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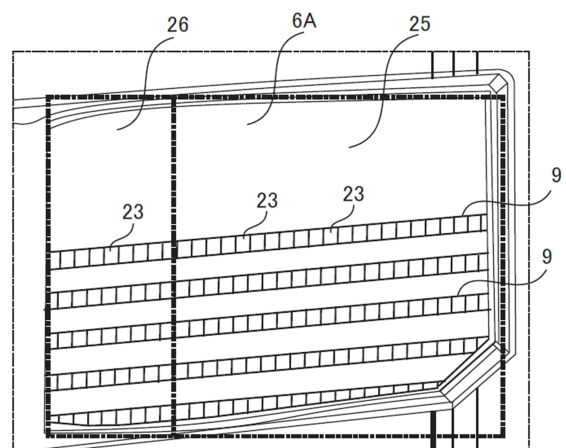
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(54) **VEHICLE LAMP**

(57) A vehicle lamp including: a light source; a projection lens provided closer to a front of a vehicle than the light source; a shade disposed between the light source and the projection lens to form cutoff lines in a light distribution pattern; and a reflector that reflects light from the light source toward the projection lens, wherein the projection lens has band-shaped regions (9), extending in a vehicle width direction, set on an incidence surface thereof, multiple prisms (23) are provided in a row in the band-shaped regions, and the multiple prisms (23) are composed of two or more types of prisms (23) having different radii of curvature in a length direction of the band-shaped regions.

[FIG. 6]



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Description**TECHNICAL FIELD**

[0001] The present disclosure relates to a vehicle lamp.

BACKGROUND

[0002] Generally, a vehicle lamp has a structure that includes a projection lens provided at the front part of a vehicle, a light source provided behind the projection lens, a reflector that reflects light from the light source toward the projection lens, a shade that forms cutoff lines in a light distribution pattern, and the like. Conventionally, the vehicle lamp described in Patent Document 1 is known as this type of vehicle lamp.

CITATION LIST**PATENT LITERATURE**

[0003] Patent Document 1: JP 4782064 B2

SUMMARY OF INVENTION**TECHNICAL PROBLEM**

[0004] Patent Document 1 discloses a vehicle lamp provided with a vertical direction diffuser for adjusting cutoff lines, the vertical direction diffuser including a projection lens element that extends substantially parallel to a horizontal portion in the upper end edge of a shade, and Patent Document 1 describes that the vertical direction diffuser blurs the cutoff lines.

However, although this vehicle lamp can mitigate the brightness difference at the cutoff lines, it cannot appropriately set, in a left-right direction of the cutoff lines, the degrees of brightness difference to be different among respective parts.

Moreover, this vehicle lamp has a problem in that, since the projection lens element has a structure that only diffuses light in a vertical direction, uneven light distribution is likely to occur.

In this type of technology, in order to improve visibility for a driver, it is useful to appropriately set the above-mentioned brightness difference in a left-right direction of an illumination region, and it is also necessary to suppress the occurrence of uneven light distribution.

[0005] The problem to be solved by the present disclosure is, in a vehicle lamp, to mitigate the brightness difference at cutoff lines in a light distribution pattern, to appropriately set a brightness difference in a left-right direction in the light distribution pattern, and further to suppress uneven light distribution.

SOLUTION TO PROBLEM

[0006] The vehicle lamp according to the present disclosure includes: a light source; a projection lens provided closer to the front of a vehicle than the light source; a shade disposed between the light source and the projection lens to form cutoff lines in a light distribution pattern; and a reflector that reflects light from the light source toward the projection lens, wherein the projection lens has band-shaped regions, extending in a vehicle width direction, set on an incidence surface thereof, multiple prisms are provided in a row in the band-shaped regions, and the multiple prisms are composed of two or more types of prisms having different radii of curvature in a longitudinal direction of the band-shaped regions.

BRIEF DESCRIPTION OF DRAWINGS

[0007]

FIG. 1 is a front view of a vehicle lamp shown as an embodiment of the present disclosure.

FIG. 2 is a configuration diagram showing the basic configuration of the same vehicle lamp.

FIG. 3 is a view from the back surface of a projection lens of the same vehicle lamp.

FIG. 4 is an enlarged back view of a low-beam portion of the same vehicle lamp.

FIG. 5 is an explanatory diagram showing the shape of prisms of the same vehicle lamp.

FIG. 6 is an enlarged back view of a low-beam portion of the same vehicle lamp and shows a light-collecting area and a diffusing area.

FIG. 7 is an explanatory diagram showing a reflector and the projection lens of the same vehicle lamp as well as a travel direction of light.

FIG. 8 is a drawing showing a light distribution pattern of the same vehicle lamp.

FIG. 9 is an explanatory diagram showing a light diffusion state in the same vehicle lamp.

DESCRIPTION OF EMBODIMENTS

[0008] Hereinafter, an embodiment of the present disclosure will be explained with reference to the drawings. Throughout the entire explanation of the embodiments described herein, the same elements are given the same number. Moreover, in the embodiments and drawings, unless otherwise noted, "front" and "back" respectively indicate "forward direction" and "backward direction" of a

vehicle, and "above", "below", "left", and "right" each indicate directions seen by a driver on board the vehicle.

[0009] A vehicle lamp according to an embodiment of the present disclosure is a vehicle lamp mounted on each of left and right automobile headlights in front of a vehicle. Hereinafter, a vehicle lamp disposed on the right side of a vehicle for left-side traveling will be described.

[0010] FIG. 1 is a diagram of a headlight 1 as viewed from a side facing the front surface thereof, and the headlight 1 shown in this diagram includes a low-beam lamp unit 2 and a high-beam lamp unit 3 configured as an Adaptive High Beam System (AHS).

The present embodiment focuses on the low-beam lamp unit 2 of the headlight 1, and hereinafter, the low-beam lamp unit will be described as a vehicle lamp 2.

[0011] FIG. 2 is a vertical cross-sectional view along the light illumination optical axis X of the vehicle lamp 2. As shown in FIG. 2, the vehicle lamp 2 includes a light source 4, a reflector 5 disposed so as to cover the light source 4 in a semi-dome shape, a projection lens 6A disposed in front of the light source 4, and a shade 7 disposed between the reflector 5 and the projection lens 6A.

(Light Source)

[0012] As a light source 4, a semiconductor-type light source can be suitably used, and in the present embodiment, an LED, which is a semiconductor-type light source having a light-emitting chip provided on a substrate on which electrical wirings for power supply (not shown), etc. are formed, is used.

[0013] The number of the light-emitting chips is not particularly limited and may be one or more.

Moreover, the shape of the light-emitting chip is not particularly limited and may be a square shape or a rectangular shape.

In addition, the present embodiment shows an example in which an LED is used as the light source 4, but semiconductor-type light sources such as an LD or an EL (organic EL) may also be used.

[0014] As shown in FIG. 2, in the present embodiment, the substrate is disposed so that the light-emitting surface of the light-emitting chip faces upward, and the light from the light source 4 is irradiated upward.

(Reflector)

[0015] The reflector 5 is disposed so as to cover the light source 4 in a semi-dome shape, and the light from the light source 4 is reflected toward the projection lens 6A by the reflecting surface 8 of the reflector 5.

[0016] The material used for the reflector 5 can be a metal material having high thermal conductivity (for example, aluminum, etc.) or a resin material, for example, polycarbonate, etc.

[0017] The reflecting surface 8 of the reflector 5 is a free-form curved surface based on a spheroidal surface

(ellipse), and in the present embodiment, as shown in FIG. 7, includes a light-collecting segment 8A, a diffusing segment 8B, and another segment 8C. Note that FIG. 7 will be described in detail later.

(Projection Lens)

[0018] In the present embodiment, as shown in FIG. 1, a low-beam projection lens 6A and a high-beam projection lens 6B are integrally formed as a structure of the projection lens 6 of the entire headlight 1. The projection lens 6 has, when viewed from a side facing a front surface of the vehicle, a height dimension (width dimension) W1, and has a shape that extends in a vehicle width direction and also obliquely upward from the center in the vehicle width direction toward an outer region.

[0019] In FIG. 1, the portion surrounded by the dashed-dotted line on the left side is the low-beam projection lens 6A, and the portion surrounded by the dashed-dotted line on the right side is the high-beam projection lens 6B. The details of the low-beam projection lens 6A will be described below.

This projection lens 6 can be formed by using a transparent resin material such as polycarbonate or acrylic.

(Shade)

[0020] A shade 7 can be suitably formed using a material that is light-impermeable, and as shown in FIG. 2, the upper end of the shade 7 is provided so as to be positioned near the second focus point of the reflector 5 (light-collecting segment 8A) and the rear focus point of the projection lens 6A.

[0021] Moreover, light from the light source 4 is reflected by the reflecting surface 8 of the reflector 5, and a portion of the light that travels toward the projection lens 6A is blocked, thereby forming cutoff lines CL1 and CL2 of a low-beam light distribution pattern PL.

[0022] The foregoing is a description of the basic structure of the vehicle lamp 2, and in this structure, when the light source 4 shown in FIG. 2 is turned on, light from the light source 4 is reflected by the reflector 5. Moreover, light that illuminates the front of the vehicle including the center of the cutoff lines CL1 and CL2 of the light distribution pattern PL and light that illuminates the front of the vehicle including the vehicle width-direction outer region of the light distribution pattern PL, shown in FIG. 8, travel toward the projection lens 6. In this case, since a portion of light from the reflector 5 is blocked by the shade 7, cutoff lines CL1 and CL2 are formed in the irradiated light distribution pattern PL.

(Main Parts of Projection Lens)

[0023] Next, the details of the projection lens 6A described above will be explained. FIG. 3 is a diagram that shows the back surface of the projection lens 6. The portion indicated by the dashed-dotted line on the right

side is the low-beam projection lens 6A, and the portion indicated by the dashed-dotted line on the left side is the high-beam projection lens 6B. As shown in this diagram, in the low-beam projection lens 6A, multiple rows (five rows in the embodiment) of band-shaped regions 9 extending in a left-right direction are provided on a back surface serving as an incidence surface, spaced apart from one another in the vertical direction, and multiple prisms 23, described below, are provided within these regions 9.

[0024] The positions at which the band-shaped regions 9 are provided within the projection lens 6A described above, the number of rows of the band-shaped regions 9, and the like are determined as appropriate positions, numbers of rows, and the like depending on structures, positions, and the like of the reflector 5 and the shade 7 disposed behind the projection lens 6A.

[0025] Here, as shown in FIG. 1, the projection lens 6 has a height dimension (width dimension) W1 as described above, and has a shape that extends in a vehicle width direction and also obliquely upward from the center in the vehicle width direction toward an outer region. The above-mentioned band-shaped regions 9 are also configured, as shown in FIG. 3, to extend in the vehicle width direction along upper and lower contour lines of the projection lens 6 and to extend toward an obliquely upward direction of the vehicle, and multiple prisms 23 are provided within these regions 9.

[0026] The details of the back surface (light incidence surface) of the projection lens 6A are shown in FIG. 4. As shown in this diagram, the band-shaped regions 9 are configured so as to extend in a left-right direction, that is, in a vehicle width direction. With respect to upper and lower horizontal partition lines 21, 21 that define this region 9, multiple vertical partition lines 22 in a vertical direction (up-and-down direction) are set apart from each other in a direction in which the horizontal partition lines 21 extend, and prisms 23 are formed in parallelogram regions surrounded by these horizontal partition lines 21, 21 and the vertical partition lines 22, 22.

[0027] As shown in FIG. 5, when the back surface of the projection lens 6A is configured as a reference plane 24, the prisms 23 are formed so as to be convex or concave with respect to the reference plane 24 (FIG. 5 shows a case in which the prisms are convex). The reference plane 24 is a convex surface that moderately curves with a radius of curvature r_1 , and the relationship with a radius of curvature r_2 of the prisms 23 is $r_1 > r_2$.

[0028] The prisms 23 are formed, within the band-shaped regions 9 shown in FIG. 4, in the parallelogram regions surrounded by the horizontal partition lines 21, 21 and the vertical partition lines 22, and are formed so as to bulge (or recess) from the above-mentioned four horizontal partition lines 21 and 21 and vertical partition lines 22, 22 toward a central part of the parallelogram. Therefore, these prisms 23 diffuse light incident on the back surface side of the projection lens 6A in a vertical direction, and also diffuse the light in a left-right direction.

[0029] FIG. 5 shows, for convenience of explanation, a case in which adjacent prisms 23 of the multiple prisms 23 are provided in a state of being in contact with each other. This arrangement state of the multiple prisms 23 may include a case in which the prisms 23 are provided in all adjacent parallelogram regions shown in FIG. 4, as well as a case in which adjacent prisms 23, 23 are configured so as to be spaced apart, as appropriate, regardless of the parallelogram regions.

[0030] As such, by spacing apart or not spacing apart the adjacent prisms 23 and also adjusting the thickness, the size, and the like of the prisms 23, the degree of diffusion of light in the left-right direction of the light distribution pattern PL can be adjusted and appropriately configured.

[0031] The back surface of the projection lens 6A is, as shown in FIG. 6, partitioned, with vertical partition lines as a boundary, into a light-collecting area 25 on a right side and a diffusing area 26 on a left side. In this case, between the light-collecting area 25 and the diffusing area 26, the light-collecting area 25 has a longer length in a horizontal direction and a larger area than the diffusing area 26. The above-mentioned band-shaped regions 9 are formed across the light-collecting area 25 and the diffusing area 26, and the multiple prisms 23 are formed in these regions 9.

[0032] In the present embodiment, the multiple prisms 23 have a relationship such that, in a length direction of the band-shaped regions 9, a radius of curvature of the prisms 23 in the light-collecting area 25 $\leq$ the radius of curvature of the prisms 23 in the diffusing area 26.

By employing this configuration, in a left-right direction of the cutoff lines CL1 and CL2 formed in the light distribution pattern PL, an effect is obtained in which a degree of mitigating a brightness difference of light near a central part of the cutoff lines CL1 and CL2 becomes greater, and a degree of mitigating a brightness difference of light on an outer region of the vehicle becomes smaller.

[0033] The horizontal cross-section in a left-right direction of this projection lens 6A is shown in FIG. 7. As shown in FIG. 7, the back surface 27 (reference plane 24) has a shape that bulges backward. Within this bulging shape region, a light-collecting area 25 and a diffusing area 26 are formed. A relationship between a radius of curvature of the light-collecting area 25 and a radius of curvature of the diffusing area 26 is such that the radius of curvature of the light-collecting area 25 $>$ the radius of curvature of the diffusing area 26.

[0034] As shown in FIG. 7, the reflector 5 includes a light-collecting segment 8A, a diffusing segment 8B, and another segment 8C. The light-collecting segment 8A is configured to reflect light from the light source 4 toward the direction of the light-collecting area 25 of the projection lens 6. The diffusing segment 8B is configured to reflect light from the light source 4 toward the direction of the diffusing area 26 of the projection lens 6. The another segment 8C is configured to mainly reflect light from the light source 4 toward the direction of the light-collecting

area 25 of the projection lens 6.

[0035] In this structure, the light reflected by the light-collecting segment 8A enters the light-collecting area 25, then passes through the lens, and travels forward including the center of the vehicle. The light reflected by the diffusing segment 8B enters the diffusing area 26, then passes through the lens, and travels in directions that diffuse toward the outer side directions of the vehicle. The light reflected by the another segment 8C mainly enters the light-collecting area 25, then passes through the lens, and travels toward the front over an entire range in a vehicle width direction.

In this case, the light-collecting segment 8A is configured such that the first focus point of the light is near the light source 4 and the second focus point is located between the light-collecting segment 8A and the projection lens 6. Moreover, the diffusing segment 8B is configured such that the first focus point of the light is near the light source 4 and the second focus point is near the front surface of the projection lens 6.

[0036] FIG. 8 shows a light distribution pattern irradiated from the projection lens 6. As shown in this diagram, since a portion of light from the reflector 5 is blocked by the shade 7 in the light distribution pattern, cutoff lines CL1 and CL2 are formed in the irradiated light distribution pattern PL.

In the diagram, the region indicated by reference number 61 is a light-collecting irradiated region of light reflected by the light-collecting segment 8A, the region indicated by reference number 62 is a lateral irradiated region of light reflected by the diffusing segment 8B, and the region indicated by reference number 63 is a diffusing irradiated region of light reflected by the another segment 8C.

[0037] FIGs. 9 (a) and (b) are diagrams that respectively show a state in which a brightness difference of light is mitigated. In these diagrams, the brightness difference of light is shown by differences in density. FIG. 9 (a) is a diagram of a case in which prisms 23 are not provided, and the brightness difference is clear in both areas A1 and A2 in the cutoff lines CL1 and CL2. FIG. 9 (b) is a diagram of a case in which prisms 23 are provided, and it can be seen that the brightness difference is mitigated in both regions A1 and A2.

[0038] As described above, the vehicle lamp 2 is a structure in which band-shaped regions 9 are configured on a back surface of the projection lens 6, and multiple concave or convex prisms 23 are provided in a length direction of the regions. For this reason, when light from the light source 4 is incident on the prisms 23 and is emitted therefrom, the light is diffused in a vertical direction and a left-right direction. This makes it possible to mitigate a brightness difference near the cutoff lines CL1 and CL2 in the light distribution pattern PL, and also to suppress occurrence of uneven light distribution. Thus, it is possible to improve long-range visibility of a driver.

[0039] Moreover, the prisms 23 that irradiate light toward the center of the vehicle are configured to have a

smaller radius of curvature than the prisms 23 that irradiate light toward outer regions. For this reason, it is possible to mitigate a brightness difference near the center of the cutoff lines CL1 and CL2 to a greater extent, to mitigate a brightness difference on outer regions of the vehicle to a smaller extent, and to appropriately mitigate a brightness difference in the left-right direction of the cutoff lines CL1 and CL2.

[0040] In addition, the multiple prisms 23 are disposed adjacent to one another with gaps therebetween in a direction in which the band-shaped regions 9 extend, and the gap length thereof are appropriately adjusted. For this reason, it is possible to appropriately configure a degree of mitigating the above-mentioned brightness difference, and to prevent a degree of the brightness difference from becoming too strong or too weak.

[0041] Further, the band-shaped regions 9 in which the prisms 23 are provided are disposed along contour lines of the projection lens 6 and are configured to follow a design slant, and therefore it is possible to achieve a good appearance without a sense of incongruity in design.

REFERENCE SIGNS LIST

[0042]

1	Headlight
2	Low-beam lamp unit (vehicle lamp)
3	High-beam lamp unit
4	Light source
5	Reflector
6	Projection lens
6A	Low-beam projection lens
6B	High-beam projection lens
7	Shade
8	Reflecting surface of reflector
8A	Light-collecting segment
8B	Diffusing segment
8C	Another segment
9	Band-shaped region
21	Horizontal partition line
22	Vertical partition line

23	Prism
24	Reference plane
25	Light-collecting area
26	Diffusing area
27	Back surface
61	Light-collecting irradiated region
62	Lateral irradiated region
63	Diffusing irradiated region
PL	Light distribution pattern
CL1	Cutoff line
CL2	Cutoff line

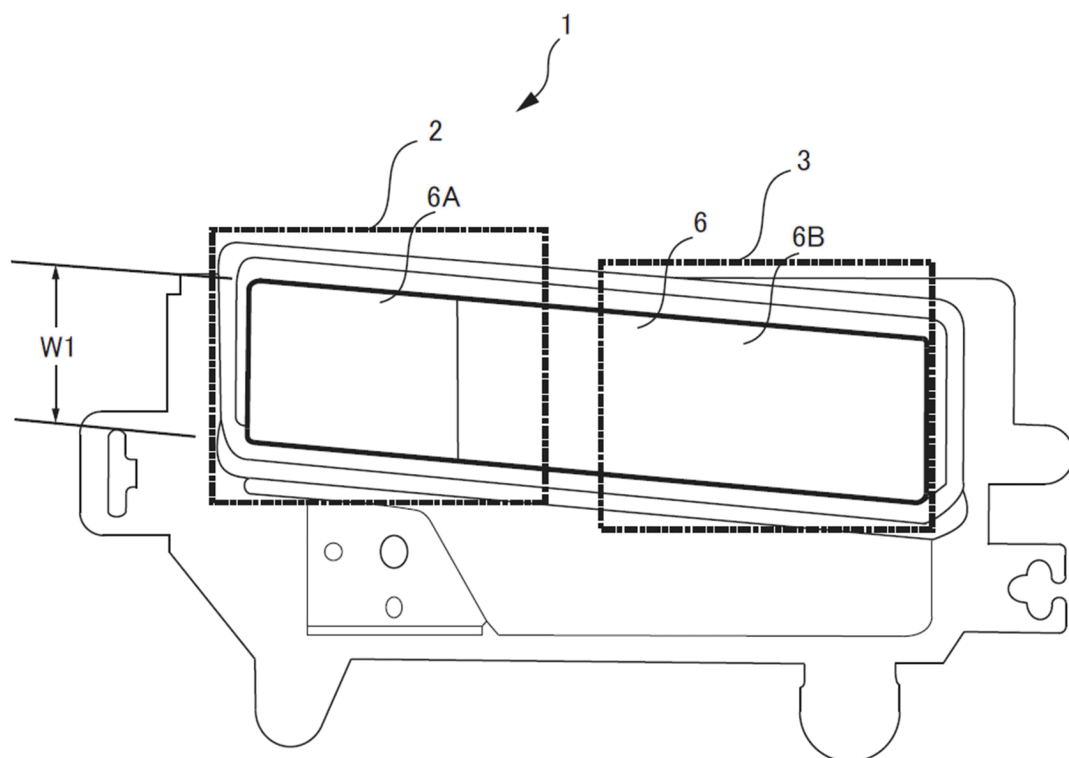
Claims

1. A vehicle lamp comprising:
 - a light source;
 - a projection lens provided closer to a front of a vehicle than the light source;
 - a shade disposed between the light source and the projection lens to form cutoff lines in a light distribution pattern; and
 - a reflector that reflects light from the light source toward the projection lens,
 wherein the projection lens has band-shaped regions, extending in a vehicle width direction, set on an incidence surface thereof, multiple prisms are provided in a row in the band-shaped regions, and
 the multiple prisms comprise two or more types of prisms having different radii of curvature in a length direction of the band-shaped regions.
2. The vehicle lamp according to claim 1, wherein
 - the projection lens comprises a light-collecting area that irradiates, as collected light, light reflected by the reflector toward a front of the vehicle, and a diffusing area that irradiates, as diffused light, light reflected by the reflector toward an outer region in front of the vehicle,
 - the multiple prisms comprise a light-collecting prism provided in the light-collecting area and a diffusing prism provided in the diffusing area, and
 - a radius of curvature of the light-collecting prism is configured to be equal to or less than a radius of curvature of the diffusing prism.

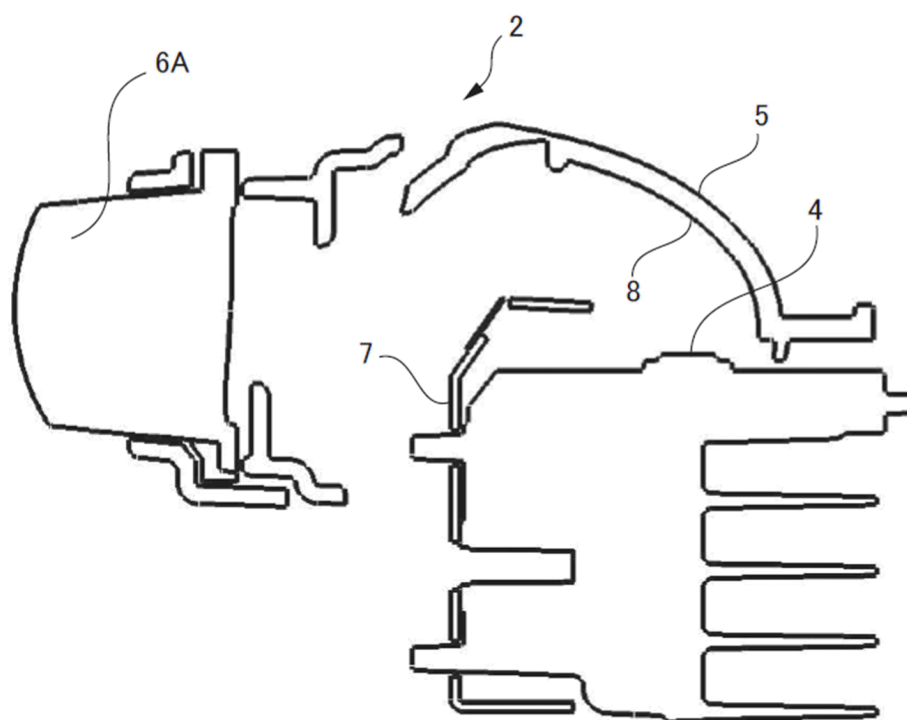
3. The vehicle lamp according to claim 1, wherein the multiple prisms comprise prisms that are disposed adjacent to one another with gaps therebetween in the length direction.
4. The vehicle lamp according to claim 1, wherein the band-shaped regions are provided in multiple rows spaced apart from one another in a vertical direction of the projection lens, and each of the band-shaped regions has multiple prisms provided therein.
5. The vehicle lamp according to claim 1, wherein the projection lens, when viewed from a side facing a front of the vehicle, has a vertical height dimension and extends in the vehicle width direction, and also has a shape extending obliquely upward from a center in the vehicle width direction toward an outer region, and
 the multiple prisms are provided in a direction in which the projection lens extends.
6. The vehicle lamp according to claim 2, wherein the reflector comprises:

a light-collecting segment that guides light from the light source to the light-collecting area of the projection lens; and
 a diffusing segment that guides light from the light source to the diffusing area of the projection lens.

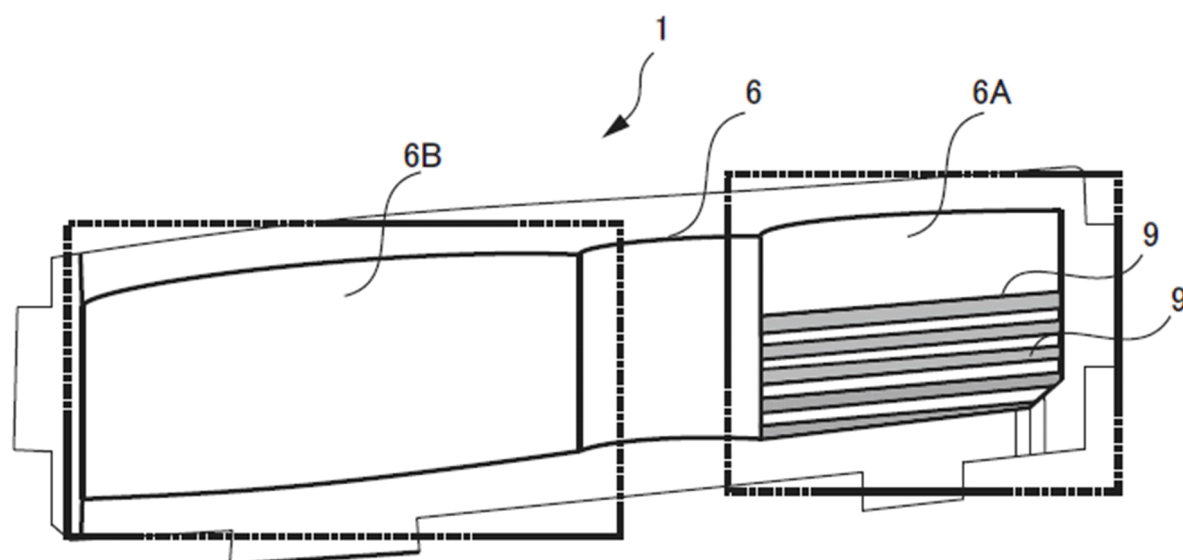
[FIG. 1]



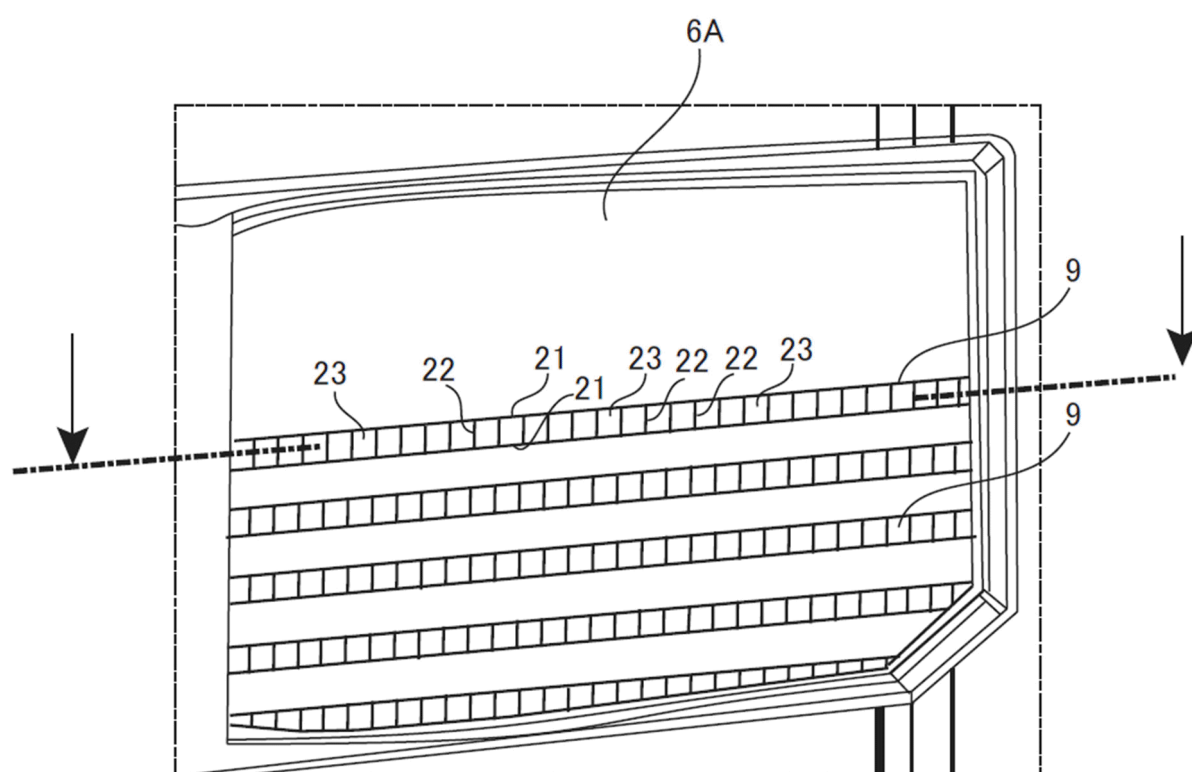
[FIG. 2]



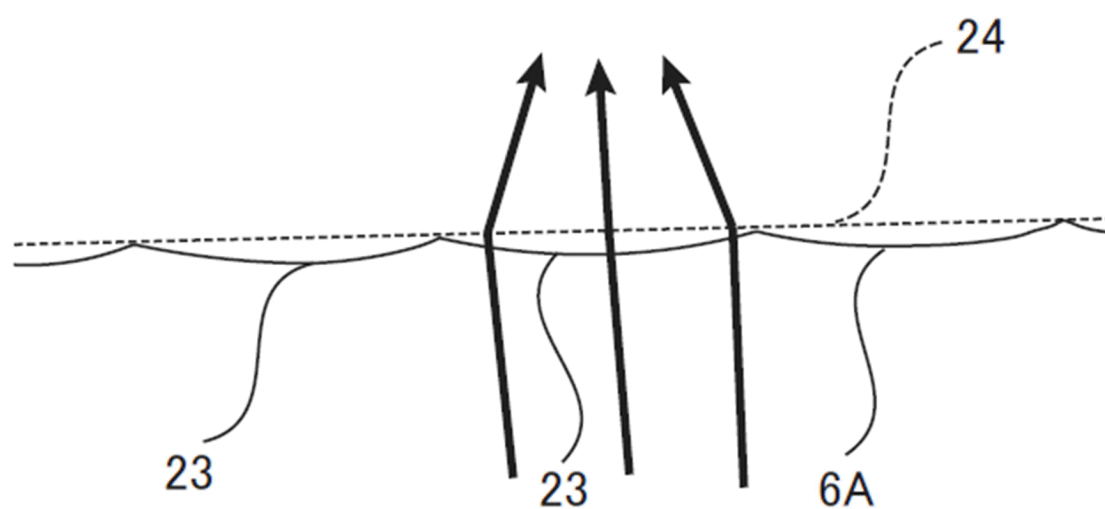
[FIG. 3]



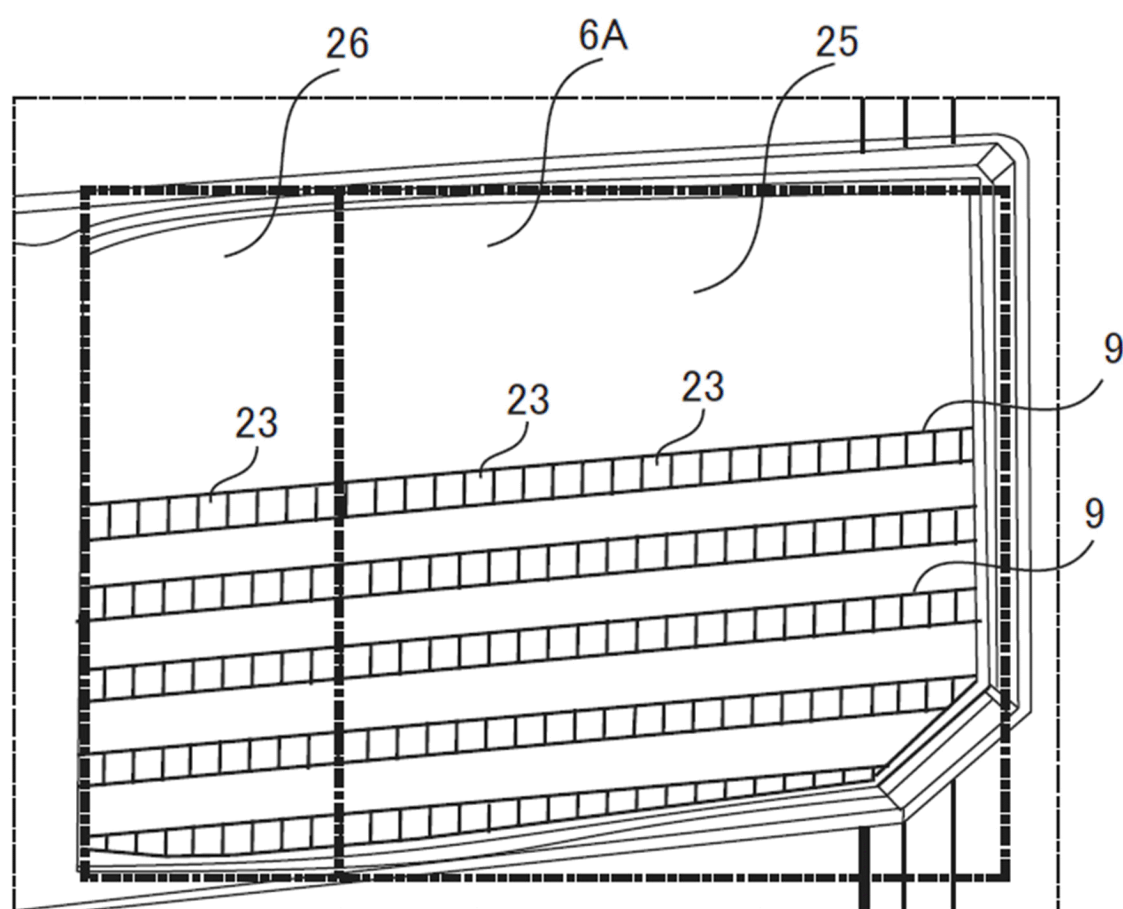
[FIG. 4]



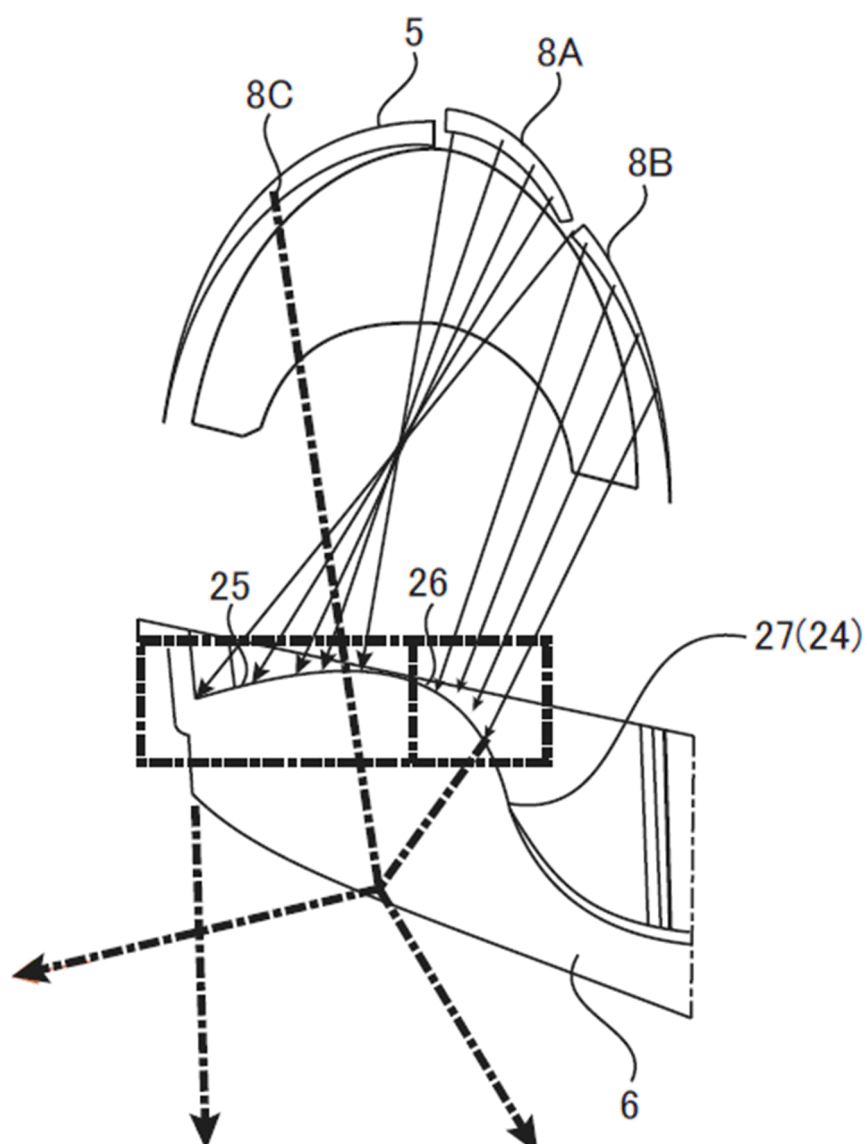
[FIG. 5]



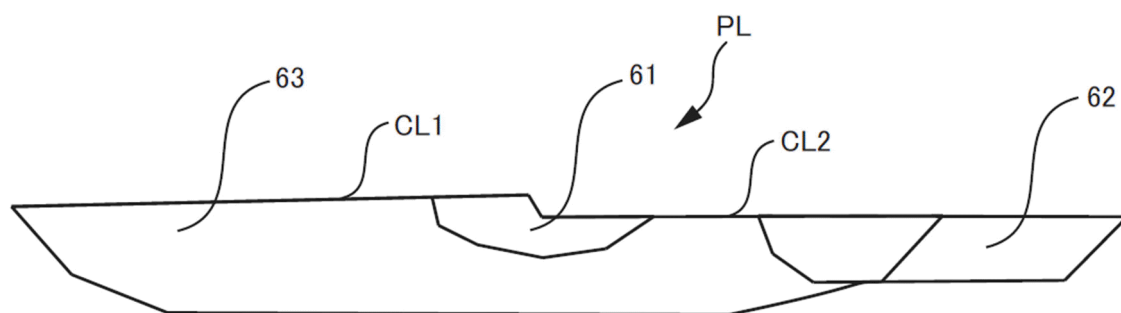
[FIG. 6]



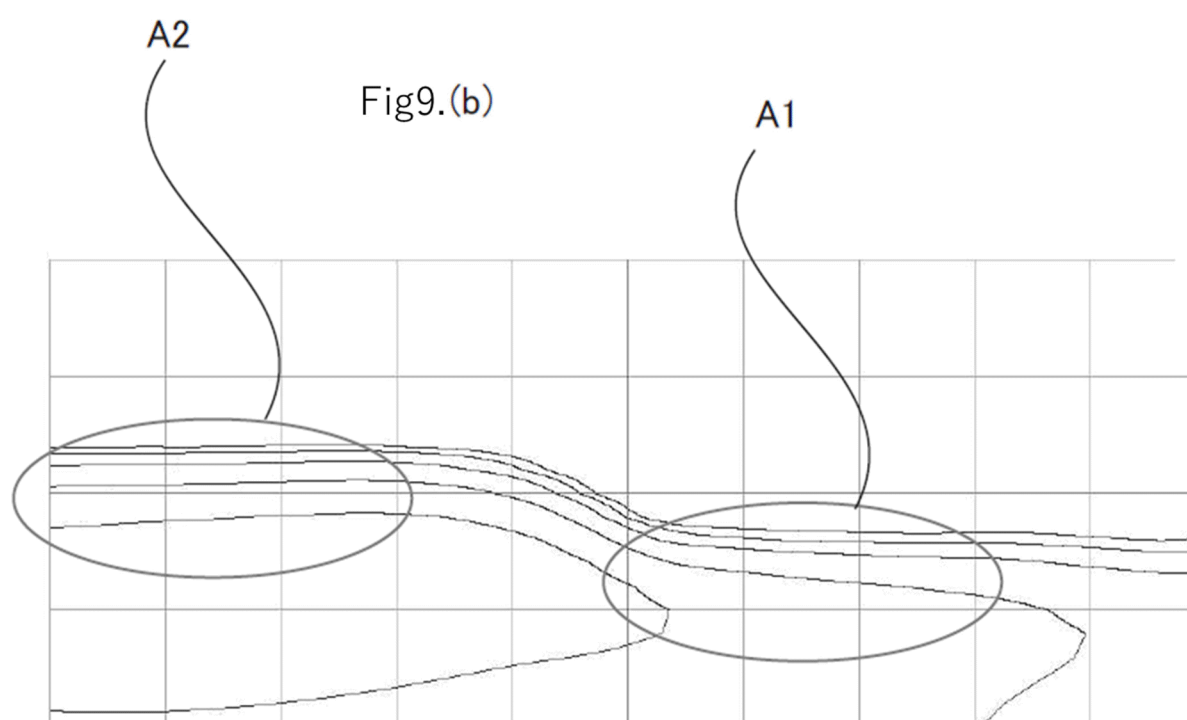
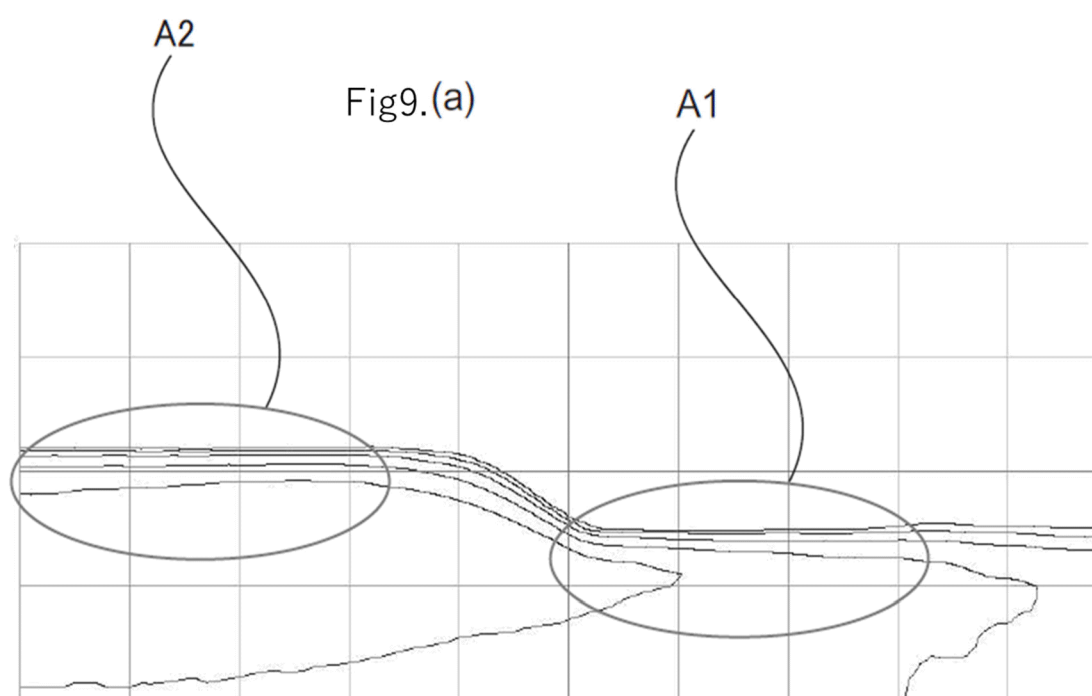
[FIG. 7]



[FIG. 8]



[FIG. 9]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2024/041582

A. CLASSIFICATION OF SUBJECT MATTER

F21S 41/275(2018.01)i; **F21S 41/26**(2018.01)i; **F21S 41/32**(2018.01)i; **F21S 41/43**(2018.01)i; **F21S 41/148**(2018.01)i;
F21V 5/02(2006.01)i; **F21V 5/04**(2006.01)i; **F21W 102/155**(2018.01)n; **F21Y 115/10**(2016.01)n; **F21Y 115/15**(2016.01)n;
F21Y 115/30(2016.01)n

FI: F21S41/275; F21S41/148; F21S41/26; F21S41/32; F21S41/43; F21V5/02 100; F21V5/04 200; F21W102:155;
F21Y115:10; F21Y115:15; F21Y115:30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F21S41/275; F21S41/26; F21S41/32; F21S41/43; F21S41/148; F21V5/02; F21V5/04; F21W102/155; F21Y115/10;
F21Y115/15; F21Y115/30

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2024
Registered utility model specifications of Japan 1996-2024
Published registered utility model applications of Japan 1994-2024

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2018-18590 A (STANLEY ELECTRIC CO., LTD.) 01 February 2018 (2018-02-01) paragraphs [0016]-[0059], fig. 1-8	1, 4
Y		3, 5
A		2, 6
Y	JP 3214118 U (EXCELLENCE OPTOELECTRONICS INC.) 21 December 2017 (2017-12-21) paragraph [0023], fig. 3	3
Y	JP 2013-196901 A (ICHIKOH INDUSTRIES, LTD.) 30 September 2013 (2013-09-30) paragraphs [0012]-[0068], fig. 1-17	5

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search

24 December 2024

Date of mailing of the international search report

14 January 2025

Name and mailing address of the ISA/JP

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2024/041582

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