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(54) **Title:** SHAPED REFLECTIVE DEVICE IN AUTOMOTIVE LED HEADLAMP

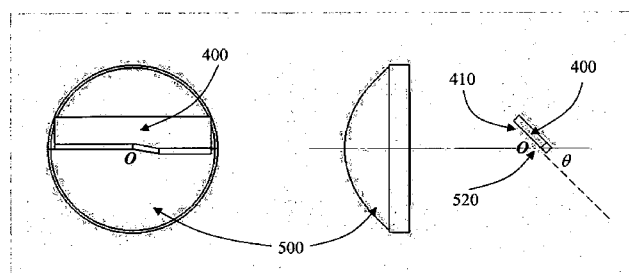


Figure 2-3

(57) **Abstract:** A novel projection type automotive LED headlamp is disclosed, wherein the headlamp comprises a reflective device having a shaped reflective surface. The shaped reflective surface reduces the system package size by folding the light path, and forms a desired intermediate spot without needing a beam shutter. A projection lens projects the intermediate spot toward the front direction to form the desired low beam illumination pattern.



SHAPED REFLECTIVE DEVICE IN AUTOMOTIVE LED HEADLAMP

Field of the Invention

The invention relates to an automotive LED headlamp, and more particularly, to a folding projection type low beam headlamp comprising a reflective device having a shaped reflective surface.

Background of the Invention

Headlamp Light Source

Traditionally, the vehicle headlamps use either halogen filament or high intensity discharge arc (HID) bulb as the light source.

More recently, solid state lighting devices, such as Light Emitting Diode (LED), are fast becoming preferred light source for automotive headlamp. LED has many advantages compared to the traditional HID/Halogen light sources for a few good reasons listed below:

1. LED is vibration and shock resistant due to the solid state lighting technology;
2. LED has much longer lifetime;
3. LED consumes less electrical power;
4. LED has color temperature close to day light, which is preferable for road illumination at night;
5. LED light source reaches maximal output within milliseconds, no warm-up delay;
6. LED is cold light source and it doesn't contain IR and UV spectrum;
7. LED light source has good potentials to be easily integrated into AFL system.

Low Beam and High Beam

A headlamp system is required to produce a low beam and a high beam.

Low beams direct most of the light downwards and have strict control of upward light to provide safe forward illumination without excessive glare. The Economic Commission for

Europe (ECE) regulation specifies low beam with a sharp, asymmetric cutoff preventing light from being cast into the eyes of drivers of preceding or oncoming vehicles.

[High beams cast most of the light straight ahead, maximizing viewing distance, but producing glare, which may cause safety issue when other vehicles are present on the road. High beam is used when there is no other road users or in severe weather conditions.]

Optical Architectures of Headlamp

Modern headlamp optical architecture is either of a multi-reflector type or a projection type.

In a multi-reflector type headlamp, a light source is located in the vicinity of the focal point of a reflector with multiple facets. The light emitted from the light source is reflected by the reflector facets, and the combination of the reflection from all the reflector facets forms the desired illumination pattern.

In a typical projection type headlamp, there are a light source and its dedicated optics to form an intermediate spot, and a projection lens to image the said intermediate spot to the front direction to form the desired illumination pattern.

Related Prior Art

In a typical projection type headlamp, it is not uncommon to use a beam shutter (also known as shield, shade, etc) to block a portion of the light coming from the light source to form the desired intermediate spot. There have been a handful of patent applications relating to projection type automotive LED headlamps. For example, in the prior art shown in US patent application US2005/0231971 filed by Koito, there is an LED light source, a reflector, a beam shutter, and a projection lens. The light emitted from LED is collected by the reflector and re-directed toward the beam shutter. The beam shutter is to block a portion of the incoming light and forms an intermediate spot. The projection lens is to image the intermediate spot toward the front direction and forms the ECE required low beam illumination pattern.

As the car's industrial design becomes more and more aerodynamic and streamlined, the space for headlamps is very limited. It is desirable to fold the optical system to reduce the overall length of the package so that the headlamp can be fitted into the limited space. It is

also desirable to remove the beam shutter from the folding system as it is hard to find a place for installing the beam shutter in such a compact system.

Summary of the Invention

Thus, it is an object of the present invention to provide a compact LED headlamp to solve the above-described problem.

The present invention relates to a projection type low beam automotive LED headlamp, wherein a reflective device having a shaped reflective surface is obliquely placed in the vicinity of the focal plane of the projection lens. The reflective device serves two purposes: 1) to fold the incoming light toward the projection lens; 2) to selectively reflect a portion of the light to form a desired intermediate spot, which is further projected to the front direction by the projection lens for creating the low beam illumination pattern. By implementing such a reflective device, the headlamp system package size is reduced and there is no additional beam shutter needed for forming the low beam illumination pattern.

Description of the Drawings

The above as well as other advantages of the present invention will become apparent to those skilled in the art from the following detailed description of the embodiments when considered in the light of the accompanying drawing in which:

Figure 1 is a perspective view of the folding optical system in present invention;

Figure 2-1 is a perspective view of the first exemplary embodiment of the reflective device according to present invention;

Figure 2-2 is a front view of the reflective device showing the desired shape of the reflective surface;

Figure 2-3 shows the position of the reflective device with regard to the projection lens in the optical system;

Figure 3-1 is the a folding optical system arrangement using the said reflective device in Figure 2-1 ;

Figure 3-2 is the another folding optical system arrangement using the said reflective device in Figure 2-1 ;

Figure 3-3 is the another folding optical system arrangement using the said reflective device in Figure 2-1;

Figure 4-1 is two-dimensional views of the second exemplary embodiment of the reflective device according to present invention;

Figure 4-2 is a perspective view of the second embodiment of the reflective device according to present invention.

Detailed Description of the Invention

The following detailed description and appended drawings describe and illustrate various exemplary embodiments of the present invention. The description and drawings serve to enable one skilled in the art to make and use the invention, and are not intended to limit the scope of the invention in any manner.

Figure 1 is a perspective view of a folding optical system of a low beam headlamp according to present invention. There are an LED light source **100**, a reflector **200**, a folding mirror **300**, a reflective device **400** having a shaped reflective surface **410**, and a projection lens **500**.

Figure 2-1 shows a perspective view of the first exemplary embodiment of the said reflective device **400** according to present invention. The said reflective device **400** has a shaped reflective surface **410**.

Figure 2-2 shows the front view of the first exemplary embodiment of the said reflective device **400** according to present invention. The shape of the reflective surface **410** may be formed by a rectangular section **420** and a trapezoidal section **430**. The trapezoidal section **430** has an oblique side **440** with regards to its adjacent sides. The oblique side **440** is

inclined at an angle α to a horizontal axis. The angle α may be, but not limited to, 15 or 45 degrees. The vertex of the angle α is at point 'O' on the shaped reflective surface **410**. The direction of the inclination of the oblique side **440** of the trapezoidal section **430** depends on the traffic handedness regulations.

Figure 2-3 shows the front view (left) and the side view (right) of the position of the reflective device **400** with regard to the projection lens **500** in the optical system. The point 'O' is located in the vicinity of the focal point **520** of the projection lens **500**. This is to ensure the horizontal cut-off line in the low beam illumination pattern is sharply projected. The shaped reflective surface **410** of the reflective device **400** is tilted to an angle θ with regard to the optical axis of the projection lens **500**. The tilting angle θ is determined in such a way that the incoming low beam's light path is re-directed towards the projection lens **500** by the shaped reflective surface **410**.

Back to Figure 1, the light emitted from the LED light source **100** is collected by the reflector **200** and redirected toward the folding mirror **300**. The folding mirror **300** changes the light path direction upwards to the reflective device **400**. The shaped reflective surface **410** of the reflective device **400** is obliquely placed in the vicinity of the focal plane **510** of the projection lens **500** and reflects a portion of the incoming light toward projection lens **500**. An intermediate spot for low beam is formed on the focal plane **510** of the projection lens **500**. The projection lens **500** is to project the intermediate spot formed by the shaped reflective surface **410** toward front direction and forms the desired low beam illumination pattern.

Figure 3-1, Figure 3-2 and Figure 3-3 illustrate various arrangements of the optical system according to the present invention. The low beam light path **600** may hit the shaped reflective surface **410** from different directions. The low beam path **600** passes through the projection lens **500** after reflected by the shaped reflective surface **410**.

The said reflective device **400** may be formed of any suitable material, including but not limited to, glass, plastic, and metal, by means known to one skilled in the art. The shaped reflective surface **410** may be coated with high reflectivity coating to enhance performance.

The shaped reflective surface may be flat, or curved.

Figure 4-1 and Figure 4-2 show 2D directional view and perspective view of the second embodiment of a reflective device **700** having a shaped reflective surface **710** according to present invention, wherein the shaped reflective surface **710** is of a curved surface profile. The shaped reflective surface **710** may be curved in horizontal direction, vertical direction, or both directions. In this particular embodiment, the shaped reflective surface **710** has a curvature in horizontal direction. The said shaped reflective surface **710** focuses the light in horizontal direction, reduces the light spot on the surface of the projection lens (not shown) therefore, effectively reduces the clear aperture of the projection lens and the size of the projection lens.

The said reflective device **700** may be formed of any suitable material, including but not limited to, glass, plastic, and metal, by means known to one skilled in the art. The shaped reflective surface **710** may be coated with high reflectivity coating to enhance performance.

Although the present invention has been described in accordance with the embodiments and examples shown, many modifications may be made by one of ordinary skill in the art without departing from the spirit and scope of the appended claims.

Claims

What is claimed is:

1. An automotive low beam headlamp, comprising
 - At least one LED light source;
 - A projection lens;
 - A reflective device, further comprising a shaped reflective surface, wherein the desired shape of the reflective surface is formed by a rectangular section and a trapezoidal section.
2. An automotive low beam headlamp in Claim 1, wherein the trapezoidal section has an oblique side which is at 45 degrees to a horizontal axis.
3. An automotive low beam headlamp in Claim 1, wherein the trapezoidal section has an oblique side which is at 15 degrees to a horizontal axis.
4. An automotive low beam headlamp in Claim 1, wherein the shaped reflective surface is disposed in the vicinity of the focal plane of the projection lens and is tilted to an angle with regard to the optical axis of the projection lens.
5. An automotive low beam headlamp in Claim 1, wherein the shaped reflective surface is a flat surface.
6. An automotive low beam headlamp in Claim 1, wherein the shaped reflective surface is a curved surface.

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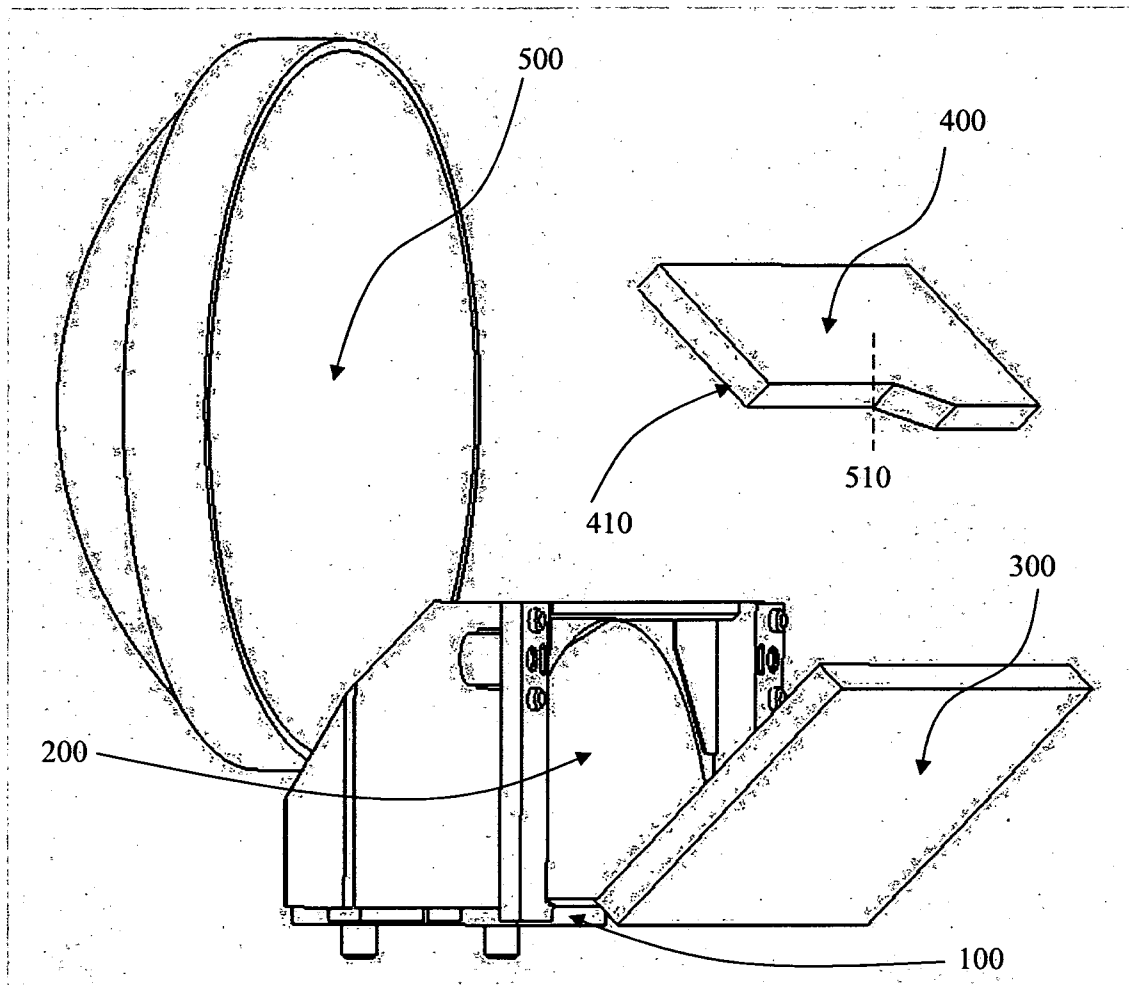


Figure 1

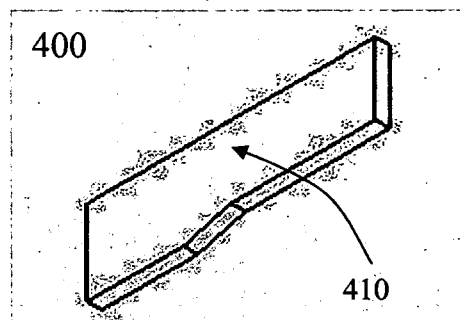


Figure 2-1

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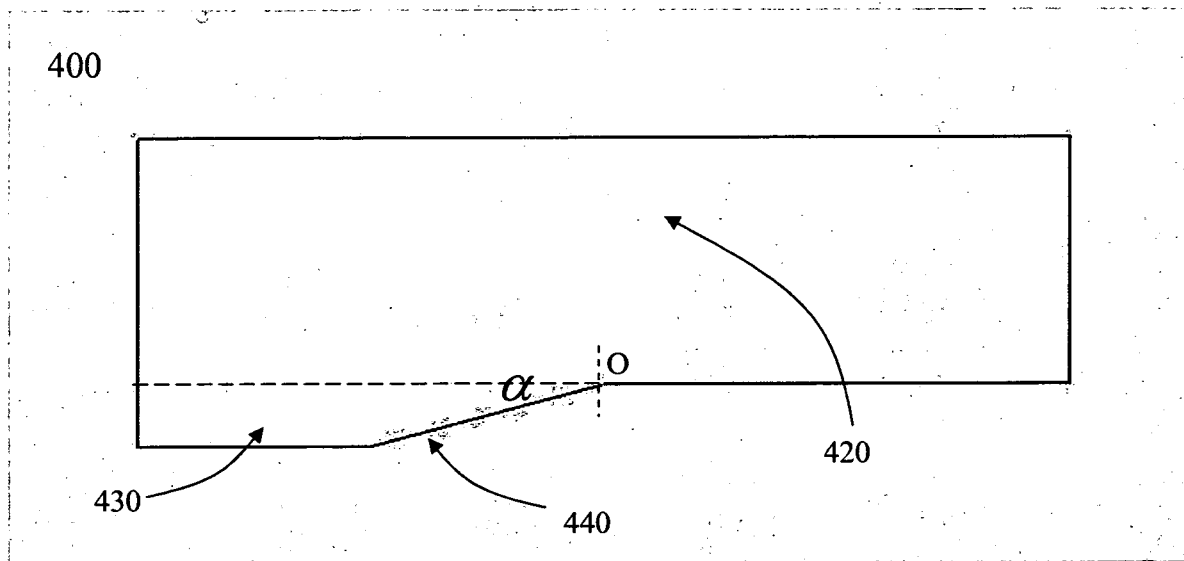


Figure 2-2

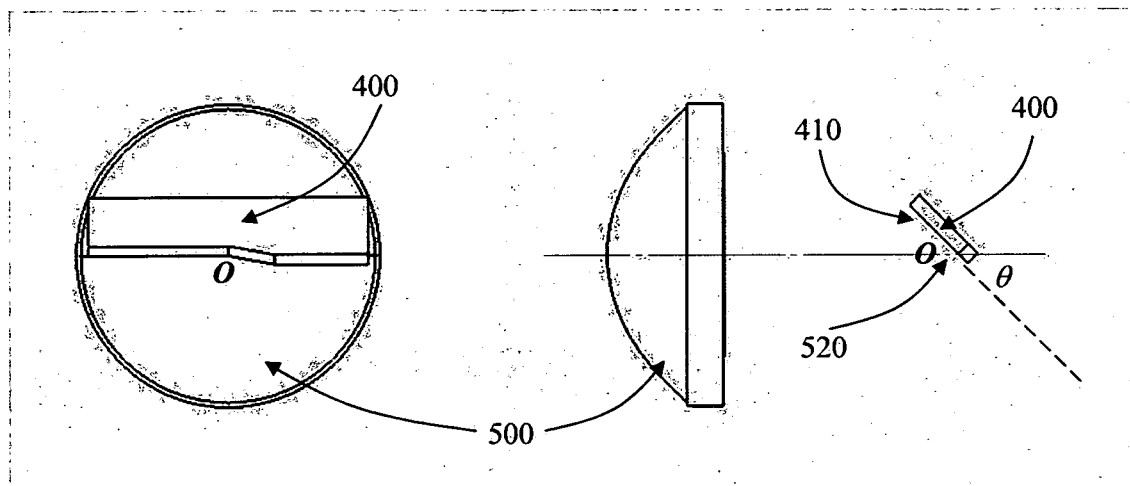


Figure 2-3

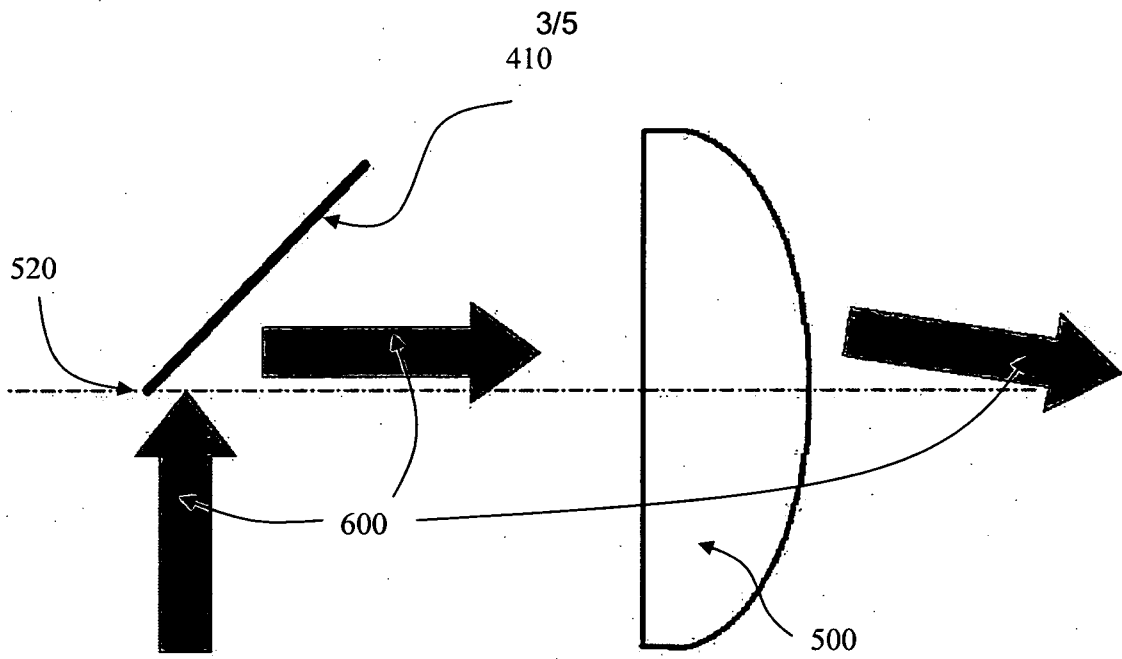


Figure 3-1

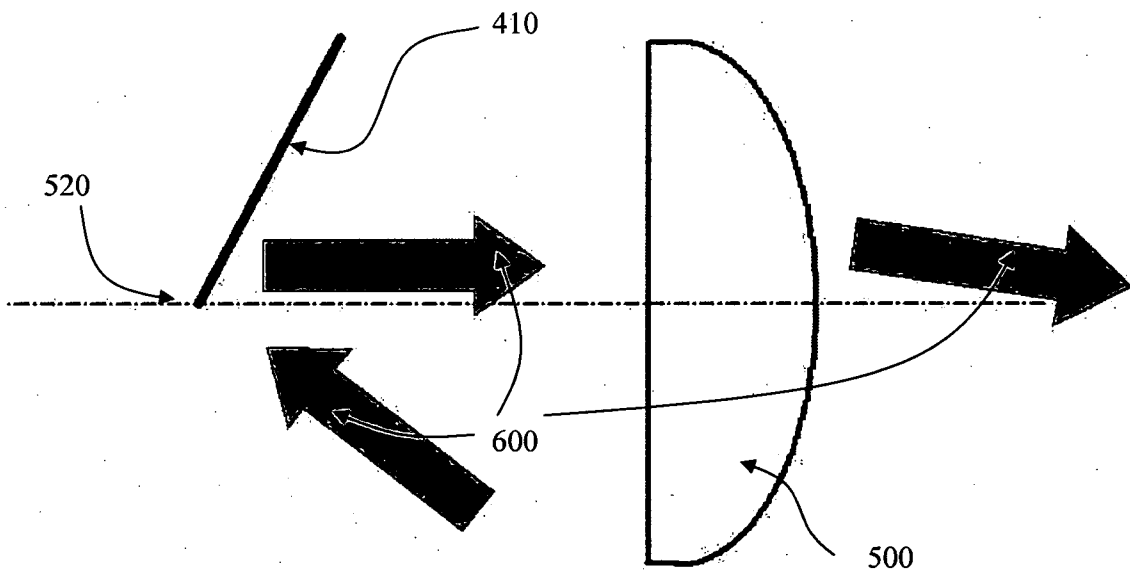


Figure 3-2

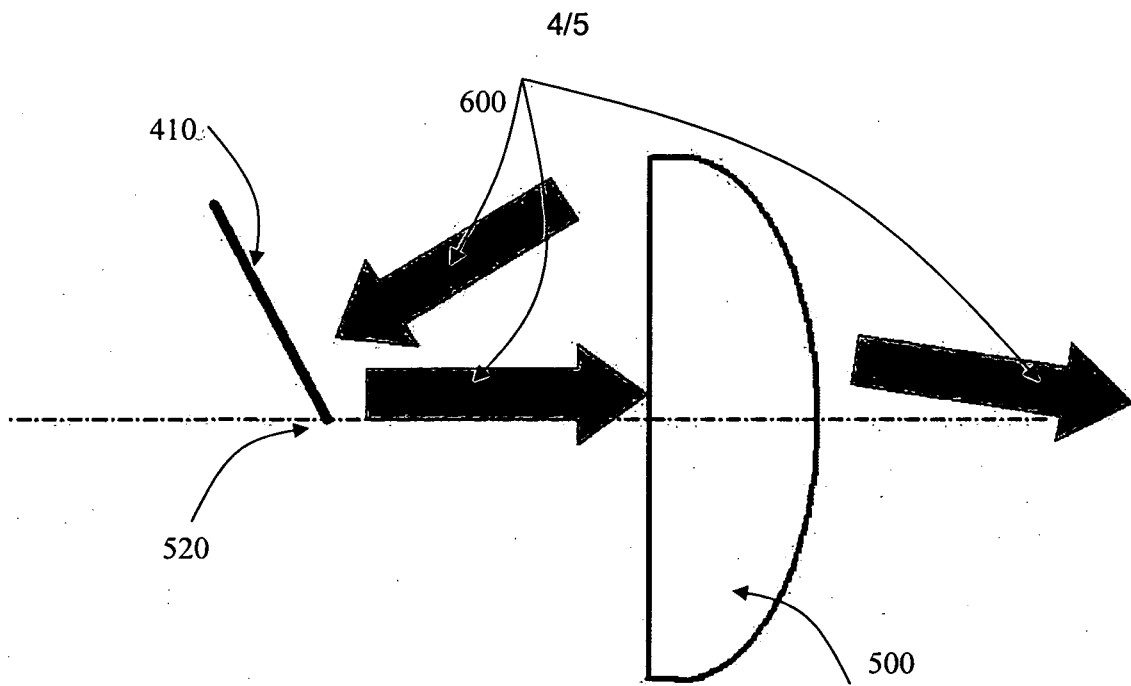


Figure 3-3

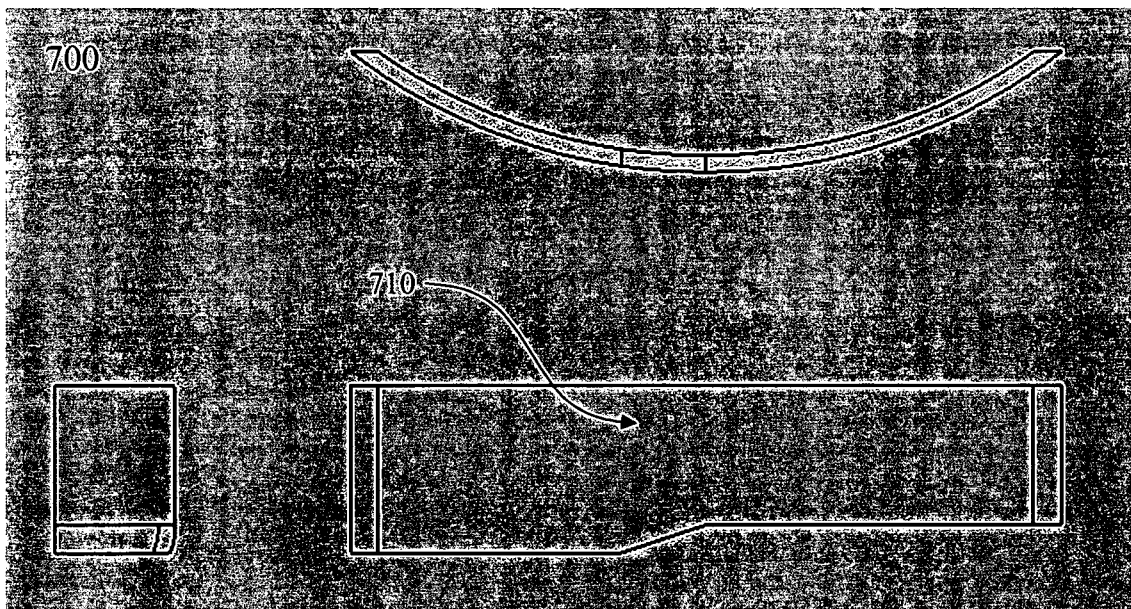


Figure 4-1

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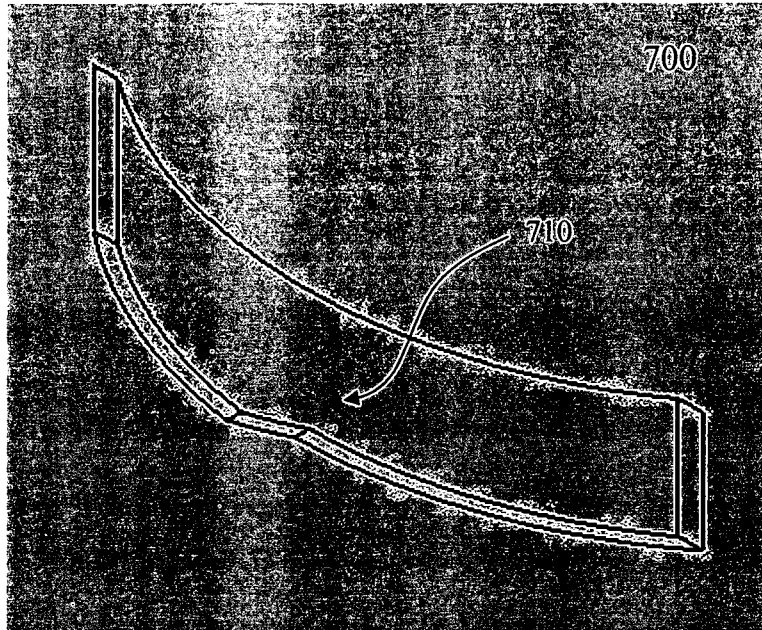


Figure 4-2

INTERNATIONAL SEARCH REPORT

International application No:

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A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

B60Q 1/16 (2006.01) **F21V 7/00** (2006.01)

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)

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPODOC & WPI: IPC B60Q1/00, B60Q1/04, F21V7/00M and keywords (headlamp, projection, lens, mirror, low beam, shape, led, and similar terms)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	U S 541460 1 A (DAVENPORT et al.) 09 May 1995 column 1, lines 18-21, 49-53, 59-62, column 2, lines 18-21, column 4, lines 40-64, Figures 6, 8	1, 3-6
X	U S 2003/0223246 A1 (ALBOU) 04 December 2003 Paragraphs [0001, 0002, 0011, 0014, 0031-0033, 0037], Figures 2, 4, 5	1, 3-7



Further documents are listed in the continuation of Box C



See patent family annex

* "A"	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E"	earlier application or patent but published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search
23 August 2010

Date of mailing of the international search report
31 AUG 2010

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/SG20 10/000249

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report				Patent Family Member			
US	54 14601	DE	434203 1	GB	2273978	JP	6223601
US	2003223246	EP	1369639	FR	2840389	JP	200404746 1
		US	6736524				
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.							
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