



US 20020044454A1

(19) **United States**

(12) **Patent Application Publication**
Roller et al.

(10) **Pub. No.: US 2002/0044454 A1**
(43) **Pub. Date: Apr. 18, 2002**

(54) **LIGHT-EMITTING DIODE COMBINATION
MARKER/CLEARANCE LAMP FOR TRUCKS
AND TRAILERS**

Related U.S. Application Data

(63) Non-provisional of provisional application No.
60/227,228, filed on Aug. 23, 2000.

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Publication Classification

(51) **Int. Cl.⁷** **F21W 11/02; B60Q 1/26**
(52) **U.S. Cl.** **362/540**

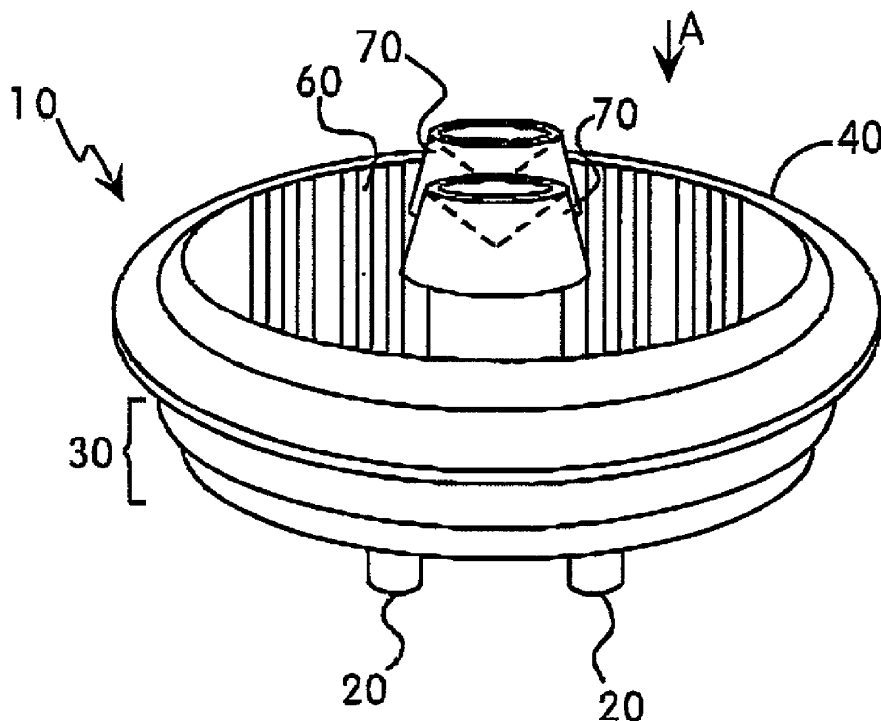
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ABSTRACT

The present invention is a vehicular combination marker/clearance lamp for trucks and trailers using a reduced number of light-emitting diodes and an optics design using total internal reflection to produce the light intensity and angular distribution required by the Department of Transportation. The present invention accomplishes this goal by utilizing a one-piece optical system. The system possesses a collimating lens, ribbed structures, and a modified conical shape, which will concentrate and distribute the light produced by the light-emitting diodes.

(21) Appl. No.: **09/938,648**

(22) Filed: **Aug. 23, 2001**



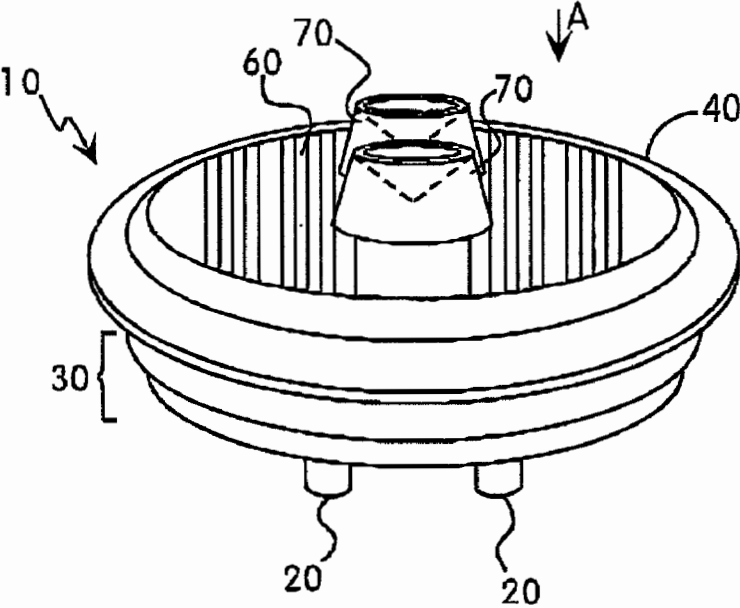


FIG. 1

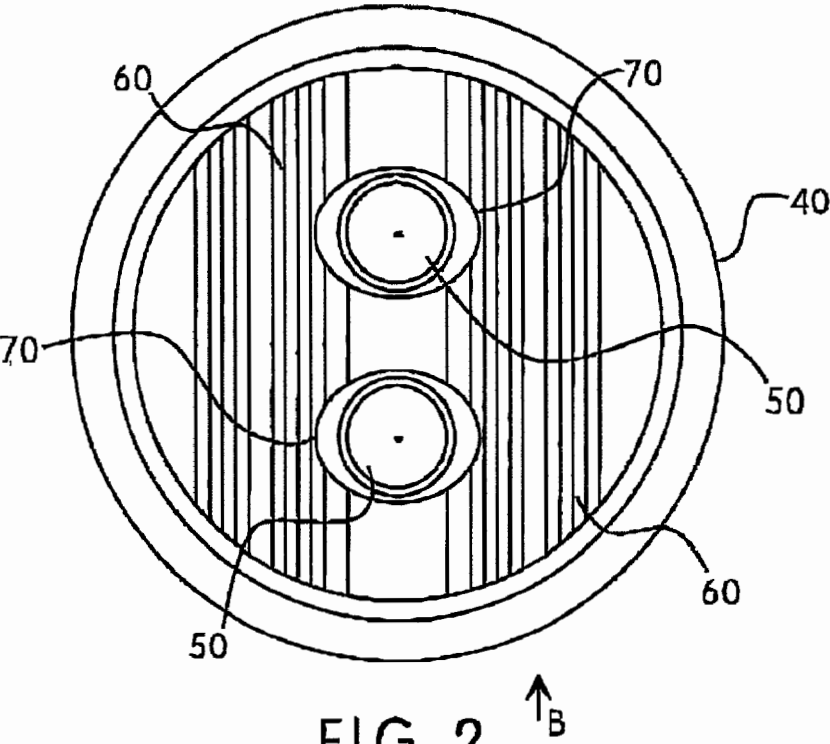


FIG. 2

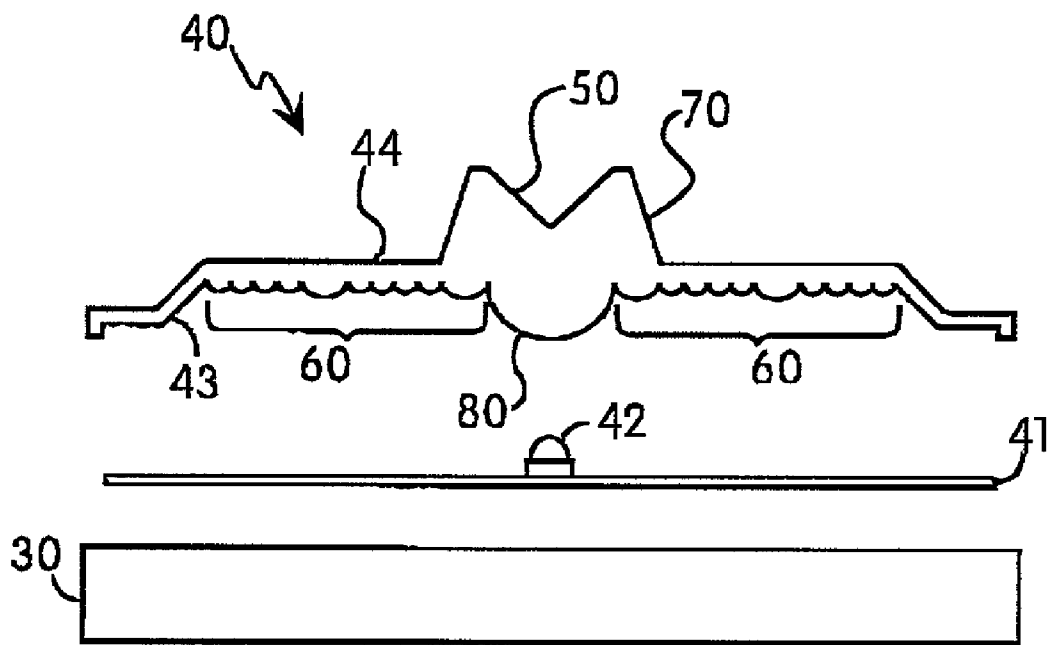


FIG. 3

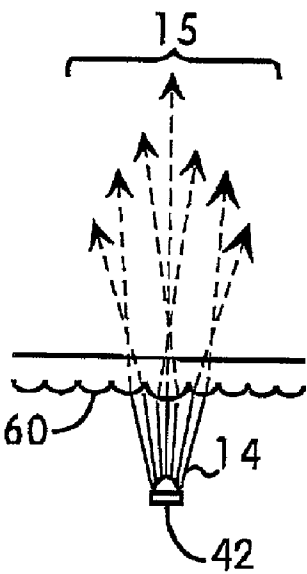


FIG. 4

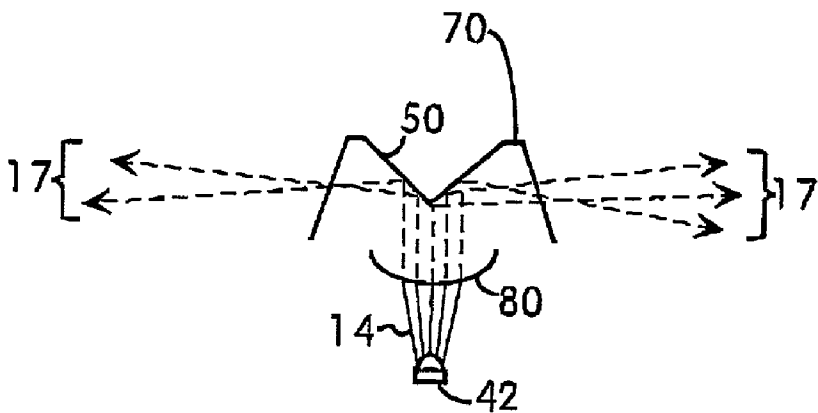


FIG. 5

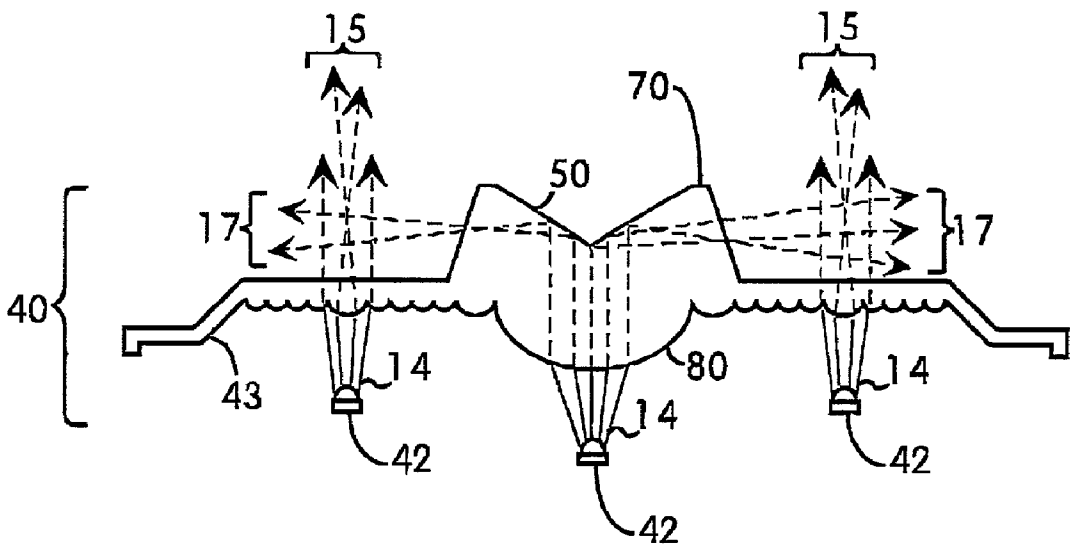


FIG. 6

LIGHT-EMITTING DIODE COMBINATION MARKER/CLEARANCE LAMP FOR TRUCKS AND TRAILERS

FIELD OF THE INVENTION

[0001] The present invention is related to combination marker/clearance lamp for vehicles, more particularly, a combination marker/clearance lamp for trucks or tractor-trailers.

BACKGROUND ART

[0002] Marker and clearance lamps are an important factor in the safe operation of trucks and trailers. These lamps make the vehicle more visible and detectable by other motorists, which effectively reduces the chances of collision.

[0003] A combination clearance and lamp should be able to indicate the overall width, height, and length of the vehicle. To accomplish this, the lamp must emit light over a wide range of angles.

[0004] In the past, combination marker/clearance lamps were made by high intensity incandescent bulbs. Combination marker/clearance lamps have also been made with light emitting diodes. Light-emitting diodes provide the advantage of a relatively long service life. However, most of the LED designs require a large number of light-emitting diodes and complicated optics or mirrors to provide for the right intensity and spread of light. A large number of light-emitting diodes create problems with heat dissipation, thereby making the design of the lamp more complicated. To achieve the desired distribution of light in these lamps, a reflective surface or mirror is required. In addition, some lamps have utilized segmented circuit boards in which light-emitting diodes have been mounted to provide for different angles of light distribution or aimed light-emitting diodes. Reflective surfaces or mirrors add additional cost and at least one extra part to the lamp design. Segmented boards, on the other hand, usually require special mounting considerations and generally can not be potted for protection. The additional requirements of segmented board construction make the construction of the lamp more complicated and potentially more fragile.

[0005] U.S. Pat. No. 5,388,035 shows a circular lamp using only three light-emitting diodes. Each of the light-emitting diodes is aimed in a specific angle such that the conical light output beam is centered on an axis that is normal to the plane of the lens wall. The rear surface of the lens front wall contains three sets of light spreading prism ribs, which are optically aligned with each light-emitting diode. This arrangement provides for an output beam whose width is about 30 degree in the vertical plane and 90 degree in the horizontal plane. There some disadvantages to this design, including but not limited to the requirement that light-emitting diodes must be aimed at the correct angle and aligned perfectly with the corresponding set of optics during construction of the lamp. The resultant lamp provides an output beam whose width is only about 30 degree in the vertical plane and 90 degree in the horizontal plane.

[0006] The subject invention overcomes these issues by using less complicated optics and, in one embodiment, a small number of light-emitting diodes, which do not require complicated alignments with optics or reflective surfaces. In

addition, the subject invention distributes light over a wider range from 0 to 90-degree angles. The increase in light distribution provides for a more visible and detectable lamp by other motorists.

SUMMARY OF THE INVENTION

[0007] The present invention solves the above mentioned limitations of the prior art in a cost-effective manner by using a simpler optics design and, in one embodiment, a reduced number of light-emitting diodes which does not require a mirror to produce the light intensity and angular distribution desired for combination marker/clearance lamps.

[0008] The present invention eliminates the need for mirrors by making use of the process of total internal reflection (TIR). The subject invention improves over past attempts to employ TIR by utilizing a collimating lens above a light source. In a preferred embodiment, the light source is an LED. In a more preferred embodiment, the light source is a plurality of LEDs. The invention also reduces the number of light-emitting diodes; the maximum number required would be approximately four but the subject invention could potentially work with as little as one light emitting diode. The optics design comprises an optical system that possesses a collimating lens under a modified conical shape and ribbed structures, which together will concentrate and disseminate the light produced by the light source over a angles ranging from 0 to 90 degrees horizontally to each side of the lamp.

[0009] A typical amber color device has one light-emitting diode positioned behind each set of vertically oriented rib shaped optics, which are designed to distribute the light horizontally over a range of approximately 0-60 degrees. It should be noted that a red colored device could be made with less than four light emitting diodes. One of the light-emitting diodes is positioned under each of the collimating lenses of the optical lens element capable of total internal reflection. The collimating lens is a convex lens that intercepts the cone of light produced by the light-emitting diodes and converts the light to a beam of parallel lights. This illuminates the modified conical depression at the center of the TIR optics system. The light hits the conical surface at greater than the critical angle causing the light to reflect from the surface rather than transmit through the surface. The light from this point is distributed more or less in a horizontal, radial pattern. The design, as implemented, deliberately allows the light to angle slightly to the front and to fan several degrees to compensate for the required draft angle of the Do plastic part and to assure that all required photometric test points are covered uniformly. Viewed from the front of the lamp, the elliptical shape of the protrusion surrounding the modified cone acts as a lens, concentrating the light, which is progressing radially from the cone, into a more directional beam in order to assure adequate intensity to the left and right of the lamp in a range of approximately 60-90 degrees.

[0010] These above mentioned and other objects of the invention will become more apparent from the following description of the best mode for carrying out the invention.

OBJECTS OF THE INVENTION

[0011] Accordingly, it is an object of the invention to utilize a reduced number of optical elements to attain the desired directional light emission.

[0012] Additionally, it is an object of the present invention to provide a combination marker/clearance lamp that utilizes a reduced number of light emitting diodes.

[0013] It is also an object of the present invention to provide a combination marker/clearance lamp that utilizes total internal reflection (TIR) to distribute light over a wide range of angles.

[0014] It is a further object of the present invention to provide a combination marker/clearance lamp that utilizes an optics design that eliminates the use of reflective surfaces and segmented circuitboards to emit and distribute light.

[0015] In addition, it is an object of this invention to provide a unique optical system, using ribbed structures, collimating lens and a conical depression.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Other aspects, objects, and advantages of the present invention appear more clearly on reading the following best mode for carrying out the invention, given by way of example and made with reference to the accompanying drawings, in which:

[0017] FIG. 1 is a three-dimensional perspective view image of the marker/clearance lamp.

[0018] FIG. 2 is a top view of the marker/clearance lamp.

[0019] FIG. 3 is a cross section of the marker/clearance lamp embodying the features of the invention.

[0020] FIG. 4 is a pictorial representation of the path of a beam of light from the light-emitting diode toward the ribbed section of the lens.

[0021] FIG. 5 is a pictorial representation of the path beam of light from the light-emitting diode toward the collimating lens and the conical depression.

[0022] FIG. 6 is a combination of FIG. 4 and 5 as an illustration of the marker/clearance lamp requirements.

BEST MODE FOR CARRYING OUT THE INVENTION

[0023] For the purpose of promoting an understanding of the present invention, reference will be made to an amber color lamp as illustrated in the drawings. It will nevertheless be understood that no limitations of the scope of the invention is thereby intended, such alterations as using a red lamp or advances in light-emitting diode technology could provide additional alterations which would fall within the spirit and scope of the invention described herein. Some of the possible alterations will be mentioned in the following description.

[0024] FIG. 1 shows a three-dimensional front view image of the marker/clearance lamp 10 feature in the invention. Lamp 10 consists of housing 30, lens 40, one or more light sources 42 and one or more terminals 20. The lens 40 incorporates a modified conical region 50 and ribbed structures 60. The lamp 10 is constructed of transparent plastic that, in a preferred embodiment, may be colored amber or red. When the lamp 10 is turned off, the circuit board 41 can be seen through the front lens 40. The top lens 40 is one piece and is not a smooth surface to the touch since it has raised regions such as the elliptical protrusion 70.

[0025] FIG. 2 shows a top view of the FIG. 1 according to the direction of the arrow A in FIG. 1. Light source 42 (not shown) is located under the optical elements described supra. The conical depression 50 at the center of elliptical protrusion 70 is shown. This surface of the conical depression 50 reflects the light laterally to an elliptical protrusion 70. The elliptical protrusion 70 acts as a concentrating lens directing the light. The ribbed structures 60 will direct the light to the angles of 0 to 60 degrees toward each side. Lens 40 can be colored amber, red, or any other desirable color. In a preferred embodiment, lens 40 is one-piece transparent plastic molding. One modification that could be made to this design is the presence of only one conical structure 50 and one elliptical protrusion 70. The use of only one conical structure 50 and one elliptical protrusion 70 is more suited, with present technology, for use as a red color lamp. As light-emitting diodes of greater intensity are developed, the number of LEDs can be reduced to as few as one provided that the conical portion of the optic was modified to allow light to progress to the front of the lamp.

[0026] FIG. 3 illustrates a cross section of the marker/clearance lamp 10 through the direction of arrow B, i.e. through one of the conical structures 50. The drawing shows the lens 40 at the top, the circuit board 41 in the middle, and the plastic housing 30 at the bottom. In a preferred embodiment, the circuit board 41 will contain as a light source one or more (preferably four light-emitting diodes in the case of an amber lamp and preferably, three in the case of a red lamp). One of the light-emitting diodes 42 is located under and in the middle of each ribbed structure 60. The ribbed structure 60 is constructed of a plurality of ribs of approximately semicylindrical shape extending side by side in the vertical orientation. This plurality of ribs resembles a plurality of convex semicylindrical contours in the lens. The rib structure 60 is present in the inner face 43 of the lens 40; the outer face 44 is planar. The radius of each convex semicylindrical rib can be varied. In a preferred embodiment, the rib directly over the light-emitting diode has a slightly longer radius than the adjacent ribs, which facilitates the focusing of the light. The rib shaped optics are designed to distribute the light horizontally approximately 60 degrees left and right of the lamp's longitudinal axis. One light-emitting diode 42 is located under each ribbed element convex lens 66. In a preferred embodiment, there are nine convex steps at each side of the conical protrusion 50. As one of ordinary skill in the art would readily appreciate, the aforementioned spreading of light can be accomplished any number of ways through the use of known optical structures. One set of rib structures is located on each side of the lamp. A red lamp only requires one conical element 50 plus an elliptical protrusion 70 surrounded by rib structures 60.

[0027] The convex lens 80 collimates the cone of light produced by the light-emitting diode 42. The collimated light will be redirected laterally and toward the elliptical protrusion 70 which then concentrates and direct the light toward the angles 60 to 90 degrees left and right of the lamp's longitudinal axis. The principle behind the optics will be further explained infra. The housing 30 presented in FIG. 3 preferably is made of the same material and color of the lens 40. The circuit board 41 has the required and is connected by power connection 20 to circuitry for the activation the light-emitting diodes 42. The circuit board 41 and the light-emitting diodes 42 embedded for protection and stability into potting material (such as epoxy). The

housing 30 joins with the lens 40 and will be sealed. After the attachment of the housing 30 and the lens 40, the lamp 10 will be hermetically sealed, for protection against humidity, dust and the like.

[0028] FIG. 4 is a schematic representation of a cone of light 14 produced by light-emitting diode 42 directed toward the rib region 60 of the lens. As mentioned above, the rib precisely above the light emitting diode 42 may have a larger radius (or depth) than the adjacent ribs, thus, aiding the concentration and distribution of light. It should be noted that FIG. 4 does not depict all of the light rays that hit the optics. It should also be noted the lamp is a three dimensional structure with depth and length, all of which help the distribution of resultant light 15 emitted from the lamp 42 to be distributed over the required angles between 0 and 60 degrees.

[0029] FIG. 5 is a representation of light hitting optical element 50 capable of TIR. A cone of light 14 produced by light-emitting diode 42 hits the convex lens 80. The convex lens 80 collimates the light producing a beam of more or less parallel light. The collimated light hits the internal surface of the modified conical structure 50 at an angle equal to or greater than the critical angle. Critical angle is defined as the least angle of incidence at which total internal reflection takes place. Total internal reflection is defined as the reflection that occurs within a substance because the angle of incidence of light striking the boundary surface is in excess of the critical angle. In other words, when light hits a surface at the critical angle or greater, the light is completely reflected from the surface and no transmission occurs through the surface of the modified cone 50. The reflected light 17 is distributed more or less uniformly-directing the light toward the extreme angles of 60 to 90 degrees. If seen from the front of the lamp, the elliptical shape 70 acts as a lens. The elliptical shape concentrates the light, which is progressing radially from the conical depression 50, into a more directional reflected beam 17. This concentration assures adequate intensity to the left and right of the lamp 6. Conical depression 50 with a diameter of approximately 6 mm is a preferred embodiment to produce a beam directed toward the angles of 60 to 90 degrees. The shape of the conical depression 50 and the space from LED 42 to the convex lens 80 insures the concentration of light into a parallel beam and eliminates the presence of hot centers caused by the light-emitting diode 42.

[0030] FIG. 6 is a schematic representation of the combination of FIGS. 4 and 5, showing the entire optics element present in lens 40. As mentioned above, the combination of the rib structure 60, the conical depression 50, the elliptical protrusion 70 and the convex lens 80, produces 17 and 15, respectively. The effect of the combined output of the light-emitting diodes and the optics is a modified rectangular

pattern of light which produces intensities of light over the angular distribution that meets the requirements desired for combination marker/clearance lamps.

[0031] The description presented in the preferred embodiments of a ribbed structure, a modified conical structure and protrusion and the convex lens is not intended to demonstrate all of the possible arrangements and modifications to design. For those skilled in the art, changes will be apparent that will fall within the scope of the present invention.

What is claimed is:

1. A lamp comprising:

a housing;

at least one terminal in contact with said housing for electrical connection to a power source;

at least one light source; and

a lens, adjacent to said light source, having at least one optical element for reflecting the light emitted from said at least one light source, and having at least one optical element for spreading the light emitted from said at least one source.

2. A lamp according to claim 1 wherein said at least one light source is a light emitting diode.

3. A lamp according to claim 2, further comprising a circuit board operatively connected to said at least one light emitting diode wherein said circuit board is operatively connected to said power source.

4. A lamp according to claim 3, further comprising potting material for embedding said at least one light emitting diode and said circuit board.

5. A lamp according to claim 1 wherein said at least one optical element for spreading light distributes the light substantially 0-60 degrees left and right of the longitudinal axis of said lamp.

6. A lamp according to claim 5 wherein said at least one optical element includes a plurality of rib structures forming convex semicylindrical contours.

7. A lamp according to claim 1 wherein said lens further has at least one optical element for distributing light substantially 60-90 degrees left and right of the longitudinal axis of said lamp.

8. A lamp according to claim 7 wherein said at least one optical element distributing the light substantially 60-90 degrees is an elliptical protrusion.

9. A lamp according to claim 8 wherein each of said at least one elliptical protrusion defines a conical depression.

10. A lamp according to claim 9 further comprising at least one convex surface for collimating light emitted from each of said at least one light source thereby illuminating each of said conical depression.

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