



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
21.09.2011 Bulletin 2011/38

(51) Int Cl.:
F21V 5/00 (2006.01) **F21V 7/00 (2006.01)**
F21S 8/12 (2006.01)

(21) Application number: **11001696.1**

(22) Date of filing: **01.03.2011**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **01.03.2010 JP 2010044472**

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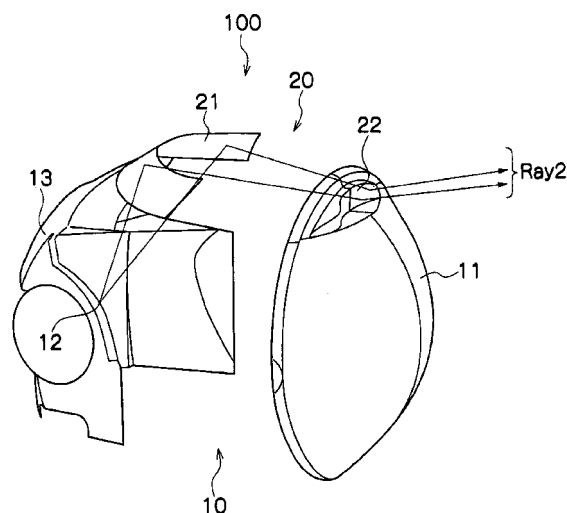
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(54) **Motorcycle projector headlight**

(57) A motorcycle projector headlight for a low beam can include a light source, a shade, a first reflector, a second reflector, a projector lens and an optical lens. A part of light emitted from the light source can form a fundamental light distribution pattern from the projector lens via the first reflector by shielding an upward portion of the light with the shade. Another part of the light can form an overhead light distribution pattern including a right and left bank light distribution pattern from the optical lens via the second reflector. Therefore, the overhead light distribution pattern can illuminate a traffic sign, etc. The right left bank light distribution pattern can illuminate a right and left triangle dark zone between a horizontal line and the fundamental light distribution pattern when a motorcycle banks. Thus, the projector motorcycle headlight can perform a favorable light distribution pattern utilizing a simple structure.

FIG. 1



Description

BACKGROUND

1. Field

[0001] The presently disclosed subject matter relates to a motorcycle headlight of a projector type, and more particularly to a motorcycle projector headlight having a favorable light distribution pattern, which can form a right and left bank light distribution pattern for illuminating a right and left triangle dark zone between a horizontal line and a horizontal cut-off line for a low beam when a motorcycle banks, and which can form an overhead light distribution pattern for illuminating a traffic sign, etc.

2. Description of the Related Art

[0002] When a motorcycle drives in a position perpendicular to a road under a low beam at night, a headlight of the motorcycle may form a light distribution pattern P1 for a low beam as shown FIG. 14a. In FIG. 14a, line H-H shows a horizontal line with respect to the road and line V-V shows a vertical line. The light distribution pattern P1 may be located under the horizontal line H-H so as not to give a glaring type light to an oncoming car due to a low beam.

[0003] However, when the motorcycle banks rightward with respect to the road because of a curved roadway, the light distribution pattern P1 may slant rightward as shown in FIG. 14b. In the case, a triangle zone A between the horizontal line H-H and a right cut-off line of the light distribution pattern P1 becomes dark as compared with the light distribution pattern P1 shown in FIG. 14a, and therefore the motorcycle reduces visibility of the triangle dark zone.

[0004] In order to prevent from causing the triangle dark zone A, a conventional projector headlight for use as a low beam light is disclosed in patent document No. 1 (Japanese Patent Application Laid Open JP2008-1306). FIG. 15 is a cross-section top view showing the conventional motorcycle projector headlight, which is disclosed in patent document No. 1. The conventional projector headlight 200 includes a projector headlight 210 for a low beam, a left cornering lamp 220L and a right cornering lamp 220R.

[0005] The projector headlight 210 includes: a light source 212; an ellipsoidal reflector 213 in which a first focus thereof is located near the light source 212; a projector lens 211 which has a focus thereof located near a second focus of the elliptical reflector 213; and a shade 214 located near the focus of the projector lens 211. In the projector headlight 210, light emitted from the light source 212 is reflected on the elliptical reflector 213 and can be emitted in a forward direction of the projector headlight 210 via the projector lens 211.

[0006] In this case, an upward portion of the light that is reflected on the elliptical reflector 213 can be shielded

by the shade 214. Accordingly, the projector headlight 210 may form the light distribution pattern P1 for a low beam including a horizontal cut-off line as shown in FIGs. 14a and 14b in accordance with a top shape of the shade 214. The left cornering lamp 220L is located in the projector headlight 200 to illuminate a leftward direction of the light distribution pattern P1 that is emitted from the projector headlight 210. The right cornering lamp 220R is located in the projector headlight 200 to illuminate a rightward direction of the light distribution pattern P1 that is emitted from the projector headlight 210.

[0007] FIG. 16a is an explanatory diagrams depicting the light distribution patterns P1 for a low beam that is formed by the headlight 210 and an auxiliary light distribution pattern P2 that is formed by the left cornering lamp 220L when a motorcycle is perpendicular to a road. Here, a description of the right cornering lamp 220R is abbreviated to ease an understanding of the conventional projector headlight 200 of the FIG. 15.

[0008] When the motorcycle banks leftward with respect to the road, although the light distribution pattern P1 slats with respect to the horizontal line H as shown in FIG. 16b, the auxiliary light distribution pattern P2 can change into another auxiliary light distribution pattern P3 by the left cornering lamp 220L. Consequently, the conventional projector headlight 200 may prevent from causing the triangle dark zone A.

[0009] Specifically, FIG. 17a is a cross-section side view showing the left cornering lamp 220L and FIG. 17b is a perspective view showing a shade of the left cornering lamp 220L of FIG. 17a. The left cornering lamp 220L includes: a light source 222; an ellipsoidal reflector 223 in which a first focus thereof is located near the light source 222; a projector lens 221 which has a focus thereof located near a second focus of the elliptical reflector 223; and a shade 224 including a fixing shade 224a and a movable shade 224b, and the shade 224 located near the focus of the projector lens 221.

[0010] In the case, the movable shade 224b is normally located near the focus of the projector lens 221 along with the fixing shade 224a as shown in FIG. 17b. Accordingly, the left cornering lamp 220L may form the auxiliary light distribution pattern P2 as shown in FIG. 16a because light emitted from the light source 222 is shielded by the movable shade 224b. When turning on a left turn signal in order to turn left, the movable shade 22b moves from the above-described normal position toward the ellipsoidal reflector 223 as shown in FIG. 17a.

[0011] Therefore, even when the motorcycle banks leftward, the left cornering lamp 220L may form the other auxiliary light distribution pattern P3 as shown in FIG. 16b because the light emitted from the light source 222 is shielded by the fixing shade 224a, of which a top surface slants rightward. A structure of the right cornering lamp 220R is basically the same as the left cornering lamp 220L except that the top surface of the fixing shade 224a slants leftward

[0012] Accordingly, the left cornering lamp 220L may

prevent from causing the triangle dark zone between the horizontal line H-H and a left horizontal cut-off line of the light distribution pattern P1 when the motorcycle banks leftward. Similarly, the right cornering lamp 220R may also prevent from causing the right triangle dark zone between the horizontal line H-H and a right horizontal cut-off line of the light distribution pattern P1 when the motorcycle banks rightward. Thus, the conventional projector headlight 200 may prevent from causing the right and left triangle dark zone, which results in a reduction of visibility.

[0013] The above-referenced Patent Documents is listed below and is hereby incorporated with its English abstract in its entirety.

1. Patent document No.1: Japanese Patent Application Laid Open JP2008-1306
2. Patent document No.2: Japanese Patent Application Laid Open JP2009-199938

[0014] However, although the conventional projector headlight 200 may illuminate the right and left triangle dark zone when a motorcycle banks, the cornering lamps 210L and 210R are required to illuminate the right and left triangle dark zone. Therefore, the projector headlight 200 includes problems in that a size thereof becomes large and a cost thereof also increases. In addition, when the projector headlight 200 forms an overhead light distribution pattern for illuminating a traffic sign and the like, an additional lamp is required for the projector headlight 200. However, the additional lamp may cause problems such that the size becomes larger and also the cost further increases.

[0015] The disclosed subject matter has been devised to consider the above and other problems, characteristics and features. Thus, embodiments of the disclosed subject matter can include a motorcycle projector headlight for a low beam having a favorable light distribution pattern that can conform to a light distribution standard for headlights with respect to a bank light distribution pattern and an overhead light distribution pattern. In this case, the embodiments of the disclosed subject matter can include a battery friendly motorcycle headlight using an LED light source as a light source with reference to a conventional vehicle headlight including the LED light source, which is disclosed in patent document No. 2.

SUMMARY

[0016] The presently disclosed subject matter has been devised in view of the above and other characteristics, desires, and problems in the conventional art, and to make certain changes to existing projector headlights. Thus, an aspect of the disclosed subject matter includes providing a motorcycle projector headlight for a low beam having a favorable light distribution pattern that can form a bank light distribution pattern and an overhead light distribution pattern while conforming to a light distribution

standard for headlights. Another aspect of the disclosed subject matter includes providing a motorcycle projector headlight using an LED light source, which can result in a battery friendly and small projector headlight having a favorable light distribution pattern so that it can be used for various types of motorcycles.

[0017] According to an aspect of the disclosed subject matter, a motorcycle projector headlight can include: a light source; a first reflector configured with an ellipsoidal surface having a first focus located at the light source; a projector lens configured as a convex lens having a focus located on an optical axis thereof, the optical axis being located on an imaginary line connecting the first focus and a second focus of the first reflector, and the focus of the projector lens being located at the second focus of the first reflector; a shade having a top edge located at the second focus of the first reflector; a second reflector located adjacent the first reflector so as to receive a part of light emitted from the light source, the second reflector configured with an ellipsoidal surface having a first focus and a second focus in a horizontal cross-section shape and configured with a parabolic surface having a focus in a vertical cross-section shape, the first focus of the ellipsoidal surface and the focus of the parabolic surface being located at the light source, and the first focus and the second focus of the ellipsoidal surface and the focus of the parabolic surface being located on a virtual vertical surface including the optical axis of the projector lens.

[0018] Additionally, the motorcycle projector headlight can include an optical lens located adjacent the projector lens so that an incoming surface thereof faces the second reflector, an optical axis thereof being located on the virtual vertical surface, an outgoing surface thereof being bilaterally symmetric in the horizontal cross-section shape with respect to the virtual vertical surface and being formed in an ellipsoidal shape in the vertical cross-section shape, wherein the second focus of the ellipsoidal surface of the second reflector is located close to the outgoing surface thereof.

[0019] In the above-described exemplary projector headlight, the projector lens can form a light distribution pattern for a low beam below a horizontal line by using light reflected on the first reflector, and the optical lens can form an auxiliary light distribution pattern below an upward direction of 4 degrees with respect to the horizontal line by using light reflected on the second reflector. A maximum lighting intensity of the auxiliary light distribution pattern between a rightward and leftward direction of 10 degrees with respect to a vertical line can be 1.08luxes on a vertical screen that is vertically set at 25 meters away from the motorcycle projector headlight.

[0020] According to the exemplary projector headlight, the projector lens can form the light distribution pattern for a low beam below a horizontal line via the first reflector, and the optical lens can form an auxiliary light distribution pattern via the second reflector. The auxiliary light distribution pattern can include an overhead light distribution pattern for illuminating a traffic sign and the like

and also can include a bank light distribution pattern for illuminating a right and left dark zone caused between the horizontal line and a horizontal cut-off line of the low beam when a motorcycle banks rightward and leftward. Additionally, the maximum light intensity of the auxiliary light distribution pattern can conform to ECE Regulation 113. Thus, the motorcycle projector headlight can provide a favorable light distribution that includes the light distribution pattern for a low beam and the auxiliary light distribution pattern, which can conform to ECE Regulation 113.

[0021] In this case, the optical lens can be integrated as one body with the projector lens, and the incoming surface of the optical lens and an incoming surface of the projector lens can be formed as a co-planar surface. The optical axis of the projector lens and the optical axis of the optical lens can be parallel with respect to each other, and the outgoing surface of the optical lens can include symmetric ellipsoidal surfaces on both sides of the outgoing surface in the horizontal cross-section surface. Thus, the disclosed subject matter can provide the motorcycle projector headlight having a favorable light distribution pattern with a simple structure and a high accuracy.

[0022] According to another aspect of the disclosed subject matter, a motorcycle projector headlight can include: a shade having a top edge; a circuit board having a mounting surface and a virtual co-planar extension of the mounting surface intersecting with the top edge of the shade; an LED light source mounted on the mounting surface of the circuit board and having an optical axis extending substantially perpendicular to the mounting surface of the circuit board; a first reflector configured with an ellipsoidal surface having a first focus and a second focus, the first focus located at the LED light source so that the optical axis of the LED light source intersects with the first reflector, and the second focus located at the top edge of the shade; a projector lens configured as a convex lens having a focus located on an optical axis, the optical axis of the projector lens intersecting with the second focus of the first reflector at the focus of the projector lens and intersecting with the optical axis of the LED light source and the virtual co-planar extension of the mounting surface of the circuit board so that the circuit board slants toward the first reflector with respect to the optical axis of the projector lens. Additionally, the motorcycle projector headlight can include the second reflector described in paragraph [0017] and the optical lens described in paragraph [0018].

[0023] In the immediately above-described motorcycle projector headlight, because structures of the second reflector and the optical lens can be substantially the same as these of the above-described aspect, the motorcycle projector headlight using the LED light source can perform the features set forth above in paragraphs [0019] - [0021]. In addition, because the optical axis of the LED light source can intersect with the first reflector so that light emitted from the LED light source can be reflected

on the first and the second reflectors without directly facing the shade, the motorcycle projector headlight using the LED light source can improve a light use efficiency. Furthermore, the LED light source can be small in size and also can be a low power consumption semiconductor. Thus, the disclosed subject matter can provide a small projector headlight that can perform a favorable light distribution pattern with a high efficiency and low power consumption.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] These and other characteristics and features of the disclosed subject matter will become clear from the following description with reference to the accompanying drawings, wherein:

[0025] FIG. 1 is a schematic perspective view showing a first exemplary structure of a motorcycle headlight of a projector type for a low beam made in accordance with principles of the disclosed subject matter;

[0026] FIG. 2 is a schematic side cross-section view showing the first structure for the motorcycle projector headlight shown in FIG. 1;

[0027] FIG. 3a and FIG. 3b are explanatory diagrams depicting light distribution patterns for a low beam and auxiliary light distribution patterns, which are formed by the motorcycle projector headlight of FIG. 1 when a motorcycle is perpendicular to a road and when the motorcycle banks rightward with respect to the road, respectively;

[0028] FIG. 4 is a diagram showing an exemplary auxiliary light distribution pattern formed by the motorcycle projector headlight of FIG. 1;

[0029] FIG. 5 is a schematic top view showing a structure of an auxiliary optical formation in the motorcycle projector headlight of FIG. 1;

[0030] FIG. 6 is a schematic side cross-section view showing the first structure of the motorcycle projector headlight of FIG. 1 including the auxiliary optical formation;

[0031] FIGs. 7a, 7b and 7c are a top view, a front view and a side view showing a projector lens and an optical lens of the motorcycle projector headlight shown in FIG. 1, respectively;

[0032] FIG. 8 is a perspective close-up view showing the optical lens shown in FIGs. 7a-7c;

[0033] FIG. 9 is an explanatory diagram including a top cross-section view of the optical lens, which shows the auxiliary light distribution pattern formed by diffusing light reflected on a second reflector in a rightward and leftward direction;

[0034] FIGs. 10a and 10b are explanatory side cross-section views showing diffusing states of the lights reflected on the second reflector by the optical lenses when each shape of outgoing surfaces of the optical lenses are circular and ellipsoidal in a vertical cross-section shape, respectively;

[0035] FIG. 11 is a schematic side cross-section view

showing an exemplary variation of the optical lens and a projector lens in the motorcycle projector headlight of FIG. 1;

[0036] FIG. 12 is a schematic side cross-section view showing an exemplary variation of the motorcycle projector headlight shown in FIG. 2;

[0037] FIG. 13 is a schematic side cross-section view showing a second exemplary structure of the motorcycle project headlight for a low beam made in accordance with principles of the disclosed subject matter;

[0038] FIGs. 14a and 14b are explanatory diagrams depicting light distribution patterns for a low beam that are formed by a conventional motorcycle projector headlight when a motorcycle is perpendicular to a road and when the motorcycle banks rightward with respect to the road, respectively;

[0039] FIG. 15 is a cross-section top view showing a conventional motorcycle projector headlight;

[0040] FIG. 16a is an explanatory diagrams depicting a light distribution patterns for a low beam and an auxiliary light distribution pattern that are formed by the conventional motorcycle projector headlight of FIG. 15 when a motorcycle is perpendicular to a road; FIG. 16b is an explanatory diagrams depicting the light distribution pattern for a low beam and another auxiliary light distribution pattern that are formed by the conventional motorcycle projector headlight of the FIG. 15 when the motorcycle banks leftward with respect to the road; and

[0041] FIG. 17a is a cross-section side view showing a left cornering lamp of the conventional motorcycle projector headlight of FIG. 15, and FIG. 17b is a perspective view showing a shade of the left cornering lamp of FIG. 17a.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0042] The disclosed subject matter will now be described in detail with reference to FIG. 1 to FIG. 13. FIG. 1 is a schematic perspective view showing a first exemplary structure of a motorcycle headlight of a projector type for a low beam made in accordance with principles of the disclosed subject matter. FIG. 2 is a schematic side cross-section view showing the first structure for the motorcycle projector headlight of FIG. 1.

[0043] The motorcycle projector headlight 100 can include a principal optical formation 10 for forming a fundamental light distribution pattern for a low beam and an auxiliary optical formation 20 for forming an auxiliary light distribution pattern. In FIG. 1, a shade is not shown in order to make FIG. 1 more visible. The principal optical formation 10 can include: a light source 12; a first reflector including a revolution-ellipsoidal surface in which a first focus thereof is located near (i.e., substantially at) the light source 12; a projector lens 11 which has a focus thereof located near (i.e., substantially at) a second focus of the first reflector 13; and a shade 14 in which a top edge thereof is located near (i.e., substantially at) the

second focus of the first reflector 13.

[0044] In the principal optical formation 10, light emitted from the light source 12 can be reflected on the first reflector 13 and the reflected light Ray1 can be emitted in a forward direction of the principal optical formation 10 via the projector lens 11. In this case, a part of the light Ray1 that is reflected on the first reflector 13 can be shielded by the shade 14. Therefore, the principal optical formation 10 can form the fundamental light distribution pattern for a low beam including a horizontal cut-off line in accordance with the top edge of the shade 14 by using the light Ray1.

[0045] The auxiliary optical formation 20 can include a second reflector 21 that is located adjacent the first reflector 13, and the second reflector 21 can receive light other than the light Ray1 reflected on the first reflector 13 in the light emitted from the light source 12. In addition, the auxiliary optical formation 20 can include an optical lens 22 that is located adjacent the projector lens 11 while facing the second reflector 21.

[0046] Accordingly, light Ray2 reflected on the first reflector 13 can enter into the optical lens 22 via an incoming surface 22a and can diffuse from an outgoing surface 22b of the optical lens 22. FIG. 3a and FIG. 3b are explanatory diagrams depicting the light distribution patterns P1 for a low beam formed by the light Ray1 and the auxiliary light distribution patterns P2 formed by the light Ray2, when a motorcycle is perpendicular to a road and when the motorcycle banks rightward with respect to the road, respectively.

[0047] In the case, the auxiliary light distribution pattern P2 can include an overhead light distribution pattern P2_{OH} for illuminating a traffic sign, etc. Additionally, the auxiliary light distribution pattern P2 can include a right and left bank light distribution pattern P2_B in order to illuminate a right and left triangle dark zone between a horizontal line H-H and a right and left horizontal cut-off line that is caused when the motorcycle banks with respect to a road. FIG. 3b shows a case where the right bank light distribution pattern P2_B illuminates the right triangle dark zone A caused when the motor cycle banks rightward.

[0048] FIG. 4 is a diagram showing an exemplary auxiliary light distribution pattern formed by the motorcycle projector headlight 100 of FIG. 1. Each of the right and left bank light distribution pattern P2_B can be located between 10 degrees and 45 degrees in a rightward and leftward direction with respect to a vertical line V-V and between 1.0 degrees and 4.0 degrees in an upward direction with respect to the horizontal line H-H. Each of light intensities of the right and left bank light distribution pattern P2_B can be approximately 2Lx on a vertical screen that is vertically set at 25 meters away from the projector headlight 100.

[0049] A region other than the bank light distribution pattern P2_B in the auxiliary light distribution pattern P2 can be used as the overhead light distribution pattern P2_{OH} along with the bank light distribution pattern P2_B

for illuminating a traffic sign, etc. A maximum light intensity of the overhead light distribution pattern $P2_{OH}$ can be 1.08Lx on the vertical screen that is vertically set at 25 meters away from the projector headlight 100. Thus, the auxiliary light distribution pattern P2 can conform to ECE Regulation 113 and can provide a favorable light distribution, which does not give a glaring type light to an oncoming car, etc.

[0050] In addition, the auxiliary light distribution pattern P2 including the overhead light distribution pattern $P2_{OH}$ can illuminate various traffic signs such as a speed-limit sign and the like. Furthermore, when the motorcycle banks rightward or leftward, the right and left bank light distribution pattern $P2_B$ can illuminate the right and left triangle dark zone caused between the horizontal line H-H and the right and left horizontal cut-off line. Therefore, the motorcycle projector headlight 100 of the disclosed subject matter can provide a high level of visibility with the light distribution pattern P1 for a low beam and the auxiliary light distribution pattern P2 as shown in FIGs. 3a and 3b.

[0051] A structure of the auxiliary optical formation 20 for forming the auxiliary light distribution pattern P2 will now be described in detail. FIG. 5 is a schematic top view showing the structure of the auxiliary optical formation 20 in the motorcycle projector headlight 100 of FIG. 1. FIG. 6 is a schematic side cross-section view showing the structure of the motor cycle projector headlight 100 including the auxiliary optical formation 20.

[0052] The second reflector 21 can be configured with an ellipsoidal surface C_H having a first focus F1 and a second focus F2 in a horizontal cross-section shape, in which the focus F1 is located near (i.e., substantially at) the light source 12 and the focus F2 is located close to the outgoing surface 22b of the optical lens 22 or close to the incoming surface 22a. With respect to a vertical cross-section shape, the second reflector 21 can be configured with a parabolic surface C_V having a focus F that is located near (i.e., substantially at) the light source 12 as shown in FIG. 6.

[0053] More specifically, an ellipsoidal surface C_{HA} is located on a horizontal surface A-A that is located at the nearest position to the first reflector 13, and the ellipsoidal surface C_{HA} can have a first focus $F1_A$ and a second focus $F2_A$. An ellipsoidal surface C_{HB} is located on a horizontal surface B-B that is located at the farthest position to the first reflector 13, and the ellipsoidal surface C_{HB} can have a first focus $F1_B$ and a second focus $F2_B$. Horizontal surfaces between the ellipsoidal surfaces C_{HA} and C_{HB} can be configured with a plurality of ellipsoidal surfaces having the first focus F1 and the second focus F2, and the horizontal surfaces can be connected by the parabolic surface C_V having the focus F in the vertical direction of the second reflector 21.

[0054] In this case, the light Ray 2 reflected on the second reflector 21 can move between the horizontal surfaces A-A and B-B in parallel with the horizontal surface A-A toward the optical lens 22, and can enter into the

optical lens 22 from the incoming surface 22a so as to gather at the second focus F2 of the second reflector 21. Because the second focus F2 of the second reflector 21 is located close to the outgoing surface 22b, the light Ray 2 can enter into the optical lens 22 with confidence even when the optical lens 22 is downsized.

[0055] Moreover, because the optical lens 22 can be downsized, an incoming surface of the projector lens 11 can be enlarged in comparison with the incoming surface 22a of the optical lens 22. Therefore, the principal optical formation 10 can provide a favorable light distribution pattern for a low beam with a high brightness because the incoming surface of the projector lens 11 can be enlarged to form the light distribution pattern P1 with a high brightness.

[0056] FIGs. 7a, 7b and 7c are top, front and side views showing the projector lens 11 and the optical lens 22, respectively. FIG. 8 is a perspective close-up view showing the optical lens 22. The optical lens 22 can be integrated as one body with the projector lens 11 in a range of a width W and a height H. The integration with projector lens 11 can result in preventing from a reduction of a fixing error in regard to the optical lens 22 and also can result in a reduction of a manufacturing process of the projector headlight 100.

[0057] The optical lens 22 can include: the incoming surface 22a receiving the light Ray 2 that is reflected on the second reflector 21; the outgoing surface 22b emitting the light Ray 2 as a diffusing light; a right and left joint portion 22b3 being provided between the optical lens 22 and the projector lens 11 to cast the optical lens 22 along with the projector lens 11; an optical axis AX; a central vertical line $22b_{CV}$ intersecting with the optical axis AX at a right angle in a vertical direction of the optical axis AX; a central horizontal line $22b_{CH}$ intersecting with the optical axis AX at a right angle in a horizontal direction of the optical axis AX; and a horizontal bottom surface 22C.

[0058] The height H of the optical lens 22 can be between 6 and 10 mil-meters in view of the auxiliary light distribution pattern P2 shown in FIG. 4. The incoming surface 22a can be formed on a vertical co-planar extension of the incoming surface of the projector lens 11 so that the light Ray2 reflected on the second reflector 21 can become approximately perpendicular to the incoming surface of the optical lens 22. However, the incoming surface 22a can be formed in a shape other than the vertical planar such as a convex surface, etc.

[0059] FIG. 9 is an explanatory diagram including a top cross-section view taken along the central horizontal line $22b_{CH}$ of the optical lens 22, which shows the auxiliary light distribution pattern P2 formed by diffusing the light Ray2 reflected on the second reflector 21 in a rightward and leftward direction by using the optical lens 22. FIGs. 10a and 10b are explanatory side cross-section views taken along the central vertical line $22b_{CV}$, which shows diffusing states in an upward and downward direction of the light Ray2 reflected on second reflector 21

by the optical lenses 22 when each shape of outgoing surfaces 22b of the optical lenses 22 are circular and ellipsoidal in a vertical cross-section shape, respectively.

[0060] The outgoing surface 22b of the optical lens 22 can be bilaterally symmetric with respect to the central vertical line 22b_{CV} in the horizontal cross-section shape. The outgoing surface 22b can include a central portion 22b1 located near the central vertical line 22b_{CV} and a right and left side portion 22b2 that is located from the central vertical line 22b_{CV} toward the right and left joint portion 22b3 in the horizontal cross-section shape as shown in FIG. 9.

[0061] The central portion 22b1 can be formed in a parabolic shape in the horizontal cross-section shape, and the right and left side portion 22b2 can be formed in an ellipsoidal shape in the horizontal cross-section shape. Accordingly, a part of the light Ray2 that passes through the central portion 22b1 can form the overhead light distribution pattern P2_{OH} formed between the right and left bank light distribution pattern P2_B. Another part of the light Ray that passes through the right and left side portion 22b2 can form the right and left bank light distribution pattern P2a of the auxiliary light distribution pattern P2 as shown in FIG. 9.

[0062] A vertical cross-section shape of the outgoing surface 22b can be formed in a circular arc shape or in an ellipsoidal shape as shown in FIG. 10a and FIG. 10b. In the case, the horizontal bottom surface 22c of the outgoing surface 22b of the optical lens 22 can intersect with a center C of the circle or the ellipsoidal in the vertical cross-section shape, and thereby can form a bottom horizontal line of the auxiliary light distribution pattern P2 with a simple structure.

[0063] The basic shape of the optical lens 22 is described above. A more specific shape of the outgoing surface 22b of the optical lens 22 can be determined in accordance with a shape of the incoming surface 22a of the optical lens 22a, a shape of the second reflector 21, a positional relation between the projector lens 11 and the optical lens 22 and the like. The positional relation between the projector lens 11 and the optical lens 22 will now be described with reference to FIGs. 7a-7c and FIG. 3a.

[0064] An optical axis PX of the projector lens 11 including the focus of projector lens 11 can be located on an imaginary line connecting the first focus and second focus of the first reflector 13. In addition, the top edge of the shade 14 and the focus of the projector lens 11 can be located near (i.e., substantially at) the second focus of the first reflector 13 located on the imaginary line including the optical axis PX of the projector lens 11. Accordingly, the light distribution pattern P1 for a low beam can be formed below the horizontal line H-H as shown in FIG. 3a. In the case, the optical axis PX of the projector lens 11 can be projected close to an intersection of the horizontal line H-H and the vertical line V-V.

[0065] On the other hand, the central vertical line 22b_{CV} of the optical lens 22 including the optical axis AX

of the optical lens 22 can be projected on the vertical line V-V in the auxiliary light distribution pattern P2 in FIG. 3a. Therefore, the optical axis AX of the optical lens 22 can be located a virtual vertical surface including the optical axis PX of the projector lens 11 as shown in FIG. 7a-7c. Thereby, the auxiliary light distribution pattern P2 emitted from the optical lens 22 can easily match the light distribution pattern P1 for a low beam emitted from the projector 11, especially in the horizontal direction.

[0066] Additionally, the optical axis AX of the optical lens 22 can be located in parallel with the optical axis PX of the projector lens 11. Thereby, the auxiliary light distribution pattern P2 including the right and left bank light distribution pattern P2_B and the overhead light distribution pattern P2_{OH} can easily conform to a light distribution standard for headlights with a simple structure while matching the light distribution pattern P1 for a low beam emitted from the projector 11, especially in the vertical direction.

[0067] According to the above-described first structure, the motorcycle projector headlight 100 can form the fundamental light distribution pattern P1 for a low beam below the horizontal line and the auxiliary light distribution pattern P2 over the horizontal line. The auxiliary light distribution pattern P2 can include the overhead light distribution pattern P2_{OH} for illuminating a traffic sign and the like and also can include the right and left bank light distribution pattern P2_B for illuminating the right and left triangle dark zone caused between the horizontal line and the horizontal cut-off line of the light distribution pattern P1 when a motorcycle banks rightward or leftward.

[0068] In addition, the motorcycle projector headlight 100 does not need the additional lamps like the conventional projector headlight to illuminate the auxiliary light distribution pattern P1. Furthermore, the maximum light intensity of the auxiliary light distribution pattern P2 can conform to ECE Regulation 113. Thus, the motorcycle projector headlight 100 can provide a favorable light distribution with a simple structure, which includes the fundamental light distribution pattern P1 for a low beam and the auxiliary light distribution pattern P2.

[0069] The above-described optical lens 22 is integrated as one body with the projector lens 11. However, the optical lens 22 can be separated from the projector lens 11 as shown in FIG. 11. In the case, the optical axis AX of the optical lens 22 can be located on the virtual vertical surface including the optical axis PX of the projector lens 11 so that the auxiliary light distribution pattern P2 can easily match the light distribution pattern P1 for a low beam in the horizontal direction.

[0070] Moreover, the optical lens 22 can be adjusted in the vertical direction so that the auxiliary light distribution pattern P2 can match the light distribution pattern P1 in the vertical direction. Therefore, the auxiliary light distribution pattern P2 can conform to a light distribution standard for headlights with confidence while preventing from giving a glaring type light to an oncoming car, etc.

[0071] FIG. 12 is a schematic side cross-section view

showing an exemplary variation of the motorcycle projector headlight shown in FIG. 2. In the first structure shown in FIG. 1 and FIG. 2, the second reflector 21 is located in the upward direction of the first reflector 13, and also the optical lens 22 is integrally located on a top surface of the projector lens 11. However, the optical lens 22 cannot be limited to the above-described position.

[0072] For example, the second reflector 21 can be located in a downward direction of the first reflector 13, and the optical lens 22 can also be located underneath a bottom surface of the projector lens 11 so as to face the second reflector 21. In this case, an opening portion 14a can be located in the shade 14 so that the light Ray2 reflected on the second reflector 21 can easily enter into the optical lens 22. The above-described position of the optical lens 22 can result in a shapely motorcycle projector headlight because the optical lens 22 can be located under the projector lens 11.

[0073] FIG. 13 is a schematic side cross-section view showing a second exemplary structure of the motorcycle projector headlight for a low beam made in accordance with principles of the disclosed subject matter. A difference between the second structure shown in FIG. 13 and the first structure shown in FIG. 1 relates to the light source 12. As the light source 12 of the first structure shown in FIG. 1, a halogen bulb, an incandescent lamp, a high-intensity discharge lamp and the like can be used for the motorcycle projector headlight 100.

[0074] An LED light source 12a can be used as the light source 12 for the second structure of the motorcycle projector headlight 100. The motorcycle projector headlight 100 can include: the shade 14 having a top edge; a circuit board 12b having a mounting surface and a virtual co-planar extension of the mounting surface intersecting with the top edge of the shade 14; the LED light source 12a mounted on the mounting surface of the circuit board 12b and having an optical axis OX extending substantially perpendicular to the mounting surface of the circuit board 12b; and the first reflector 13 configured with an ellipsoidal surface having a first focus and a second focus, the first focus located near (i.e., substantially as) the LED light source 12a so that the optical axis OX of the LED light source intersects with the first reflector, and the second focus located near (i.e., substantially at) the top edge of the shade 14.

[0075] Additionally, the motorcycle projector headlight 100 can also the projector lens 11 configured as a convex lens having the optical axis PX and the focus located on the optical axis PX, the optical axis PX of the projector lens 11 intersecting with the second focus of the first reflector at the focus of the projector lens 11 and intersecting with the optical axis OX of the LED light source 12a and the virtual co-planar extension of the mounting surface of the circuit board 12b so that the circuit board 12b slants toward the first reflector 13 with respect to the optical axis PX of the projector lens 11. Moreover, the motorcycle projector headlight 100 can include the same second reflector 21 and the same optical lens 22 as these

of the first structure shown in FIG. 1.

[0076] In this case, the LED light source 12a can become small in size and also can reduce power consumption with compared to the light source 12 such as the high-intensity discharge lamp, etc. Furthermore, because light emitted from the LED light source 12a can be reflected as the lights Ray1 and Ray2 on the first and the second reflectors 13 and 21 without directly facing the shade 14, the motorcycle projector headlight 100 can improve the light use efficiency. Thus, the second structure of the disclosed subject matter can provide a small projector headlight that can perform a favorable light distribution pattern with a high efficiency and low power consumption.

[0077] Various modifications of the above disclosed embodiments can be made without departing from the spirit and scope of the presently disclosed subject matter. For example, the above-described incoming surface 22a of the optical lens 22 may not be limited to the vertical flat shape. Instead, various shapes such as a slanted planar surface, an ellipsoidal surface, a parabolic surface and the like can be used as the incoming surface 22a of the optical lens 22.

[0078] While there has been described what are at present considered to be exemplary embodiments of the invention, it will be understood that various modifications may be made thereto, and it is intended that the appended claims cover such modifications as fall within the true spirit and scope of the invention. All conventional art references described above are herein incorporated in their entirety by reference.

Claims

1. A motorcycle projector headlight, comprising:

a light source;
a first reflector configured with an ellipsoidal surface having a first focus and a second focus, and the first focus located at the light source;
a projector lens configured as a convex lens having an optical axis and a focus located on the optical axis, the optical axis being located on an imaginary line connecting the first focus and the second focus of the first reflector, and the focus of the projector lens being located at the second focus of the first reflector;
a shade having a top edge located at the second focus of the first reflector;
a second reflector located adjacent the first reflector so as to receive a part of light emitted from the light source, the second reflector configured with an ellipsoidal surface having a first focus and a second focus in a horizontal cross-section shape and configured with a parabolic surface having a focus in a vertical cross-section shape, the first focus of the horizontal ellipsoidal

surface of the second reflector and the focus of the vertical parabolic surface of the second reflector being located at the light source, and the first focus and the second focus of the horizontal ellipsoidal surface and the focus of the vertical parabolic surface of the second reflector being located on a virtual vertical surface including the optical axis of the projector lens; and
 an optical lens having an incoming surface, an outgoing surface and an optical axis, the optical lens located adjacent the projector lens so that the incoming surface of the optical lens faces the second reflector, the optical axis of the optical lens being located on the virtual vertical surface including the optical axis of the projector lens, the outgoing surface of the optical lens being bilaterally symmetric in the horizontal cross-section shape with respect to the virtual vertical surface including the optical axis of the optical lens and being formed in an ellipsoidal shape or a circular arc shape in the vertical cross-section shape, wherein the second focus of the horizontal ellipsoidal surface of the second reflector is located close to the outgoing surface of the optical lens or the incoming surface of the optical lens.

2. A motorcycle projector headlight, comprising:

a shade having a top edge;
 a circuit board having a mounting surface and a virtual co-planar extension of the mounting surface intersecting with the top edge of the shade;
 an LED light source mounted on the mounting surface of the circuit board and having an optical axis extending perpendicular to the mounting surface of the circuit board;
 a first reflector configured with an ellipsoidal surface having a first focus and a second focus, the first focus located at the LED light source so that the optical axis of the LED light source intersects with the first reflector, and the second focus located at the top edge of the shade;
 a projector lens configured as a convex lens having an optical axis and a focus located on the optical axis, the optical axis of the projector lens intersecting with the second focus of the first reflector at the focus of the projector lens and intersecting with the optical axis of the LED light source and the virtual co-planar extension of the mounting surface of the circuit board so that the circuit board slants toward the first reflector with respect to the optical axis of the projector lens;
 a second reflector located adjacent the first reflector so as to receive a part of light emitted from the LED light source, the second reflector configured with an ellipsoidal surface having a first focus and a second focus in a horizontal

cross-section shape and configured with a parabolic surface having a focus in a vertical cross-section shape, the first focus of the horizontal ellipsoidal surface of the second reflector and the focus of the vertical parabolic surface of the second reflector being located at the LED light source, and the first focus and the second focus of the horizontal ellipsoidal surface of the second reflector and the focus of the vertical parabolic surface of the second reflector located on a virtual vertical surface including the optical axis of the projector lens; and
 an optical lens having an incoming surface, an outgoing surface and an optical axis, the optical lens located adjacent the projector lens so that the incoming surface of the optical lens faces the second reflector, the optical axis of the optical lens being located on the virtual vertical surface including the optical axis of the projector lens, the outgoing surface of the optical lens being bilaterally symmetric in the horizontal cross-section shape with respect to the virtual vertical surface including the optical axis of the optical lens and being formed in an ellipsoidal shape or a circular arc shape in the vertical cross-section shape, wherein the second focus of the horizontal ellipsoidal surface of the second reflector is located close to the outgoing surface of the optical lens or the incoming surface of the optical lens.

3. The motorcycle projector headlight according to claim 1, wherein the projector lens forms a light distribution pattern for a low beam below a horizontal line by using light reflected on the first reflector, and the optical lens forms an auxiliary light distribution pattern below an upward direction of 4 degrees with respect to the horizontal line by using light reflected on the second reflector.
4. The motorcycle projector headlight according to claim 2, wherein the projector lens forms a light distribution pattern for a low beam below a horizontal line by using light reflected on the first reflector, and the optical lens forms an auxiliary light distribution pattern below an upward direction of 4 degrees with respect to the horizontal line by using light reflected on the second reflector.
5. The motorcycle projector headlight according to claim 3, wherein a maximum lighting intensity of the auxiliary light distribution pattern between a rightward and leftward direction of 10 degrees with respect to a vertical line is 1.08luxes on a vertical screen that is vertically set at 25 meters away from the motorcycle projector headlight.
6. The motorcycle projector headlight according to

claim 4, wherein a maximum lighting intensity of the auxiliary light distribution pattern between a rightward and leftward direction of 10 degrees with respect to a vertical line is 1.08luxes on a vertical screen that is vertically set at 25 meters away from the motorcycle projector headlight. 5

7. The motorcycle projector headlight according to claim 1, wherein the optical lens is integrated as one body with the projector lens, and the incoming surface of the optical lens and an incoming surface of the projector lens are formed as a co-planar surface. 10
8. The motorcycle projector headlight according to claim 2, wherein the optical lens is integrated as one body with the projector lens, and the incoming surface of the optical lens and an incoming surface of the projector lens are formed as a co-planar surface. 15
9. The motorcycle projector headlight according to claim 1, wherein the optical axis of the projector lens and the optical axis of the optical lens are parallel with respect to each other. 20
10. The motorcycle projector headlight according to claim 1, the outgoing surface of the optical lens includes symmetric ellipsoidal surfaces on both sides of the outgoing surface in the horizontal cross-section surface. 25

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FIG. 1

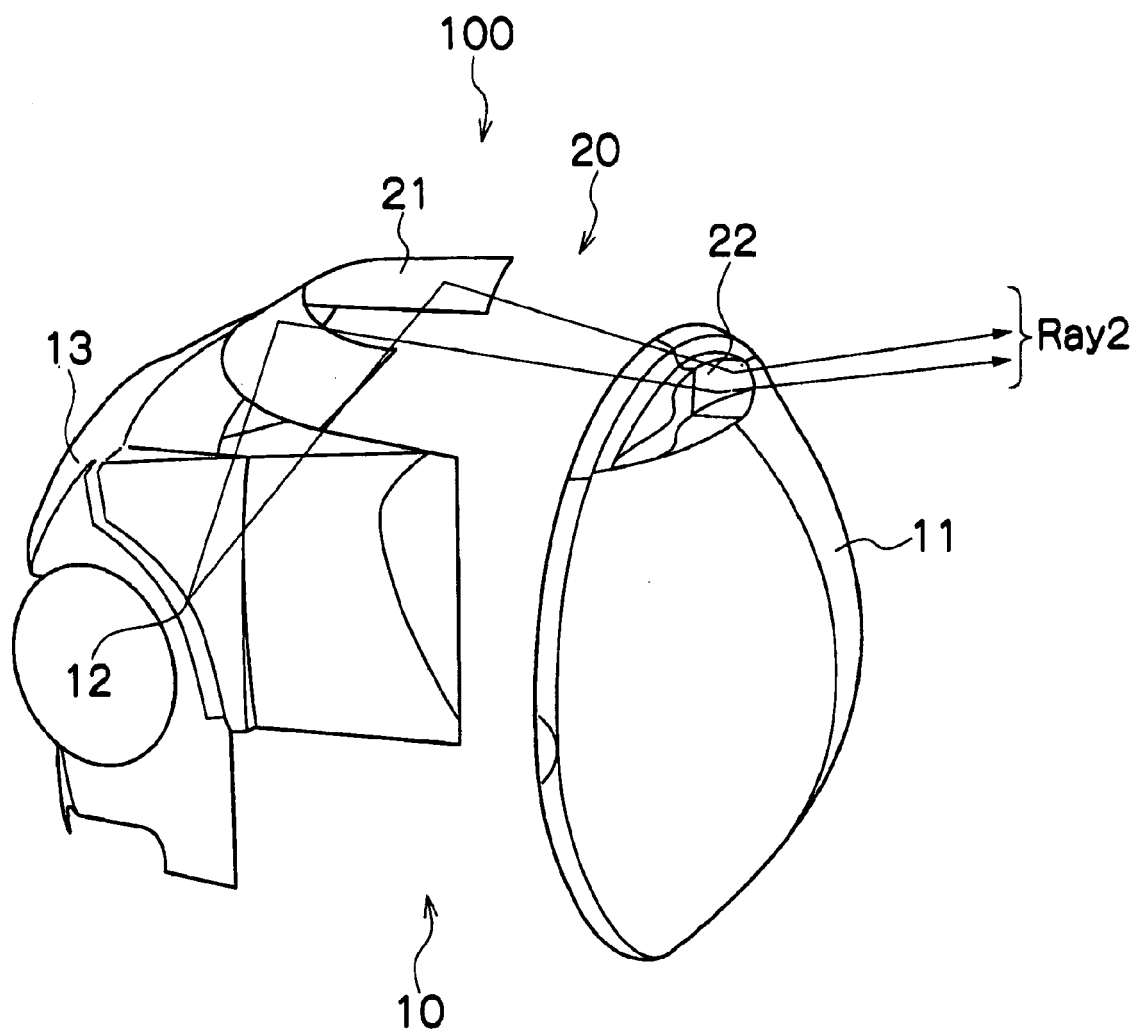


FIG. 2

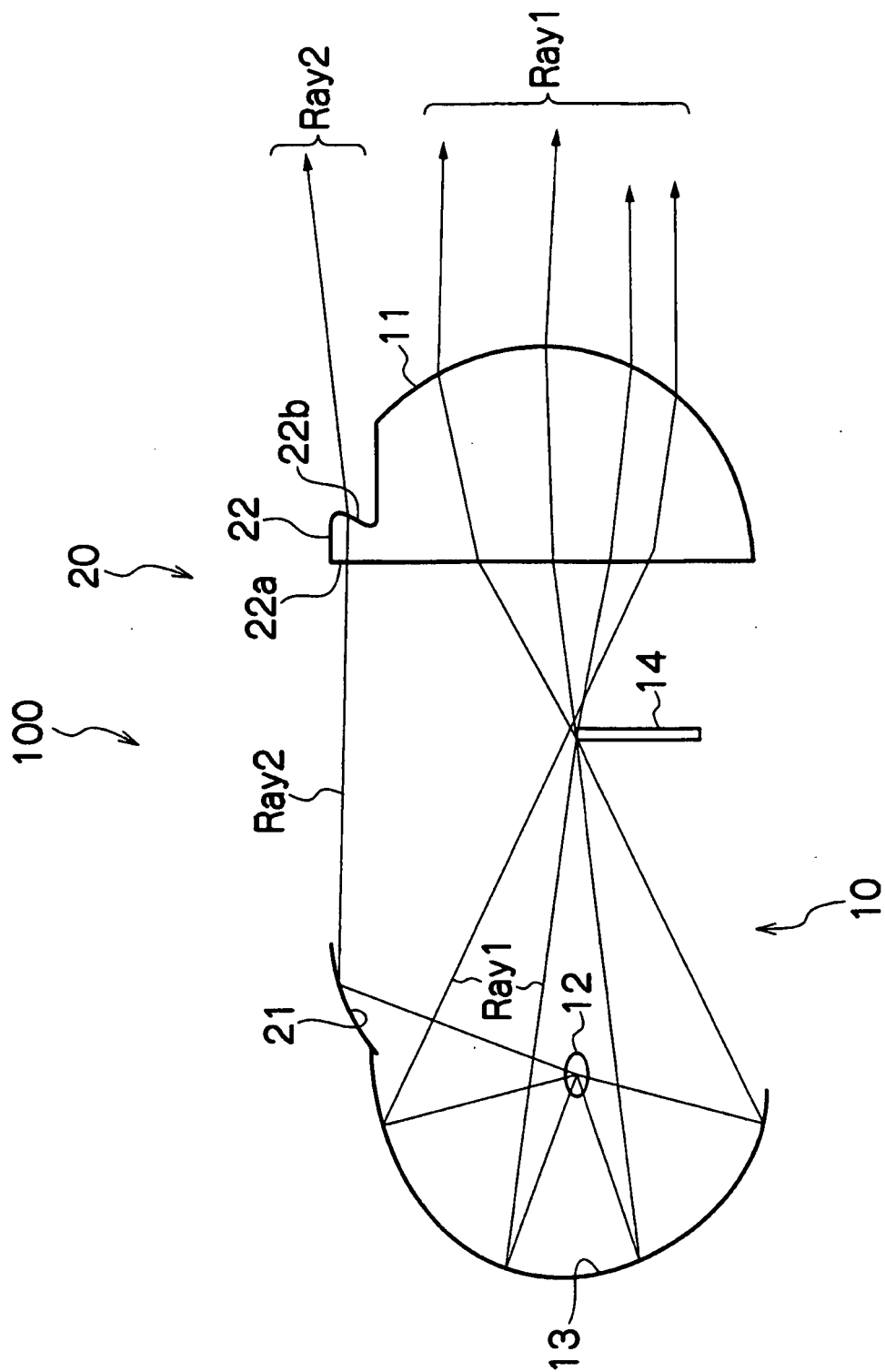


FIG. 3a

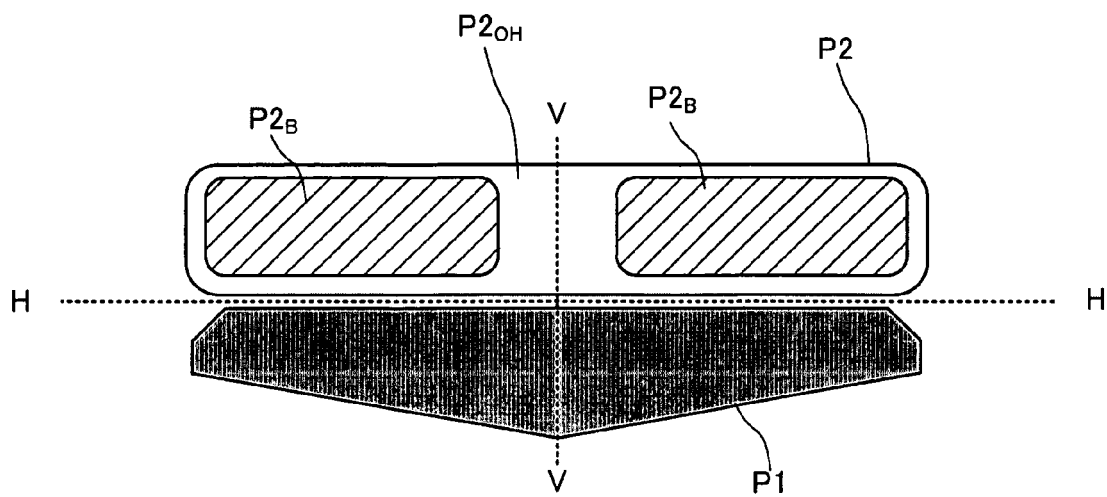


FIG. 3b

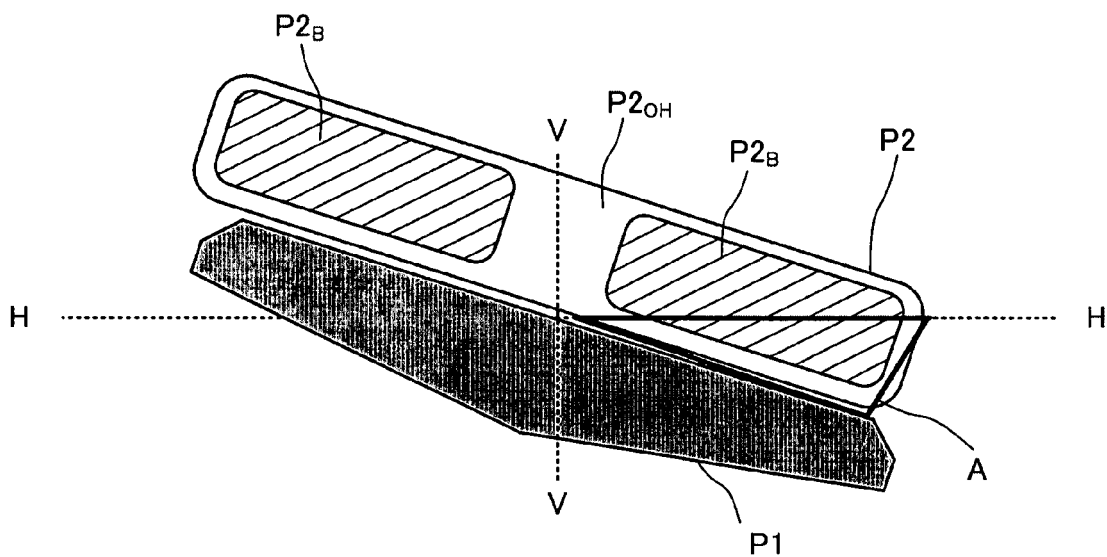


FIG. 4

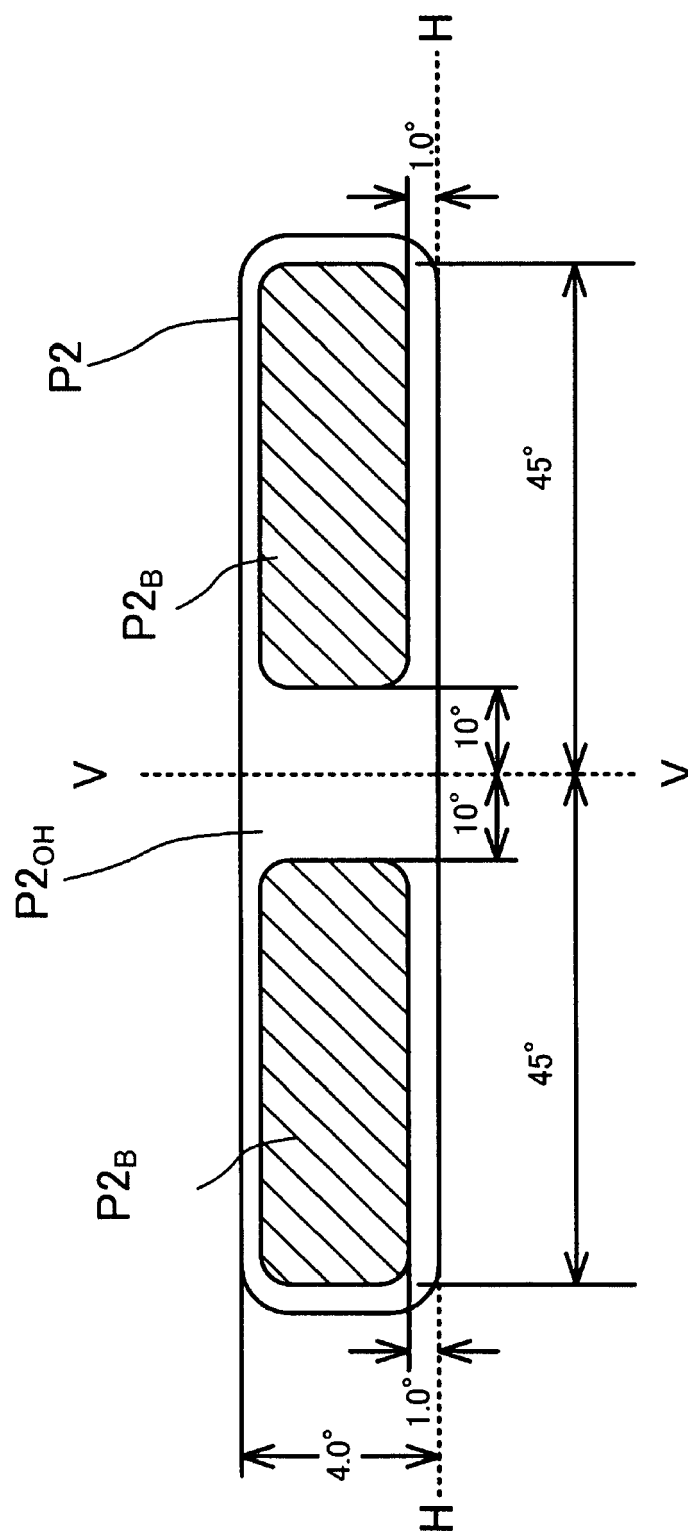


FIG. 5

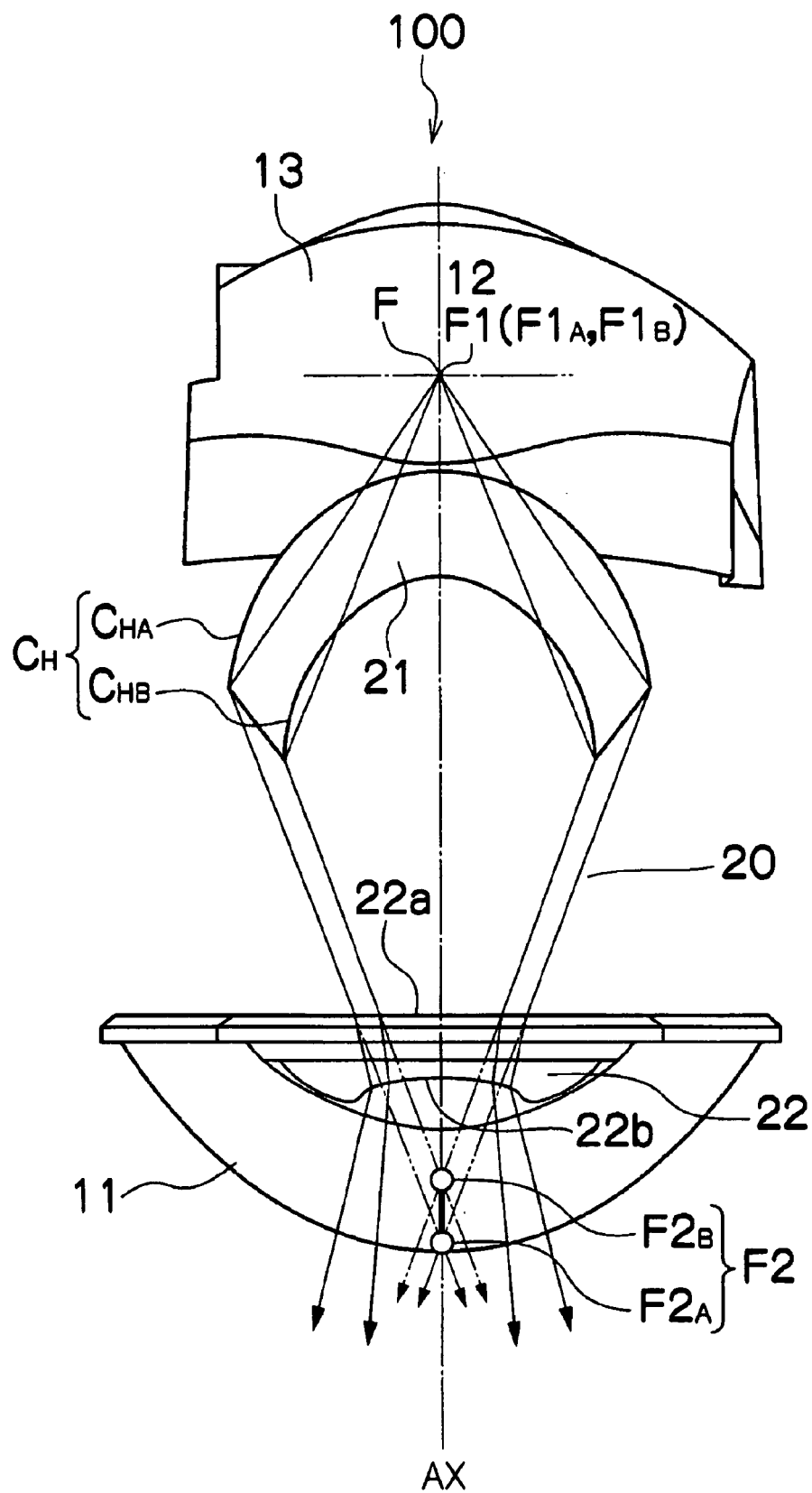


FIG. 6

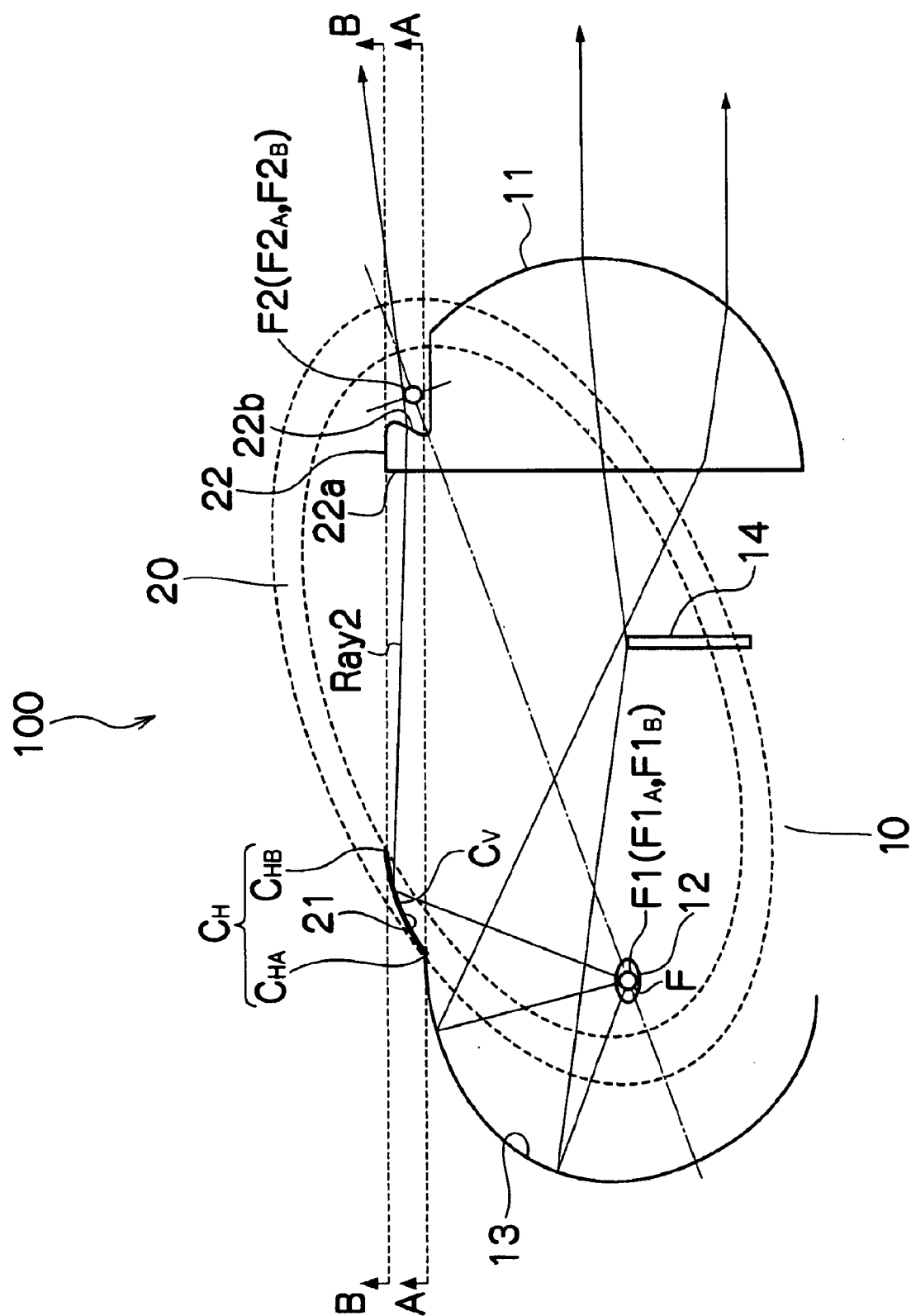


FIG. 7a

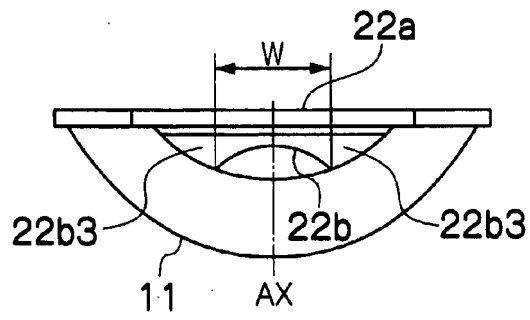


FIG. 7b

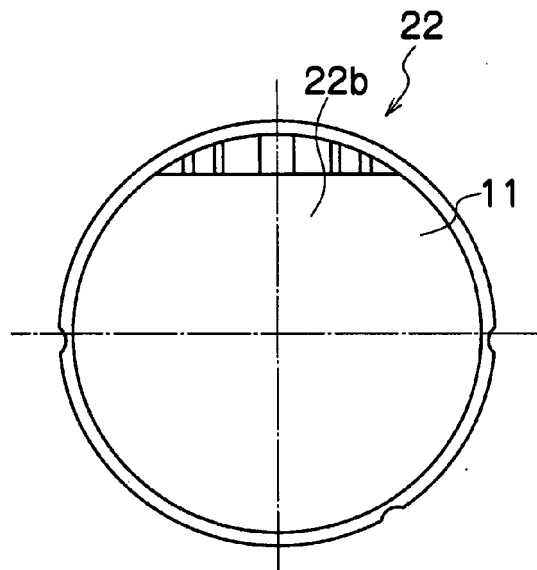


FIG. 7c

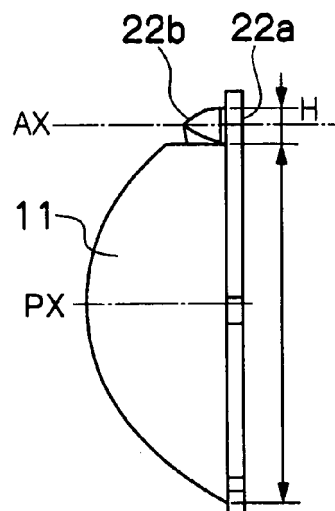


FIG. 8

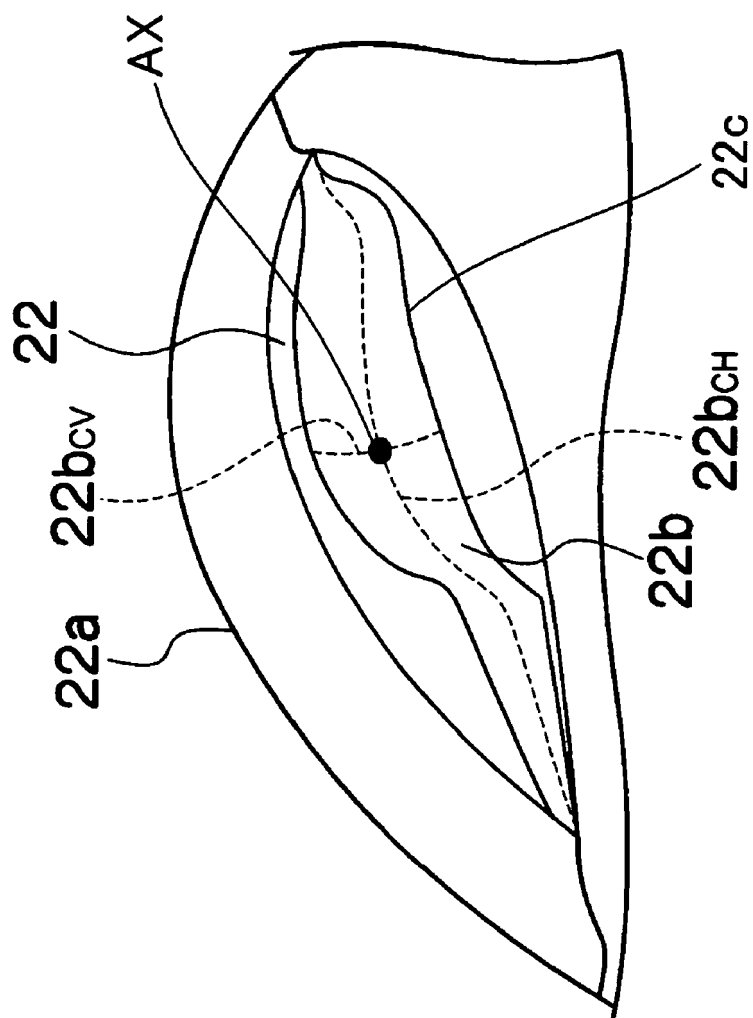


FIG. 9

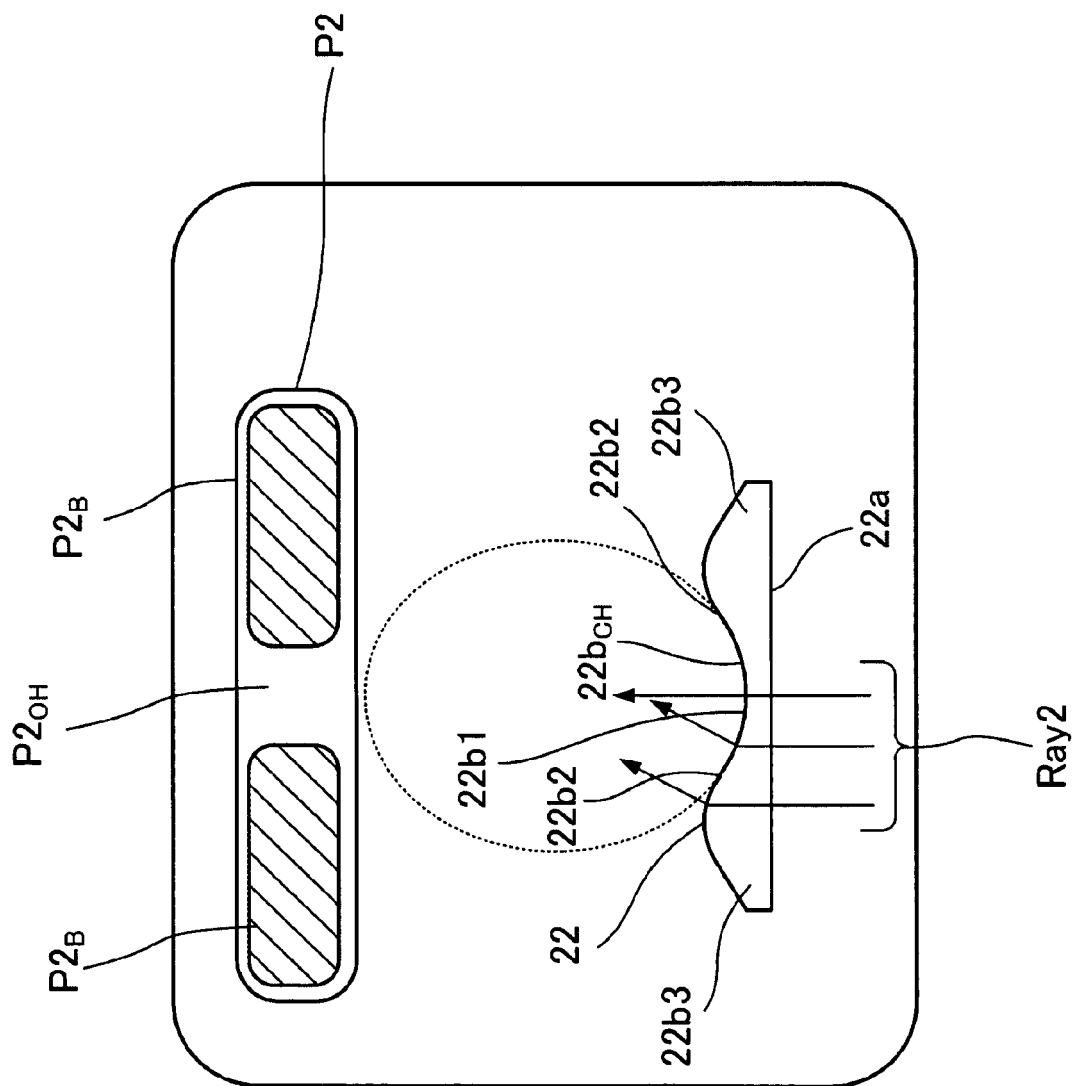


FIG. 10a

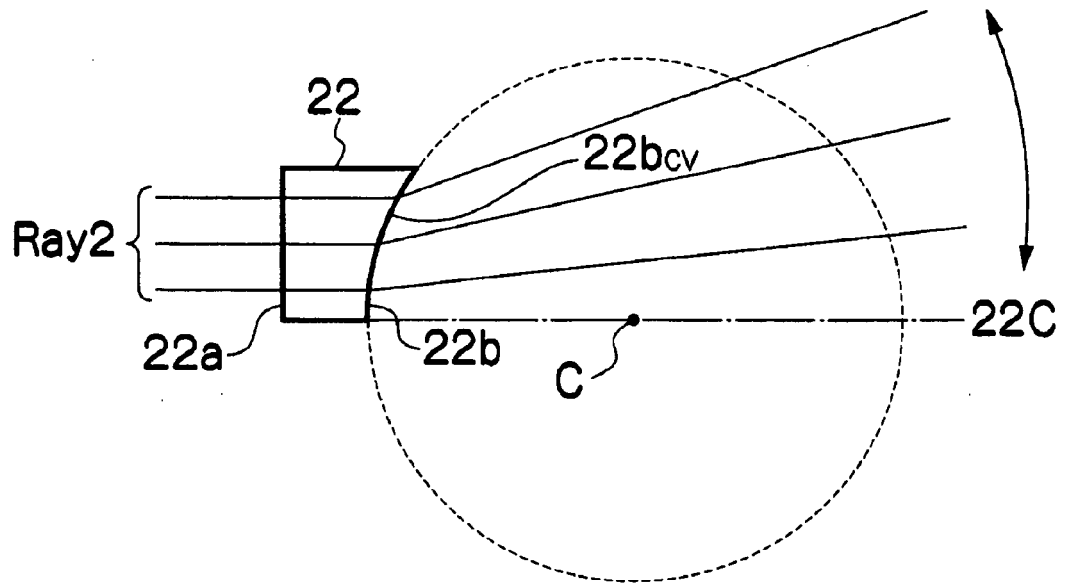


FIG. 10b

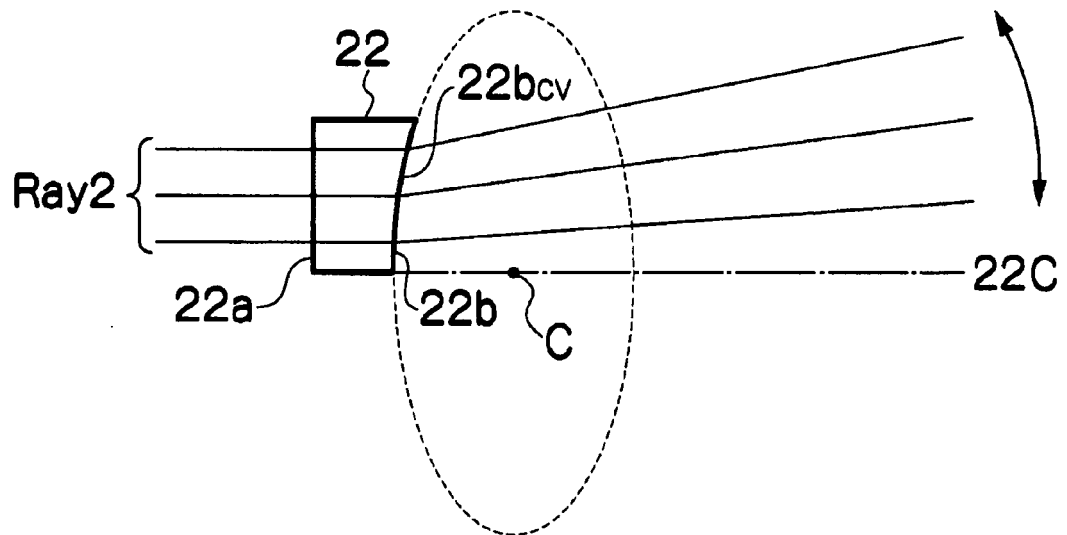


FIG. 11

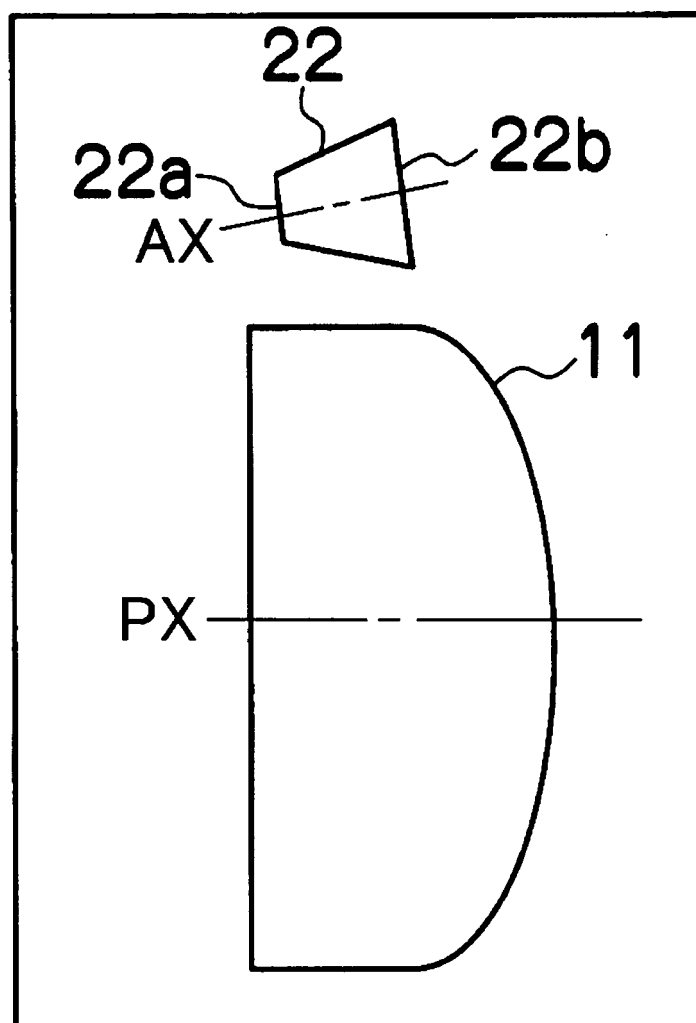


FIG. 12

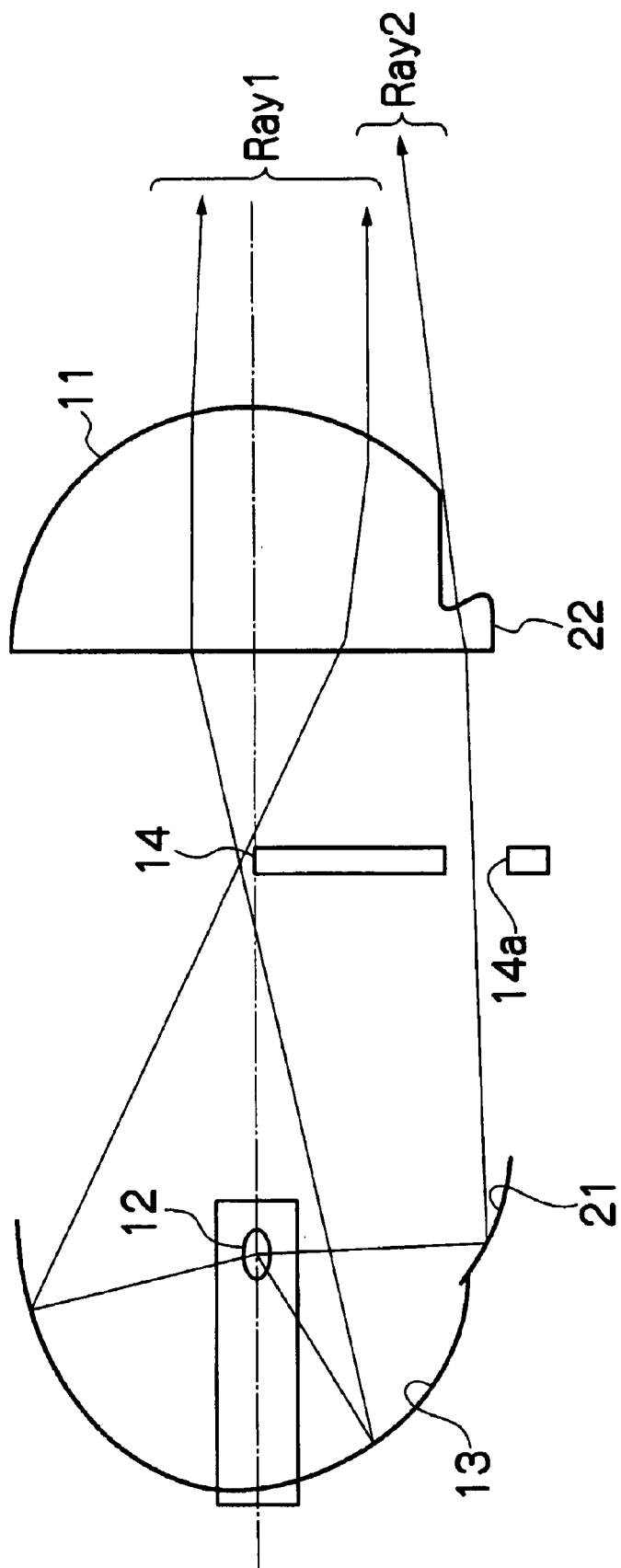


FIG. 13

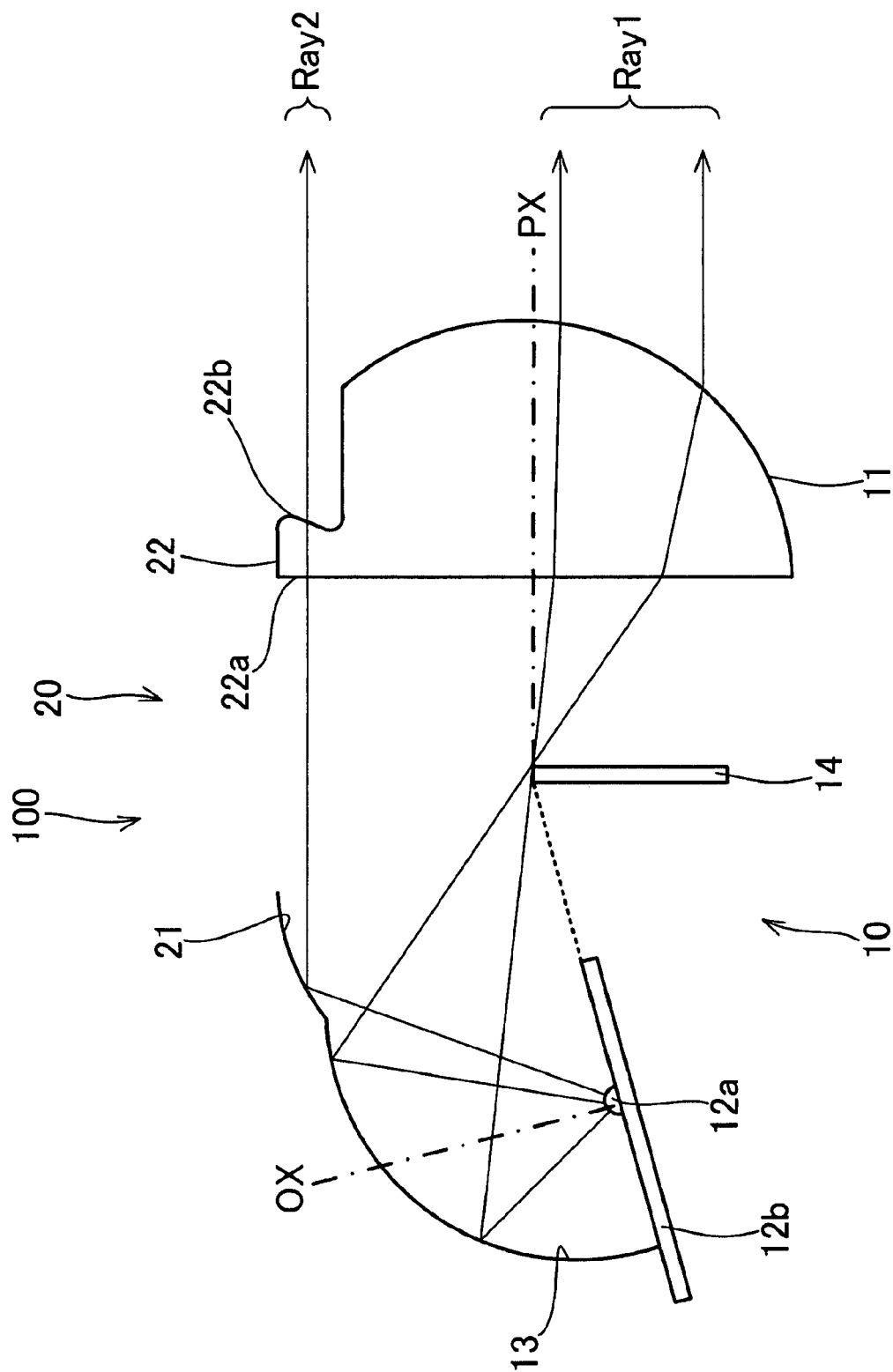


FIG. 14a Conventional Art

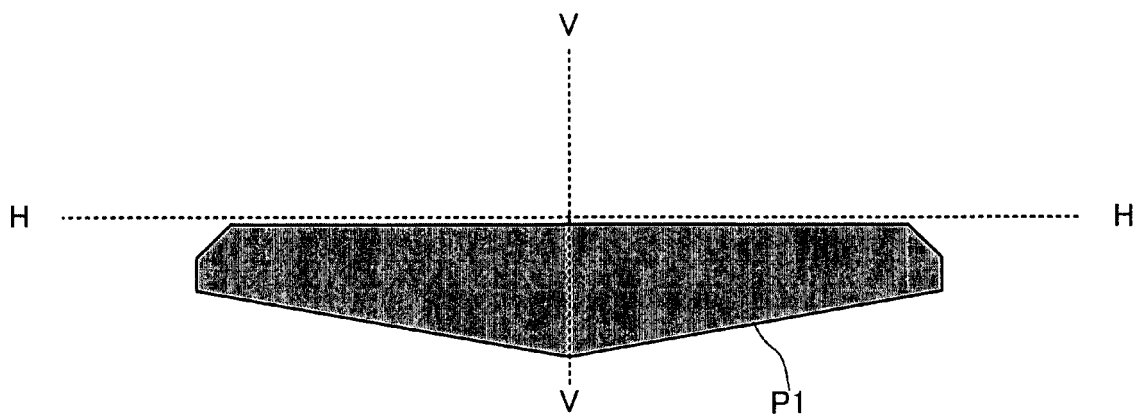


FIG. 14b Conventional Art

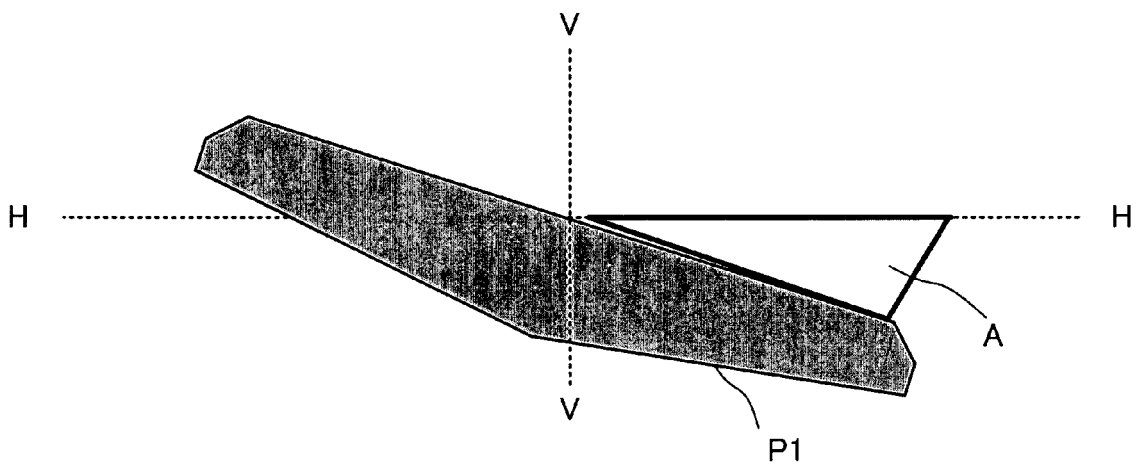


FIG. 15 Conventional Art

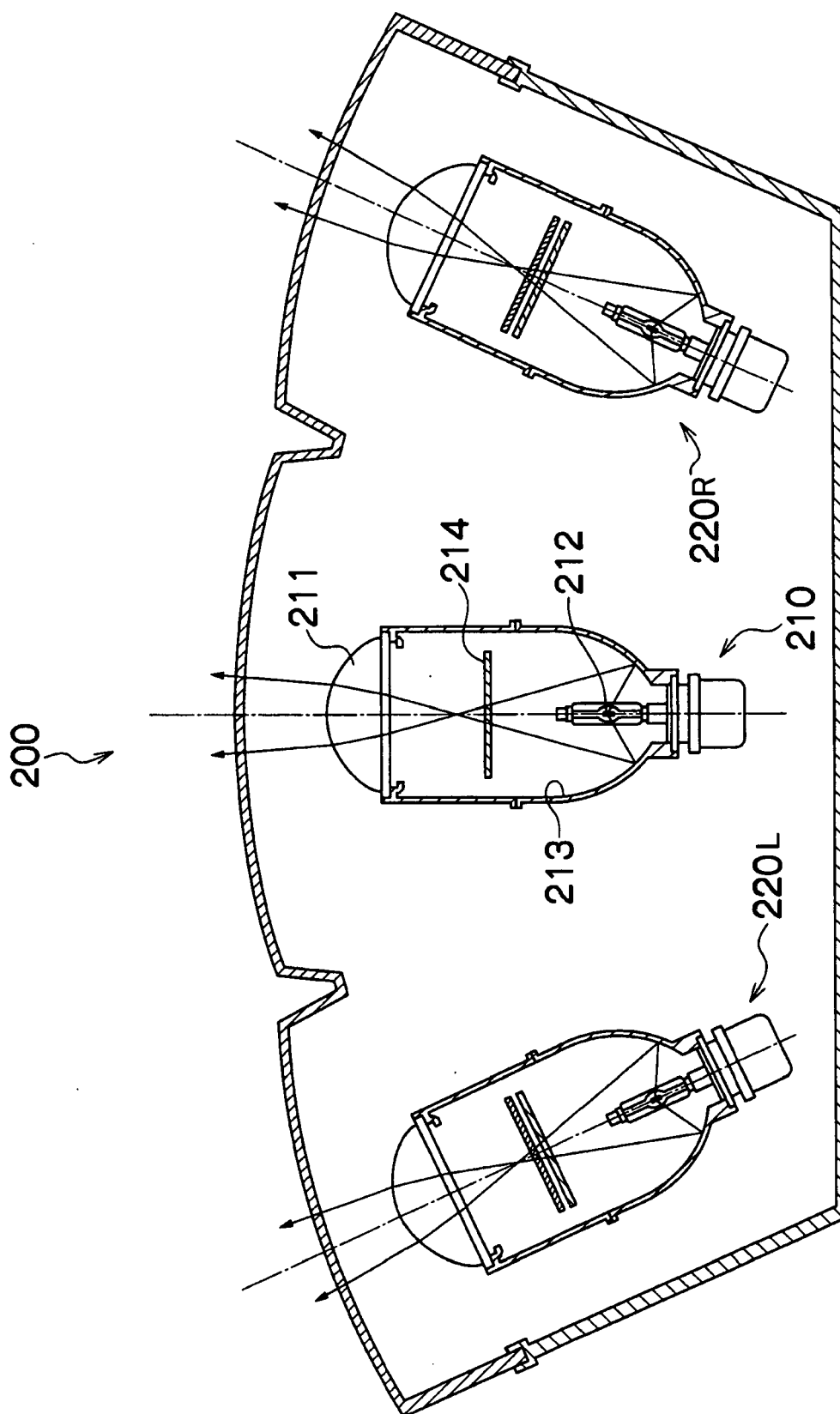


FIG. 16a Conventional Art

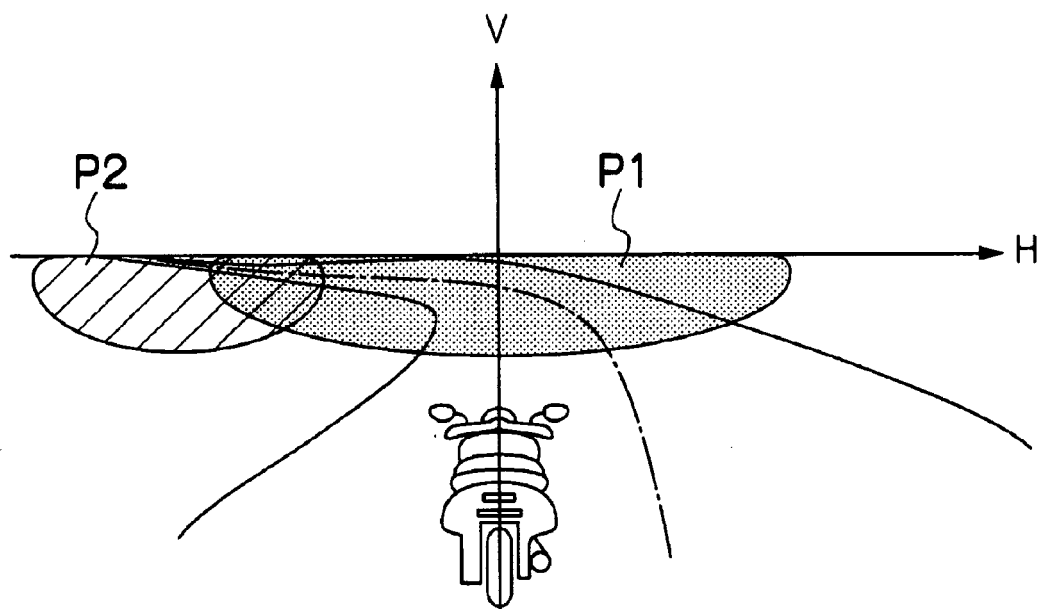


FIG. 16b Conventional Art

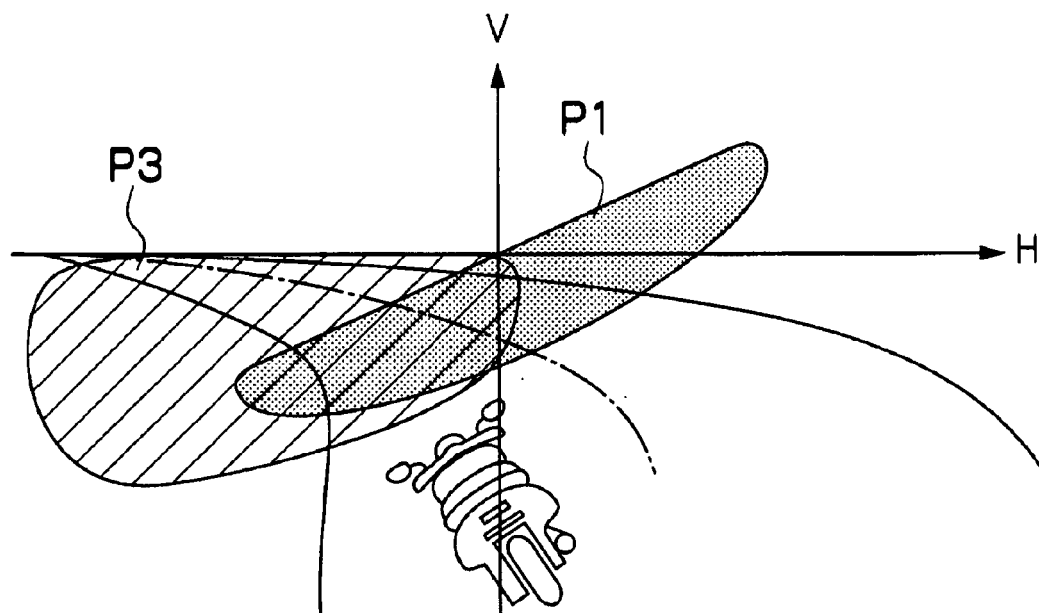


FIG. 17a

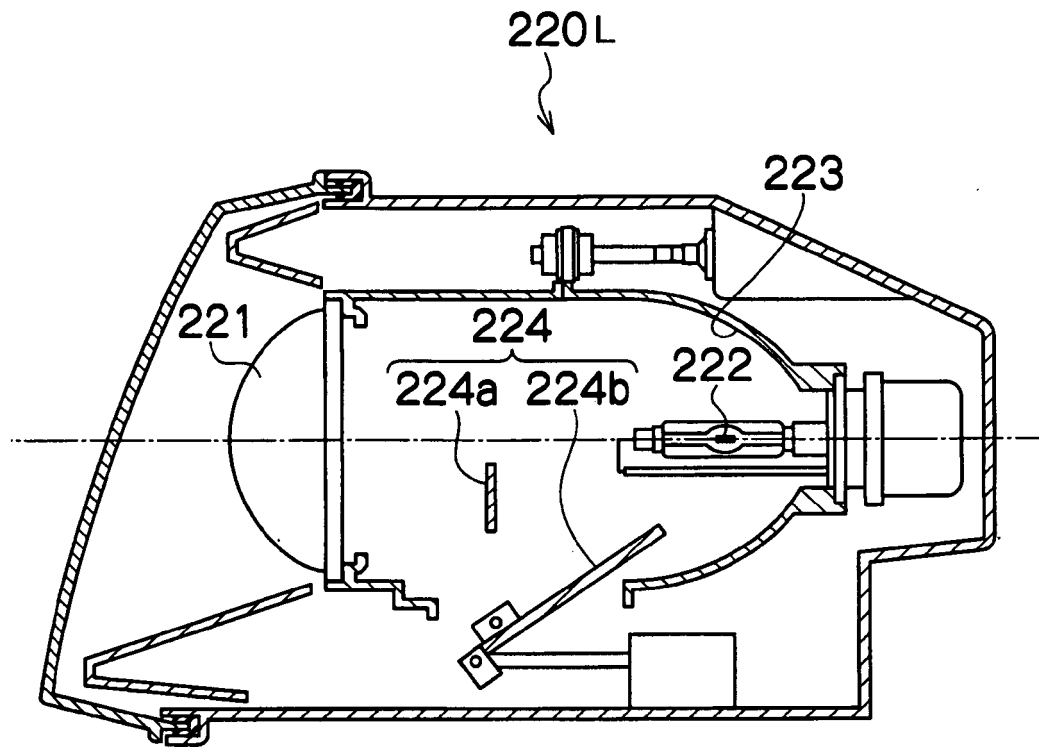
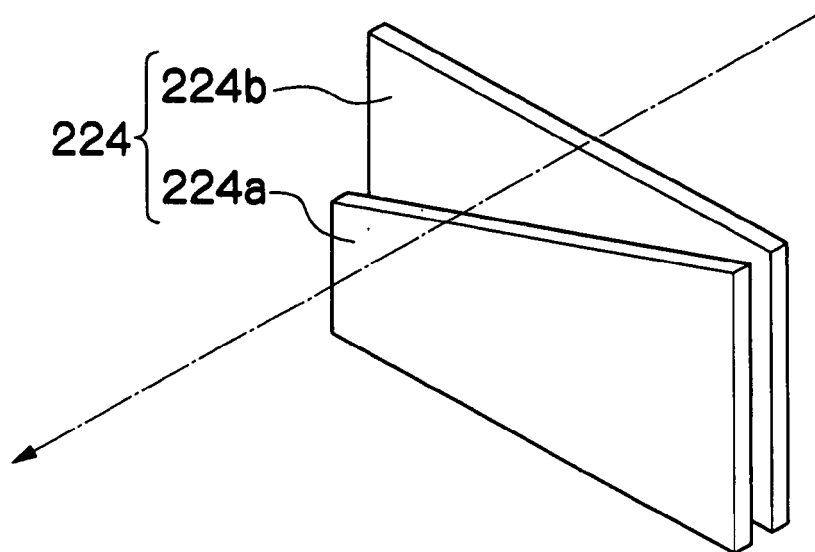


FIG. 17b



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2008001306 A [0004] [0013]
- JP 2009199938 A [0013]