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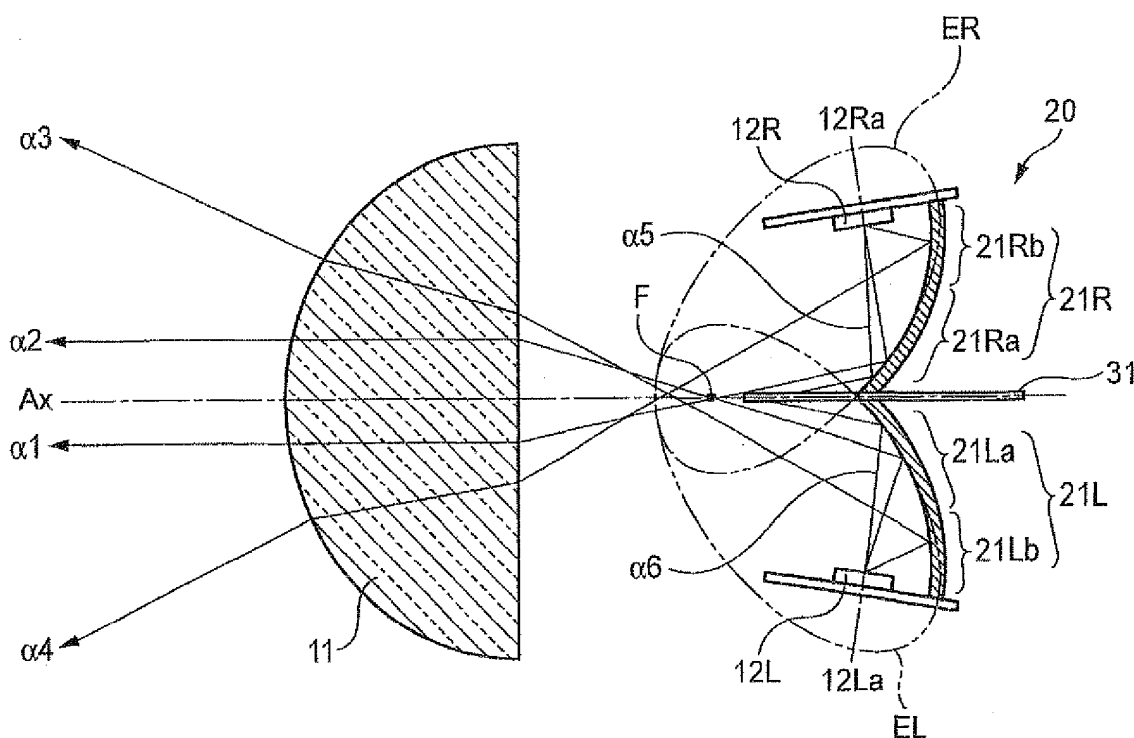
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(54) **Vehicle lamp**

(57) A vehicle lamp 1 is provided with a projection lens 11, a right semiconductor light-emitting element 12R, a left semiconductor light-emitting element 12L, a right condensing reflection face 21Ra, and a left condensing reflection face 21La. An illumination axis 12Ra

of the right semiconductor light-emitting element 12R directs to the right condensing reflection face 21Ra. An illumination axis 12La of the left semiconductor light-emitting element 12L directs to the left condensing reflection face 21La.

FIG.2



Description

BACKGROUND OF THE INVENTION

<FIELD OF THE INVENTION>

[0001] The present invention relates to a vehicle lamp for projecting light from a light source forward, and more particularly, to a vehicle lamp capable of improving a visibility of a driver of an own vehicle without giving glare to a driver of a preceding vehicle or a driver of an oncoming vehicle.

<RELATED ART>

[0002] As a luminance of semiconductor light-emitting elements (e.g. LEDs) is increased in recent years, vehicle lamps composed of LEDs have been developed. Patent document 1 proposes a kind of vehicle lamp capable of forming a plurality of different irradiation areas for illuminating a front area or only side areas of a vehicle depending on whether a pedestrian, a preceding vehicle or an oncoming vehicle is present so that no glare is given to the pedestrian, the driver of the preceding vehicle or the driver of the oncoming vehicle. The vehicle lamp according to Patent document 1 is composed of a plurality of LED units, each LED unit having a high degree of light condensation and a narrow irradiation area, and the Patent document 1 proposes to form a plurality of light distribution patterns by providing the plurality of LED units for illuminating areas different from one another and by controlling the ON/OFF operation of each LED unit. Patent Document 1: US 2007/0147055

[0003] The vehicle lamp disclosed in Patent document 1 has a configuration in which three reflectors are used to enhance the utilization ratio of the flux of light and to raise the illuminance. However, this configuration requires the three reflectors oriented in directions different from one another to form a left side irradiation pattern, a right side irradiation pattern and a central irradiation pattern, respectively, thereby having a problem that the vehicle lamp becomes large in size. When an attempt is made to solve this problem, that is, to make the vehicle lamp compact in size, by adopting a configuration in which the three reflectors are integrated while the intervals among them are shortened so that the reflectors are overlapped with one another, the area of the reflection face of the integrated reflector is decreased. As a result, the utilization ratio of a flux of light is reduced, and sufficient illuminance is not obtained.

SUMMARY OF THE INVENTION

[0004] One or more embodiments of the invention provide a vehicle lamp including semiconductor light-emitting elements as light sources and having a high utilization ratio of a flux of light.

[0005] In accordance with one or more embodiments

of the invention, a vehicle lamp 1 may include a projection lens 11, a right semiconductor light-emitting element 12R, a left semiconductor light-emitting element 12L, a right condensing reflection face 21Ra, and a left condensing reflection face 21La. The projection lens 11 may be disposed on an optical axis Ax of the vehicle lamp 1. A horizontal cross section of the right condensing reflection face 21Ra may be formed by a part of a substantially elliptic shape ER having a first focal point on the right light-emitting element 12R and a second focal point on a rear focal point F of the projection lens 11. A horizontal cross section of the left condensing reflection face 21La may be formed by a part of a substantially elliptic shape EL having a first focal point on the left light-emitting element 12L and a second focal point on the rear focal point F of the projection lens 11. An illumination axis 12Ra of the right semiconductor light-emitting element 12R may direct to the right condensing reflection face 21Ra. An illumination axis 12La of the left semiconductor light-emitting element 12L may direct to the left condensing reflection face 21La.

[0006] Other aspects and advantages of the invention will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

FIG. 1 is a schematic vertical sectional view showing a vehicle lamp of an exemplary embodiment.

FIG. 2 is a sectional view taken on line II-II of FIG. 1 in a state in which a movable shielding plate is not positioned in a vicinity of a rear focal point.

FIG. 3 is a sectional view taken on line II-II of FIG. 1 in a state in which the movable shielding plate is positioned in the vicinity of the rear focal point.

FIG. 4 is a schematic view showing a high-beam light distribution pattern formed by the vehicle lamp of the exemplary embodiment.

FIG. 5 is a schematic view showing a chasing high-beam light distribution pattern formed by the vehicle lamp of the exemplary embodiment.

FIG. 6 is a schematic view showing a first half high-beam light distribution pattern formed by the vehicle lamp of the exemplary embodiment.

FIG. 7 is a schematic view showing a second half high-beam light distribution pattern formed by the vehicle lamp of the exemplary embodiment.

DETAILED DESCRIPTION OF EMBODIMENT

[0008] A vehicle lamp according to an exemplary embodiment of the invention will be described below referring to the accompanying drawings. The exemplary embodiment is not intended to limit the invention but to serve as an example thereof, and all features or combinations thereof described in the exemplary embodiment not al-

ways essential to the invention.

<Overall structure of vehicle lamp>

[0009] FIG. 1 is a vertical sectional view showing a vehicle lamp of the exemplary embodiment. As shown in FIG. 1, a vehicle lamp 1 according to the exemplary embodiment is a vehicle headlamp equipped with a translucent cover 2 being transparent, a lamp body 3, and a lamp unit 10 accommodated in a lamp chamber formed of the translucent cover 2 and the lamp body 3.

[0010] An optical axis Ax of the vehicle lamp 1 extends in a front-rear direction of a vehicle. In the vehicle lamp 1, light from the lamp unit 10 is projected forward, and light distribution pattern switching can be performed among a high-beam light distribution pattern, a chasing high-beam light distribution pattern, a first half high-beam light distribution pattern, and a second half high-beam light distribution pattern.

[0011] As shown in FIG. 1, the lamp unit 10 is equipped with a projection lens 11 disposed on the optical axis Ax and serving as a convex lens; a pair of left and right LEDs (semiconductor light-emitting elements) 12L and 12R disposed behind a rear focal point F of the projection lens 11; a reflector 20 having a pair of left and right reflection faces 21L and 21R for reflecting the light from the LEDs 12L and 12R forward along the optical axis Ax; and a shading member 30, having a fixed shielding plate 31 and a movable shielding plate 32, for forming predetermined light distribution patterns by shielding part of the reflected light.

[0012] The lamp unit 10 is mounted on a base 5, and the base 5 is secured to a frame 7. A radiation unit 8, such as a radiation fin, is mounted behind the frame 7 to radiate heat generated in the LEDs 12L and 12R. The frame 7 is supported on the lamp body 3 via an aiming mechanism 9A and a leveling mechanism 9B. The optical axis Ax of the lamp unit 10 is adjusted and fixed using the aiming mechanism 9A so as to extend while being directed downward approximately 0.5 to 0.6° with respect to the horizontal direction. Furthermore, the lamp unit 10 is mounted on the lamp body 3 so that the optical axis Ax is adjustable in the vertical direction using the leveling mechanism 9B.

[0013] FIG. 2 is a sectional view taken on line II-II of FIG. 1. Referring to FIG. 2, the LEDs 12L and 12R are each formed of a white light-emitting diode in which a light-emitting face with a rectangular shape of 1x4 mm is formed on a substrate, for example. The LEDs 12L and 12R are disposed on both the left and right sides of the vehicle with the optical axis Ax interposed therebetween, one on each side. Furthermore, the LEDs 12L and 12R are disposed so as to be opposed to each other while the illumination axes 12La and 12Ra thereof are directed to the optical axis Ax. To be more exact, the LEDs 12L and 12R are disposed so as to be slightly inclined to the rear of the vehicle from the state of being opposed to each other to a state in which the illumination axes 12La

and 12Ra thereof are directed to the reflection faces 21L and 21R of the reflector 20.

[0014] The reflector 20 has the pair of left and right reflection faces 21L and 21R and is centered at the optical axis Ax. The left and right reflection faces 21L and 21R are reflection faces formed by aluminum deposition, for example, and the two reflection faces are connected to each other and integrated. Furthermore, the reflection faces 21L and 21R have condensing reflection faces 21La and 21Ra formed on the side of the optical axis Ax and also have diffuse reflection faces 21Lb and 21Rb formed on the sides opposite to (away from) the optical axis Ax so as to be continuous from the condensing reflection faces 21La and 21Ra, respectively.

[0015] The left and right condensing reflection faces 21La and 21Ra have an approximately elliptic spherical shape. Each of the respective horizontal cross-sections thereof is part of each of ellipses EL and ER having a first focal point located on the light-emitting face of each of the left and right LEDs 12L and 12R and also having a second focal point located at the rear focal point F of the projection lens 11. Moreover, the left and right condensing reflection faces 21La and 21Ra are disposed so as to face the left and right LEDs 12L and 12R, respectively. With this configuration, the lights emitted from the left and right LEDs 12L and 12R located at the first focal points are reflected by the left and right condensing reflection faces 21La and 21Ra, pass through the rear focal point F located at the second focal point, and enter the projection lens 11, whereby lights being parallel with the optical axis Ax are projected ahead of the vehicle as lights $\alpha 1$ and $\alpha 2$ shown in FIG. 2.

[0016] The left and right diffuse reflection faces 21Lb and 21Rb are reflection faces formed on the outsides of the left and right condensing reflection faces 21La and 21Ra (on the opposite sides of the optical axis Ax) so as to be continuous therefrom, respectively, and are used to project diffused lights to the side areas of the vehicle. In the exemplary embodiment, the left diffuse reflection face 21Lb reflects the light from the left LED 12L to the forward right side of the vehicle, and the right diffuse reflection face 21Rb reflects the light from the right LED 12R to the forward left side of the vehicle, whereby the lights are emitted while being diffused to the forward right and left sides of the vehicle as lights $\alpha 3$ and $\alpha 4$ shown in FIG. 2. The diffuse reflection faces 21Lb and 21Rb are each formed of a face having an approximately elliptic shape or an approximately parabolic shape in cross section, for example.

[0017] In the vehicle lamp 1 according to the exemplary embodiment described above, the illumination axes of the pair of the LEDs 12L and 12R are disposed so as to be directed to the left and right reflection faces 21L and 21R of the reflector 20, respectively. Furthermore, the reflection faces 21L and 21R are formed so as to cover the LEDs 12L and 12R, respectively, as understood easily referring to the side view shown in FIG. 1. Hence, most of the lights from the LEDs 12L and 12R spreading radi-

ally can be reflected by the reflector 20, and the utilization ratio of the flux of light can be raised, whereby the vehicle lamp 1 can have higher illuminance.

<Shading member>

[0018] The vehicle lamp 1 according to the exemplary embodiment is further equipped with the shading member 3 having the fixed shielding plate 31 and the movable shielding plate 32 as shown in FIG. 1. This shading member 30 will be described in detail referring to FIGS. 1 and 3. FIG. 3 is a view showing a state in which the movable shielding plate 32 is positioned in the vicinity of the rear focal point F shown in FIG. 2.

[0019] The fixed shielding plate 31 is a plate-like shielding member disposed so as to extend along the optical axis Ax from the boundary of the left and right condensing reflection faces 21La and 21Ra of the reflector 20. In the exemplary embodiment, the fixed shielding plate 31 is a shielding plate extending to just close to the rear focal point F along the optical axis Ax from the boundary of the condensing reflection faces 21La and 21Ra.

[0020] When one of the LEDs 12L and 12R is turned ON while the movable shielding plate 32 is not positioned at its shielding position, the fixed shielding plate 31 shields part of the lights reflected by the reflector 20, and a vertical cut line is formed. In other words, lights $\alpha 5$ and $\alpha 6$ emitted from the LEDs 12R and 12L and reflected by the areas of the condensing reflection faces 21La and 21Ra near the center of the optical axis Ax are shielded by the fixed shielding plate 31 and are not emitted ahead of the vehicle.

[0021] The movable shielding plate 32 is configured so that its position can be switched between a shielding position where part of the lights entering from the reflector 20 to the projection lens 11 on the optical axis Ax and in the vicinity of the rear focal point F of the projection lens 11 is shielded and a non-shielding position. Furthermore, the movable shielding plate 32 is formed into an approximately U-shape in cross section being open on the side of the reflector 20, and extending portions extending in parallel with the optical axis Ax are formed at both the left and right ends of the movable shielding plate 32. The extending portions of the movable shielding plate 32 are formed so as to enclose the rear focal point so that the reflected lights from the reflector 20 are suppressed from coming around the rear focal point and from being projected ahead of the vehicle.

[0022] Referring to FIG. 1, the movable shielding plate 32 is located at a position on the side of the base 5 away from the rear focal point F during normal time and is moved to a position on the side of the optical axis Ax in the vicinity of the rear focal point F by an actuator 33 as necessary. In other words, the position of the movable shielding plate 32 can be switched between the two positions. In the state in which the movable shielding plate 32 is located at the position on the side of the base 5 away from the rear focal point F, the movable shielding

plate 32 does not shield the lights reflected by the reflector 20 and entering the projection lens 11.

[0023] When the movable shielding plate 32 is moved by the actuator 33 from the position on the side of the base 5 away from the rear focal point F to the position on the side of the optical axis Ax in the vicinity of the rear focal point F, the movable shielding plate 32 is positioned in the vicinity of the rear focal point F on the optical axis Ax. The lights reflected by the condensing reflection faces 21La and 21Ra of the reflector 20 pass through the vicinity of the rear focal point F. In this state, part of the reflected lights from the left and right condensing reflection faces 21La and 21Ra is shielded by the movable shielding plate 32. Hence, when positioned in the vicinity of the rear focal point F, the movable shielding plate 32 shields the lights for illuminating the central area ahead of the vehicle. A known actuator, such as an actuator equipped with a feed screw mechanism and a motor for driving the mechanism, can be used as the actuator 30.

[0024] Additional reflection faces 32a may be formed on both sides of the movable shielding plate 32, one face on each side. Since part of the lights not reflected by the reflector 20 but directly emitted ahead of the vehicle from the LEDs 12L and 12R can be reflected by these additional reflection faces 32a and can be projected ahead of the vehicle via the projection lens 11, the additional reflection faces 32a formed as described above enhances the utilization ratio of the light.

<Light distribution patterns>

[0025] Next, light distribution patterns (high-beam light distribution pattern, first and second half high-beam light distribution patterns and chasing high-beam light distribution pattern) capable of being formed by the vehicle lamp 1 according to the exemplary embodiment will be described below referring to FIGS. 4 to 7. FIGS. 4 to 7 are perspective views showing light distribution patterns formed on an imaginary vertical screen disposed 25 m ahead of the vehicle lamp 1 by the irradiation light of the vehicle lamp 1. In the figures, V-V designates the vertical direction, and H-H designates the horizontal direction.

[0026] FIG. 4 shows the high-beam light distribution pattern that is used effectively in the case that a wide area ahead of the vehicle traveling normally is desired to be illuminated. The high-beam light distribution pattern can be formed by turning ON both the left and right LEDs 12L and 12R and by positioning the movable shielding plate 32 of the shading member 30 to the base 5 so that the reflected lights from the reflector 20 are not shielded as shown in FIG. 2. The reflected lights $\alpha 1$ and $\alpha 2$ from the right and left condensing reflection faces 21Ra and 21La are projected to the central area ahead of the vehicle, and irradiation areas A1 and A2 are formed in the central area ahead of the vehicle. The reflected lights $\alpha 3$ and $\alpha 4$ from the diffuse reflection faces 21Lb and 21Rb are projected to the right and left side areas ahead of the vehicle, and irradiation areas A3 and A4 are formed at

the right and left side areas ahead of the vehicle. These irradiation areas A1 to A4 are formed by the high-beam light distribution pattern as detailed above, and the wide area ahead of the vehicle is illuminated.

[0027] FIG. 5 shows the chasing high-beam light distribution pattern that is used effectively in the case that a preceding vehicle is traveling ahead of the subject vehicle. The chasing high-beam light distribution pattern can be accomplished by turning ON both the left and right LEDs 12L and 12R and by positioning the movable shielding plate 32 of the shading member 30 in the vicinity of the rear focal point F as shown in FIG. 3.

[0028] More specifically, part of the lights emitted from the left and right LEDs 12L and 12R and reflected by the left and right condensing reflection faces 21La and 21Ra is shielded by the movable shielding plate 32 positioned in the vicinity of the rear focal point F as shown in FIG. 3. Hence, irradiation areas A1a and A2a not illuminating the central area ahead of the vehicle are formed. In addition, the lights $\alpha 3$ and $\alpha 4$ emitted from the left and right LEDs 12L and 12R and reflected to the right and left sides by the left and right diffuse reflection faces 21Lb and 21Rb are not shielded by the movable shielding plate 32 but projected forward, and the irradiation areas A3 to A4 are formed at the right and left side areas ahead of the vehicle.

[0029] Hence, the chasing high-beam light distribution pattern having the irradiation areas A1a, A2a, A3 and A4 so that only the central area ahead of the subject vehicle is not illuminated is formed ahead of the subject vehicle as shown in FIG. 5. By virtue of the chasing high-beam light distribution pattern, the visibility of the driver of the subject vehicle can be improved without giving glare to the driver of the preceding vehicle traveling at the central area ahead of the subject vehicle.

[0030] FIG. 6 shows the first half high-beam light distribution pattern that is used effectively in the case that a preceding vehicle is traveling ahead of the subject vehicle and an oncoming vehicle is coming on the right side ahead of the subject vehicle. The first half high-beam light distribution pattern can be accomplished by positioning the movable shielding plate 32 of the shading member 30 in the vicinity of the rear focal point F as shown in FIG. 3 and by turning ON only the right LED 12R without turned ON the left LED 12L.

[0031] More specifically, part of the light emitted from the right LED 12R and reflected by the right condensing reflection face 21Ra is shielded by the movable shielding plate 32 positioned in the vicinity of the rear focal point F as shown in FIG. 3. Hence, an irradiation area A1b not illuminating the central area ahead of the subject vehicle is formed. Furthermore, the light $\alpha 4$ emitted from the right LED 12R and reflected by the right diffuse reflection face 21Rb is not shielded but projected, and the irradiation area A4 is formed at the left side area ahead of the subject vehicle.

[0032] Hence, the first half high-beam light distribution pattern having the irradiation areas A1b and A4 so that

only the left side area ahead of the subject vehicle is illuminated is formed ahead of the subject vehicle as shown in FIG. 6. By virtue of the first half high-beam light distribution pattern, the forward visibility of the driver of the subject vehicle can be improved without giving glare to the driver of the preceding vehicle traveling ahead of the subject vehicle and to the driver of the oncoming vehicle coming on the right side ahead of the subject vehicle.

[0033] FIG. 7 shows the second half high-beam light distribution pattern that is used effectively in the case that an oncoming vehicle is coming on the right side ahead of the subject vehicle and a preceding vehicle is not traveling ahead of the subject vehicle. The second half high-beam light distribution pattern can be accomplished by not positioning the movable shielding plate 32 of the shading member 30 at its shielding position as shown in FIG. 2 and by turning ON only the right LED 12R.

[0034] More specifically, the right LED 12R is turned ON and the movable shielding plate 32 of the shading member 30 is positioned on the side of the base 5 so as not to shield the reflected light from the reflector 20 as shown in FIG. 2. The reflected light $\alpha 1$ from the right condensing reflection face 21Ra is projected to the central area ahead of the subject vehicle, and the irradiation area A1 is formed at the central area ahead of the subject vehicle. The reflected light $\alpha 4$ from the left diffuse reflection face 21Rb is projected to the left side area ahead of the subject vehicle, and the irradiation area A4 is formed at the left side area ahead of the subject vehicle. At this time, the fixed shielding plate 31 shields the lights reflected by the areas of the condensing reflection faces 21Ra and 21La in the vicinity of the center of the optical axis Ax. As a result, a vertical cut-off line VCL shown in FIG. 7 is formed in the second half high-beam light distribution pattern.

[0035] Hence, the second half high-beam light distribution pattern having the irradiation areas A1 and A4 so that the wide area from the central area to the left side area ahead of the subject vehicle is illuminated is formed ahead of the subject vehicle as shown in FIG. 7. By virtue of the second half high-beam light distribution pattern, the forward visibility of the driver of the subject vehicle can be improved without giving glare to the driver of the oncoming vehicle coming on the right side ahead of the subject vehicle.

[0036] According to the exemplary embodiment, the vehicle lamp is equipped with a pair of semiconductor light-emitting elements disposed on the left and right sides thereof with the optical axis thereof interposed therebetween and a reflector having a pair of left and right reflection faces. Furthermore, the semiconductor light-emitting elements are disposed so that the illumination axes thereof are respectively directed to the reflection faces of the reflector. Hence, most of the light from the semiconductor light-emitting elements spreading radially from the illumination axes can enter the reflectors. As a result, the light emitted from the semiconductor light-

emitting elements can be reflected efficiently by the reflector, whereby a vehicle lamp having a high utilization ratio of the flux of light can be provided.

[0037] In the vehicle lamp 1 according to the exemplary embodiment, the pair of the LEDs 12L and 12R is disposed so that the illumination axes thereof are directed to the left and right reflection faces 21L and 21R of the reflector 20, respectively, whereby the utilization ratio of the flux of light is raised. In addition, the vehicle lamp 1 is configured so that a plurality of light distribution patterns can be formed by virtue of the shading member 30 equipped with the fixed shielding plate 31 and the movable, shielding plate 32. As a result, it is possible to accomplish the vehicle lamp 1 capable of forming a plurality of light distribution patterns having high illuminance although the vehicle lamp 1 is a type equipped with a small reflector in which the left and right reflection faces thereof are integrated.

[0038] In the exemplary embodiment described above, it is described that the left and right diffuse reflection faces 21Lb and 21Rb are reflection faces for reflecting the lights entered from the left and right LEDs 12L and 12R in directions opposite to each other. However, each of the left and right diffuse reflection faces 21Lb and 21Rb may be used as a reflection face for reflecting the light in both the left and right directions. With this configuration, it is possible to form a light distribution pattern capable of illuminating a wider range uniformly.

[Description of Reference Numerals and Signs]

[0039] 1 vehicle lamp, 2 translucent cover, 3 lamp body, 5 base, 10 lampunit, 11 projection lens, 12L, 12R LED (semiconductor light-emitting element), 20 reflector, 21La, 21Ra condensing reflection face, 21Lb, 21Rb diffuse reflection face, 30 shading member, 31 fixed shielding plate, 32 movable shielding plate

Claims

1. A vehicle lamp (1) comprising:

a projection lens (11) disposed on an optical axis (Ax) extending in a front-rear direction of a vehicle,
a right semiconductor light-emitting element (12R) disposed on a right side of the optical axis (Ax);
a left semiconductor light-emitting element (12L) disposed on a left side of the optical axis (Ax);
a reflector (20) including a right condensing reflection face (21Ra) and a left condensing reflection face (21La),
wherein a horizontal cross section of the right condensing reflection face (21Ra) is formed by a part of a substantially elliptic shape (ER) having a first focal point on the right light-emitting

element (12R) and a second focal point on a rear focal point (F) of the projection lens (11), wherein a horizontal cross section of the left condensing reflection face (21La) is formed by a part of a substantially elliptic shape (EL) having a first focal point on the left light-emitting element (12L) and a second focal point on the rear focal point (F) of the projection lens (11), and wherein an illumination axis (12Ra) of the right semiconductor light-emitting element (12R) directs to the right condensing reflection face (21Ra) and an illumination axis (12La) of the left semiconductor light-emitting element (12L) directs to the left condensing reflection face (21La), such that light reflected on the right and left condensing reflection faces (21Ra, 21La) is projected forward along the optical axis (Ax) via the projection lens (11).

2. The vehicle lamp (1) according to claim 1, further comprising:

a fixed shielding plate (31) extending along the optical axis (Ax) from a boundary of the right condensing reflection face (21Ra) and the left condensing reflection face (21La), and
a movable shielding plate (32) movable between a shielding position and a non-shielding position, wherein, in the shielding position of the movable shielding plate (32), a part of the light entering from the condensing reflection faces (21Ra, 21La) to the projection lens is shielded by the movable shielding plate (32) on the optical axis (Ax) and in a vicinity of the rear focal point (F) of the projection lens (11) so as to form a light distribution pattern not allowing light to be projected to a front central portion of the vehicle lamp.

3. The vehicle lamp (1) according to claim 1 or 2, further comprising:

a right diffuse reflection face (21Rb) formed on an outside of the right condensing reflection face (21Ra) away from the optical axis (Ax) and configured to reflect light so as to illuminate a forward-left side area of the vehicle; and
a left diffuse reflection face (21Lb) formed on an outside of the left condensing reflection face (21La) away from the optical axis (Ax) and configured to reflect light so as to illuminate a forward-right side area of the vehicle.

FIG.1

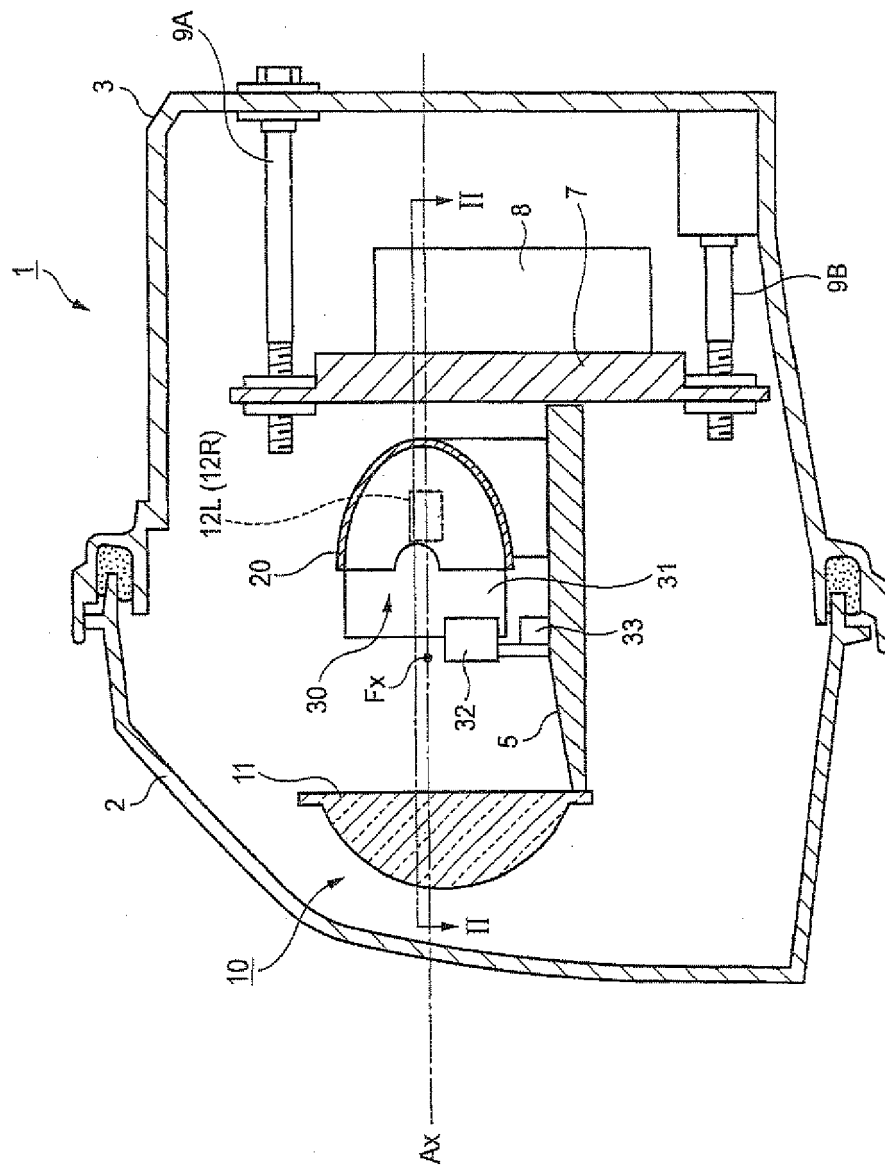


FIG. 2

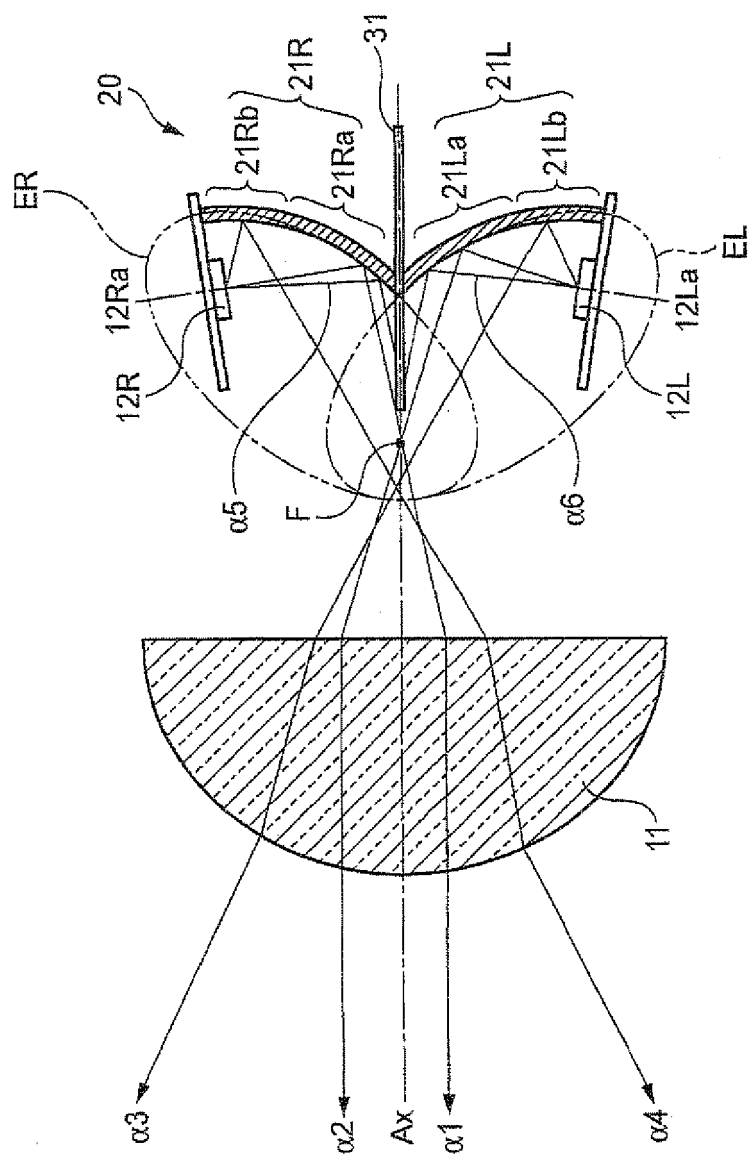


FIG.3

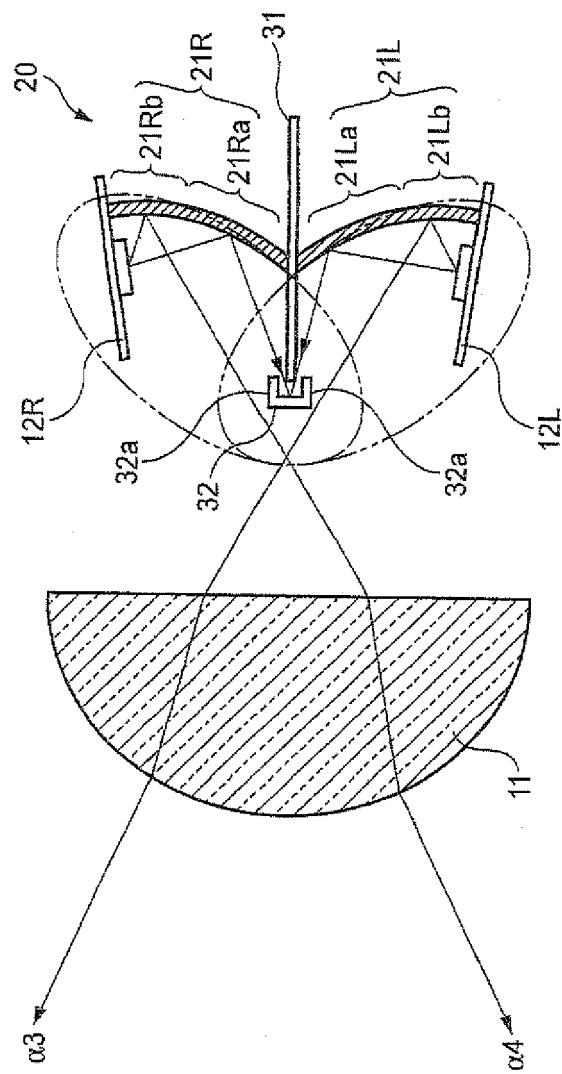


FIG. 4

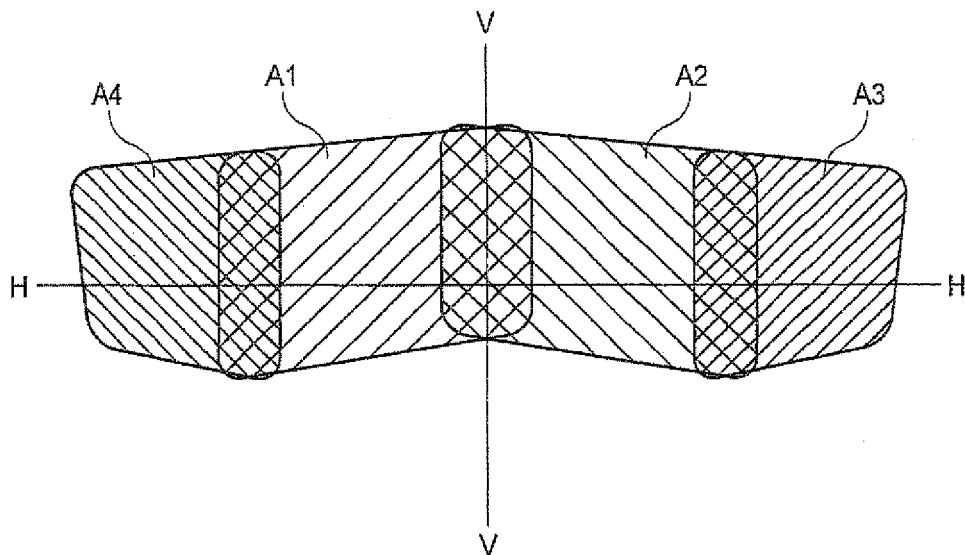


FIG. 5

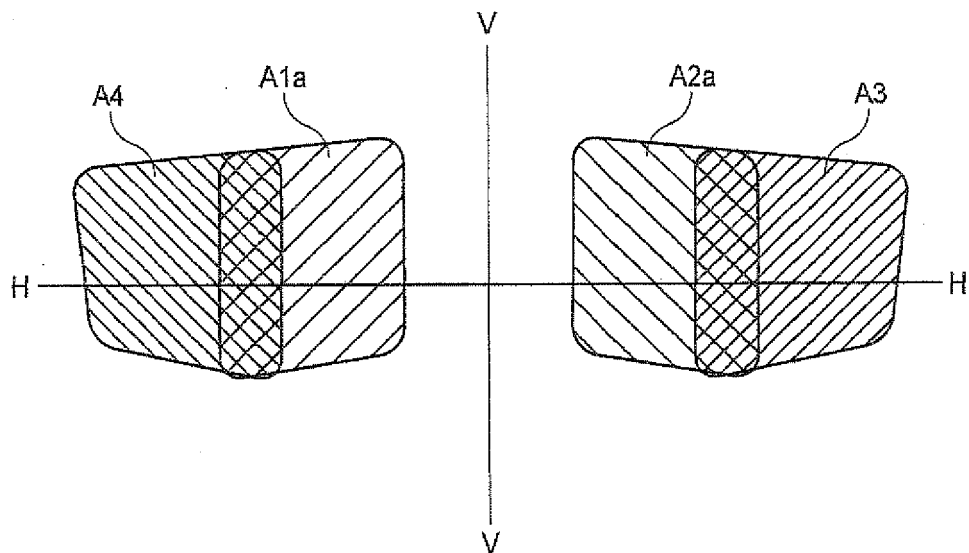


FIG. 6

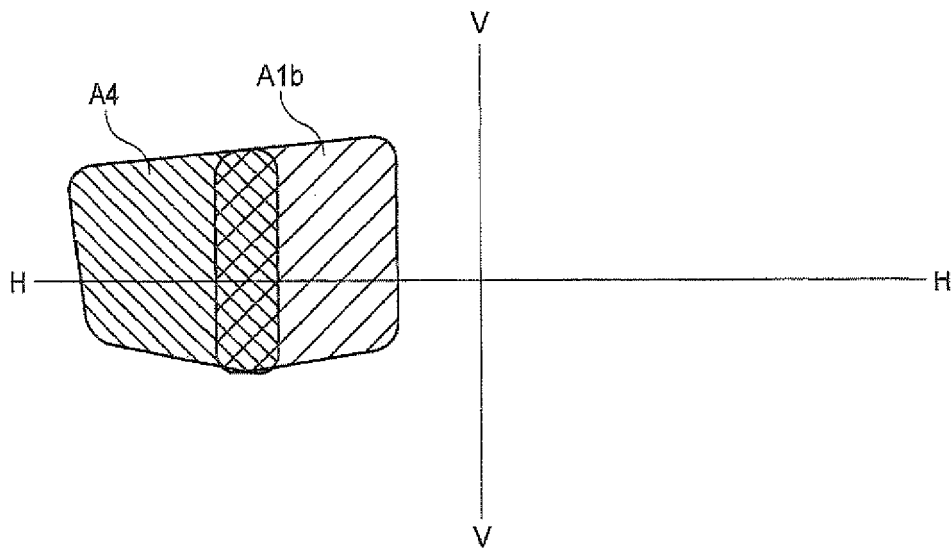
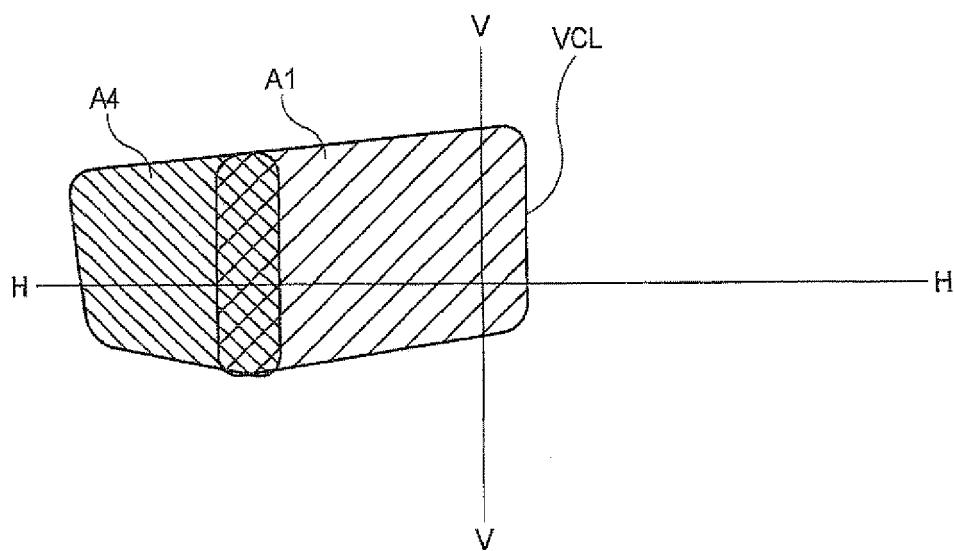


FIG. 7



REFERENCES CITED IN THE DESCRIPTION

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