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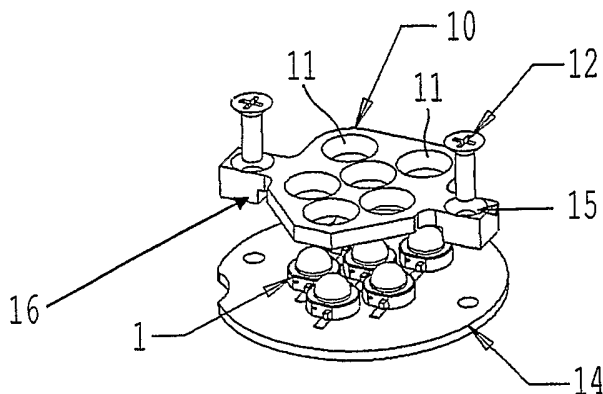
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(54) Title: HIGH FLUX LIGHT EMITTING DIODE (LED) REFLECTOR ARRAYS



(57) Abstract: A reflector device to be utilized with light emitting diodes (LEDs), and particularly with high-flux LEDs. In the reflector structure individual reflector portions surround at least one LED. Light output from each individual LED is reflected by sloping walls of each individual reflector portion and is redirected. As a result, light that may otherwise be lost is redirected to a more useful direction. Each individual reflector portion can have a crosssection of a conic shape, a complicated curve, and can also be oval in shape. A light device can be realized by utilizing such a master reflector with an LED light source.

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TITLE OF THE INVENTION

HIGH FLUX LIGHT EMITTING DIODE (LED) REFLECTOR ARRAYS

DISCUSSION OF THE BACKGROUND

FIELD OF THE INVENTION

The present invention is directed to reflectors to utilize with light emitting diodes (LEDs), and particularly when the LEDs are high-flux LEDs.

DISCUSSION OF THE BACKGROUND

High-flux LEDs are becoming more and more prevalent. A high-flux LED is generally an LED with greater luminous output in comparison with earlier developed traditional 5 mm LEDs, and an LED that has a larger size chip than in the traditional 5 mm LED. A high-flux LED for the purposes of this disclosure is defined as an individual LED package that is capable of dissipating more than .75 watts of electric power. With improvement in high-flux LED technology, more and more companies are developing different types of high-flux LEDs. High-flux LEDs also typically have larger viewing angles in comparison with a traditional 5 mm LED. To use such high-flux LEDs efficiently, mechanisms have been provided to redirected light output from the larger viewing angle of the high-flux LEDs. One known way to use the light output from high-flux LEDs more efficiently is to use a reflective/refractive lens to redirect output light. That approach has been utilized by companies such as Lumileds, Osram, and Fraen, etc.

SUMMARY OF THE INVENTION

However, the applicants of the present invention recognized that a significant drawback exists in utilizing such a reflective/refractive lens. Such a reflective/refractive lens is a plastic lens, and one major drawback of utilizing such a plastic lens is that the lens is usually very bulky. That results in limiting the LED packing density and makes the LED difficult to mount.

Accordingly, one object of the present invention is to address the above-noted and other drawbacks in the background art.

Another object of the present invention is to provide novel reflectors to be utilized with LEDs, and which may find particular application with high-flux LEDs. Such novel reflectors are small in size and easy to utilize.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the present invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

Figures 1a-1c show a first embodiment of the present invention;

Figures 2a-2c show a further embodiment of the present invention;

Figures 3a-3g show a further embodiment of the present invention;

Figures 4a and 4b show specific implementations of embodiments of the present invention;

Figure 5a shows a detailed view of a reflector of an embodiment of the present invention;

Figure 5b shows results achieved by the embodiment of Figure 5a;

Figure 6a shows a detailed view of a reflector of a further embodiment of the present invention;

Figure 6b shows results achieved by the embodiment of Figure 6a;

Figure 7a shows a detailed view of a reflector of a further embodiment of the present invention;

Figures 7b and 7c show results achieved by the embodiment of Figure 7a;

Figure 8a shows a detailed view of a reflector of a further embodiment of the present invention;

Figures 8b and 8c show possible results achievable by the embodiment of Figure 8a;

Figure 9a shows a further embodiment of a reflector structure of the present invention;

Figure 9b shows results achieved by the embodiment of Figure 9a;

Figure 10 shows details of a further embodiment of the present invention;

Figures 11a-11c show views of further embodiments of the present invention;

Figures 12a and 12b show a modification of a reflector structure of the present invention;

Figures 13a and 13b show a further modification of a reflector structure of the present invention; and

Figures 14a and 14b show a further modification of a reflector structure of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following description to the drawings, like reference numerals designate identical or corresponding parts throughout the several views.

As discussed above, the applicants of the present invention recognized that high-flux LEDs typically have larger viewing angles in comparison with traditional 5 mm LEDs, and that a background approach to utilizing a reflective/refractive lens to redirect light from plural high-flux LEDs has a drawback in making an overall light device bulky and difficult to mount.

To address such drawbacks in the background art, the present inventors realized that enhanced packing density and mountability could be realized by utilizing a reflector for LEDs in which each LED, or at least a group of LEDs, fits into its own reflector portion. Such a structure allows high redirection of light from each individual LED in a device that is not very bulky and that is not difficult to mount. The present invention is particularly applicable to high-flux LEDs because high-flux LEDs have large viewing angles. Further, high-flux LEDs are typically utilized in systems in which fewer LEDs are provided, making it more feasible to provide an individual reflector for each LED.

A first embodiment of the present invention is shown in Figures 1a-1c.

As shown in Figures 1a-1c a plurality of high-flux LEDs 1 are mounted onto an LED printed circuit board 14. In the embodiment shown in Figures 1a-1c a master reflector device 10 having individual reflecting portions or reflectors 11 is provided. Those individual reflectors 11 are provided to each surround one respective high-flux LED 1. That is, in this embodiment of the present invention each LED 1 is surrounded by a respective reflector 11 of the master reflector device 10.

As shown most clearly in Figure 1c, each individual LED 1 fits inside an individual reflector 11 and walls of the reflector 11 are sloped with respect to the LED 1. That allows light output from sides of the LED 1 to be efficiently reflected. High-flux LEDs have a large viewing angle, meaning that they emit a larger amount of light in divergent directions. By utilizing the master reflector 10 of Figure 1 light can be reflected by the sloped walls of the individual reflectors 11, which light would otherwise not be viewed.

The reflector device 10 may be made of molded plastic and may have an aluminum coating coated on the reflective wall surfaces of the individual reflectors 11. With such a

structure the reflective surfaces can reflect a portion of light from each individual high-flux LED 1 that would otherwise be lost.

As shown in Figures 1a-1c, the master reflector device 10 also includes holes 15 through which mounting screws 12 are passed to mount the master reflector 10 to the LED printed circuit board 14. Further, the master reflector device 10 includes a step 16. The size of the step 16 is chosen so that when the master reflector 10 is mounted on the LED printed circuit board 14, each individual reflector 11 is at the appropriate height relative to the LED 1 surrounded by the individual reflector 11. Figure 1c specifically shows from a side view the mounting of the master reflector 10 so that each individual reflector portion 11 is at the appropriate height relative to each high-flux LED 1.

Figures 2a-2c show a further embodiment of the present invention, which shows a master reflector 20 of a different shape and with a different mounting structure. In the embodiment of Figure 2 the master reflector 20 is not mounted to the LED printed circuit board 24 by the screws 22 passing through holes 25, but instead the master reflector 20 is mounted to receptacle portions 26 in a lamp housing.

A further implementation of an embodiment of the present invention is shown in Figures 3a-3g. Figures 3a-3g show an embodiment of how the master reflector device of the present invention can be specifically incorporated into an LED light device including a lens and the LEDs. In that further embodiment of Figures 3a-3g, the system combining the LEDs and the reflectors includes heat stake features to allow the reflector to be assembled to a lens prior to the LED sub-assembly. Once the lens/reflector sub-assembly is complete, then the LED sub-assembly can be assembled onto a back post of the reflector using screws.

More specifically, Figure 3a shown a lens 35 with heat stakes 32 used for mounting purposes. Figure 3b shows an LED printed circuit board 34 including plural high-flux LEDs 1. Figure 3c shows front F and back B sides of a master reflector 30 with individual reflector portions 31.

As shown in Figures 3d and 3e, the master reflector 30 is fit inside the lens 35 with the heat stakes 32.

Then, as shown in Figures 3f and 3g, the LED printed circuit board 34 with the LEDs 1, the LEDs 1 not being shown in those figures as they are on the opposite face of the LED board 34 (i.e. Figures 3f and 3g show the back side of the LED board 34), are then fit into the assembly shown in Figure 3e, so that each individual LED 1 is fit inside one of the individual reflectors 31. The overall assembly is then assembled by screws 32.

Such a further embodiment allows the master reflector 30 to be fit into the lens 31 prior to the LED printed circuit board 34 being fit thereto.

By utilizing the embodiment of Figures 3a-3g, benefits in a manufacturing operation can be achieved. Specifically, utilizing the embodiment of Figures 3a-3g allows a pre-assembly of the lens 35 to the reflector 30, and as a result if desirable an additional heat sink can be assembled to the LED board 34 and not to the lens 35. With that structure the lens 35 can be used for a mounting application.

The reflector structures noted in each of the embodiments of Figures 1-3 are applicable to different types of LEDs. As examples only, the reflector structures may be utilized with Lumileds Luxeon type package LEDs such as shown in the embodiment of Figure 4a, or may also be utilized with surface mounted type package LEDs such as Osram's Golden Dragon LEDs, such as shown for example in Figure 4b. Another example of high-flux LEDs is Nichia's NCCx-series LEDs.

Further, in the embodiments shown in Figures 1-3 the shape of each individual reflector 11, 21, 31 can be symmetrical to the optical axis of the individual LEDs 1, although an unsymmetrical shape can also be realized, as discussed in a further embodiment below.

Further, and as shown for example in Figure 5a, the cross-section of each individual reflector 11, 21, 31 may be conic. When utilizing an individual reflector 11, 21, 31 with a conic cross-section as shown in Figure 5a, the output light distribution may have an angular distribution such as shown in Figure 5b.

As another possible shape of each individual reflector 11, 21, 31, each individual reflector 11, 21, 31 may have a cross-section of a complicated curve as shown for example in Figure 6a. When utilizing individual reflectors 11, 21, and 31 with such a shape of a complicated curve as shown in Figure 6a, the output light distribution takes the form shown in Figure 6b.

In each of the reflecting surfaces shown in Figures 5a and 6a, a portion of the light output from the high-flux LED 1 propagates to the reflective surfaces of the individual reflectors 11, 21, 31, and the light is reflected to a direction closer to the optical axis of the LED 1. Other portions of the light output from the LED 1 are not interfered with by the reflectors 11, 21, 31 and travel uninterrupted. The divergent angle of the light can be changed by changing the slope or curvature of the reflective surfaces and the height of the reflectors.

Different modifications of the cross-section of each individual reflector 11, 21, 31 can of course be implemented, particularly between the two noted shapes in Figures 5a and 6a to achieve any desired light output.

As shown in Figure 7a, the shape of each individual reflector may also be that of an oval. With that shape light as shown in Figures 7b and 7c are output. As shown in Figure 7b, by utilizing an individual reflector 11, 21, 31 with an oval shape an isotropic angular intensity distribution of the output light can be realized. Further, Figure 7c shows the typical angular intensity distribution when utilizing an oval shape individual reflector 11, 21, 31. With such an oval shape the light divergent angles in the two directions perpendicular to the LED axis are different, thereby resulting in an oval shape distribution.

In the embodiments noted above the individual reflector portions 11, 21, 31 are substantially shown as symmetrically shaped with respect to an optical axis of light output by the surrounded LED 1. However, as shown for example in Figure 8a any of the individual reflector portions 11, 21, 31 can be shaped unsymmetrically, i.e. offset from an axis of light output from each individual LED 1.

Further, when utilizing unsymmetrically shaped LEDs the individual reflectors of a multi-reflector-device do not have to be identical. As an example, each individual reflector could be tilted at an angle, which slightly differs from the angle of tilt of other individual reflectors. Figures 8b and 8c provide examples of how such a feature can be utilized to obtain a desired light output. Figure 8c shows light output from three adjacent LEDs in which each of the adjacent LEDs is non-tilted. Because each LED is non-tilted the light output from each LED will differ, and as can be seen in Figure 3c three "rings" of output light are realized that are not congruent.

However, if it is desired that the light output from three adjacent LEDs are to be superimposed upon one another, then the three LEDs can be tilted so that the three "rings" of output light could be shifted to overlap and approximate a light output of one more powerful LED, as shown for example in Figure 8b. Utilizing such a feature can be important in signals and lamps with a secondary optic in the range of the light-sources near field. In that environment, by tilting the reflectors from adjacent LED the light can be concentrated on the secondary optic.

The individual reflectors can be tilted to be unsymmetrical with respect to an axis of the light output of the LED in any desired manner, and Figures 8a-8c only show examples of such an operation.

Each of the embodiments noted above shows each high-flux LED 1 surrounded by an individual reflector 11, 21, or 31.

However, a usage may be desired in which only one direction of a light beam needs to be compressed while the other direction may be preferably left unchanged. In that situation a two-dimensional reflector such as shown in Figure 9a can be utilized. In the two-dimensional reflector shown in Figure 9a a master reflector 90 includes three individual reflector portions 91₁, 91₂, and 91₃. Each individual reflector portion 91₁, 91₂, and 91₃ surrounds plural LEDs set forth in a linear configuration. As noted above, with such a structure only one direction of the light beam is compressed while the other direction is unchanged.

The typical angular intensity distribution of light output by the embodiment of Figure 9a is shown in Figure 9b.

By utilizing the LED reflectors in the present invention light that may otherwise not be utilized can be effectively redirected to increase the performance of LEDs.

The applicants of the present invention have also recognized that it may be beneficial in any of the LED structures noted above to reduce the reflection of impinging light, for example from sunlight impinging on the reflectors and/or the LEDs, i.e. to reduce the sun phantom-effect.

With reference to Figure 10 in the present specification, a structure for achieving that result is shown.

Figure 10 shows the structure in which LEDs 1 are mounted on a LED printed circuit board 14, 24, 34, which can correspond to any of the LED printed circuit boards 14, 24, 34 in any of the embodiments noted above, and also with any needed modifications. A master reflector 10, 20, 30 with individual reflector elements 11, 21, 31 is provided around the LEDs 1. As shown in Figure 10, in such a structure the LED board 14, 24, 34 is mounted onto a structure 105 with heat sink properties. Further, various electronic components 110 for driving the LEDs are also provided. Blank soldering joints/pads 115 are also utilized in such a structure to provide soldering, contact pads, etc.

In such a structure as in Figure 10 impinging light, for example from sunlight or from other sources, would conventionally be reflected off of the blank soldering joints/pads 115 and electronic devices 110. However, the present invention avoids that result by providing light absorbing members 100 as an extension of the master reflectors 10, 20, 30. The light absorbing members 100 extend above the electronics 110 and the blank soldering joints/pads 115. As a result phantom light can be reduced since impinging light will not be reflected from the blank soldering joints/pads 115 and electronic devices 110, but instead will be

absorbed by the light absorbing members 100. Those members 100 can be formed of any non-reflective material.

In the embodiments noted above each individual reflector 11, 21, 31 has sloped walls which can be coated with the reflective material such as aluminum. However, it may be desirable in each individual reflector to provide an antireflection portion to reduce the reflection of incident extraneous light, for example sunlight. Different structures to achieve that result are shown in Figures 11a-11c. In each of these figures an anti-reflection area is provided at a portion of the reflector. That portion at which the anti-reflection area is provided may be a portion that is particularly susceptible to incident light, for example to incident sunlight. The position of the anti-reflection area will depend on several factors such as characteristics of secondary optics, critical angle of extraneous light, and viewing area to the observer. To decide where the anti-reflection area is best positioned, how big it is, and what form it has, one can use optical simulation software to arrive at a theoretical solution or one can build a prototype and take a look at where the main reflexes occur as a practical solution.

As shown in the specific embodiment of Figure 11a a master reflector surrounds the LED 1. In that structure a metallized or reflective area 125 is provided on almost all sides of the LED 1. However an area 12d that is not reflective is also provided. That non-reflective area 120 can take the form of an area having a matte finish as shown in Figure 11a, can be a dark area 121 as shown in Figure 11b, or can be an omitted area 122 as shown in Figure 11c, i.e. an area where there is no metallized area or reflective area. Utilizing any of the matte finished area 120, dark area 121, or omitted area 122 spreads or absorbs incident extraneous light that otherwise would be reflected towards a viewer.

The embodiments noted above show the reflectors 11, 21, 31 as having generally smooth walls. However, the reflectors are not limited to such a structure.

With reference to Figures 12a and 12b, the side reflective walls of any of the above-noted reflectors 11, 21, 31 can also include facets 120, Figure 12a showing a side reflective wall of a reflector and an LED 1 from a side view and Figure 12b showing the same LED 1 and reflector from a top view. As shown in Figures 12a and 12b, the side reflective walls of the reflector have facets 120.

As a further feature of the present invention, the side reflective walls of the reflectors can be utilized to capture a portion of light output from the corresponding surrounded LED to provide a general indication of light being output from the LEDs. Different embodiments of achieving such a result are shown in Figures 13a, 13b, and 14a, 14b.

As shown in Figure 13a, the side reflective walls of the reflector 11, 21, 31 include a specialized reflector zone 130. The specialized reflector zone 130 is positioned to reflect a small portion of light from the LED 1 specifically towards a light sensor 135. As shown in Figures 13a and 13b, different individual reflectors 11, 21, 31 include the same specialized reflector zone 130 and all output light to the same sensor 135. With such an operation it becomes possible to measure a defined percentage of luminance intensity of all of the LEDs. As shown in Figures 13a and 13b, the specialized reflector zones 130 are only a small portion of the reflectors 11, 21, 31 and thereby only a small amount of optical light is lost from being visible and is provided to the sensor 135. The light sensed at the sensor 135 can be utilized in, for example, an intensity feedback operation.

Figures 14a and 14b show an alternative structure to achieve the same result as shown in Figures 13a and 13b. In Figures 14a and 14b, the specialized reflector zone takes the shape of a small hole 140 provided in a wall of the reflector 11, 21, 31. A small portion of light from the LED 1 is then passed through the small hole 140 and provided to a sensor 135.

The above-noted structures can be applied to any or all of the reflectors 11, 21, 31, dependent on how precise an indication of output light is desired.

Obviously, numerous additional modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the present invention may be practiced otherwise than as specifically described herein.

CLAIMS:

1. A light reflector device configured to be used with a printed circuit board on which a plurality of light emitting diodes (LEDs) are mounted, comprising:

(a) a master reflector including a plurality of individual reflectors, one of said plurality of individual reflectors configured to surround at least one of the plurality of LEDs, each individual reflector including reflective surfaces surrounding the respective at least one of the plurality of LEDs.

2. A light reflector device according to claim 1, wherein said master reflector is made of molded plastic, and said reflective surfaces include an aluminum coating.

3. A light reflector device according to claim 1, wherein each individual reflector surrounds plural of the respective plurality of LEDs arranged linearly.

4. A light reflector device according to claim 1, wherein each individual reflector surrounds a single respective of the plurality of LEDs.

5. A light reflector device according to claim 1, wherein each individual reflector has a conic cross-section.

6. A light reflector device according to claim 1, wherein each individual reflector has a cross-section of a complicated curve.

7. A light reflector device according to claim 1, wherein each individual reflector has an oval shape around an axis of the respective one of the plurality of LEDs.

8. A light reflector device according to claim 1, wherein at least one of said individual reflectors is unsymmetric relative to the respective LED.

9. A light reflector device according to claim 1, further comprising:
(b) a light absorbing member extending from said master reflector.

10. A light reflector device according to claim 1, wherein each individual reflector includes a light absorbing area.

11. A light reflector device according to claim 1, wherein each individual reflector has the reflective surfaces as one of smooth surfaces or faceted surfaces.

12. A light reflector device according to claim 1, wherein each individual reflector includes on a reflective surface a specialized reflective zone to direct light to a sensor.

13. A light device comprising:

(a) a printed circuit board on which a plurality of light emitting diodes (LEDs) are mounted;

(b) a master reflector including a plurality of individual reflectors, one of said plurality of individual reflectors configured to surround at least one of the plurality of LEDs, each individual reflector including reflective surfaces surrounding the respective at least one of the plurality of LEDs.

14. A light reflector device according to claim 13, wherein said master reflector is made of molded plastic, and said reflective surfaces include an aluminum coating.

15. A light reflector device according to claim 13, wherein each individual reflector surrounds plural of the respective plurality of LEDs arranged linearly.

16. A light reflector device according to claim 13, wherein each individual reflector surrounds a single respective of the plurality of LEDs.

17. A light reflector device according to claim 13, wherein each individual reflector has a conic cross-section.

18. A light reflector device according to claim 13, wherein each individual reflector has a cross-section of a complicated curve.

19. A light reflector device according to claim 13, wherein each individual reflector has an oval shape around an axis of the respective one of the plurality of LEDs.

20. A light device according to claim 13, further comprising;

(c) connecting screws configured to secure said printed circuit board to said master reflector.

21. A light device according to claim 13, further comprising:

(c) a lens mounted to said master reflector.

22. A light device according to claim 13, wherein at least one of said individual reflectors is unsymmetric relative to the respective surrounded LED.

23. A light device according to claim 13, further comprising:

(c) a light absorbing member extending from said master reflector.

24. A light device according to claim 13, wherein each individual reflector includes a light absorbing area.

25. A light reflector device according to claim 13, wherein each individual reflector has the reflective surfaces as one of smooth surfaces or faceted surfaces.

26. A light reflector device according to claim 13, wherein each individual reflector includes on a reflective surface a specialized reflective zone to direct light to a sensor.

27. A light reflector device configured to be used with a printed circuit board on which a plurality of light emitting diodes (LEDs) are mounted, comprising:

(a) master reflecting means including a plurality of individual reflecting means, one of said plurality of individual reflecting means surrounding at least one of the plurality of LEDs and for reflecting light output from the respective at least one of the plurality of LEDs.

28. A light reflector device according to claim 27, further comprising:

(b) light absorbing means for absorbing impinging light.

29. A light device comprising:

(a) means for supporting a plurality of light emitting diodes (LEDs);

(b) master reflecting means including a plurality of individual reflecting means, one of said plurality of individual reflecting means surrounding at least one of the plurality of LEDs and for reflecting light output from the respective at least one of the plurality of LEDs.

30. A light device according to claim 29, further comprising:

(c) means for securing said means for supporting to said master reflecting means.

31. A light device according to claim 29, further comprising:

(c) optic means mounted to said master reflecting means.

32. A light device according to claim 29, further comprising:

(c) light absorbing means for absorbing impinging light.

33. A light device according to claim 29, wherein at least one individual reflecting means includes means for directing a portion of light output from a surrounded LED to a light sensor.

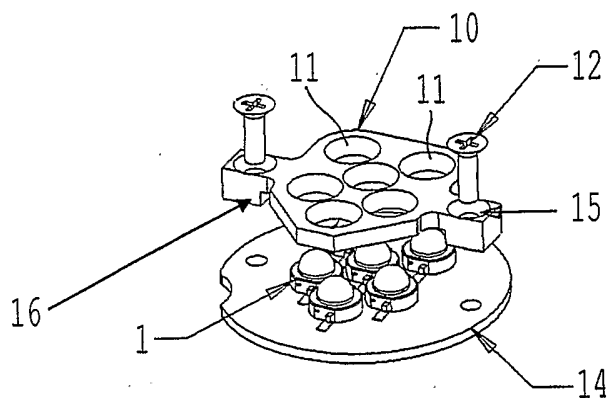


FIG. 1a

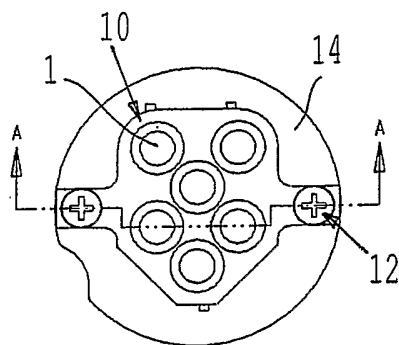


FIG. 1b

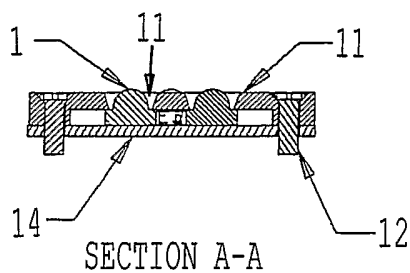


FIG. 1c

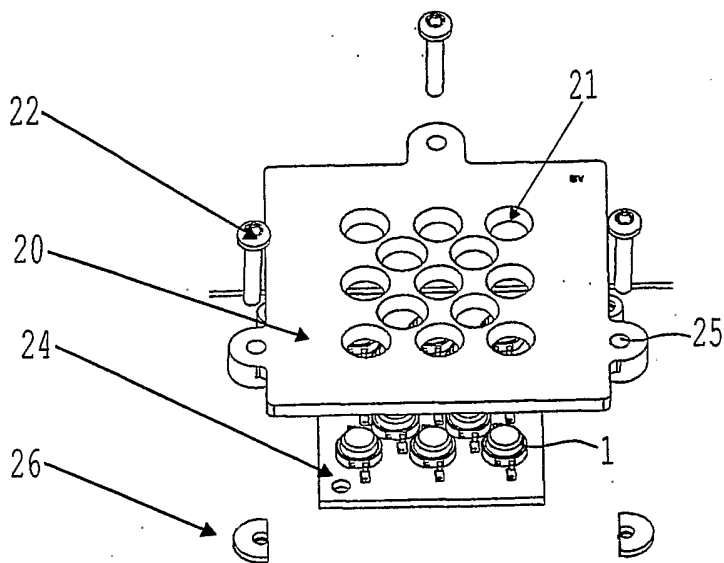


FIG. 2a

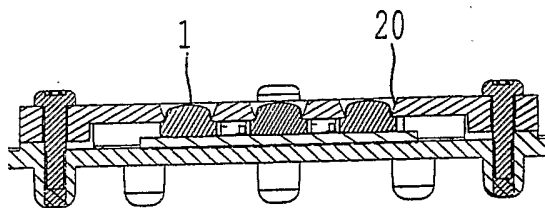


FIG. 2b

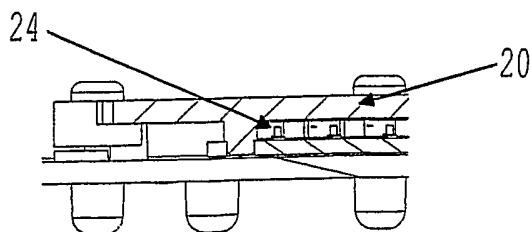


FIG. 2c

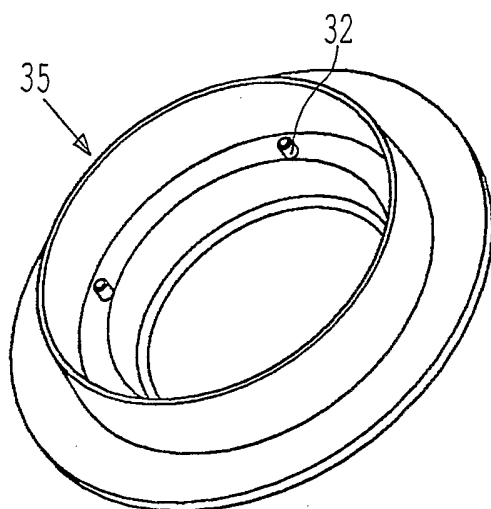


FIG. 3a

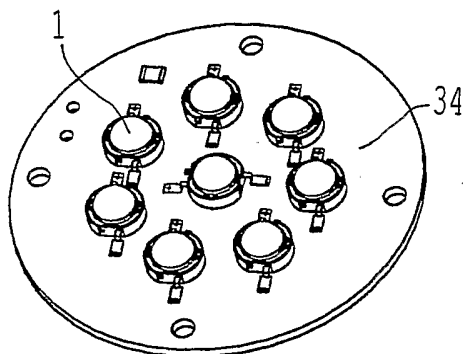


FIG. 3b

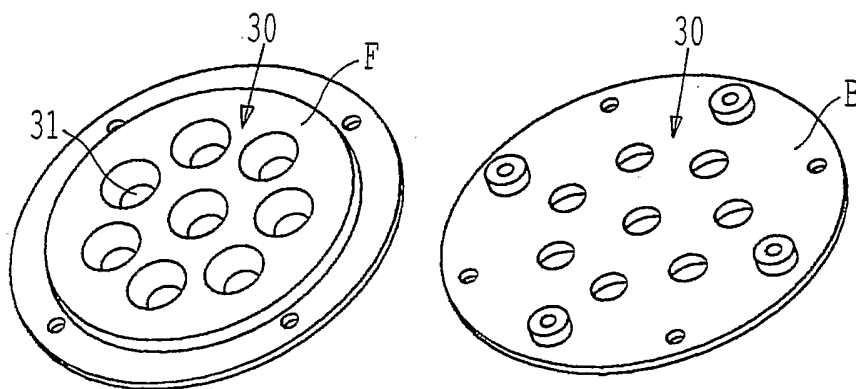


FIG. 3c

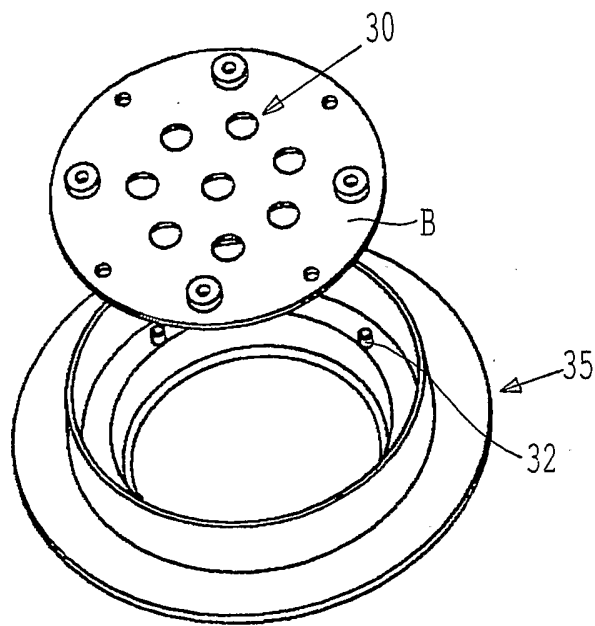


FIG. 3d

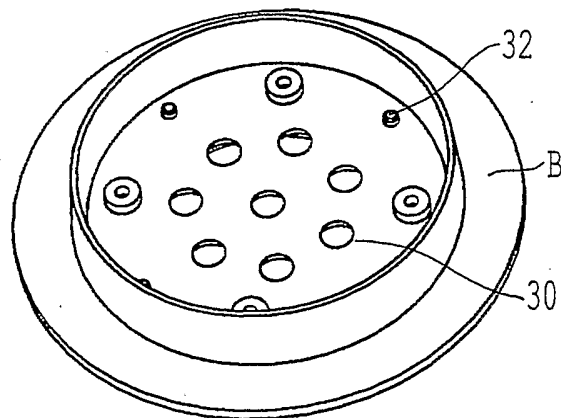


FIG. 3e

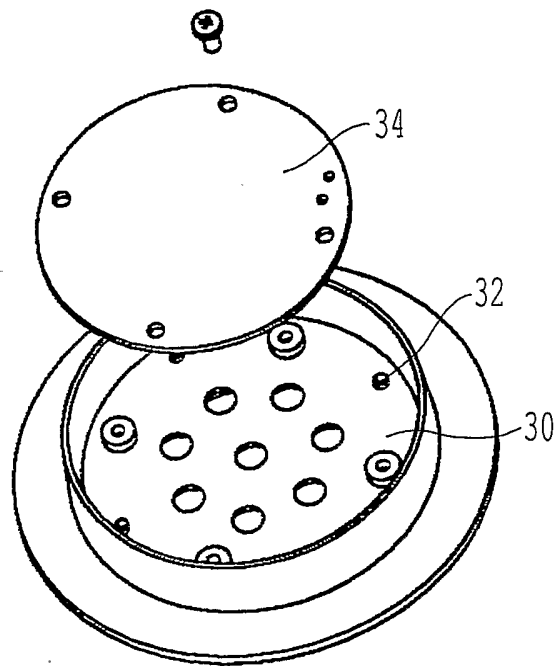


FIG. 3f

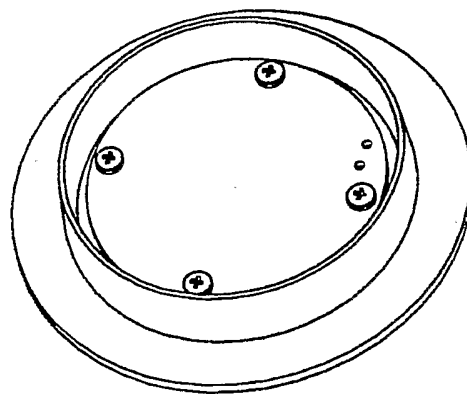


FIG. 3g

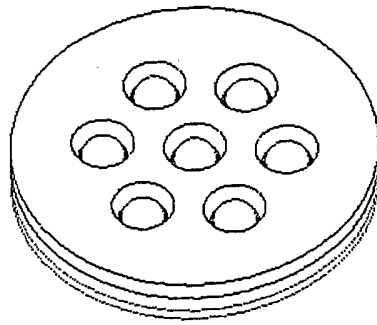


FIG. 4a

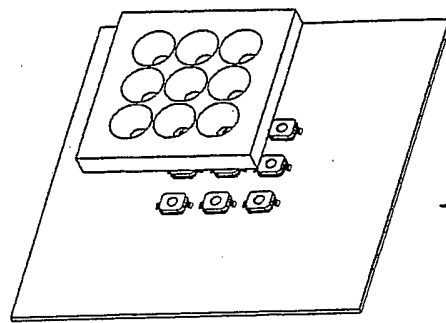


FIG. 4b

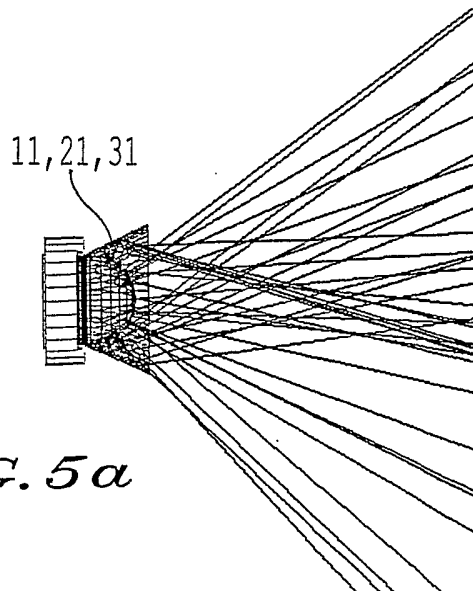


FIG. 5a

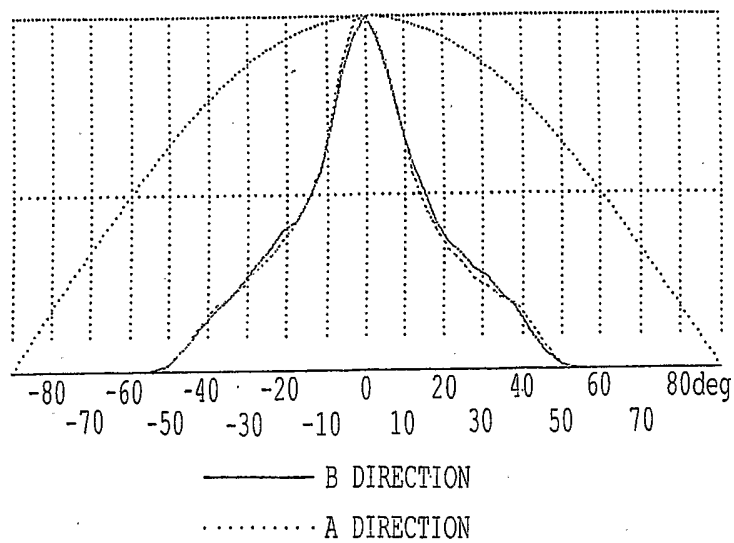


FIG. 5b

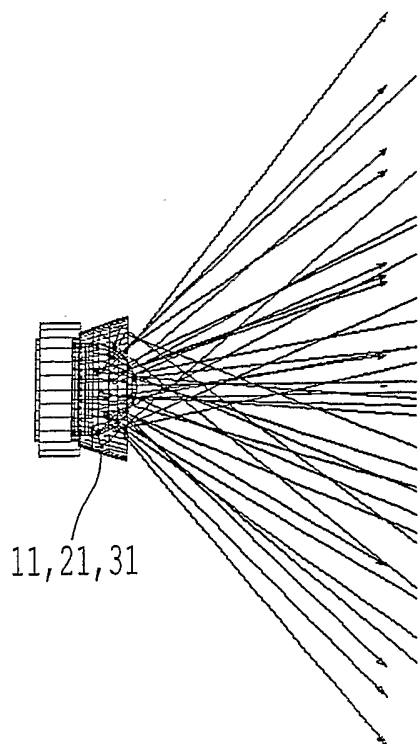


FIG. 6a

FIG. 6b

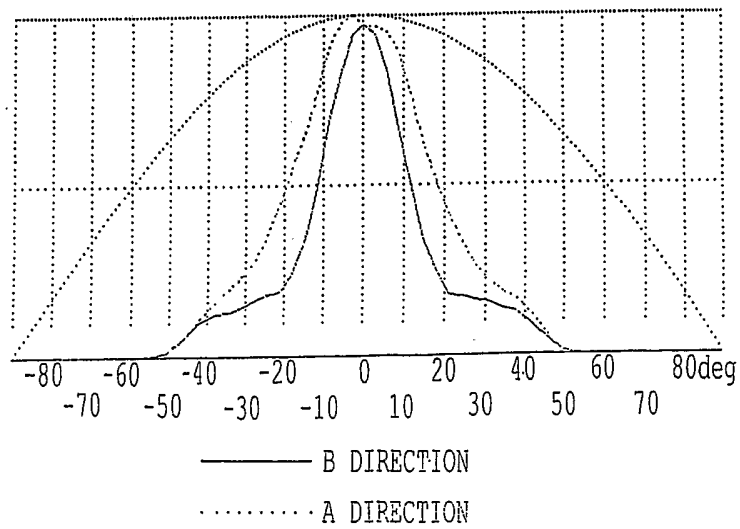
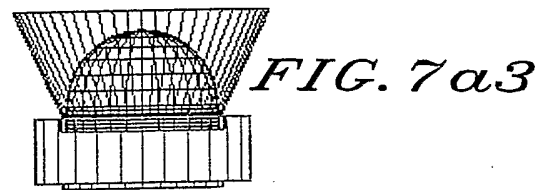
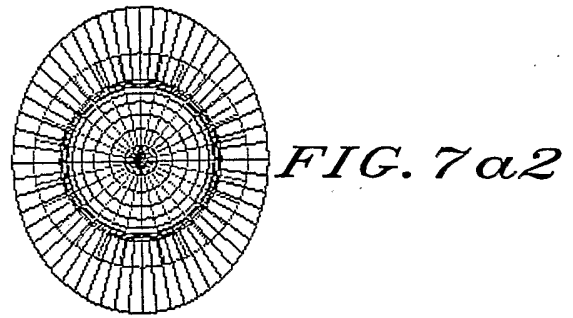
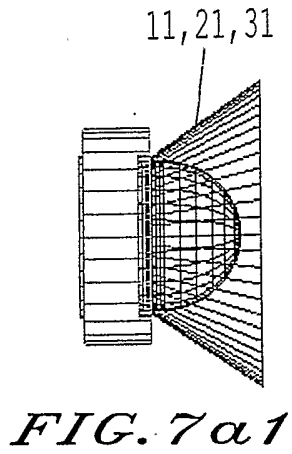
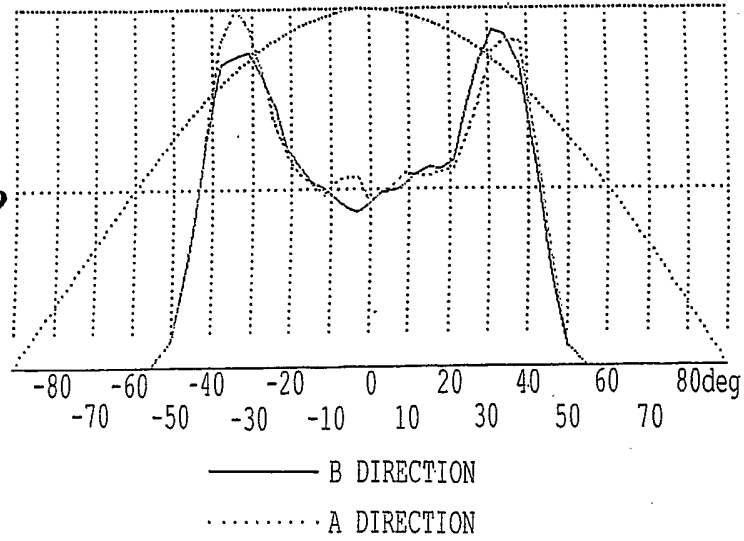


FIG. 7b

VERTICAL ANGLE

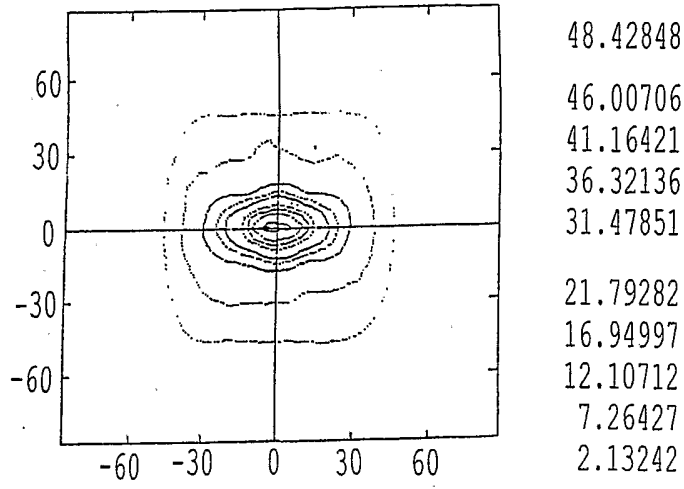


FIG. 7c

HORIZONTAL ANGLE

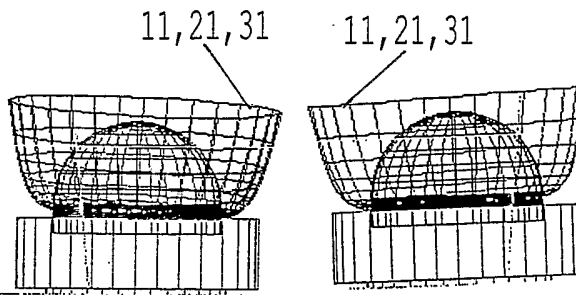


FIG. 8a1

FIG. 8a2

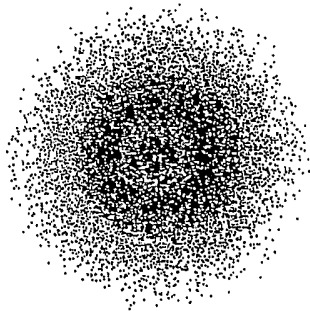


FIG. 8b



FIG. 8c

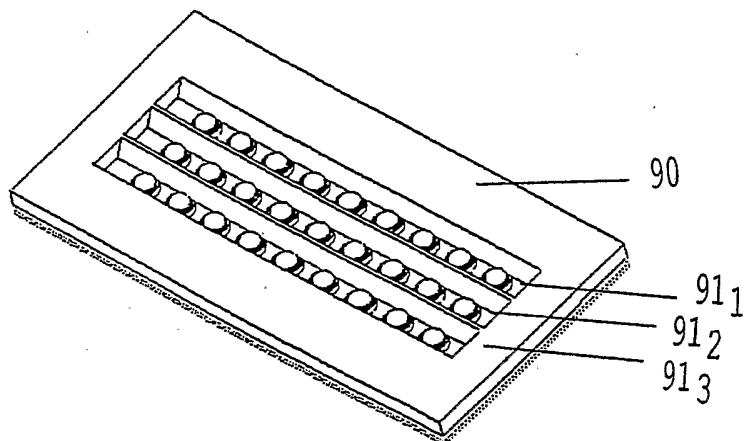


FIG. 9a

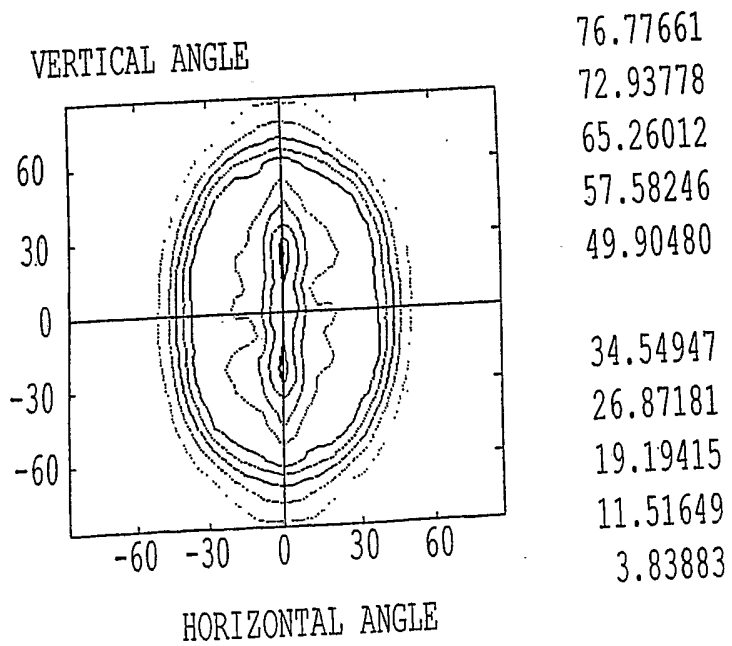


FIG. 9b

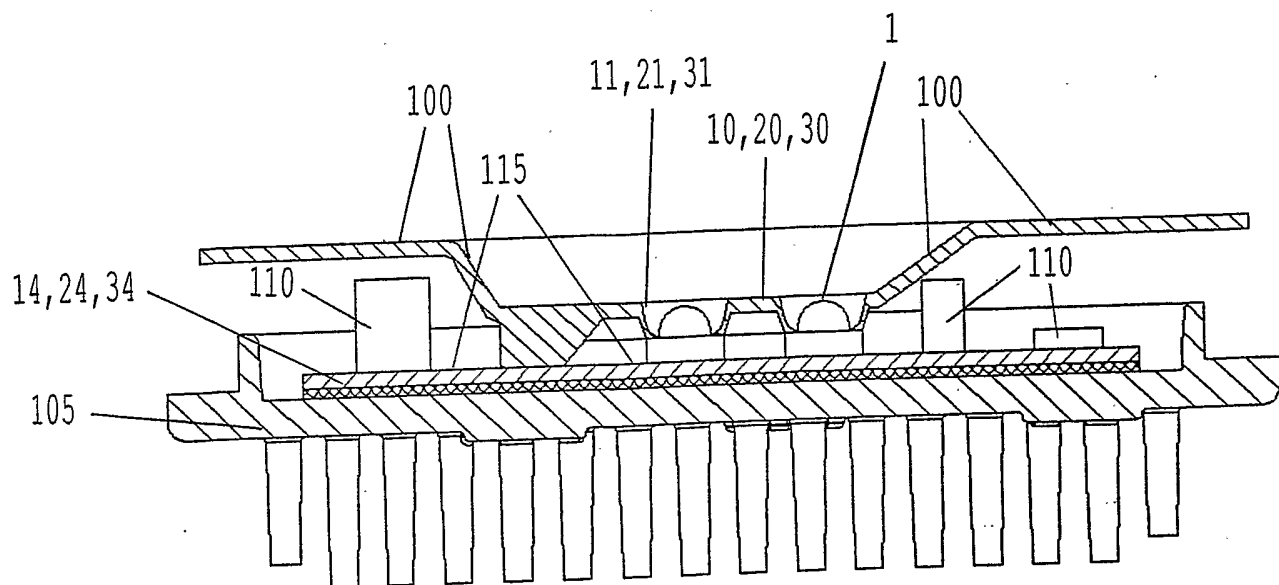


FIG. 10

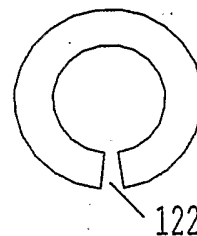
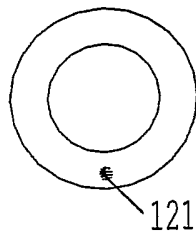
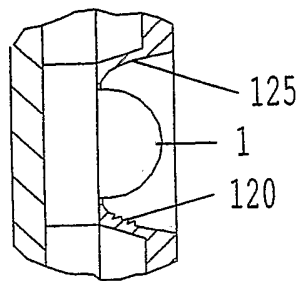


FIG. 11a

FIG. 11b

FIG. 11c

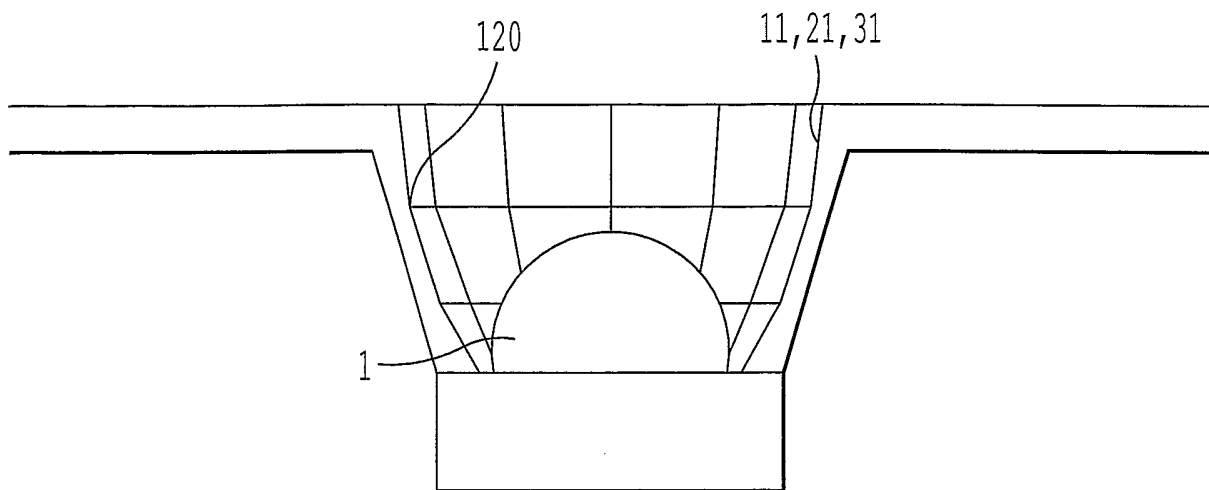


FIG. 12a

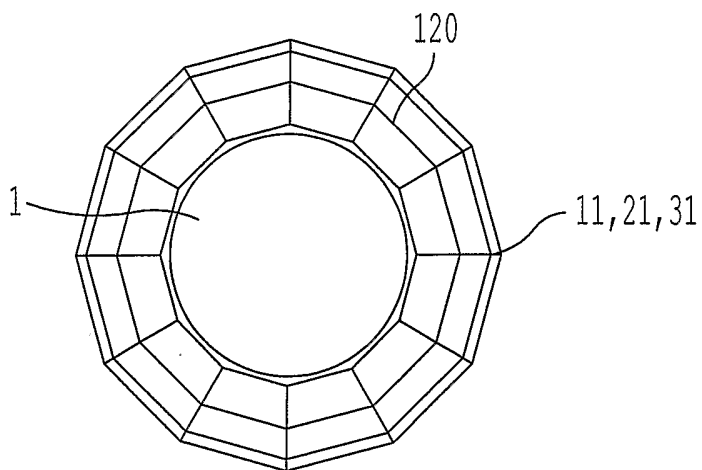


FIG. 12b

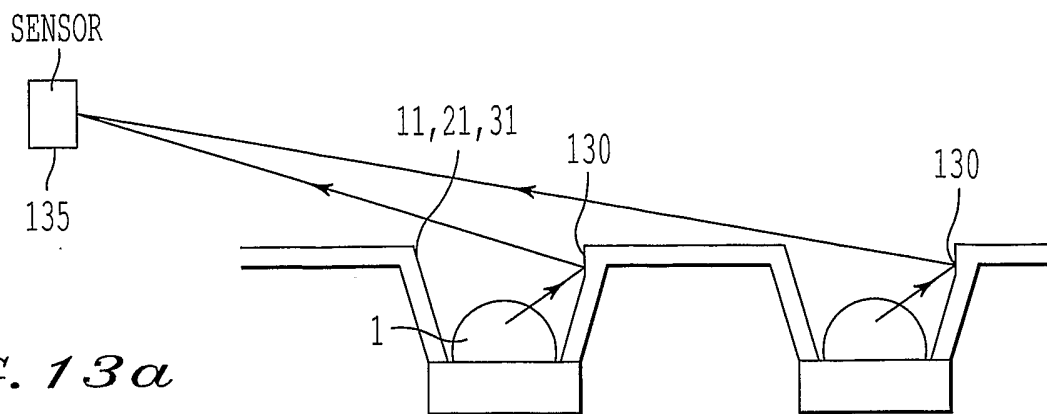


FIG. 13a

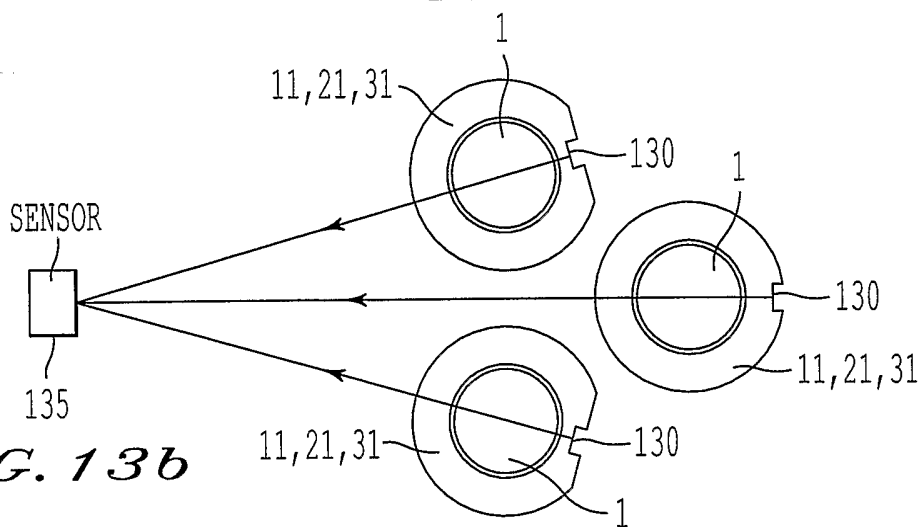


FIG. 13b

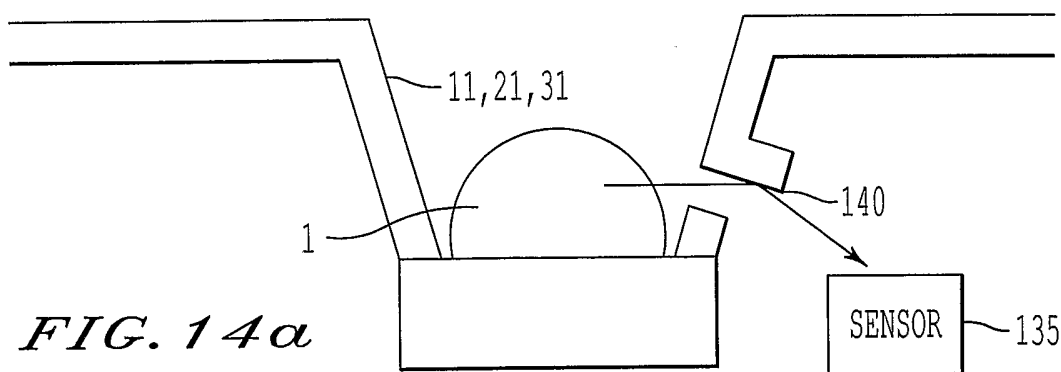


FIG. 14a

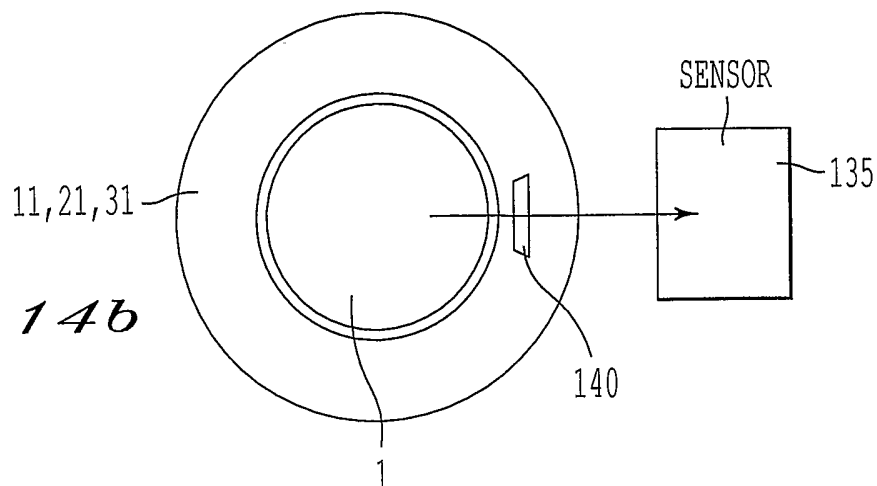


FIG. 14b

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US04/32316

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : F21V 1/00
US CL : 362/241

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)
U.S. : 362/241,238,346,227,235,236,237,240,249,317,341,347,348,350,800

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,271,408 A (TESHIMA et al.) 02 June 1981 (02.06.1981), see entire document.	1,2,4-14,16-33
X	US 5,418,384 A (YAMANA et al.) 23 May 1995 (23.05.1995), see entire document.	1,3,13,15
A	US 4,628,422 A (EWALD) 09 December 1986 (09.12.1986), see entire document.	1-33
A	US 4,733,335 A (SERIZAWA et al.) 22 March 1988 (22.03.1988), see entire document.	1-33
A	US 4,935,665 A (MURATA) 19 June 1990 (19.06.1990), see entire document.	1-33
A	US 4,975,814 A (SCHAIRER) 04 December 1990 (04.12.1990), see entire document.	1-33
A	US 5,903,768 A (SATO) 11 May 1999 (11.05.1999), see entire document.	1-33

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents.	
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"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	
"P" document published prior to the international filing date but later than the priority date claimed	"&" document member of the same patent family

Date of the actual completion of the international search

02 June 2005 (02.06.2005)

Date of mailing of the international search report

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