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E. P. CREEHAN
RADIANT ENERGY PROJECTOR
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2,272,186

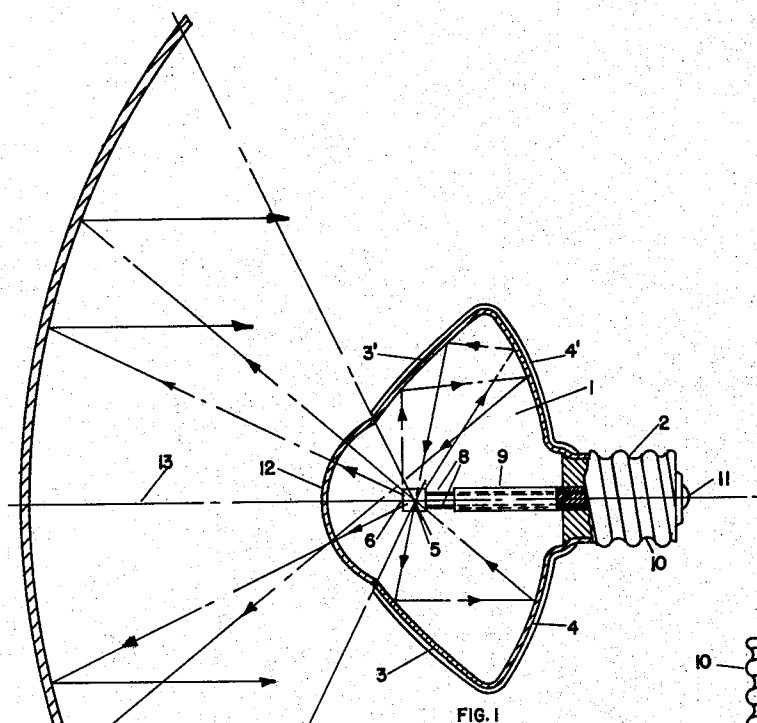


FIG. 1

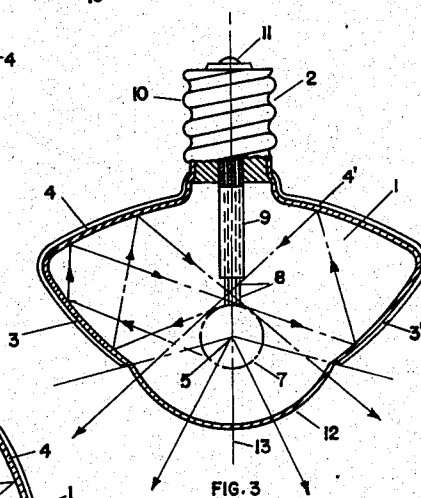


FIG. 3

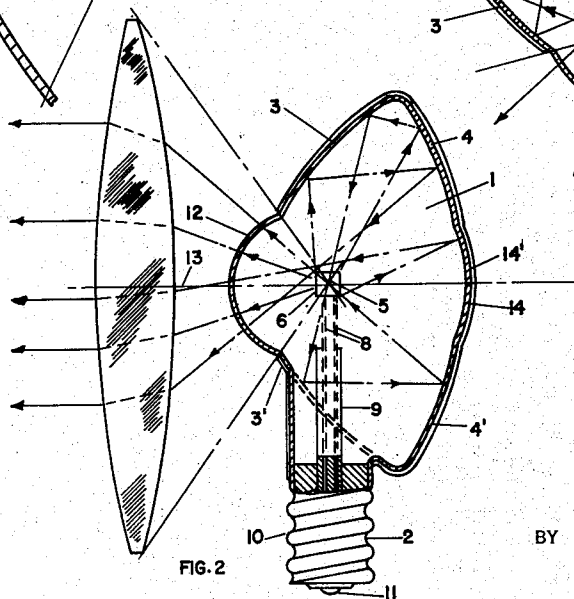


FIG. 2

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RADIANT ENERGY PROJECTOR

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7 Claims. (Cl. 176—34)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

My invention relates to a radiant energy projector and, more particularly, to an improved device of the stated character which has for its principal object the projection of a divergent beam of radiant energy in which either optimum beam candlepower or optimum beam lumens is attained consistent with high efficiency and in which the attainment of one of these optimum factors does not cause appreciable deviation in value from the optimum of said other factor.

In carrying my invention into effect, I employ a plurality of opposing coaxial confocal paraboloidal reflectors of different focal lengths and a source of radiant energy substantially coincident with the common focal point. The paraboloidal reflector of lesser focal length is apertured to permit the passage of a divergent beam of radiant energy. By means of certain geometrical relationships between the focal lengths and between the solid angles defined by the common focal point, the aperture in the paraboloidal reflector of lesser focal length, and the peripheral portions of the paraboloidal reflector of greater focal length, all to be more particularly described hereinafter, either optimum beam candlepower or optimum beam lumens is achieved without appreciable diminution in the other of said optimum factors.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing wherein:

Fig. 1 depicts the device of my invention in partial longitudinal section as employed with a shallow type reflector;

Fig. 2 depicts another embodiment of the device of my invention in partial longitudinal section as employed with a lens;

Fig. 3 discloses a still further embodiment of the device of the present invention in partial longitudinal section which is designed for general illumination.

Turning now to the several figures of the drawing, there is shown disclosed therein a lamp envelope identified in general by the reference character 1 to which there is secured in the usual manner the conventional base 2. Portions 3 and 4 of the envelope peripherally joined by a filleted surface are paraboloidal in form and are confocal at the point 5, as well as coaxial. Furthermore, it should be noted that the confocal paraboloidal envelope portions 3 and 4 are of unequal focal length, the paraboloid of lesser focal length

in each instance being identified by the reference character 3. The envelope portions 3 and 4 are coated exteriorly or interiorly at 3' and 4', respectively, with a suitable material for reflecting the radiant energy incident thereupon to thus provide a plurality of opposing coaxial confocal paraboloidal reflectors 3' and 4' of different focal lengths in which the paraboloidal reflector 3' of lesser focal length is apertured to allow the passage of a divergent beam of radiant energy.

A source of radiant energy 6 (Figs. 1 and 2) and 7 (Fig. 3) is substantially coincident with the common focal point 5 and is supplied with electrical energy by the lead-in wires 8, sealed in the conventional press 9 and cooperating with the customary electrical contacts 10 and 11 of the lamp base 2. In Figs. 1 and 2, the source of radiant energy 6 is a filament concentrated in the form of a cube, while in Fig. 3, the filament 7 is concentrated in the form of a sphere, thus providing in the latter instance a filament of the general illumination type. In each case, however, the various convolutions of the filament are sufficiently spaced to permit the passage of the radiant energy through the interspaces thus provided. Where the source of radiant energy is of the filamentary type, the envelope may or may not be provided with a gaseous filling, as well understood by those skilled in the art, and the material of the filament may be of any character known to the prior art to insure the desired spectral emission. The source of radiant energy is not to be understood as being restricted to a filament, since any other convenient source of visible and/or invisible light energy may be advantageously employed. Thus, by way of example, the source of radiation may be constituted by a space discharge substantially coincident with the common focal point 5 in a gas and/or vapor at the desired operating pressure or pressures.

That portion of the envelope identified by the reference character 12 through which the radiant energy emerges in a divergent beam is preferably, although not necessarily, a segment of a sphere with its center substantially coincident with the common focal point 5. This spherical configuration is employed for increasing the radiating surface and minimizing refraction, the spacing of the spherical surface from the source of radiant energy being determined by the wattage to be dissipated. The spherical portion 12 of the envelope may be either transparent or translucent and fabricated of any suitable refractory material or a material having any desired filtering characteristics.

It is undesirable to have any of the rays of the emergent beam leave the lamp after a single reflection, since under these circumstances, they will proceed parallel to the axis 13 of the device and hence fail to pass in proximity to the source of radiant energy. By disposing the lamp base 2 in opposing relation to the ray pervious portion 12 of the envelope in the manner delineated in Figs. 1 and 3, that portion of the paraboloidal reflector 4' of larger focal length substantially coextensive with the projected area of the ray pervious portion 12 is removed, thus precluding any parallel ray projection. Alternatively, as disclosed in Fig. 2, a small spherical reflecting surface 14' may be disposed either interiorly or exteriorly of the envelope upon a surface 14 thereof of corresponding contour with its center of curvature substantially coincident with the common focal point 5. This spherical reflector 14' replaces that portion of the paraboloidal reflector 4' of longer focal length which is coextensive with the projected area of the ray pervious portion 12 of the envelope. Thus, any ray which in the absence of the spherical reflector 14' would proceed outwardly of the device parallel to the axis 13 is now returned through the source of radiant energy 6. The spherical reflector construction depicted in Fig. 2 should be employed when using the lamp with a lens to project a parallel beam, all as delineated in the drawing, since it is desirable that all rays striking the lens come directly from the source of radiant energy. The construction, however, may also be employed in the lamps of Figs. 1 and 3 if desired.

As noted hereinbefore, it is an important feature of the present invention to produce a divergent beam of radiant energy in which either optimum beam candlepower or optimum beam lumens is attained consistent with high efficiency and in which the attainment of one of these optimum factors is achieved without appreciable diminution in the other of said optimum factors. By establishing certain relationships between the focal lengths of the paraboloidal reflectors 3' and 4' and between the solid angles defined by these reflectors and the common focal point 5, the foregoing is possible of achievement.

The beam candlepower is controlled by the ratio of the focal lengths of the paraboloidal reflectors. If the focal lengths are equal in magnitude, the number of reflections is excessive, while if one focal length greatly exceeds the other in magnitude, the source is unduly magnified. An excessive number of reflections results in low efficiency, while substantial magnification of the source causes low beam candlepower. I have, therefore, determined that a ratio of the greater focal length to the lesser focal length of the paraboloidal reflectors involved which is not less than 2 nor greater than 2.5 will result in the production of a beam candle power that is adequate for all purposes, yet consistent with the attainment of high efficiency. When the aforesaid ratio is substantially 2, optimum beam candlepower is achieved without appreciable deviation from an optimum value of beam lumens. The upper ratio limit of 2.5 makes it possible to establish equality in the solid angle relationship to thus insure optimum beam lumens without substantial deviation from the optimum value of beam candlepower. Where an optimum value of beam lumens is desired, it is essential that the solid angle defined by the common focal point 5

and the aperture in the paraboloidal reflector 3' of lesser focal length be substantially equal to that defined by the common focal point and the peripheral portions of the paraboloidal reflector 4' of greater focal length.

Thus, where accurate light control is desired, the focal length ratio should be approximately 2 while concurrently therewith the solid angle relationship approaches equality. Where, on the other hand, general directivity only is desired, the solid angles hereinbefore discussed should be substantially equal. Under these circumstances, however, the focal length ratio is no longer 2 but, on the other hand, does not exceed 2.5.

When using the lamp of the present invention in conjunction with a reflector or lens as disclosed respectively in Figs. 1 and 2 of the drawing, the primary object is the attainment of a high beam candlepower. This desideratum is achieved when the focal length ratio is substantially equal to 2. Thus, the focal length ratio in the lamps of Figs. 1 and 2 is chosen so as to be substantially equal to 2, while the solid angle relationship deviates somewhat from equality, all in the manner hereinbefore described. In Fig. 3, however, where general directivity only is desired, the solid angle defined by the common focal point 5 and the aperture in the paraboloidal reflector 3' of lesser focal length is made and as shown is substantially equal to the solid angle defined by the said common focal point and the peripheral portions of the paraboloidal reflector 4' of greater focal length. By establishing this equality in the solid angle relationship, the focal length ratio in the lamp of Fig. 3 of necessity and by virtue of the foregoing construction becomes and is greater than 2 but is not in excess of 2.5.

In view of the foregoing, it should thus be clear that in the lamp of the present invention a large portion of the total energy is redirected and substantially superimposed upon the remaining undirected portion. The net result is a lamp in which the energy proceeds to the area of utilization as if it were all being radiated from the source through the solid angle determined by the common focal point and the edges of the aperture in the paraboloid of lesser focal length without intervening reflections. The energy of the divergent beam, furthermore, approximately obeys the law of inverse squares.

According to the provisions of the patent statutes, I have set forth the principle and mode of operation of my invention and have illustrated and described what I now consider to represent its best embodiments. However, I desire to have it understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

The invention herein described and claimed may be used and/or manufactured by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

I claim:

1. A device for the projection of light energy comprising in combination a plurality of opposing, coaxial, confocal, paraboloidal reflectors of different focal lengths, a source of light energy substantially coincident with the common focal point, the ratio of the focal lengths of the said reflectors being substantially equal to 2 and the paraboloidal reflector of lesser focal length being

apertured to permit the passage of the light energy.

2. A device for the projection of light energy comprising in combination a plurality of opposing, coaxial, confocal paraboloidal reflectors of different focal lengths, a source of light energy substantially coincident with the common focal point, the paraboloidal reflector of lesser focal length being apertured to permit the passage of the light energy and the solid angle defined by the common focal point and the aperture in the paraboloidal reflector of lesser focal length being substantially equal to that defined by the common focal point and the peripheral portions of the paraboloidal reflector of greater focal length.

3. A device for the projection of light energy comprising in combination a plurality of opposing, coaxial, confocal, paraboloidal reflectors of different focal lengths, a source of light energy substantially coincident with the common focal point, the ratio of the focal lengths of the said reflectors being not less than 2 nor greater than 2.5 and the paraboloidal reflector of lesser focal length being apertured to permit the passage of the light energy.

4. A device for the projection of light energy comprising in combination a plurality of opposing, coaxial, confocal paraboloidal reflectors of different focal lengths, a source of light energy substantially coincident with the common focal point, the paraboloidal reflector of lesser focal length being apertured to permit the passage of the light energy, a spherical reflector confocal with the said paraboloidal reflectors and in opposing relation to the aperture in one of the latter, the ratio of the focal lengths of the said paraboloidal reflectors being not less than 2 nor greater than 2.5.

5. An electric lamp for the projection of light energy comprising in combination an envelope, a plurality of opposing coaxial confocal paraboloidal reflectors of different focal lengths associated with said envelope, a source of light energy disposed within said envelope and substantially coincident with the aforesaid common focal point, the paraboloidal reflector of lesser focal

length being apertured to permit the passage of the light energy, a lamp base secured to the envelope and in opposing relation to the aperture in the paraboloidal reflector of lesser focal length and means associated with said base and source for supplying the latter with electrical energy, the ratio of the focal lengths of the said paraboloidal reflectors being not less than 2 nor greater than 2.5.

6. An electric lamp for the projection of light energy comprising in combination an envelope, a plurality of opposing, coaxial, confocal paraboloidal reflectors of different focal lengths associated with said envelope, a source of light energy disposed within said envelope and substantially coincident with the aforesaid common focal point, the paraboloidal reflector of lesser focal length being apertured to permit the passage of the light energy, a spherical reflector confocal with the said paraboloidal reflectors and in opposing relation to the aperture in one of the latter, a lamp base secured to the envelope and means associated with said base and source for supplying the latter with electrical energy, the ratio of the focal lengths of said paraboloidal reflectors being not less than 2 nor greater than 2.5.

7. An electric lamp for the projection of light energy comprising in combination an envelope, a plurality of opposing, coaxial, confocal paraboloidal reflectors of different focal lengths associated with said envelope, a source of light energy disposed within said envelope and substantially coincident with the aforesaid common focal point, the paraboloidal reflector of lesser focal length being apertured to permit the passage of the light energy, and the solid angle defined by the common focal point and the aperture in the paraboloidal reflector of lesser focal length being substantially equal to that defined by the common focal point and the peripheral portions of the paraboloidal reflector of greater focal length, a lamp base secured to the envelope and means associated with said base and source for supplying the latter with electrical energy.

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