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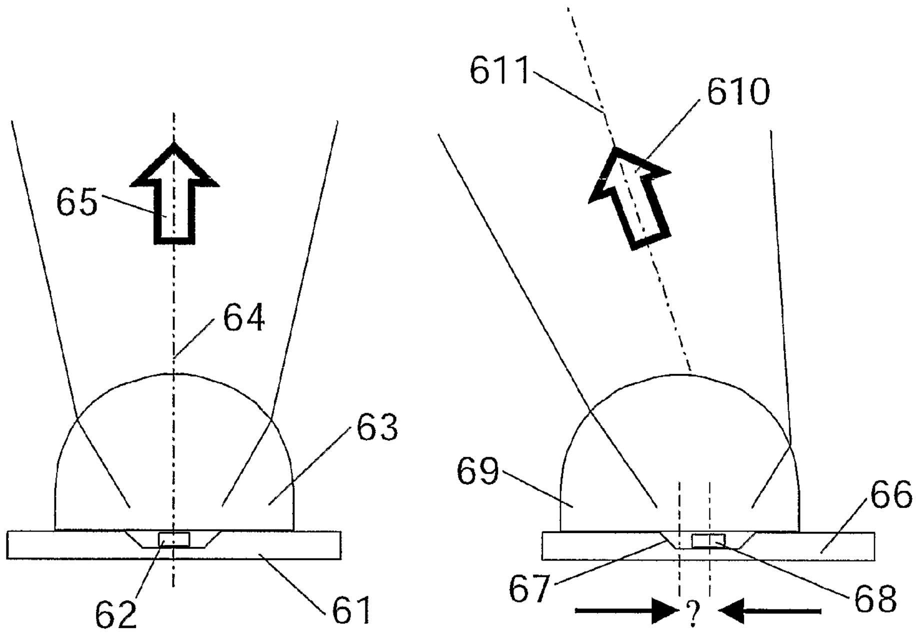
(54) **Title:** OPTICAL LIGHT SOURCE HAVING DISPLACED AXES



(57) **Abstract:** Semiconductor light source packaging includes optical subsystems arranged to cause an output beams directional bias. A symmetry axis of either of three subsystems including a semiconductor light emitting chip, reflector, and lens, are displaced laterally with respect to the other two which may remain colinear. The displacement is translated by the lens to effect a direction change in the output beam. Namely, rather than a output beam being emitted in a direction orthogonal form the system plane, a beam is emitted in a direction a few degrees from the system normal .

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Title: Optical Light Source Having Displaced Axes

BACKGROUND OF THE INVENTIONS

Field

The following inventions disclosure is generally concerned with lighting and light source systems and specifically concerned with packaging for light emitting semiconductors which promotes an output beam having a directional bias.

Prior Art

Arrays of light emitting diodes, LEDs, are used to form lighting systems of many types. One example of particular interest is very large display screens for sporting events. These display screens are comprised of hundreds of thousands of elements in a two dimensional array. Sports fans viewing the display from great distances can see video images presented on thereon. In these circumstances, the relative position between the display and the viewers suggests a preferred output beam direction for each pixel element. It is not always efficient to have the LEDs produce a beam perpendicular to the display plane. Indeed, if a display plane is oriented vertically, then it is sometimes preferred that the majority of the light output be directed in a slightly downward direction; these displays are typically located higher than the viewers who look at them. To achieve this, standard LED devices are used in special mounting apparatus which have a tilt bias built therein. Standard LEDs having a mounting seat perpendicular to their output beam direction are set into these tilted mounting seats. Figure 1 illustrates a planar display screen 1 having a plurality of LED elements (five). These LEDs have a planar baseplate 3 which lies on the tilted seats 4 of the mounting system. The LED lens 5 produces a beam axis normal to the mounting plane or perpendicular and orthogonal with respect to the baseplate. The beam 7 thus has a slight downward bias with respect to the display plane. As all LEDs are mounted in similar fashion, the display of Figure 1 is best viewed in the far field by a person looking slightly up towards the display.

While systems and inventions of the art are designed to achieve particular goals and objectives, some of those being no less than remarkable, known systems have limitations which prevent their use in new ways now possible. Inventions of the art are not used and cannot be used to realize advantages and objectives of inventions taught herefollowing.

SUMMARY OF THE INVENTIONS

Comes now, Abramov, V.S.; Shishov, A.V.; and Scherbakov, N.V. with inventions of special packaging for light sources including devices having optical subsystems with displaced axes and biased output beams. It is a primary function of these lighting systems to provide output beams having directional bias with respect to a system mounting plane.

These semiconductor lighting systems are generally comprised of semiconductor die and supporting optomechanical packaging. In particular, an optomechanical package arranged with at least one optical subsystem having a positional bias which promotes a direction shift in an output beam. Thus, optical systems of these devices are made of sub-systems which may be position shifted with respect to each other to cause the direction bias in the output beam. In a first example, a lens may be displaced with respect to a semiconductor chip and reflector thus causing an output to be comprised of a downward pointing beam.

Semiconductor lighting system packages of these inventions are arranged with three major optical sub-systems including: a light source, a reflector and a lens. A semiconductor light producing source emits light from its several facets, in several directions simultaneously. To couple this light into a single beam, a reflector turns light emitted from four side facets upwardly and into the beam which is emitted from the chip top surface. Accordingly, these semiconductor lighting systems nearly always comprise a chip and some version of a reflector. Further, a lens takes highly divergent light from the semiconductor and focuses it into a more narrow beam. Each of these three optical subsystems have a symmetry axis associated therewith.

Optomechanical packages of these inventions include a displacement with respect to either of these symmetry axes. Such displacement is arranged to provide an output beam which leaves the device in a non-orthogonal direction with respect to its baseplate and mounting plane. Experts in optics will quickly understand how a *position* displacement is translated to a *direction* change in the output beam and this is further explained in detail.

Objectives of these Inventions

It is a primary object of these inventions to provide new light sources.

It is an object of these inventions to provide light sources having a mechanical package which promotes an output beam bias with respect to direction.

It is a further object to provide mechanical packages for semiconductor light sources where subsystems are arranged with displacements

A better understanding can be had with reference to detailed description of preferred embodiments and with reference to appended drawings. Embodiments presented are particular ways to realize these inventions and are not inclusive of all ways possible. Therefore, there may exist embodiments that do not deviate from the spirit and scope of this disclosure as set forth by appended claims, but do not appear here as specific examples. It will be appreciated that a great plurality of alternative versions are possible.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

These and other features, aspects, and advantages of the present inventions will become better understood with regard to the following description, appended claims and drawings where:

Figure 1 is a prior art drawing of an optical system showing an optical output with a downward bias;

Figure 2 is a ray trace diagram showing fundamental lens principles; and

Figure 3 is illustrates major subsystems of a semiconductor optomechanical package;

Figure 4 illustrates these subsystems and their symmetry axes in perspective drawings;

Figure 5 illustrates a special package of these inventions where a lens has been displaced with respect to a semiconductor die and its mount/reflector system.

Figure 6 is a diagram to show the resulting output generated from the system of Figure 5;

Figure 7 shows an alternative version whereby a semiconductor die is displaced with respect to both a lens and reflector;

Figure 8 shows yet another alternative version whereby a reflector is displaced with respect to both a semiconductor die and a lens;

Figure 9 illustrates a planar mounting system having a plurality of elements and an output not orthogonal to the mounting plane;

Figure 10 is a cross section diagram of a special version of LED package which also serves the objectives of these inventions;

Figure 11 is a perspective diagram of yet another special version which also may be used to achieve an output beam with a directional bias;

Figure 12 illustrates a special indexing means used to assure a proper displacement alignment between optical sub-systems; and

Figure 13 shows a common LED package with displaced optical sub-systems.

PREFERRED EMBODIMENTS OF THESE INVENTIONS

In accordance with each of preferred embodiments of these inventions, there is provided optomechanical packaging systems for semiconductor light emitting diodes having a output beam with directional bias. It will be appreciated that each of the embodiments described include both an apparatus and method and that the apparatus and method of one preferred embodiment may be different than the apparatus and method of another embodiment.

Optical sources commonly known as 'LEDs' are primarily comprised of an emitting chip and an optomechanical package. The optical portion of the system usually includes a reflector to couple side emitted light into a primary beam. In addition, optical systems almost invariably include a lens to condense light into a more narrow beam. Accordingly, one might say the optical system of an LED comprises three major parts: a source, a reflector and a lens.

Optical systems of these inventions are LED packages having three major parts or sub-systems as mentioned. Further, these packages differ from their cousins in the arts in that either of these major optical subsystems is position shifted with respect to the others. Optomechanical packages are arranged with a position or alignment bias which promotes a direction shift in an output beam. Sub-systems having a reference axis, or an axis of symmetry, may be position shifted, or 'mis-aligned' with respect to each other to cause direction bias in the output beam. Such displacement is arranged with the purpose of providing an output beam which leaves the device in a non-orthogonal direction with respect to its baseplate and mounting plane.

One will gain a greater understanding of the full scope of these inventions in view of the following descriptions with specific references to the drawings appended hereto and reference numerals therein.

Review of a general optics principle lies at the heart of an understanding of these inventions. Figure 2 illustrates. In an optics system including a lens 'L', the lens performs a Fourier transform of the object plane 'OP'. A point source is mapped into plane waves which propagate in a direction which depends on the position of the point source in the object plane. Thus, any displacement from the lens optical axis 'OA' in the object plane, in other words a *position* change with respect to a point source, results in a *direction* change of the output beam. Point source 'B' lying on the optic axis in the object plane creates a beam which leaves the lens in a direction perpendicular to the object plane. Point source 'A' which is displaced away from and above the geometric center of the system results in a beam having a propagation direction shifted downwardly with respect to the system axis. In the far field 'FF', plane waves will arrive lower than those from point source 'B'. One should pay particular attention to the location in the object plane where point sources may be placed behind lenses, lenses which necessarily have an axis or at least a basic symmetry construct (in the special case of cylindrical lenses the symmetry is planar rather than linear). These system elements/concepts are found in LED optomechanical packages.

Now with reference to Figure 3, a better understanding of certain LED packages is realized. A baseplate 31 is a substrate having a flat surface which provides a system reference plane 32. When LED systems shown are mounted, the output beam direction is coupled to the baseplate via an orthogonal relationship; that is, output beams leave the package perpendicular to the mounting plane. The substrate may have provided therein a special recess 33 having rotational and axial symmetry. Properly prepared, the recess operates as a reflector for light coming from the sides of the semiconductor die 34. A semiconductor die or 'chip' is cylindrical with rectangular cross section and its geometry lies with an axis at its center. Finally, a third optical subsystem includes a spherical lens 35 formed into the top surface of hard plastic molded cover element 36. A spherical lens has axial symmetry by definition. In the drawing, all three optical sub-systems, the semiconductor chip, the reflector and the lens, share a common axis 37. In this way, the 'point source' appears to lie where the axis intersects with the object plane of the lens. As such, the resulting output beam is orthogonal and perpendicular to the baseplate or system reference plane. Due to the construction described, the baseplate provides a mechanical reference and foundation and as such is necessarily related to the beam output direction. When these LED devices are mounted to other systems, the mounting plane suggests the beam direction (normal) and designers of systems deploying LEDs count on the beam direction being perpendicular to the mounting surface.

It furthers an understanding of these inventions to present these optical subsystems in perspective and in greater detail with the respective axes physically removed from one another. Figure 4A shows a semiconductor chip 41 which takes roughly the shape of a cube. A primary emission surface, a top surface 42 is geometrically centered about axis 43. One should note that a 'loose' definition of 'centered' is intended here. Semiconductor die are best made with flat facets and do not readily support truly axial symmetries. Thus, an approximation is acceptable and the die is said to have a 'symmetry axis' as shown. Light emitted from the chip will be approximately symmetric about this axis. Some account is to be taken for electrical contacts and other small deviation.

Figure 4B shows a 'recess' or surface of revolution object 44. While a 'recess' seems to refer to a non-existing entity, it is to be understood that a recess is formed in a substrate or some other bulk material object. The recess surface is then polished and/or metalized to form a reflector. A good reflector for an LED system may be a simple conic section having a flat floor 45 which the chip may be bonded. The surface 46 will receive light from the sides of the chip and turn that light upward into a common beam; a beam comprised of top surface emission. In this arrangement, the reflector is said to have an axis 47. A spherical lens 48 of Figure 4C also has a reference and symmetry axis 49. These three optical subsystems are shown in conjunction with their respective axes. While nearly all optical systems demand accurate alignment between such optical components as these, we will now see where a intended 'mis-alignment' or purposeful displacement with respect to either of these axes will cause a desirable effect.

Figure 5 illustrates a first preferred version of these inventions. A light emitting device includes a baseplate 51 and a semiconductor die 52 having a top surface thereon and a symmetry axis extending orthogonally therefrom. An axially symmetric reflector 53 is a recess cut into the baseplate. Both the die and reflector have common or colinear axes 54. These two optical sub-systems are in good alignment and cooperate together to form a optical beam which leaves the baseplate in a normal direction. However, since the cover element and lens 55 having a reference axis 56 is displaced in position by an amount Δ 57 with respect to both the die axis and the reflector axis, the beam appears to the lens to be coming from a point not on the axis of the lens but rather from a point slightly displaced in position. After the Fourier transform performed by the lens, this is embodied as a beam direction change and the final output beam does not leave parallel with either axis but instead with a few degrees of angular deviation with respect thereto. In this case, the lens reference axis is parallel with but not colinear with either the die axis or the reflector axis. One should note: it is not necessary nor desirable to tilt the lens, the die, the reflector, or the mounting surfaces. Also, here the lens is said to have a reference axis rather than a symmetry axis to account for the special case of cylindrical lenses which do not have axial symmetry but work well with these inventions principles.

Figure 6 shows a side-by-side comparison of two systems: a first having no displacement and a second having a pronounced displacement. A first device has optical sub-systems each with its axis colinear with the other two. Baseplate 61 is a substrate with two flat sides, one of which has a recess, a conic shaped indent, formed therein. The recess is well aligned and optically coupled to a semiconductor die 62. A cover element 63 of hard molded plastic has a spherical top surface to form a lens. The semiconductor chip 63 is mounted at the floor of the recess with its top surface parallel to the system reference plane. Each of said recess, lens and chip, has a symmetry axis 64, one colinear with the other. As a result, optical output beam 65 emanates from device in a direction perpendicular with respect to the system reference plane.

In contrast, baseplate 66 having reflector 67 formed therein and chip 68 mounted thereto is shifted laterally by an amount Δ in position with respect to the lens 69. As a result, the device produces an output beam 610 which leaves the system in a direction 611 that is not perpendicular to the system plane, but rather is angled a few degrees away from the system normal.

Figure 7 shows an alternative version. A cover element with lens 71 and reflector 72 share a common axis 73. Semiconductor diode chip 74 is displaced in the recess and has an axis 75 which is displaced by an amount Δ from the other two axes. The chip axis is parallel to, but not colinear with the axes of the lens and reflector. This device also produces a beam which leaves the system with a direction bias that is a few degrees away from the direction of the three optical subsystem axes. It is useful to remind the reader that a lateral displacement, i.e. a shift of *position*, is translated into a *beam angle* change in the far field. It is not necessary to place the lens and an angle with respect to the baseplate; nor is it necessary to mount the chip at an angle with respect to the floor which it is bonded. The reflector is not turned at an angle to shine the light is a different direction. While those ideas may be quite valuable is some other invention, those are not part of these present systems.

Another alternative version is illustrated in Figure 8. In this version the reflector axis is displaced from the other two axes which remain colinear. Lens cover element 81 and diode chip 82 share a common axis 83. The baseplate having a reflector 84 formed therein is shifted right a bit to cause its axis 85 a small lateral displacement Δ 86. This system will also generate an output beam whose direction is characterized as being shifted a few degrees from the system normal.

Now, with this full understanding of how the optical sub-systems of an LED package may be manipulated to achieve angular bias of output beams, it is useful to review how these devices might be used in conjunction with larger systems. Figure 9 illustrates one such system having a large planar area 91 covered with LED elements 92 each having a biased output beam. The LED baseplate 93 is flat and mounts flush with the plane which makes up the system surface. Normally shaped spherical lens 94 suggests a system normal direction 95 orthogonal with respect to the entire system plane. However, the output beam 96 is slightly downward shifted due to a positional shift in either the chip, the lens, or the reflector at the designer's option.

The versions presented thus far include examples drawn for clarity. It is to be understood that electrical systems not shown, that is circuits, interconnects, wire bonds, et cetera are all implied. In addition, simplest block descriptions of elements are used. It is understood that complex surface relief Fresnel lenses may be used in place of those spherical lenses shown without deviation from the spirit of the invention. Optical experts will be familiar with the axial nature of Fresnel lenses and readily connect them with these systems. A few other alternatives are illustrated to indicate that the concepts of these inventions hold valid for a great plurality of detailed optical system and sub-system arrangements.

One interesting alternative of Figure 10 includes versions where the reflector is integrated with the lens as a single unit molded cover element 101. The top surface 102 is spherical and polished smooth to form a first lens. The cover element undersurface includes several important features. First, a second lens 103 is provided. A special total internal reflection TIR type reflector 104 is a conic section formed in the undersurface of the cover element. Finally, a flat seat 105 is useful for assuring the cover element joins the baseplate with good alignment and appropriate coupling. A flat substrate 106 without recess is the baseplate. In this version, both lenses and the reflector share a single axis 107. The semiconductor chip 108 is moved slightly right by an amount Δ. While this arrangement is believed most efficient, it is easy to extend the same idea and form a molded cover element with a displaced reflector such that either lens and the reflector have a shifted axis; the semiconductor chip thereafter might be aligned with either other axes.

While the previous examples all use spherical lenses having a clear and distinct axis, we must account for the special case where a cylindrical lens has a symmetry plane rather than a line which is a symmetry axis. In such systems, it is easy to understand how the plane is reduced to a line we call a 'reference axis'. All real cylindrical lenses have finite extent. As such, a centerline of the symmetry plane is implied and we use this as our reference axis for all embodiments having cylindrical lenses. From that reference axis, a semiconductor chip or reflector, or both, might have a positional displacement. The output 'ribbon' beam of the cylindrical lens is similarly shifted from the system normal and may have a downward angular shift by a few degrees. Figure 11 illustrates. Cylindrical lens 111 and chip 112 are well aligned. A reflector is not shown but one may be used in such systems. The system normal 113 and the output beam exit the device in the same direction. In systems of these inventions, cylindrical lens 114 is slightly displaced laterally with respect to chip 115 to form a position shift Δ 116. The system normal 117 and the output beam 118 direction are not the same, but rather output beam has an angular shift downward a few degrees.

In some systems, one can easily gauge the amount of proper lens displacement for a desired design output. However, in some cases it is necessary to provide a mechanism to assist in providing the precise amount of displacement between a lens and a semiconductor chip. A cover element 121 having a lens 122 and substrate 123 can be formed with cooperating indexing means properly placed to assure a desired displacement between the lens and the baseplate having a semiconductor chip properly positioned and aligned thereto. A cover element may have integrated therewith pins 124 which fit into corresponding holes 125 in the baseplate substrate. When chip 126 is properly mounted in its place, the alignment of the lens is automatic when the cover element and the substrate are later brought together via the indexing means.

Just because some of the diagrams used here are not identical to those which might be used to describe the most common LED packages, it would be a mistake to assume that these inventions do not account for those packages too. The same principles first taught here can be used in most standard LED packages. To wit, Figure 13 illustrates cover element 131 with lens surface 132 and reflector 133 having axis 135 slightly shifted from the lens axis 136. A semiconductor chip mounted in the reflector would produce a beam which radiates in a direction different than axes direction. Base 134 implies a system flat or reference plane and provides alignment in mounting systems. In this way, standard LED packages also support these inventions.

One will now fully appreciate how semiconductor light emitting systems can be arranged with an output having a directional bias with respect to its mechanical package. Although the present inventions have been described in considerable detail with clear and concise language and with reference to certain preferred versions thereof including best modes anticipated by the inventors, other versions are possible. Therefore, the spirit and scope of the invention should not be limited by the description of the preferred versions contained therein, but rather by the claims appended hereto.

CLAIMS

What is claimed is:

1) Light emitting devices comprising:

at least one semiconductor die having a substantially planar top surface and a symmetry axis extending orthogonally therefrom said top surface;

an axially symmetric reflector; and

a lens having a reference axis,

either of said semiconductor die symmetry axis, reflector symmetry axis, or lens reference axis is not colinear with either other.

2) Light emitting devices of claim 1, said semiconductor die symmetry axis is displaced from and parallel to both the reflector symmetry axis and the lens reference axis which are colinear.

3) Light emitting devices of claim 1, said reflector symmetry axis is displaced from and parallel to both the semiconductor die symmetry axis and the lens reference axis which are colinear.

4) Light emitting devices of claim 1, said lens reference axis is displaced from and parallel to both the semiconductor die symmetry axis and the reflector symmetry axis which are colinear.

5) Light emitting devices of claim 1, said reflector symmetry axis is displaced from and parallel to the semiconductor die symmetry axis which is displaced from and parallel to the lens reference axis.

6) Light emitting devices of claim 1, further comprising a substrate at least one flat surface defining a system reference plane and corresponding system normal direction, said system reference plane being parallel to said semiconductor die planar top surface.

7) Light emitting devices of claim 6, said substrate has a recess having axial symmetry and a flat bottom formed therein to effect said reflector and a mount surface suitable for receiving said semiconductor die thereon.

8) Light emitting devices of claim 7, said semiconductor die is affixed at said mount surface to form a colinear relationship between the symmetry axis of the semiconductor die and the reflector symmetry axis, said lens reference axis being displaced from both the reflector symmetry axis or the semiconductor die symmetry axis.

9) Light emitting devices of claim 8, said lens is characterized as a cylindrical lens having a symmetry plane in which lies said reference axis.

10) Light emitting devices of claim 1, said lens and reflector are formed in a single piece molded cover element.

11) Light emitting devices of claim 10, further comprising a substrate at least one flat surface defining a system reference plane and corresponding system normal direction, said system reference plane being parallel to said semiconductor die planar top surface.

12) Light emitting elements of claim 11, said cover element is affixed to said substrate whereby said chip symmetry axis is not colinear with the lens axis

13) Light emitting devices of claim 11, said reflector symmetry axis and lens reference axis are not colinear.

14) Light emitting devices of claim 6, said substrate and lens cover element have cooperating indexing means which imparts an alignment relationship between said cover element and substrate when indexing means is engaged.

15) Lighting systems comprising a plurality of LED elements distributed about a system planar surface, said LED elements comprising a package having a planar mounting reference where said package planar mounting reference is parallel with the system planar surface when the LED elements are mounted thereto, said LED elements having optical output which emanates from the system planar surface at an angle not orthogonal thereto.

16) Lighting systems of claim 15, each of said LED elements is comprised of a semiconductor die having a symmetry axis, an axially symmetric reflector, and a lens having a reference axis either of said lens reference axis or reflector symmetry axis or die symmetry axis is displaced from either other.

17) Lighting systems of claim 16, said LED elements outputs are arranged whereby each output beam propagates in substantially the same direction as each other.

18) Lighting systems of claim 16, said lens and reflector are formed together as a single piece cover element of molded plastic.

19) Lighting systems of claim18, a plurality of cover elements are formed as a single piece molded system to provide an array of units.

20) Lighting systems of claim 19, said substrate is affixed to cover elements via an indexing means whereby reflector is optically coupled to said semiconductor die.

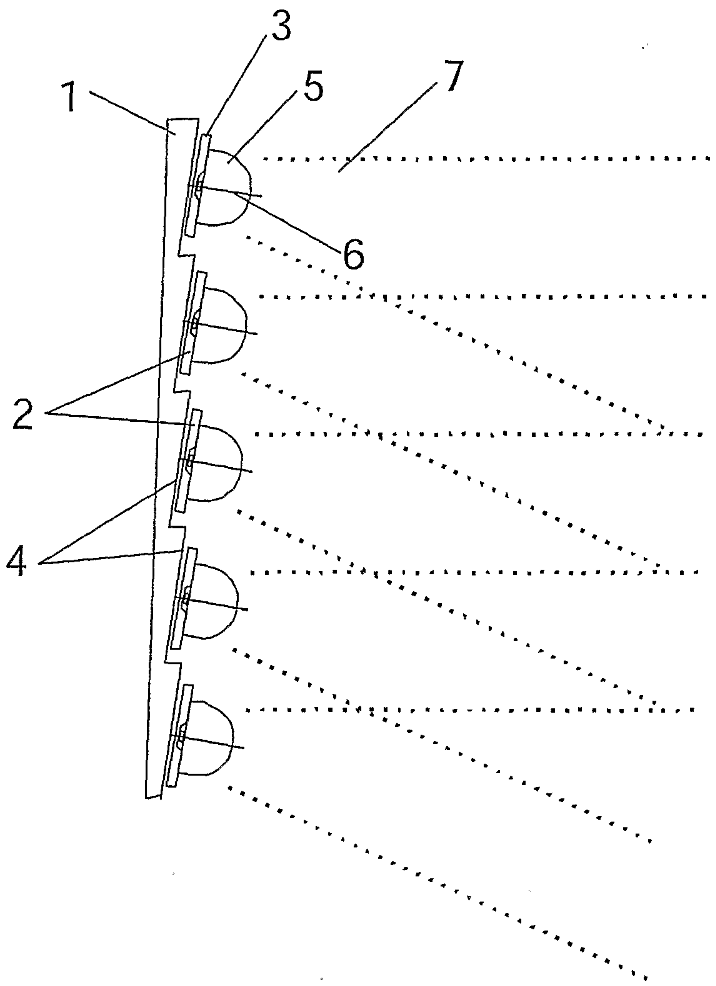

Fig. 1
Prior Art

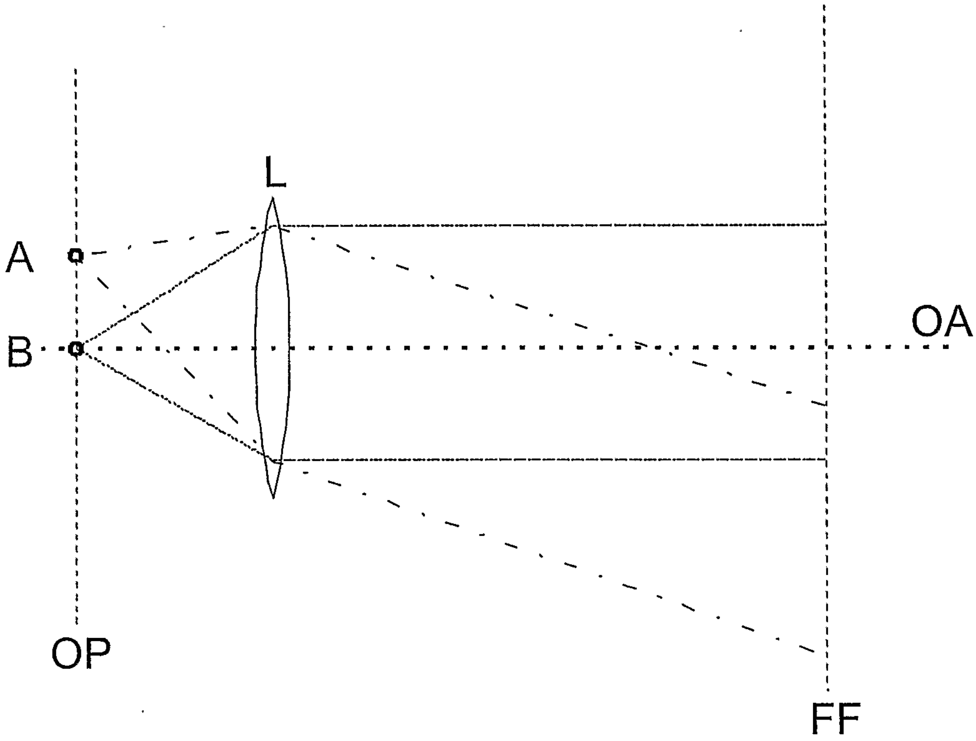

Fig. 2

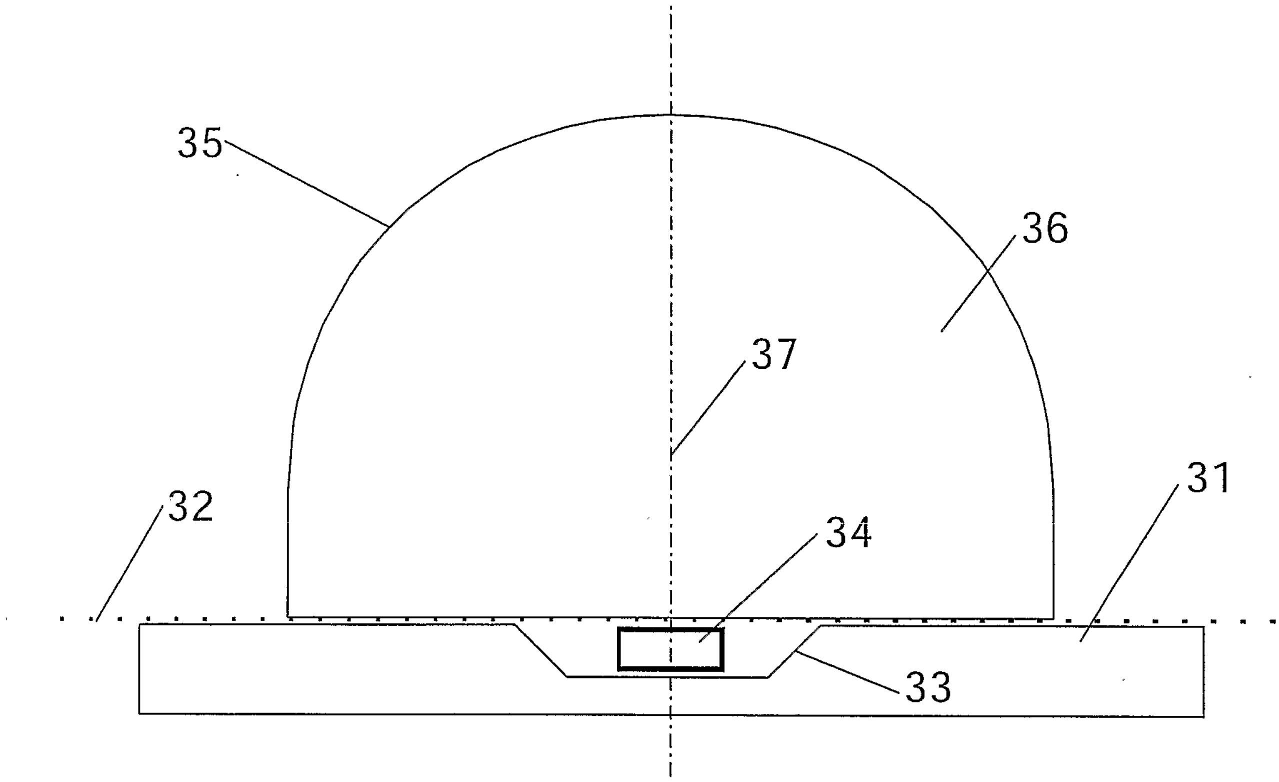

Fig. 3

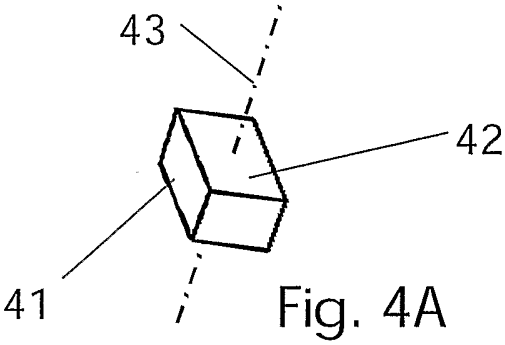

Fig. 4A

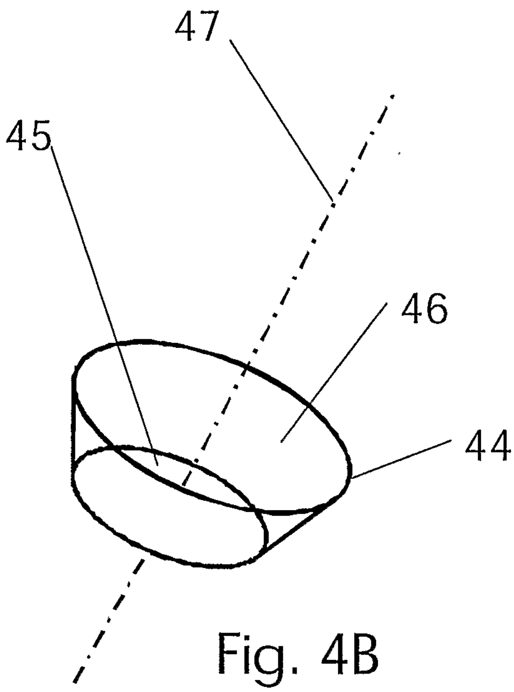

Fig. 4B

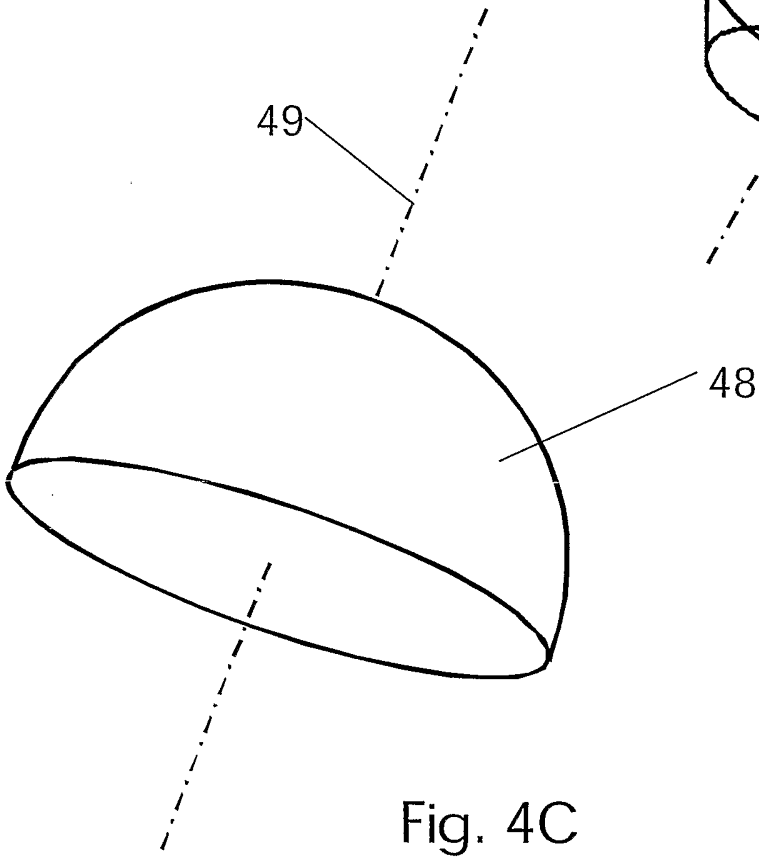

Fig. 4C

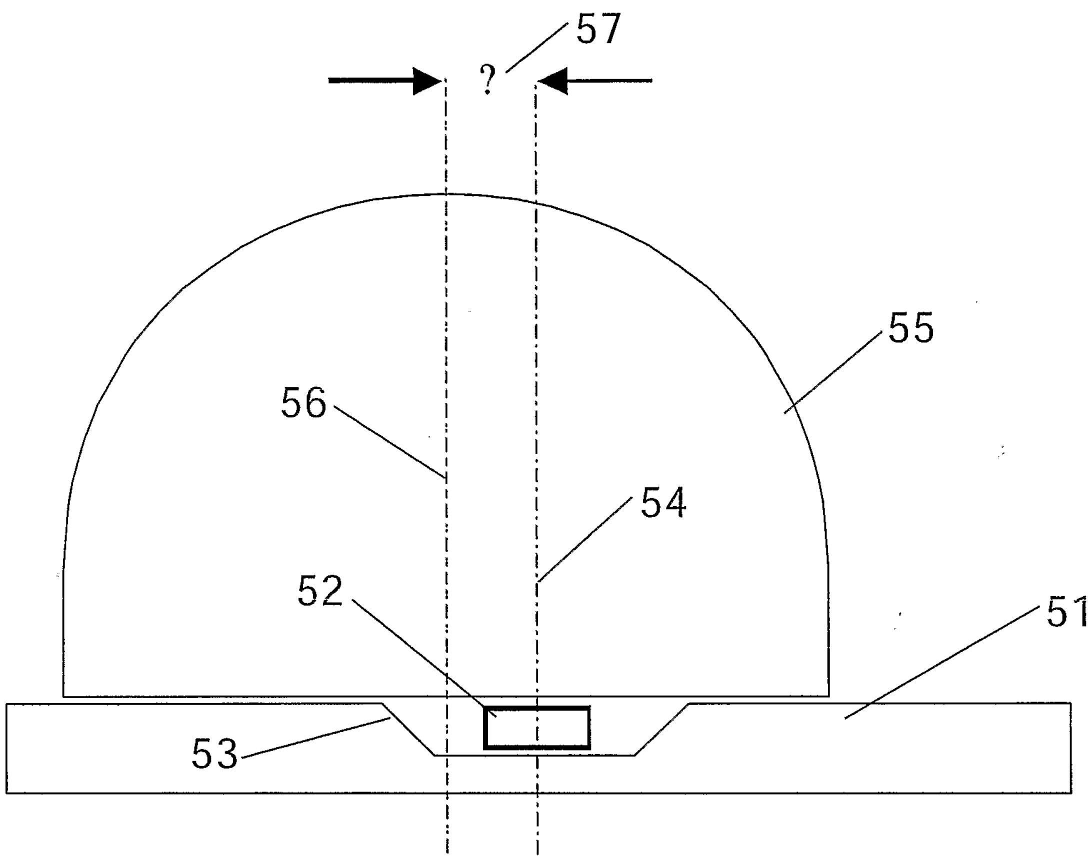

Fig. 5

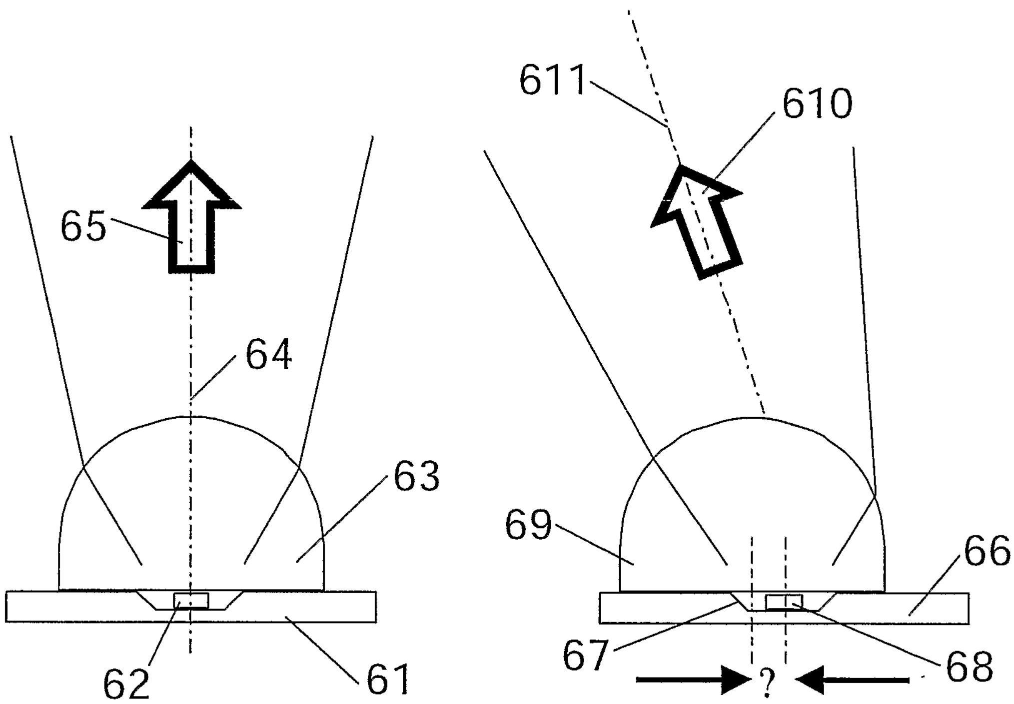

Fig. 6

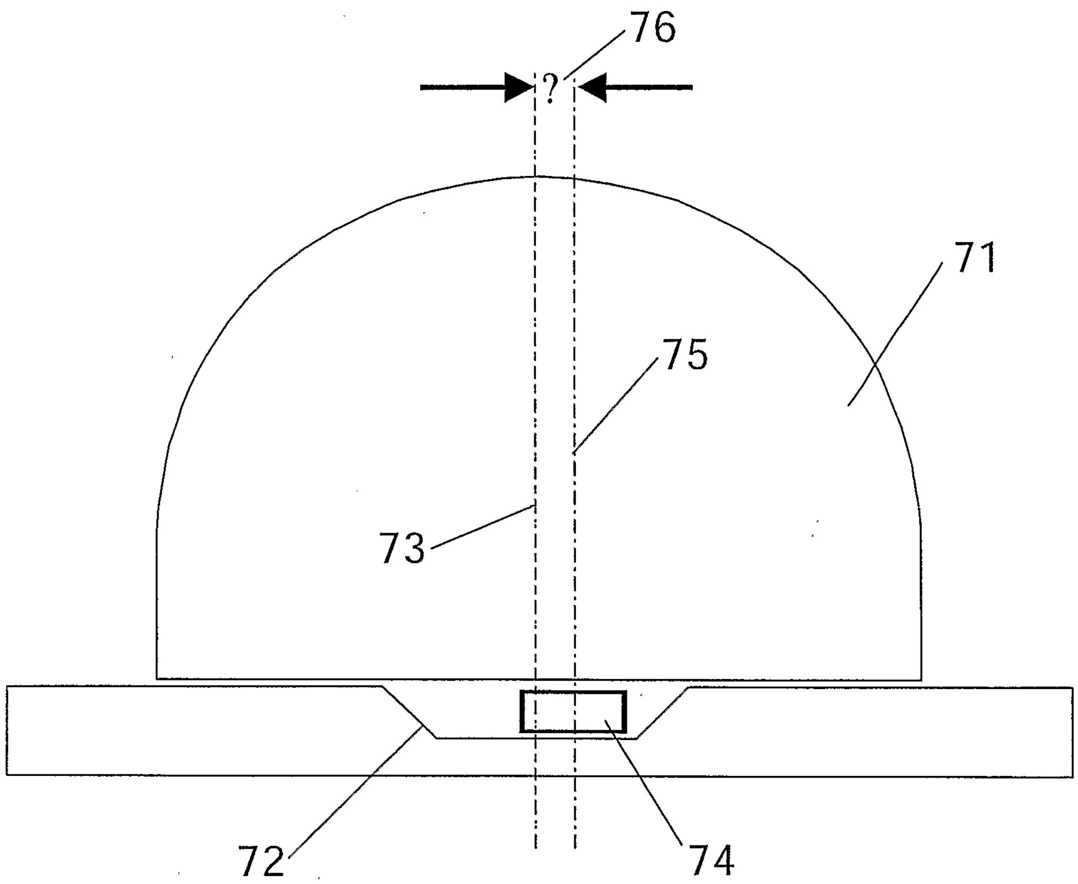

Fig. 7

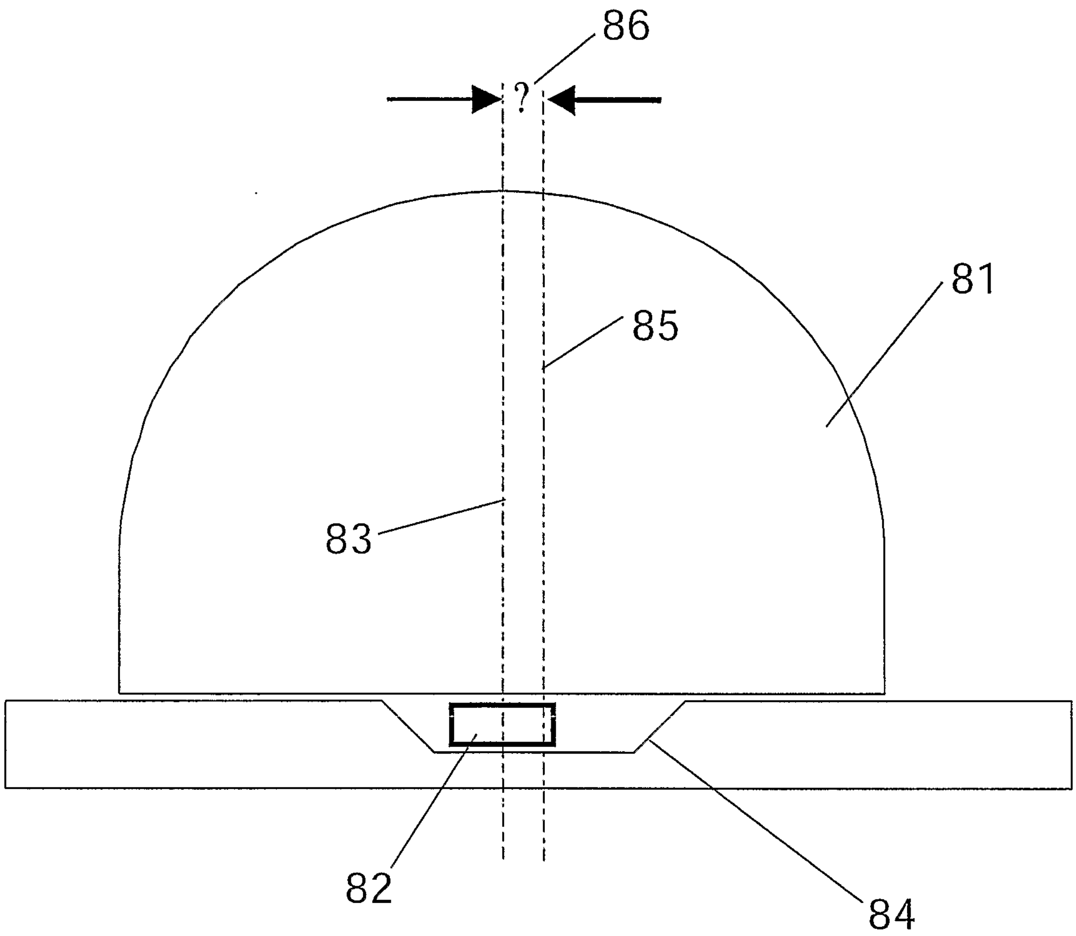

Fig. 8

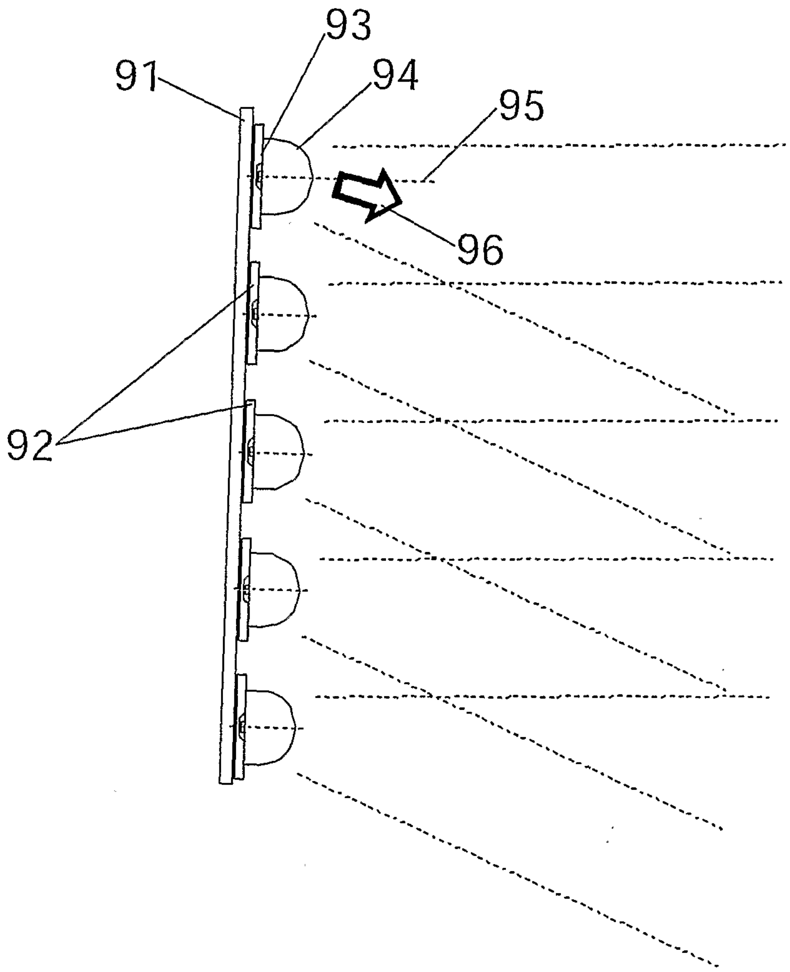

Fig. 9

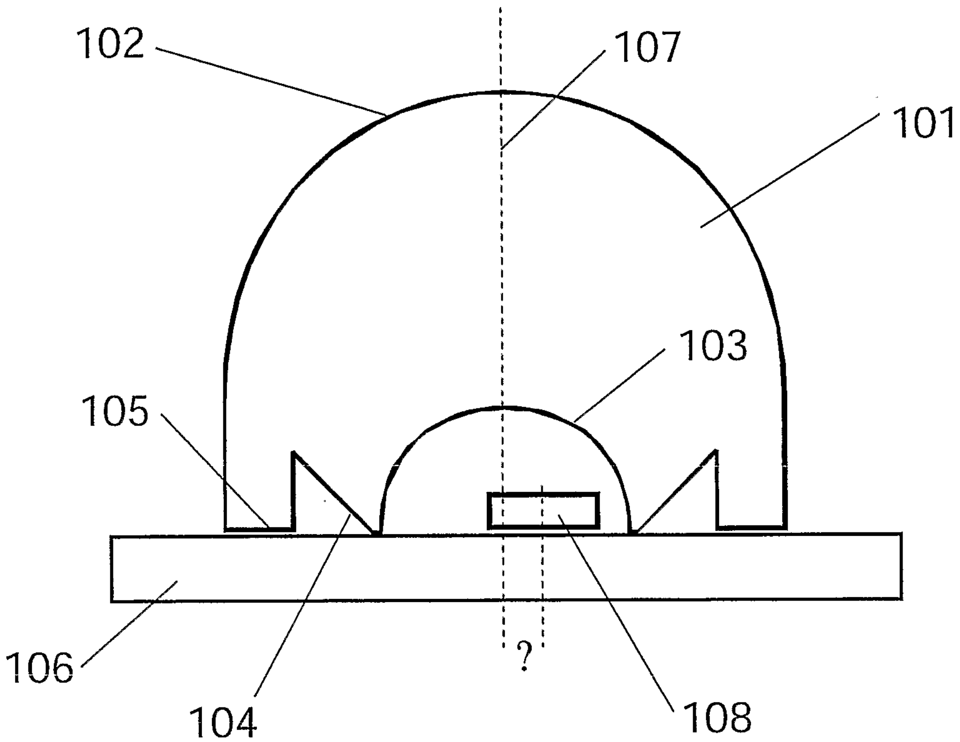

Fig. 10

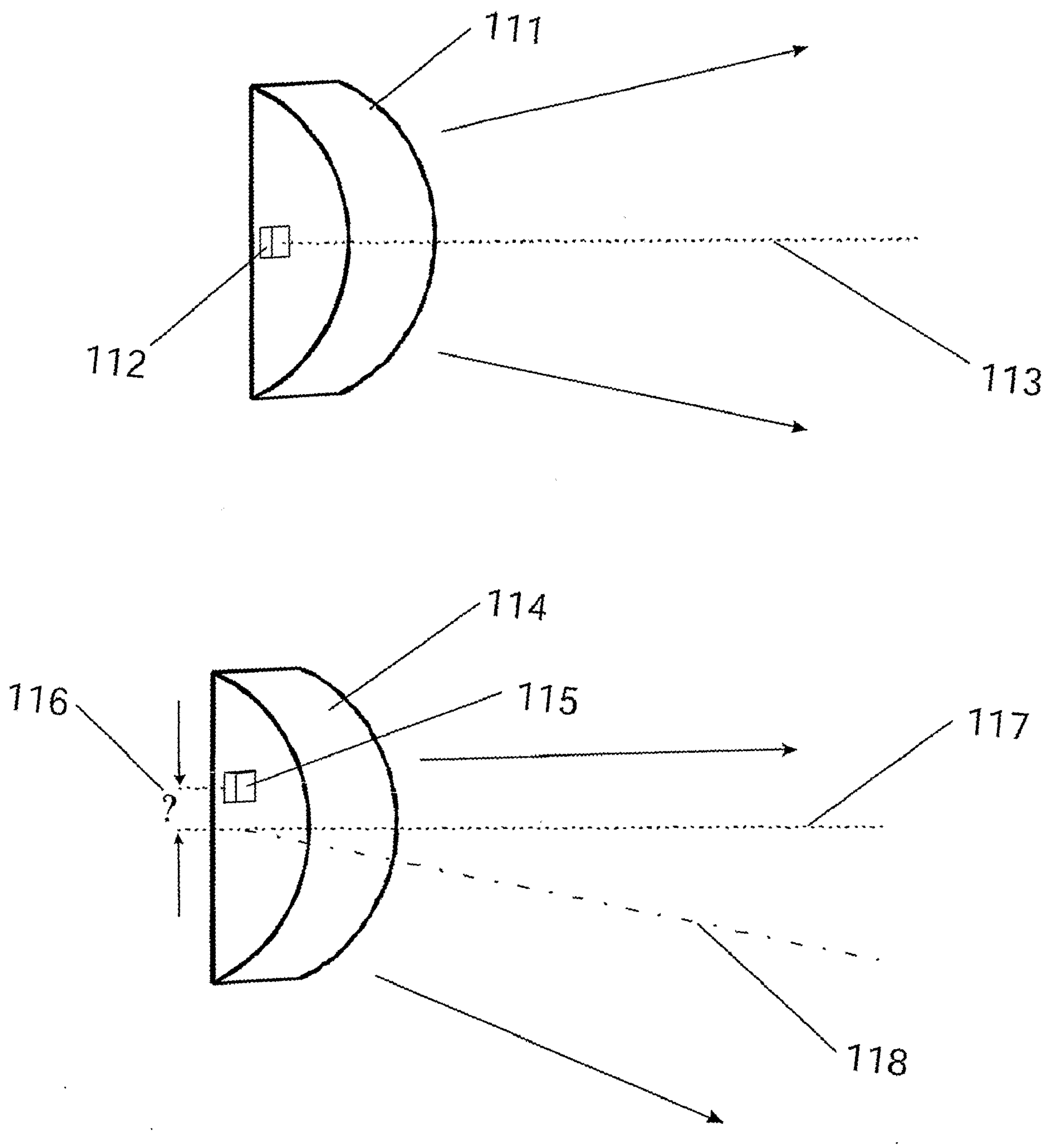

Fig. 11

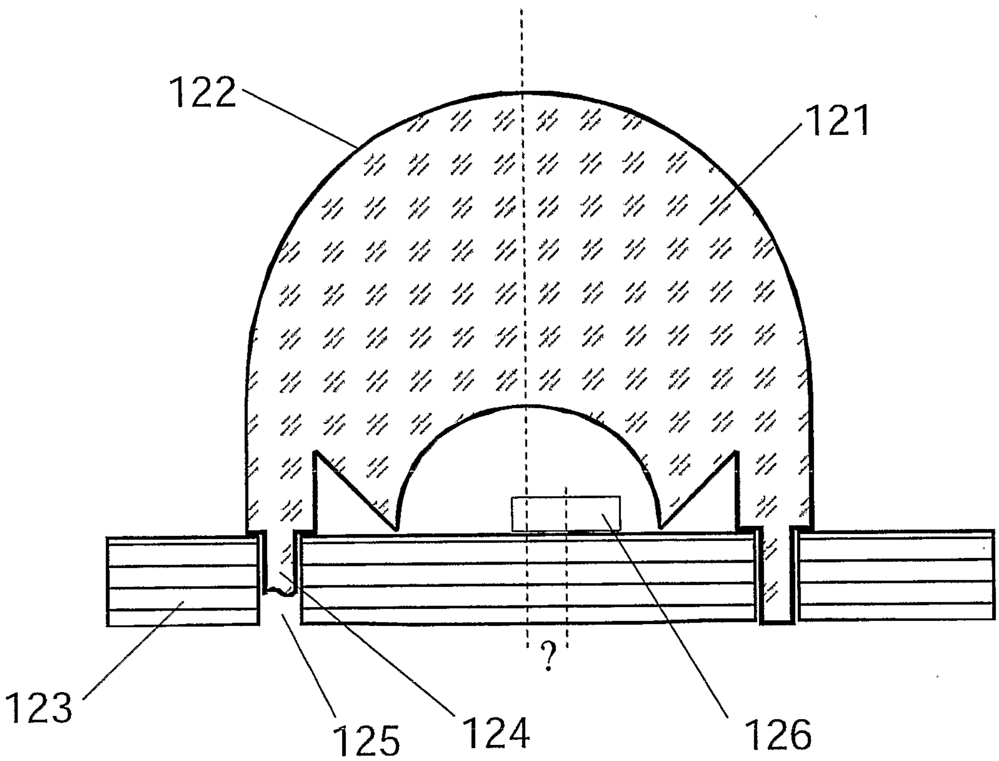

Fig. 12

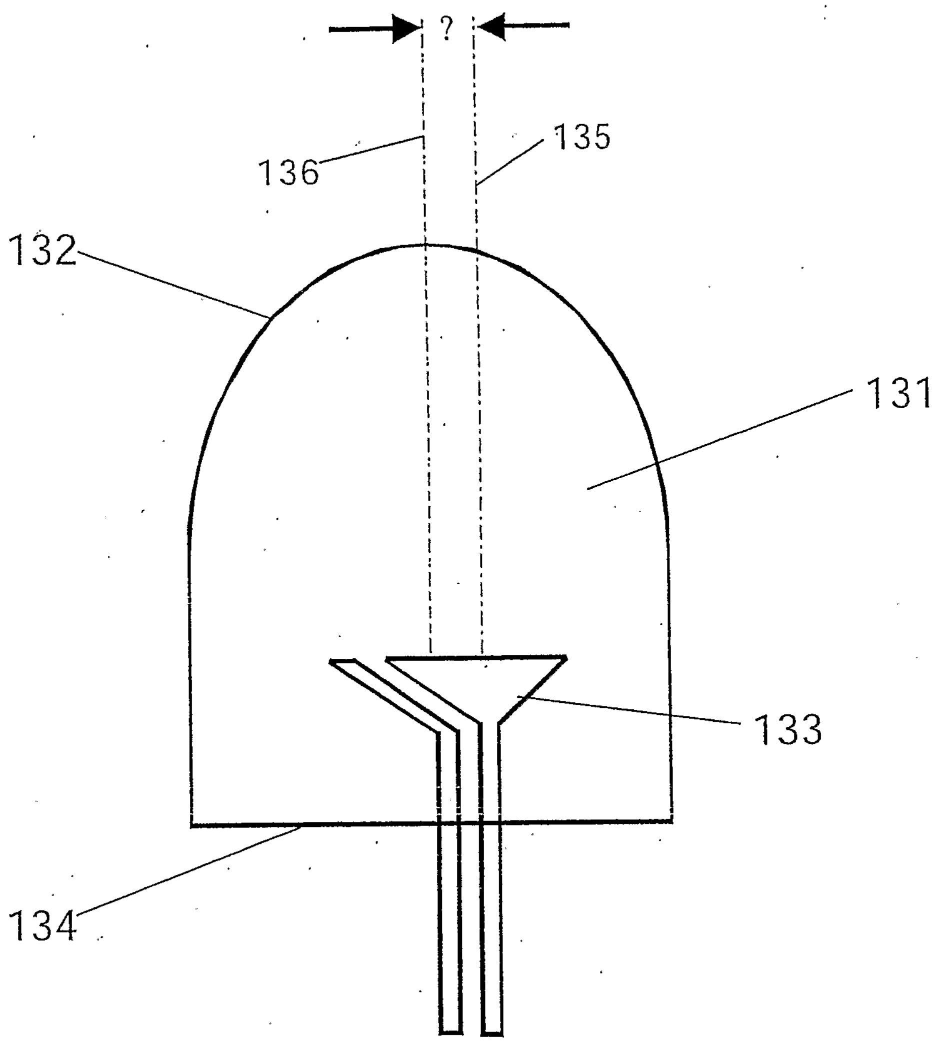

Fig. 13

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2006/000802

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01L33/00 G09F9/33

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)
H01L G09F

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 practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 08 264839 A (ROHM CO) 11 October 1996 (1996-10-11) paragraphs [0004] - [0017]	1,6-8, 14-20
X	JP 05 121785 A (SHARP CORP) 18 May 1993 (1993-05-18) paragraphs [0003] - [0014]	1,6-8, 14-20
X	US 2004/037076 A1 (KATOH M ET AL) 26 February 2004 (2004-02-26) examples 7,13	1,4,6, 15-20
X	JP 2003 031011 A (STANLEY ELECTRIC CO) 31 January 2003 (2003-01-31) paragraphs [0025], [0036]	1-9, 15-20

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 August 2006	25/08/2006

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	van der Linden, J.E.

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2006/000802

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/159850 A1 (TAKENAKA Y) 19 August 2004 (2004-08-19) paragraphs [0076] - [0079]	1,2,6,7, 14
X	US 2003/099115 A1 (REILL J) 29 May 2003 (2003-05-29) paragraphs [0033] - [0039], [0045]	1,6-8,14
X	WO 2004/084316 A (ACOL TECHNOLOGIES) 30 September 2004 (2004-09-30) page 12, lines 9-28	1-6, 10-14
X	US 2004/207999 A1 (SUEHIRO Y ET AL) 21 October 2004 (2004-10-21) paragraphs [0079] - [0083]	1,2,6,14
X	US 3 875 456 A (KANO T ET AL) 1 April 1975 (1975-04-01) examples 2,4	1,5,6
X	US 5 875 205 A (SPAETH ET AL) 23 February 1999 (1999-02-23) column 2, lines 18-64	1,4,6

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2006/000802

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
JP 8264839	A	11-10-1996	NONE		
JP 5121785	A	18-05-1993	NONE		
US 2004037076	A1	26-02-2004	JP 2004104077	A	02-04-2004
			US 2006039143	A1	23-02-2006
JP 2003031011	A	31-01-2003	NONE		
US 2004159850	A1	19-08-2004	CN 1523681	A	25-08-2004
			JP 2004274027	A	30-09-2004
US 2003099115	A1	29-05-2003	NONE		
WO 2004084316	A	30-09-2004	CA 2519080	A1	30-09-2004
			EP 1604408	A2	14-12-2005
			US 2005233485	A1	20-10-2005
			US 2004183081	A1	23-09-2004
US 2004207999	A1	21-10-2004	JP 2004281605	A	07-10-2004
US 3875456	A	01-04-1975	JP 48102585	A	22-12-1973
US 5875205	A	23-02-1999	NONE		