be reduced. Owing to this, it is possible to effectively prevent the light distribution from varying on the road surface ahead of the vehicle.

[0100] Also, since the third lens portion 412Z3 is disposed below the first and second lens portions 412Z1, 412Z2, although the light emitted from the light emitting surface 14A and output from the third lens portion 412Z3 is diffused downwardly, the output angle of the light from the horizontally diffusing section 412Z3a can be set not so large. This can facilitate the formation of the light distribution pattern PB3 as a light distribution pattern which is capable of diffusing the light not only in the horizontal direction but also in the downward direction.

[0101] While the rear surface 12b of the convex lens 12 is explained as a flat surface in each of the embodiments described above, it may be configured as a convex surface or a concave surface.

[0102] Further, while the light distribution patterns PA, PB formed by the light irradiation from the vehicle lamps 10, 410 are described as forming a part of the low beam light distribution patterns PL I, PL2 for a left-hand traffic light distribution in the respective embodiments described above, similar functions and effects as the embodiments described above can be obtained also in a case in which they form a part of a low beam light distribution patterns for a right-hand traffic light distribution by right-and-left reversing the configurations of the vehicle lamps 10, 410.

[0103] The numeric values shown as specifications in the respective embodiments described above are merely examples, and they may of course be set to different values as needed.

[0104] The present application is based on Japanese patent application (JP 2008-139586) filed on May 28, 2008, the content of which is incorporated herein by reference.

DESCRIPTION OF REFERENCE SIGNS

[0105]

10, 410	Vehicle Lamp
12, 412	Convex Lens
12Z1, 412Z1	First Lens Portion
14Za, 412Z1a	Horizontally Diffusing Section
12Z2, 412Z2	Second Lens Portion
12Z2a, 412Z2a	Obliquely Diffusing Section
12a, 412a	Front Surface
12b, 412b	Rear Surface
14	Light Emitting Device
14A, 114A	Light Emitting Surface as Surface Light Source

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	14A1, 114A1, 214A1, 314A1	First Side
	14A2, 114A2, 214A2, 314A2	Second Side
	14a	Light Emitting Chip
	14b	Substrate
5	14c, 114c	Fluorescent Thin Film
	14d	Light Shield Film
	16	Metal Plate
	12c, 412c	Flat Plate Portion
	18	Base Member
10	212	Primary Light Source
	214	Light Guide Member
	214A	Light Exit Surface as Surface Light Source
	214b	Rear End Face
	312	Discharge Bulb
15	314	Bulb Tube
	314A	Window Portion as Surface Light Source
	412Z3	Third Lens Portion
	412Z3a	Horizontally Wider-Diffusing Section
	Ax	Optical Axis
20	Ax I	Bulb axis
	B	Boundary Line
	C1,	Cell
	CL1	Horizontal Cutoff Line
	CL2	Oblique Cutoff Line
25	E	Elbow Point
	F	Rear Focal Point
	HZ	Hot Zone
	Io	Inverted Projection Image
	Io1	Horizontal Portion
30	Io2	Inclined Portion
	Iz1, Iz2	Inverted Projection Image
	L 1 c, L 1 m, L2c, L2m	Curved Line
	PA, PB	Light Distribution Pattern
	PA1, PB1	First Light Distribution Pattern
35	PA1a,	PA2a Upper End Edge
	PA2,	PB2 Second Light Distribution Pattern
	PB3	Third Light Distribution Pattern
	PL1, PL2	Low Beam Light Distribution Pattern

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Claims

1. A vehicle lamp comprising a convex lens disposed on an optical axis extending in a front-rear direction of the lamp and a surface light source disposed near a rear focal point of the convex lens, wherein the vehicle lamp is configured to form a light distribution pattern having horizontal and oblique cutoff lines on an upper end portion by controlling a deflection of direct light from the surface light source using the convex lens, **characterized in that** a lower end edge of the surface light source includes a first side and a second side, each extending linearly so as to form an obtuse angle with each other in a front view of the lamp, the surface light source is disposed to face forward such that a point of intersection of the first side and the second side is positioned on the rear focal point of the convex lens and such that the first side is positioned on a horizontal plane including the optical axis, a portion of the convex lens is configured as a first lens portion that deflects and/or diffuses light from the surface light source in a direction parallel to the first side, and at least another portion of the convex lens is configured as a second lens portion that deflects and/or diffuses light from the surface light source in a direction parallel to the second side.
2. The vehicle lamp as set forth in claim 1, **characterized in that** at least another portion of the convex lens other than the first lens portion and the second lens portion is configured as a third lens portion that diffuses light from

the surface light source in the horizontal direction, and
the third lens portion is configured to diffuse the light from the surface light source more laterally than the lights
outgoing from the first and second lens portions respectively.

- 5 3. The vehicle lamp as set forth in claim 2, **characterized in that** the third lens portion is disposed below the first and
second lens portions.

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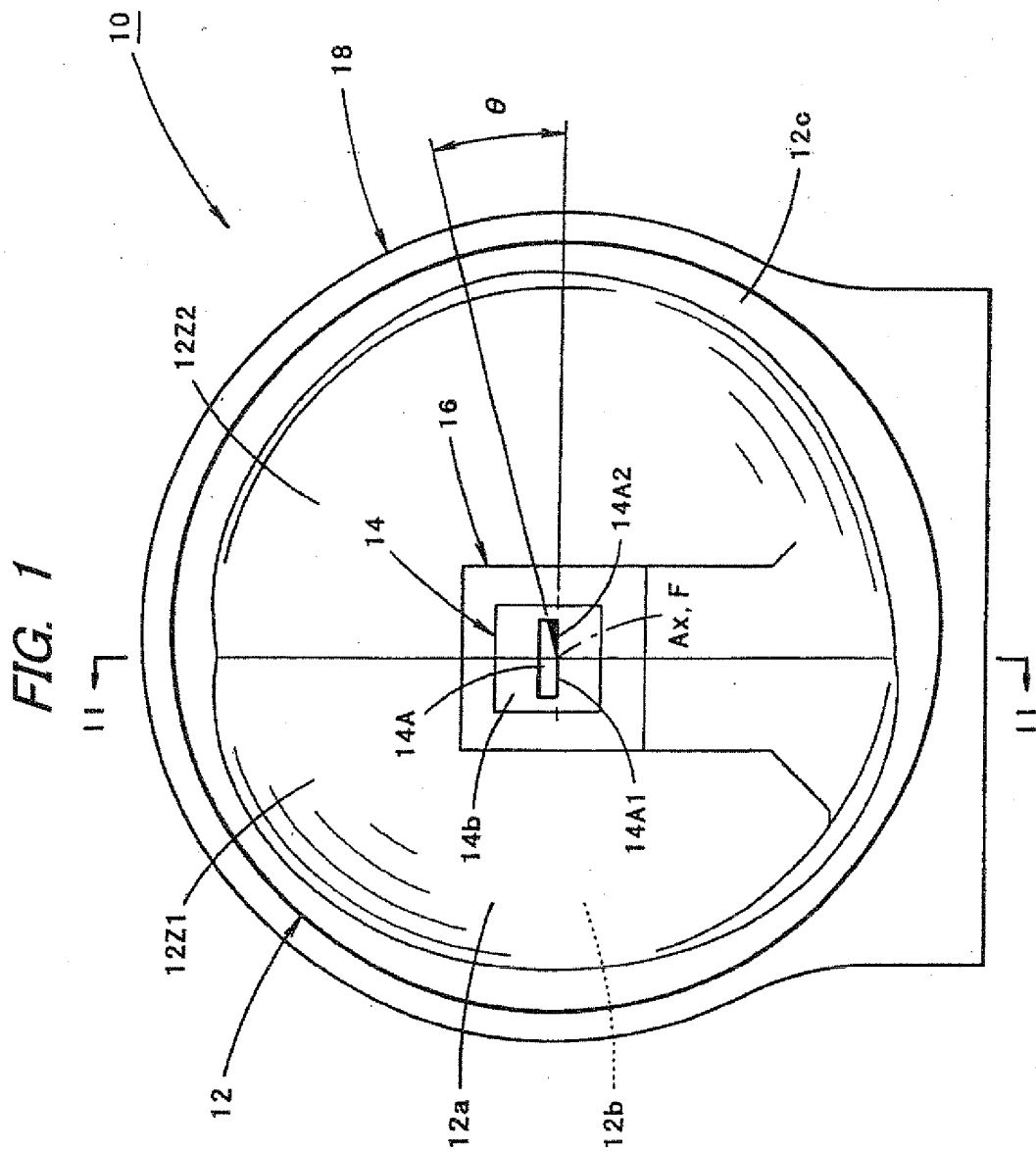


FIG. 2

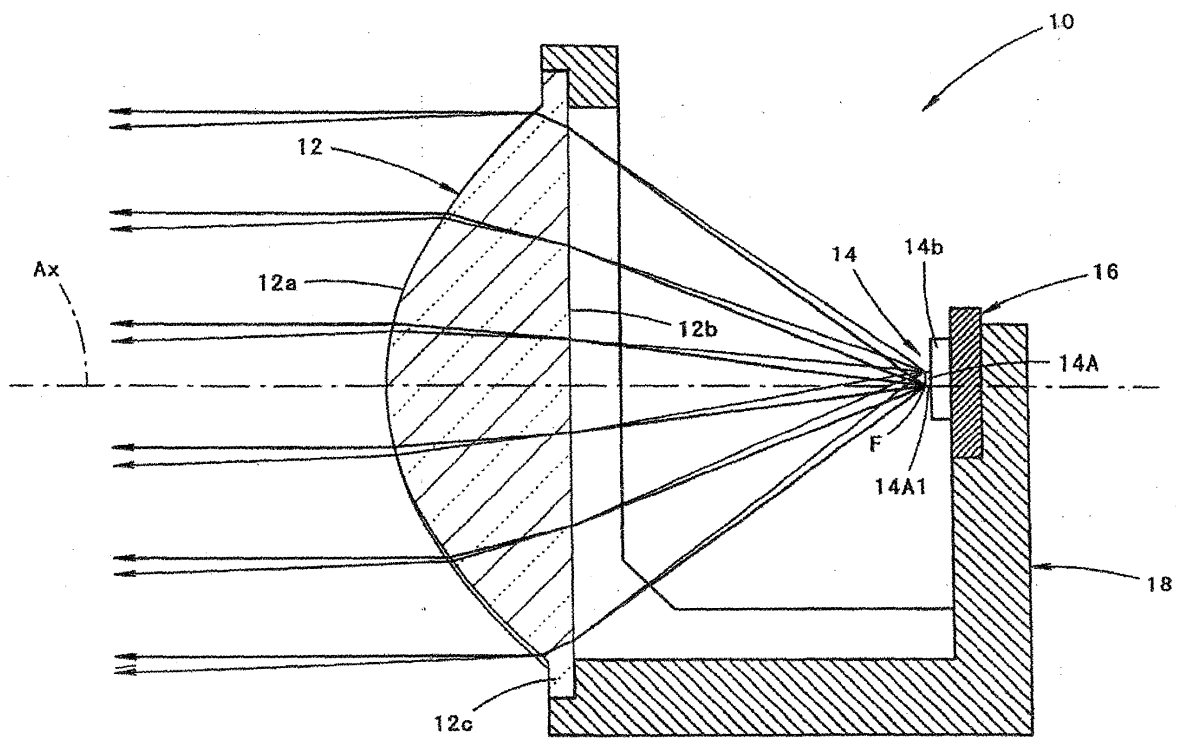


FIG. 3

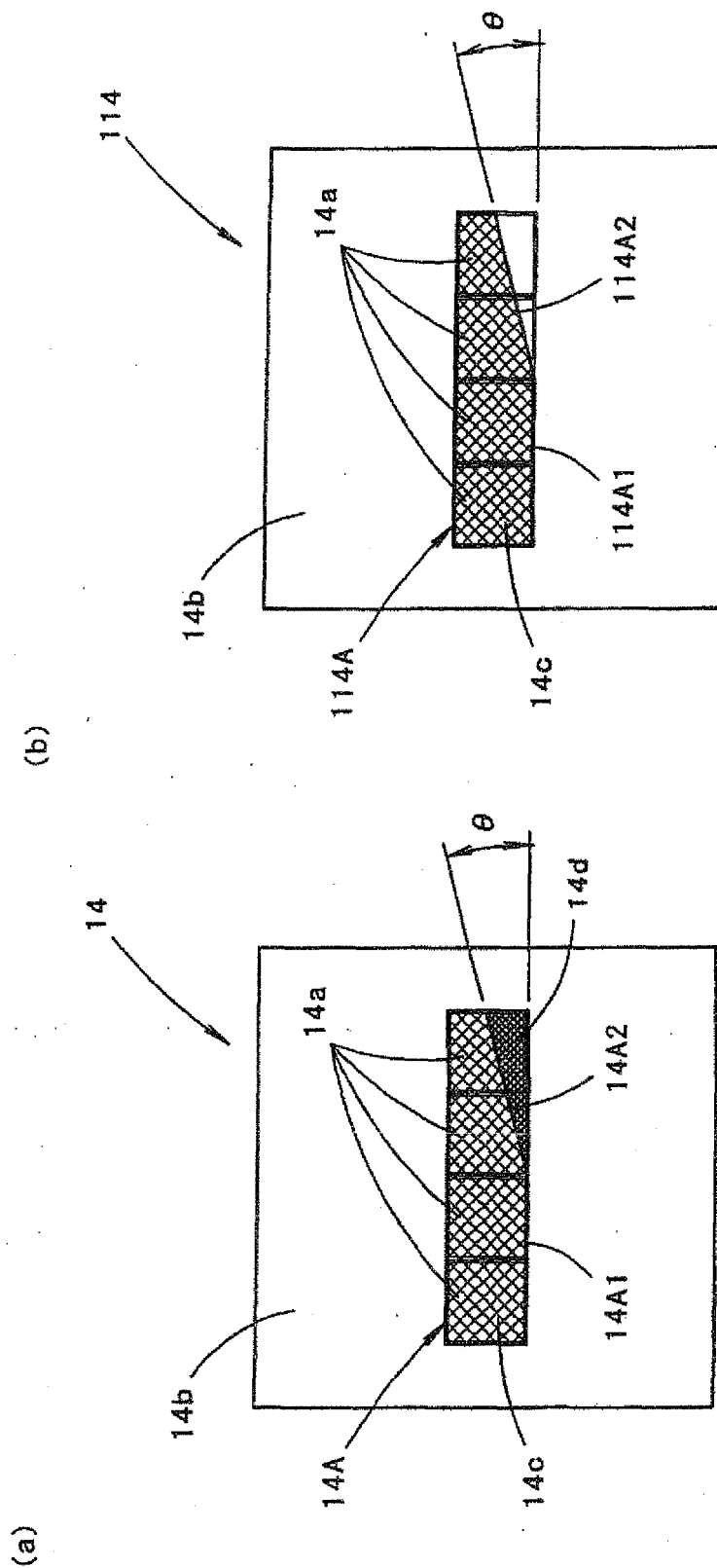


FIG. 4

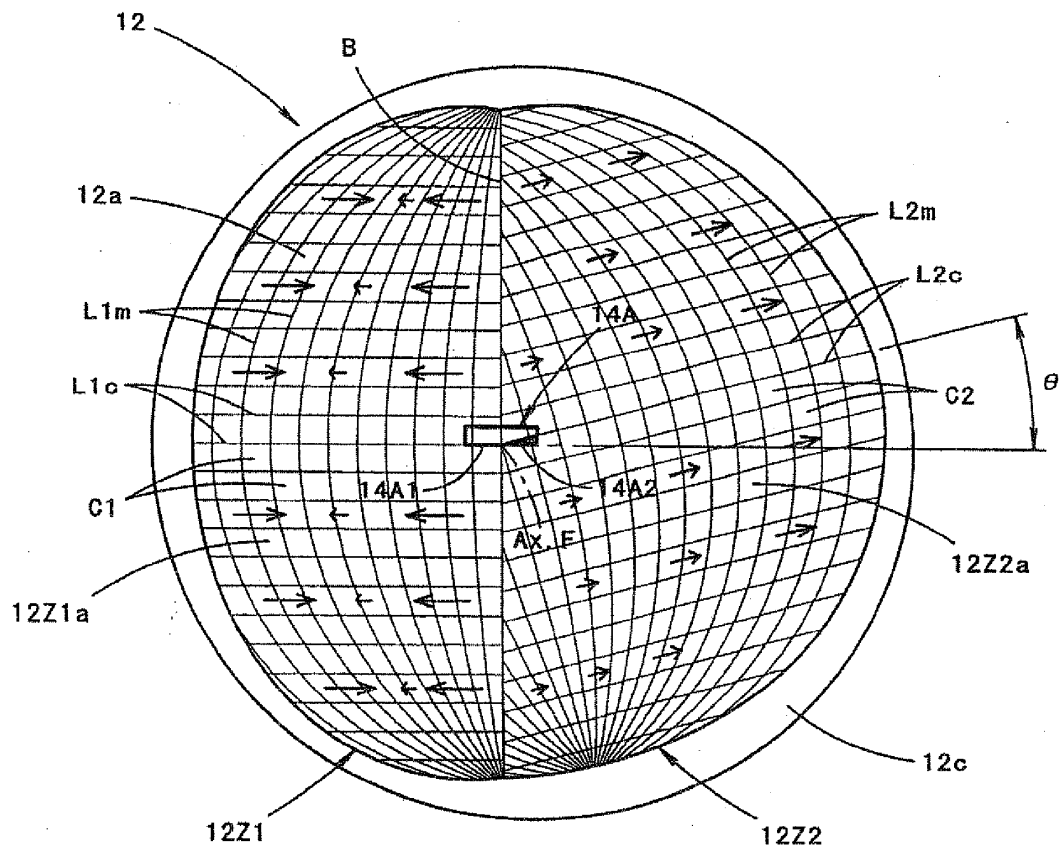


FIG. 5

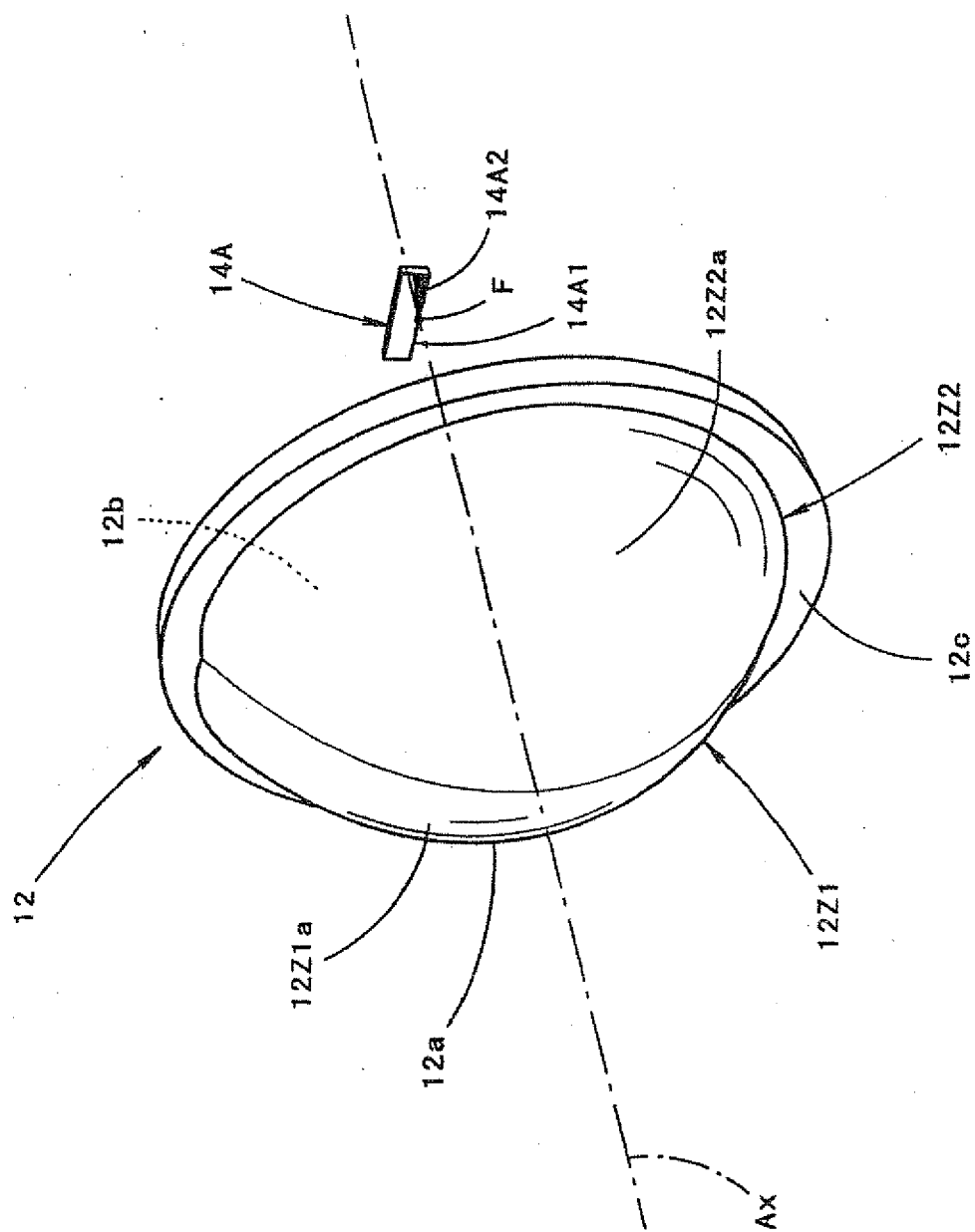


FIG. 6

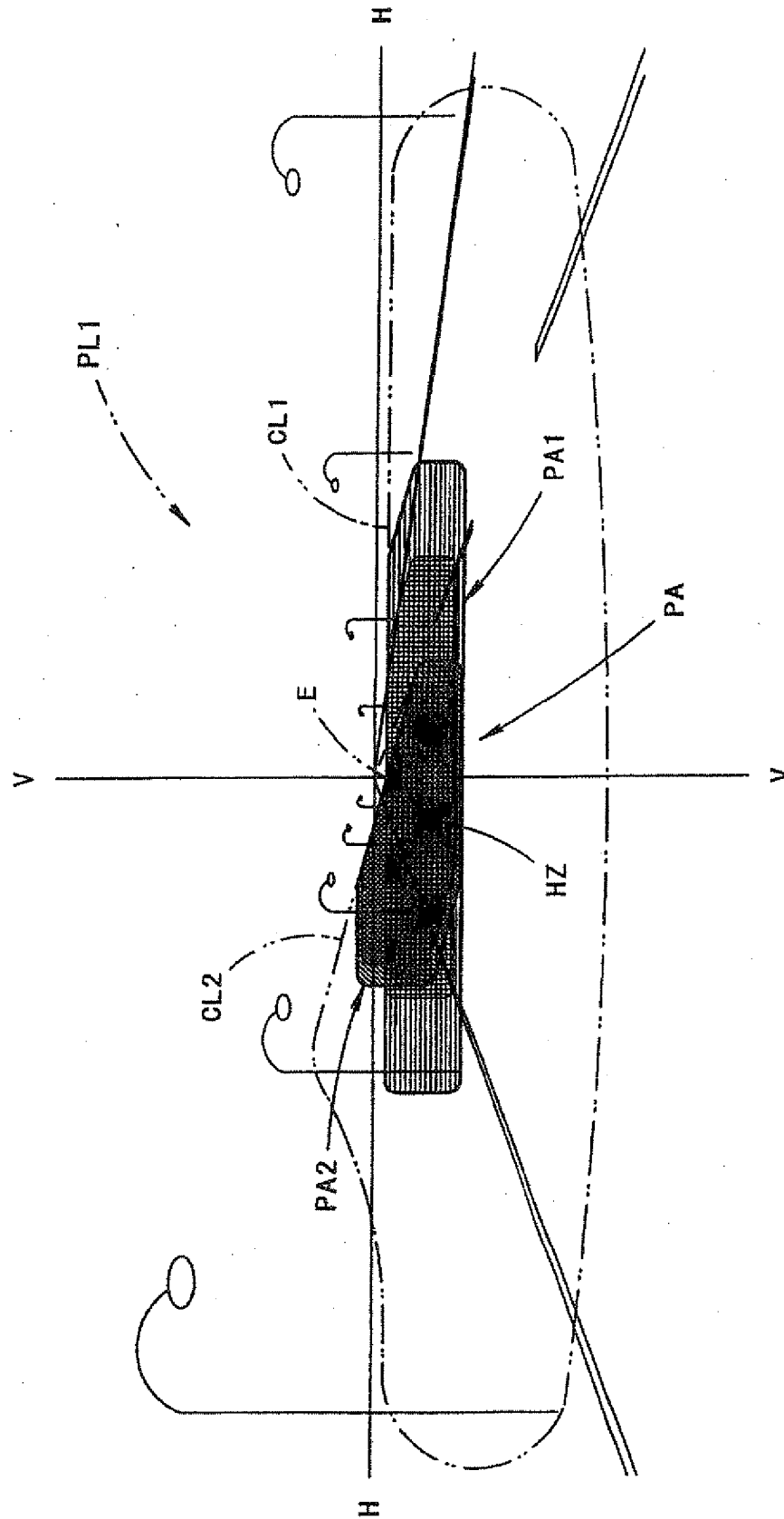


FIG. 7

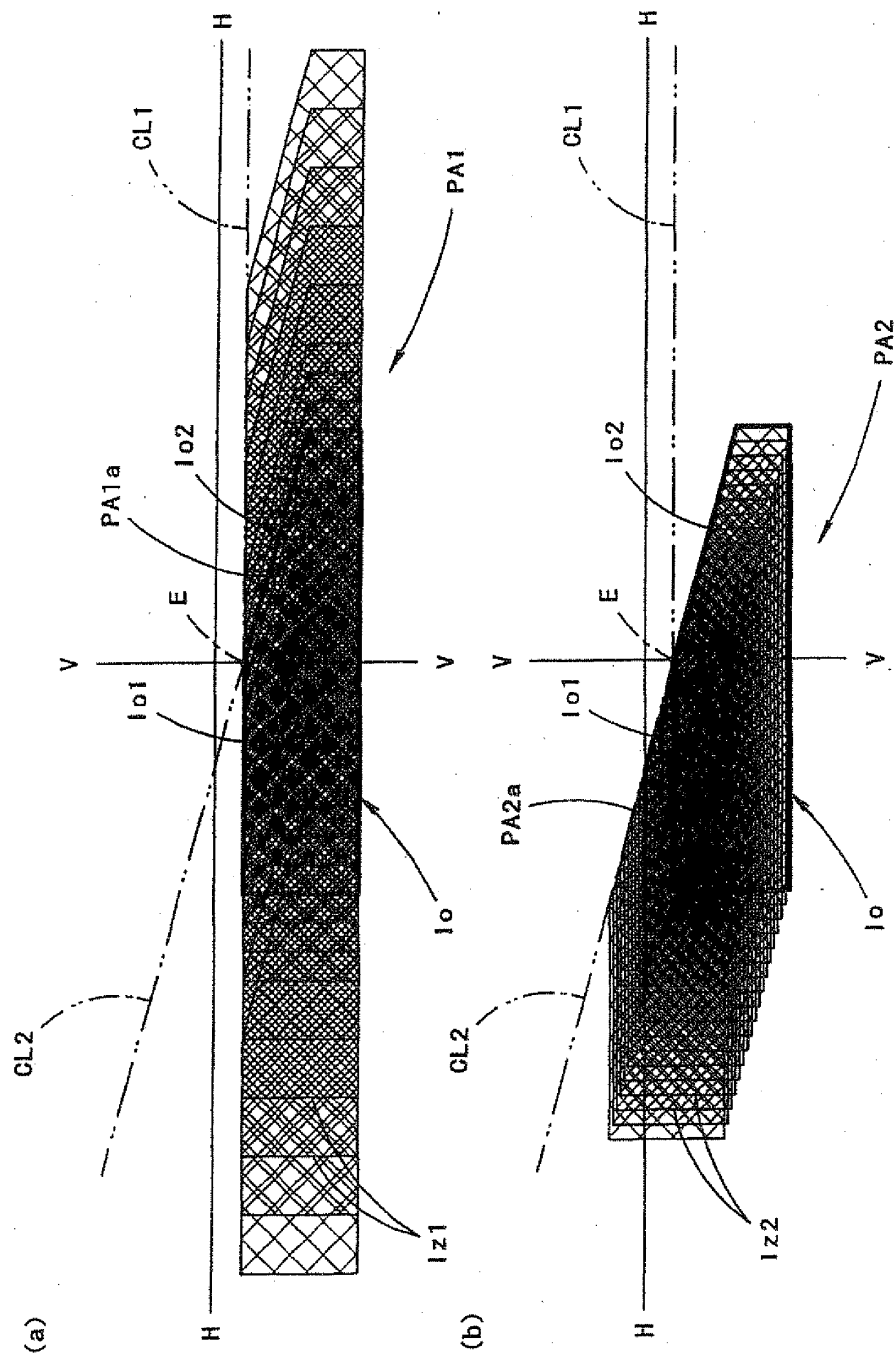
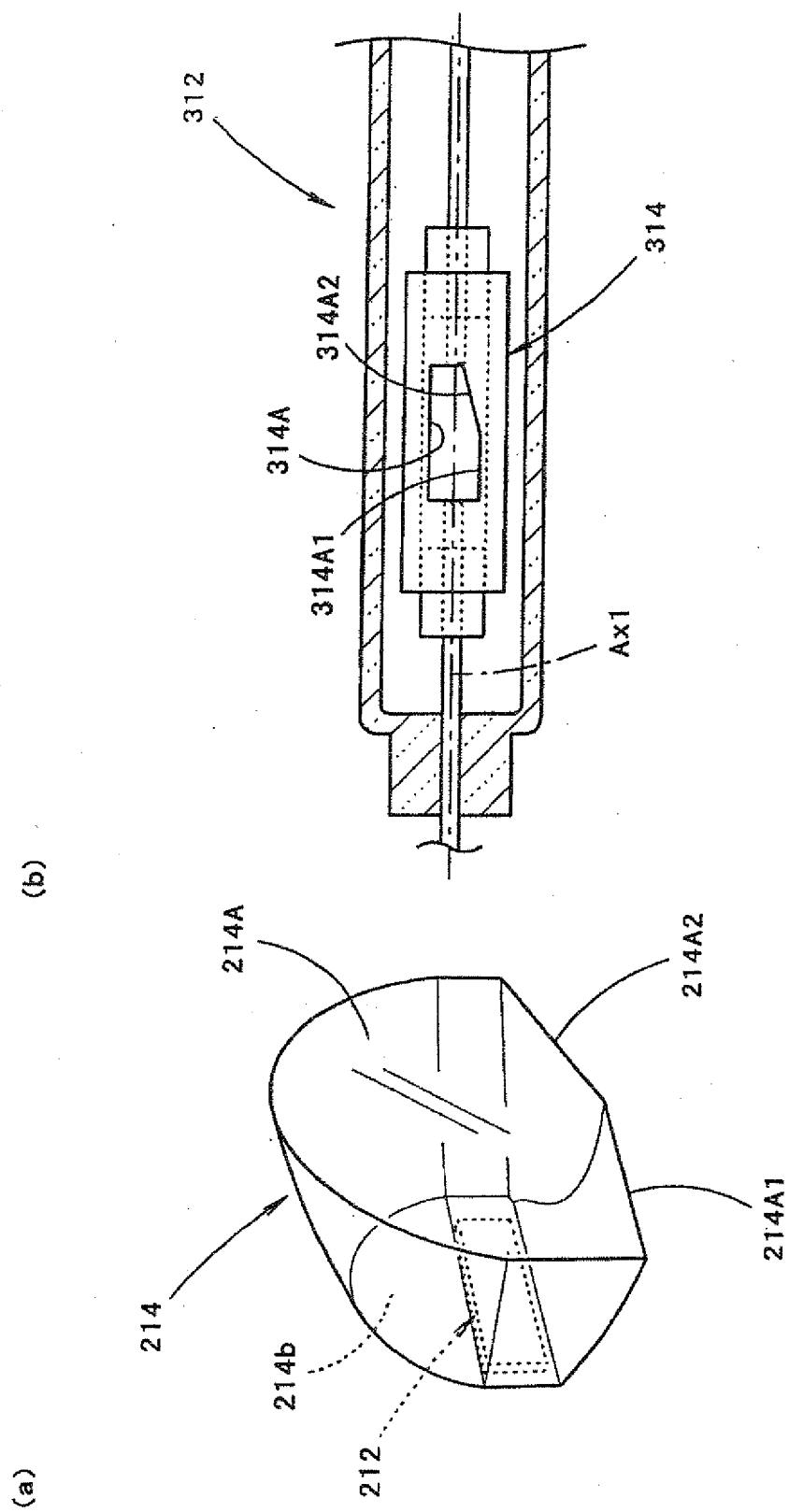


FIG. 8



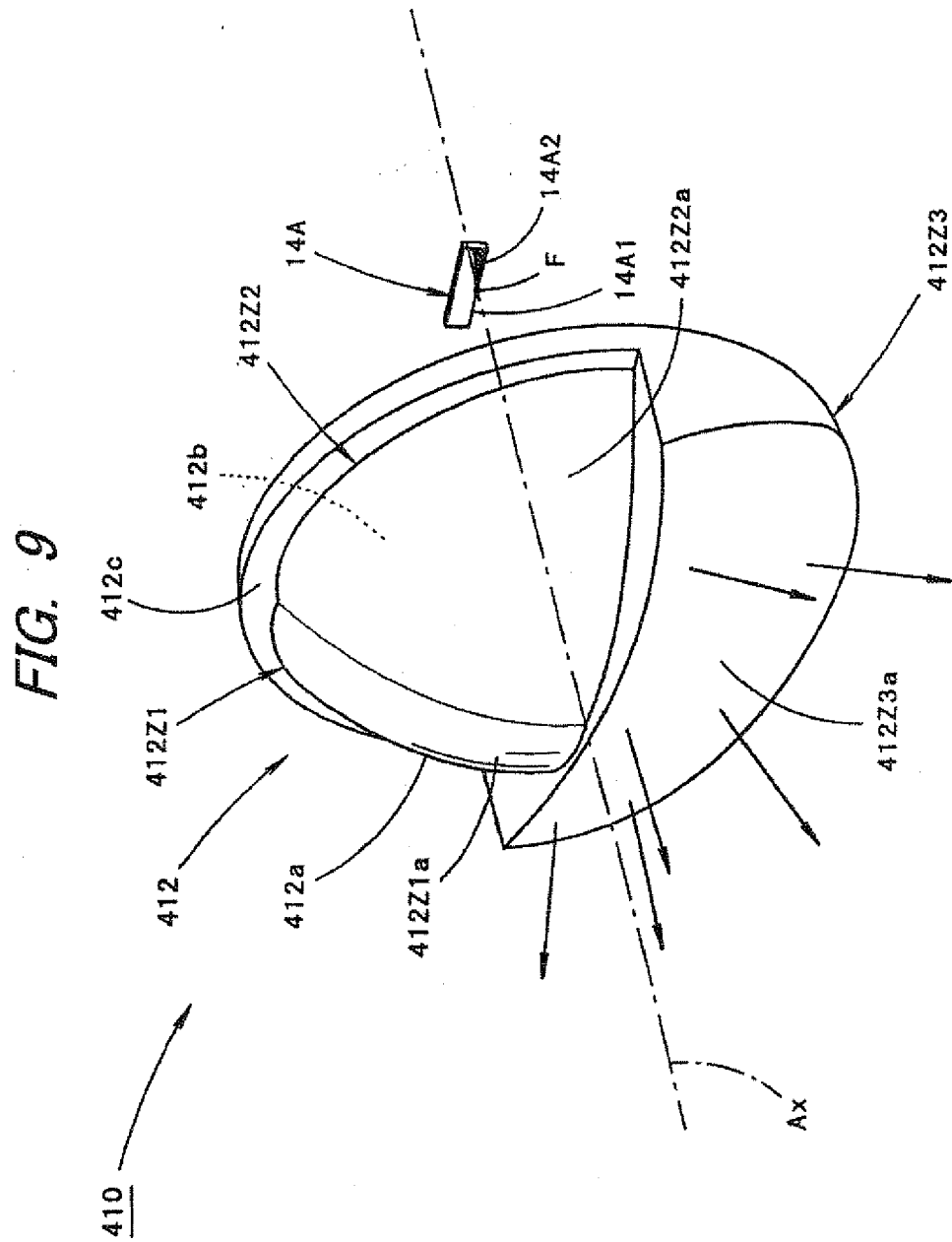
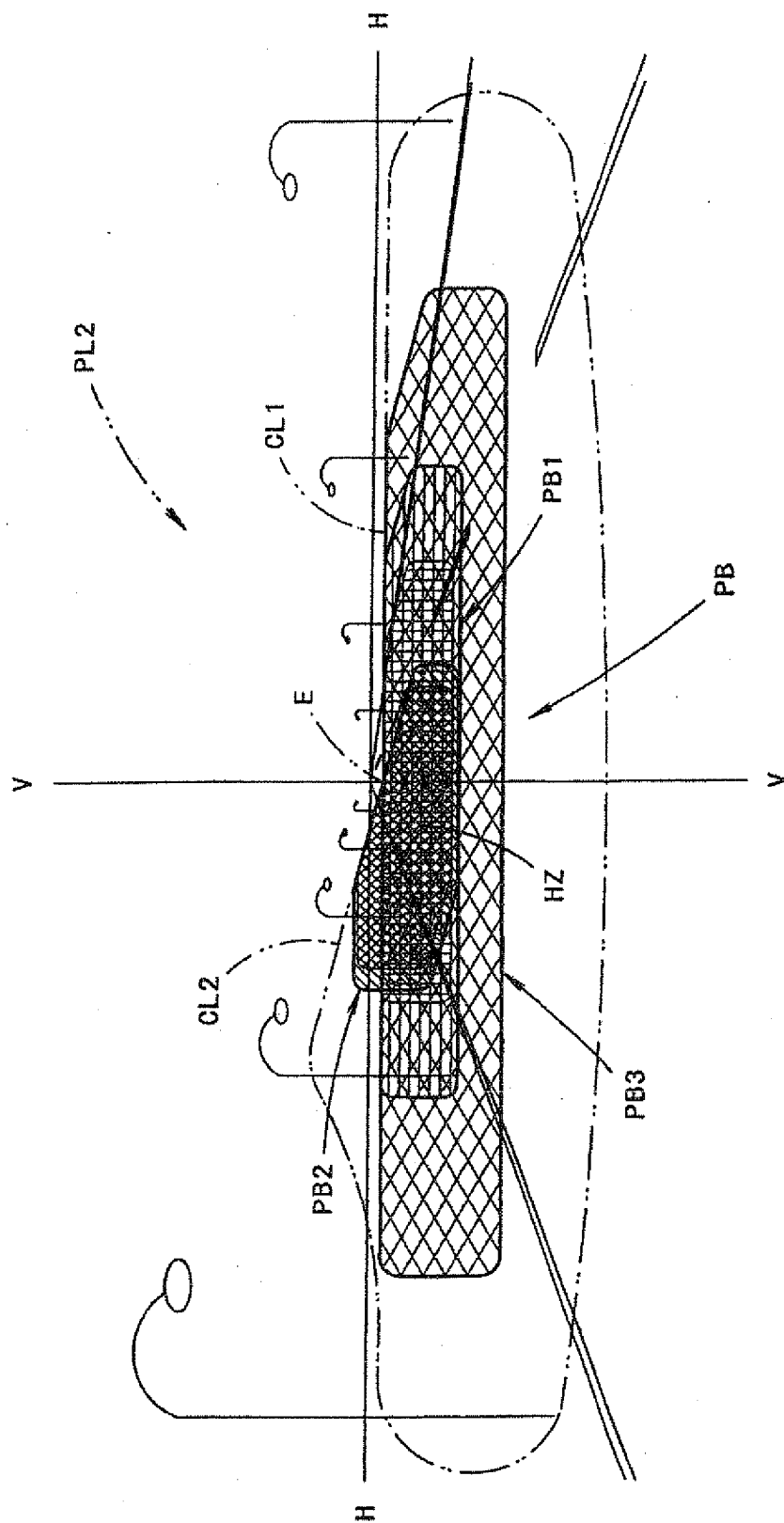


FIG. 10



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2009/059620

A. CLASSIFICATION OF SUBJECT MATTER

F21S8/10(2006.01)i, F21S8/12(2006.01)i, F21W101/10(2006.01)n, F21Y101/02(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)

F21S8/10, F21S8/12, F21W101/10, F21Y101/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2009
Kokai Jitsuyo Shinan Koho	1971-2009	Toroku Jitsuyo Shinan Koho	1994-2009

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2006-210296 A (Ichikoh Industries Ltd.), 10 August, 2006 (10.08.06), Full text; all drawings & EP 1686308 A1	1-3
Y	JP 2005-183327 A (Stanley Electric Co., Ltd.), 07 July, 2005 (07.07.05), Full text; all drawings (Family: none)	1-3
Y	JP 2005-63706 A (Stanley Electric Co., Ltd.), 10 March, 2005 (10.03.05), Full text; all drawings & US 2005/0041434 A1 & EP 1526581 A2 & CN 1583465 A	1-3

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

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"&" document member of the same patent family

Date of the actual completion of the international search
31 July, 2009 (31.07.09)Date of mailing of the international search report
11 August, 2009 (11.08.09)Name and mailing address of the ISA/
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2009/059620

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	JP 57-5202 A (Koito Manufacturing Co., Ltd.), 12 January, 1982 (12.01.82), Figs. 1 to 3 (Family: none)	1-3
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Form PCT/ISA/210 (continuation of second sheet) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

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