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(54) **HEADLAMP DEVICE FOR A VEHICLE**

(57) A headlamp device includes an upper lens (41), a lower lens assembly (42), a low-beam reflector (5), a high-beam reflector (6), a blocking board (7), a first light source (91) and a second light source (92). The first light source (91) and the second light source (92) are each operable to switch between an on-state and an off-state. When the first light source (91) is in the on-state and when the second light source (92) is in the off-state, low beam light rays are generated by cooperation of the upper lens (41), the low-beam reflector (5), the blocking board (7) and the first light source (91). When the second light source (92) is in the on-state, high beam light rays are generated by cooperation of the lower lens assembly (42), the high-beam reflector (6) and the second light source (92).

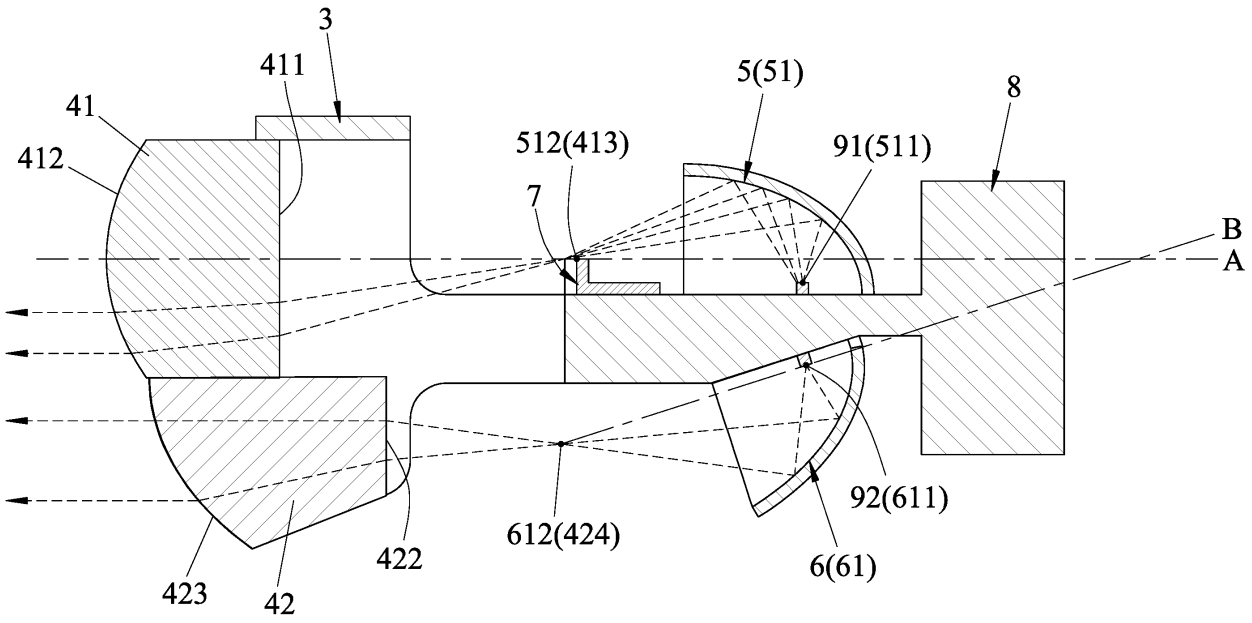

FIG.4

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Description

[0001] The disclosure relates to a headlamp device, and more particularly to a headlamp device capable of emitting low beam and high beam light rays.

[0002] Referring to Figures 7 and 8, a conventional headlamp device disclosed in Taiwanese Utility Model Patent No. M248960 includes a headlamp 80 and a headlight function switching device 90. The headlamp 80 includes a light emitting member 81, a reflecting member 82 and a lens 83. The light emitting member 81 generates light beams. The reflecting member 82 and the lens 83 are respectively located at two opposite sides of the light emitting member 81. The headlight function switching device 90 is disposed between the light emitting member 81 and the lens 83, and includes a fixed plate 901, a solenoid valve 902 and a blocking board 903. The solenoid valve 902 is fixedly mounted to the fixed plate 901. The blocking board 903 is operable by the solenoid valve 902 to move relative to the light emitting member 81 in an up-down direction between an upper position and a lower position. When the blocking board 903 is at the upper position, the light beams generated by the light emitting member 81 are reflected by the reflecting member 82 and propagate in such a manner that some of the light beams are blocked by the blocking board 903 while the remaining light beams pass through the lens 83 to serve as low beam light rays (see Figure 8) which form a light distribution pattern that has a clear cut-off line. When the blocking board 903 is at the lower position, the light beams generated by the light emitting member 81 are reflected by the reflecting member 82 and pass through the lens 83 without being blocked by the blocking board 903, so as to serve as high beam light rays (see Figure 7).

[0003] By virtue of the solenoid valve 902 controlling the blocking board 903 to move between the upper position and the lower position, the conventional headlamp device is switchable between a low beam mode where the low beam light rays are generated and a high beam mode where the high beam light rays are generated. However, the solenoid valve 902 may be slow to react to user input and is prone to malfunction. Once the solenoid valve 902 has malfunctioned, the conventional headlamp device can no longer switch between the low beam mode and the high beam mode.

[0004] Therefore, an object of the disclosure is to provide a headlamp device that can alleviate at least one of the drawbacks of the prior art.

[0005] According to the disclosure, the headlamp device includes a compound lens unit, a low-beam reflector, a high-beam reflector, a blocking board and a light emitting unit. The compound lens unit includes an upper lens and a lower lens assembly. The upper lens has a low-beam optical axis, an upper light-incident surface, an upper light-emergent surface and an upper focal point. The upper light-incident surface and the upper light-emergent surface are respectively located at two opposite sides of the upper lens in a direction of the low-beam optical axis. The upper focal point is located at one side of the upper light-incident surface opposite to the upper light-emergent surface. The lower lens assembly is located below the upper lens, includes a plurality of lower lenses, and has a lower light-incident surface, a lower light-emergent surface and a lower focal point. The lower light-incident surface is cooperatively formed by the lower lenses, faces in a direction that is the same as that of the upper light-incident surface, and is offset from the upper light-incident surface. The lower light-emergent surface is cooperatively formed by the lower lenses, and is opposite to the lower light-incident surface in the direction of the low-beam optical axis. The lower focal point is located at one side of the lower light-incident surface opposite to the lower light-emergent surface. The low-beam reflector is located at one side of the upper focal point opposite to the upper light-incident surface, and has a low-beam reflecting surface that is arc-shaped and that has a first low-beam reflecting focal point and a second low-beam reflecting focal point. The first low-beam reflecting focal point and the second low-beam reflecting focal point are respectively distal from and proximate to the upper light-incident surface of the upper lens. The second low-beam reflecting focal point coincides with the upper focal point of the upper lens. The high-beam reflector is located at one side of the lower focal point opposite to the lower light-incident surface, and has a high-beam optical axis and a high-beam reflecting surface. The high-beam reflecting surface is arc-shaped, and has a first high-beam reflecting focal point and a second high-beam reflecting focal point. The first high-beam reflecting focal point and the second high-beam reflecting focal point are respectively distal from and proximate to the lower light-incident surface of the lower lens assembly. The second high-beam reflecting focal point coincides with the lower focal point of the lower lens assembly. The first high-beam reflecting focal point and the second high-beam reflecting focal point are located on the high-beam optical axis. The blocking board has a top end at which the second low-beam focal point is located. The light emitting unit includes a first light source and a second light source. The first light source substantially coincides with the first low-beam reflecting focal point of the low-beam reflector. The second light source substantially coincides with the first high-beam reflecting focal point of the high-beam reflector. Each of the first light source and the second light source is operable to switch between an on-state in which light beams are generated, and an off-state in which light beams cease to be generated. When the first light source is in the on-state and when the second light source is in the off-state, the light beams generated by the first light source are reflected by the low-beam reflecting surface of the low-beam reflector such that some of the light beams are blocked by the blocking board while the remaining light beams travel into the upper lens through the upper light-incident surface and exit the upper lens through the upper light-emergent surface to serve as low

beam light rays. When the second light source is in the on-state, the light beams generated by the second light source are reflected by the high-beam reflecting surface of the high-beam reflector such that the light beams travel into the lower lens assembly through the lower light-incident surface and exit the lower lens assembly through the lower light-emergent surface to serve as high beam light rays.

[0006] Other features and advantages of the disclosure will become apparent in the following detailed description of the embodiment with reference to the accompanying drawings, of which:

Figure 1 is a perspective view of an embodiment of a headlamp device according to the disclosure;
Figure 2 is a sectional view taken along line II - II in Figure 1;
Figure 3 is a sectional view taken along line III - III in Figure 2;
Figure 4 is a sectional view, similar to Figure 2, illustrating several representative light beams that are generated by the embodiment;
Figure 5 is a contour plot illustrating light distribution that is formed by low beam light rays generated by the embodiment;
Figure 6 is a contour plot illustrating light distribution that is formed by high beam light rays generated by the embodiment;
Figure 7 is a sectional view illustrating a conventional headlamp device when emitting high beam light rays; and
Figure 8 is another sectional view illustrating the conventional headlamp device when emitting low beam light rays.

[0007] Referring to Figures 1 to 4, an embodiment of a headlamp device according to the disclosure includes a compound lens unit 4, a base 2, a low-beam reflector 5, a high-beam reflector 6, a blocking board 7 and a light emitting unit 9.

[0008] The compound lens unit 4 includes an upper lens 41 and a lower lens assembly 42. The upper lens 41 has a low-beam optical axis (A), an upper light-incident surface 411, an upper light-emergent surface 412 and an upper focal point 413. The upper light-incident surface 411 and the upper light-emergent surface 412 are respectively located at two opposite sides of the upper lens 41 in a direction (X) of the low-beam optical axis (A). In this embodiment, the upper light-emergent surface 412 is in front of the upper light-incident surface 411 with "front" being the forward-facing side of the headlamp device. The upper focal point 413 is located at one side of the upper light-incident surface 411 opposite to the upper light-emergent surface 412.

[0009] The lower lens assembly 42 is located below the upper lens 41, includes a plurality of lower lenses 421, and has a lower light-incident surface 422, a lower light-emergent surface 423 and a lower focal point 424. In this embodiment, the lower lenses 421 and the upper lens 41 are formed as one-piece. The lower light-incident surface 422 is cooperatively formed by the lower lenses 421, faces in a direction that is the same as that of the upper light-incident surface 411 of the upper lens 41, and is offset from the upper light-incident surface 411 in the direction (X) of the low-beam optical axis (A) (i.e., the lower light-incident surface 422 is not flush with the upper light-incident surface 411). Specifically, the upper light-incident surface 411 is forwardly offset from the lower light-incident surface 422. The lower light-emergent surface 423 is cooperatively formed by the lower lenses 421, is opposite to the lower light-incident surface 422 in the direction (X) of the low-beam optical axis (A) of the upper lens 41, and has a first section 425 and two second sections 426 located below the low-beam optical axis (A). The second sections 426 are respectively located at two opposite sides of the first section 425 in a transverse direction (Y) transverse to the direction (X) of the low-beam optical axis (A) and are offset from the first section 425 in the direction (X) of the low-beam optical axis (A) (i.e., the lower light-emergent surface 423 is configured to not be a smooth surface). The lower focal point 424 is located at one side of the lower light-incident surface 422 opposite to the lower light-emergent surface 423. In this embodiment, the lower lens assembly 42 of the compound lens unit 4 includes four lower lenses 421. The first section 425 of the lower light-emergent surface 423 is formed by two of the lower lenses 421, and the second sections 426 of the lower light-emergent surface 423 are respectively formed by the other two of the lower lenses 421. In this embodiment, each of the upper lens 41 and the lower lenses 421 of the lower lens assembly 42 of the compound lens unit 4 is a plano-convex lens.

[0010] The base 2 is located rearwardly of the upper lens 41 and the lower lens assembly 42, and is where the low-beam reflector 5, the high-beam reflector 6, the blocking board 7 and the light-emitting unit 9 are disposed on.

[0011] The low-beam reflector 5 and the high-beam reflector 6 are respectively disposed at two opposite sides of the base 2. The low-beam reflector 5 is located at one side of the upper focal point 413 of the upper lens 41 opposite to the upper light-incident surface 411 of the upper lens 41, and has a low-beam reflecting surface 51 that is arc-shaped and that faces the upper light-incident surface 411. The low-beam reflecting surface 51 has a first low-beam reflecting focal point 511 and a second low-beam reflecting focal point 512. The first low-beam reflecting focal point 511 and the second low-beam reflecting focal point 512 are respectively distal from and proximate to the upper light-incident surface 411 of the upper lens 41. The second low-beam reflecting focal point 512 coincides with the upper focal point 413 of the upper lens 41.

[0012] The high-beam reflector 6 is located at one side of the lower focal point 424 of the lower lens assembly 42 opposite to the lower light-incident surface 422 of the

lower lens assembly 42, and has a high-beam optical axis (B) and a high-beam reflecting surface 61. The high-beam reflecting surface 61 is arc-shaped, faces the lower light-incident surface 422, and has a first high-beam reflecting focal point 611 and a second high-beam reflecting focal point 612. The first high-beam reflecting focal point 611 and the second high-beam reflecting focal point 612 are respectively distal from and proximate to the lower light-incident surface 422 of the lower lens assembly 42. The second high-beam reflecting focal point 612 coincides with the lower focal point 424 of the lower lens assembly 42. The first high-beam reflecting focal point 611 and the second high-beam reflecting focal point 612 are located on the high-beam optical axis (B). In this embodiment, the low-beam optical axis (A) of the upper lens 41 and the high-beam optical axis (B) of the high-beam reflector 6 intersect, and cooperatively form an angle (θ) of intersection. In this embodiment, the angle (θ) of intersection of the low-beam optical axis (A) and the high-beam optical axis (B) is greater than 0 degree, but is not greater than 60 degrees.

[0013] The blocking board 7 has a top end at which the second low-beam focal point 512 is located.

[0014] The light emitting unit 9 includes a first light source 91 and a second light source 92. The first light source 91 substantially coincides with the first low-beam reflecting focal point 511 of the low-beam reflector 5. The second light source 92 substantially coincides with the first high-beam reflecting focal point 611 of the high-beam reflector 6. Each of the first light source 91 and the second light source 92 is operable to switch between an on-state in which light beams are generated, and an off-state in which light beams cease to be generated. Each of the first light source 91 and the second light source 92 is a light-emitting diode made of at least one semiconductor die.

[0015] Referring further to Figure 5, when the first light source 91 is in the on-state and when the second light source 92 is in the off-state, the light beams generated by the first light source 91 are reflected by the low-beam reflecting surface 51 of the low-beam reflector 5 such that some of the light beams are blocked by the blocking board 7 (i.e., some of the reflected light beams that do not perfectly pass through the second low-beam reflecting focal point 512 of the low-beam reflecting surface 51 are blocked by the blocking board 7) while the remaining light beams travel into the upper lens 41 through the upper light-incident surface 411 and exit the upper lens 41 through the upper light-emergent surface 412 to serve as low beam light rays. By virtue of the blocking board 7 blocking some of the light beams, light distribution pattern formed by the low beam light rays has a clear cut-off line as shown in Figure 5.

[0016] Referring further to Figure 6, when the second light source 92 is in the on-state, the light beams generated by the second light source 92 are reflected by the high-beam reflecting surface 61 of the high-beam reflector 6 such that the light beams travel into the lower lens assembly 42 through the lower light-incident surface 422 and exit the lower lens assembly 42 through the lower light-emergent surface 423 to serve as high beam light rays. Light distribution pattern formed by the high beam light rays is shown in Figure 6.

[0017] It is noted that, by virtue of the upper light-incident surface 411 of the upper lens 41 being forwardly offset from the lower light-incident surface 422 of the lower lens assembly 42, the compound lens unit 4 may provide relatively good stray-light rejection when the low beam light rays are generated. That is to say, when the first light source 91 is in the on-state and when the second light source 92 is in the off-state, the light beams generated by the first light source 91 but traveling in undesirable paths (namely, stray light) may be prevented from exiting the lower lens assembly 42 through the lower light-emergent surface 423. Therefore, stray light will not substantially affect the light distribution pattern formed by the low beam light rays. In this embodiment, a distance between the upper light-incident surface 411 of the upper lens 41 and the lower light-incident surface 422 of the lower lens assembly 42 in the direction (X) of the low-beam optical axis (A) ranges from 1 to 30 millimeters.

[0018] Since each individual one of the lower lenses 421 of the lower lens assembly 42 constitutes only one of the first section 425 and the second sections 426, curvature of each of the first section 425 and the second sections 426 is individually adjustable by adjusting the curvature of the corresponding lower lens(es) 421. In addition, the high-beam reflector 6 may prevent the light beams generated by the second light source 92 from dispersing. Therefore, by virtue of the high-beam reflector 6, and by virtue of the curvature of each of the first section 425 and the second sections 426 being individually adjustable, the lower lens assembly 42 may achieve a better effect of focusing light so that the light beams exiting the lower lens assembly 42 through the lower light-emergent surface 423 may be adjusted to serve as the high beam light rays even when only the second light source 92 is in the on-state (i.e., for the high beam light rays to be generated, it is not necessary for the first light source 91 and the second light source 92 to simultaneously be in the on-state to create overlapping light beams or patterns). Consequently, the embodiment may be relatively energy-saving.

[0019] Referring back to Figures 1 to 4, the embodiment further includes a heat dissipating member 8 and a fixing frame 3. The heat dissipating member 8 is disposed on the base 2 and serves the purpose of heat dissipation. The fixing frame 3 is disposed in front of the base 2, connects the base 2 to the compound lens unit 4, and has the compound lens unit 4 disposed thereon. In this embodiment, the upper lens 41 and the lower lens assembly 42 of the compound lens unit 4 are held fixedly by the fixing frame 3.

[0020] In summary, by virtue of each of the first light source 91 and the second light source 92 being operable to switch between the on-state and the off-state, the em-

bodiment of the headlamp device is capable of emitting low beam light rays and high beam light rays and is switchable between the low-beam mode and the high-beam mode without a solenoid valve. Therefore, the headlamp device according to the disclosure may react relatively quickly when operated and may have a relatively long service life so reliability of the headlamp device is improved. Consequently, the drawbacks of the prior art have been alleviated and the purpose of the disclosure can certainly be fulfilled.

[0021] In the description above, for the purposes of explanation, numerous specific details have been set forth in order to provide a thorough understanding of the embodiment. It will be apparent, however, to one skilled in the art, that one or more other embodiments may be practiced without some of these specific details. It should also be appreciated that reference throughout this specification to "one embodiment," "an embodiment," an embodiment with an indication of an ordinal number and so forth means that a particular feature, structure, or characteristic may be included in the practice of the disclosure. It should be further appreciated that in the description, various features are sometimes grouped together in a single embodiment, figure, or description thereof for the purpose of streamlining the disclosure and aiding in the understanding of various inventive aspects, and that one or more features or specific details from one embodiment may be practiced together with one or more features or specific details from another embodiment, where appropriate, in the practice of the disclosure.

Claims

1. A headlamp device comprising:

a compound lens unit (4) including

an upper lens (41) that has

a low-beam optical axis (A),
an upper light-incident surface (411),
an upper light-emergent surface (412), and
an upper focal point (413), said upper light-incident surface (411) and said upper light-emergent surface (412) being respectively located at two opposite sides of said upper lens (41) in a direction (X) of the low-beam optical axis (A), said upper focal point (413) being located at one side of said upper light-incident surface (411) opposite to said upper light-emergent surface (412), and

a lower lens assembly (42) that is located below said upper lens (41), that includes a plurality of lower lenses (421), and that has

a lower light-incident surface (422) cooperatively formed by said lower lenses (421), facing in a direction that is the same as that of said upper light-incident surface (411), and offset from said upper light-incident surface (411),
a lower light-emergent surface (423) cooperatively formed by said lower lenses (421), and opposite to said lower light-incident surface (422) in the direction (X) of the low-beam optical axis (A), and
a lower focal point (424) located at one side of said lower light-incident surface (422) opposite to said lower light-emergent surface (423);

a low-beam reflector (5) located at one side of said upper focal point (413) opposite to said upper light-incident surface (411), and having a low-beam reflecting surface (51) that is arc-shaped and that has

a first low-beam reflecting focal point (511) and a second low-beam reflecting focal point (512) respectively distal from and proximate to said upper light-incident surface (411) of said upper lens (41), said second low-beam reflecting focal point (512) coinciding with said upper focal point (413) of said upper lens (41);

a high-beam reflector (6) located at one side of said lower focal point (424) opposite to said lower light-incident surface (422), and having

a high-beam optical axis (B), and
a high-beam reflecting surface (61) that is arc-shaped and that has

a first high-beam reflecting focal point (611) and a second high-beam reflecting focal point (612) respectively distal from and proximate to said lower light-incident surface (422) of said lower lens assembly (42), said second high-beam reflecting focal point (612) coinciding with said lower focal point (424) of said lower lens assembly (42), said first high-beam reflecting focal point (611) and said second high-beam reflecting focal point (612) being located on said high-beam optical axis (B);

a blocking board (7) having a top end at which said second low-beam focal point

(512) is located; and

a light emitting unit (9);
said headlamp device being **characterized in that**:

said light emitting unit (9) including

a first light source (91) that substantially coincides with said first low-beam reflecting focal point (511) of said low-beam reflector (5), and
a second light source (92) that substantially coincides with said first high-beam reflecting focal point (611) of said high-beam reflector (6), each of said first light source (91) and said second light source (92) being operable to switch between an on-state in which light beams are generated, and an off-state in which light beams cease to be generated;

wherein, when said first light source (91) is in the on-state and when said second light source (92) is in the off-state, the light beams generated by said first light source (91) are reflected by said low-beam reflecting surface (51) of said low-beam reflector (5) such that some of the light beams are blocked by said blocking board (7) while the remaining light beams travel into said upper lens (41) through said upper light-incident surface (411) and exit said upper lens (41) through said upper light-emergent surface (412) to serve as low beam light rays; and
when said second light source (92) is in the on-state, the light beams generated by said second light source (92) are reflected by said high-beam reflecting surface (61) of said high-beam reflector (6) such that the light beams travel into said lower lens assembly (42) through said lower light-incident surface (422) and exit said lower lens assembly (42) through said lower light-emergent surface (423) to serve as high beam light rays.

2. The headlamp device as claimed in claim 1, **characterized in that** the low-beam optical axis (A) of said upper lens (41) and the high-beam optical axis (B) of said high-beam reflector (6) intersect, and cooperatively form an angle (θ) of intersection.

3. The headlamp device as claimed in claim 2, **characterized in that** said angle (θ) of intersection of the low-beam optical axis (A) and the high-beam optical axis (B) is greater than 0 degree, and is less than or equal to 60 degrees.

4. The headlamp device as claimed in claim 1, **characterized in that**:

said upper light-emergent surface (412) is in front of said upper light-incident surface (411) of said upper lens (41) of said compound lens unit (4); and
said upper light-incident surface (411) of said upper lens (41) of said compound lens unit (4) is forwardly offset from said lower light-incident surface (422).

5. The headlamp device as claimed in claim 4, **characterized in that** a distance between said upper light-incident surface (411) of said upper lens (41) and said lower light-incident surface (422) of said lower lens assembly (42) in the direction (X) of the low-beam optical axis (A) ranges from 1 to 30 millimeters.

6. The headlamp device as claimed in claim 1, **characterized in that** said lower light-emergent surface (423) has
a first section (425), and
two second sections (426) respectively located at two opposite sides of said first section (425) in a transverse direction (Y) transverse to the direction (X) of the low-beam optical axis (A), said second sections (426) being offset from said first section (425).

7. The headlamp device as claimed in claim 6, **characterized in that**:

said lower lens assembly (42) of said compound lens unit (4) includes four of said lower lenses (421); and
said first section (425) of said lower light-emergent surface (423) of said lower lens assembly (42) is formed by two of said lower lenses (421), and said second sections (426) of said lower light-emergent surface (423) are respectively formed by the other two of said lower lenses (421).

8. The headlamp device as claimed in claim 1, **characterized in that** said upper lens (41) and said lower lenses (421) are formed as one-piece.

9. The headlamp device as claimed in claim 1, **characterized in that** each of said first light source (91) and said second light source (92) of said light emitting unit (9) is a light-emitting diode made of at least one semiconductor die.

10. The headlamp device as claimed in claim 1, further **characterized by** a base (2) on which said low-beam reflector (5), said high-beam reflector (6), said blocking board (7) and said light-emitting unit (9) are disposed.

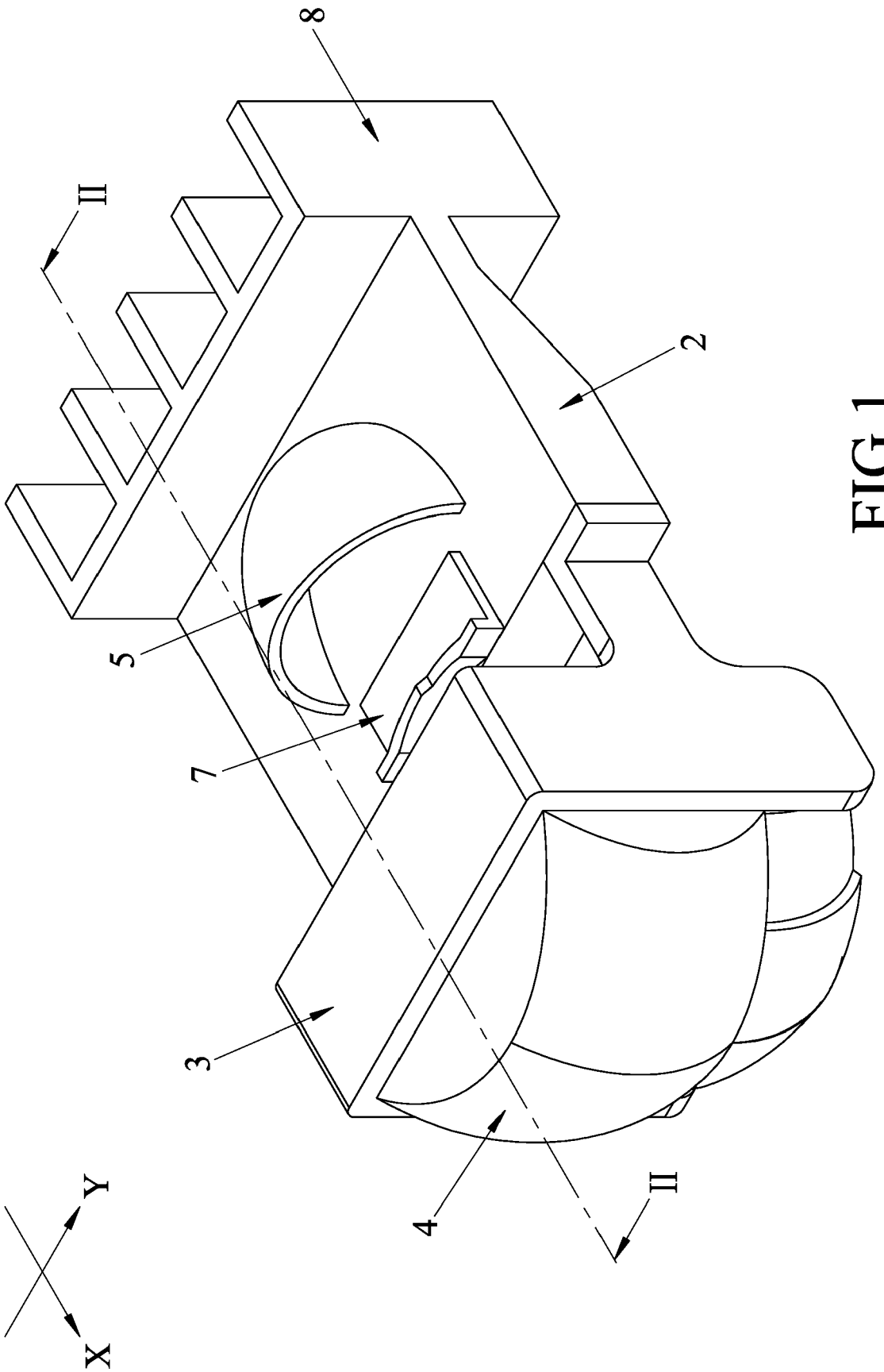
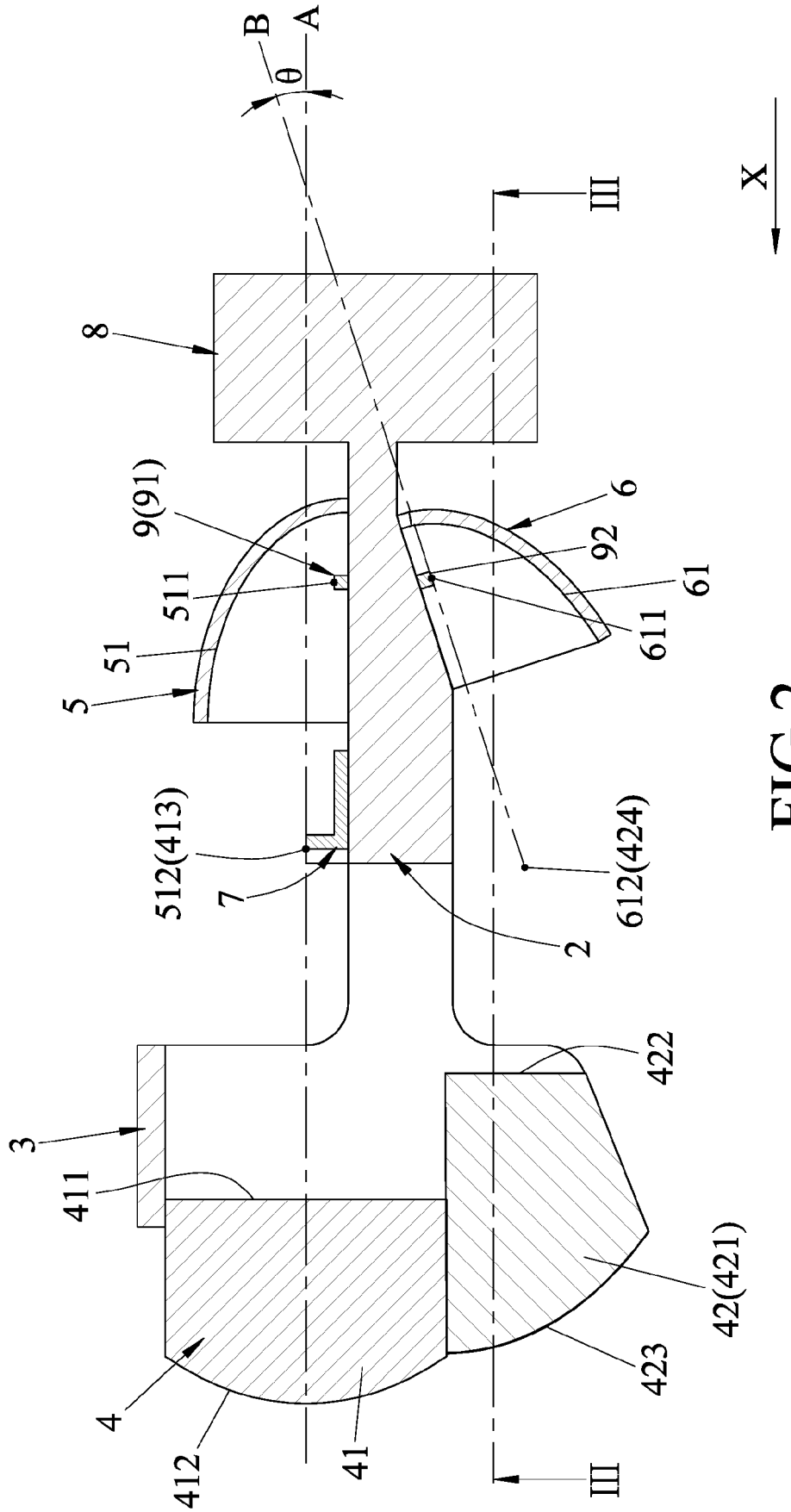


FIG.1


B
A
θ
III
X
8
9(91)
6
92
511
61
51
611
5
512(413)
612(424)
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411
42(421)
423
4
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41
III

FIG.2

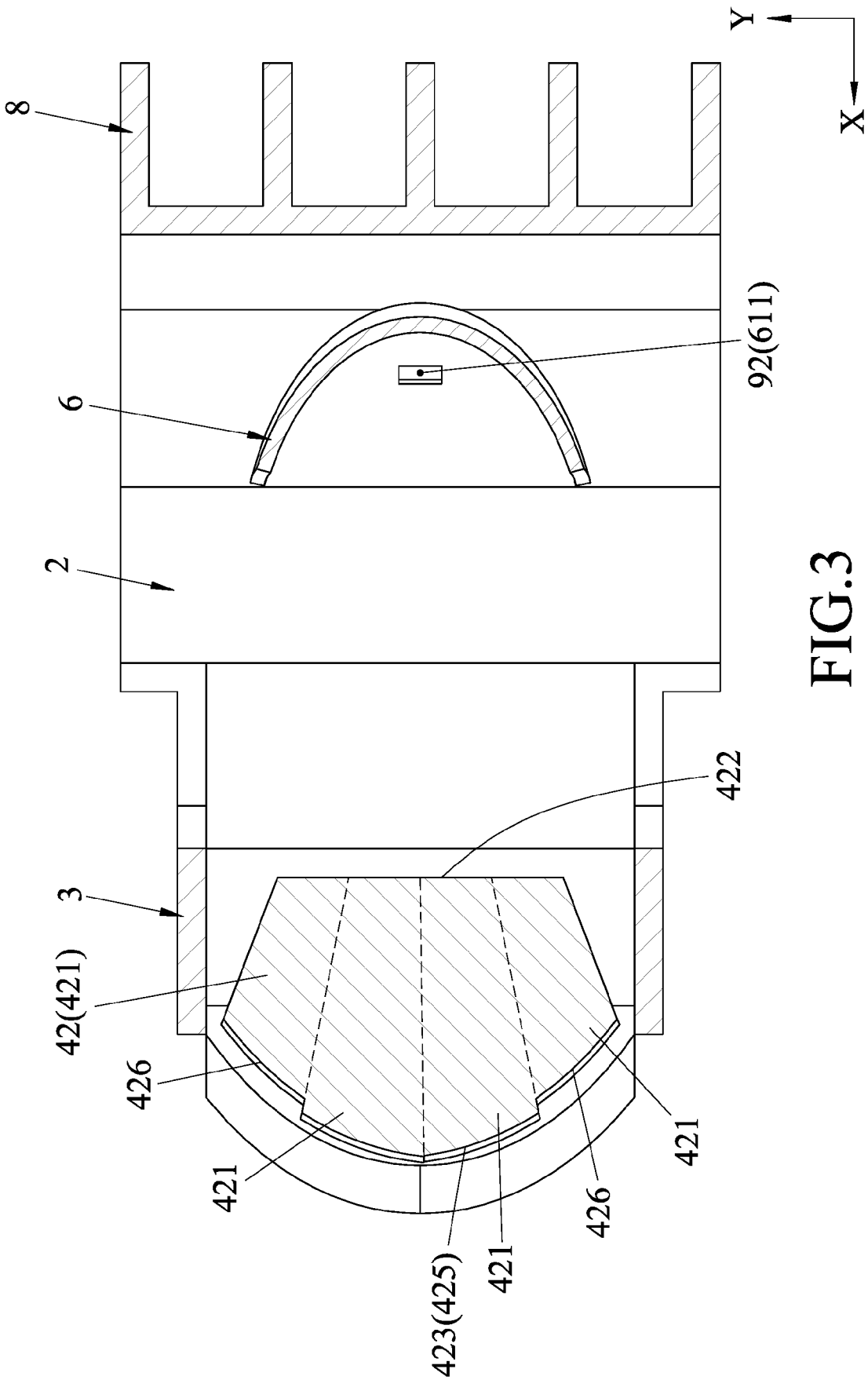

FIG.3

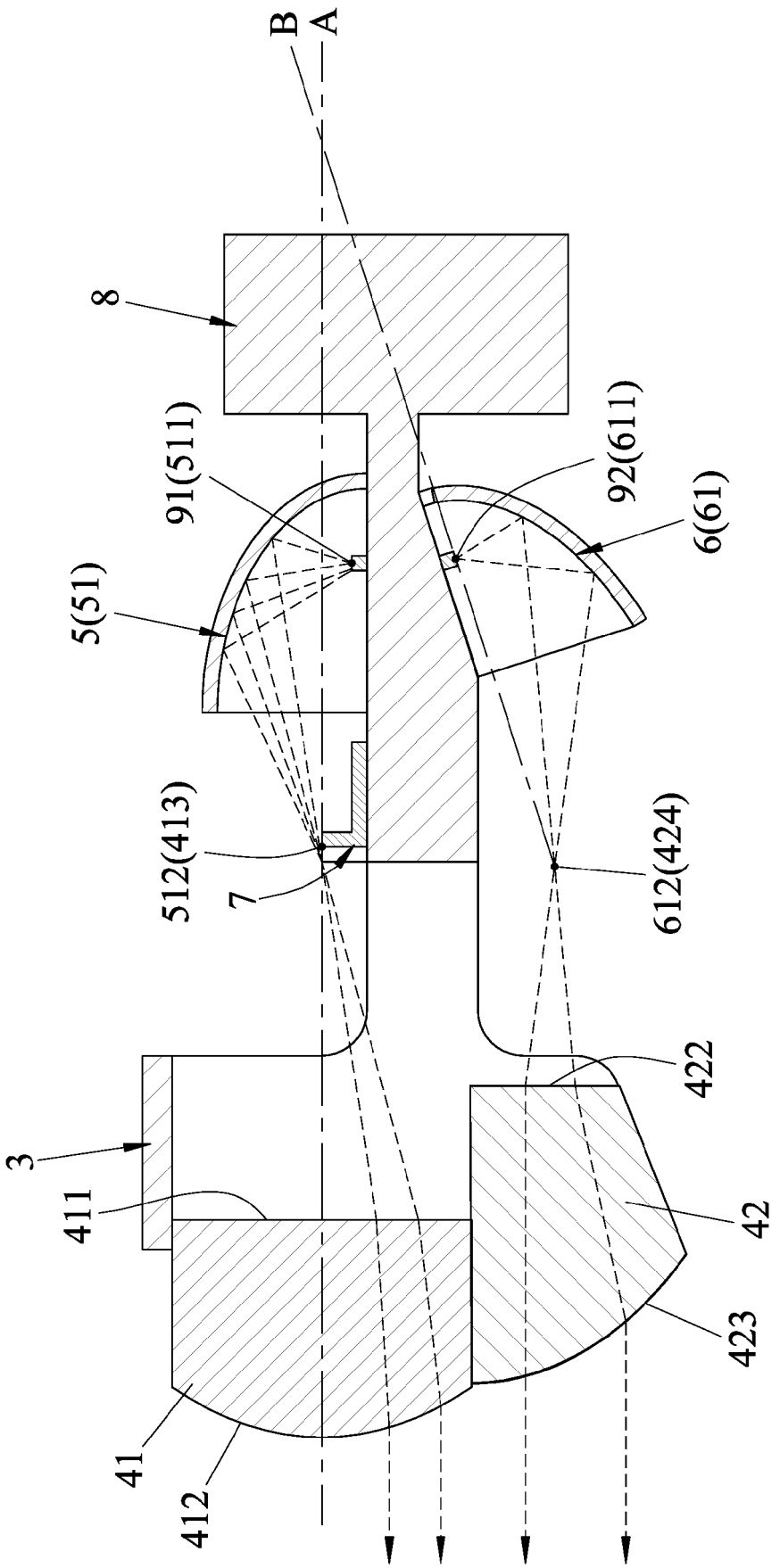

FIG.4

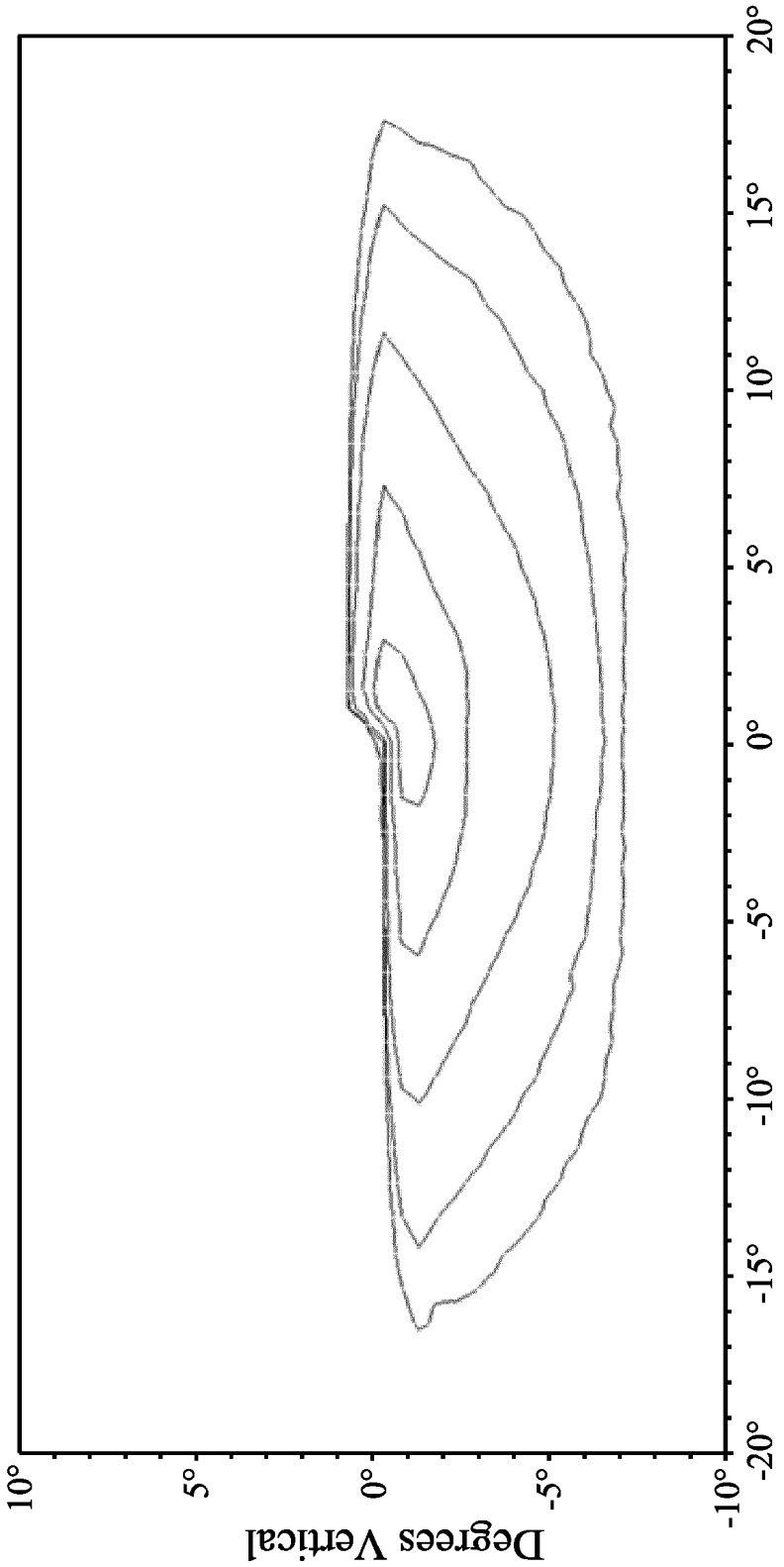
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FIG.5

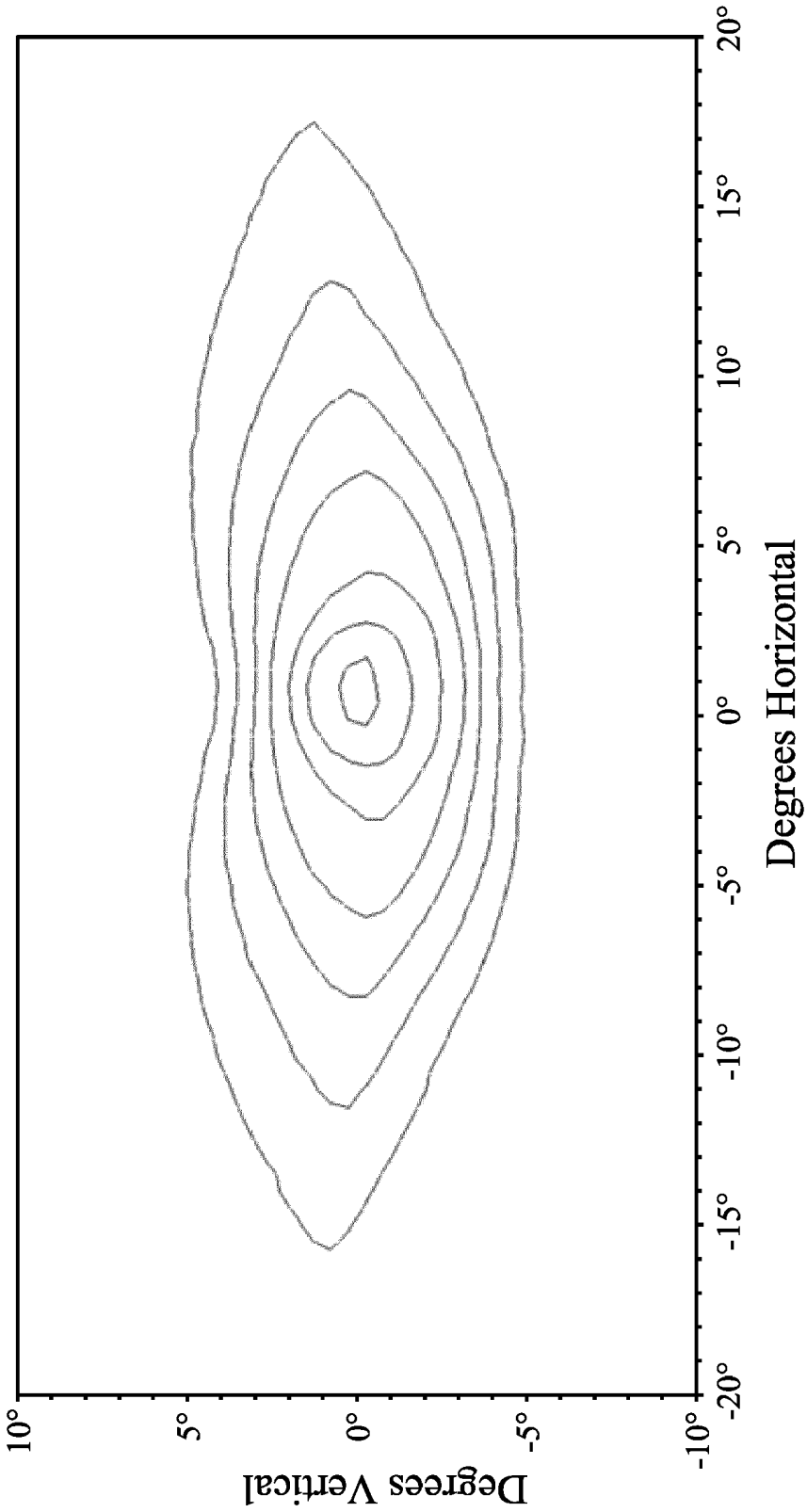
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FIG.6

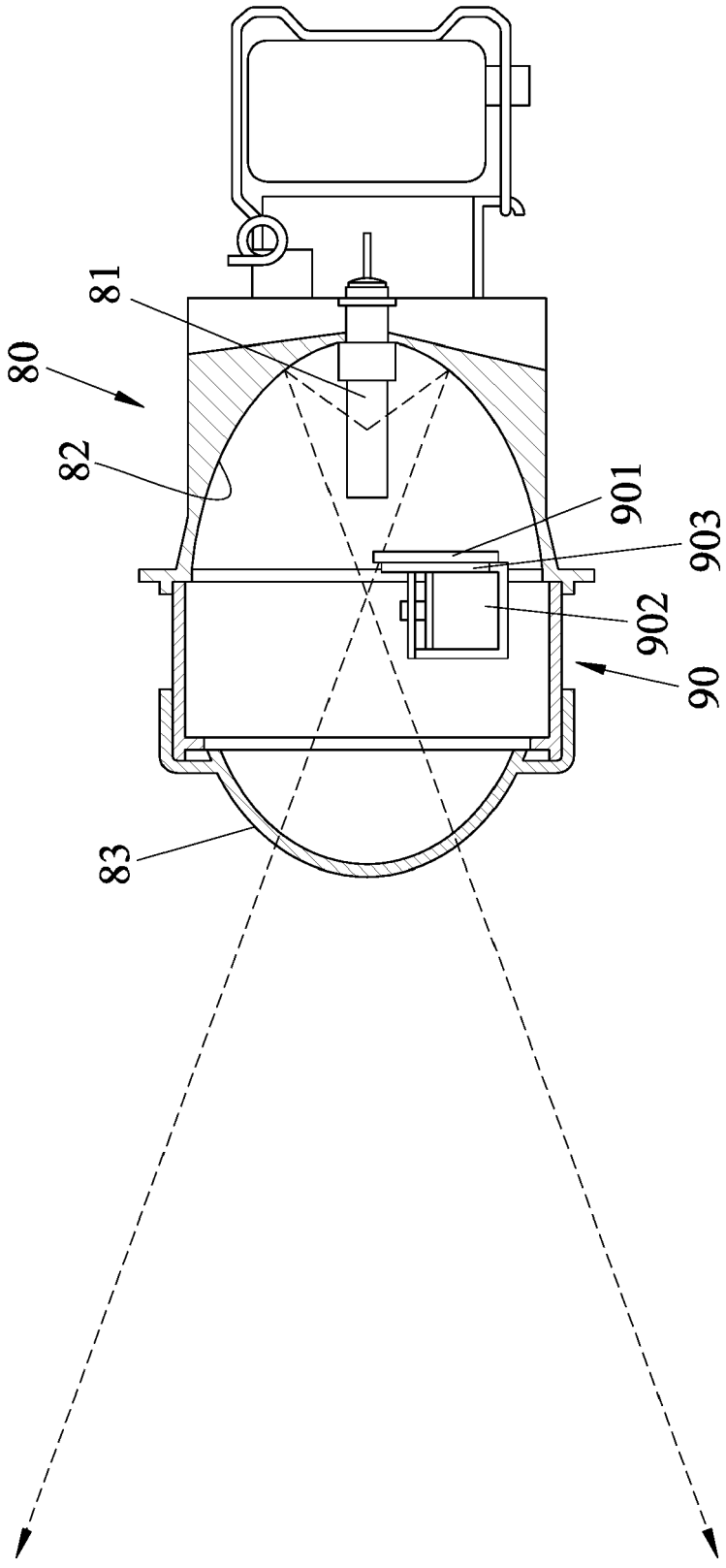

FIG.7
PRIOR ART

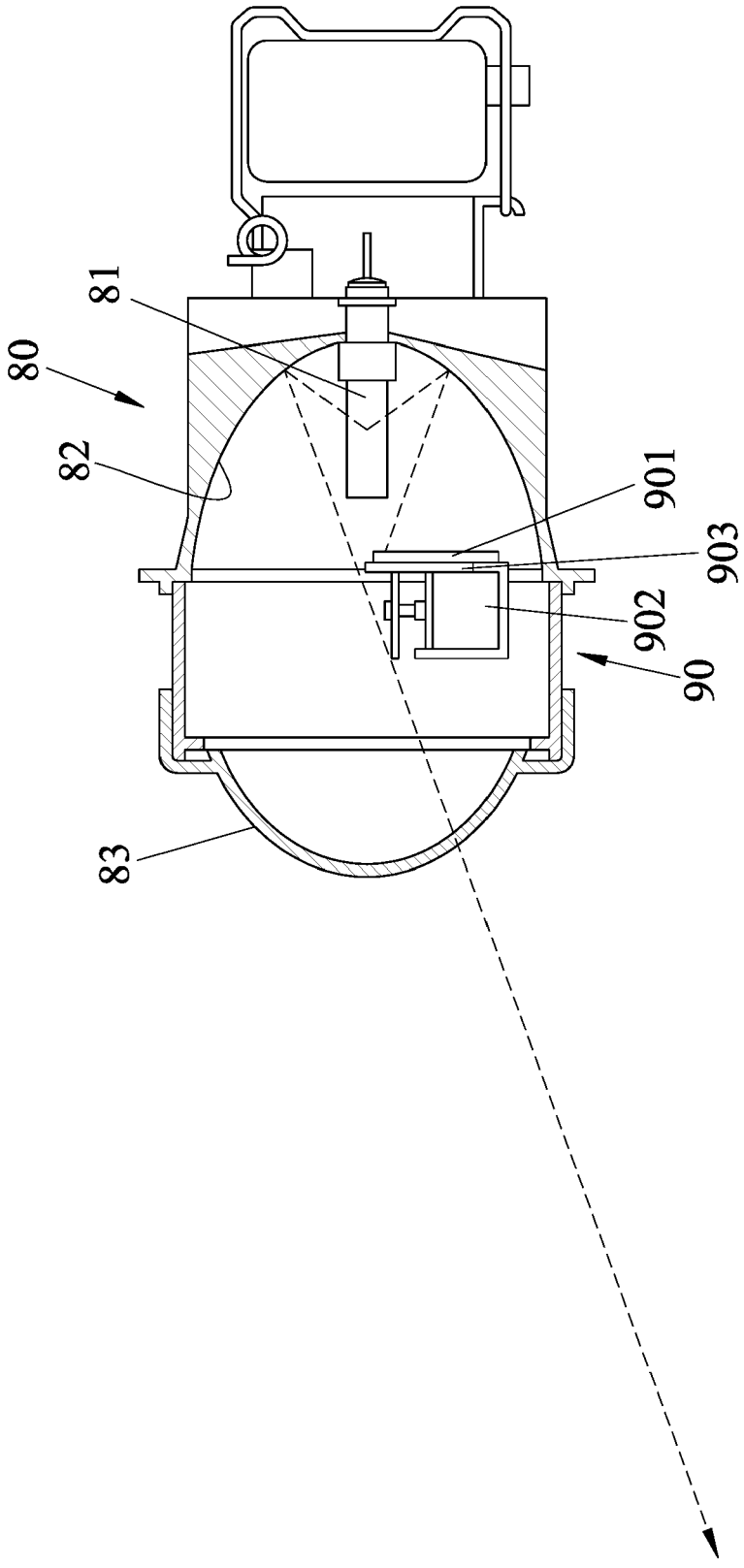

FIG.8
PRIOR ART

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EUROPEAN SEARCH REPORT

Application Number
EP 21 18 0441

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Place of search	Date of completion of the search	Examiner
Munich	13 October 2021	Panatsas, Adam

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