

[54] **SHARP CUT OFF LIGHT BEACON**
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[51] Int. Cl.**F21v 11/02**
[58] Field of Search**240/1.2, 3, 11.4 R, 240/41 R, 41.35 D, 41.1, 46.31, 46.37, 103**

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[57] **ABSTRACT**

A light beacon structure including a reflector with a light source and a series of light stops mounted within the reflector. The reflector is a distorted cylindrical paraboloid type such that with its central axis horizontal, each point on the reflector projects a wedge of light with the bottom of the wedge approximately horizontal. The optical stops are positioned to cut off direct radiation from the source below the central axis of the reflector.

7 Claims, 3 Drawing Figures

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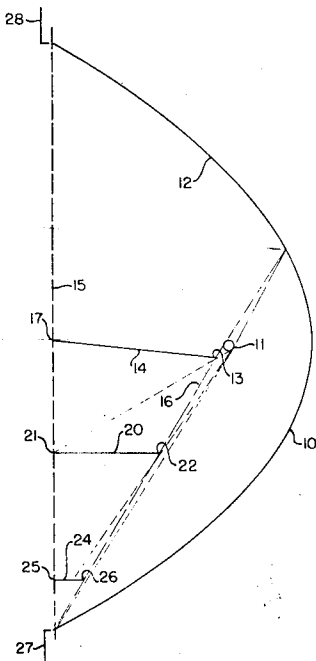


FIG. 2

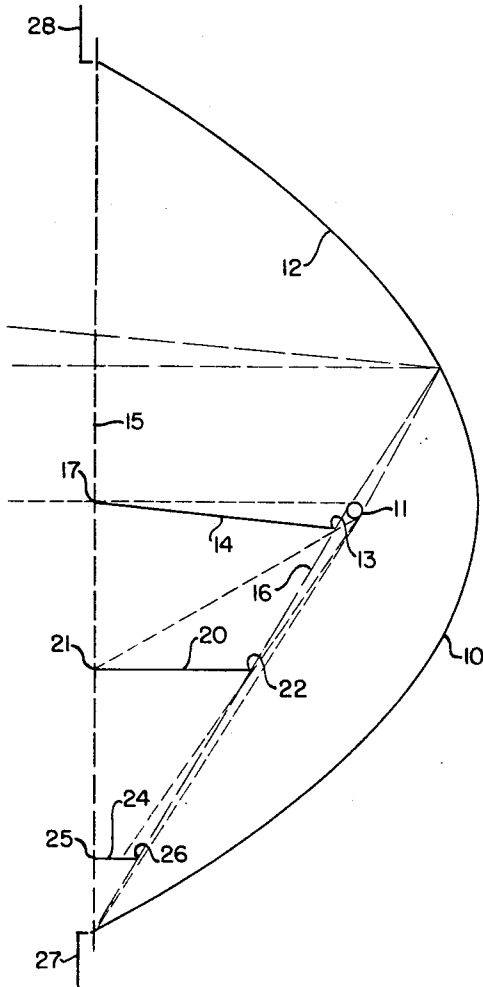
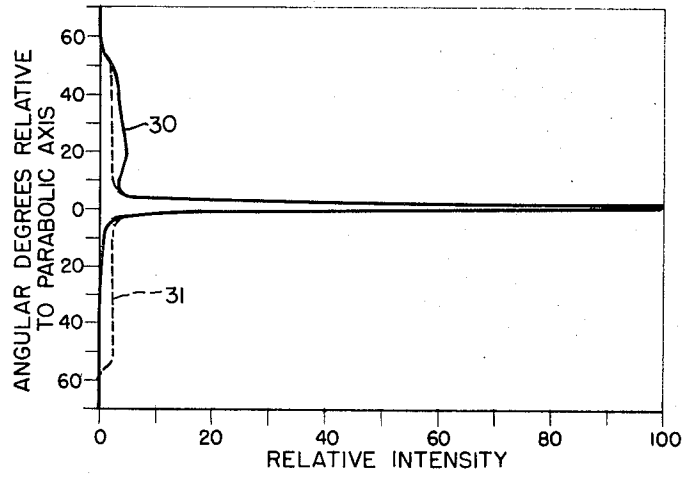
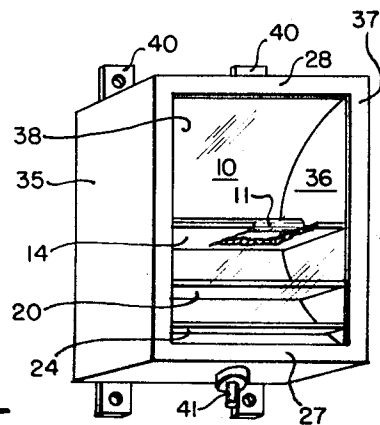


FIG. 1

FIG 3



SHARP CUT OFF LIGHT BEACON

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to light beacons and in particular to warning and navigational beacons.

2. History of the Invention

Beacons, both rotating and fixed, have continually been a source of aggravation to people in the near vicinity, particularly at night. Beacons of sufficient intensity for effective use during daylight and in fog also frequently draw strong objections from local inhabitants.

The present utilization of extremely high intensity xenon flash lamps in many of these beacons has increased the flow of objections from people in the neighborhood.

Optical stops have been used exterior to the reflector to block and reduce light in undesired directions, but these are expensive, bulky and not wholly satisfactory. A single optical stop has been commonly used adjacent to the light source to block direct radiation outside of the desired beam, but it reduces efficiency by undesired blocking of radiation to and from certain portions of the reflector.

It has been common in the past to use reflector and lens configurations that collimate or shape the projected beam. However, a problem occurs due to the finite size of the source filament. (The term filament is used in its usual sense in lighting technology to include actual filamentary elements, gaseous discharge spaces and other light-emitting sites.) Each point on a parabolic reflector receives the apex of a cone of light in which the base of the cone is the filament and has the diameter of the filament. From each point on the reflector the light is projected as a cone having the same apex angle as that of the cone received. Thus the beam from a parabolic reflector is never truly collimated, each elementary part of it diverging with distance. This problem is greatly reduced when striving for a very sharp cut-off on one side of the beam by using what has been called a macrofocal parabolic reflector. This is described in "Macrofocal Conics as Reflector Contours" by Spencer, Montgomery and Fitzgerald in Journal of the Optical Society of America, Vol. 55 No. 1 January, 1965 pages 5-11. Such a reflector can be designed to virtually eliminate reflection below a horizontal plane. It is still necessary to block direct radiation from the source with minimal beam interference.

SUMMARY OF THE INVENTION

Now in accordance with the present invention a beacon is provided with substantially no divergence of light on one side of a plane through the axis of the reflector. With the reflector axis horizontal, a highly intense horizontal beam is provided with a sharp cut off below the horizontal plane. This is achieved with a combination of a macrofocal cylindrical parabolic reflector and optical stops. The paraboloid shape of the reflector is distorted in accordance with a computed curve whereby a substantially collimated beam is produced in which each elemental portion of the projected beam diverges substantially only in one direction with respect to the central axis of projection. In the other direction (the direction of nondivergence), a plurality of rectangular optical stops are positioned within the reflector such that they allow light from the illumination source to

pass freely to all parts of the reflector but block direct radiated light in the direction of nondivergence.

Thus it is an object of the invention to provide a high intensity beacon with a sharp cut off in a plane adjacent to and parallel with the beam axis.

It is a further object of the invention to provide a high intensity beacon using a macrofocal cylindrical parabolic reflector and a plurality of internal rectangular stops to produce a light beam with a sharp cut off below its projection axis.

Further objects and features of the invention will become apparent upon reading the following description together with the drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a diagrammatical illustration of the inventive beacon.

FIG. 2 is a graph of relative beam intensity taken through 140° of arc about the beam axis.

FIG. 3 is a perspective view of a beacon assembly according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Embodiment of the invention is shown diagrammatically in FIG. 1 using a macrofocal cylindrical parabolic reflector, a high intensity xenon lamp, and three rectangular stops. Reflector 10 is depicted at one-third the size of an actual model. In describing the preferred embodiment, exemplary dimensions will be those of the actual model and thus three times the size of those shown in the drawing.

Reflector 10 is a macrofocal parabolic reflector extended in cylindrical fashion. Xenon lamp 11 at the near focus of the reflector likewise is extended along the focus of the reflector. Xenon lamp 11, typically has a quartz envelope with an interior diameter of seven millimeters, and an exterior diameter of nine millimeters. Lamp 11 is centered at the near focus of the reflector, but since it has a finite diameter the reflector is distorted from a true parabolic curve in a manner such that no light from lamp 11 will be reflected in a direction on one side of the parabolic axis. Since the parabolic axis of a cylindrical parabolic reflector is in fact a plane, the term parabolic axis as used herein encompasses such plane.

In FIG. 1, the shape of reflector 10 is computed relative to the interior diameter of lamp 11 in accordance with the equations given in the article, "Macrofocal Conics as Reflector Contours," such that each point of reflection on reflector 10 reflects a discrete wedge of light from lamp 11 in which the bottom of the wedge is parallel with the parabolic axis. The word bottom is used relative to the orientation in FIG. 1. Reflector 10 is suitably made of stainless steel, copper, aluminum, or the like with a highly polished reflective surface 12. Surface 12 may be plated with chromium or similar highly reflective material to obtain the high polish.

Reflector 10 is extended far enough along its parabolic curve to intercept at least 60 percent of the light from lamp 11. A first optical stop 14 made of a rectangular metal plate is positioned extending from a point near lamp 11 to the plane of the reflector opening and extending the entire length of the reflector. Edge 13 of stop 14 closest to lamp 11 is positioned on line 16 drawn tangent to the filament surface of lamp 11 nearest opening 15 to the bottom edge of reflector 10. Edge

13 is further arbitrarily positioned on a horizontal plane, about one lamp diameter below the bottom surface of lamp 11. Horizontal is used relative to the orientation of FIG. 1 and is parallel with the parabolic axis.

Edge 17 of stop 14 at opening 15 is positioned on a horizontal line drawn tangent to the upper inner surface of lamp 11. The upper surface of stop 14 may be reflective so as to increase light output in the quadrant above the main beam. While stop 14 is depicted as a flat rectangular plate, it may be slightly curved in order to change the intensity pattern of the auxiliary output in the upper quadrant. Stop 14 has been described with a slight tilt relative to the parabolic axis in order to stop any amount of light from the upper inner surface of lamp 11 diverging in a direction below the parabolic axis.

Second stop 20 is a flat rectangular plate positioned with its outer edge lying above the intersection of opening 15 and an extended line drawn tangent to a lower inner surface of lamp 11 and touching edge 13. Inner edge 22 of stop 20 meets line 16 with stop 20 parallel with the parabolic axis.

Third stop 24 is a flat rectangular plate positioned with its outer edge 25 at opening 15 close enough to the lower edge of reflector 10 to block any further direct radiation from lamp 11 in the downward direction. Inner edge 26 of stop 24 is positioned meeting line 16. Stops 20 and 24 preferably have dull black light absorbent surfaces.

Stops 20 and 24 are parallel with the parabolic axis while stop 14 is shown tilted to block the horizontal aperture of lamp 11. Thus, as depicted, stop 14 is the only one having any interference with light projected along the parabolic axis. This can be compromised by changing the tilt of stop 14 so that it is anywhere in the range from parallel with the parabolic axis to where it will fully block the horizontal aperture of the lamp 11 as shown. The graph of FIG. 2 was made with stop 14 tilted approximately halfway between these two extreme positions. The position depicted in FIG. 1 gives the sharpest cut off below the parabolic axis. It is desirable that stop 14 block at least a portion of the direct radiation from lamp 11 along the parabolic axis.

While stop 14 is preferably in close proximity to lamp 11, stops 20 and 24 may be arranged in different positions meeting the requirements previously set forth. While it is possible to use a different number of stops, two stops are not as effective and more than three stops are unnecessary within the practical limitations of the lamp and reflector design.

Frame portions 27 and 28 are illustrated to depict the frame of the beacon housing to the extent it blocks any of the light directed or reflected from lamp 11. The beacon housing is depicted more fully in FIG. 3. Relative to FIG. 1, the parabolic axis and the light beam axis are defined as a horizontal line extending across the diameter of lamp 11.

It will be noted in the graph of FIG. 2 that the relative beam intensity is 2.0 percent at -10° with no stops in place. With the stops in place, below the parabolic axis the light intensity drops to less than 0.4 percent at -10° and to less than 0.1 percent at -40° . Without the stops the relative light intensity at $+3^\circ$ above the parabolic axis is about 25 percent. At 3° below the parabolic axis the relative light intensity is about 8 percent. At 20° above the parabolic axis the relative light intensity is about 4 percent with the stops in place as compared to

2 percent with no stops. This is a result of the upper reflective surface on stop 14.

FIG. 3 depicts a beacon in accordance with the invention enclosed in housing 35. While the diagrammatic illustration of FIG. 1 shows only a cross section, it will be seen in FIG. 3 that reflector 10 is extended in cylindrical fashion with flat reflective plates 36 (only 1 shown) at each end. Lamp 11 is tubular, extending between the end plates 36. Stops 14, 20 and 24 are positioned upon small blocks (not shown) secured to end plates 36. Stops 14, 20 and 24 are suitably adhesively bonded to the blocks, for example by an epoxy adhesive.

Housing 35 has cover 37 suitably fitted to housing 35 with a weather proof gasket (not shown). Cover 37 consists of a frame supporting a glass window 38 in front of reflector 10. Four metal tabs 40 connected to housing 35 serve to secure the beacon to a tall structure or other support for utilization. Electrical connection 41 connects internally with housing 35 to lamp 11 and externally to a power supply (not shown).

While the invention is described with relation to a specific detailed embodiment, it is not intended to be limited thereby but to cover the invention broadly within the spirit and scope of the appended claims.

I claim:

1. A light beacon having a substantially horizontal beam sharply attenuated below the horizontal comprising:

- a. A macrofocal cylindrical parabolic reflector;
- b. A light source of circular cross-section supported substantially at the near focus of said reflector;
- c. means to support said reflector with its parabolic axis substantially horizontal and so that the reflected light from said source is cut off below a horizontal plane; and,
- d. A plurality of rectangular light stops positioned inside said reflector below the parabolic axis so as to substantially block direct radiation from said source below the parabolic axis while passing substantially all radiation from said source to all points on said reflector, whereby a high intensity beam is directed along the parabolic axis with sharp attenuation at angles below said axis and reduced attenuation at angles above said axis.

2. A sharp cut off light beacon comprising:

- a. a cylindrical parabolic reflector;
- b. a linearly extended light source located substantially along the near focus of said reflector;
- c. three rectangular light stops positioned on one side of the parabolic axis of said reflector, each with an inner edge meeting a line drawn tangent to the filament surface of said source nearest the reflector opening to the edge of the reflector on said one side, and each with an outer edge substantially at the aperture plane of said reflector, a first one of said stops closest to said light source being tilted so as to block at least part of the direct radiation from said source in the direction of said parabolic axis, and each of the other ones of said stops being parallel with said parabolic axis whereby said light stops substantially attenuate all direct radiation from said source at angles greater than ten degrees from said parabolic axis toward said one side.

3. A sharp cut off light beacon comprising:

- a. A cylindrical parabolic reflector distorted from the true parabolic contour such that said reflector re-

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fects substantially no light from a light source located substantially at its near focus at angles diverging toward a predetermined side of the parabolic axis;

- b. A linearly extended light source located substantially along the near focus of said reflector;
- c. A plurality of rectangular light stops positioned on said predetermined side of the parabolic axis of said reflector, each with an inner edge meeting a line drawn tangent to the filament surface of said source nearest the reflector opening to the edge of the reflector on said predetermined side, and each with an outer edge substantially at the aperture plane of said reflector, a first one of said stops closest to said light source being tilted so as to block at least part of the direct radiation from said source in the direction of said parabolic axis, and each of the other ones of said stops being parallel with said parabolic axis.
- 4. A sharp cut off light beacon according to claim 3 wherein said reflector has the contour of a macrofocal cylindrical paraboloid.
- 5. A sharp cut off light beacon comprising:
 - a. A cylindrical parabolic reflector;

- b. A linearly extended light source located substantially along the near focus of said reflector;
- c. A plurality of rectangular light stops positioned on one side of the parabolic axis of said reflector, each with an inner edge meeting a line drawn tangent to the filament surface of said source nearest the reflector opening to the edge of the reflector on said one side, and each with an outer edge substantially at the aperture plane of said reflector, a first one of said stops closest to said light source being tilted so as to block at least part of the direct radiation from said source in the direction of said parabolic axis, and each of the other ones of said stops being parallel with said parabolic axis, the surface of said first one of side stops facing side light source being reflective whereby reflected light diverging away from said one side is increased.
- 6. A sharp cut off light beacon according to claim 5 wherein all other light stop surfaces are light absorbent so as to attenuate spurious reflections.
- 7. A sharp cut off light beacon according to claim 5 wherein the first stop has its inner edge within one lamp diameter of said lamp.

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