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LUMINAIR

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Fig. 1

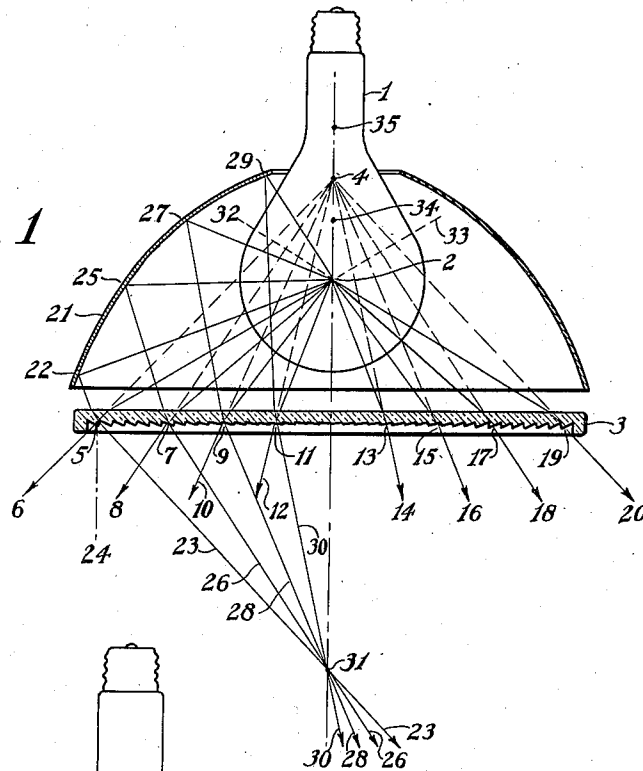
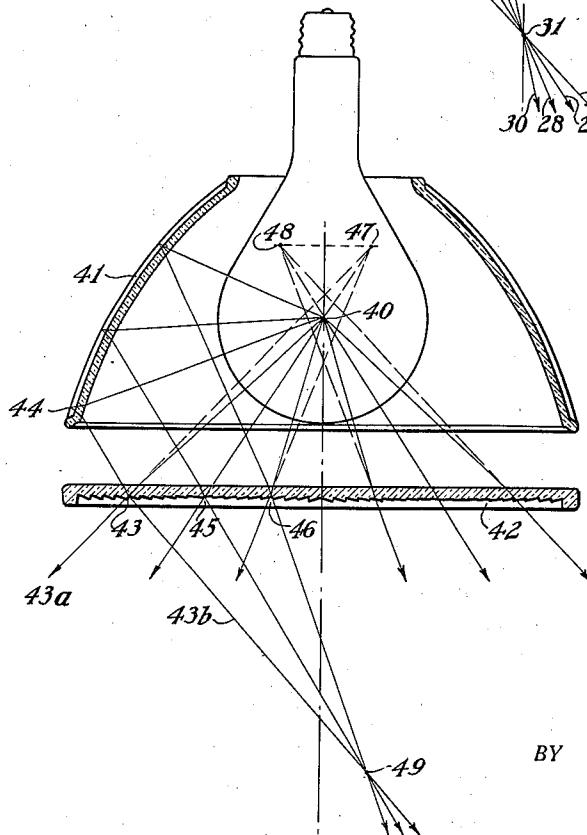


Fig. 2



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LUMINAIR

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5 Claims. (Cl. 240—93)

The present invention relates to luminaires, and more particularly to luminaires designed for interior illumination and employing a reflector and a lens in association with a light source, the lens acting on both reflected and direct light.

Lens-reflector combinations heretofore in use for interior illumination (as distinguished from signals, headlights and the like) have generally used a spherical reflector behind the light source so that the reflected light falls on the lens at the same angles as the direct light and increases emitted light without substantially changing the spread. The angle through which the spherical reflector can be used effectively is limited to the angle subtended by the lens and hence the spherical reflector-lens combination is of limited efficiency. In cases where the reflector has been made deep and its contour altered to allow the light to spread out from the lens, it has been found that bright spots and undesirable appearances were obtained at wide angles of view. These effects were the result of the reflected light striking the lens prisms at undesirable angles.

The present invention contemplates a luminaire having a reflector and lens each designed in such a way as to cooperate in giving intensive lighting with a considerably higher efficiency than heretofore available. According to the new design the reflector, which can be prismatic or opaque, is made deep and the prisms on the lens are arranged to properly control both the direct light and the reflected light.

In practice it has been found that an effective means for securing the high efficiency without undesirable lighting effects comprises a lens receiving light from a light source and reducing its spread, and a cooperating reflector also receiving light from the light source and directing it to the lens at angles such that the distribution of light obtained from the lens is the same with direct light and with reflected light, the only difference being that from any point on the lens, direct light is delivered on one side of a line drawn through said point and parallel with the axis of the system, while reflected light is delivered on the other side of the same line.

The accompanying drawing shows, for purposes of illustrating the present invention, two of the many embodiments in which the invention may take form, it being understood that the drawing is illustrative of the invention rather than limiting the same.

In the drawing:

Figures 1 and 2 are sectional views through luminaires embodying the present invention.

In Figure 1 of the drawing the lamp is shown at 1 and the light center at 2. A lens reduces the spread of light from the light source 2 so that the virtual center for light emitted from the lens is 4. Light rays are shown in light solid lines. Virtual light rays are shown in dash lines. For a typical point 5 on the lens, the light ray 2—5 from the light center 2 is refracted by the lens prisms so that it emerges in the direction 5—6, as if it were emitted from virtual light center 4 without refraction. Similarly at point 7, light ray 2—7 from light center 2 is refracted so that it emerges in direction 7—8, the same as if it were emitted from virtual light center 4 without refraction. Similarly for typical points 9, 11, 13, 15, 17, and 19, the light rays from light center 2 are refracted so that they emerge in directions 9—10, 11—12, 13—14, 15—16, 17—18 and 19—20 respectively, all as if emitted from point 4.

A reflector form is shown at 21. The shape of the reflector form is such that light ray 2—22 striking the reflector at point 22 is reflected to point 5 on the lens. It is refracted by the lens so that it emerges from the lens in direction 5—23, this direction being at the same angle from the normal to the lens as 5—6 which is the direct light emerging from point 5. Thus if 5—24 is the normal to the lens at point 5, the angle 6—5—24 is the same as angle 23—5—24. Similarly the reflector contour 21 is such that light ray 2—25 striking the contour at point 25 is reflected to point 7 on the lens and emerges in direction 7—26 at the same angle from the normal to the lens as direct light ray 2—7—8. Similarly for all points on the contour of the reflector. Typical points 27 and 29 are shown with light rays reflected to points 9 and 11 on the lens at angles such that the emerging light rays 9—28 and 11—30 are at the same angle from the normal to the lens as light rays 9—10 and 11—12 respectively.

From the geometry of this construction it will be clear that light rays reflected by the reflector and refracted from the lens will come to a focus at point 31 below the lens, the distance of point 31 below the lens being the same as the distance of virtual light center 4 above the lens. Therefore, the entire construction will deliver light from two virtual light centers, 4 and 31, and the light distribution obtained from these points will be identical.

In any cross-section through the complete construction, the lefthand side of the lens will be delivering light received directly from the lamp and emitted in a predetermined light distribution directed toward the left of the center of the lens.

The same lefthand side of the lens will be receiving light reflected from the reflector and emitted from the lens in exactly the same predetermined light distribution, but with sign reversed, so that it is directed toward and across the axis of the lens.

In actual practice when such a construction as this is used in rooms of usual ceiling height, the difference in position of virtual light centers 4 and 31 becomes negligible so that in effect the same lighting result is obtained from both centers. At any point in a room the near side of the lens is delivering light received by the lens directly from the light source and refracted to the given point, while the far side of the lens is delivering light reflected from the reflector and then refracted by the lens toward the same point in the room.

In previous combinations of lenses and reflectors (such as above referred to) it has been customary to use a spherical reflector back of the lamp. Such a reflector reflects the light back on its own path through the light center to be acted upon by the lens in the same way that direct light is acted upon. The amount of light included by the lens directly from the lamp is indicated by angle 5-2-19. A spherical reflector above the lamp will be of value only within the angle 32-2-33, the line 2-32 being line 19-2 extended and the line 2-33 being line 5-2 extended. This spherical reflector would, therefore, intercept only a small part of the light going upward from the lamp. The rest of the light included in angles 5-2-32 and 19-2-33, cannot be reflected to the lens to be refracted into directions desired and hence such constructions are necessarily inefficient. It will be apparent that the new construction described above can use a deep reflector intercepting practically all of the light which is not caught by the lens direct. The reflector not only intercepts such light but returns it to the lens in directions such that the reflected light is emitted from the lens in exactly the same light distribution as the direct light. Thus high efficiency and correct light distribution is obtained.

The reflector may be of any material whatever giving specular reflection of light such as polished metal, mirrored glass, reflecting prisms, etc. Even diffusely reflecting material insofar as it has a specularly reflected component will operate in accordance with the idea of this construction. The lens is usually of Fresnel or stepped outline, although in some instances a double convex lens may be used.

The above is a description of the construction in its simplest geometrical form. Many variations may be introduced to satisfy varied requirements from the standpoints of light distribution and mechanical construction. For example, a certain light distribution desired may not have its light center at a point such as 4 in this figure, but may be such that there is no one point which is its virtual light center. In a typical case of this kind, the virtual light center for various directions of light required at the various angles from the vertical may move back and forth between points like point 34 and point 35. In this case, the locus of the virtual light center will be the line connecting points 34 and 35. The lens will be designed to give this exact light distribution; then the reflector will be designed to give the same light distribution with the reflected light directed by the lens toward the opposite side of the lens axis. The

principle involved will be the same and all the advantages obtained will be the same but the distribution instead of being the distribution which may result from a single center 4 will be an exact distribution having no definite center for every light ray from the lens but filling the needs of some particular lighting requirement.

In the construction shown in Figure 2, the light source is indicated at 40, the reflector (of prismatic or other material) at 41 and the lens plate at 42.

The lens prisms are designed to receive light both direct and from the reflector, and at any point such as 43, on the lens the prisms spread the direct light 40-43 at a certain angle such as 43a one side of the vertical and the reflected light 40-44-43 at the equal angle 43b on the opposite side of the vertical. The direct light is depressed slightly by the lens prisms while the reflected light is elevated by the same prism and leaves the lens at the same angle on the opposite side of the vertical. Similarly at point 45 on the lens which happens to be a point where prism angles change direction. Here the direct light goes straight through and the reflected light goes straight through, the design being such that these two light rays leave at the same angle from the vertical but on opposite sides. Similarly for other points on the lens. In this design, the lens prisms outside of 45 are depressing prisms while the lens prisms inside of 45 are elevating or spreading prisms. 46 is a point on the lens inside of point 45 and hence the prism at 46 elevates slightly the light direct from the lamp and depresses slightly the light reflected from the reflector.

A lens like that illustrated in Fig. 2 does not produce a virtual light center at a point such as point 4, Fig. 1. In the cross-section shown in Fig. 2, the left-hand side of the lens produces a virtual center for the direct light at point 47 and the right-hand side of the lens produces a virtual center for the direct light at point 48. The construction of the reflector to cooperate with the lens brings the reflected light from the left-hand side of the lens to a focus or point 49. This is located below the lens a distance equal to the distance point 47 above the lens. The reflected light from the right-hand side of the lens would come to a focus at a point corresponding to 49 but on the other side of the axis of the system.

Where the prisms are concentric, the virtual center will move around in a horizontal ring or circle of which points 47 and 48 are two opposite points on the circumference. Just as in Fig. 1, it was stated that the virtual center might not be a point but might be a locus on the line 34-35, so in Fig. 2, the locus of the virtual center is a horizontal circle whose diameter is the line 47-48. Therefore, the lens brings reflected light to a focus in a ring or circle the same size as circle 47-48 but located below the lens at a position exactly corresponding to 47-48 above the lens. 49 is one point on this lower circle.

The reflector is designed to cooperate exactly with this lens so that no matter what the lens prisms at any one point are doing, the light emitted from that point will always include light from the lamp emitted on one side of the normal and light from the reflector emitted at exactly the same angle on the other side of the normal.

Where a substantially point light source is employed the reflectors of Figures 1 and 2 will be annular and the lens plates will have concentric prisms. Where a long light is employed the re-

flectors will be trough shaped and the lens plates a series of parallel prisms. The description above given would then refer to a typical transverse section.

5 With this new design one can use a reflector as deep as desired because the prisms on the lens are designed to do the right thing to both the reflected light and the direct light. The only limit in depth of reflector is that, in case of a square lens, it must be placed far enough above the lens to allow direct light to reach the corners of the lens for reasons of appearance. If the lens were round, the reflector could be carried right down to contact with the lens.

15 This great depth of reflector tends to increase lens efficiency materially. Furthermore, the reflector shape itself is one which is more efficient than a spherical shape, first because it returns less light through the lamp bulb itself and second because prismatic reflectors act more efficiently when light strikes the surface at an angle than when light strikes the surface normally.

20 Luminaires constructed as herein shown are specially well adapted for flush mounting and for use in general illumination. They give a sufficient spread of beam to avoid the expense of close spacing at ordinary mounting heights.

What is claimed is:

1. A luminaire comprising a light source, an open-mouthed reflector about the light source and a prismatic light transmitting member disposed across the mouth of the reflector to intercept direct and reflected light and refractively transmit the same, the reflected light being received by the prismatic member at a different angle from the reflector axis than that of the direct light incident on the same area of the transmitting member, the prisms being of variant refractive power to refract said reflected light to emerge at each point at substantially the same angular divergence from the reflector axis as that of the direct light refracted from said point and on the opposite side of the axis.

2. A luminaire as claimed in claim 1, wherein

said prisms include outer light concentrating prisms and inner light spreading prisms.

3. A luminaire as claimed in claim 1, wherein each cross-section of the construction delivers from the prismatic transmitting member a given light distribution with virtual center above the member and made up of light direct from the lamp and the same distribution with virtual center below the member and made up of light directed from the reflector.

4. A luminaire comprising a light source, an open mouthed light converging reflector about the light source and a flat light transmitting and refracting member disposed across the mouth of the reflector and positioned in relation thereto so that the reflected light is received by the member at a different angle from the normal to the said member than that of the direct light incident on the same area of the transmitting member; said member being provided with prisms of variant refractive power to refract said reflected light to emerge at each point at substantially the same angular divergence from the normal to the transmitting member at that point as that of the direct light refracted from said point and on the opposite side of the normal at said point.

5. A luminaire comprising a light source, an annular reflector about the light source having a cross section to converge reflected rays toward the reflector axis beyond the mouth of the reflector, and a coaxial lens having annular prisms of variant refractive power, each prism intercepting the diverging direct light and refracting it in a manner to decrease the divergence thereof so that the virtual source of the direct light is substantially along the axis but further from the lens than the true source, each prism of the lens refracting the reflected light toward the axis to increase the convergence thereof so that the virtual source of the reflected light is substantially along the axis, the lens being substantially equidistant from the two virtual sources.

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