

- [54] **LUMINAIRE FOR AREA LIGHTING**
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Related U.S. Application Data

- [63] Continuation-in-part of Ser. No. 94,697, Dec. 3, 1970, abandoned.
- [52] U.S. Cl.240/25, 240/41.3, 240/14.3, 240/41.35, 240/103
- [51] Int. Cl.F21s 1/00, F21s 3/00, F21v 7/06
- [58] Field of Search.....240/25, 41.3, 41.35, 3, 41, 240/11.4, 103

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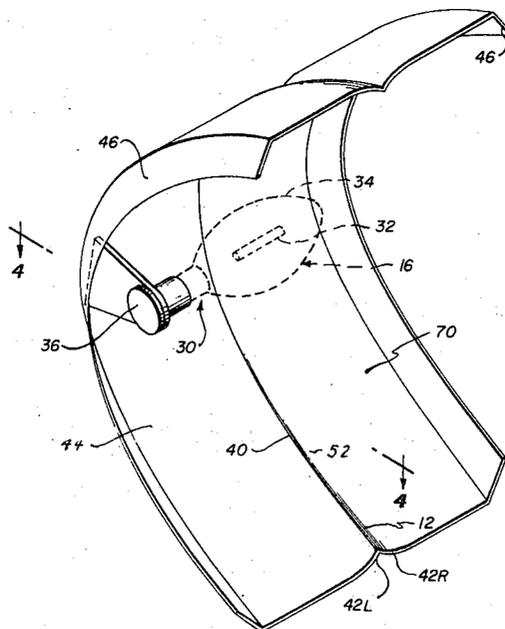
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[57] **ABSTRACT**

This luminaire includes an elongated generally horizontal light source, a multiple section generally parabolic reflector disposed behind the light source, and a refractor in front of the light source. The reflector includes two symmetrical transversely disposed paraboloid sections with the light source at the focus of both sections to produce essentially two spaced beams of reflected light. The area between the beams is illuminated by direct light which passes through a control lens to form a third beam. The overall effect is essentially a rectangle of light of generally uniform intensity suitable for lighting a rectangular area such as a roadway from a luminaire set back from the roadway.

10 Claims, 12 Drawing Figures



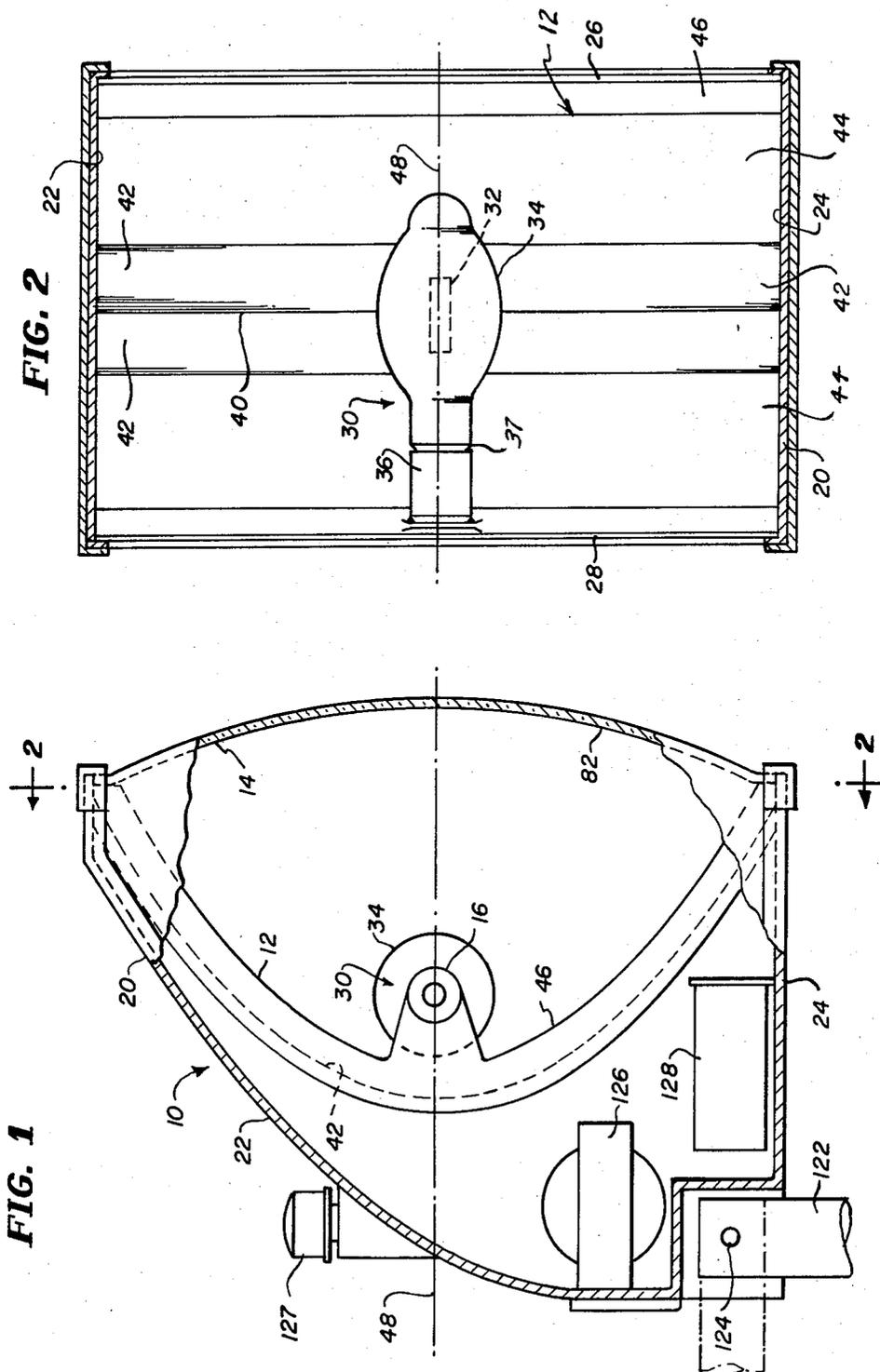


FIG. 1

FIG. 2

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FIG. 5

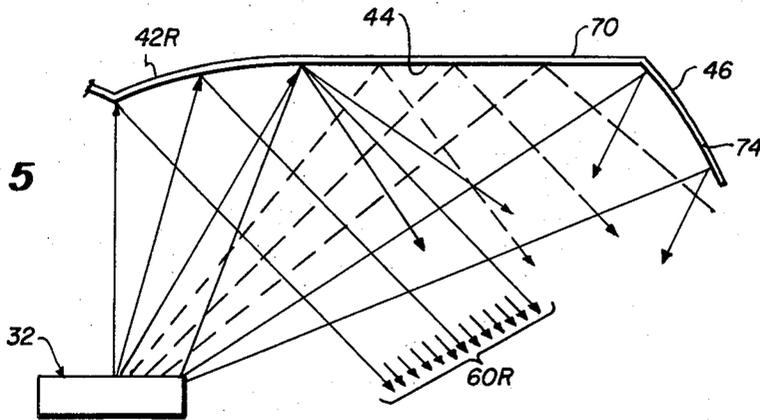


FIG. 7

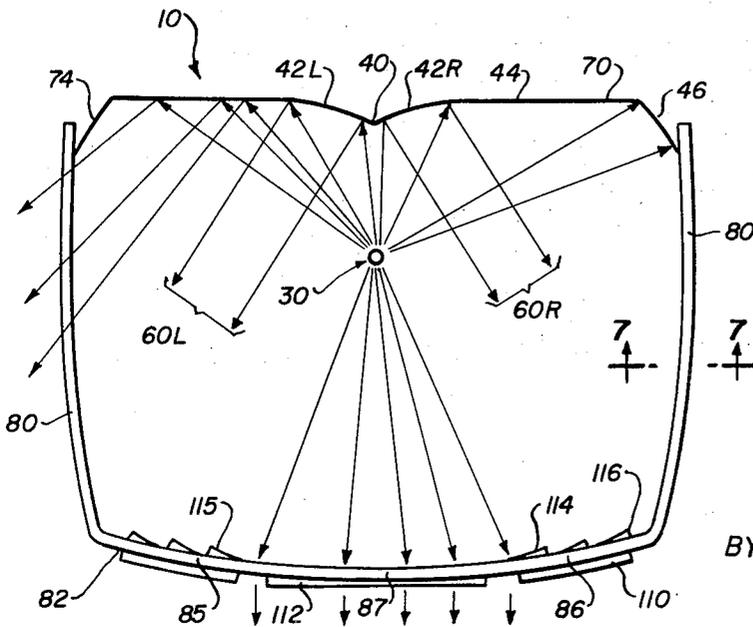
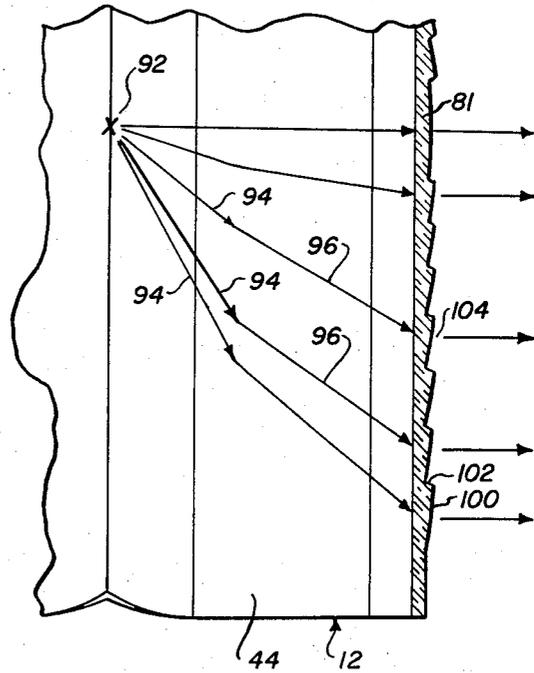


FIG. 6

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FIG. 9

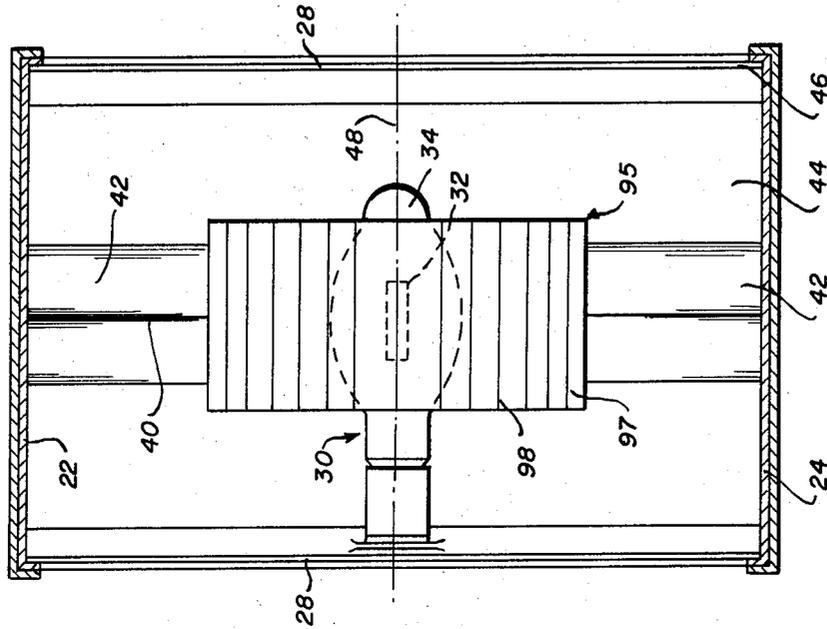
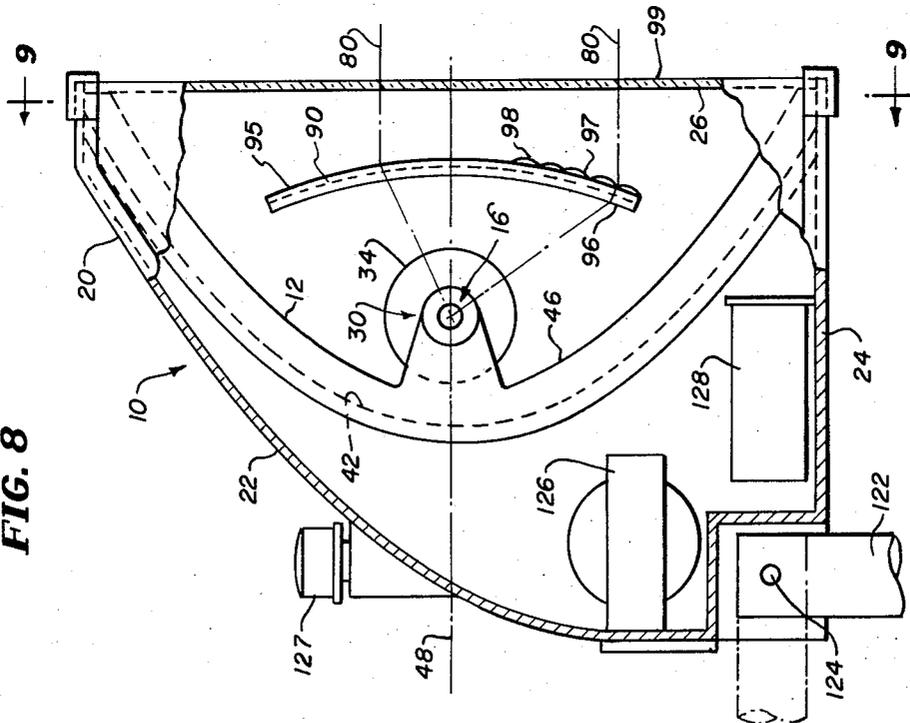


FIG. 8



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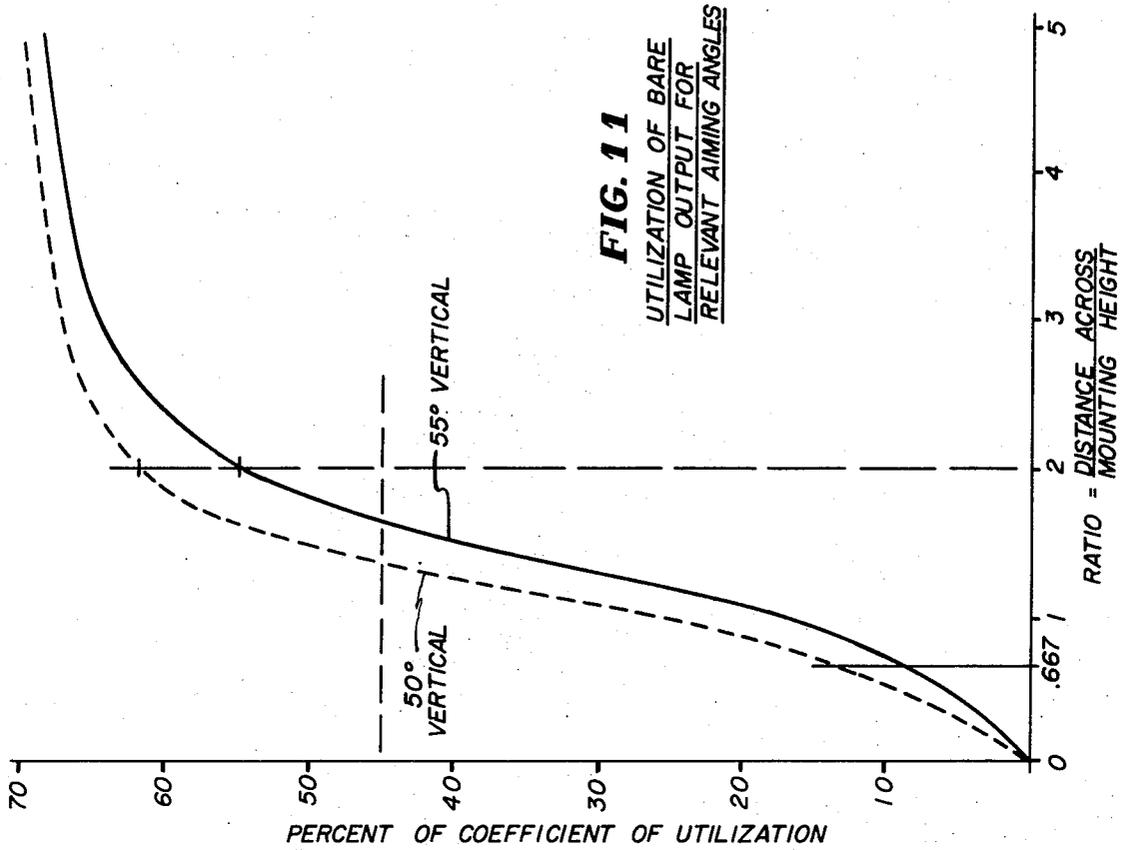
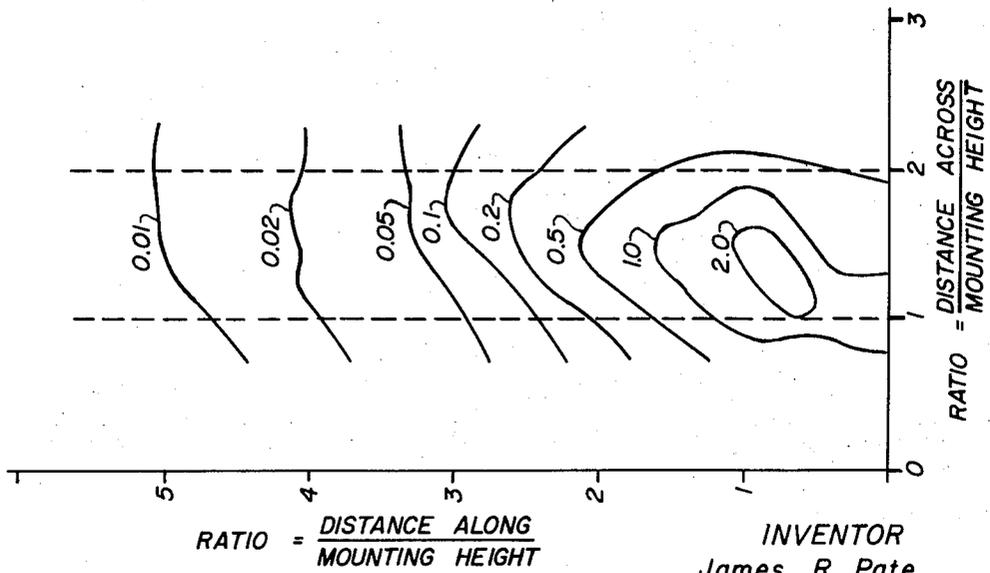


FIG. 10
 ISOLUX CHART



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LUMINAIRE FOR AREA LIGHTING

The present application is a continuation-in-part of my application Ser. No. 94,697 received by the U.S. Patent Office on Dec. 3, 1970, now abandoned.

BACKGROUND OF THE INVENTION

For lighting a rectangular area such as a roadway there has frequently been used, a point light source with domed shaped reflector and bowl-shaped refractor. In another approach, others have used elongated tube light sources disposed vertically or angled slightly from the horizontal while pointing toward the surface being lighted. Such luminaires generally overhang a portion of the roadway perpendicular to the center line of a roadway (or angled slightly therefrom). In at least one patent of this type, the reflector wall is parabolic in section at the most exposed reflector portion and elliptic in section adjacent the lighting tube. The reflector of this prior art patent is uniform in the direction parallel to the tube length. The refractor is generally parabolic and frequently is uniform in section throughout.

In the prior art of street lighting, other elongated luminaires extending out over the roadway are known, these generally are inclined from the mounting at an angle of inclination from the horizontal of from five to 45°.

Where luminaires have been disposed parallel to the center line of the roadway, they have in some instances used elongated tube lighting with parabolic reflectors with the reflector cross section uniform along the length of the tube and terminating in flat planar sides rectangularly disposed relative to the reflector, and merely enclosing the luminaire sides.

SUMMARY OF THE INVENTION

The present luminaire has as one of its intended uses, lighting for streets, highways and roadways classified as freeways or interstate highways, having limited access and having an easement sufficient to attain a sizeable setback from the edge of the pavement.

In such installations, it is clearly desirable to have the standards for the luminaires displaced from the traffic lanes sufficiently to preclude the collision of automobiles with these standards. It is to this end that I have invented the luminaire which can be mounted at a location spaced from the roadway and yet illuminate traffic lanes efficiently and uniformly.

In other uses, for example, stadium lighting, the transmitted light should be of uniform intensity and free of glare, or other variations in intensity from section to section. The major components of my luminaires are the light source comprising a horizontally disposed tube such as that of a mercury lamp, a symmetrical reflector structure which surrounds the lamp and has its focus at the light center, and a refractor member which receives the direct light from the lamp and from which substantially all of the reflected light is diverted. The reflector structure includes twin paraboloid sections with the light source at the focus of each section and therefore, according to the laws of optics, the light emitted from the light center striking the reflector surface will be emitted as twin bands of parallel light, one band emanating from each paraboloid section. Direct light rays emitted from the front of the lamp strike the refractor and are refracted into a third

beam which illuminates the space between the reflected beams.

It is therefore an object of the invention to provide a new and improved luminaire suitable for roadway lighting, stadium lighting and the like.

It is a further object of the invention to provide a luminaire with a reflector which surrounds the light source in a lateral sense with paraboloid sections on each side to produce twin spaced beams of reflected light.

It is a further object of the invention to provide a new and improved luminaire reflector with a horizontal tube light source, the tube axis being parallel to the surface being lighted. The luminaire has a reflector with adjoining reflector sections each productive of a controlled beam of light, and a refractor receptive of direct light for producing a third beam for transmission to an area to be illuminated.

It is still a further object of the invention to produce an improved uniform area of illumination on a roadway from a luminaire disposed on a standard set back from the roadway being illuminated.

It is another object of the invention to provide a luminaire with controlled reflected light beams and at least one direct refracted light beam to produce a rectangular area of light of uniform intensity.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view in elevation of a first embodiment of a luminaire using my invention, with the housing and refractor broken away to show the interior thereof;

FIG. 2 is a sectional view taken along line 2—2 of FIG. 1;

FIG. 3 is a perspective view of the reflector of FIGS. 1 and 2;

FIG. 4 is a sectional view taken along the lines 4—4 of FIG. 3;

FIG. 5 is an enlarged sectional view of the right side of the reflector shown in FIG. 4, with a showing of the rays therefrom;

FIG. 6 is a sectional view similar to FIG. 4 showing the reflector with the cover lens shown in greater detail;

FIG. 7 is a sectional view taken along line 7—7 of FIG. 6 showing an optional form of refractor side lens usable herein;

FIG. 8 is a side elevation similar to FIG. 1 showing my invention using a second form of control lens;

FIG. 9 is a sectional view taken along line 9—9 of FIG. 8;

FIG. 10 is an Isolux chart for the luminaire of FIGS. 9 and 10;

FIG. 11 is a Utilization chart for the luminaire of FIGS. 9 and 10; and

FIG. 12 is a side view similar to FIG. 1, of a luminaire employing a further embodiment of my invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIG. 1, I show a first embodiment of my invention. In that figure I show the luminaire 10 which includes in general, a reflector 12, a refractor 14, and a light source 16.

The major components of the luminaire are mounted in a suitable enclosing housing 20, which may be any suitable shape such as that shown. The housing 20 comprises a section of sheet metal or the like shaped to approximate a cylindrical section 22 leading to a mounting base or floor section 24, the housing being open at the front and sides. The front opening and the open sides 28 of the housing are covered by a suitably covering refractor 26 of glass or other translucent material (shown partially broken away in FIG. 1). Alternatively the sides may be partially covered with opaque members to the extent that the opaque sides do not interfere with the generated beam pattern. In either event, the refractor 26 may comprise a one piece member covering both sides and the front so that the housing may be sealed against the elements and suitably weather-proofed to allow the luminaire to function in general outdoor use for roadway lighting or stadium lighting or the like.

The light source 16 in the preferred form is a mercury arc lamp 30 of any conventional type with an arc tube 32 surrounded by a glass envelope or globe 34, the glass terminating at one end in a mounting base 37. The mounting base 37 mounts in a suitable screw-type or bayonet socket 36 which in known fashion is affixed to the housing and supports the lamp and connects the lamp to a suitable source of operating current.

Alternatively, the lamp 30 may be that known by the trade name Lucalox or may be any other suitable high intensity lamp having an elongated tube 32 capable of mounting with the tube axis disposed horizontally, and generally parallel to the reflector.

As used in my luminaire, the lamp 30 is mounted with the arc tube 32 disposed with its axis horizontal, the base being secured in the side open socket 36 to position the lamp in front of the reflector.

Within the housing walls and spaced from the lamp 30 in a front-to-rear sense is the reflector 12. The reflector may be fabricated of any conventional reflector material to provide a highly reflective surface. The reflector surface may be of suitably coated aluminum, for example, and is symmetrical about a vertical plane 40 through approximately the center of axial length of the arc tube 32 and the width center of the reflector. The reflector on each side of plane 40 includes in sequence a first surface 42 comprising a compound parabolic member which in one form is a section of a paraboloid. Abutting surface 42 is a second surface 44 which is a section of a parabolic cylinder symmetrical about a horizontal axis in a common central plane 48 with the axis of the lamp tube 32, and a third section 46 comprising an enclosed end portion section which may also be a section of a parabolic cylinder.

Surfaces 42, each of which may be called a main beaming surface, are each configured in the shape of a section of a paraboloid with its parabolic section 50 in the horizontal sense shown in FIG. 4, and in its parabolic section 52 in the vertical sense shown generally in FIG. 2.

The following description of the luminaire will assume the luminaire to be in the position of FIG. 1, aimed horizontally, with the reflector disposed symmetrically about the horizontal central plane 48. It is understood that in use the luminaire will most frequently be inclined downwardly to position the light from the luminaire relative to the surface being lighted.

Viewed in the vertical sense of FIGS. 1-3, the axis of each paraboloid surface 42 and of each parabolic cylinder section 44 are co-planar, the common plane 48 passing horizontally through the axis of the lamp tube 32. Thus, all rays generated by the lamp and intercepted by reflector will be reflected in rays parallel to the horizontal plane 48 in a band.

In view of FIGS. 4 and 5, each surface 42 is parabolic when viewed in the horizontal sense. Each parabola comprising surface 42 and its continuation is shown in dashed lines in FIG. 4, and is indicated by the reference numeral 50'. The axis of each surface 42 and continuation 50' is centered at the center of axial length lamp tube 32, at the focus of the parabola.

Each surface 42 extends from the central plane 40 of the reflector for arc distance of approximately 30° and blends into the edge of surface 44 which in the FIG. 4-6 showing is a straight line or linear surface representation. Thus, the light from the lamp striking each surface 42 will be reflected in parallel rays from the parabolic reflector in both the horizontal and vertical senses. Such rays are shown in FIGS. 5 and 6 by the reference numerals indicating the resultant beams 60 L (left) and 60 R (right).

To insure the proper spread of the beams from 42 R (R indicating the right side surface 42 as seen in FIGS. 5 and 6) and 42 L (left side), each surface 42 R and 42 L is symmetrical about the central plane 40. The axis or latus rectum 62 of both surfaces 42 R and 42 L may be inclined from the center line plane any suitable angular extent within the range 30° to 60° with the focus of the parabolic surface coinciding with the center of lamp tube 32, the one requirement being the angle is equal for both surfaces 42 L and 42 R.

Thus both surfaces 42 are symmetrically disposed, each having its focus at the center of lamp tube 32 to incline its rays angularly from the reflector in parallel, both in the horizontal sense and in the vertical sense, as mentioned previously.

Outboard of surface 42 is the surface 44 of the parabolic cylinder which appears as a planar surface or straight line 70 in FIGS. 4-6. The planar surface 70 is parallel to the lamp tube 32 and outwardly thereof, thus all light rays striking section 44 will be reflected outwardly at a reflective angle (of course equal to the angle of incidence). These rays spread horizontally, generally outwardly of the beam generated by surface 42 and provide a buffer zone of light of intermediate intensity at the outer periphery of the beam reflected from surface 42.

When viewed in a vertical section, the surface 70 is parabolic with its focus at the center of light tube 32, hence the reflected rays when viewed vertically will emerge as parallel rays in a band of defined width.

The refractor 14 may form part of the outer enclosure as seen in FIGS. 1, 3 and 6. To complete the enclosure about the housing 20, the covering refractor 26, which may be unitary in construction, includes side sections 81 and a front panel 82, seen best in FIG. 6. Side section 81 covers the side openings 28. The front panel 82 includes three transverse sections 85, 86 and 87 respectively. Sections 85 and 87 are of approximately equal width and each extends the full height of the refractor, and each of these sections is approximately one half of the width of center section 86.

The two outer sections 85 and 87 have on their exterior surface refracting prisms in the form of horizontal continuous ribs or ridges 110 of the condensing type with their focal point at the directrix of surface 42 at plane 48. The central section 86 has its prisms in the form of horizontal ribs 112, each of which extends transversely for the extent of the center section.

On its inner side, the front panel refractor 82, the separate sections 85, 86 and 87 are maintained. In the central section 86 at the immediate center of the panel and for an arc distance equal to approximately 30° on each side of center plane 40, no prisms are necessary. Outwardly of the immediate central section, the refractor has prisms 114 in the form of right triangles with the refracting face 115 of each triangle inclined toward the adjacent outer side of the luminaire. Each prism therefore has its front-directed side 116 outward of the slant height.

The direct rays from lamp 30 diverge and the greater proportion of the generated light (approximately 65 percent) falls within a spread of approximately 30° in both directions from the forward projection of the light.

The central section 86 receives the direct light from the lamp and channels the light into a central beam comprised of parallel rays. The outer sections 85 and 87 in conjunction with the side sections receive and channel the reflected rays into beams at a desired angle dependent on the refracting face of the inner prisms.

Another form of refractor or lens usable in my luminaire is shown in FIGS. 8 and 9. The reflector and lamp shown in the embodiment of FIGS. 8 and 9 may be identical to that shown in the previous figures. A smaller refracting lens 90 is used for this embodiment. The refractor 90 of FIGS. 8 and 9 comprises a small plano-convex lens which may be a Fresnel lens. Refractor 90 has a concave face 95 confronting the lamp 30 and a convex face 97 as its light emitting face. This lens may have convex prisms 98 in the form of horizontally continuous ribs configured to produce a rectangular beam comprised of substantially parallel rays of direct light emitted by the lamp. The lens, as shown, has sufficient area and is spaced from the lamp tube a distance which has been calculated to channel upwards of 60 percent of the direct light transmitted by the lamp tube through lens 90. However, the lens, if desired, may be curved as shown in FIG. 8 or planar, is dimensioned to receive substantially none of the light reflected from surfaces 42 and 44. The refractor will refract and pass rays bending such rays to produce a beam of parallel light rays, indicated by numerals 80 in FIG. 8, the beam being intermediate between the beams generated by the reflective surfaces 42 L and 42 R. A suitable translucent outer cover 99 may be used to protect the luminaire interior from the elements, such cover being shown as a flat member with minimum diffraction.

The length and spatial positioning of the refractor horizontally will be determined empirically in conjunction with the angle between vertical center plane 40 and the axes 62 of surfaces 42 L and 42 R. The refractor length is chosen so that substantially no reflected rays will pass through the refractor, and that upwards of 60 percent of the light directed towards the refractor directly will be refracted and beamed.

As far as the reflector is concerned, and more particularly surface 42, as shown in all embodiments the parameters which determine its characteristics are the optimum of 30° to 60° between each parabolic axis 62 and the central plane 40 as shown in detail in FIG. 4. With an angle of less than 30°, the parabola of each surface 42 would beam its reflected rays through the area of direct light, thereby causing a general diffusion in the center of the beam, hence a loss of efficient utilization. For the angle of over 60°, each parabola would become too steep and the length of its parabolic arc would be too long for economic reasons. The axis of such a parabola would be laterally disposed from the area of greatest light output of the bare lamp to such an extent that a dark area would appear between the reflected and refracted beam areas.

By mounting the lamp horizontally in front of the reflector, the light transmitted toward each main beaming surface 42 from the arc tube 32 is emitted from a tube less than one inch in height and closely approximates a point source. By approximating a point source, stray light is reduced, allowing greater control of the reflective surface and the exit beam. Less spread is engendered and the percentage of generated light which is used approaches a relative maximum.

By using the configured combination shown, approximately 80 to 90 percent of the light emitted by the lamp tube reaches either the reflector or refractor for concentration into the beams combinedly making up the rectangular ribbon of light. Of the light reaching the refractor and reflector approximately 66 percent is reflected, 33 percent refracted. Each of the three beams transmits about 20 to 22 percent of the total light emitted by the lamp tube so that approximately each beam is of equal intensity.

The extent of the surfaces 42 on either side of the plane 40 is described as approximately 30°. This figure was chosen to receive sufficient flux from the lamp to generate the resultant beam as indicating reflection of approximately 66 percent of the emitted light from the lamp.

As seen in FIG. 1, luminaire housing 20 is mounted to a standard or pole 122. The mounting 124 is pivotal to allow the angle of inclination of the luminaire with respect to the horizontal to be set as desired.

Within the housing 20 is shown the lamp ballast 126 and capacitor 128 to provide the starting current. Atop the housing may be a photoelectric control 127 which senses the ambient light conditions for turning the luminaire on and off. This feature is, of course, optional.

In FIG. 6, I show positioned with respect to reflector 12, lamp 30 and refractor 14, a three sided clear lens or translucent covering 26. This covering provides protection against the elements and produces as little attenuation of the transmitted light as is practical. It would also be entirely feasible to incorporate the refractor 14 with this covering 26.

In FIG. 6, I also show the two beams 60 L and 60 R generated by the two paraboloid sections 42 and the central beam 80 which has a horizontal spread. The beams as shown are parallel to one another vertically with the luminaire in the position of FIG. 1.

In FIG. 7, I show a vertical section through an optional form of side lens or refractor 81 usable with my luminaire, in place of the clear cover lens referred to by numeral 26.

The lens of FIG. 7, I indicate by the numeral 81, mounted at the side of reflector 12. The center of light source 16 is indicated by point 92 with rays of light 94 emanating from the source. The rays are reflected from surface as indicated by a change of direction as rays 96.

The lens 81 has vertically spaced horizontal ribs in the form of prisms 100. These prisms are generally triangular with a horizontal top surface 102 and a convex upward and outward face 104. The triangular prisms on the lens are provided below the light center to lift the light beams of rays 94 below the light center and transmit these in a horizontal beam comprised of parallel rays 96 reflected from the reflected surface.

In FIG. 10, I show an Isolux chart for the luminaire of FIGS. 8 and 9 with the luminaire mounted at the 0 point along the horizontal axis for a lamp of 20,500 lumens. The luminaire, as can be seen, is designed to be set back from the roadway being lighted, the roadway being one to two mounting heights units away from the luminaire. In the area between 1 unit and 2 units, for example, the light pattern on the object area is clearly quite uniform outwardly for a longitudinal distance of approximately 2.06 mounting height units (entire area of a roadway of one unit width illuminated to 0.5 foot candle with a maximum of 2.0). The form and the pattern in rate of degrees is smooth, allowing adjacent luminaires to illuminate adjacent areas of roadway and produce a uniform and consistent light level.

In FIG. 11, I show a graph of Light Utilization which will be understood by those skilled in the art. The graph shows along the Y axis the utilization of lamp lumens (in percent) as a function of distance from a luminaire positioned at the origin along the X axis, indicative of road width. For example, a suitable strip to be lighted by the luminaire may stretch from a near boundary of 0.667 unit (a unit being the ratio of one unit distance for a mounting height of the same measure) to a far boundary of 2 units. Viewing the curve indicated to be the 55° angle, the utilization would be approximately 46 percent, 55 percent for the far boundary less 9 percent for the near boundary, or approximately 46 percent. Further as the object area is moved closer to the luminaire and the angle of tilt is reduced, for example from 55° to 50°, the efficiency of utilization increases as indicated by the steeper curve of the 50° line.

In FIG. 12, I show a variant approach to the construction of the reflector used in my luminaire. The remainder of the luminaire would use the principles set forth previously, except that reflector 140 replaces paraboloid section surfaces 42 of FIG. 3 with surfaces 142 in FIG. 13. In the sense shown in FIG. 12, the surface comprises a sector 145 of circular configuration with the lamp 30 at the focus of the circular sector. In the horizontal sense or horizontal section (not shown), the surface 142 is parabolic as previously disclosed. In this way, the height of the beam is narrowed and concentrated in the two zones generated by the right and left surfaces 142 L and 142 R.

Due to the concentration of light into the two beams, the parabolic cylindrical sections 44 which would be identical to those surfaces described for the prior embodiment would be of greater importance in providing overlap between the two reflected light zones and the single central refracted zone. The parabolic section surfaces would soften the light intensity at the edges of the beam zones to provide the area of uniform intensity required.

By the use of my luminaire, I provide a source of roadway lighting of high efficiency utilizing an optimum percentage of the light generated by the source in both reflected and refracted patterns.

While I have described what I at present consider to be the preferred embodiments of my invention, it will be understood that modifications may be made therein and it is intended to cover in the appended claims all such modifications which fall within the true spirit and scope of the invention.

I claim:

1. A luminaire for providing a substantially rectangular lighted zone on a roadway comprising a horizontally elongated light source for emitting rays of light therefrom, reflector means spaced behind said light source and having walls which are substantially parabolic in vertical section, said walls including wall portions which are parabolic in horizontal section, said last mentioned wall portions adjoining one another with the axis of each of said portions converging along the center line of said light source, and the horizontal extent of each of said parabolic portions, each comprising a length subtended by an angle of approximately 30° in horizontal section, said angle formed by the intersection of said axes.

2. A luminaire as claimed in claim 1, wherein said walls include sections outboard of said last-mentioned parabolic sections, said outboard sections being rectilinear in horizontal section.

3. A luminaire as claimed in claim 1, wherein there are translucent light transmitting members positioned to receive rays from said reflector, and ray lifting prisms on said members.

4. A luminaire as claimed in claim 2, wherein said light source comprises a mercury lamp with its tube disposed horizontally.

5. A luminaire for roadway lighting providing a substantially rectangular area of illumination on said roadway spaced a distance from said luminaire, means for directing said illumination toward a section of roadway spaced therefrom, said luminaire comprising a horizontally elongated, high intensity light source emitting rays of light along the length therefrom, reflector means spaced behind said light source and having adjoining surfaces of substantially paraboloid section with the light source positioned at the axis of each of said paraboloid sections to generate a beam of light from each of said sections with said beams being horizontally spaced apart, and lens means spaced from said light source on the side opposite said reflector means for receiving the direct rays from said light source and for refracting said rays into a beam in the area between the spaced apart reflected beams to combinedly form a substantially rectangular illuminated area.

6. A luminaire as claimed in claim 5, wherein there are translucent closure members on each side of said luminaire, and convex prisms on said closure members positioned to receive beams of light from said reflectors and to refract said beams into parallel light beams.

7. A reflector for use in a luminaire having a horizontally elongated tubular light source, said reflector comprising a first and second symmetrically disposed reflecting surface of parabolic sections adjoining one another, the axis of each of said parabolic sections when viewed in a horizontal plane intersecting at the center of the height of the tubular light source with the

angle between said axes being within the range of 60° to 120°, each said reflector section generative of a beam of light with said beams being parallel to one another in one plane and diverging in said horizontal plane, wherein the length of each of said sections in a horizontal plane subtends an angle of approximately 30°, and further reflecting surfaces on each outboard side of the said parabolic sections comprising on each side a section of parabolic cylinder, and wherein the center line plane of said cylinders and said parabolic sections are in a common plane with said light source.

8. A reflector as claimed in claim 7, wherein said parabolic sections comprise sections of circular cross-section in a plane normal to said horizontal plane.

9. A luminaire for mounting on a pole spaced from a substantially rectangular area to be illuminated, said luminaire comprising a high intensity light source comprising a cylindrical tube mounted on a horizontal axis, a reflector on the side of said cylindrical tube remote from said rectangular area, said reflector comprising

two symmetrical surfaces abutting along a surface in alignment with the center of height of said tube, said reflector surfaces being parabolic in a plane including the axis of said cylinder and surfaces being arcuate in a plane perpendicular to the axis of said tube, the axes of each of said surfaces in the plane in which said surfaces are parabolic are equi-angularly aligned with a plane perpendicular to the axis of said tube to meet at the height center of said tube, whereby each of said surfaces emits a reflected beam of light to cover the ends of said rectangular area, and a refractor mounted between said tube and said roadway to concentrate light emitted toward said area into a beam midway between said reflected beams to completely illuminate said area.

10. A luminaire as claimed in claim 9, wherein said length of each of said surfaces subtends an angle of approximately 30° from said perpendicular plane.

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