(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 050 251 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
31.08.2022 Bulletin 2022/35

(21) Application number: **22157898.2**

(22) Date of filing: **22.02.2022**

(51) International Patent Classification (IPC):
***F21S 41/148** (2018.01)* ***F21S 41/265** (2018.01)*
***F21S 41/275** (2018.01)* ***F21S 41/32** (2018.01)*
***F21S 41/36** (2018.01)* ***F21S 41/365** (2018.01)*
***F21S 41/40** (2018.01)* ***F21S 41/43** (2018.01)*
***F21S 41/663** (2018.01)* ***F21S 41/675** (2018.01)*
***F21S 41/689** (2018.01)* ***F21S 41/698** (2018.01)*
***F21S 41/683** (2018.01)* ***F21S 41/33** (2018.01)*

(52) Cooperative Patent Classification (CPC):
F21S 41/148; F21S 41/265; F21S 41/275; F21S 41/321; F21S 41/36; F21S 41/43; F21S 41/683; F21S 41/689

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

(30) Priority: **24.02.2021 TW 110106537**

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

(57) A headlamp device includes a blocking board (7), a compound reflector unit (5) that includes a first reflector (51) and a second reflector (52), a lens (4) that has a light-incident surface (41) and a light-emergent surface (42), and a light emitting unit (6). When the light emitting unit (6) generates light beams, a portion of the light beams are reflected by the first reflector (51), and another portion of the light beams are reflected by the second reflector (52). The blocking board (7) blocks some of the light beams reflected by the compound reflector unit (5) such that the remaining light beams travel into the lens (4) through the light-incident surface (41) and exit the lens (4) through the light-emergent surface (42) to serve as low beam light rays.

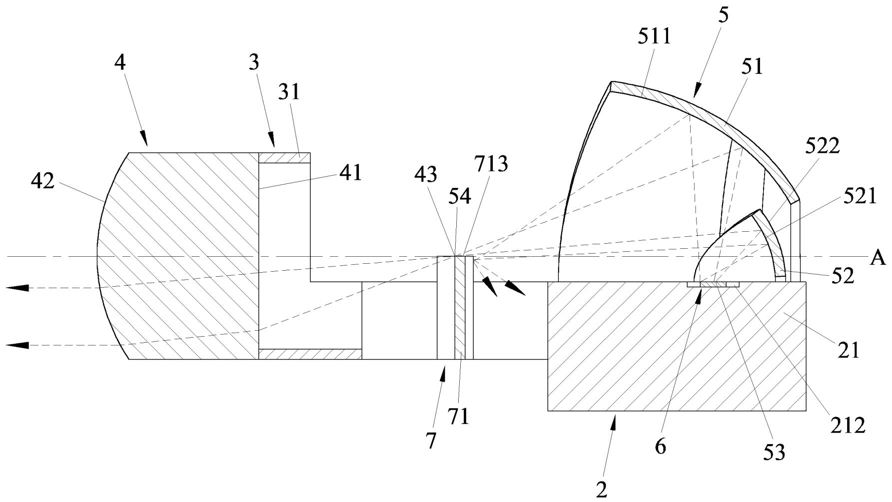

FIG.7

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Description

[0001] The disclosure relates to a headlamp device, and more particularly to a headlamp device for a vehicle.

[0002] A conventional headlamp device (see Figure 1) for a vehicle is disclosed in Taiwanese Patent No. 1709710. The conventional headlamp device includes a compound lens unit 92, a reflector 93, a blocking board 94 and a light emitting unit 95. The compound lens unit 92 includes an upper lens 921 and a lower lens 922. The upper lens 921 has an optical axis (E), an upper light-incident surface 923, an upper light-emergent surface 924 and an upper focal point 925. The upper light-incident surface 923 and the upper light-emergent surface 924 are respectively located at two opposite sides of the upper lens 921 in a direction of the optical axis (E). The upper focal point 925 is located at one side of the upper light-incident surface 923 opposite to the upper light-emergent surface 924. The lower lens 922 is located below the optical axis (E), and has a lower light-incident surface 926, a lower light-emergent surface 927 and a first lower focal point 928. The lower light-incident surface 926 faces in a direction that is the same as that of the upper light-incident surface 923. The lower light-emergent surface 927 is opposite to the lower light-incident surface 926 in the direction of the optical axis (E). The first lower focal point 928 is located at one side of the lower light-incident surface 926 opposite to the lower light-emergent surface 927. The reflector 93 is located at one side of the upper focal point 925 opposite to the upper light-incident surface 923, and has a reflecting surface 931. The reflecting surface 931 is arc-shaped, and has a first reflecting focal point 932 and a second reflecting focal point 933. The first reflecting focal point 932 and the second reflecting focal point 933 are respectively distal from and proximate to the upper light-incident surface 923 of the upper lens 921. The second reflecting focal point 933 coincides with the upper focal point 925 of the upper lens 921. The blocking board 94 has a top end at which the second reflecting focal point 933 is located. The light emitting unit 95 includes a first light source 951 and a second light source 952. The first light source 951 has a light emitting surface 953 that faces upwardly, and substantially coincides with the first reflecting focal point 932 of the reflector 93. The second light source 952 has a light emitting surface 954 that faces toward the lower light-incident surface 926 of the lower lens 922, and substantially coincides with the first lower focal point 928 of the lower lens 922. Each of the first light source 951 and the second light source 952 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 951 is in the on-state and when the second light source 952 is in the off-state, the light beams generated by the first light source 951 are reflected by the reflecting surface 931 of the reflector 93 such that some of the light beams are blocked by the blocking board 94 while the remaining light beams travel into the upper lens 921 through the upper light-incident surface 923 and exit the upper lens 921 through the upper light-emergent surface 924 to serve as low beam light rays (i.e., when the first light source 951 is in the on-state and when the second light source 952 is in the off-state, the conventional headlamp device is in a low-beam mode). When the second light source 952 and the first light source 951 are in the on-state, the light beams generated by the second light source 952 travel into the lower lens 922 though the lower light-incident surface 926 and exit the lower lens 922 through the lower light-emergent surface 927, to cooperate with the light beams that exit the upper lens 921 through the upper light-emergent surface 924 to serve as high beam light rays (i.e., when the first light source 951 and the second light source 952 are in the on-state, the conventional headlamp device is in a high-beam mode).

[0003] Even though the conventional headlamp device is switchable between the low-beam mode and the high-beam mode to emit low beam light rays and high beam light rays, it still requires two light sources to achieve the effect, which may need to be simplified.

[0004] Therefore, an object of the disclosure is to provide a headlamp device for a vehicle that is further improved.

[0005] According to the disclosure, the headlamp device includes a base, a lens, a light emitting unit, a blocking board and a compound reflector unit. The lens is spaced apart from the base along an optical axis, and has a light-incident surface, a light-emergent surface and a lens focal point. The light-incident surface is proximate to the base. The light-emergent surface is opposite to the light-incident surface. The lens focal point is located at one side of the light-incident surface opposite to the light-emergent surface and is located on the optical axis. The light emitting unit is mounted to the base and is operable to generate light beams. The blocking board has a first surface, a second surface, a top surface and a bottom surface. The first surface is proximate to the light emitting unit. The second surface is opposite to the first surface along the optical axis. The top surface interconnects the first surface and the second surface. The lens focal point is substantially located on the top surface. The bottom surface interconnects the first surface and the second surface, and is located below the top surface. The compound reflector unit includes a first reflector and a second reflector. The first reflector is mounted to the base and has a curved reflecting surface. The second reflector is mounted to the base, is located between the first reflector and the base, and has a curved reflecting surface offset from the reflecting surface of the first reflector. The first reflector and the second reflector share a first common focal point and a second common focal point that are respectively distal from and proximate to the light-incident surface of the lens. The first common focal point substantially coincides with the light emitting unit. The second common focal point is located on the optical axis and coincides with the lens focal point of the lens. The blocking board further has a board groove that is formed in the top surface, that is formed through the first surface, and that is farther to the light-incident surface of the lens than the second common focal point of the compound reflector unit. When the light emitting unit generates the light beams, a portion of the light beams are reflected by the reflecting surface of the first reflector to substantially pass through the second common focal point, and another portion of the light beams are reflected by the reflecting surface of the second reflector to substantially pass through the second common focal point. The blocking board blocks some of the light beams that are reflected by the reflecting surface of the first reflector and the reflecting surface of the second reflector such that the remaining light beams travel into the lens through the light-incident surface and exit the lens through the light-emergent surface to serve as low beam light rays.

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

Figure 1 is a sectional view of a conventional headlamp device illustrating several representative light beams that are generated by the conventional headlamp device;
Figure 2 is a perspective view of a first embodiment of a headlamp device according to the disclosure;
Figure 3 is another perspective view of the first embodiment;
Figure 4 is a partly exploded perspective view of the first embodiment;
Figure 5 is a perspective view of a blocking board of the first embodiment;
Figure 6 is a sectional view taken along line VI - VI in Figure 3;
Figure 7 is a sectional view of the first embodiment illustrating several representative light beams that are generated by the first embodiment;
Figure 8 is a sectional view of a modification of the first embodiment illustrating several representative light beams that are generated by the modification of the first embodiment when the blocking board is at an alternate position;
Figure 9 is a schematic view illustrating an illumination that is produced on a screen by low beam light rays of the first embodiment;
Figure 10 is a schematic view illustrating an illumination that is produced on a screen by high beam light rays of the first embodiment;
Figure 11 is a perspective view of a compound reflector unit of a second embodiment of the headlamp device;
Figure 12 is a perspective view of a lens of a third embodiment of the headlamp device;
Figure 13 is a perspective view of a lens of a fourth embodiment of the headlamp device; and
Figure 14 is another perspective view of the lens of the fourth embodiment.

[0007] Before the disclosure is described in greater detail, it should be noted that where considered appropriate, reference numerals or terminal portions of reference numerals have been repeated among the figures to indicate corresponding or analogous elements, which may optionally have similar characteristics.

[0008] Referring to Figures 2 to 4, a first embodiment of a headlamp device according to the disclosure is adapted for use in a vehicle. The first embodiment includes a base 2, a frame 3, a lens 4, a compound reflector unit 5, a light emitting unit 6 and a blocking board 7.

[0009] The lens 4 is spaced apart from the base 2 along an optical axis (A) (see Figure 6) that extends in a direction (X) (i.e., the optical axis (A) extends through the lens 4). In this embodiment, the direction (X) of the optical axis (A) is parallel to a front-rear direction. The base 2 has a base main body 21 that has a base top surface 211, an accommodating hole 212 that is indented from the base top surface 211, and two base protrusion parts 22 that are spaced apart from each other in a transverse direction (Y) transverse to the direction (X) of the optical axis (A). Each of the base protrusion parts 22 protrudes forwardly from the base main body 21. In this embodiment, the base 2 is configured to be a heat dissipation member, but in other embodiments, the base 2 is not limited to be a heat dissipation member.

[0010] The frame 3 is located in front of the base 2, and includes a frame main body 31 and two base connecting parts 32 that are located at two opposite sides of the frame main body 31 in the transverse direction (Y). Each of the base connecting parts 32 interconnects the frame main body 31 and a respective one of the base protrusion parts 22 of the base 2.

[0011] Referring further to Figure 7, the lens 4 is located in front of the base 2, is fixedly mounted to the frame main body 31 of the frame 3, and has a light-incident surface 41, a light-emergent surface 42 and a lens focal point 43. The light-incident surface 41 is proximate to the base 2. The light-emergent surface 42 is opposite to the light-incident surface 41. The lens focal point 43 is located at one side of the light-incident surface 41 opposite to the light-emergent surface 42, and is located on the optical axis (A).

[0012] The light emitting unit 6 is mounted to the accommodating hole 212 of the base 2 and is operable to generate light beams. The light emitting unit 6 is located under the optical axis (A), and a distance between the light emitting unit 6 and the optical axis (A) ranges from 0.5 to 10 millimeters. In this embodiment, the light emitting unit 6 is configured to be a light-emitting diode made of at least one semiconductor die, but in other embodiments, the light emitting unit 6 is not limited to be a light-emitting diode.

[0013] The compound reflector unit 5 includes a first reflector 51 and a second reflector 52. The first reflector 51 is mounted to the base 2 and has a curved reflecting surface 511 that faces the light-incident surface 41 of the lens 4. The second reflector 52 is mounted to the base 2, is located between the first reflector 51 and the base main body 21 of the base 2, and has a curved reflecting surface 521 and a reflector facing surface 522. The reflecting surface 521 of the second reflector 52 is offset from the reflecting surface 511 of the first reflector 51 and faces the light-incident surface 41 of the lens 4. The reflector facing surface 522 is opposite to the reflecting surface 521 of the second reflector 52 and faces the reflecting surface 511 of the first reflector 51. Specifically, a distance between the reflecting surface 511 of the first reflector 51 and the reflector facing surface 522 of the second reflector 52 is no less than 0.1 millimeter so that the reflecting surface 521 of the second reflector 52 is offset from the reflecting surface 511 of the first reflector 51. In this embodiment, the distance is measured in a direction parallel to the optical axis (A). The first reflector 51 and the second reflector 52 share a first common focal point 53 and a second common focal point 54 that are respectively distal from and proximate to the light-incident surface 41 of the lens 4. The first common focal point 53 substantially coincides with the light emitting unit 6. The second common focal point 54 is located on the optical axis (A) and coincides with the lens focal point 43 of the lens 4.

[0014] The blocking board 7 is disposed between the lens 4 and the compound reflector unit 5, and between the base protrusion parts 22 of the base 2. Referring further to Figure 5, the blocking board 7 has a board main body 71, and two board protrusion parts 72 that are spaced apart from each other in the transverse direction (Y). Each of the board protrusion parts 72 extends rearwardly from the board main body 71 and is connected to a respective one of the base protrusion parts 22 of the base 2. In certain embodiments, the blocking board 7 is disposed between the base protrusion parts 22 of the base 2 in a manner that the base 2 clamps the board protrusion parts 72 of the blocking board 7 via the base protrusion parts 22. The board main body 71 has a first surface 711, a second surface 712, a top surface 713, a bottom surface 714 and a board groove 715. The first surface 711 is proximate to the light emitting unit 6. The second surface 712 is opposite to the first surface 711 along the optical axis (A). The top surface 713 interconnects the first surface 711 and the second surface 712. The lens focal point 43 of the lens 4 is substantially located on the top surface 713. The bottom surface 714 interconnects the first surface 711 and the second surface 712, and is located below the top surface 713 in an up-down direction (Z) perpendicular to the transverse direction (Y) and to the direction (X) of the optical axis (A). The board groove 715 is formed in the top surface 713, is formed through the first surface 711, and is farther to the light-incident surface 41 of the lens 4 than the second common focal point 54 of the compound reflector unit 5 (i.e., is farther to the light-incident surface 41 than the lens focal point 43).

[0015] When the light emitting unit 6 generates the light beams (see Figure 7), a portion of the light beams are reflected by the reflecting surface 511 of the first reflector 51 to substantially pass through the second common focal point 54, and another portion of the light beams are reflected by the reflecting surface 521 of the second reflector 52 to substantially pass through the second common focal point 54. The blocking board 7 blocks some of the light beams that are reflected by the reflecting surface 511 of the first reflector 51 and the reflecting surface 521 of the second reflector 52 such that the remaining light beams travel into the lens 4 through the light-incident surface 41 and exit the lens 4 through the light-emergent surface 42 to serve as low beam light rays that form a light distribution pattern having a clear cut-off line. Specifically, when the light beams generated by the light emitting unit 6 are reflected by the reflecting surface 511 of the first reflector 51 and the reflecting surface 521 of the second reflector 52, some of the light beams travel through the second common focal point 54 of the compound reflector unit 5 while some of the light beams may stray (i.e., travel in undesirable paths) from the second common focal point 54. The board groove 715 of the blocking board 7 blocks a portion of the light beams that stray from the second common focal point 54 to prevent the light beams that stray from the second common focal point 54 from traveling into the lens 4 through the light-incident surface 41. Specifically, by virtue of the blocking board 7 having the board groove 715, a portion of the light beams that stray from the second common focal point 54 and that travel toward the top surface 713 of the blocking board 7 are reflected by the board groove 715 to travel away from the light-incident surface 41 (i.e., without the board groove 715, the portion of the light beams that stray from the second common focal point 54 and that travel toward the top surface 713 are reflected by the top surface 713 and then may travel toward the light-incident surface 41). Consequently, referring further to Figure 9, an illumination that is produced on a screen by the low beam light rays of the first embodiment meets the illumination requirements of Regulation No 112 of the United Nations Economic Commission for Europe, UN-ECE, at a test point 50L (i.e., left side road shoulder in 50 meters). Furthermore, the blinding and glare effects that may be caused directly by the first embodiment, or that could be indirectly caused by the reflection of the low beam light rays of the first embodiment on wet roads, are reduced.

[0016] In a modification, the blocking board 7 is rotatably mounted to the base 2, and is operable to rotate relative to the lens 4 to an alternate position (see Figure 8), at which the blocking board 7 is away from the second common focal point 54 of the compound reflector unit 5. Specifically, when the blocking board 7 is rotated to the alternate position, the blocking board 7 is rotated about an imaginary axis (not shown) that extends through the blocking board 7 in the transverse direction (Y) in a manner that a top end and a bottom end of the blocking board

7 respectively approach the light emitting unit 6 and the lens 4 (i.e., according to the viewing angle of Figure 8, the blocking board 7 is rotated clockwise). When the blocking board 7 is at the alternate position, the light beams that are reflected by the reflecting surface 511 of the first reflector 51 and the reflecting surface 521 of the second reflector 52 and that travel through the second common focal point 54 travel into the lens 4 through the light-incident surface 41, and exit the lens 4 through the light-emergent surface 42 to serve as high beam light rays. Figure 10 illustrates an illumination that is produced on a screen by the high beam light rays of the modification. In both Figures 9 and 10, the light beams that exit the lens 4 through the light-emergent surface 42 after being reflected by the reflecting surface 511 of the first reflector 51 are distal from the optical axis (A) and form a zone (C) on the screen, and the light beams that exit the lens 4 through the light-emergent surface 42 after being reflected by the reflecting surface 521 of the second reflector 52 are proximate to the optical axis (A) and form a zone (D) on the screen. The light beams that form the zone (D) are more concentrated than those in the zone (C). By virtue of the reflecting surface 521 of the second reflector 52 being offset from the reflecting surface 511 of the first reflector 51 toward the lens 4, an effect of focusing light is enhanced when the light beams are reflected by the reflecting surface 521 of the second reflector 52. Therefore, without another light emitting component, the light beams that are generated by the light emitting unit 6 and that exit the lens 4 through the light-emergent surface 42, when the blocking board 7 is at the alternate position, meet the requirement of serving as high beam light rays. That is to say, by virtue of the blocking board 7 being operable to rotate to the alternate position, the modification is switchable between a low-beam mode and a high-beam mode with only one light emitting component (i.e., the light emitting unit 6). It is noted that, in the modification, the blocking board 7 is actuated to rotate relative to the lens 4 by an actuator (not shown). There will be no further details describing how the blocking board 7 is actuated to rotate since it is not considered as a subject matter of this disclosure.

[0017] It is noted that, the distance between the reflecting surface 511 of the first reflector 51 and the reflector facing surface 522 of the second reflector 52, the size of each of the first reflector 51 and the second reflector 52, and curvature of each of the first reflector 51 and the second reflector 52 are adjustable so as to change the directions in which the light beams that are reflected by the compound reflector unit 5 travel, to meet different operational requirements.

[0018] Referring to Figure 6 again, an imaginary line (B) is defined to extend from a first intersection point (B1) of the optical axis (A) and a plane (not shown) that has a normal vector in the direction (X) of the optical axis (A) and that passes through a front edge of the light emitting unit 6, toward a second intersection point (B2) that is at an intersection of a plane (not shown) having a normal vector in the transverse direction (Y) and containing the optical axis (A), and a top end of the second reflector 52. The imaginary line (B) cooperates with the optical axis (A) to define an angle therebetween. The angle is adjustable from 30 to 60 degrees in different embodiments. As the angle changes, the portion of the light beams that are reflected by the reflecting surface 511 of the first reflector 51 and another portion of the light beams that are reflected by the reflecting surface 521 of the second reflector 52 change. Consequently, the area of each of the zone (C) and the zone (D) on the screen changes accordingly. By adjusting the angle, the headlamp device according to the disclosure may meet the requirements for headlamps according to different regulations. In addition, curvature of each of the reflecting surface 511 of the first reflector 51 and the reflecting surface 521 of the second reflector 52 is individually adjustable, which achieves a better effect of focusing light than a headlamp device that has only one reflecting surface.

[0019] Referring further to Figure 11, a second embodiment of the headlamp device according to the disclosure is similar to the first embodiment and includes a different configuration of the compound reflector unit 5. In the second embodiment, the first reflector 51 and the second reflector 52 of the compound reflector unit 5 are formed as one-piece (the reflector facing surface 522 is omitted), and the compound reflector unit 5 further includes a reflector connecting surface 55. The reflector connecting surface 55 interconnects the reflecting surface 511 of the first reflector 51 and the reflecting surface 521 of the second reflector 52. In the second embodiment, since the reflector facing surface 522 of the second reflector 52 is omitted, a distance between the reflecting surface 511 of the first reflector 51 and the reflecting surface 521 of the second reflector 52 is either a width of the reflector connecting surface 55, or a distance between the reflecting surface 511 and the reflecting surface 521 in a direction parallel to the optical axis (A), and is no less than 0.1 millimeter. By virtue of the first reflector 51 and the second reflector 52 being formed as one-piece, there is no need to assemble the compound reflector unit 5, which may reduce manufacturing cost and simplify the manufacturing process. The second embodiment has the same functionality and achieves the same results as the first embodiment.

[0020] Referring further to Figure 12, a third embodiment of the headlamp device according to the disclosure is similar to the first embodiment and includes a different configuration of the lens 4. In the third embodiment, the light-emergent surface 42 of the lens 4 is formed by a plurality of curved surface parts that are offset from each other. Specifically, the light-emergent surface 42 of the lens 4 has a first curved surface part 421 through which the optical axis (A) extends, and two second curved surface parts 422. The first curved surface part 421 has an upper section 423, and a lower section 424 that is located below the upper section 423 and that is offset from the upper section 423 (i.e., the upper section 423 is not flush with the lower section 424). The second curved surface parts 422 are respectively located at two opposite sides of the first curved surface part 421 in the transverse direction (Y). The second curved surface parts 422 are offset from the first curved surface part 421 (i.e., the first curved surface part 421 is not flush with each of the second curved surface parts 422). Each of the second curved surface parts 422 has an upper section 425 and a lower section 426 that is located below the upper section 425 and that is offset from the upper section 425 (i.e., the upper section 425 is not flush with the lower section 426). Specifically, each of the second curved surface parts 422 is rearwardly offset from the first curved surface part 421. The lower section 424 of the first curved surface part 421 is rearwardly offset from the upper section 423 of the first curved surface part 421. For each second curved surface part 422, the lower section 426 is rearwardly offset from the upper section 425.

[0021] A distance between the upper section 423 and the lower section 424 of the first curved surface part 421 in a direction parallel to the optical axis (A) is no less than 0.1 millimeter. A distance between the upper section 425 and the lower section 426 of each of the second curved surface parts 422 in a direction parallel to the optical axis (A) is no less than 0.1 millimeter. A distance between the upper section 423 of the first curved surface part 421 and the upper section 425 of each of the second curved surface parts 422 in a direction parallel to the optical axis (A) is no less than 0.1 millimeter. A distance between the lower section 424 of the first curved surface part 421 and the lower section 426 of each of the second curved surface parts 422 in a direction parallel to the optical axis (A) is no less than 0.1 millimeter.

[0022] It is noted that, curvature of each of the upper section 423 and the lower section 424 of the first curved surface part 421 is individually adjustable. For each second curved surface part 422, curvature of each of the upper section 425 and the lower sections 426 is individually adjustable. By adjusting the curvature of each of the upper section 423 and the lower section 424 of the first curved surface part 421 and the upper sections 425 and the lower sections 426 of the second curved surface parts 422, the directions in which the light beams that exit the lens 4 through the light-emergent surface 42 travel may be adjusted to achieve a better effect of focusing light than an aspheric lens that has a light-emergent surface without offset sections (i.e., the light-emergent surface of the aspheric lens is configured to be a smooth surface).

[0023] The third embodiment has the same functionality and achieves the same results as the first embodiment.

[0024] Referring further to Figures 13 and 14, a fourth embodiment of the headlamp device according to the disclosure is similar to the first embodiment. In the fourth embodiment, the headlamp device further includes a grating unit 8 that has two grating subunits 81, 82 respectively disposed on the light-incident surface 41 and the light-emergent surface 42 of the lens 4. Each of the grating subunits 81, 82 is configured to be one of a coated grating, a microstructured grating, and a mixture of coated and microstructured gratings. An area of the grating subunit 81 is no greater than one-third of the surface area of the light-incident surface 41 of the lens 4. An area of the grating subunit 82 is no greater than one-third of the surface area of the light-emergent surface 42 of the lens 4. In one embodiment, the grating subunits 81, 82 are respectively disposed on the light-emergent surface 42 and the light-incident surface 41 of the lens 4.

[0025] It is noted that, in certain embodiments, the grating unit 8 may have only one of the grating subunits 81, 82, and the one of the grating subunits 81, 82 is disposed on one of the light-incident surface 41 and the light-emergent surface 42 of the lens 4. The area of the one of the grating subunits 81, 82 is no greater than one-third of the surface area of the one of the light-incident surface 41 and the light-emergent surface 42 of the lens 4.

[0026] It is noted that, the coated grating may be formed by evaporation, sputtering or adhesion. The microstructured grating may be formed by a process of sand blasting, grinding, laser processing or etching. To acquire a lens disposed with a microstructured grating, each of the processes of sand blasting, grinding, laser processing and etching may be directly performed on a lens, or may be performed on a mold cavity/mold core that is used in injection molding for producing lenses.

[0027] Each of the grating subunits 81, 82 of the grating unit 8 is adapted to block a portion of the light beams that are reflected by the compound reflector unit 5 so that the light beams that define the cut-off line of the light distribution pattern formed by the low beam light rays or the high beam light rays are more concentrated. Thus, the cut-off lines of the light distribution patterns of the headlamp device are relatively clear.

[0028] The fourth embodiment has the same functionality and achieves the same results as the first embodiment.

[0029] In summary, by virtue of the compound reflector unit 5 including the first reflector 51 and the second reflector 52, and by virtue of the board groove 715 of the blocking board 7 reflecting a portion of the light beams that stray from the second common focal point 54 of the compound reflector unit 5 (i.e., travel toward the top surface 713 of the blocking board 7 in undesired paths) and that may travel toward the light-incident surface 41 of the lens 4, when the headlamp device is in the low-beam mode, the headlamp device achieves a better effect of focusing light (i.e., the brightness of the headlamp device is enhanced) and still meets the illumination requirements of Regulation No 112 of UNECE at the test point 50L (i.e., the blinding and glare effects are reduced). Moreover, by virtue of the reflecting surface 521 of the second reflector 52 being offset from the reflecting surface 511 of the first reflector 51, and by virtue of the blocking board 7 being operable to rotate to the alternate position, the headlamp device is switchable between the low-beam mode and the high-beam mode without another light emitting component, and the light beams that are generated by the headlamp device meet the requirement of serving as low beam light rays when the headlamp device is in the low-beam mode, and still meet the requirement of serving as high beam light rays when the headlamp device is in the high-beam mode. Moreover, by virtue of the curvature of the reflecting surface 521 of the second reflector 52 being individually adjustable, and by virtue of the angle that is defined by the imaginary line (B) and the optical axis (A) being adjustable, the headlamp device achieves a better effect of focusing light, and may meet requirements in different regulations for headlamps.

[0030] 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 embodiments. 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 for a vehicle, said headlamp device comprising:

a base (2);
a lens (4) spaced apart from said base (2) along an optical axis (A), and having

a light-incident surface (41) that is proximate to said base (2),
a light-emergent surface (42) that is opposite to said light-incident surface (41), and
a lens focal point (43) that is located at one side of said light-incident surface (41) opposite to said light-emergent surface (42) and that is located on the optical axis (A);

a light emitting unit (6) mounted to said base (2) and operable to generate light beams; and
a blocking board (7) having

a first surface (711) that is proximate to said light emitting unit (6),
a second surface (712) that is opposite to said first surface (711) along the optical axis (A),
a top surface (713) that interconnects said first surface (711) and said second surface (712), said lens focal point (43) being substantially located on said top surface (713), and
a bottom surface (714) that interconnects said first surface (711) and said second surface (712), and that is located below said top surface (713);

said headlamp device being **characterized by**:

a compound reflector unit (5) including

a first reflector (51) that is mounted to said base (2) and that has a curved reflecting surface (511), and
a second reflector (52) that is mounted to said base (2), that is located between said first reflector (51) and said base (2), and that has a curved reflecting surface (521) offset from said reflecting surface (511) of said first reflector (51), said first reflector (51) and said second reflector (52) sharing a first common focal point (53) and a second common focal point (54) that are respectively distal from and proximate to said light-incident surface (41) of said lens (4), said first common focal point (53) substantially coinciding with said light emitting unit (6), said second common focal point (54) being located on the optical axis (A) and coinciding with said lens focal point (43) of said lens (4), said blocking board (7) further having a board groove (715) that is formed in said top surface (713), that is formed through said first surface (711), and that is farther to said light-incident surface (41) of said lens (4) than said second common focal point (54) of said compound reflector unit (5);

wherein, when said light emitting unit (6) generates the light beams, a portion of the light beams are reflected by said reflecting surface (511) of said first reflector (51) to substantially pass

through said second common focal point (54), and another portion of the light beams are reflected by said reflecting surface (521) of said second reflector (52) to substantially pass through said second common focal point (54); and
wherein said blocking board (7) blocks some of the light beams that are reflected by said reflecting surface (511) of said first reflector (51) and said reflecting surface (521) of said second reflector (52) such that the remaining light beams travel into said lens (4) through said light-incident surface (41) and exit said lens (4) through said light-emergent surface (42) to serve as low beam light rays.

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

said blocking board (7) is disposed between said lens (4) and said compound reflector unit (5), and is operable to rotate relative to said lens (4) to an alternate position, at which said blocking board (7) is away from said second common focal point (54) ; and
when said blocking board (7) is at the alternate position, the light beams that are reflected by said reflecting surface (511) of said first reflector (51) and said reflecting surface (521) of said second reflector (52) and that travel through said second common focal point (54) travel into said lens (4) through said light-incident surface (41) and exit said lens (4) through said light-emergent surface (42) to serve as high beam light rays.

3. The headlamp device as claimed in claim 1, **characterized in that** said first reflector (51) and said second reflector (52) of said compound reflector unit (5) are formed as one-piece, and said compound reflector unit (5) further includes a reflector connecting surface (55) that interconnects said reflecting surface (511) of said first reflector (51) and said reflecting surface (521) of said second reflector (52) .

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

said second reflector (52) of said compound reflector unit (5) further has a reflector facing surface (522) opposite to said reflecting surface (521) thereof; and
a distance between said reflecting surface (511) of said first reflector (51) and said reflector facing surface (522) of said second reflector (52) is no less than 0.1 millimeter.

5. The headlamp device as claimed in claim 1, **characterized in that** said light emitting unit (6) is located under the optical axis (A), and a distance between said light emitting unit (6) and the optical axis (A) ranges from 0.5 to 10 millimeters.

6. The headlamp device as claimed in claim 1, further **characterized by** a grating unit (8) that is disposed on at least one of said light-incident surface (41) and said light-emergent surface (42) of said lens (4), said grating unit (8) being configured to be one of a coated grating, a microstructured grating, and a mixture of coated and microstructured gratings.

7. The headlamp device as claimed in claim 6, **characterized in that** an area of said grating unit (8) is no greater than one-third of a surface area of the at least one of said light-incident surface (41) and said light-emergent surface (42) of said lens (4) on which said grating unit (8) is disposed.

8. The headlamp device as claimed in claim 1, **characterized in that** said light-emergent surface (42) of said lens (4) is formed by a plurality of curved surface parts that are offset from each other.

9. The headlamp device as claimed in any one of claims 1 and 8, **characterized in that** said light-emergent surface (42) of said lens (4) has

a first curved surface part (421) through which the optical axis (A) extends, and
two second curved surface parts (422) that are respectively located at two opposite sides of said first curved surface part (421) in a transverse direction (Y) transverse to a direction (X) of the optical axis (A), said second curved surface parts (422) being offset from said first curved surface part (421), said first surface curved surface part (421) having an upper section (423) and a lower section (424) that is located below said upper section (423) and that is offset from said upper section (423), each of said second curved surface parts (422) having an upper section (425) and a lower section (426) that is located below said upper section (425) of said second curved surface part (422) and that is offset from said upper section (425) of said second curved surface part (422).

10. The headlamp device as claimed in claim 9, **characterized in that**:

a distance between said upper section (423) and said lower section (424) of said first curved surface part (421) in a direction parallel to the optical axis (A) is no less than 0.1 millimeter;

a distance between said upper section (425) and said lower section (426) of each of said second curved surface parts (422) in a direction parallel to the optical axis (A) is no less than 0.1 millimeter;

a distance between said upper section (423) of said first curved surface part (421) and said upper section (425) of each of said second curved surface parts (422) in a direction parallel to the optical axis (A) is no less than 0.1 millimeter; and

a distance between said lower section (424) of said first curved surface part (421) and said lower section (426) of each of said second curved surface parts (422) in a direction parallel to the optical axis (A) is no less than 0.1 millimeter.

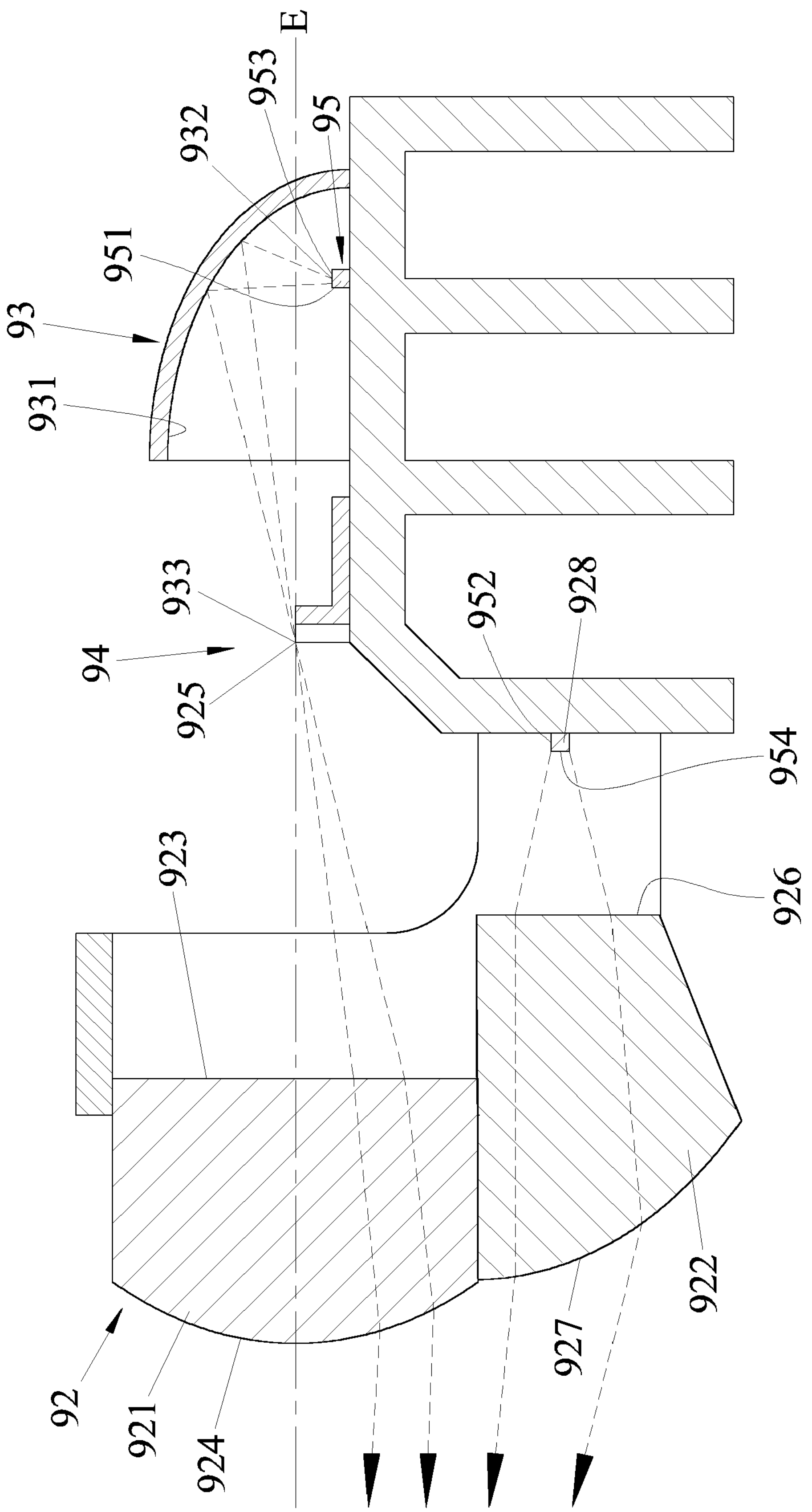

FIG.1
PRIOR ART

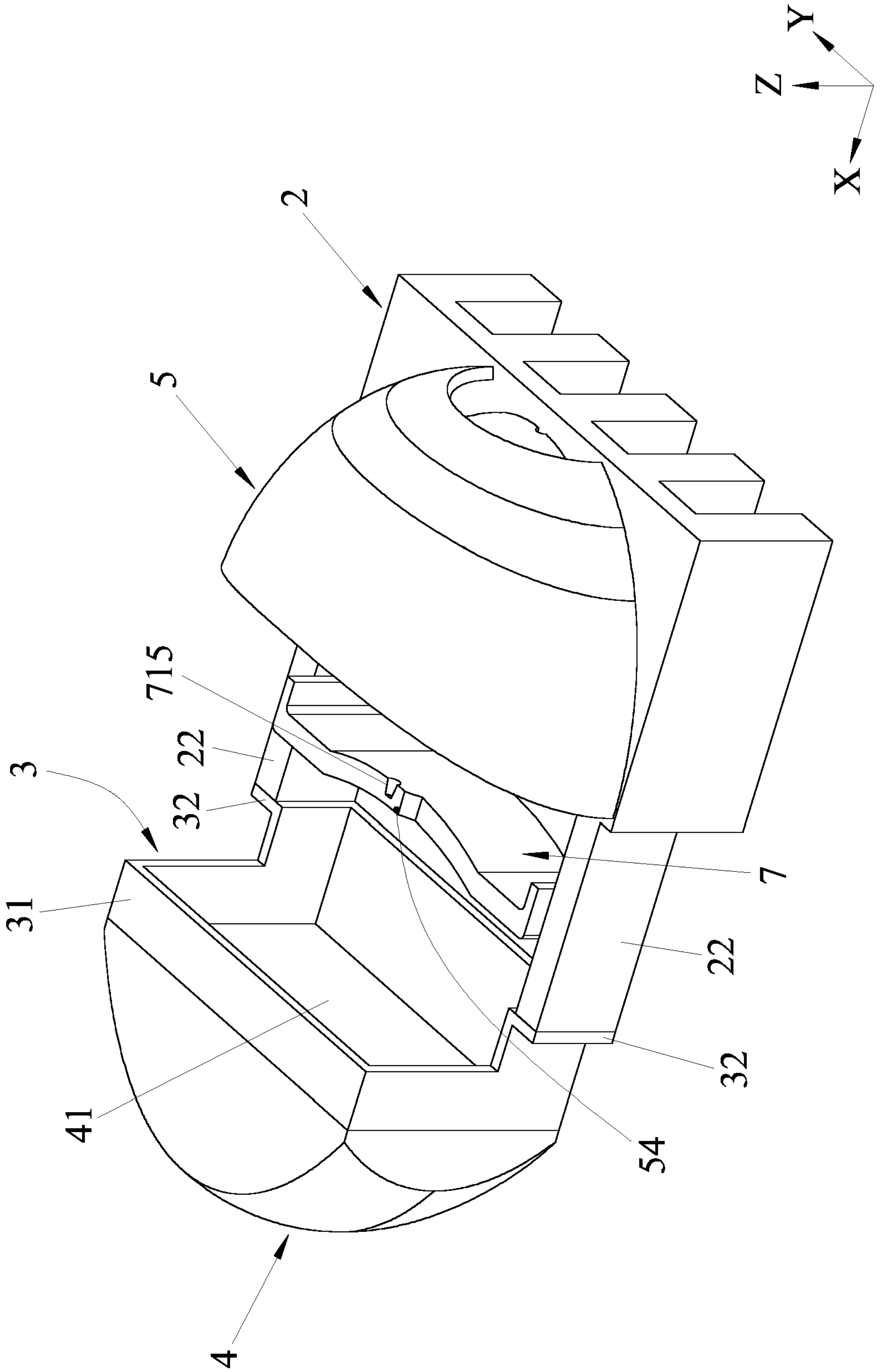

FIG.2

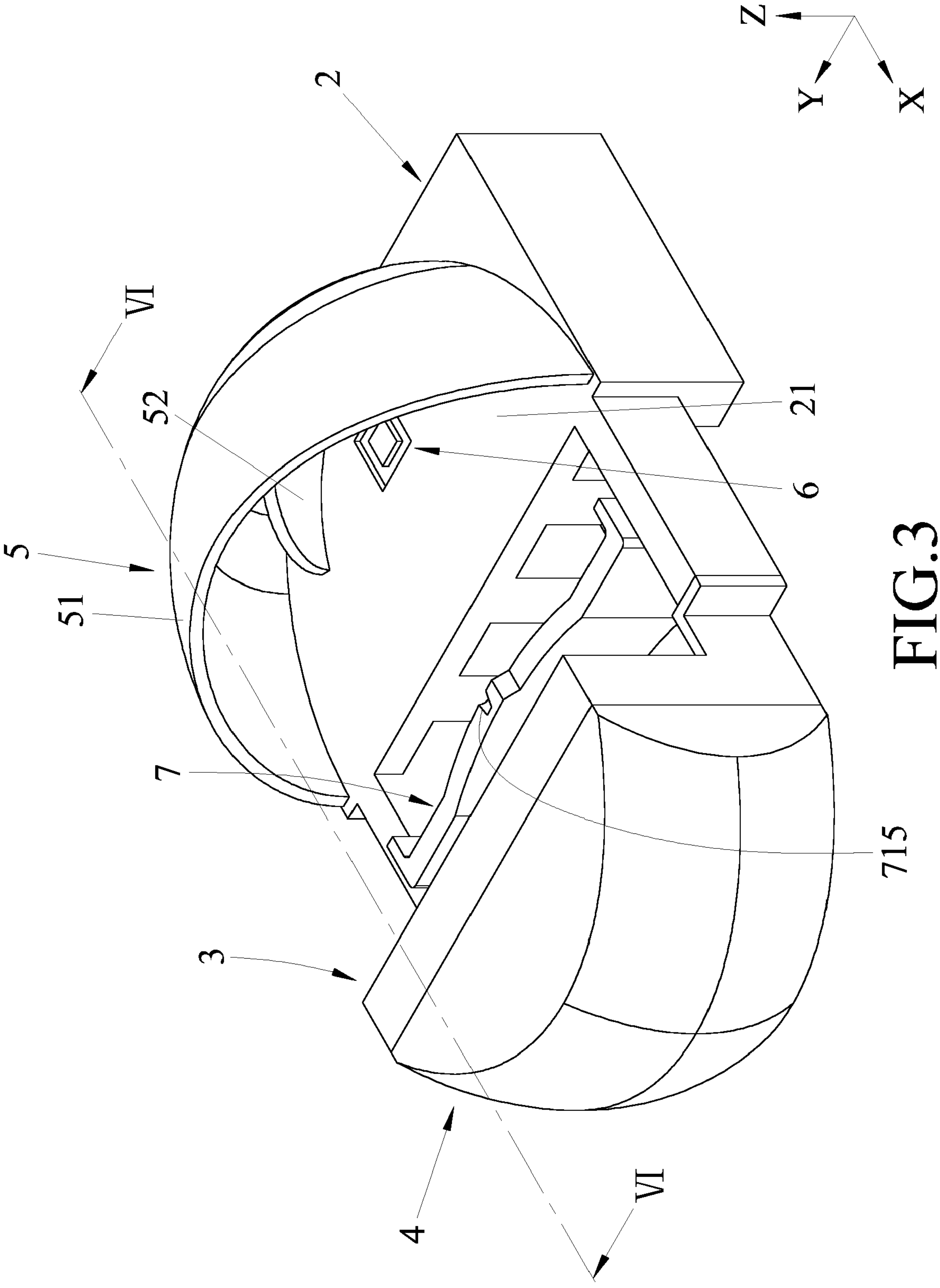

FIG.3

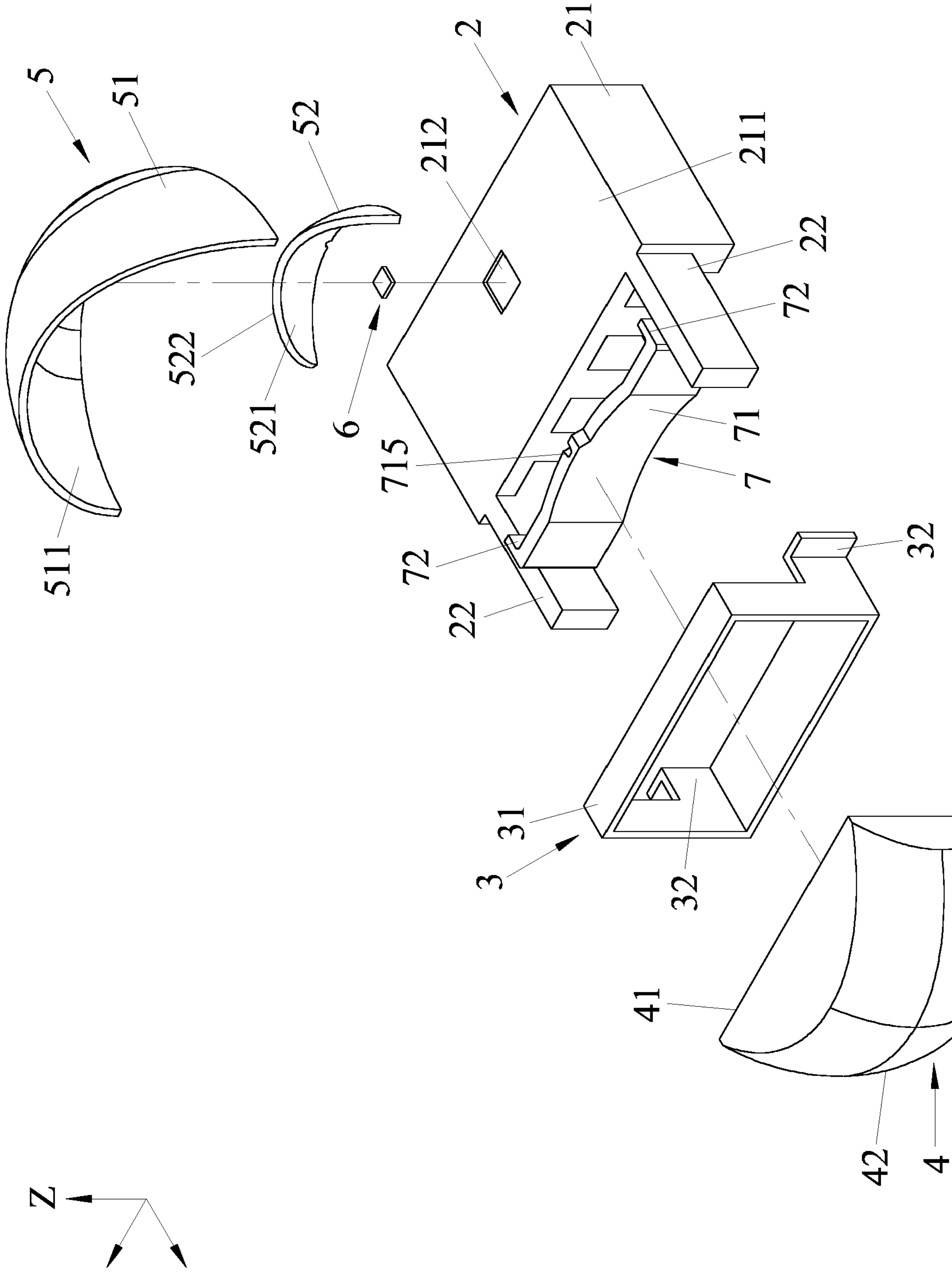

FIG.4

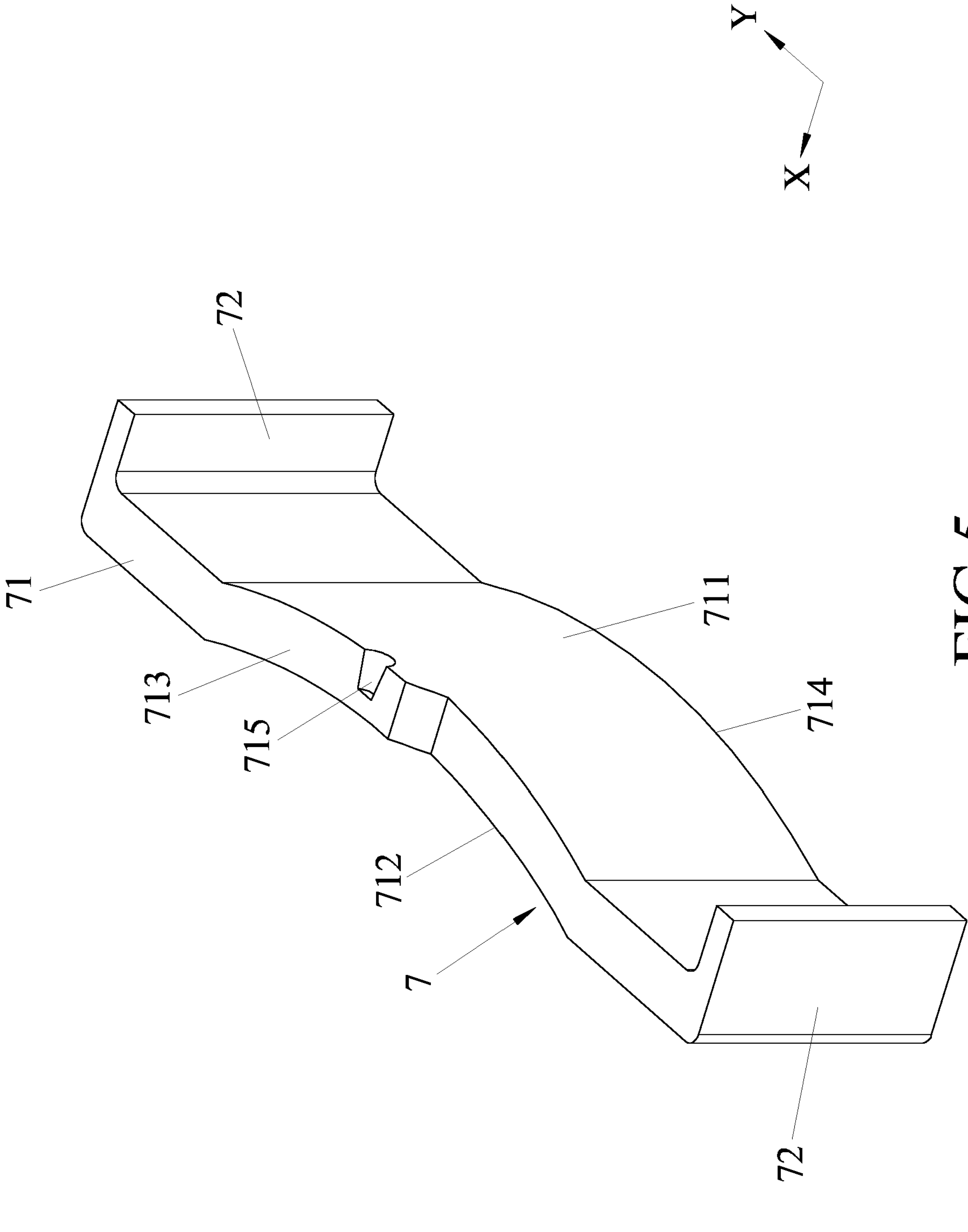

FIG.5

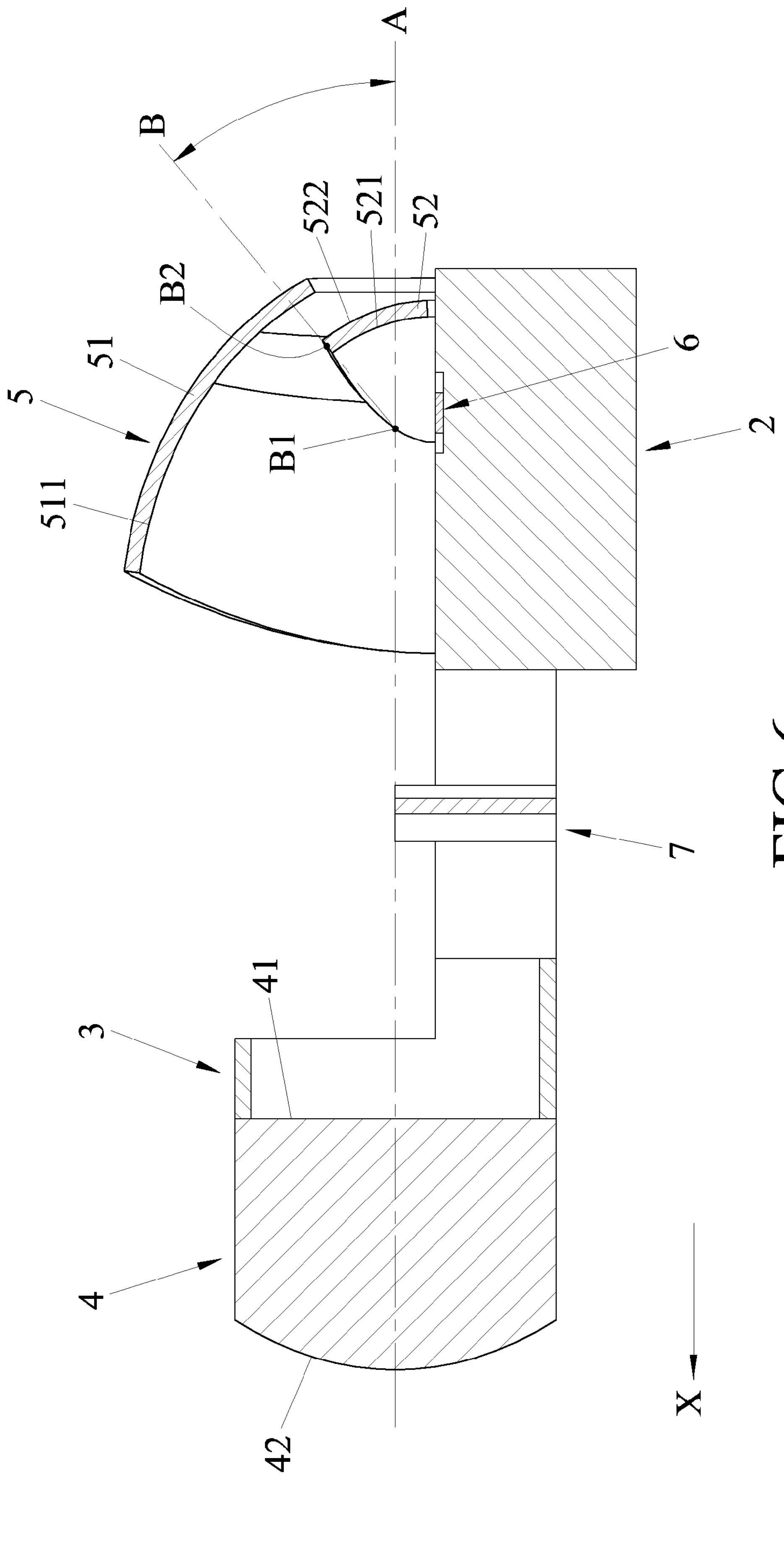

FIG.6

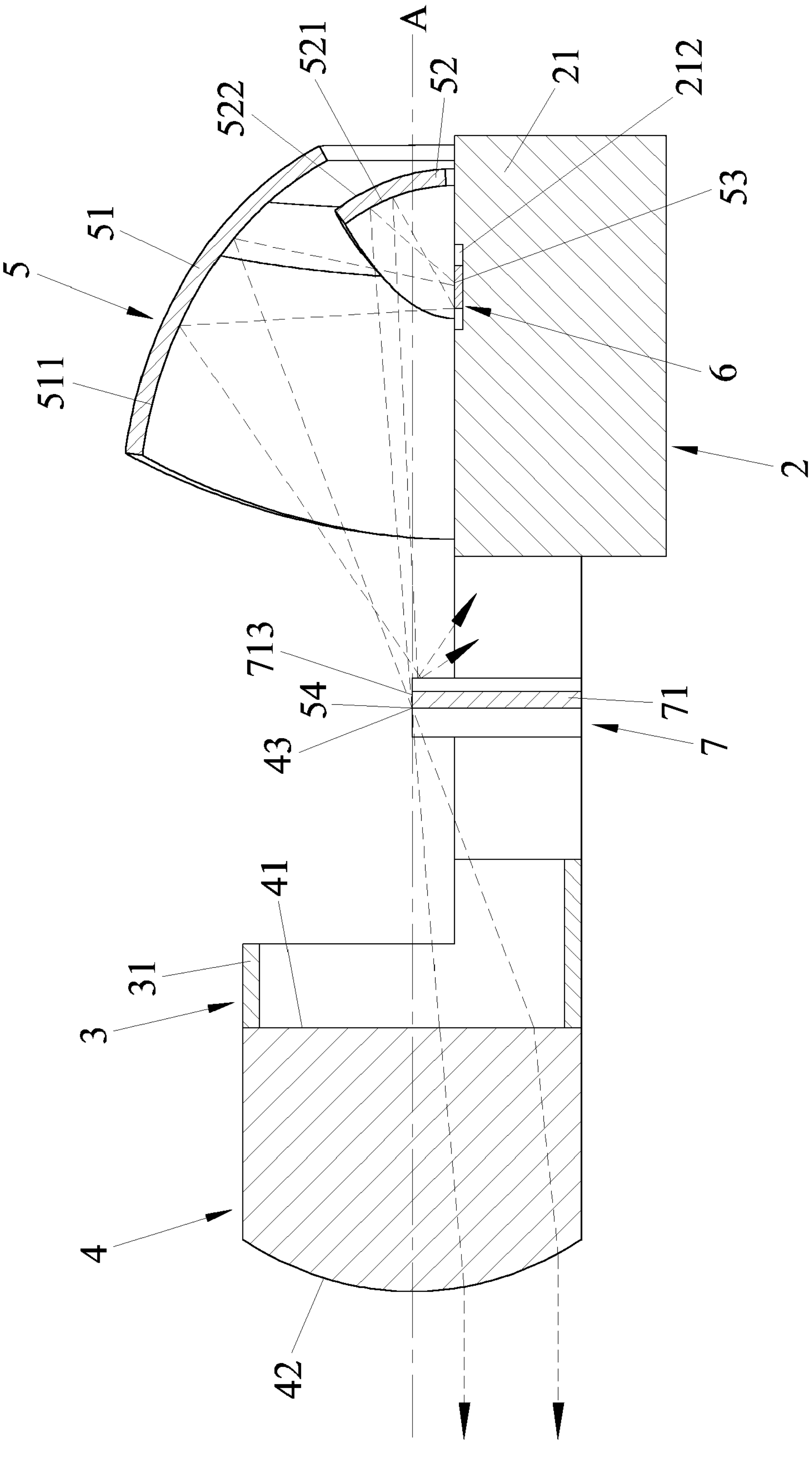

FIG.7

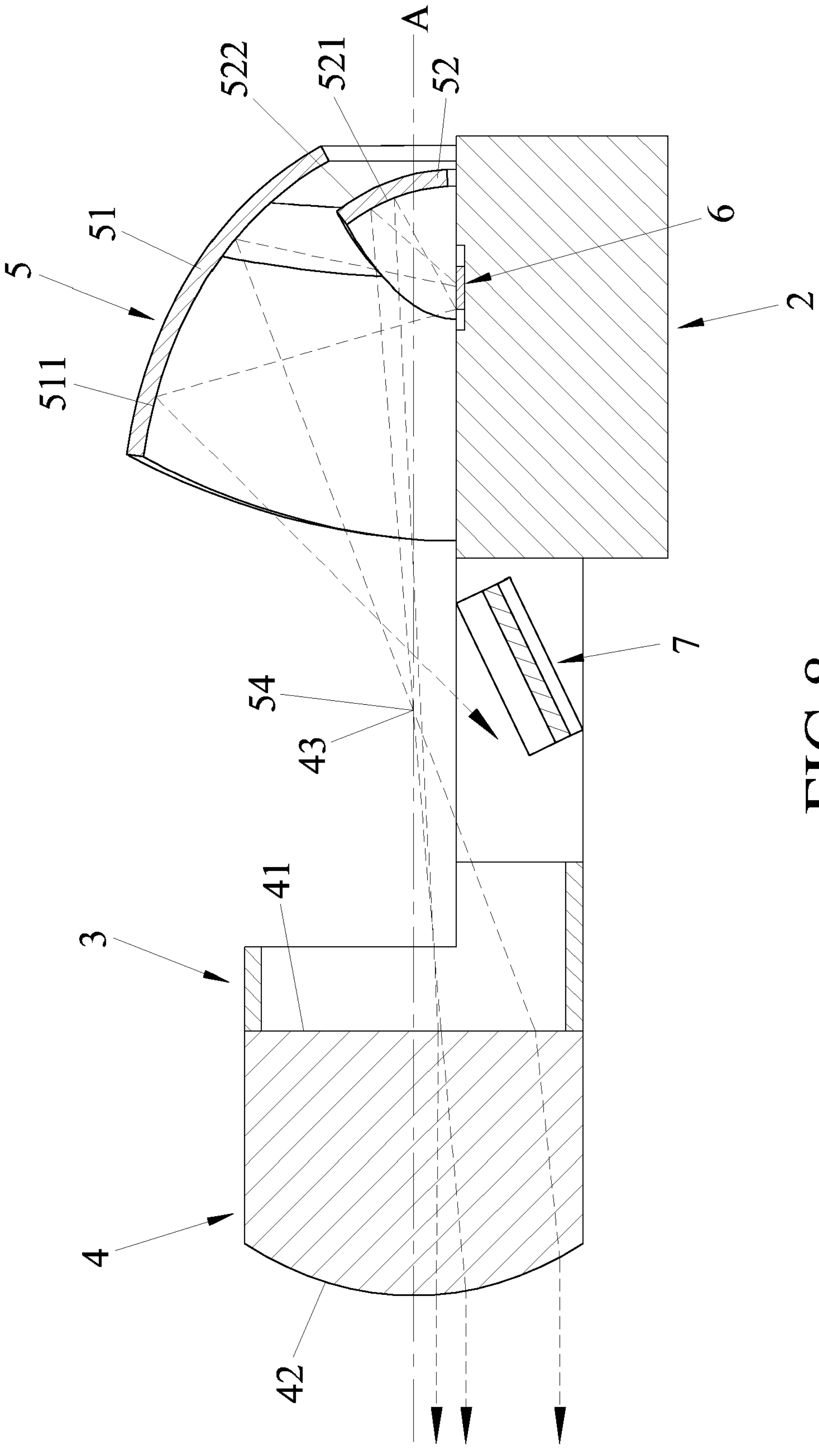

FIG.8

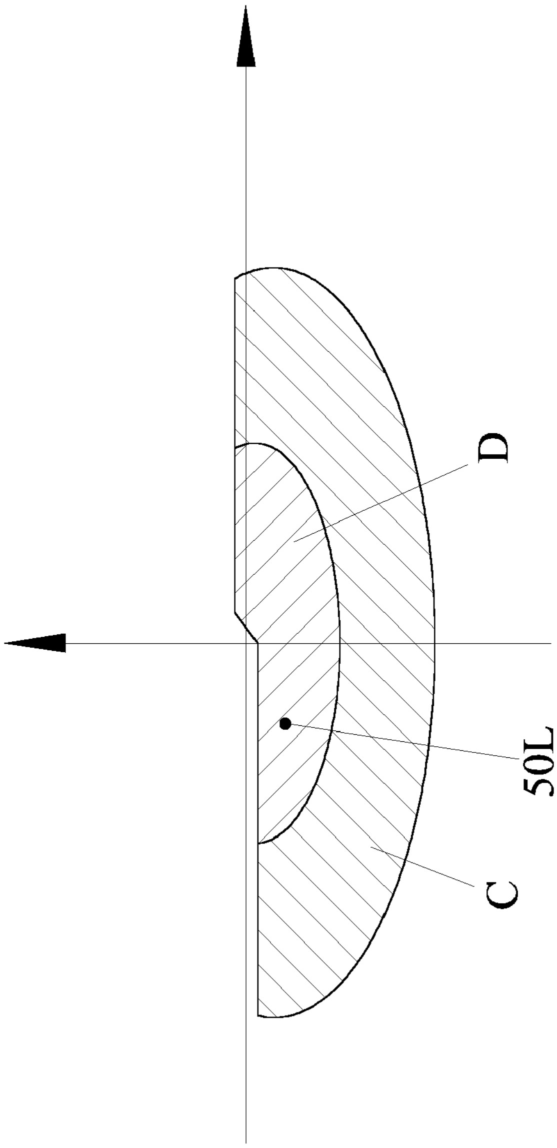

FIG.9

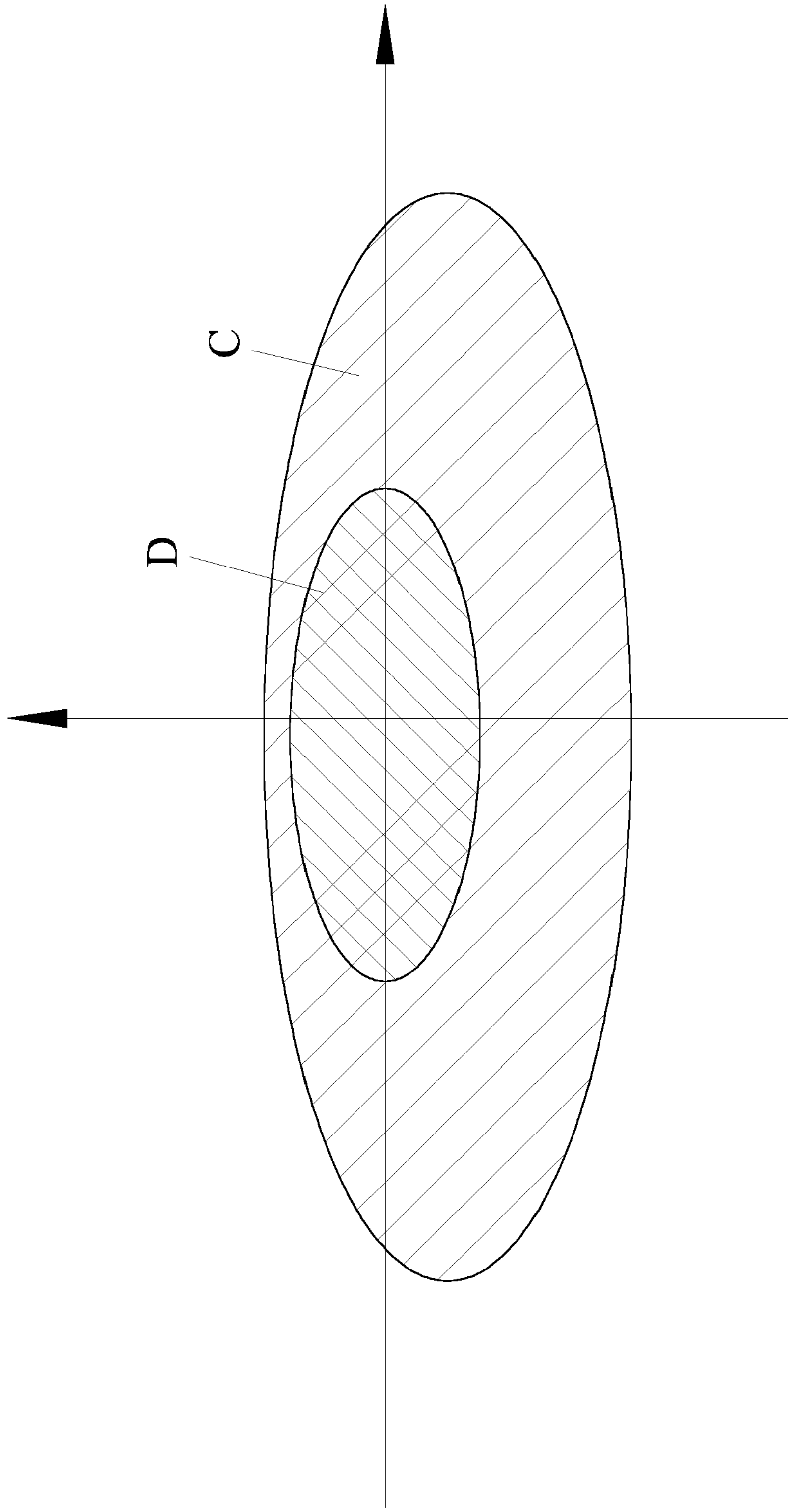

FIG.10

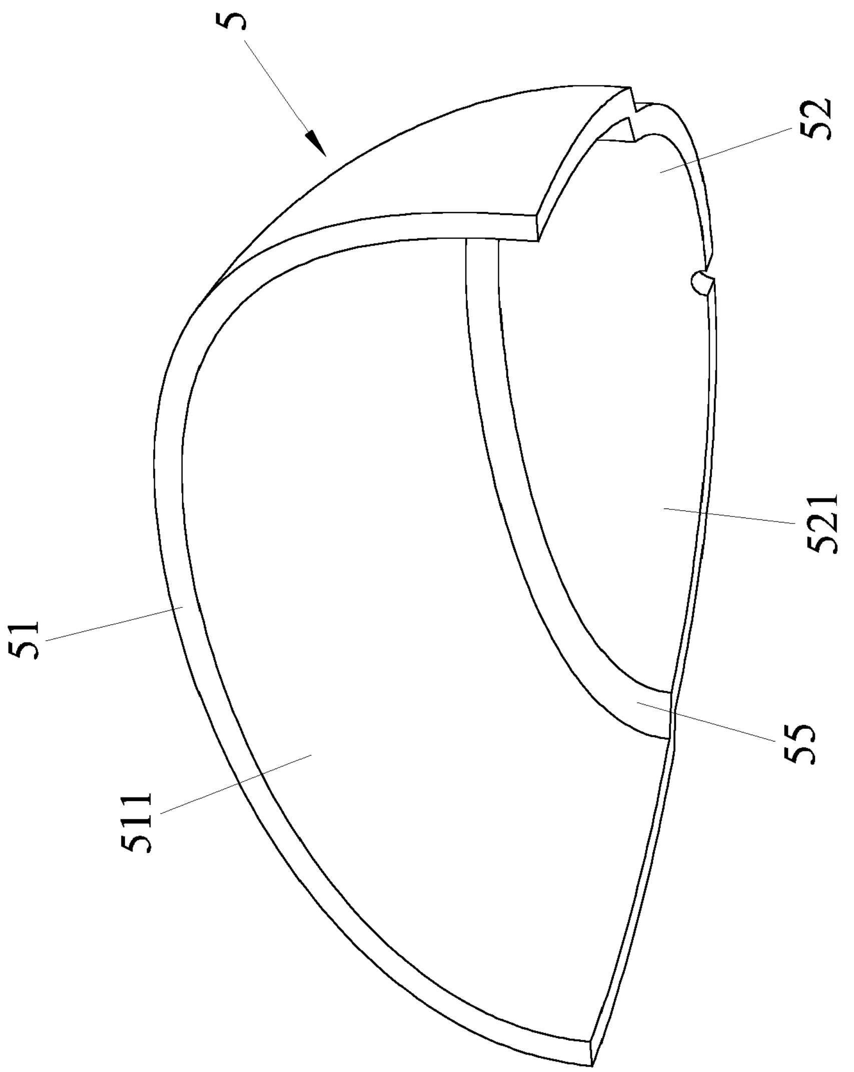

FIG.11

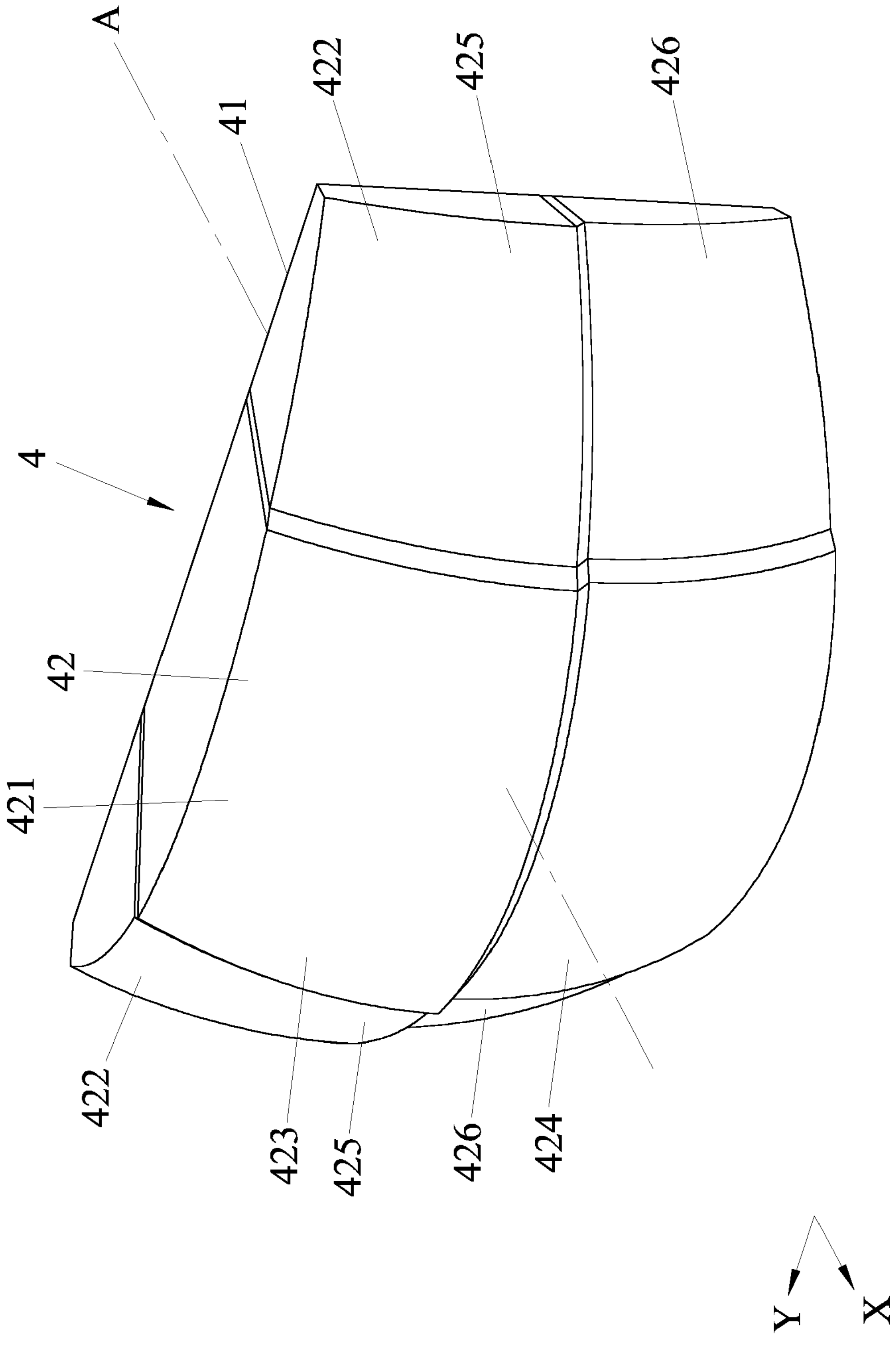

FIG.12

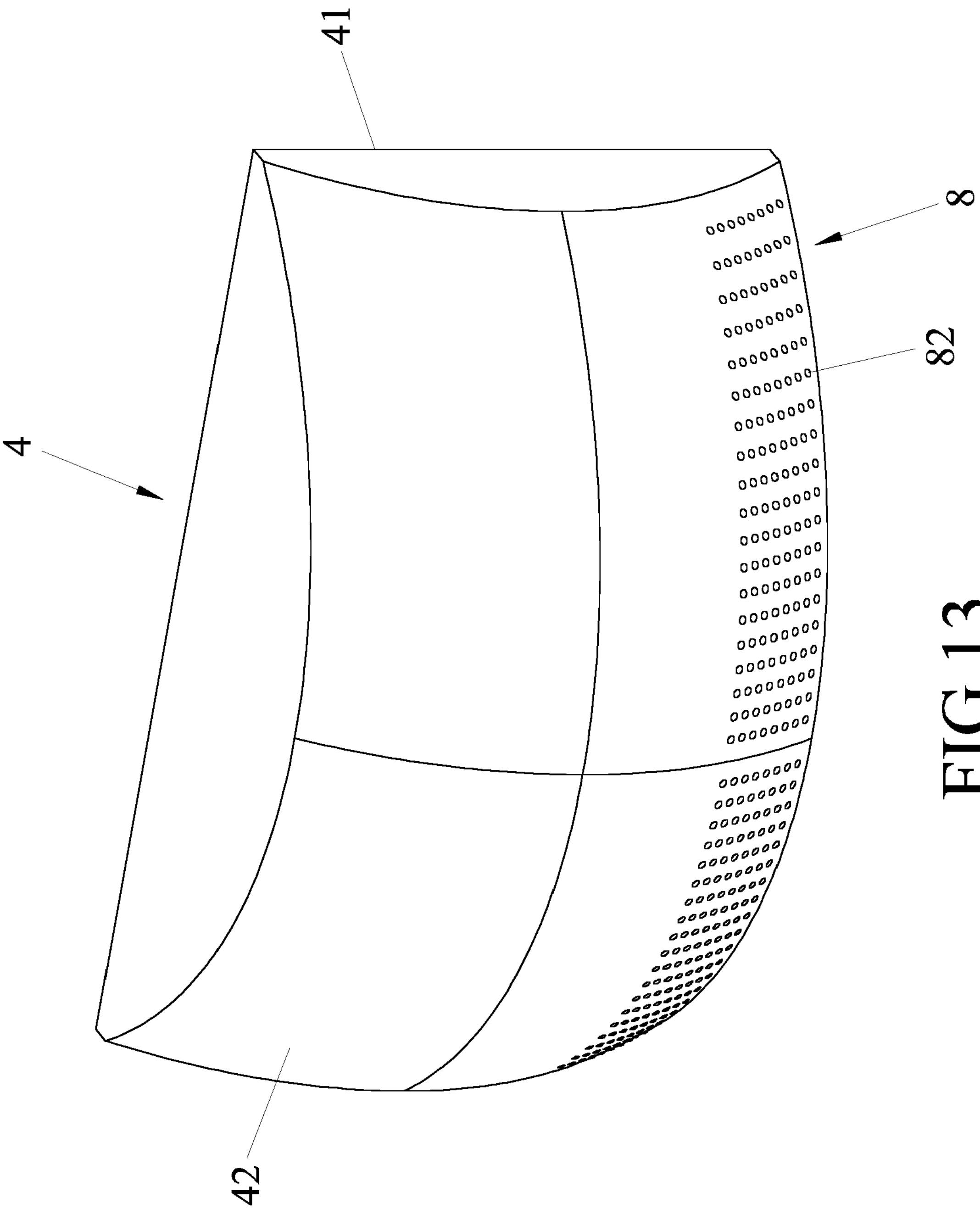

FIG.13

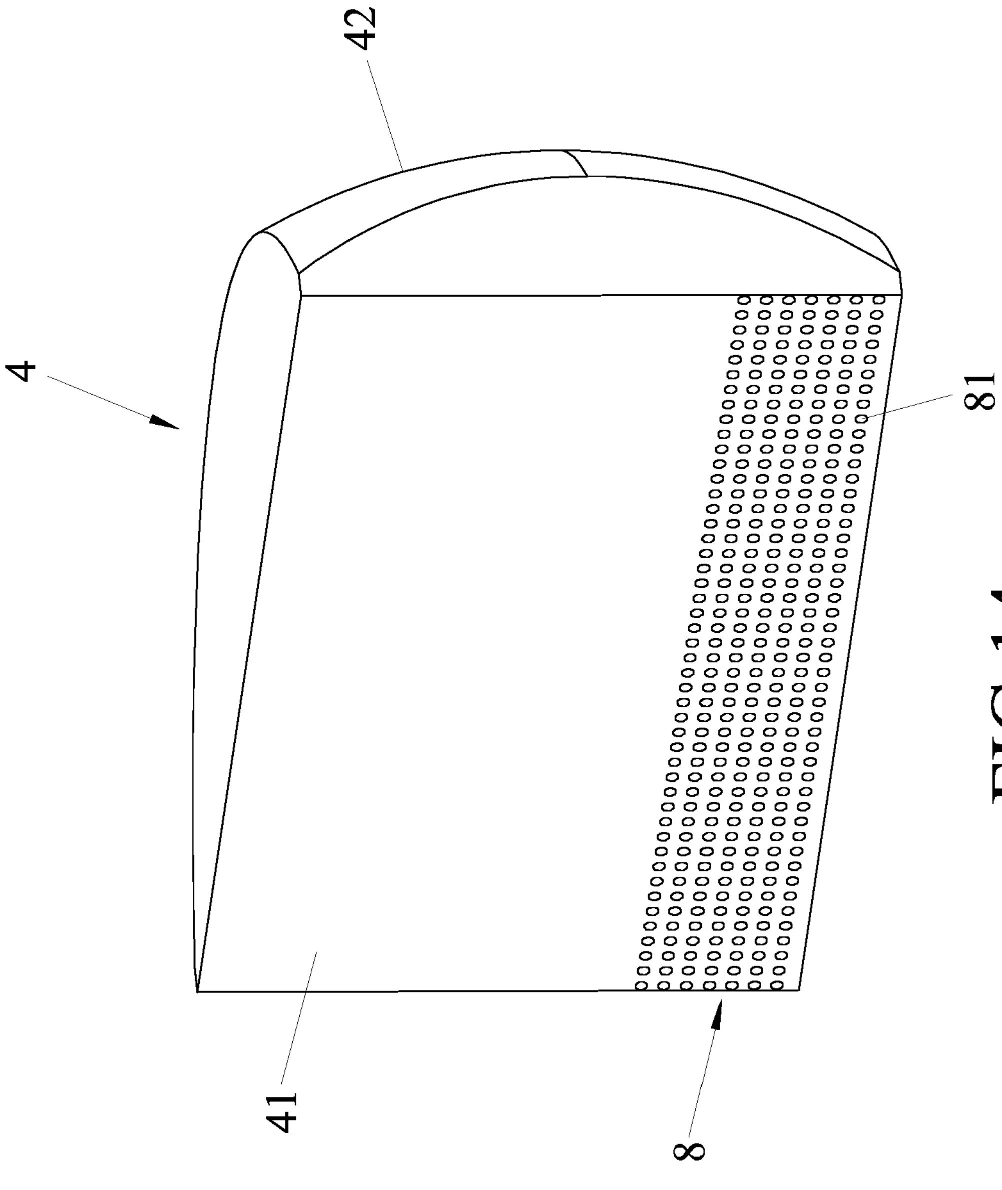

FIG.14

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EUROPEAN SEARCH REPORT

Application Number
EP 22 15 7898

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2019/234579 A1 (WANG CHENG [TW]) 1 August 2019 (2019-08-01) * abstract; figures * -----	1-10	INV. F21S41/148 F21S41/265 F21S41/275 F21S41/32 F21S41/36 F21S41/365 F21S41/40 F21S41/43 F21S41/663 F21S41/675 F21S41/689 F21S41/698 F21S41/683 F21S41/33
A	US 2018/272921 A1 (WANG CHENG [TW]) 27 September 2018 (2018-09-27) * abstract; figures 1-20 * -----	1-10	
A	JP 2015 115276 A (KOITO MFG CO LTD) 22 June 2015 (2015-06-22) * abstract; figures * -----	1-10	
A	JP 2010 129321 A (ICHIKOH INDUSTRIES LTD) 10 June 2010 (2010-06-10) * abstract; figures * -----	1-10	
A	JP 2009 193810 A (ICHIKOH INDUSTRIES LTD) 27 August 2009 (2009-08-27) * abstract; figures * -----	1-10	
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The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
Munich	3 June 2022	Panatsas, Adam

CATEGORY OF CITED DOCUMENTS

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L : document cited for other reasons

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