United States Patent [19]

Stahlhut

[11] **3,735,124**

[45] **May 22, 1973**

[54] PRISMATIC LENSES FOR LIGHTING FIXTURES

[75] Inventor: **Leo G. Stahlhut**, Kirkwood, Mo.

[73] Assignee: **Emerson Electric Co.**, St. Louis, Mo.

[22] Filed: **Aug. 5, 1971**

[21] Appl. No.: **169,303**

[52] **U.S. Cl.** ....**240/106 R**, 240/106.1

[51] **Int. Cl.** **F21v 5/04**

[58] **Field of Search** ....240/93, 78 LD, 106 R, 240/106.1, 146, 147; 350/168, 188

[56] **References Cited**

UNITED STATES PATENTS

3,234,376	2/1966	Ceglia	240/106 R
593,045	11/1897	Cummings	240/106.1

FOREIGN PATENTS OR APPLICATIONS

8,324	9/1909	Great Britain	240/106 R
620,639	3/1949	Great Britain	240/106 R

Primary Examiner—Samuel S. Matthews
Assistant Examiner—Russell E. Adams, Jr.
Attorney—Gravely, Lieder & Woodruff

[57] **ABSTRACT**

A prismatic lens for an overhead lighting fixture is formed from a transparent material and has a lower face composed of a plurality of arcuate surfaces arranged side-by-side. These surfaces form convex magnifying segments or lenticules in the lens. The opposite or upper face is composed of a plurality of V-shaped depressions extending downwardly from a generally flat intervening surface. The depressions are located behind and centered relative to the arcuate surfaces, whereas the intervening surfaces are positioned directly behind the junctures of adjacent arcuate surfaces. The prismatic lens diverts light rays emanating from a light source behind it primarily into zones disposed oblique to the lens so that the intensity of illumination is minimal in the reflected glare zone located directly beneath the lens and in the direct glare zone located generally to the side of the lens, but is maximum in the oblique zones located between the reflected and direct glare zones. This distribution provides the most pleasant and comfortable illumination for most visual observations performed beneath the fixture.

19 Claims, 13 Drawing Figures

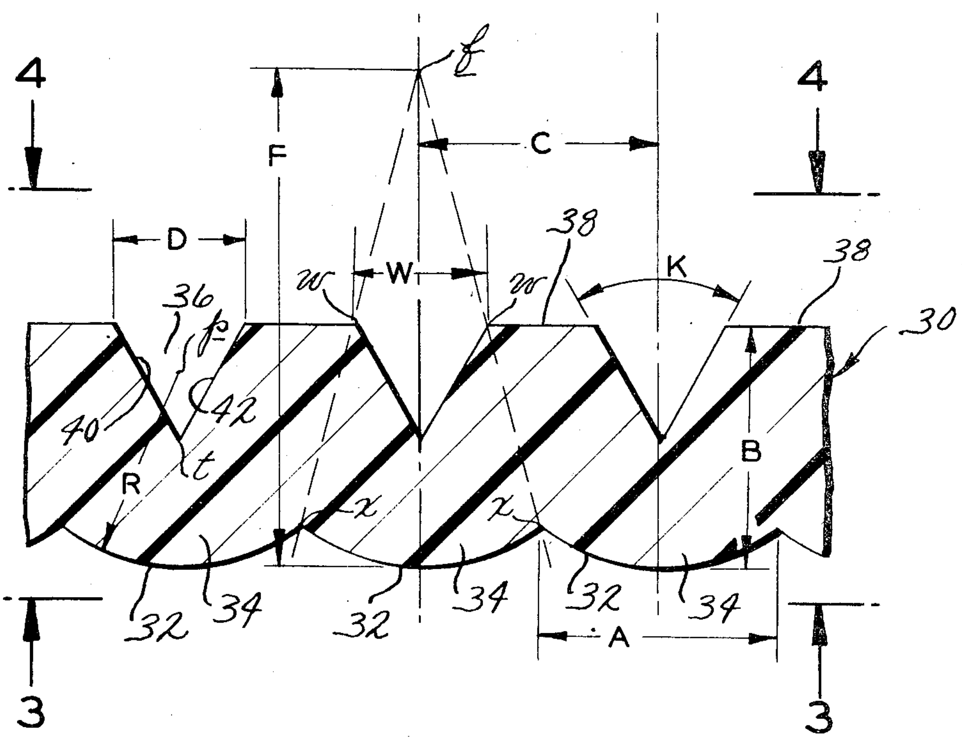


FIG. 1

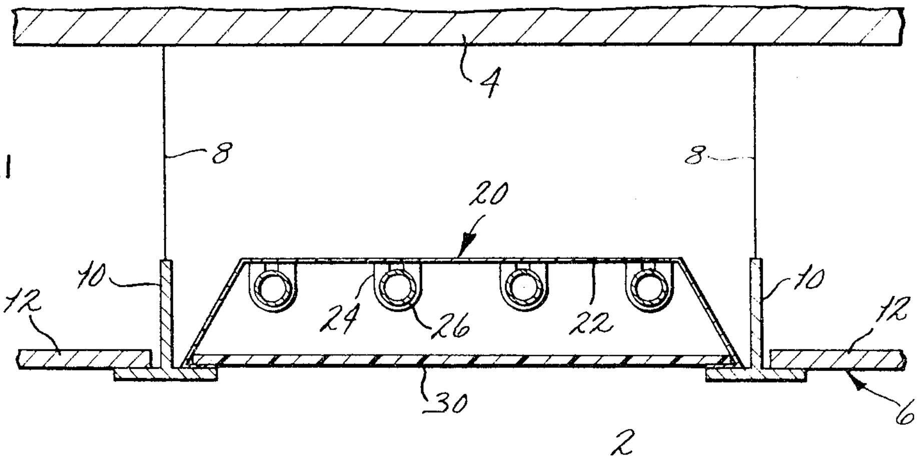


FIG. 2

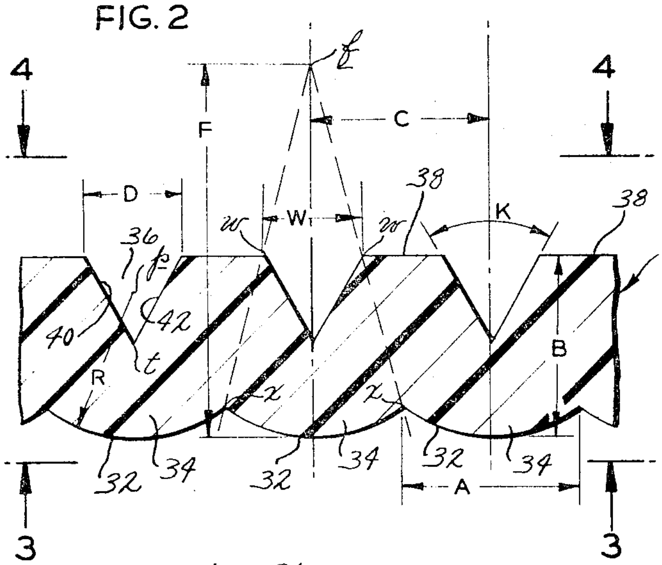
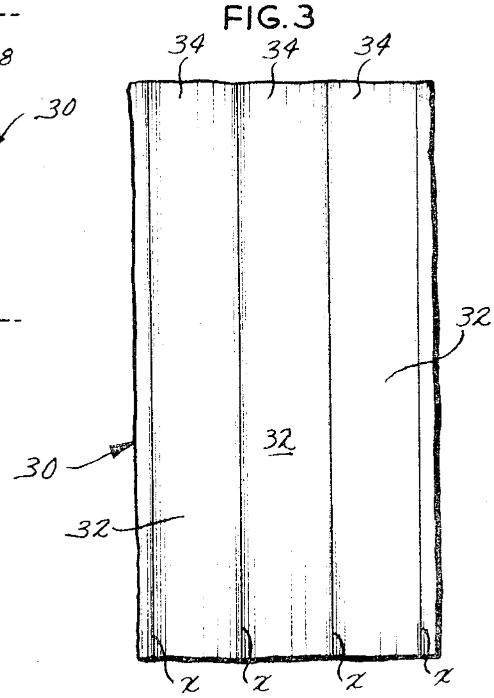


FIG. 3



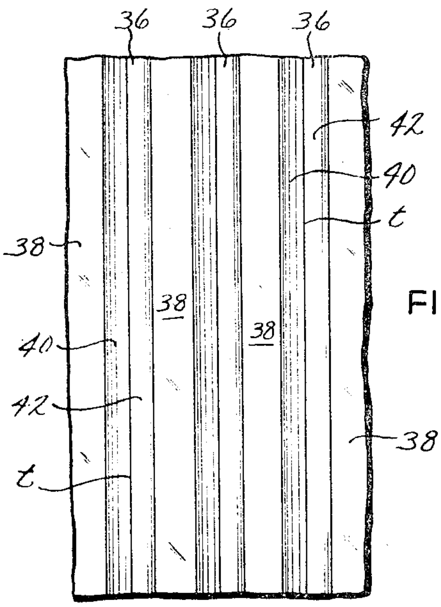


FIG. 4

INVENTOR

LEO G. STAHLHUT

BY Gravely, Lieder & Woodruff

ATTORNEYS

FIG. 5

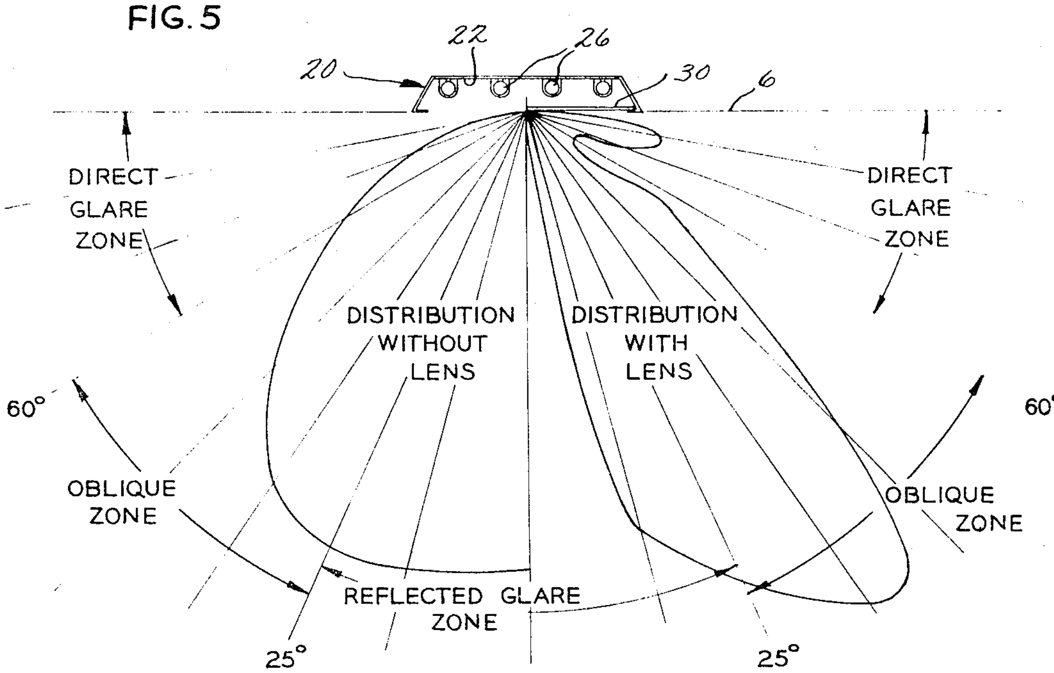
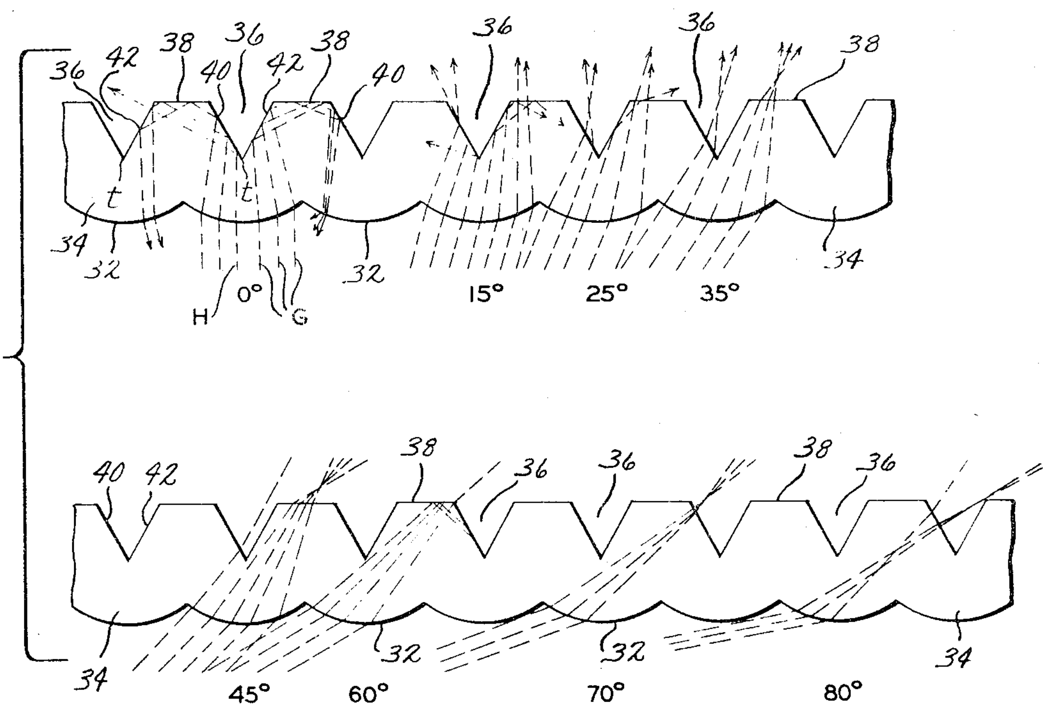


FIG6



INVENTOR

LEO G. STAHLHUT

BY Gravely, Lieder & Woodruff

ATTORNEYS

FIG. 7

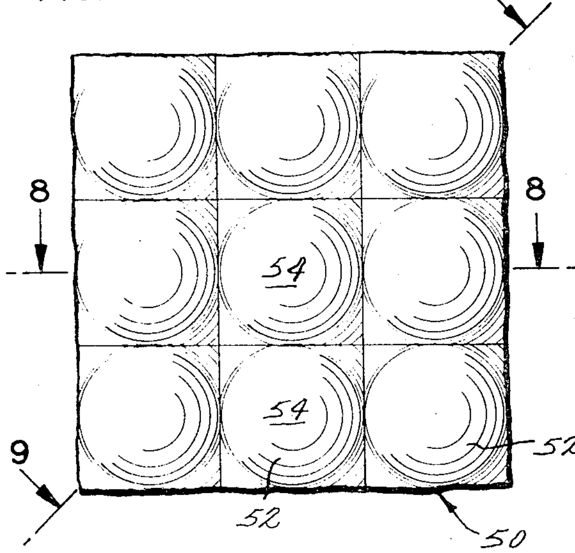


FIG. 10

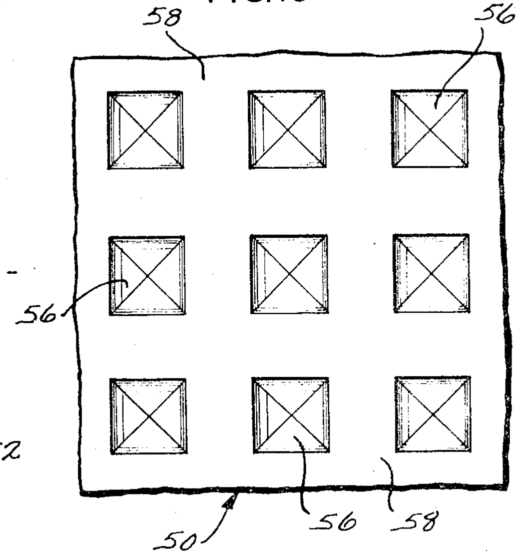


FIG. 8

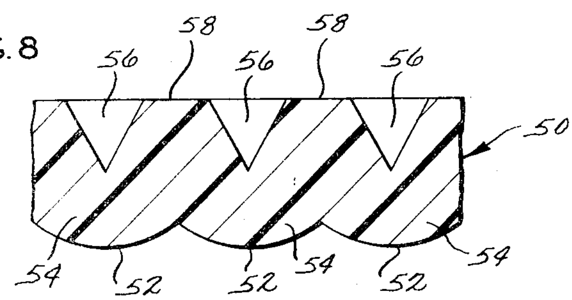
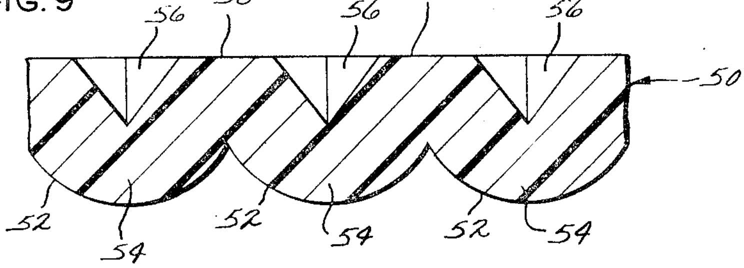


FIG. 9



INVENTOR

LEO G. STAHLHUT

BY Gravely, Lieder & Woodruff

ATTORNEYS

FIG. 11

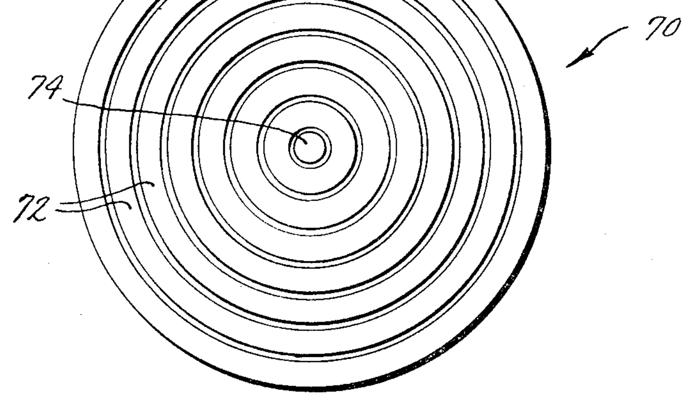


FIG. 12

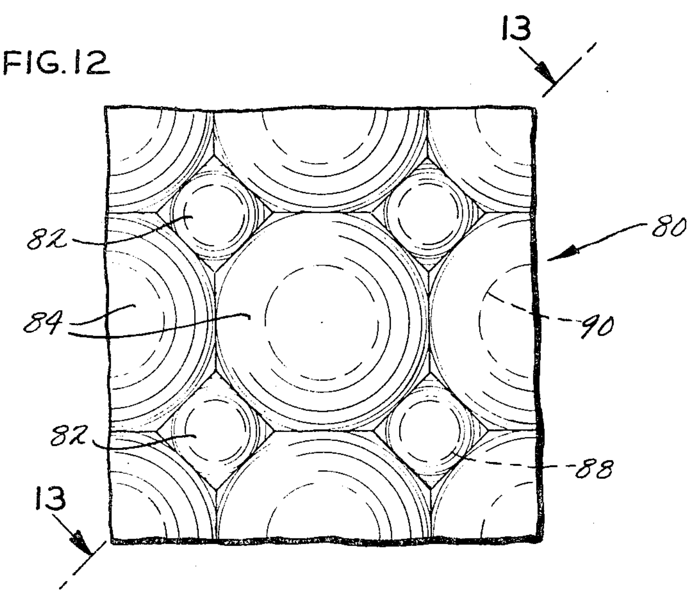
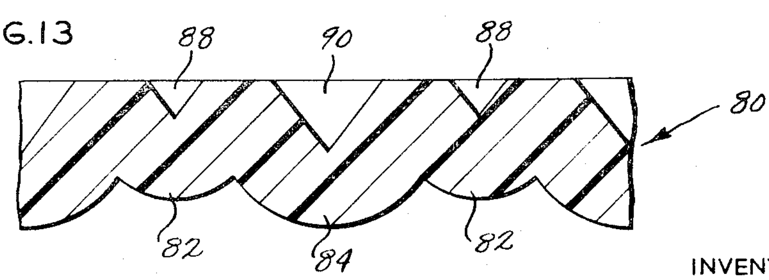


FIG. 13



INVENTOR

LEO G. STAHLHUT

BY Gravely, Lieder & Woodruff

ATTORNEYS

PRISMATIC LENSES FOR LIGHTING FIXTURES

BACKGROUND OF THE INVENTION

This invention relates to lighting devices and more particularly to lenses for lighting fixtures.

Extensive research in the field of overhead lighting has developed that light rays emitted obliquely with respect to the horizontal or vertical produce the most pleasant and comfortable lighting conditions for offices and most other applications where overhead lighting is employed. Indeed, lighting engineers consider it desirable to concentrate most, if not practically all, of the liqht emitted from overhead fixtures in oblique zones extending between about 25° to 60° with respect to the nadir, that is with respect to a line extending vertically from the fixture. Light which leaves the fixture at greater angles, that is at angles approaching the horizontal, produces a condition known as direct glare. This simply means that one looking across the room observes glare from the overhead light fixtures, and when the intensity of illumination in this zone is high, the direct glare becomes annoying and extremely uncomfortable. On the other hand, light rays which leave the fixture at lesser angles, that is at angles approaching the vertical or nadir, produce a condition known as reflected glare. This condition results in a large amount of reflection from horizontal working surfaces such as desk tops and any printed matter on those surfaces, and when that reflection is of a high intensity visual work performed at such surfaces becomes uncomfortable, although the source of the discomfort may not be readily apparent to the worker. For purposes of comparison reflected glare may be equated to the glare observed when reading a newspaper in direct sunlight, whereas the more comfortable lighting effect derived from oblique light rays in the oblique zone may be equated to reading the same newspaper in the shade. Lighting engineers describe the desired oblique concentration of illumination as a "batwing" pattern or distribution.

Heretofore, lighting engineers have eliminated direct glare to a large measure by installing baffles on lighting fixtures. These baffles, however, are large and unsightly and not compatible with present architectural practices. Moreover, they make lighting fixtures unnecessarily complicated. Aside from baffling, so-called prismatic lenses have been developed for lighting fixtures and these lenses substantially reduce the intensity of direct glare from overhead lighting fixtures.

Insofar as the reflected glare is concerned, diffusing panels have been developed which reduce such glare considerably, but not enough to eliminate all discomfort from high intensity fixtures. Furthermore, diffusing panels do not eliminate or for that matter even significantly reduce direct glare.

Currently, prismatic lenses are being produced which significantly reduced both direct and reflected glare. These lenses, however, require opaque coatings at critical areas on their surfaces and as a result they block some of the light which might otherwise be emitted from the light fixtures. In other words, they reduce the efficiency of the lighting fixture. Furthermore, the opaque coatings necessitate an additional production step, adding appreciably to the cost of the lenses.

SUMMARY OF THE INVENTION

One of the principal object of the present invention

is to produce a prismatic lens which concentrates the light emitted from overhead lighting fixtures in oblique zones. Another object is to produce a lens of the type stated which substantially eliminates both direct glare and reflected glare, and accordingly distributes light from an overhead fixture in a manner which is comfortable and pleasant to one working beneath it. A further object is to produce a fixture lens of the type stated which is highly efficient. An additional object is to produce a lens of the type stated which is easy and economical to manufacture. Still another object is to produce a lens of the type stated which is attractive in appearance and does not conflict with contemporary architecture. Yet another object is to provide a lenticule for providing a fixture lens with the foregoing advantages. These and other objects and advantages will become apparent hereinafter.

The present invention is embodied in a transparent lens having a plurality of arcuate surfaces arranged side-by-side on one face and inclined surfaces forming depressions in the opposite face. An intervening surface extends between each depression. Each arcuate surface forms a separate lenticule and the invention further resides in the individual lenticules. The lens concentrates rays in zones oblique to it. The invention also consists in the parts and in the arrangements and combinations of parts hereinafter described and claimed.

DESCRIPTION OF THE DRAWINGS

In the accompanying drawings which form part of the specification and wherein like numerals and letters refer to like parts wherever they occur:

FIG. **1** is a sectional view in elevation showing a ceiling containing a light fixture provided with a lens constructed in accordance with and embodying the present invention, details of contour being omitted from the lens inasmuch as they are illustrated in enlarged form in FIG. **2**;

FIG. **2** is a transverse sectional view of the lens;

FIG. **3** is a plan view taken along line **3—3** of FIG. **2** and showing the underside of the lens;

FIG. **4** is a plan view taken along line **4—4** of FIG. **2** and showing the top surface of the lens;

FIG. **5** is a sectional view of the lighting fixture showing its light distribution with and without the lens, the light distribution being graphed in polar coordinates;

FIG. **6** is a sectional view of the lens showing various light rays in the lens;

FIG. **7** is a plan view showing the underside of a modified lens;

FIGS. **8** and **9** are sectional views taken along lines **8—8** and **9—9**, respectively, of FIG. **7**;

FIG. **10** is a plan view showing the top surface of the modified lens illustrated in FIG. **7**;

FIG. **11** is a plan view showing the underside of another modified lens;

FIG. **12** is a fragmentary plan view showing the underside of still another modified lens; and

FIG. **13** is a sectional view taken along line **13—13** of FIG. **12.**

DETAILED DESCRIPTION

Referring now to the drawings (FIG. **1**) **2** designates a room having a ceiling **4** from which a false ceiling **6** is suspended by means of wires **8** and a grid formed by crossed T-bars **10.** Aside from the T-bars **10,** the false ceiling 6 includes ceiling panels 12 which occupy some of the grid spaces and lighting fixtures 20 which occupy the remaining grid spaces. Actually, the sides and ends of the panels 12 and fixtures 20 rest upon the horizontal flanges of the T-bars 10 and are easily removed for access to the true ceiling 4 or pipes and other conduits extending between the true ceiling 4 and the false ceiling 6.

Each lighting fixture 14 includes (FIG. 1) a reflector 22 which is configured to reflect light downwardly into the room 2, a plurality of sockets 24 positioned in front of the reflector 16, and a series of fluorescent lamps 26, the ends of which fit into and are engaged with the sockets 24. In addition, each lighting fixture 20 is provided with a prismatic lens 30 which extends completely across the reflector 22 in front of the fluorescent lamps 26 and lies generally flush with the ceiling panels 12. The prismatic lens 30 completely masks the lamps 26 and reflector 22 and concentrates the light emitted from the lamps 26 in oblique zones extending on each side of the nadir.

The prismatic lens 30 is formed as an integral unit from any suitable transparent material such as clear acrylic or polycarbonate plastic or glass. The lens 30 possesses a lenticular pattern, meaning that its light refracting and light reflecting surfaces are substantially greater in length than breadth and normally extend longitudinally of the lens 30 and fixture 20. Consequently, the prismatic lens 30 may be formed in an extruding operation, provided, of course, that the transparent material of the lens 30 is capable of being extruded.

The downwardly presented face of the lens 30, that is the face presented away from the lamps 26 and toward the interior of the room 2, is composed of (FIGS. 2 and 3) a plurality of longitudinally extending arcuate surfaces 32 which are positioned side-by-side and intersect at lines x. Each surface 32 forms a segment of an arc having a radius R which emanates from a center p located to the rear of the surface 32. In effect, the surfaces 32 form convex lenticules or lens segments 34, which are cylindrical magnifiers in the lens 30. The focal point of each lens segment 34 is located at a point f, or more accurately at a line f, which is disposed behind the lens 30 and is centered relative to the arcuate surface 32 forming the lens segment 34. The distance from the center of the arcuate surface 32 to the focal point f represents the focal length F of the lens segment 34, and as is the case with cylindrical lenses in general, this distance F is approximately 2½ to 2¾ times greater than the radius R of the arcuate surface 32. The distance between the lines x—x at each side of every lens segment 34 is termed the width A of the lens segment 34.

The opposite or rear face of the lens 30, that is the face presented toward the lamps 26, is composed of (FIGS. 2 and 4) a plurality of V-shaped grooves 36 which are disposed directly behind the arcuate surfaces 32 and are separated by intervening surfaces 38 which are located directly behind the lines x forming the intersections of the arcuate surfaces 32. The intervening surfaces 38 are normally planar and coplanar with respect to each other, and they lie in a plane which is parallel to and located above the horizontal center plane of the lens 30. Each surface 38, however, may be curved slightly or composed of a pair of intersecting flat surfaces disposed at an angle no greater than 15° with respect to the horizontal center plane of the lens 30. The greatest vertical distance between the intervening surface 38 and the lowest point along the arcuate surfaces 32 is called the thickness B of the lens 30. Lines interconnecting the focal point f and the lines x—x at the sides of the lens segment 34 intersect the plane defined by the intervening surfaces 38 at points, or more accurately lines, w—w which are spaced a distance W apart.

Each groove 36 (FIGS. 2 and 4) is defined by a pair of planar side surfaces 40 and 42 which are disposed at an angle K with respect to each other and intersect each other at a line t which is centered relative to the corresponding arcuate surface 32. The distance between the lines t of adjacent grooves 36 represents the spacing C between adjacent grooves 36. The side surfaces 40 and 42 also intersect the intervening surfaces 38 and the spacing between the lines of intersection so formed is termed the width D of the groove 36.

Since the convex lens segments 34, the grooves 36, and the intervening surfaces 38 are substantially greater in length than in width and furthermore possess the same transverse cross-sectional shape anywhere along the lens 30, the lens 30 is classified as a lenticular lens arrangement as oposied to a spherical lens arrangement.

In the prismatic lens 30 the following relationships between the foregoing dimensions should exist:

A. The width A of the lens segment 34 should equal the spacing C between the grooves 36.

B. The thickness B of the lens 30 should be between approximately 0.75 and 1.50 the radius R of the arcuate surfaces 32.

C. The width D of the groove 36 should be between 0.50 and 1.25 the distance W between the lines w—w.

D. The groove angle K should be between 40° and 78° and preferably 60°.

In operation, the fluorescent lamps 26 emit light rays which pass outwardly through the prismatic lens 30 and illuminate the room 2. Behind the lens 30 the combined effect of the rays emitted directly from the lamps 26 as well as the rays reflected from the reflector 22 results in a large concentration of rays directly below the lamps and this concentration diminishes as the angle from the normal or nadir increases (see FIG. 5, left side). In other words, the illumination provided by the fixture 20 alone has its greatest intensity directly below the fixture 20, that is along the nadir, and the intensity becomes progressively less as the angle from the vertical increases. Thus, without the lens 30 the fixture 20 would produce high intensity illumination in the reflected zone directly beneath it, and this in turn would produce uncomfortable and annoying reflection from horizontal working surfaces in the room 2 as well as from objects on those surfaces. The fixture 2 absent its lens 30 would also furnish a substantial illumination in the oblique zones on each side of the reflected zone, and would further cause significant illumination in the direct glare zone. The latter, of course, would be annoying to one looking directly across the room 2. The prismatic lens 30 through refraction of the light rays redistributes the rays in a more pleasing pattern and in particular distributes the rays such that the intensity of illumination is greatest in the oblique zones (see FIG. 5, right side). The light rays emitted into the reflected glare and direct glare zones are indeed minimal and are clearly not offensive.

The light distribution produced by the fixture **20** both with and without its lens is best illustrated in the polar graph of FIG. **5.** Note that without the lens (left side of graph) the intensity of the illumination is greatest directly beneath the fixture in the reflected glare zone and as the angle from the nadir increases the intensity of the illumination progressively diminishes. The left side of the graph represents the lighting distribution behind the lens **30** or in other words, the orientation and relative concentration of rays entering the lens **30.** Note further that with the lens **30** the illumination has its greatest intensity in the oblique zones and in the reflected glare and direct glare zones the intensity is diminished considerably.

While the light rays emanating from the lamps **26** pass downwardly through the prismatic lens **30** and enter the room **2,** for purposes of analysis it is more desirable to consider the rays as emanating from the room, or more particularly from the eye of an individual working within the room, and then tracing them backwardly into the lighting fixture **20,** if in fact they do enter the interior of the fixture **20.** This is a standard and accepted practice in the field of optics and derives from the fact that light rays are perfectly reversible. By tracing the rays backwardly one can determine with a fair degree of accuracy the relative intensity of illumination at various angles below the lens **30.**

Referring now to FIG. **6** and still tracing rays backwardly, practically all of the normal or 0° rays which can be traced into the lens **30** through one of the arcuate surfaces **32** thereof are reflected outwardly through adjacent arcuate surfaces **32.** For example, any ray G enters the lens **30** through the arcuate surface **32** in offset relation to the line *t* which represents the center of the corresponding groove **36.** Upon entering the lens **30** the ray G is refracted slightly toward the overlying groove **36** and approaches side surface **42** of that groove **36** at an angle greater than the critical angle for the transparent material, which in this graphical analysis is acrylic plastic marketed by Rohm and Haas under the trademark PLEXIGLASS. In this connection, it should be noted that the critical angles as well as other angles of refraction are measured from the normal to the air-acrylic interface at the point where the rays meet that interface. Inasmuch as the ray G approaches the surface **42** at an angle greater than the critical angle, the surface **42** reflects the ray G toward the intervening surface **38,** and the ray G approaches that surface also an angle greater than the critical angle. The intervening surface **38** therefore reflects the ray G toward the side surface **40** of the adjacent groove **36** and since the ray G also approaches that surface at an angle greater than the critical angle it is again reflected. The final reflection directs the ray G toward arcuate surface **32** of the adjacent convex lens segment **34,** and the ray G leaves the lens **30** through that surface, being refracted as it does. Consequently, one who sights along the foregoing path, which is the nadir to the lens, would not observe the lamps **26** or any light derived from the lamp **26,** but instead would merely observe a reflection of some object located in the room **2** below the false ceiling **6.**

However, a ray H which can be traced into the lens **30** close to the center of one arcuate surface **32,** will pass with little refraction toward the portion of its side surface **40** located near the line *t* of the overlying groove **36.** The ray H will furthermore approach the side surface **40** at an angle greater than the critical angle, and as a result that ray will be reflected toward the side surface **42** of the adjacent groove **36.** The ray H is presented almost perpendicular to the surfaces **42** of the adjacent groove **36** and clearly at an angle less than the critical angel. As a result it leaves the lens **30** through that side surface **42,** and when again in air it is disposed at a relatively large angle with respect to the vertical or nadir. The ray H demonstrates that light rays emanating from the lamps **26** and oriented at a steep angle behind the lens **30** will enter the lens **30** through the surfaces **40** and **42** near the juncture of those surfaces and the intervening surfaces **38** and will further pass through the lens **30,** leaving it in a downwardly or vertical path which lies within the reflected glare zone. From the foregoing analysis it is quite apparent that relatively few rays will, after passing through the lens **30,** be directed vertically, and those rays which do come through are oriented at a steep angle behind the lens **30.** Bearing in mind that the fixture **2** absent the lens **30** produces its highest concentration of illumination directly downwardly and that at steep angles the illumination is extremely low in intensity, the illumination which does leave the lens **30** along the vertical is also low in intensity. Clearly, the intensity is not enough to produce an offensive glare in the reflected glare zone.

Still continuing to trace rays backwardly (FIG. **6**), at 15° most of the rays which can be traced into the lens **30** from below are reflected back into the room **2,** although some do pass through. Those rays which do pass through are furthermore oriented at very small angles with respect to the vertical, and when actual situation is considered, these represent paths along which light passes through the lens **30** and leaves it at 15°. Since the unreflected rays are disposed at relatively small angles behind the lens **30** they are in effect high intensity rays emitted by the lamps **26.** Accordingly, at 15° more illumination exists on the underside of the fixture than at 0°, but the concentration is not great enough to cause annoyance or discomfort, notwithstanding the fact the 15° rays are also within the reflected glare zone.

At 25°, 35° and 45° (FIG. **6**) all of which are within the oblique zone, it is apparent that for all intents and purposes the lens **30** is fully transparent since all of the rays pass completely through the lens **30.** Moreover, on the back side of the lens **30** the rays so traced are presented at relatively small angles with respect to the vertical or nadir and consequently correspond with high intensity rays emitted directly from the lamps **26** or reflected by the reflector **22.**

At 60° (FIG. **6**) few rays can be traced thorough the lens **30,** indicating that little light is emitted at that angle.

At 70° and 80° (FIG. **6**) rays can be traced backwardly only into one-half of each arcuate surface **32,** whereas at lesser angles the rays can be traced into more than one-half and in most instances into the entire surface **32.** By reason of this fact, the light passing through the lens **30** at 70° and 80° is greatly diminished. Nevertheless, the 70° and 80° rays do pass through the lens **30** and are disposed at moderate angles behind it. Thus, they correspond to rays of moderate intensity emitted by the lamps **26,** but by reason of the limited area of emergence at the arcuate surface **32** they are not concentrated significantly to produce significant glare in the direct glare zone.

The direct glare produced by the 70° and 80° rays may be reduced still further, however, by positioning an overlay sheet similar to the one described in U.S. Pat. No. 3,288,990 over the upwardly presented face of the lens **30.**

From the foregoing analysis it is apparent that the prismatic lens **30** distributes the light from the lamps **26** and reflector **22** with greatest intensity is in the oblique zones and with considerably reduced intensity in the reflected glare and direct glare zones. Since the light from the lamps **26** is for the most part distributed obliquely into the oblique zones, it provides maximum comfort to those making visual observations in the room **2.** The lens **30** contains no opaque surfaces and by reason of this fact absorbs only a minimal amount of the light emanating from the lamp **26.** Accordingly, the lens **30** is highly efficient.

It is also possible to incorporate the foregoing principles into a prismatic lens **50** (FIGS. **7–10**) which is similar to the lens **30,** but has its reflecting and refracting surfaces arranged in a spherical pattern instead of a lenticular pattern. Thus, in lieu of longitudinally extending arcuate surfaces **32** which create the cylindrical lens segments **34,** the lens **50** on its bottom face is provided with adjoining surfaces **52,** each of which forms a segment of a sphere. The surfaces **52** create button-like protrusions or more accurately spherical lenticules or convex lens segments **54** (FIGS. **8–9**) on the lens **50,** and these segments correspond to the cylindrical lens segments **34** of the lens **30.** Instead of grooves **36,** the lens **50** behind each spherical lens segment **54** has a pocket **56** (FIGS. **8–10**) which possesses the shape of an inverted four-sided pyramid. The pocket **56** may also be in the shape of an inverted cone, but the pyramidal configuration is preferred. The pockets **56** are separated by a planar intervening surface **58** which is parallel to and disposed beneath the horizontal center plane of the lens **50.**

The lens **50** functions similar to the lens **30,** only the oblique zone of high intensity illumination created beneath each spherical lens segment **54** is generally conical instead of wing-shaped as is true of the oblique zone located beneath each cylindrical lens segment **34** in the lens **30.** By reason of this fact, the lens **50** is more desirable where the positioning and orientation of work surfaces and stations in the room **2** is not known in advance or is likely to change. In other words, the lens **50** is suitable for universal arrangement of work surfaces or stations, whereas more care must be exercised in arranging work surfaces or stations beneath the lens **30.**

With one exception the dimensions previously prescribed for the lens **30** also apply to the lens **50,** only their pertinence is three dimensional instead of two dimensional as is true of the lens **30.** The single exception applies only to the pyramidal pockets **56,** and particularly to the included angle K between the opposing side surface thereof. The maximum value of that angle should not exceed 66° instead of 78°. This resides in the fact that the angle between the opposing surfaces at a cross-section taken diagonally through the pyramidal pocket **56** (FIG. **9**) will measure 78° when the angle in a cross-section taken normal to the surfaces (FIG. **8**) measures 66°. This also illustrates why pockets **56** having a pyramidal shape are preferred to those of conical shape. Indeed, if conically shaped pockets are employed, the direct glare would increase along lines of sight extending diagonally with respect to the grid created by the arrangement of convex lens segments **54** and the pockets **56** and lamp images would appear.

For point or concentrated sources of light such as incandescent lamps, another modified lens **70** (FIG. **11**) may be provided, and that lens possesses the same cross-sectional shape as the lens **30,** but the lenticules close upon themselves. More particularly, the lens **70** possesses a series of circular lenticules **72** which are concentric about a center spherical lenticule **74.** Each lenticule **72** has a downwardly presented arcuate surface which is disposed in front of a circular groove (not shown) of a V-shaped cross-section located at the back surface of the lens **70.** The center lenticule **72** is disposed in front of a conical pocket. Instead of being circular, the lenticules **72** may also take the form of squares or rectangles of increasing size.

It is possible to provide still another modified prismatic lens **80** which is similar to the lens **50,** but possesses spherical lenticules of two different sizes. In particular, the lens **80** on its downwardly presented surface (FIG. **12**) has a series of spaced minor lenticules **82** which are separated by adjoining major lenticules **84.** Both the lenticules **82** and **84** are of the spherical variety, that is their downwardly presented surfaces constitute segments of spheres. However, in plan the minor lenticules **82** are square, while the major lenticules **84** are octagonal. On its opposite side (FIG. **13**), the lens **80** has a planar intervening surface **86** which surrounds a series of conical pockets **88** and **90.** The pockets **88** are disposed behind and centered on the minor lenticules **82,** whereas the pockets **90** are disposed behind and centered on the major lenticules **84.**

This invention is intended to cover all changes and modifications of the example of the invention herein chosen for purposes of the disclosure which do not constitute departures from the spirit and scope of the invention.

What is claimed is:

1. A lens for distributing light emitted by a light source to better illuminate an area in front of the light source, said lens comprising: a relatively thin light-transmitting material positioned between the light source and the area to be illuminated and having a front face presented toward the area to be illuminated and a rear face presented toward the light source, one of said faces being comprised of a plurality of adjacent convex surfaces, the other of said faces being comprised of a plurality of surfaces inclined with respect to the general direction assumed by the thin light transmitting material and arranged to form depressions in the material, each depression being located directly behind a convex surface on said one face, the other of said faces being further comprised of an intervening surface area located between the depressions and oriented generally in the direction assumed by the relatively thin light-transmitting material, the convex surfaces, the inclined surfaces, and the intervening surface area being positioned relative to one another such that light from the light source, after passing through the lens, is concentrated in zones oblique to the general direction assumed by the light-transmitting material.

2. A lens according to claim **1** wherein the adjacent convex surfaces intersect, and the intervening surface area intersects the inclined surfaces.

3. A lens according to claim **2** wherein each depression is centered relative to a convex surface and the intervening surfaces are located directly opposite the junctures of adjacent convex surfaces.

4. A lens according to claim **3** wherein the depressions are V-shaped in cross-section with the apex of each V-shaped configuration being located directly opposite and centered relative to a convex surface.

5. A lens according to claim **4** wherein the spacing between the centers of adjacent depressions equals the width of the arcuate surfaces.

6. A lens according to claim **1** wherein each convex surface is formed about a center whereby it forms the segment of a circle.

7. A lens according to claim **6** wherein the width of each convex surface is between 1.00 and 1.87 times the radius of the convex surface.

8. A lens according to claim **6** wherein the thickness of the lens measured between the intervening surface area and the outermost portion of the convex surface is between 0.75 and 1.5 times the radius of the convex surface.

9. A lens according to claim **4** wherein the greatest angle between the opposed inclined surfaces which form the depression is between 40° and 78°.

10. A lens according to claim **4** wherein each depression is a groove and each convex surface forms a segment of a cylinder.

11. A lens according to claim **4** wherein each convex surface forms a segment of a sphere.

12. A lens according to claim **11** wherein each depression possesses the shape of a four-sided pyramid.

13. A lens according to claim **1** wherein the light-transmitting material is nonlaminate, and the front and rear surfaces thereof are completely exposed.

14. A lens according to claim **1** wherein the face comprised of the inclined surfaces and intervening surface area is presented toward the light source and the face comprised of the convex surfaces is presented toward the area to be illuminated.

15. A lens according to claim **1** wherein the intervening surface area is disposed at no more than 15° with respect to the general direction assumed by the light transmitting material.

16. A lens according to claim **1** wherein the intervening surface area is planar.

17. A light fixture lens having the capability of concentrating light emitted from a light source in a light fixture in zones generaly oblique to the nadir of the lens to provide more pleasant illumination of the area beyond the lens and fixture, said lens comprising a nonlaminate light transmitting material which is relatively thin and has a rear face presented toward the light source and a front face presented toward the area to be illuminated, the rear face being comprised of a generally flat surface area presented substantially perpendicular to the nadir of the lens and a plurality of intersecting inclined surfaces presented at oblique angles with respect to the generally flat surface area to form generally V-shaped depressions in the light transmitting material, the front face being comprised of adjacent convex surfaces with each convex surface being presented in front of a different V-shaped depression and being centered with respect to that depression so that the junctures of adjacent convex surfaces will be in front of the generally flat surface area, the relative positioning of the convex surfaces, the inclined surfaces, and the generally flat surface area being such that the light from the light source, after passing through the lens, is concentrated in zones oblique to the nadir for the lens.

18. A lens for distributing light emitted by a light source to better illuminate an area in front of the light source; said lens comprising: a relatively thin one-piece light-transmitting material positioned between the light source and the lens and having a rear face presented toward the light source and a front face presented toward the area to be illuminated, the front face being comprised of a plurality of adjacent convex surfaces, the back face being comprised of a surface area extended generally in the direction assumed by the thin light-transmitting material and surfaces inclined with respect to that surface area to form depressions which open toward the light source and interrupt the surface area, the relative positioning of the depressions, the surface area and the convex surfaces, and the configuration of the depressions all being such that light from the light source, after passing through the lens, is concentrated in zones oblique to the general direction in which the light-transmitting material extends so that the concentration of light is minimized along the nadir to the lens.

19. A lens according to claim **18** wherein the front and rear faces of the light-transmitting material are completely exposed.

* * * * *