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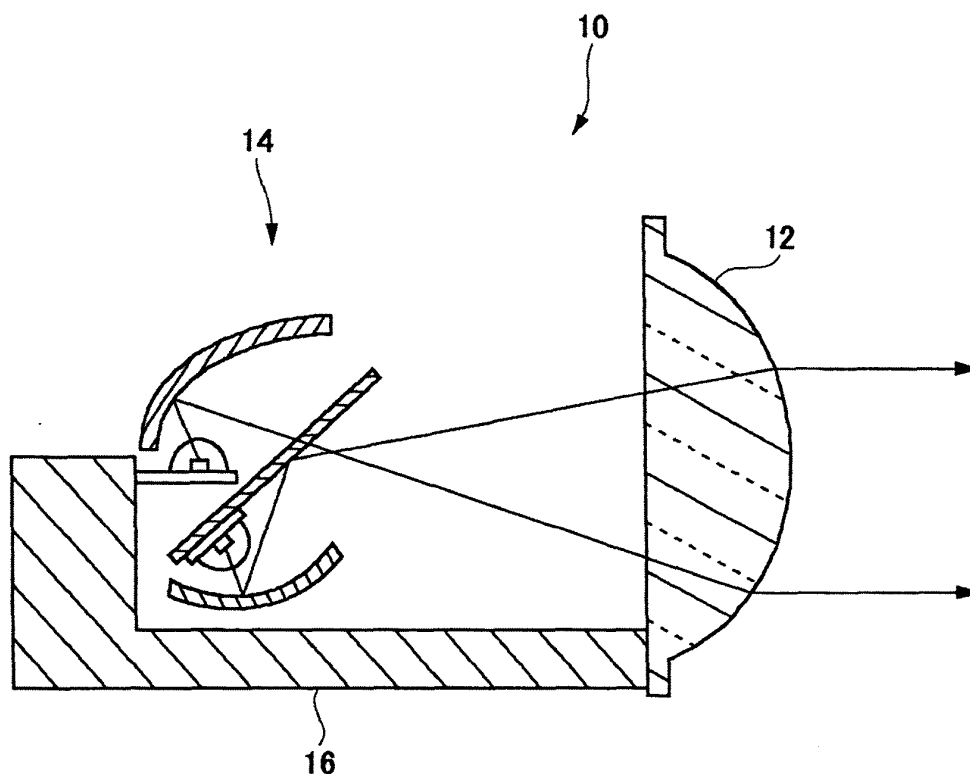
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(54) **Lighting unit**

(57) A lighting unit includes a projection lens, a first image forming section for forming a first projected image on a rear focal plane of the projection lens, and a second image forming section for forming a second projected image on the rear focal plane of the projection lens. The first image forming section includes a first light source

and a shading member for intercepting a part of a light emitted from the first light source to form the first projected image. The second image forming section includes a second light source and a reflecting surface for reflecting a light emitted from the second light source to form the second projected image.

FIG. 1



Description

TECHNICAL FIELD

[0001] The present invention relates to a lighting unit.

BACKGROUND ART

[0002] At night, a car is usually caused to run by irradiating a low beam to illuminate a road surface, and irradiating a high beam to make sure of a forward part if necessary. When a light is irradiated in an upward direction from a so-called cutoff line, however, there is a possibility that a glare might be given to a driver of a forward running car or a pedestrian in a forward part of a vehicle. For this reason, for example, there has been proposed a headlight for a vehicle which determines a position of a person and forms, on an image forming device, a mask having a dimension and a position corresponding to the person, thereby forming a shadow projected around the person (for instance, see Patent Document 1). For example, moreover, there has been proposed a headlamp device for a vehicle which detects a presence of a forward running car and carries out dimming to perform an extinction in a single direction depending on a result of the detection, thereby irradiating a light subjected to the extinction in other directions (for instance, see Patent Document 2). For example, furthermore, there has been proposed a night vision system for a vehicle which detects an object and attenuates a light of at least one of pixels in an optical attenuating matrix depending on a result of the detection (for instance, see Patent Document 3).

[Patent Document 1] JP-A-2004-231178 Publication

[Patent Document 2] JP-A-4-81337 Publication

[Patent Document 3] JP-A-2006-188224 Publication

[0003] As described in the Patent Documents, there has been proposed a technique in which an intermediate member divided into a plurality of sections capable of switching a transmission and shading of light is disposed between a light source and a projection lens to mask an irradiation of a light in a forward direction, thereby suppressing a glare to be given to a person who is present in a forward part. However, the intermediate member capable of switching the transmission and the shading of light has a complicated structure and a cost might also be increased.

SUMMARY

[0004] The invention provides a lighting unit capable of forming a plurality of light distribution patterns with a simple structure.

[0005] A lighting unit according to an exemplary embodiment of the invention comprises:

a projection lens;

a first image forming section for forming a first projected image on a rear focal plane of the projection lens; and

a second image forming section for forming a second projected image on the rear focal plane of the projection lens,

wherein the first image forming section includes a first light source and a shading member for intercepting a part of a light emitted from the first light source to form the first projected image, and

the second image forming section includes a second light source and a reflecting surface for reflecting a light emitted from the second light source to form the second projected image.

[0006] According to the aspect, by a simple structure of the shading member and the reflecting surface, it is possible to form both a light distribution pattern through the first projected image and a light distribution pattern through the second projected image. As compared with the case in which the intermediate member capable of switching the transmission and the shading of light is used, therefore, it is possible to provide a lighting unit taking a lower cost.

[0007] The shading member may have an edge portion for defining a portion of the first projected image which is adjacent to the second projected image. The reflecting surface may be provided to reach the edge portion of the shading member.

[0008] According to the aspect, it is possible to easily cause the light distribution pattern formed by the first projected image to be close to the light distribution pattern formed by the second projected image. For this reason, it is possible to form an integral light distribution pattern through the first projected image and the second projected image when both the first light source and the second light source are turned ON.

[0009] The second image forming section may be provided to make a pair. The pair of second image forming sections may form a pair of second projected images to interpose the first projected image therebetween.

[0010] The second image forming section reflects a light through the reflecting surface, thereby forming a light distribution pattern. For this reason, there is a possibility that the light distribution pattern formed by the second projected image might be darker than that formed by the first projected image. According to the aspect, it is possible to form the light distribution pattern through the first projected image between the light distribution patterns through the second projected images. Thus, it is possible to wholly form a light distribution pattern having a bright center. Therefore, it is possible to obtain an excellent distant visibility also in the case in which the lighting unit according to the aspect is used in a headlamp for a vehicle, for example.

[0011] The first image forming section may be provided to make a pair. A pair of shading members included in the pair of first image forming sections may be formed to

take a shape of a wedge in combination of adjacent portions to each other.

[0012] According to the aspect, in the case in which the first image forming sections are provided adjacently to each other, it is possible to cause boundaries between a pair of first projected images to be close to each other with a simple structure. Therefore, it is possible to prevent a boundary between a pair of light distribution patterns formed by the pair of first projected images from being darker than the other portions.

[0013] The pair of shading members may be formed to take a shape of a wedge with tips positioned further behind a rear focal point of the projection lens in combination of adjacent portions to each other.

[0014] According to the aspect, it is possible to provide, with a simple structure, an overlapping region on the mutual boundaries between the pair of first projected images formed by the pair of shading members. Therefore, it is possible to prevent the boundaries between the pair of light distribution patterns through the pair of first projected images from being darker than the other portions more greatly.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig. 1 is a sectional view showing a structure of a lighting unit according to a first embodiment.

Fig. 2 is a sectional view showing a structure of a light source unit according to the first embodiment.

Fig. 3 is a view showing a shading plate seen from a view point P in Fig. 2.

Fig. 4 is a view showing an additional light distribution pattern formed on the virtual vertical screen by means of the lighting unit according to the first embodiment.

Fig. 5 is a view showing a structure of a light source unit according to a second embodiment.

Fig. 6 is a top view showing a lighting unit according to a third embodiment.

Fig. 7 is a sectional view taken along Q - Q in Fig. 6.

Fig. 8 is a view showing a central unit seen from the forward part.

Fig. 9 is a view showing an additional light distribution pattern formed on the virtual vertical screen by means of the lighting unit according to the third embodiment.

DETAILED DESCRIPTION

[0016] Embodiments according to the invention (which will be hereinafter referred to as embodiments) will be described below in detail with reference to the drawings.

(First Embodiment)

[0017] Fig. 1 is a sectional view showing a structure of

a lighting unit 10 according to a first embodiment. In Fig. 1, a right side is set to be a front part of a lighting device, and a left side is set to be a rear part of the lighting device. The front part of the lighting device will be hereinafter referred to as a "front part" and the rear part of the lighting device will be hereinafter referred to as a "rear part". The lighting unit 10 is included in a headlamp for a vehicle. The lighting unit 10 includes a projection lens 12, a light source unit 14 and a holder 16.

[0018] The projection lens 12 is formed by a planoconvex aspherical lens having a front side surface to be a convex surface and a rear side surface to be a plane, and projects a light source image formed on a focal plane at the rear side as an inverted image in a forward direction. Description will be given based on a projected image formed on a virtual vertical screen disposed in a forward position of 25 m of a vehicle, for example. As a matter of course, a virtual plane assumed to form the projected image is not restricted to the vertical plane but may be a horizontal plane supposing a road surface, for example. The holder 16 supports both the projection lens 12 and the light source unit 14.

[0019] Fig. 2 is a sectional view showing a structure of the light source unit 14 according to the first embodiment.

The light source unit 14 has a shading plate 18, a first image forming unit 20, a second image forming unit 22, a third image forming unit 24, a fourth image forming unit 26 and a fifth image forming unit 28. First of all, a shape of the shading plate 18 will be described with reference to Fig. 3.

[0020] Fig. 3 is a view showing the shading plate 18 seen from a view point P in Fig. 2. The shading plate 18 is a plate-shaped member taking an external shape of a rectangle. A first slit 18a, a second slit 18b and a third slit 18c which are rectangular opening portions respectively are formed on the shading plate 18. The second slit 18b is provided as an opening portion which is slender in a vertical direction and takes a rectangular shape on an almost center of the shading plate 18. The first slit 18a and the third slit 18c are disposed transversely to interpose the second slit 18b therebetween. Although the first slit 18a and the third slit 18c have an equal height to that of the second slit 18b, they are provided as opening portions having greater widths than a width of the second slit 18b.

[0021] A reflecting surface 18d having an aluminum material deposited thereon is provided in a rectangular region between the first slit 18a and the second slit 18b. The reflecting surface 18d is provided to reach each of an edge portion of the first slit 18a and that of the second slit 18b. In place of the aluminum, silver may be deposited. The reflecting surface 18d has an equal height to heights of the first slit 18a and the second slit 18b and has a smaller width than that of the first slit 18a and a greater width than that of the second slit 18b.

[0022] A reflecting surface 18e having an aluminum material deposited thereon is provided in a rectangular region between the third slit 18c and the second slit 18b.

The reflecting surface 18e is provided to reach each of the edge portion of the second slit 18b and that of the third slit 18c. In place of the aluminum, silver may be deposited. The reflecting surface 18e has an equal height to heights of the third slit 18c and the second slit 18b and has a smaller width than that of the third slit 18c and a greater width than that of the second slit 18b. Regions other than the reflecting surfaces 18d and 18e are set to be a light absorbing surface 18f which is subjected to black painting to suppress a reflection of a light.

[0023] Returning to Fig. 2, the shading plate 18 is disposed with a tilt to be gradually higher in a forward direction. At this time, planes provided with the reflecting surfaces 18d and 18e are disposed to be turned in a downward and forward direction.

[0024] The first image forming unit 20 includes a first reflector 30, a substrate 40 and a portion for forming the first slit 18a in the shading plate 18. The substrate 40 is provided with a first light emitting device 50. The first light emitting device 50 has a light emitting chip (not shown) and a thin film. The light emitting chip is constituted by a white light emitting diode having a square light emitting surface of approximately 1 mm square. It is a matter of course that the light emitting chip is not restricted thereto but may be another light source taking a shape of an element which carries out a surface emission like an almost dot, for example, a laser diode. The thin film is provided to cover the light emitting surface of the light emitting chip. The substrate 40 is disposed in such a manner that the first light emitting device 50 emits a light in an upward direction behind the first slit 18a of the shading plate 18.

[0025] The first reflector 30 is disposed above the substrate 40 to reflect a light emitted from the first light emitting device 50 toward the first slit 18a through a reflecting surface 30a. The shading plate 18 functions as a shading member for intercepting a part of the light reflected by the first reflector 30 and forming a first projected image on a rear focal plane of the projection lens 12 by the light passing through the first slit 18a. Moreover, the first image forming unit 20 functions as image forming section for forming the first projected image.

[0026] The second image forming unit 22 includes a second reflector 32, a substrate 42 and the reflecting surface 18d provided in the shading plate 18. The substrate 42 is provided with a second light emitting device 52. The second light emitting device 52 to be used is the same as the first light emitting device 50. The substrate 42 is attached to a lower surface of the shading plate 18, that is, a surface on which the reflecting surface 18d is provided. At this time, the substrate 42 is disposed in such a manner that the second light emitting device 52 is positioned in a lower and rear part from the reflecting surface 18d. Thus, the second light emitting device 52 is disposed to emit a light in a downward and forward direction.

[0027] The second reflector 32 is provided below the second light emitting device 52 to reflect the light emitted

from the second light emitting device 52 toward the reflecting surface 18d through a reflecting surface 32a. The reflecting surface 18d further reflects the light reflected by the second reflector 32 in a forward direction, thereby forming a second projected image on the rear focal plane of the projection lens 12. Accordingly, the second image forming unit 22 functions as image forming section for forming the second projected image.

[0028] The third image forming unit 24 includes a third reflector 34, a substrate 44 and a portion for forming the second slit 18b in the shading plate 18. The substrate 44 is provided with a third light emitting device 54. The third light emitting device 54 to be used is the same as the first light emitting device 50. The substrate 44 is disposed in such a manner that the third light emitting device 54 emits a light in an upward direction behind the second slit 18b of the shading plate 18.

[0029] The third reflector 34 is disposed above the substrate 44 to reflect the light emitted from the third light emitting device 54 toward the second slit 18b through a reflecting surface 34a. The shading plate 18 functions as a shading member for intercepting a part of the light reflected by the third reflector 34 and forming a third projected image on the rear focal plane of the projection lens 12 by the light passing through the second slit 18b. Moreover, the third image forming unit 24 functions as image forming section for forming the third projected image.

[0030] Each of the third reflector 34 and the third light emitting device 54 is disposed on a left side seen from a forward part of the first reflector 30 and the first light emitting device 50. Moreover, a partitioning member (not shown) is provided between the first reflector 30 and the third reflector 34. The partitioning member prevents a light emitted from the first light emitting device 50 and reflected by the first reflector 30 from being incident on the second slit 18b. Furthermore, the partitioning member prevents a light emitted from the third light emitting device 54 and reflected by the third reflector 34 from being incident on the first slit 18a.

[0031] The fourth image forming unit 26 includes a fourth reflector 36, a substrate 46 and the reflecting surface 18e provided in the shading plate 18. The substrate 46 is provided with a fourth light emitting device 56. The fourth light emitting device 56 to be used is the same as the first light emitting device 50. The substrate 46 is attached to a lower surface of the shading plate 18, that is, a surface on which the reflecting surface 18e is provided. At this time, the substrate 46 is disposed in such a manner that the fourth light emitting device 56 is positioned in a lower and rear part from the reflecting surface 18e. Thus, the fourth light emitting device 56 is disposed to emit a light in a downward and forward direction.

[0032] The fourth reflector 36 is provided below the fourth light emitting device 56 to reflect the light emitted from the fourth light emitting device 56 toward the reflecting surface 18e through a reflecting surface 36a. The reflecting surface 18e further reflects the light reflected by the fourth reflector 36 in a forward direction, thereby

forming a fourth projected image on the rear focal plane of the projection lens 12. Accordingly, the fourth image forming unit 26 functions as image forming section for forming the fourth projected image.

[0033] Each of the fourth reflector 36 and the fourth light emitting device 56 is disposed on a left side seen from a forward part of the second reflector 32 and the second light emitting device 52. Moreover, a partitioning member (not shown) is provided between the second reflector 32 and the fourth reflector 36. The partitioning member prevents a light emitted from the second light emitting device 52 and reflected by the second reflector 32 from reaching the reflecting surface 18e. Furthermore, the partitioning member prevents a light emitted from the fourth light emitting device 56 and reflected by the fourth reflector 36 from reaching the reflecting surface 18d.

[0034] The fifth image forming unit 28 includes a fifth reflector 38, a substrate 48 and a portion for forming the third slit 18c in the shading plate 18. The substrate 48 is provided with a fifth light emitting device 58. The fifth light emitting device 58 to be used is the same as the first light emitting device 50. The substrate 48 is disposed in such a manner that the fifth light emitting device 58 emits a light in an upward direction in a rear part of the third slit 18c of the shading plate 18.

[0035] The fifth reflector 38 is provided above the substrate 48 to reflect the light emitted from the fifth light emitting device 58 toward the third slit 18c through a reflecting surface 38a. The shading plate 18 functions as a shading member for intercepting a part of the light reflected by the fifth reflector 38 and forming a fifth projected image on the rear focal plane of the projection lens 12 by the light passing through the third slit 18c. Moreover, the fifth image forming unit 28 functions as image forming section for forming the fifth projected image.

[0036] Each of the fifth reflector 38 and the fifth light emitting device 58 is disposed on a left side seen from a forward part of the third reflector 34 and the fifth light emitting device 58. Moreover, a partitioning member (not shown) is provided between the third reflector 34 and the fifth reflector 38. The partitioning member prevents a light emitted from the third light emitting device 54 and reflected by the third reflector 34 from being incident on the third slit 18c. Furthermore, the partitioning member prevents a light emitted from the fifth light emitting device 58 and reflected by the fifth reflector 38 from being incident on the second slit 18b.

[0037] Fig. 4 is a view showing an additional light distribution pattern PA1 formed on the virtual vertical screen by means of the lighting unit 10 according to the first embodiment. The projection lens 12 projects the first projected image formed by the first image forming unit 20 in a forward direction to form a first divided light distribution pattern PA11. Moreover, the projection lens 12 projects the second projected image formed by the second image forming unit 22 in the forward direction to form a second divided light distribution pattern PA12. Furthermore, the projection lens 12 projects the third projected image

formed by the third image forming unit 24 in the forward direction to form a third divided light distribution pattern PA13. In addition, the projection lens 12 projects the fourth projected image formed by the fourth image forming unit 26 in the forward direction to form a fourth divided light distribution pattern PA14. Moreover, the projection lens 12 projects the fifth projected image formed by the fifth image forming unit 28 in the forward direction to form a fifth divided light distribution pattern PA15. The additional light distribution pattern PA1 is formed in combination of the first divided light distribution pattern PA11 to the fifth divided light distribution pattern PA15.

[0038] The additional light distribution pattern PA1 is formed by overlapping a light irradiated from the lighting unit 10 included in a headlamp for a vehicle which is provided on a left side of the vehicle and a light irradiated from the lighting unit 10 included in a headlamp for a vehicle which is provided on a right side of the vehicle. The lighting unit 10 functions as an additional light source for forming the additional light distribution pattern PA1. The lighting unit 10 may function as a light source for a high beam which serves to form a so-called light distribution pattern for a high beam. The divided light distribution patterns are not restricted to a rectangular shape but may take a shape of a trapezoid or a parallelogram or other shapes, for example.

[0039] In the vehicle (not shown) provided with the headlamp for a vehicle which includes the lighting unit 10, an intermediate beam switch (not shown) is disposed in addition to a well-known high beam switch (not shown). When the intermediate beam switch is turned ON by a user, an intermediate beam mode is started. In the intermediate beam mode, a light emitting device for forming any of the first divided light distribution pattern PA11 to the fifth divided light distribution pattern PA15 in which a forward running car such as a car running in an opposite lane or a leading car is present is turned OFF to suppress a glare given to a driver of the forward running car.

[0040] More specifically, a camera (not shown) and a control portion (not shown) are disposed in the vehicle provided with the headlamp for a vehicle which includes the lighting unit 10. The control portion has a CPU for executing various calculation processings, an ROM for storing various control programs and an RAM to be utilized as a work area for storing data and executing a program, and serves to control an irradiation of a light through the lighting unit 10. The camera has an image pick-up device such as a CCD (Charge Coupled Device) sensor or a CMOS (Complementary Metal Oxide Semiconductor) sensor and serves to pick up a video in a forward part of a vehicle, thereby generating image data. The camera is connected to the control portion and the image data thus generated are output to the control portion.

[0041] When the intermediate beam switch is turned ON by the user, an intermediate beam ON signal is output to the control portion so that the control portion starts to control a light irradiated from a headlamp unit in the in-

intermediate beam mode. In the intermediate beam mode, the control portion analyzes image data input from the camera and decides whether or not there is a forward running car such as a car running in an opposite lane which has a headlamp set in a lighting state. If there is the forward running car, the control portion specifies a position of the car running in an opposite lane by utilizing a position of the headlamp which is obtained through the analysis. Since a technique for specifying a position of a forward running car by utilizing image data is well-known, thus, description will be omitted.

[0042] The control portion utilizes the specified position of the forward running car to decide whether or not the forward running car is present in any of regions in which the first divided light distribution pattern PA11 to the fifth divided light distribution pattern PA15 are formed. If the forward running car is present in any of the regions in which the divided light distribution patterns are formed, the control portion turns OFF a light emitting device for forming the divided light distribution pattern decided to have the forward running car. Without turning OFF the light emitting device, the control portion may control to turn ON the light emitting device in order to reduce a luminous intensity of an illuminating light for forming the divided light distribution pattern decided to have the forward running car more greatly than that in the case in which non-presence of the vehicle is decided.

(Second Embodiment)

[0043] Fig. 5 is a view showing a structure of a light source unit 80 according to a second embodiment. A structure of a lighting unit is the same as that in the first embodiment except that the light source unit 80 is provided in place of the light source unit 14. The same portions as those in the first embodiment have the same reference numerals and description will be omitted.

[0044] The light source unit 80 includes a shading plate 82, a first image forming unit 84, a second image forming unit 86, a third image forming unit 88, a fourth image forming unit 90 and a fifth image forming unit 92.

[0045] The shading plate 82 is a plate-shaped member taking an external shape of a rectangle. A first slit 82a, a second slit 82b and a third slit 82c which are rectangular opening portions respectively are formed on the shading plate 82. Shapes and sizes of the first slit 82a, the second slit 82b and the third slit 82c and a relative positional relationship therebetween are the same as those of the first slit 18a, the second slit 18b and the third slit 18c in the shading plate 18.

[0046] A reflecting surface 82d having an aluminum material deposited thereon is provided in a rectangular region between the first slit 82a and the second slit 82b. The reflecting surface 82d is provided to reach each of an edge portion of the first slit 82a and that of the second slit 82b. In place of the aluminum, silver may be deposited.

[0047] A reflecting surface 82e having an aluminum

material deposited thereon is provided in a rectangular region between the third slit 82c and the second slit 82b. The reflecting surface 82e is provided to reach each of an edge portion of the third slit 82c and that of the second slit 82b. In place of the aluminum, silver may be deposited.

[0048] Shapes and sizes of the reflecting surface 82d and the reflecting surface 82e and a relative positional relationship therebetween are the same as those of the reflecting surface 18d and the reflecting surface 18e in the shading plate 18. Regions other than the reflecting surfaces 82d and 82e are set to be a light absorbing surface 82f which is subjected to black painting to suppress a reflection of a light.

[0049] The shading plate 82 is disposed with a tilt to be gradually lower in a forward direction. At this time, planes provided with the reflecting surfaces 82d and 82e are disposed to be turned in an upward and forward direction.

[0050] The first image forming unit 84 includes a first reflector 94, a substrate 104 and a portion for forming the first slit 82a in the shading plate 82. The substrate 104 is provided with a first light emitting device 114. The first light emitting device 114 to be used is the same as the first light emitting device 50. The substrate 104 is disposed in such a manner that the first light emitting device 114 emits a light in an upward direction behind the first slit 82a of the shading plate 82.

[0051] The first reflector 94 is disposed above the substrate 104 to reflect a light emitted from the first light emitting device 114 toward the first slit 82a through a reflecting surface 94a. The shading plate 82 functions as a shading member for intercepting a part of the light reflected by the first reflector 94 and forming a first projected image on a rear focal plane of a projection lens 12 by the light passing through the first slit 82a.

[0052] The second image forming unit 86 includes a second reflector 96, a substrate 106 and the reflecting surface 82d provided in the shading plate 82. The substrate 106 is provided with a second light emitting device 116. The second light emitting device 116 to be used is the same as the first light emitting device 114. The substrate 106 is disposed in such a manner that the second light emitting device 116 emits a light in a forward direction above the shading plate 82.

[0053] The second reflector 96 is provided ahead of the second light emitting device 116 to reflect the light emitted from the second light emitting device 116 toward the reflecting surface 82d of the shading plate 82 through a reflecting surface 96a. The reflecting surface 82d further reflects the light reflected by the second reflector 96 in a forward direction, thereby forming a second projected image on the rear focal plane of the projection lens 12.

[0054] The third image forming unit 88 includes a third reflector 98, a substrate 108 and a portion for forming the second slit 82b in the shading plate 82. The substrate 108 is provided with a third light emitting device 118. The third light emitting device 118 to be used is the same as

the first light emitting device 114. The substrate 108 is disposed in such a manner that the third light emitting device 118 emits a light in an upward direction behind the second slit 82b of the shading plate 82.

[0055] The third reflector 98 is disposed above the substrate 108 to reflect the light emitted from the third light emitting device 118 toward the second slit 82b through a reflecting surface 98a. The shading plate 82 functions as a shading member for intercepting a part of the light reflected by the third reflector 98 and forming a third projected image on the rear focal plane of the projection lens 12 by the light passing through the second slit 82b.

[0056] Each of the third reflector 98 and the third light emitting device 118 is disposed on a left side seen from a forward part of the first reflector 94 and the first light emitting device 114. Moreover, a partitioning member (not shown) is provided between the first reflector 94 and the third reflector 98. The partitioning member prevents a light emitted from the first light emitting device 114 and reflected by the first reflector 94 from being incident on the second slit 82b. Furthermore, the partitioning member prevents a light emitted from the third light emitting device 118 and reflected by the third reflector 98 from being incident on the first slit 82a.

[0057] The fourth image forming unit 90 includes a fourth reflector 100, a substrate 110 and the reflecting surface 82e provided in the shading plate 82. The substrate 110 is provided with a fourth light emitting device 120. The fourth light emitting device 120 to be used is the same as the first light emitting device 114. The substrate 110 is disposed in such a manner that the fourth light emitting device 120 emits a light in a forward direction above the shading plate 82.

[0058] The fourth reflector 100 is provided ahead of the fourth light emitting device 120 to reflect the light emitted from the fourth light emitting device 120 toward the reflecting surface 82e of the shading plate 82 through a reflecting surface 100a. The reflecting surface 82e further reflects the light reflected by the fourth reflector 100 in a forward direction, thereby forming a fourth projected image on the rear focal plane of the projection lens 12.

[0059] Each of the fourth reflector 100 and the fourth light emitting device 120 is disposed on a left side seen from a forward part of the second reflector 96 and the second light emitting device 116. Moreover, a partitioning member (not shown) is provided between the second reflector 96 and the fourth reflector 100. The partitioning member prevents a light emitted from the second light emitting device 116 and reflected by the second reflector 96 from reaching the reflecting surface 82e. Furthermore, the partitioning member prevents a light emitted from the fourth light emitting device 120 and reflected by the fourth reflector 100 from reaching the reflecting surface 82d.

[0060] The fifth image forming unit 92 includes a fifth reflector 102, a substrate 112 and a portion for forming the third slit 82c in the shading plate 82. The substrate 112 is provided with a fifth light emitting device 122. The fifth light emitting device 122 to be used is the same as

the first light emitting device 114. The substrate 112 is disposed in such a manner that the fifth light emitting device 122 emits a light in an upward direction behind the third slit 82c of the shading plate 82.

[0061] The fifth reflector 102 is provided above the substrate 112 to reflect the light emitted from the fifth light emitting device 122 toward the third slit 82c through a reflecting surface 102a. The shading plate 82 functions as a shading member for intercepting a part of the light reflected by the fifth reflector 102 and forming a third projected image on the rear focal plane of the projection lens 12 by the light passing through the third slit 82c.

[0062] Each of the fifth reflector 102 and the fifth light emitting device 122 is disposed on a left side seen from a forward part of the third reflector 98 and the third light emitting device 118. Moreover, a partitioning member (not shown) is provided between the third reflector 98 and the fifth reflector 102. The partitioning member prevents a light emitted from the third light emitting device 118 and reflected by the third reflector 98 from being incident on the third slit 82c. Furthermore, the partitioning member prevents a light emitted from the fifth light emitting device 122 and reflected by the fifth reflector 102 from being incident on the second slit 82b.

[0063] An additional light distribution pattern formed by a lighting unit including the light source unit 80 is the same as the additional light distribution pattern PA1 in Fig. 4. In other words, the projection lens 12 projects the first projected image formed by the first image forming unit 84 in a forward direction to form a first divided light distribution pattern PA11. Moreover, the projection lens 12 projects the second projected image formed by the second image forming unit 86 in the forward direction to form a second divided light distribution pattern PA12. Furthermore, the projection lens 12 projects the third projected image formed by the third image forming unit 88 in the forward direction to form a third divided light distribution pattern PA13. In addition, the projection lens 12 projects the fourth projected image formed by the fourth image forming unit 90 in the forward direction to form a fourth divided light distribution pattern PA14. Moreover, the projection lens 12 projects the fifth projected image formed by the fifth image forming unit 92 in the forward direction to form a fifth divided light distribution pattern PA15. In the same manner as in the first embodiment, an intermediate beam mode is provided in a vehicle including a headlamp for a vehicle which has a lighting unit.

(Third Embodiment)

[0064] Fig. 6 is a top view showing a lighting unit 130 according to a third embodiment and Fig. 7 is a sectional view taken along Q - Q in Fig. 6. With reference to both of Figs. 6 and 7, description will be given to a structure of the lighting unit 130.

[0065] The lighting unit 130 includes a projection lens 132 and a light source unit 134. A shape of the projection lens 132 is the same as that of the projection lens 12

according to the first embodiment. The light source unit 134 has a first image forming unit 140, a second image forming unit 142, a third image forming unit 144 and a fourth image forming unit 146. A central unit 160 is provided in the light source unit 134. The second image forming unit 142 and the third image forming unit 144 are provided in the central unit 160.

[0066] The central unit 160 has a partitioning member 162, a shading member 164, a substrate 166, a second reflector 168, a shading plate 170, a substrate 172, a third reflector 174 and a shading plate 176. A second light emitting device 152 is provided on the substrate 166 and a third light emitting device 154 is provided on the substrate 172. The second light emitting device 152 and the third light emitting device 154 which are to be used are the same as the first light emitting device 50, respectively.

[0067] The partitioning member 162 is formed to take a shape of a thick plate and is disposed in such a manner that both surfaces are turned in leftward and rightward directions as seen from a forward part. The substrate 166 is attached to a side surface of the partitioning member 162 in such a manner that the second light emitting device 152 emits a light in the rightward direction as seen from the forward part. The substrate 172 is attached to a side surface of the partitioning member 162 in such a manner that the third light emitting device 154 emits a light in the leftward direction as seen from the forward part. The shading member 164 is formed to take a shape of a wedge as seen from above and is fixed to a front surface of the partitioning member 162 in such a manner that a tip portion 164a is turned in a forward direction.

[0068] The second reflector 168 is disposed on a right side of the second light emitting device 152 as seen from a forward part and the shading plate 170 is disposed ahead of the second reflector 168. At this time, the shading plate 170 is disposed with a gradual tilt in a forward direction close to an optical axis of the projection lens 132. Moreover, an interval is provided between a left edge portion of the shading plate 170 and the shading member 164 as seen from the forward part. A reflecting surface 170a having an aluminum material deposited wholly is provided on an external surface of the shading plate 170.

[0069] The third reflector 174 is disposed on a left side of the third light emitting device 154 as seen from the forward part and the shading plate 176 is disposed ahead of the third reflector 174. At this time, the shading plate 176 is disposed with a gradual tilt in the forward direction close to the optical axis of the projection lens 132. Moreover, an interval is provided between a right edge portion of the shading plate 176 and the shading member 164 as seen from the forward part. A reflecting surface 176a having an aluminum material deposited wholly is provided on an external surface of the shading plate 176.

[0070] Fig. 8 is a view showing the central unit 160 seen from the forward part. The central unit 160 is provided with an upper plate 190 and a lower plate 192. The

upper plate 190 is attached to upper parts of the shading member 164, the shading plate 170 and the shading plate 176. The lower plate 192 is attached to lower parts of the shading member 164, the shading plate 170 and the shading plate 176.

[0071] Thus, there is formed an opening portion 194 which is surrounded by the left edge portion of the shading plate 170, the upper plate 190, the tip portion 164a of the shading member 164, and the lower plate 192. Moreover, there is formed an opening portion 196 which is surrounded by the right edge portion of the shading plate 176, the upper plate 190, the tip portion 164a of the shading member 164, and the lower plate 192. An interval between the left edge portion of the shading plate 170 and the tip portion 164a of the shading member 164 is set to be greater than an interval between the right edge portion of the shading plate 176 and the tip portion 164a of the shading member 164. For this reason, a width of the opening portion 194 is greater than that of the opening portion 196.

[0072] Returning to Figs. 6 and 7, the second image forming unit 142 includes the second light emitting device 152, the second reflector 168, the shading plate 170 and the shading member 164. A light emitted from the second light emitting device 152 is reflected by a reflecting surface 168a of the second reflector 168 and is emitted from the opening portion 194 so that a second projected image is formed on a rear focal plane of the projection lens 132. The opening portion 194 defines the second projected image. Accordingly, the second image forming unit 142 functions as image forming section for forming the second projected image. Moreover, the shading plate 170, the shading member 164, the upper plate 190 and the lower plate 192 function as shading members for intercepting a part of the light emitted from the second light emitting device 152 and forming the second projected image on the rear focal plane of the projection lens 132.

[0073] The second light emitting device 152 is disposed on a first focal point F1 of the second reflector 168. The second reflector 168 is provided in such a manner that a second focal point F2 to be another focal point is placed in a forward higher position than the first focal point F1. By placing the second focal point F2 in the higher position than the first focal point F1 in which the second light emitting device 152 is disposed, thus, it is possible to increase a luminous intensity of an upper part of the second projected image formed by the second image forming unit 142. Therefore, it is possible to increase an illuminance of a lower part of a light distribution pattern formed by the projection of the second projected image through the projection lens 132. Accordingly, it is possible to increase an illuminance in the vicinity of a so-called H line, thereby enhancing a distant visibility of a vehicle driver.

[0074] The third image forming unit 144 includes the third light emitting device 154, the third reflector 174, the shading plate 176 and the shading member 164. A light emitted from the third light emitting device 154 is reflected

by a reflecting surface 174a of the third reflector 174 and is emitted from the opening portion 196 so that a third projected image is formed on a rear focal plane of the projection lens 132. The opening portion 196 defines the third projected image. Accordingly, the third image forming unit 144 functions as image forming section for forming the third projected image. Moreover, the shading plate 176, the shading member 164, the upper plate 190 and the lower plate 192 function as shading members for intercepting a part of the light emitted from the third light emitting device 154 and forming the third projected image on the rear focal plane of the projection lens 132.

[0075] The third light emitting device 154 is disposed on the first focal point F1 of the third reflector 174. The third reflector 174 is provided in such a manner that the second focal point F2 to be another focal point is placed in a forward higher position than the first focal point F1. By placing the second focal point F2 in the higher position than the first focal point F1 in which the third light emitting device 154 is disposed, thus, it is possible to increase a luminous intensity of an upper part of the third projected image formed by the third image forming unit 144. Therefore, it is possible to increase an illuminance of a lower part of a light distribution pattern formed by the projection of the third projected image through the projection lens 132. Accordingly, it is possible to increase an illuminance in the vicinity of the so-called H line, thereby enhancing a distant visibility.

[0076] The first image forming unit 140 includes a first light emitting device 150, a first reflector 180 and the reflecting plane 170a provided in the shading plate 170. The first light emitting device 150 to be used is the same as the first light emitting device 50.

[0077] The first reflector 180 is disposed in a right and forward part of the first light emitting device 150 and reflects a light emitted from the first light emitting device 150 toward the reflecting surface 170a of the shading plate 170 through a reflecting surface 180a. The reflecting surface 170a further reflects the light reflected by the first reflector 180 in a forward direction, thereby forming a first projected image on the rear focal plane of the projection lens 132. Accordingly, the first image forming unit 140 functions as image forming section for forming the first projected image.

[0078] The fourth image forming unit 146 includes a fourth light emitting device 156, a second reflector 182 and the reflecting surface 176a provided in the shading plate 176. The fourth light emitting device 156 to be used is the same as the first light emitting device 50.

[0079] The second reflector 182 is disposed in a left and forward part of the fourth light emitting device 156 and reflects a light emitted from the fourth light emitting device 156 toward the reflecting surface 176a of the shading plate 176 through a reflecting surface 182a. The reflecting surface 176a further reflects the light reflected by the second reflector 182 in a forward direction, thereby forming a fourth projected image on the rear focal plane of the projection lens 132. Accordingly, the third image

forming unit 144 functions as image forming section for forming the fourth projected image.

[0080] Thus, the first image forming unit 140 and the fourth image forming unit 146 form the first projected image and the fourth projected image to interpose the second projected image and the third projected image which are formed by the second image forming unit 142 and the third image forming unit 144 therebetween. The first projected image and the fourth projected image are formed by two reflections of a light emitted from the light emitting device. On the other hand, the second projected image and the third projected image are formed by a single reflection of the light emitted from the light emitting device. By disposing projected images formed through a certain number of reflections to interpose a projected image formed through a smaller number of reflections therebetween, thus, it is possible to form a projected image having a high luminous intensity on a center as a whole. Accordingly, it is possible to enhance a distant visibility of a vehicle driver through a lighting unit.

[0081] The reflecting surface 170a is provided to reach the left edge portion of the shading plate 170 for defining the second projected image. When both the first light emitting device 150 and the second light emitting device 152 are turned ON, therefore, it is possible to form an integral light distribution pattern through the first projected image and the second projected image.

[0082] Moreover, the reflecting surface 176a is provided to reach the right edge portion of the shading plate 176 for defining the third projected image. When both the third light emitting device 154 and the fourth light emitting device 156 are turned ON, therefore, it is possible to form an integral light distribution pattern through the third projected image and the fourth projected image.

[0083] In the third embodiment, furthermore, the second image forming unit 142 and the third image forming unit 144 are disposed adjacently to each other in such a manner that the second and third projected images formed through a small number of reflections are adjacent to each other. Consequently, it is also possible to carry out ON/OFF operations through a division of a projected image having a high luminous intensity.

[0084] The shading member 164 is wedge-shaped to have both a function for intercepting a part of the light emitted from the second light emitting device 152 to form the second projected image in the second image forming unit 142 and a function for intercepting a part of the light emitted from the third light emitting device 154 to form the third projected image in the third image forming unit 144. In other words, the shading member 164 is wedge-shaped in combination of mutually adjacent portions in the shading member for defining the second projected image included in the second image forming unit 142 and the shading member for defining the third projected image included in the third image forming unit 144. Consequently, the second projected image and the third projected image are caused to be close to each other.

[0085] Furthermore, the tip portion 164a of the shading

member 164 is provided to be positioned further behind the rear focal plane of the projection lens 132. Thus, the tip portion 164a is disposed to provide a region in which the second and third projected images overlap each other over the rear focal plane of the projection lens 132.

[0086] Fig. 9 is a view showing an additional light distribution pattern PA2 formed on the virtual vertical screen by means of the lighting unit according to the third embodiment. The projection lens 132 projects the first projected image formed by the first image forming unit 140 in a forward direction to form a first divided light distribution pattern PA21. Moreover, the projection lens 132 projects the second projected image formed by the second image forming unit 142 in the forward direction to form a second divided light distribution pattern PA22. Furthermore, the projection lens 132 projects the third projected image formed by the third image forming unit 144 in the forward direction to form a third divided light distribution pattern PA23. In addition, the projection lens 132 projects the fourth projected image formed by the fourth image forming unit 146 in the forward direction to form a fourth divided light distribution pattern PA24. The additional light distribution pattern PA2 is formed in combination of the first divided light distribution pattern PA21 to the fourth divided light distribution pattern PA24. The additional light distribution pattern PA2 is formed by overlapping a light irradiated from the lighting unit 130 included in a headlamp for a vehicle which is provided on a left side of the vehicle and a light irradiated from the lighting unit 130 included in the headlamp for the vehicle which is provided on a right side of the vehicle.

[0087] Thus, the lighting unit 130 forms the second divided light distribution pattern PA22 and the third divided light distribution pattern PA23 which have high illuminances on the center of the additional light distribution pattern PA2, thereby enhancing a distant visibility in the forward part of the vehicle. By utilizing a reflected light to be diffused through the first reflector 180 and the second reflector 182, moreover, there are formed the first divided light distribution pattern PA21 and the fourth divided light distribution pattern PA24 which are extended transversely from the second divided light distribution pattern PA22 and the third divided light distribution pattern PA23. Consequently, it is possible to illuminate a wide range in the transverse direction.

[0088] In the same manner as in the embodiments, an intermediate beam mode is provided in a vehicle (not shown) including a headlamp for a vehicle which has a lighting unit. In the intermediate beam mode according to the third embodiment, a glare is prevented from being given to a driver of a forward running car such as a car running in an opposite lane or a leading car through an OFF operation of the light emitting device for forming any of the first divided light distribution pattern PA21 to the fourth divided light distribution pattern PA24 in which the forward running car is present.

[0089] While the invention has been described with respect to a limited number of embodiments, those skilled

in the art, having benefit of this disclosure, will appreciate that other embodiments can be devised which do not depart from the scope of the invention as disclosed herein. Accordingly, the scope of the invention should be limited only by the attached claims.

Claims

1. A lighting unit comprising:
 - a projection lens;
 - a first image forming section for forming a first projected image on a rear focal plane of the projection lens; and
 - a second image forming section for forming a second projected image on the rear focal plane of the projection lens,
 wherein the first image forming section includes a first light source and a shading member for intercepting a part of a light emitted from the first light source to form the first projected image, and the second image forming section includes a second light source and a reflecting surface for reflecting a light emitted from the second light source to form the second projected image.
2. The lighting unit according to claim 1, wherein the shading member has an edge portion for defining a portion of the first projected image which is adjacent to the second projected image, and the reflecting surface is provided to reach the edge portion of the shading member.
3. The lighting unit according to claim 1 or 2, wherein the second image forming section is provided to make a pair, and the pair of second image forming sections forms a pair of second projected images to interpose the first projected image therebetween.
4. The lighting unit according to any of claims 1 to 3, wherein the first image forming section is provided to make a pair, and a pair of shading members included in the pair of first image forming sections is formed to take a shape of a wedge in combination of adjacent portions to each other.
5. The lighting unit according to claim 4, wherein the pair of shading members is formed to take a shape of a wedge with tips positioned further behind a rear focal point of the projection lens in combination of adjacent portions to each other.

FIG. 1

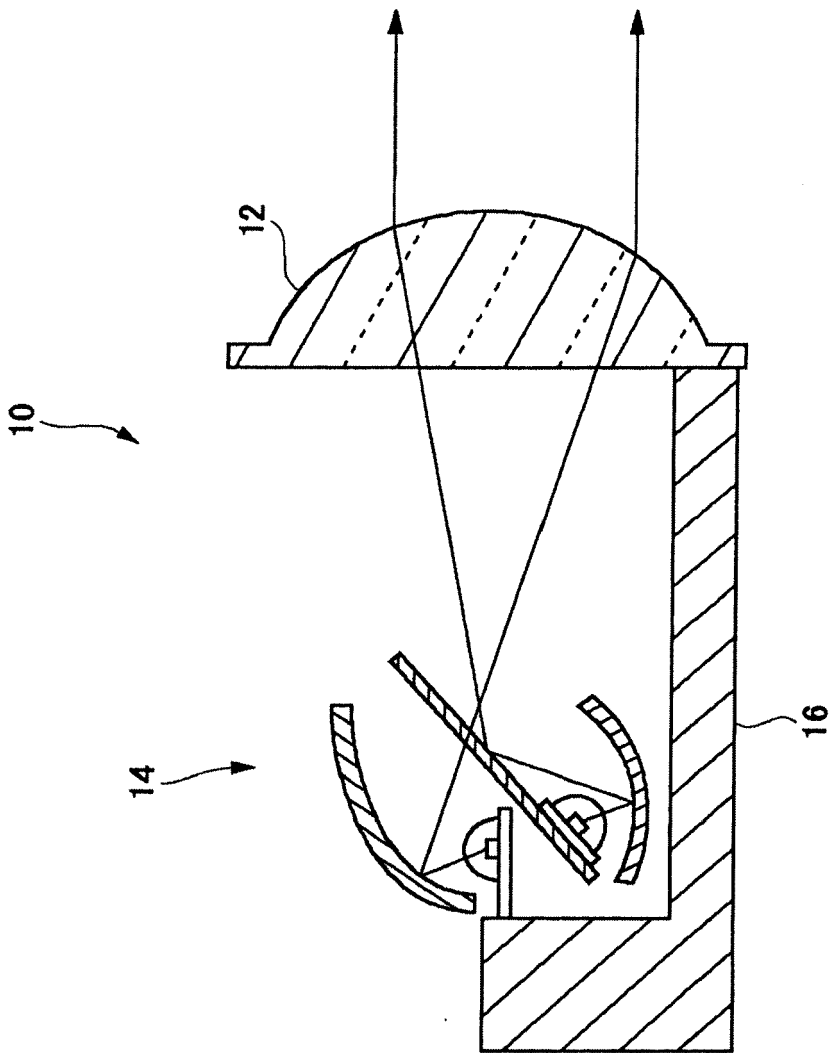


FIG. 2

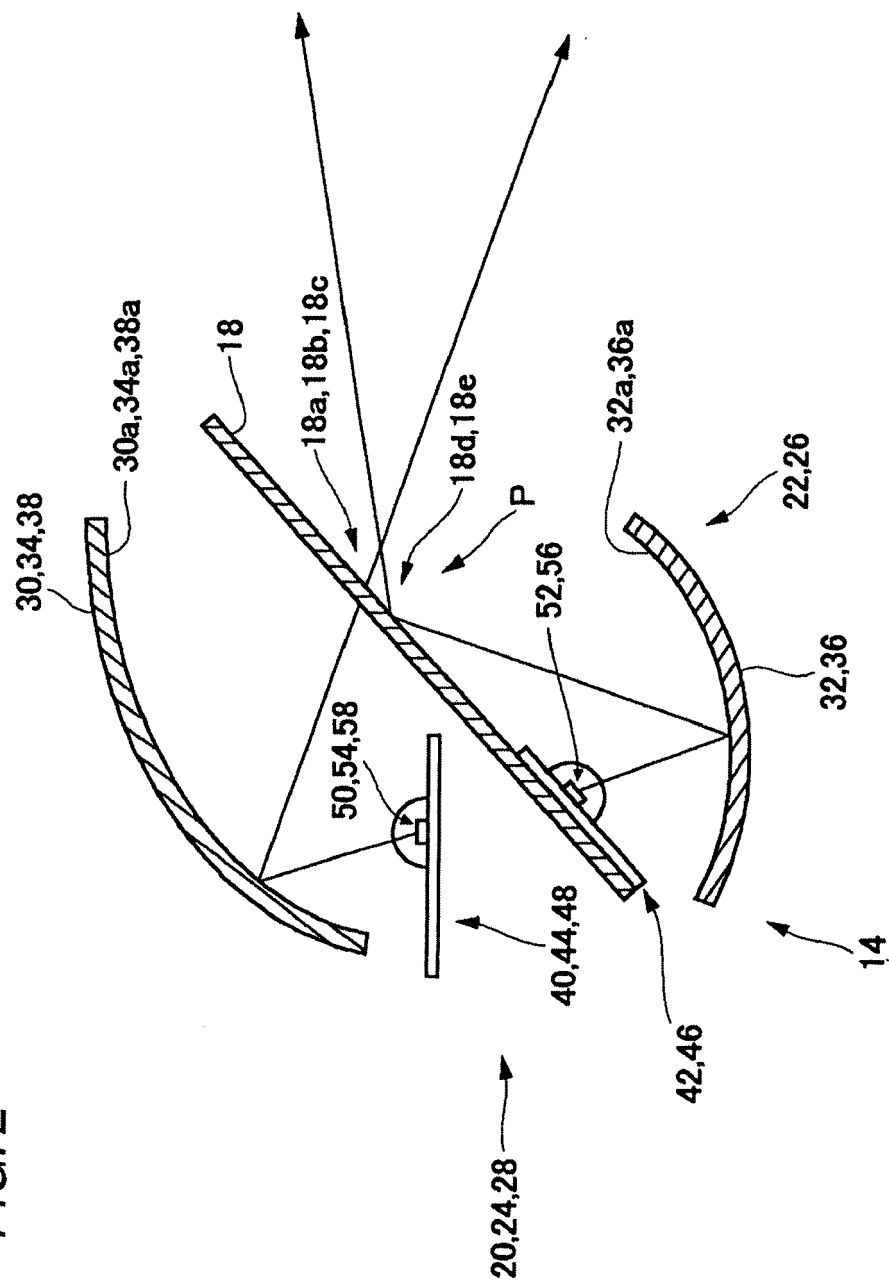


FIG. 3

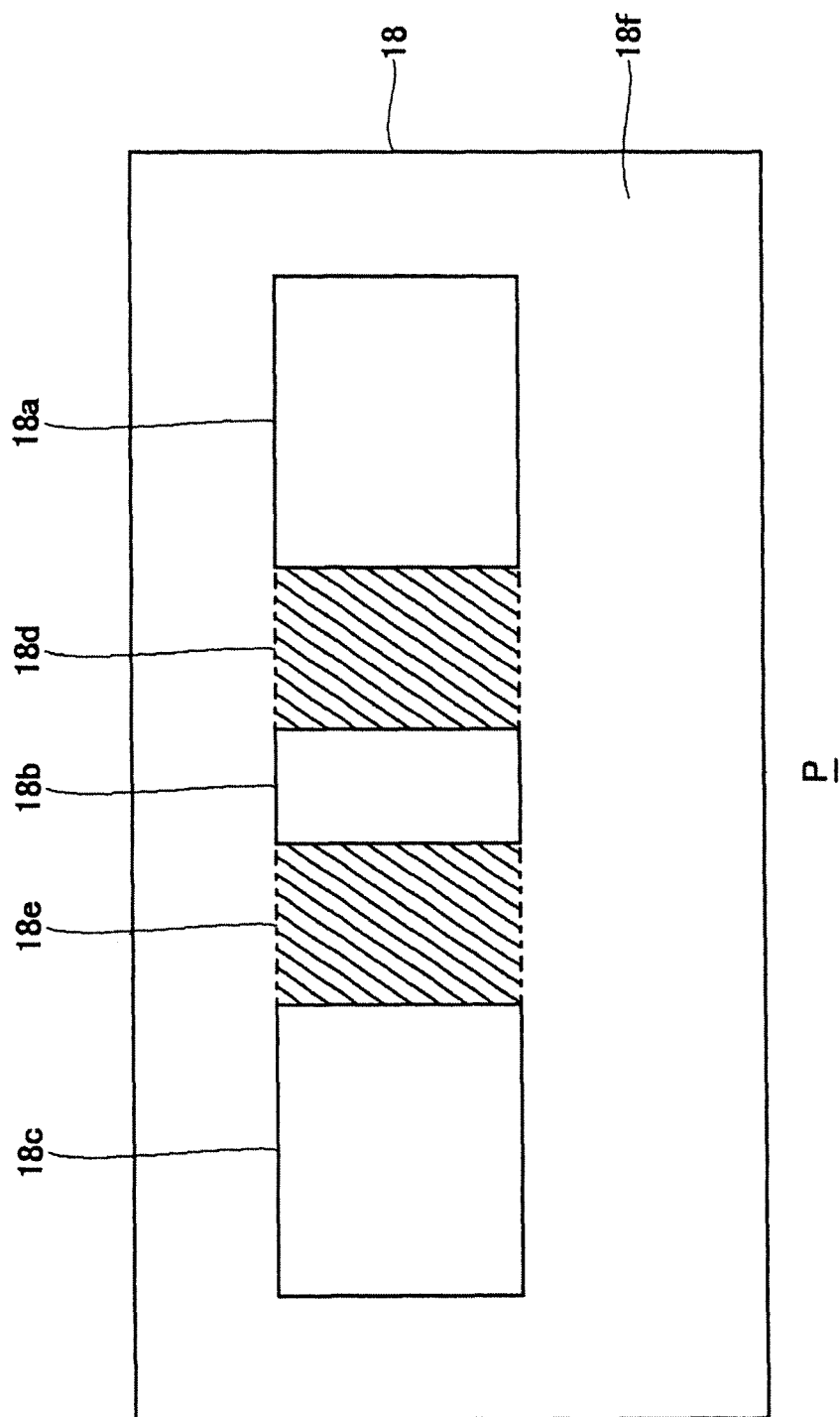


FIG. 4

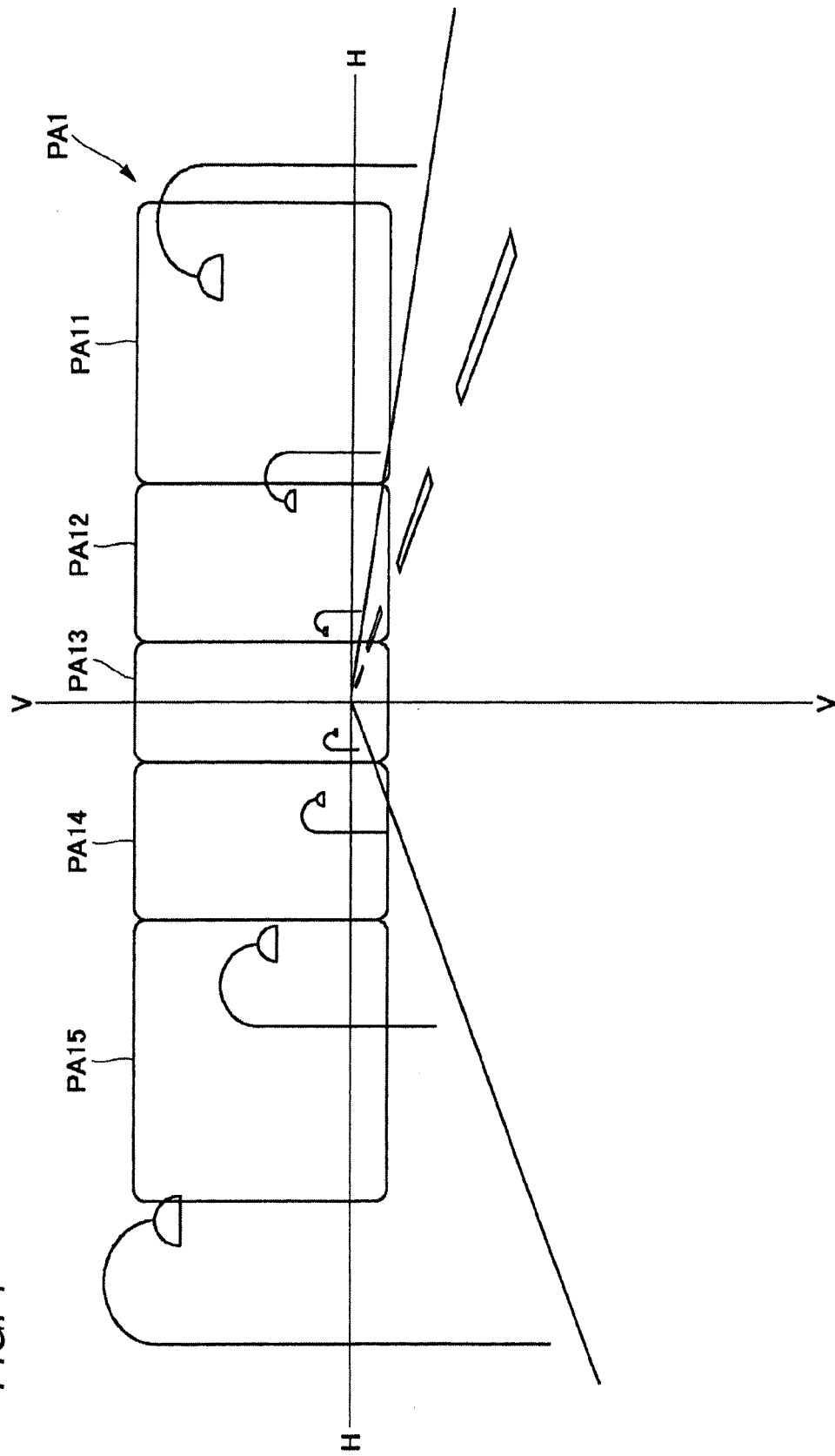
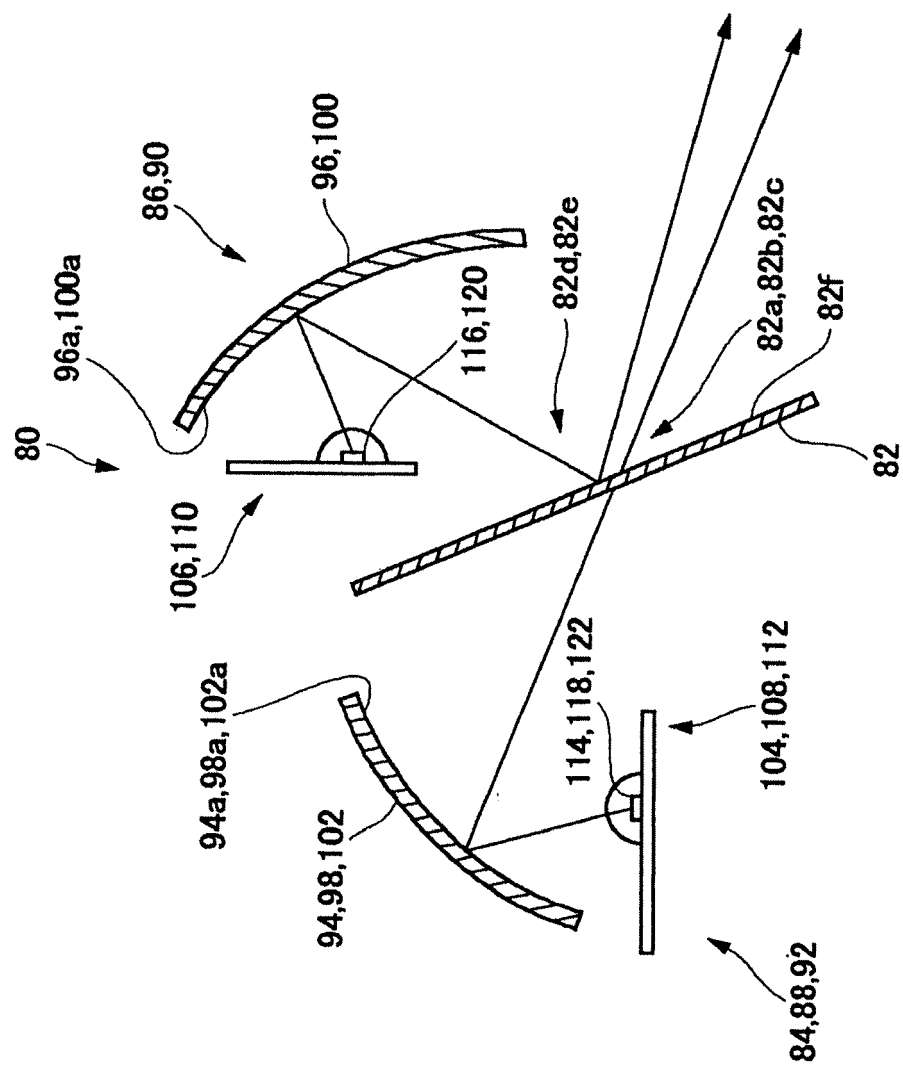


FIG. 5



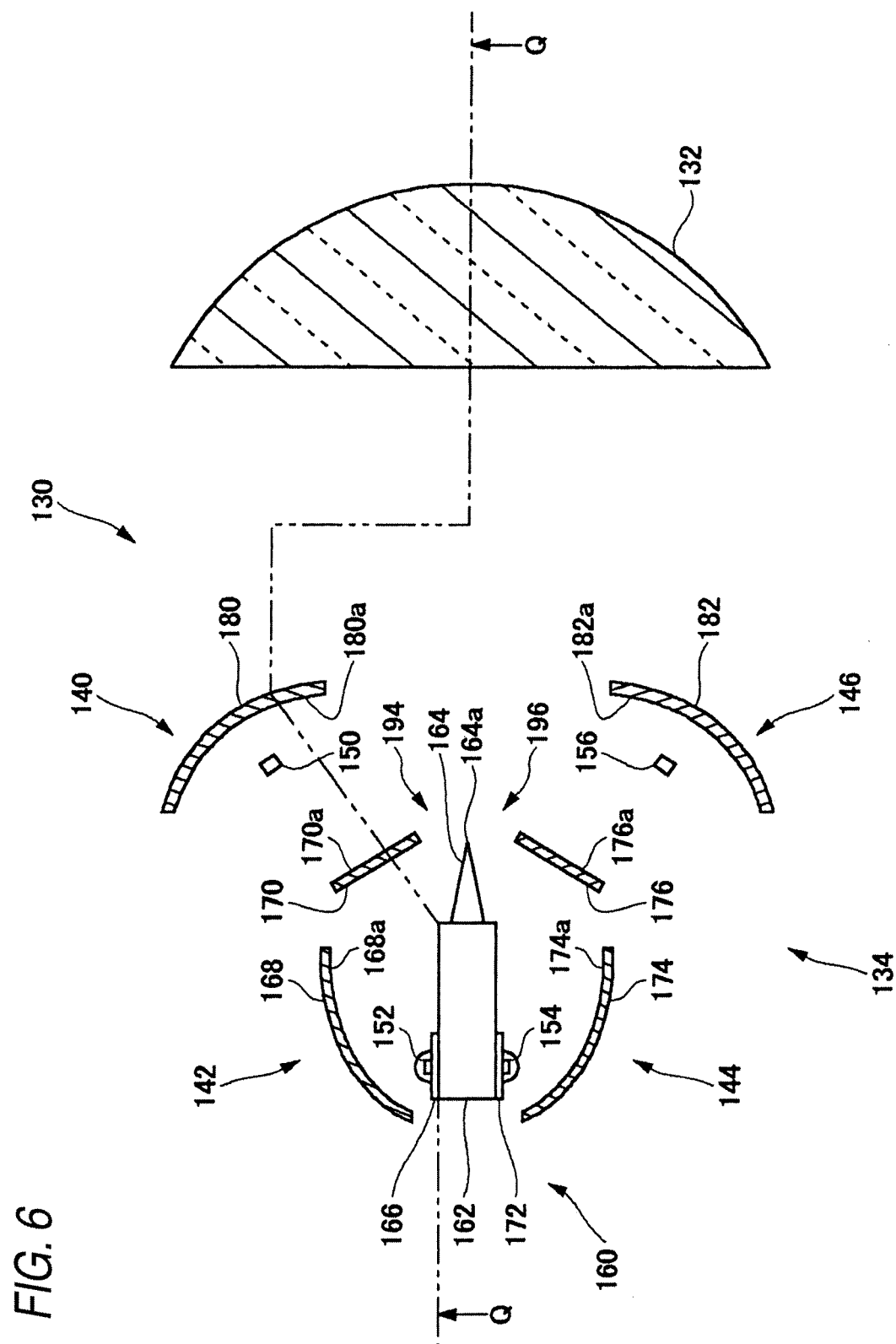


FIG. 7

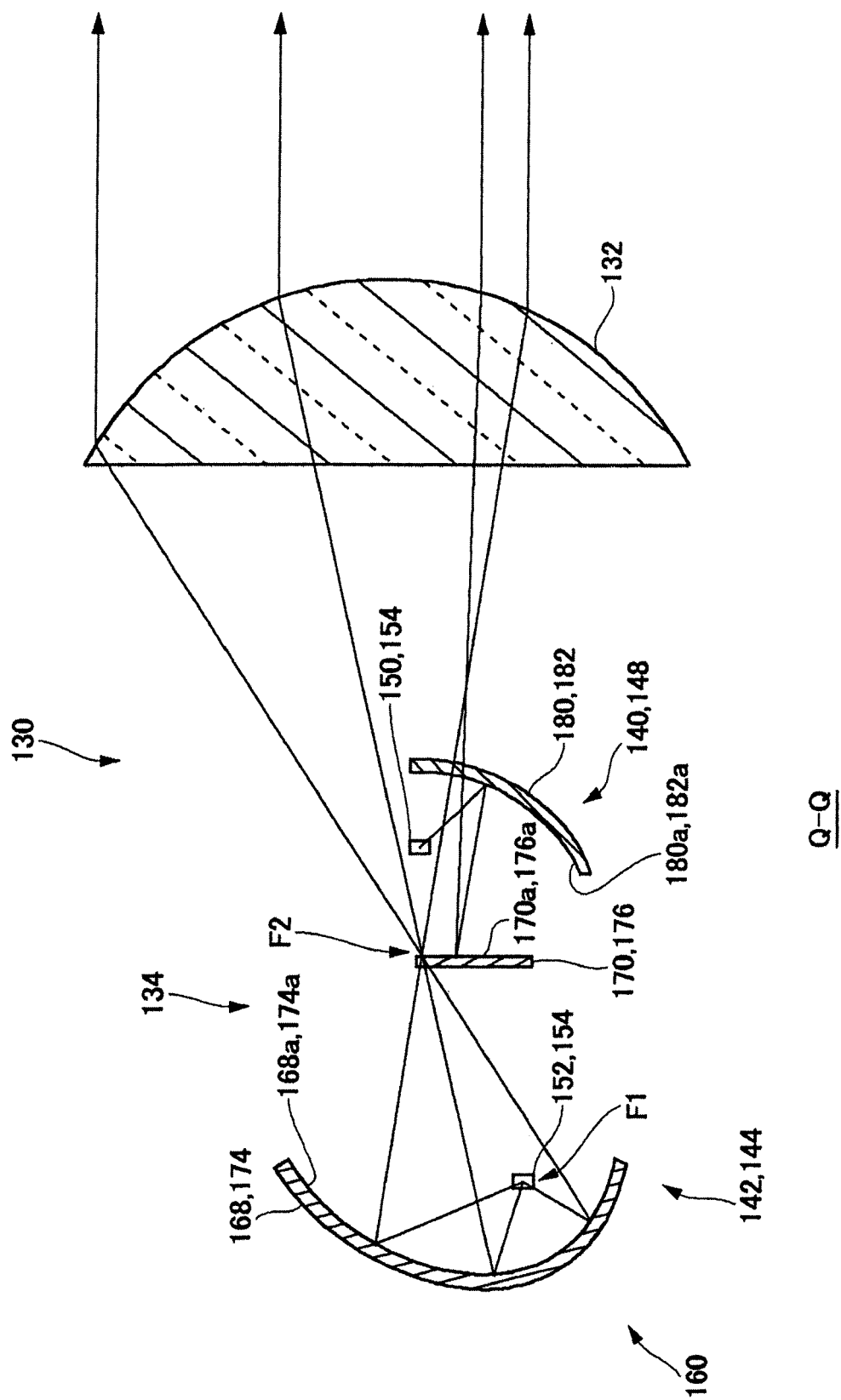


FIG. 8

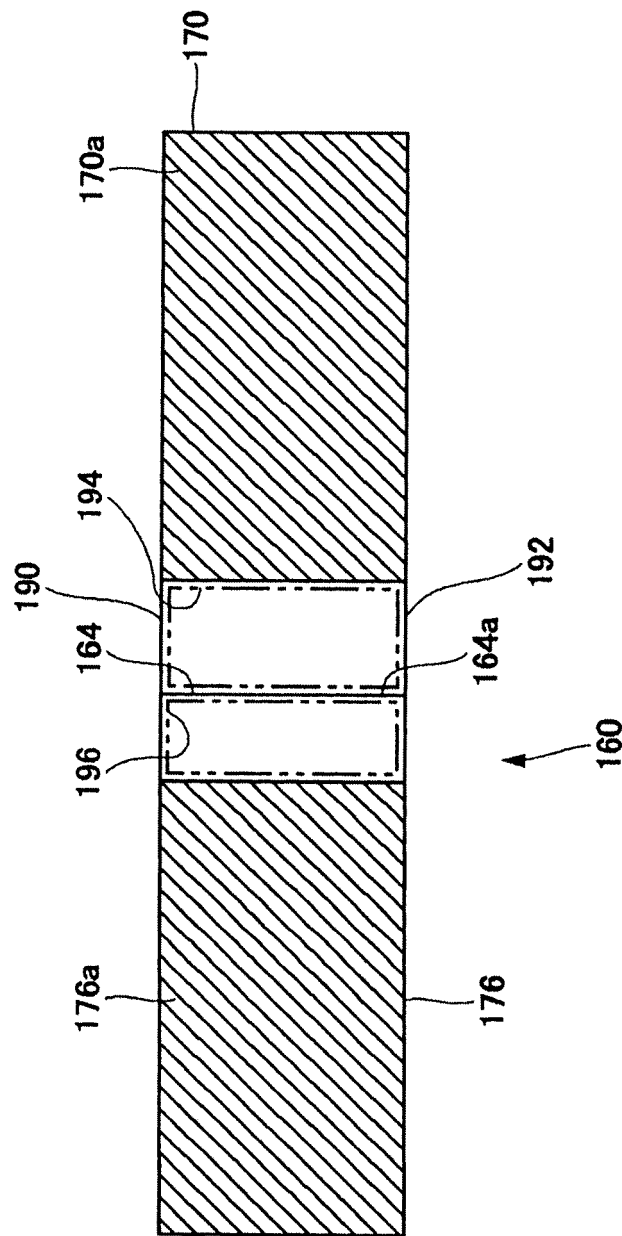
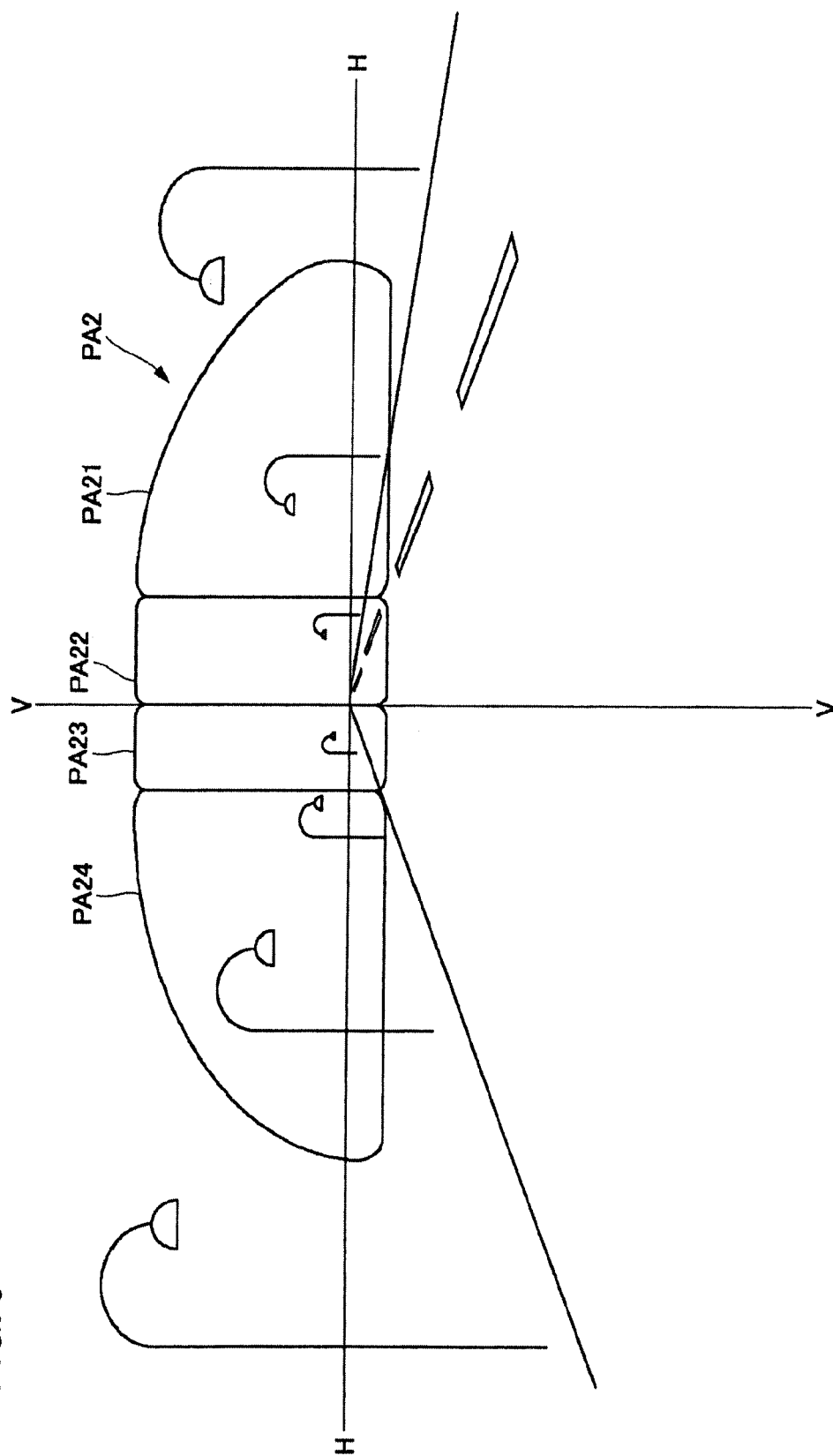


FIG. 9



REFERENCES CITED IN THE DESCRIPTION

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