March 1, 1938. C. A. B. HALVORSON 2,110,018

LIGHTING UNIT

Filed April 18, 1936 2 Sheets-Sheet 1

Fig. 1.

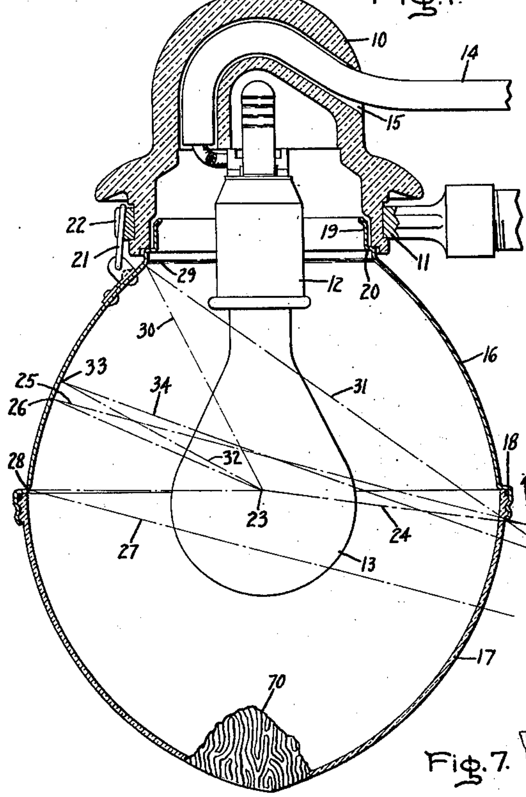


Fig. 2.

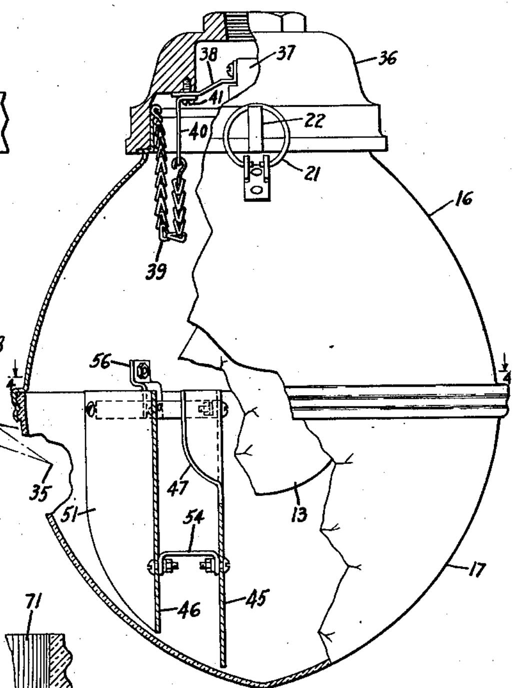


Fig. 7.

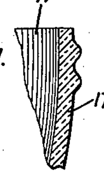


Fig. 3.

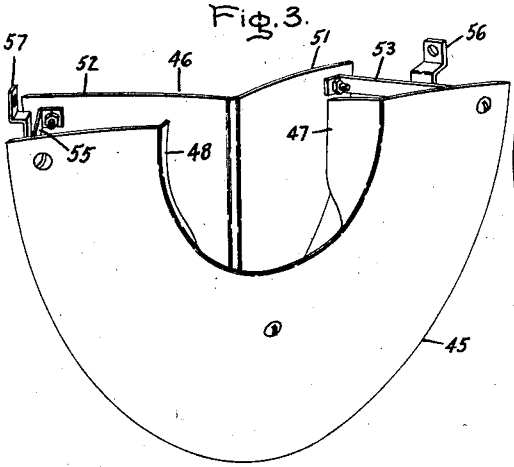
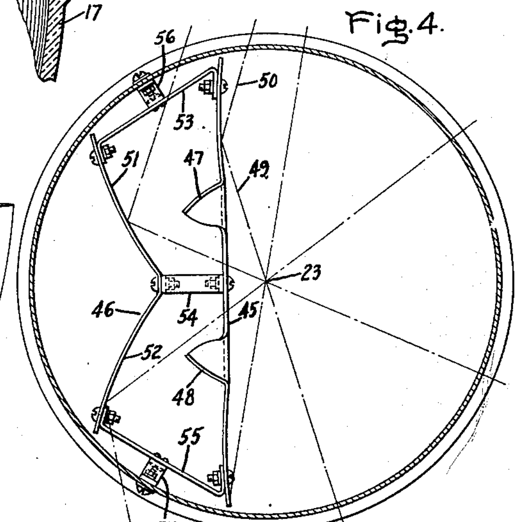


Fig. 4.



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His Attorney.

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LIGHTING UNIT

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Fig. 5.

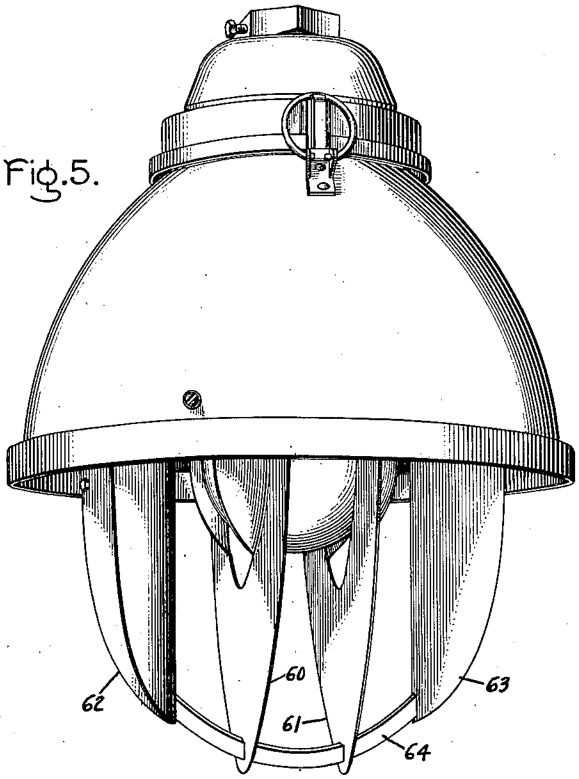
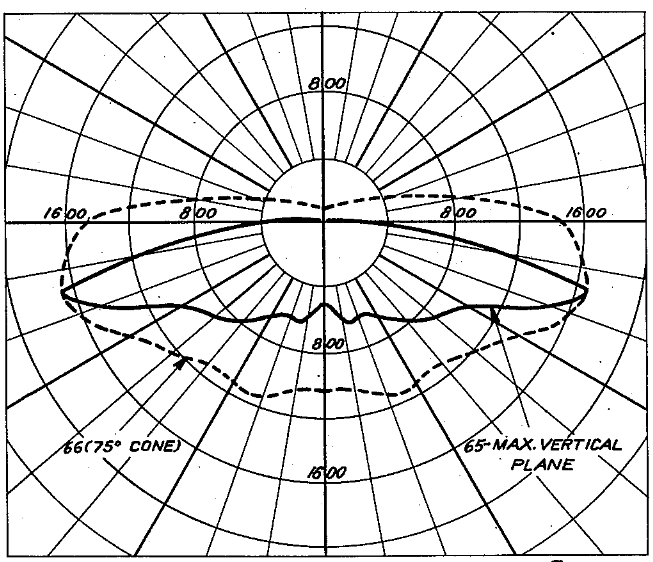


Fig. 6.



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by Harry E. Dunham
His Attorney.

Patented Mar. 1, 1938 **2,110,018**

UNITED STATES PATENT OFFICE

2,110,018

LIGHTING UNIT

Cromwell A. B. Halvorson, Lynn, Mass., assignor to General Electric Company, a corporation of New York

Application April 18, 1936, Serial No. 75,160

7 Claims. (Cl. 240—25)

My invention relates to lighting units and more particularly to large luminaires such as are used for lighting sections of highways, or similar large areas.

One object of my invention is to provide an improved luminaire which will be substantially self-cleansing.

Another object of my invention is to provide an improved deflector having a beam cut-off of less than 180° which will provide an improved light distribution.

Another object of my invention is to provide a luminaire which will be substantially nonglaring to motor vehicle operators.

Another object of my invention is to provide improved means in combination with a reflector for modifying the distribution of light horizontally without substantially modifying the distribution in vertical planes.

For a better understanding of my invention, together with other and further objects thereof, reference is had to the following description, taken in connection with the accompanying drawings and its scope will be pointed out in the appended claims.

In the accompanying drawings, Fig. 1 is a vertical sectional view of a luminaire built in accordance with my invention; Fig. 2 is a modified unit equipped with an improved deflector in accordance with my invention; Fig. 3 is a perspective view of the deflector used in Fig. 2; Fig. 4 is a plan view of the deflector of Fig. 3 illustrating the distribution of light thereby in a horizontal plane; Fig. 5 is a modified deflector; Fig. 6 illustrates diagrammatically light distribution of the unit shown in Figs. 2, 3 and 4; and Fig. 7 is a fragmentary view of a modification of Fig. 1.

Referring to Fig. 1 in detail, the unit illustrated comprises an insulator 10 which is supported by a metal collar 11. A socket 12 containing a lamp 13 is mounted in the insulator 10 and a cable 14 threaded through a conduit 15 carries current to the socket and lamp.

The lamp 13 is enclosed by a circular reflector 16 and a globe 17 which are sealed to each other at their perimeters by a flange 18 on the reflector 16 which is rolled into grooves in the perimeter of the globe 17. The reflector 16 is further equipped with a sleeve 19, which is of such a diameter that it fits into the open end of the insulator 10. This sleeve is joined to the reflector, a shoulder 20 being formed, at this point, which fits up against the lower end of the insulator. The whole assembly is attached to the insulator 10 by several spaced latches 21 which engage hooks 22 on the supporting collar 11. The joints between the reflector and globe and the joint between the insulator and reflector are dust-proof. Since there is no other place for air to enter the globe, it remains clean indefinitely. The air space between the cable and cable conduit wall is very small and permits merely enough air to flow in and out of the unit to take care of expansion and contraction resulting from temperature changes.

The outside of the reflector 16 is smooth, the reflector being made of a metal sheet such as aluminum, the reflecting surface of which is specially treated to retain its reflectivity. Any rain striking the unit freely flows over the surface of the reflector and down over the surface of the globe. The flange 18 extends beyond the surface of the reflector only enough to extend over the grooved perimeter of the globe. The grooved perimeter is slightly thicker than the globe wall, thereby forming a flange, so that the presence of the flange 18 constitutes a slight hindrance to the flow of water from the surface of the reflector to the surface of the globe.

The proper distribution of light in luminaires of this type becomes of primary importance in view of the high intensity source used and of the comparatively large area over which this available light is to be distributed. In view of the high intensity of the light source, it is desirable to confine the light from the unit within a beam having a spread of less than 180° to avoid glare and to distribute the light within this beam so as to produce a uniform surface brightness upon the highway surface which is illuminated by the unit.

In order to obtain this desired distribution of light, the center 23 of the light source in the lamp 13 is placed on the axis of the reflector and relatively to the edge of the reflector flange 18 so that a line 24 drawn from the edge of the reflector through the center may be at an angle of approximately 10° with a horizontal line through the center. This provides a collecting angle of substantially 200° for the reflector. Although this 200° angle includes the flange 18, it is correct to consider the flange as a part of the reflector, since its inner surface is a continuation of the reflector surface and the glass which is in front of it reduces its reflecting efficiency only nominally. The beam spread of this reflector is made as nearly supplementary to the collecting angle as possible since it is found that, for general use, this beam spread is acceptable. These angles represent only the virtual cut-off angles. Some light is projected beyond these cut-off angles because the source has a vertical dimension. The maximum intensity is somewhat below this cut-off since with this type of reflector it has not been practical to provide the maximum intensity immediately below the virtual cut-off.

The light within this defined beam should be distributed so as to project a large portion of the generated light flux toward the outer portions of the beam to correspondingly increase the intensity of the light at the remote portions of the illuminated area. In order to accomplish this distribution, the reflector is shaped as a complex surfaced conoid, the surface of which is generated by a curve having an elliptical section and a parabolic section revolved about a vertical axis. The respective sections of this curve have a common focus in the center of the light source, and their respective axes are so arranged that the surfaces project light as close to the opposite edge of the reflector as possible. Referring to Fig. 1, I have indicated the line **24** which represents the virtual cut-off of the beam. The highest candle power or intensity is obtained, however, by projecting a beam of parallel rays, as indicated by the line **25** intercepting the reflector at a point **26** and passing below the opposite edge of the reflector. The other edge of the beam is indicated by a line **27** which is parallel to line **25**, and is projected from the edge **28** of the reflector. This beam is approximately 15° to the horizontal, and therefore approximately five degrees below the virtual cut-off. This section of the reflector, between the edge **28** and the parallel designated by the point **26** is therefore a parabolic curve having its axis passing through the light center **23** and tilted at 15 degrees to the horizontal.

Considering the upper edge **29** of the reflecting surface we find a ray **30** from the light source **23** reflected along the line **31** and just clearing the lower edge **28** of the reflector opposite to the reflecting element. Another ray **32** from the source **23** intercepts the reflector surface at point **33** and is reflected along line **34**, which is at an angle to the ray **31** and intersects it at a point **35** outside of the reflector and below the edge of flange **18**. The surface between points **26** and **29** is an ellipsoid having its secondary focus at point **35**. This point **35** is, of course, representative of the focal point of one increment of this surface. As this curve moves about the vertical axis of the reflector, this point **35** becomes a focal region having the form of a circle. The reflector, therefore, distributes the light in a parallel beam and in a spread beam, both beams being as far out toward the edge of the reflector and the illuminated area as possible. The reflected light is therefore at the edge of the beam, thereby building up the intensity of the light at the edges of the illuminated area. The area closer to the unit is illuminated by direct light from the source, it being most intense in this area. As a result of this distribution, a substantially uniformly bright pattern of light is obtained on the road surface.

When the luminaires, as above described, are mounted on city streets near the curbing, the symmetrical light distribution about the axis of the luminaire becomes a source of annoyance to adjacent residents and some means must be employed to throw the light flux toward the street. For this purpose, I provide several improved means, one of which is an improved deflector which, in combination with the above-described reflector, provides a desired light distribution. Figs. 2, 3, and 4 illustrate one example of such deflector.

Fig. 2 illustrates a modification of the unit shown in Fig. 1. In this modification the reflector **16** and globe **17** are the same as in Fig. 1, but instead of the insulator **10** a metal cap **36** is used. The socket **37** is attached to this cap by a bracket **38**. The reflector **16** is attached to the cap **36** by latches **21** and is further connected to the cap by a chain **39** attached at one end to the flange **19** of the reflector and of the other end to the cap **36** through a rod **40** and screw **41**.

The deflector comprises a pair of reflectors **45** and **46** arranged in such relation to the lamp **13** and its light source that it intercepts a substantial portion of the light flux normally directed towards the adjacent houses and projects this in directions along the street or highway on each side of the luminaire. This is well indicated in Figs. 3 and 4. Reflector **45** is therein disclosed as being nearest to the light source. It is outwardly shaped to fit into the globe **17**, its upper edge extending up to the intersection of the globe **17** and the flange **18**. This reflector is placed close to the light source and is, therefore, cut out to accommodate the lamp bulb **13**. Ears **47** and **48** are provided to intercept light which would otherwise project back of the luminaire. The reflector surface on either side of the light source is shaped to conform to a parabola having its focus, or focal line coinciding with the axis of the reflector which passes through the center **23** and its axis horizontally moved 15° towards the street. Light rays **49**, therefore, striking this surface are deflected towards the street, as indicated by the line **50**.

The reflector **46** comprises a pair of parabolic cylinder surfaces **51** and **52**, the focus, or focal line, of which also coincides with the reflector axis through the center **23** of the light source. These surfaces deflect the light projected through the cut-out portion of deflector **45**. The reflector **46** is also formed to fit into the globe **17**. It is attached to the deflector **45** by a set of brackets **53**, **54**, and **55**, bracket **54** holding the lower ends of the deflectors and brackets **53** and **55** spacing the upper corners thereof. The brackets **53** and **55** are in turn attached to the main reflector **16** by brackets **56** and **57**, respectively.

In Fig. 5, I have illustrated a modification of my deflector. The deflector herein shown comprises substantially two deflectors, such as shown in Figs. 2, 3, and 4, mounted on opposite sides of the lamp and reflector axis. Thus, we have members **60** and **61** corresponding to member **45** on opposite sides of the lamp axis and members **62** and **63** corresponding to deflector **46** mounted directly in back of the members **60** and **61**, respectively. The lower edge of these reflectors are spaced by a strap **64** which is made of the same material as the reflectors and is shaped to conform to the usual globe that is ordinarily used with these units. This modification may readily be used without the globe **17**, shown in Figs. 1, 2, and 4.

In Fig. 6, I have illustrated the light distribution obtainable with the lighting unit as illustrated in Figs. 2, 3, and 4. The curve **65** is the average of the readings obtained in a series of vertical planes. The curve **66** indicates the readings obtained in a cone of 75° from the vertical axis of the light source. The curve **65** clearly indicates the maximum candle power or intensity, being at approximately 15° below the horizontal and the virtual cut-off being somewhat above this, this latter point being difficult to determine. The curve **66** clearly indicates the distribution horizontally away from the house side of the luminaire and toward the street side.

The globe **17** shown in Fig. 1 may be of clear glass or may be of rippled glass as indicated at **70**, this rippling comprising a series of irregularly spaced cylindrical protuberances tending to disperse light at right angles to their respective axes. In addition to these ripples on the outside of the globe, it may be desirable to provide groups of prisms on the inside of the globe. Fig. 7 illustrates a fragment of said globe having prisms on the inner surface, as indicated at **71**, for deflecting the light away from the house side of the unit and projecting it in the manner shown in the distribution curves for the deflectors. These prisms are substantially vertical and effect a redistribution of light in the horizontal planes but do not change substantially the distribution in vertical planes the light projected by the reflector **16**.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a street-lighting unit, the combination of a light source, a reflector having a collecting angle greater than 180° comprising a paraboloidal surface and an ellipsoidal surface, the said paraboloidal surface extending from the edge of said reflector toward the axis thereof and arranged to project a parallel beam, the upper edge of which clears the opposite edge of the reflector, and said ellipsoidal surface, the secondary focal region thereof being outside of said reflector whereby substantially all of the reflected light is projected below the edge of the reflector and away from the vicinity of the unit, and the direct light only illuminates the region immediately below said unit.

2. In a street-lighting unit, the combination of a conoidal reflector having a vertical axis and a collecting angle of at least 180° and a set of deflectors attached to said reflector and extending below the edge thereof comprising parabolic cylinders arranged parallel to the axis of said reflector and arranged to deflect that segment of the normally symmetrical beam which is projected toward said deflector into predetermined directions horizontally, so as to add the light of this segment to the remaining segment of the beam without altering the beam spread.

3. In a street-lighting unit, the combination of a light source, a conoidal reflector having a vertical axis and a collecting angle of not less than 180° arranged to collect the light projected upwardly from said source and redirect it in a beam having a predetermined spread symmetrically about its axis, a bowl-shaped globe attached to the open end of said reflector and a deflector attached to said reflector and projecting into said bowl comprising a curved surface having its focal axis coinciding with the axis of said reflector and arranged to redistribute the light from said flux in horizontal planes without materially affecting the vertical distribution of said light flux.

4. In a street-lighting unit, the combination of a conoidal reflector having a vertical axis and a collecting angle of not less than 180° arranged to collect upwardly projected light from a source at its focus and to redirect it symmetrically about said vertical axis, a globe attached to the open end of said reflector, a deflector within said globe comprising a plurality of curved reflecting surfaces arranged parallel to each other and to the axis of said reflector for changing the horizontal distribution about said vertical axis.

5. In a street-lighting unit, the combination of a conoidal reflector having a vertical axis and a collecting angle of not less than 180° arranged to collect upwardly projected light from a source located at its focus and to redirect it symmetrically about a vertical axis, a globe attached to the open end of said reflector, a deflector within said globe comprising a plurality of parabolic cylinders having their respective axes coincident with the axis of said reflector and parallel to each other on opposite sides of said reflector axis for changing the horizontal distribution of the light projected by said reflector into two definite directions.

6. In a street lighting luminaire, the combination of a light source and a reflector, said reflector comprising a surface of revolution generated by a curve comprising a parabolic section extending between the lower edge of said surface to a point intersected by a line drawn parallel to the axis of said parabolic curve and passing below the opposite edge of said surface, and an elliptical section adjacent to said parabolic section, said elliptic section having a focus in the center of said light source, and a conjugate focal region immediately below the lower edge of said surface, whereby the light flux projected from said elliptical surface of revolution is projected to the focal region immediately below the edge of said surface of revolution, and thereafter spread into a beam, whereby substantially all of the reflected light from said surface of revolution is projected away from the region immediately below said luminaire.

7. In a street lighting unit the combination of a light source, a conoidal reflector having a collecting angle greater than 180° comprising a paraboloidal surface and an ellipsoidal surface, said paraboloidal surface extending from the open end of said reflector toward the axis thereof and arranged to project a parallel beam, the upper edge of which clears the opposite edge of the reflector, said ellipsoidal surface extending beyond said paraboloidal surface and towards the axis of said reflector and having a secondary focal region outside of said reflector, said region being sufficiently beyond the edge of said reflector so that substantially no light projected by said elliptical surface is intercepted by the opposite edge of said reflector, whereby substantially all of said light is projected away from the region directly below said reflector, said region being illuminated only by direct light from said light source.

CROMWELL A. B. HALVORSON.