

Jan. 2, 1945.

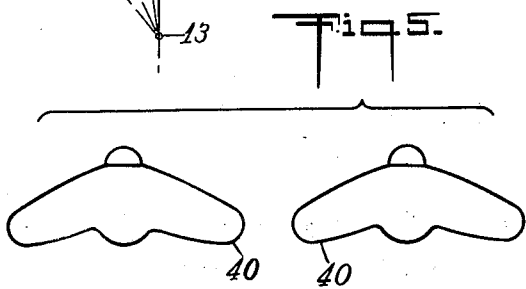
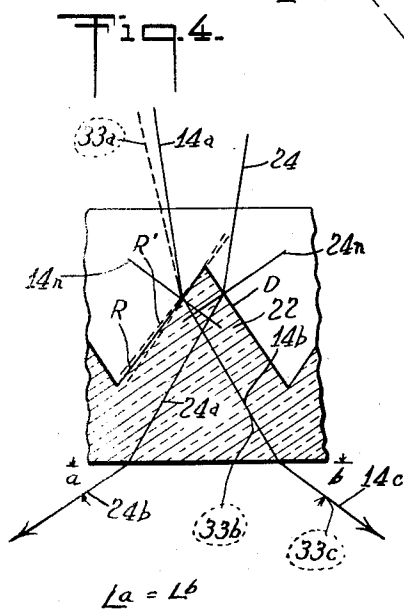
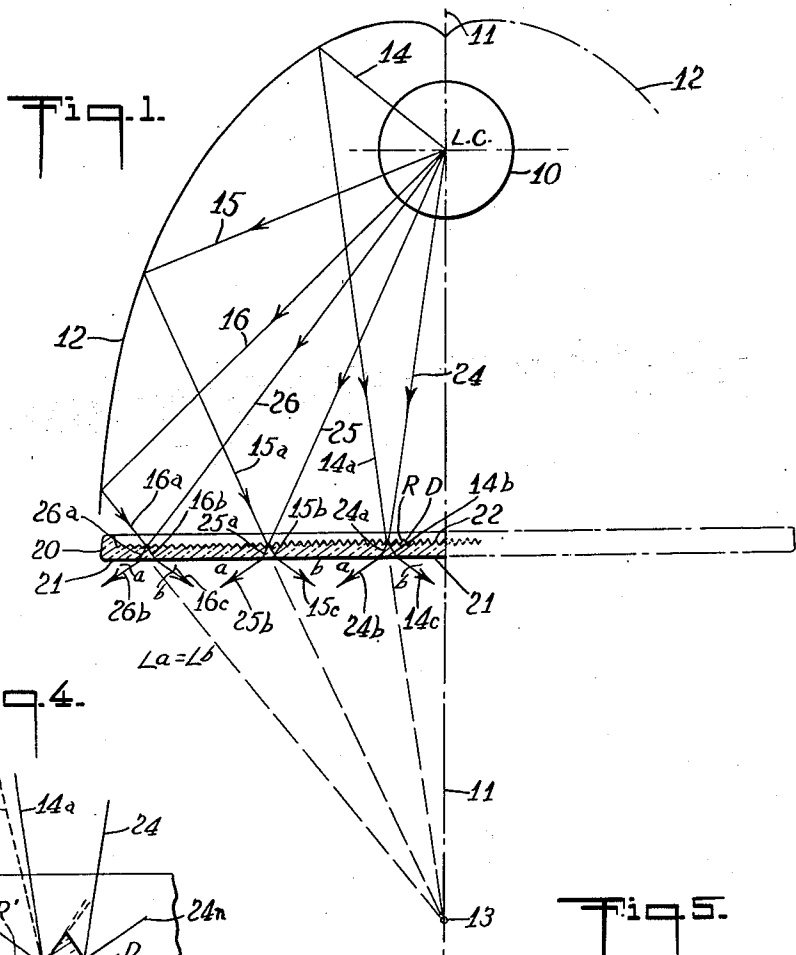
T. W. ROLPH

2,366,356

LUMINAIRE

Filed Oct. 14, 1942

2 Sheets-Sheet 1



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Fig. 2.

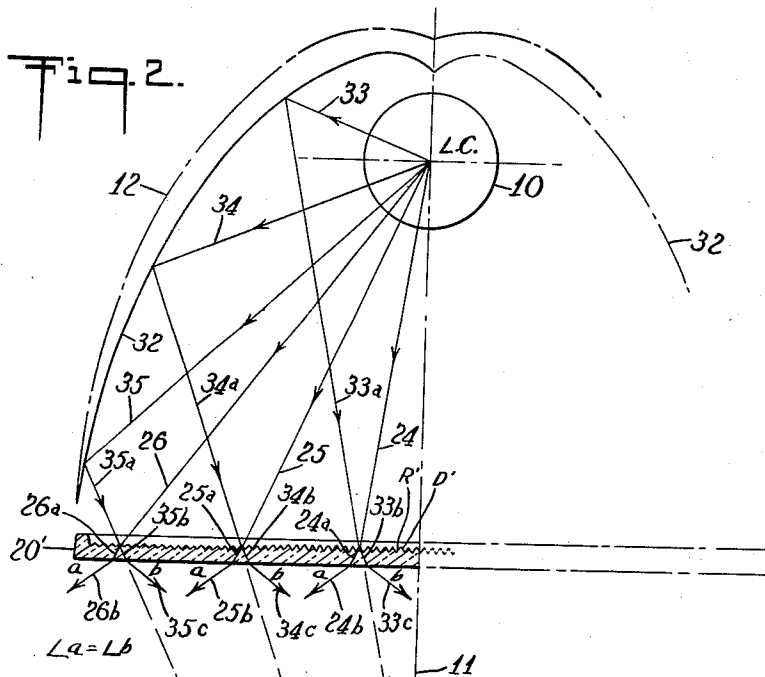
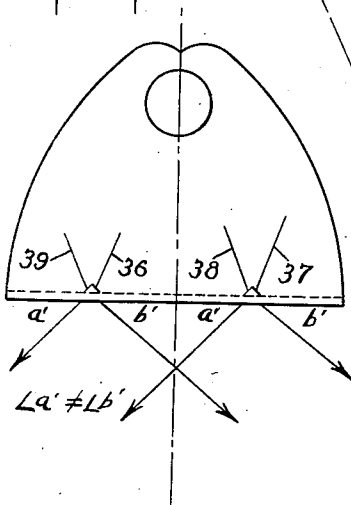


Fig. 3.



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## UNITED STATES PATENT OFFICE

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## LUMINAIRE

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8 Claims. (Cl. 240—93)

The present invention relates to luminaires, and is more particularly directed toward luminaires employing a reflector and a prismatic light transmitter for securing an extensive distribution of light, especially from long light sources.

The present invention contemplates a luminaire for this purpose having an inverted reflecting trough to receive the source and a prismatic plate across the mouth of the trough, and wherein the prismatic plate has alternate surfaces arranged to divert light received directly by them from the source away from nadir without having it cross the axis of symmetry of the luminaire, while the intermediate surfaces of the plate act to deliver light reflected to them by the reflector to the other side of the nadir at angles of elevation above the nadir usually corresponding with the vertical angles of the transmitted direct light.

The present invention is particularly directed toward luminaires designed for use in locations where much higher light intensities are desired at wider angles from nadir than at nadir, or where the spacing between luminaires is so great that high candlepower is required toward the area midway between the luminaires in order to obtain uniform illumination. While the invention is more especially adapted for long light sources, such as fluorescent lamps, it is also suitable for use in connection with filament source luminaires.

The accompanying drawings show, for purposes of illustrating the present invention, three embodiments in which the invention may take form, it being understood that the drawings are illustrative of the invention rather than limiting the same.

In these drawings:

Figure 1 is a vertical sectional view through a form of the invention employing symmetric prisms for symmetric distribution;

Figure 2 is a similar view of another form of the invention employing asymmetric prisms for symmetric distribution;

Figure 3 is a similar view of a form of the invention employing asymmetric prisms for asymmetric distribution;

Figure 4 is a diagram illustrating optical action; and

Figure 5 illustrates the type of distribution curve obtained.

In Figure 1 the light source is shown at 10 and the vertical plane of symmetry through the luminaire is indicated by the vertical line 11. The light source is received in a specular reflector having halves 12, 12 each of which, except for the portion directly above the source, is prefer-

ably of the contour of an ellipse with one focus at L. C. and the other focus at 13. For satisfactory results this reflector must be of a highly specular nature, such as properly treated aluminum, smooth silvered glass, or the like, or it may be ribbed and silvered glass of flat or other shape, the prisms thereon rendering it in effect a reflector form of desired contour. Light rays such as 14, 15 and 16 intercepted by the reflector are converged toward the point 13.

The mouth of the reflector of Figure 1 is closed by a prismatic plate or cover 20 having a smooth lower surface 21 and V-shaped prismatic ribs 22 on the upper surface, and in this figure the plate is placed halfway between the foci so that it occupies the position of the minor axis of the ellipse. With an ellipse of the eccentricity indicated the aperture of the reflector is shown to be in the neighborhood of 40° each side of the nadir, but this is subject to considerable variation.

It will be noted from the drawings that ribbings have faces D toward the axial plane and that these faces intercept direct rays, such as rays 24, 25 and 26, while the other faces R intercept the faces D intercept rays from the reflector, such as rays 14a, 15a and 16a. The diverging direct light, such as rays 24, 25 and 26, striking the surfaces D are bent away from the nadir and rendered parallel, in the glass or refracting medium used, as indicated at 24a, 25a and 26a, and are again bent farther from the nadir, retaining their parallelism and are emitted as indicated at 24b, 25b and 26b. For purposes of illustration these rays 24b, 25b and 26b are shown at approximately 55° to the nadir, but again the angle of the dominant light may be varied so long as too much light is not lost by internal reflections. The converging reflected rays 14a, 15a, 16a are refracted on striking the surfaces R, rendered parallel as indicated at 14b, 15b and 16b and are emitted at approximately the same angle to the nadir as the direct light rays but on the other side of the plane of symmetry as indicated at 14c, 15c and 16c.

As the basis for the construction illustrated in Figure 1 is the employment of a prismatic plate halfway between the source and conjugate focus of an elliptical reflector it is obvious that the line connecting the source L. C. and focus 13 forms the base of a series of isosceles triangles whose sides are the direct rays 24, 25 and 26 and the extensions of the lines 14a, 15a, 16a. Rays 14a, 15a and 16a therefore make the same angle with the vertical as rays 24, 25 and 26 but of opposite sign. As by hypothesis the lower surface of the plate is flat (although it may be somewhat con-

vex or concave) and the emergent light is spread symmetrically by each ribbing it follows that the surfaces R and D are at the same angle to the vertical but of opposite sign, and that each rib or prism is symmetric. The slopes of these surfaces vary from one rib or prism to the next in such a way that the surfaces D collimate the divergent direct rays and the surfaces R collimate the convergent reflected rays, the slopes of the collimated beams in the refracting medium being the same but of opposite sign. As the same amount of deviation takes place on the emergent surface the beams remain collimated and high intensities are built up at angles remote from the nadir.

It is also possible to embody the present invention in a construction having asymmetric ribs or prisms in the light transmitting plate. This will occur whenever the conjugate focus is nearer to, or farther from, the plate than the source, or whenever it is offset from the vertical axis of symmetry of the luminaire.

An arrangement is shown in Figure 2 in which the conjugate focus 30 for the left side of the reflector is considerably lower than in Figure 1 and to the right of the vertical axis of symmetry 11. The halves of the reflector form are indicated at 32, 32 and for purposes of comparison the reflector form 12 is indicated in Figure 2 in dotted lines. The prismatic cover or plate 20' of Figure 2 is shown at the same distance from the source and of the same size as in Figure 1.

The direct rays from the source L. C. at Figure 2 to the plate 20' are the same as those shown in Figure 1. The surfaces D' intercepting these rays are at the same slope as those shown in Figure 1 (and 4), and as the rays take the same paths as in Figure 1 the same reference characters are used to indicate the paths of the direct light in Figure 2. The rays 33, 34 and 35 from the source striking the reflector are returned as indicated at 33a, 34a and 35a and strike the other surfaces R' of the ribbings at altered angles from what the angles that similarly placed ribbings on the form shown in Figure 1 would have received reflected light, and as the deviation of these rays is such that the rays 33b, 34b, 35b in the glass or refracting medium are to be collimated at the same slope as before it follows that the surfaces R' of the ribbing are tilted at different angles to the vertical. The emitted rays 33c, 34c, 35c correspond with the rays 14c, 15c, 16c, respectively, of Figure 1.

The difference between the typical ribbing of the plate of Figure 1 and the plate of Figure 2 is indicated at an enlarged sketch in Figure 4. In this figure the ribbing of Figure 1, together with light ray paths is indicated in full lines, while the altered slope of the surface R' and path of the ray 33a incident thereon is indicated in light dotted lines. The figure also shows the normals 24n and 14n respectively. These normals are below the incident rays and their vertical angle varies from one rib to another.

Luminaires according to the present invention are usually alike on opposite sides of the central axis, and this is indicated in Figures 1, 2 and 4 by showing angle  $a$  equal to angle  $b$ . As all the light redirection is accomplished before the emitted light crosses the central axis it is possible to secure an asymmetric distribution by having the surfaces of the ribbings to one side of the axis which operate on direct light and the faces of the ribbings on the other side of the central axis which operate on reflected light produce a beam to one side of the luminaire which

has a different vertical angle than the beam produced by the remaining surfaces. This is shown in Figure 3 where the faces of the ribs receiving the direct light 36 on one side of the axis and the faces of the ribs receiving reflected light 37 on the other side of the axis deliver the light at an angle to nadir (for example 45°) which differs from the angle to nadir (for example 50°) of the light directed by the other faces of the ribs which act on direct light 38 and reflected light 39. Here angle  $a'$  does not equal angle  $b'$ .

It is also possible to embody the present invention in constructions in which the reflector form departs from the true ellipse and becomes what may be termed a quasi-ellipse or even an ogive, provided the light intercepting surfaces on the faces of the ribbons remote from the axis are adjusted to angles to properly deviate the light rays received by them.

While the light rays shown in the drawings are assumed as coming from a point source it will be obvious that owing to the size of the source there will be considerable diffusion and spreading. The overall result, however, is such that the output of the luminaire is spread at substantial angles away from the nadir at the expense of light in the region of the nadir. With long sources, such as fluorescent lamps, the reflector and ribbings are parallel, while with filament or point sources they are annular.

Typical light distributions from luminaires such as illustrated above may take the form indicated by the curves 40 of Figure 5. It will be noted that these curves show a much lower intensity in the region of nadir than at angles in the neighborhood of 45° to 55° above the nadir. This high angled light is available for lighting areas between remotely spaced units.

Since it is obvious that the invention may be embodied in other forms and constructions within the scope of the claims, I wish it to be understood that the particular forms shown are but a few of these forms, and 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 an open mouthed reflector about the source, each side of the reflector being of a profile to converge the reflected rays toward the plane of the mouth of the reflector without having them cross the reflector axis within the reflector, a light source in the reflector-axis and a prismatic light transmitting member across the reflector mouth, said member having a surface on the light incident side composed of V-shaped ribs whose surfaces facing the reflector axis have their normals such amounts below the direct light incident thereon that said direct light is spread away from the axis to a substantially uniform angle with respect thereto, and whose surfaces facing away from the reflector axis have their normals such amounts below the convergent reflected light incident thereon that said reflected light is diverted toward the reflector axis so as to cross the said axis and spread away from said axis at a substantially uniform angle with respect thereto.

2. A luminaire such as claimed in claim 1, wherein the sides of the reflector are symmetrical and the sides of the ribs are symmetrical.

3. A luminaire such as claimed in claim 1, wherein the sides of the reflector are symmetrical and the sides of the ribs are asymmetrical.

4. A luminaire symmetrical about a normally

vertical plane comprising a light source whose center is in said plane, a light transmitting plate below the source, a downwardly opening specular reflector about the source and of a profile to converge reflected light toward a region substantially below the plate and adjacent the plane of symmetry, the plate covering the mouth of the reflector and having prismatic ribs on its upper surface, alternate surfaces of the ribs facing the source and refracting direct light away from the nadir an amount such that the direct light emitted from the lower surface of the plate is at substantially uniform angles above the nadir, the intermediate surfaces of the ribs facing the reflector and refracting the light reflected onto them by the reflector so that it is emitted from the lower surface of the plate at angles above the nadir substantially the same as the angle of emission of the direct light, but of opposite sign so that reflected light is directed across the plane of symmetry.

5. A luminaire symmetrical about a normally vertical plane comprising a horizontal light source whose center is in said plane, a light transmitting plate below the source, a horizontal, inverted trough shaped specular reflector of a profile to converge reflected light toward a region substantially below the plate and in the neighborhood of the plane of symmetry, the plate covering the mouth of the reflector and having prismatic ridges on its upper surface parallel with the light source, the ridge surfaces which face the light source and the plane of symmetry having such variant slope decreasing with the distance from the plane of symmetry as to receive direct light as it spreads away from the nadir at each side of the plane of symmetry and refract it further away from the nadir in variant amounts for transmission from the lower surface in two beams of substantially parallel rays, the ridge surfaces facing away from the plane of symmetry and facing the reflector having such variant slope decreasing with the distance from the plane of symmetry as to receive reflected light as it converges toward said region below the plate and refract it away from the nadir in variant amounts for transmission from the lower surface in two beams of substantially parallel rays each of which crosses the plane of symmetry and merges with one of the beams composed of redirected direct light.

6. A refracting plate for increasing the spread of divergent light and for increasing the convergence of convergent light so that its rays will cross and diverge at the same angle of divergence as the divergently emitted light, said plate having a smooth light emergent surface and an opposite light incident surface composed of V-shaped ridges with straight sides and being symmetrical on opposite sides of an axis at right angles to the plate, the slopes of the axis-facing sides of the ridges continuously varying such that said divergent direct light falling on the ridges on each side of the axis and coming from an axially disposed source on the side of the plate having the ridges is refracted by the ridges into substantial parallelism in a direction oblique to the plate and is transmitted from the smooth surface as a substantially parallel beam diverging from said axis, the slopes of the other sides of the ridges continuously varying such that light falling thereon and converging toward a region

on the side of the plate opposite the said source is refracted by the ridges into substantial parallelism in a direction with an equal angle of obliquity to the plate but of opposite sign and is transmitted from the smooth surface as a substantially parallel beam which crosses the axis and proceeds in the same direction as the beam produced by the axis-facing surfaces of the ridges on the opposite side of the axis.

7. A refractor for increasing the spread of divergent light and for increasing the convergence of convergent light so that its rays will cross and diverge at the same angle of divergence as the divergently emitted light, said refractor being symmetrical on opposite sides of a central region and having a smooth light emergent surface and a succession of V-shaped ribs with straight sides and of varying refracting power from a maximum refracting power at the central region to a minimum refracting power at the lateral regions on the light incident surface, the refracting power of all the faces of the ribs facing toward the central region of maximum refracting power and on one side of said region being such that they will render substantially parallel divergent light falling thereon from a source on the same side of the plate as the ribs and opposite the region of maximum refracting power and deviate said light from said central region, the refracting power of all the faces of the ribs facing toward the regions of minimum refracting power being such that they will render substantially parallel light converging toward them and deviate said light toward said central region with substantially an equal angle of obliquity to the plane of the smooth surface.

8. A normally horizontal light refracting and transmitting plate of substantially even thickness and having its lower light emergent surface smooth and its upper light incident surface composed of inverted V-shaped ridges with straight sides and apex angles which increase from a minimum in the central region of the plate to a maximum at the more remote regions, the slopes of the surfaces facing the central region being such that their normals have such angles of incidence to light rays diverging from a point a predetermined distance above the central region of the light incident side of the plate that the refracted rays on the plate are directed away from said central region brought into substantial parallelism and directed downwardly and outwardly toward the light emergent surface at angles of incidence less than the critical angle whereby such light is refractively transmitted as a downwardly and outwardly diverging beam of parallel rays, the slopes of the surfaces facing away from the central region being such that their normals have such angles of incidence to light rays incident thereon and converging toward a point below the central region of the plate that the refracted rays in the plate are directed toward said central region, brought into substantial parallelism and directed downwardly and inwardly toward the light emergent surface at angles of incidence of opposite sign to the angle of incidence of the first mentioned rays and less than the critical angle and with a substantially equal angle of obliquity to the plate whereby the latter mentioned light is refractively transmitted downwardly and inwardly.

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