Oct. 28, 1941. T. W. ROLPH 2,260,693

LUMINAIRE

Filed Sept. 28, 1938 2 Sheets-Sheet 1

Fig. 1.

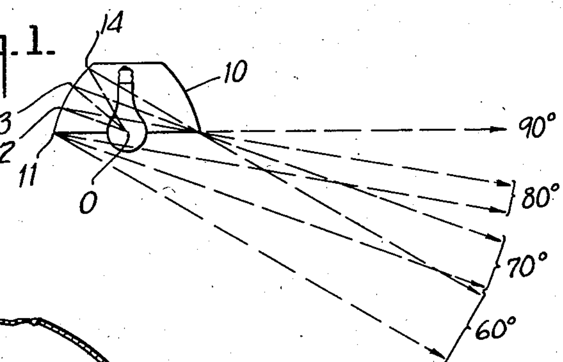


Fig. 2.

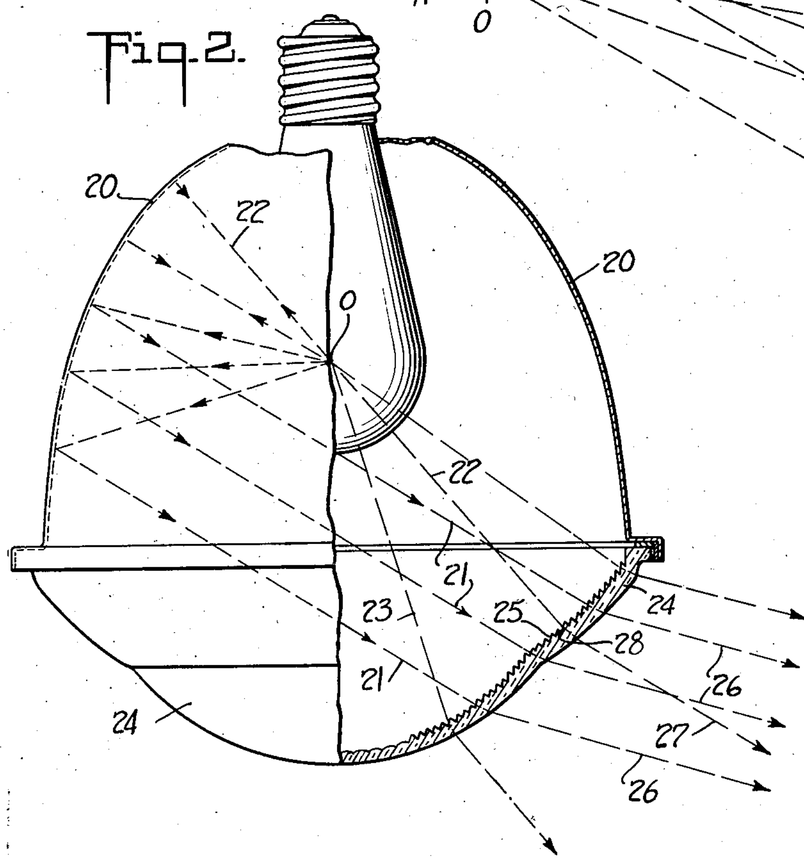
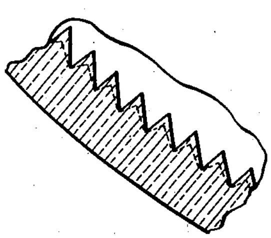


Fig. 8.



INVENTOR
THOMAS W. ROLPH
BY
[signature]
his ATTORNEY

Oct. 28, 1941. T. W. ROLPH 2,260,693

LUMINAIRE

Filed Sept. 28, 1938 2 Sheets-Sheet 2

Fig. 3.

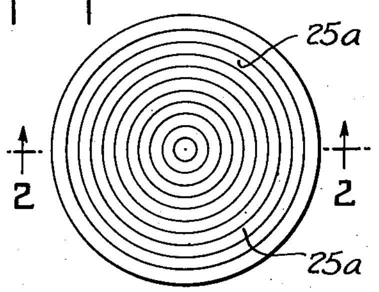


Fig. 4.

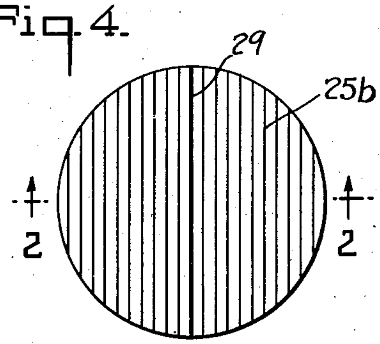


Fig. 5

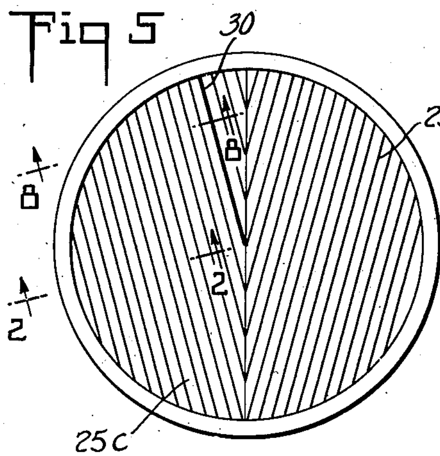


Fig. 7.

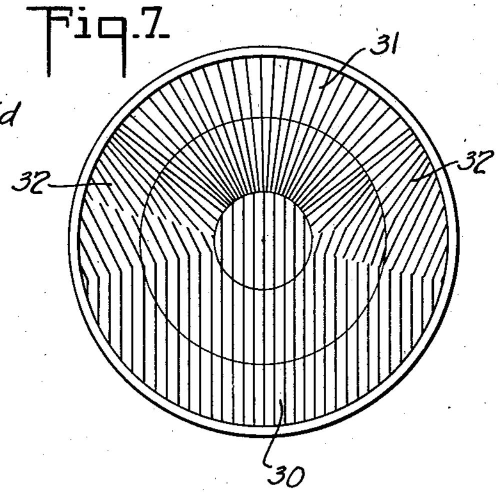
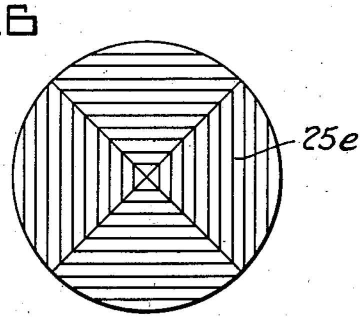


Fig. 6



INVENTOR
THOMAS W. ROLPH
BY
[signature]
his ATTORNEY

Patented Oct. 28, 1941

2,260,693

UNITED STATES PATENT OFFICE

2,260,693

LUMINAIRE

Thomas W. Rolph, Newark, Ohio, assignor to Holophane Company, Inc., New York, N. Y., a corporation of Delaware

Application September 28, 1938, Serial No. 232,073

13 Claims. (Cl. 240—93)

The present invention relates to luminaires, and is more particularly directed toward luminaires designed for street lighting.

Street lighting luminaires designed for the efficient use of light employ either a reflector, a refractor, or a combination of reflector and refractor.

Efficient reflectors can be made to put more light on a street than efficient refractors, but to do this, reflectors have to be designed to turn a large part of the light down at much lower angles than is customary in street lighting practice and therefore the gain in efficiency is obtained only at a sacrifice in spread of light.

Street luminaires using both reflector and refractor take advantage of the efficiency of the reflector and use one-piece laterally concentrating refractors to build up the maximum candlepower with or without a supplementary deflector in the refractor on the house side. Compared with the older types of refractors, these reflector-refractor units show an increase in light on the street but a decrease in the spacing required for equivalent light distribution along the street.

The present invention contemplates a luminaire employing both a reflector and a refractor which will take advantage of the efficiency possibility of reflectors and overcome the spacing drawback of street lighting luminaires employing reflectors only.

The accompanying drawings show, for purposes of illustrating the present invention, one of the many embodiments in which the invention may take form, together with modifications of certain parts, it being understood that the drawings are illustrative of the invention rather than limiting the same.

In these drawings:

Figure 1 is a diagrammatic view illustrating the change in effectiveness of a shielding reflector at various angles of maximum candlepower;

Figure 2 is an elevational view with parts in section taken on the line 2—2 of Figures 3, 4 and 5;

Figures 3 to 7, inclusive, are top plan views of different forms of refractor; and

Figure 8 is a sectional view taken on the line 8—8 of Figure 5, at an enlarged scale.

Figure 1 indicates the concentration characteristics and limitations of a deep bowl or shielding reflector. The reflector is shown at 10, the light source at 0.

Lines drawn on this diagram at any desired angle of maximum candlepower indicate the proportion of reflector surface which can be used to direct light at that angle. At high angles of beam, the edge of the reflector eclipses light which might be reflected from the upper part of the opposite side of the reflector into the beam direction and this upper part can only be used for directing light below the beam. As the angle of the beam moves downward, the proportion of the reflector which can be used for directing light into the beam increases. The change in beam concentration with change in angle of beam is rapid. For a 90° beam, the shielding reflector is completely ineffective; no light whatever can be obtained in a beam at this angle. At 80°, the proportion of reflector (between points 11 and 12) contributing to the beam is small. At 70°, the width of this area has increased up to point 13 while at 60°, the region 11—14 of the reflector can be very effective in producing a beam of the intensity generally required for street lighting. The shielding reflector is an effective device for obtaining concentration at relatively low angles and its effectiveness decreases rapidly as the angle of the beam is raised.

The shielding reflector by itself is not sufficiently effective to give a satisfactory street lighting beam at 75°, which is the customary angle for best practice in this country today. The shielding reflector combined with a lateral refractor, takes the reflector beam at 75° and concentrates it laterally so that a satisfactory street lighting distribution is obtained with high intensity at 75°. There is, however, a sacrifice of light distribution along the street as compared with that obtained by refractors at customary spacing. For example, a bowl refractor may give a satisfactory distribution of illumination at a spacing of eight times the mounting height and to obtain similar distribution with the reflector with lateral refractor, the spacing must be somewhat less than seven times the mounting height.

The construction herein shown takes maximum advantage of the efficiency possibilities of the shielding reflector by concentrating the light at a relatively low angle and then passing this light through a refracting bowl to elevate to the proper angle that portion of the beam which strikes the street and to direct the balance of the light onto the street below the beam. The shape of the bowl can be so selected that the elevating effect on a part of the light and the lateral redistribution of the balance of the light is provided by a consistent pattern of prisms on the inner surface. This makes it possible to provide a one-piece refracting bowl which is smooth outside. As an illustrative example, a reflector concentrating the light at 55° and a bowl elevating a part of the light to 75° measured, as usual, from the nadir and redirecting the balance of the light into the street area will be discussed.

The luminaire has a light source 0 and an inverted specular reflector such as shown at 20. It is usually dish shaped, either annular or elliptical, or it may be an inverted trough. It has a cut-off angle at 55° and its profile is typically a parabola to produce reflected rays 21 parallel to one another, but the profile may be such as to produce a small convergence or divergence. It intercepts a zone of light more than 60° above the horizontal, measured, as usual, from the horizontal plane through the light source and a 35° zone below the same, so that a very substantial portion of the lumen output of the source is redirected. A band of light of about 70° extent may be emitted at angles of about 55° above nadir. The upper part of the reflector form directs rays more nearly vertical, as indicated at 22. Direct rays pass through the mouth of the reflector, as indicated at 23. The reflector may be metal, prismatic glass or mirrored glass, or any other suitable material.

The light passing out of the reflector is intercepted by a light controlling prismatic member indicated generally at 24. It is usually in the form of a shallow bowl or trough smooth on the outside and provided with prismatic ribs on the inside. These ribs have a series of active surfaces 25 which intercept the reflected rays 21 and the direct rays 23 and elevate the reflected rays to an angle of about 75°, as indicated at 26, and the direct rays to a lesser extent as indicated at 27. The other faces 28 of the ribs are designed to receive a maximum amount of light.

Where symmetric distribution is desired the reflector is annular and the refractor is a round dish having circular prisms such as indicated at 25*a* in Figure 3.

Where asymmetrical distribution is desired with two beams at 180° to one another the prisms 25*b* are parallel to one another and symmetrical with respect to a median line indicated at 29, as shown in Figure 4. Where this form of distribution is desired the luminaire may be elliptical or a modification of an ellipse.

Where asymmetrical distribution is desired with two beams with angles at other than 180°, as when the luminaire is to be mounted to one side of the center of the street or road, the prisms are arranged in sets, as indicated at 25*c* and 25*d* of Figure 5.

Where distribution in four directions at 90° to one another is desired the prisms 25*e* may be disposed as indicated in Figure 6.

Figure 7 illustrates a modified refractor with parallel prisms 30 on the street side, radial prisms 31 on the house side and intermediate diverging prisms 32.

At angles slightly to one side of the line 2—2 (Figures 4 and 5) the light is still elevated nearly as much as at 2—2. Moving away from this line, however, around toward the back of the refractor, less and less elevation is obtained and more and more lateral redirection is obtained. At 90° from the line 2—2, the prism 30 (Figure 5) will be radial. A radial prism gives lateral redirection of the light, ordinarily without elevation, but lateral redirection on a sloping surface like this also produces some degree of elevation. Therefore, the prisms vary from purely elevating prisms at a selected angle, say 15° out from the curb (line 2—2) to laterally redirecting and elevating prisms at their outer ends. Thus the 55° beam from the reflector is elevated to 75° in directions up and down the street while the 55° beam at other lateral angles is elevated in varying amounts below 75° and is redirected laterally in varying amounts in different parts of the refractor. The maximum elevation is obtained in directions up and down the street where elevation is most needed. The maximum lateral redirection is obtained in directions toward the house side, where lateral redirection is most needed.

The direct light is handled by the prisms in much the same way as the reflected light but since the direct light striking the refractor is received at lower angles than 55°, it is elevated and redistributed to strike the street at angles below 75°.

The action will not be perfect (in luminaires designed for asymmetric distribution) if each prism runs throughout its entire length at the same angle. The angle of any prism for the required elevation at its center along the line 2—2 will not always be the correct angle for lateral redirection when this prism reaches the edge of the refractor. Therefore, it may be necessary to vary each prism angle somewhat throughout its length. This can be accomplished best by stepping from one prism angle to another at one or more points along each prism, as indicated by Figure 8, where the full line prism outline is taken on line 8—8 of Figure 5, and the dotted outline is the same as in Figure 2.

While the vertical angles indicated in Figure 2 are 55° from the reflector and 75° from the refractor, these can be varied within reasonable limits. Thus the beam angle from the prisms might be 70° for a spacing of six times the mounting height instead of 75° which is used for a spacing of eight times the mounting height. The best angle of beam from the reflector depends upon the design and will be determined in each case by design considerations.

The bowl shape is determined largely by the degree of elevation required from the outer surface at the upper edge. This need not determine the shape exactly, however. In making the mold and cutting plunger prisms running in various directions, it is desirable to have a spherical contour or one made up of two spherical parts, but departure from such a contour toward conical or other shape is possible when important enough to justify the added complication in mold manufacture.

A deflector will not ordinarily be necessary. The reflector extends down below the light source far enough to provide satisfactory cut-off even on the house side.

With light sources having a substantially point source, the light controlling elements will usually be annular, but an elliptical, or other reflector form concave in all directions toward the source, may in some cases be used.

For certain lighting requirements, it may be desirable to design the entire unit as a tipped construction. For example, if the unit were tipped out toward the street 15°, the cut-off on the house side would be lowered by 15°. There would be a corresponding elevation of the cut-off on the street side but since this is directly across the street, the cut-off up and down the street would remain substantially the same as if the unit were not tipped. The prismatic design would be altered to make proper allowance for the tipping.

It is obvious that the invention may be embodied in many forms and constructions within the scope of the claims and I wish it to be understood that the particular form shown is but one of the many forms. Various modifications and changes being possible, I do not otherwise limit myself in any way with respect thereto.

What is claimed is:

1. A luminaire comprising a light source, a reflector of substantially parabolic profile with the focus at the light source with the axis downwardly sloping and intercepting a band of light extending both below and above the horizontal plane through the light source and reflecting it at substantially uniform downwardly sloping angles parallel with the axis across the reflector axis and out through the mouth of the reflector, and a prismatic light transmitting refractor below the reflector and of a depth to intercept the reflected light after it has crossed the reflector axis and transmit it at higher angles measured from the nadir and into regions screened against direct and reflected light by the lower edge of the reflector, the prisms being of substantially uniform refracting power so that the reflected and refracted light is transmitted at substantially uniformly high angles.

2. A luminaire such as claimed in claim 1, wherein the reflector is dish shaped and the refractor is in the form of a shallow bowl.

3. A luminaire such as claimed in claim 1, wherein the reflector is annular and the refractor has annular prisms for elevating the reflected and refracted light uniformly about the axis.

4. A luminaire such as claimed in claim 1, wherein the refractor has sets of substantially parallel prisms disposed on opposite sides of the axis to produce two beams directed at 90° to the sets of prisms.

5. A luminaire such as claimed in claim 1, wherein the refractor has sets of substantially parallel prisms disposed on opposite sides of the axis, the sets of prisms being at a small angle to one another to produce two beams directed at 90° to the sets of prisms.

6. A luminaire such as claimed in claim 1, wherein the reflector is annular and the refractor is in the form of a shallow dish provided with sets of substantially parallel prisms disposed on opposite sides of the axis, the sets being at a small angle to one another to produce two beams at less than 180° horizontally.

7. A luminaire such as claimed in claim 1, wherein the reflector has an upper zone reflecting light at angles more nearly vertical than the angle of cut-off, said light falling on the prismatic surfaces of the outer portion of the refractor and being thereby directed into the same general direction as the other reflected and refracted light.

8. A luminaire comprising a light source, a reflector having an open mouth spaced below the source to provide a predetermined cut-off angle below the horizontal plane through the light source, the reflector having a substantially parabolic profile with the focus on the light source and with the axis downwardly sloping and parallel with the angle of cut off as determined by the position of the light source and the lower edge of the reflector, the reflector being adapted to direct the reflected light across the reflector axis and out through the reflector mouth at angles substantially parallel with the angle of cut-off, and a refractor intercepting said reflected light after all of it has crossed the reflector axis and transmitting it at higher angles above the nadir.

9. A luminaire such as claimed in claim 8, wherein the reflector is annular and the prisms on the refractor are asymmetrically disposed to produce beams asymmetric horizontally.

10. A luminaire comprising a substantially point light source, a reflector form having comparatively steep walls disposed about a vertical axis and concave in all directions toward the light source and intercepting a band of light extending both below and above the horizontal plane through the light source and reflecting it across the reflector axis and out through the mouth of the reflector, and a refractor below the reflector form and of a depth to intercept the reflected light after it has crossed the reflector axis, the refractor having a series of prisms disposed in planes perpendicular to a radial plane through the light source and having variant refracting power along the length thereof to provide simple elevation of the reflected and the direct light in said radial plane and both elevation and lateral redirection of the reflected and direct light at points remote from said radial plane.

11. A luminaire such as claimed in claim 10, wherein the degree of elevation of the refracted light decreases with increase of angular distance from said radial plane.

12. A luminaire such as claimed in claim 10, wherein the lateral redirection increases with increase of angular distance from said radial plane.

13. A luminaire comprising a light source, a reflector having an open mouth spaced below the source to provide a predetermined cut-off angle below the horizontal plane through the light source, the reflector having a substantially parabolic profile with the focus on the light source and with the axis downwardly sloping and parallel with the angle of cut off as determined by the position of the light source and the lower edge of the reflector, the reflector being adapted to direct the reflected light across the reflector axis and out through the reflector mouth at angles substantially parallel with the angle of cut-off, and a refractor intercepting said reflected light and transmitting it at higher angles above the nadir, the reflector being annular and the prisms on the refractor being asymmetrically disposed to produce beams asymmetric horizontally, and having portions of different refractive power to divert light toward the axis of the adjacent beam.

THOMAS W. ROLPH.