United States Patent

[11] 3,600,570

[72] Inventor **Mizuo Okada**
Kozagun, Japan

[21] Appl. No. **782,557**
[22] Filed **Dec. 10, 1968**
[45] Patented **Aug. 17, 1971**

[73] Assignee **Mitsubishi Rayon Company, Limited**
Tokyo, Japan

[32] Priority **Dec. 11, 1967, Dec. 25, 1967**
[33] **Japan**
[31] **42/103476 and 42/108002**

[54] **LOW GLARE LOUVER**
6 Claims, 13 Drawing Figs.

[52] **U.S. Cl.** ..... **240/78 LD,** 240/46.39, 240/106.1
[51] **Int. Cl.** **F21s 1/06**
[50] **Field of Search** ..... 240/78 LD, 46.39, 106, 106.1

[56] **References Cited**

UNITED STATES PATENTS

2,143,149	1/1939	Guth	240/78 LD-7
2,904,673	9/1959	Guth, Sr.	240/78 LD-7
2,927,994	3/1960	Guth, Sr.	240/78 LD-7
2,971,083	2/1961	Phillips et al.	240/78 LD-7
2,996,609	8/1961	Wilson	240/78 LD-7
3,179,797	4/1965	Franck	240/78 LD-7

Primary Examiner—Samuel S. Matthews
Assistant Examiner—Richard M. Sheer
Attorney—Sughrue, Rothwell, Mion, Zinn & Macpeak

ABSTRACT: A low glare louver constructed of a grid of cells made of transparent material produces a low brightness ceiling by controlling the light from the light source. The opposite surfaces of each beam of the grid slope downwardly producing a thicker base for forming a multiprism lens or a cylindrical lens.

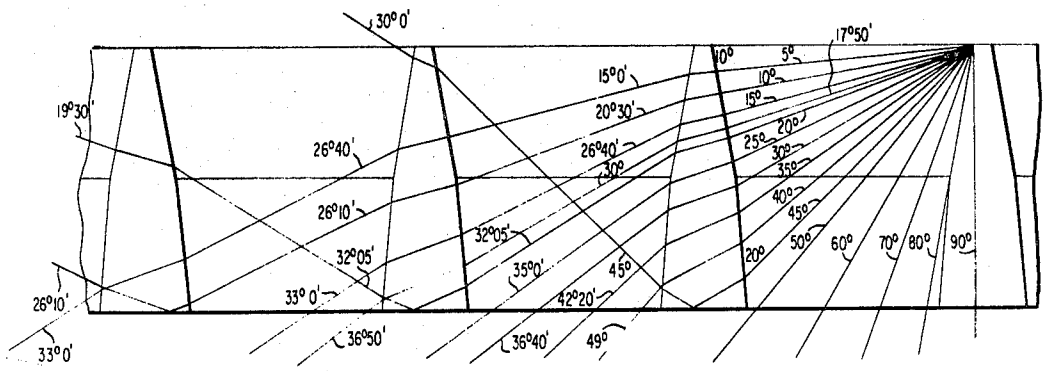


FIG. 2

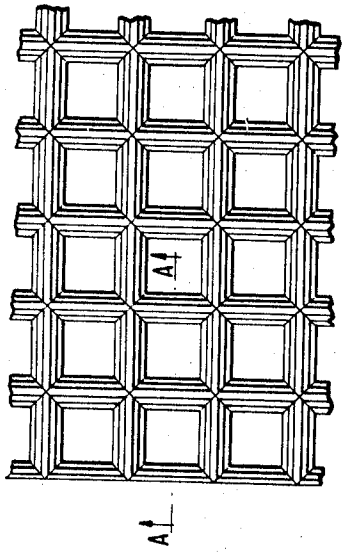


FIG. 3

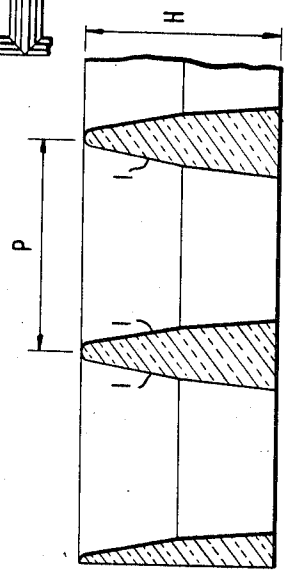


FIG. 1

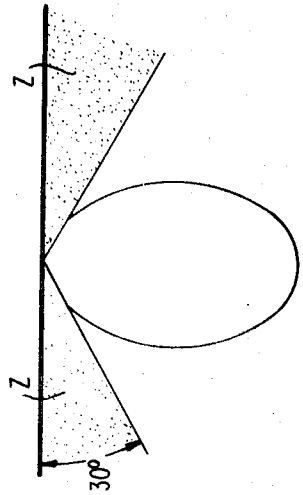
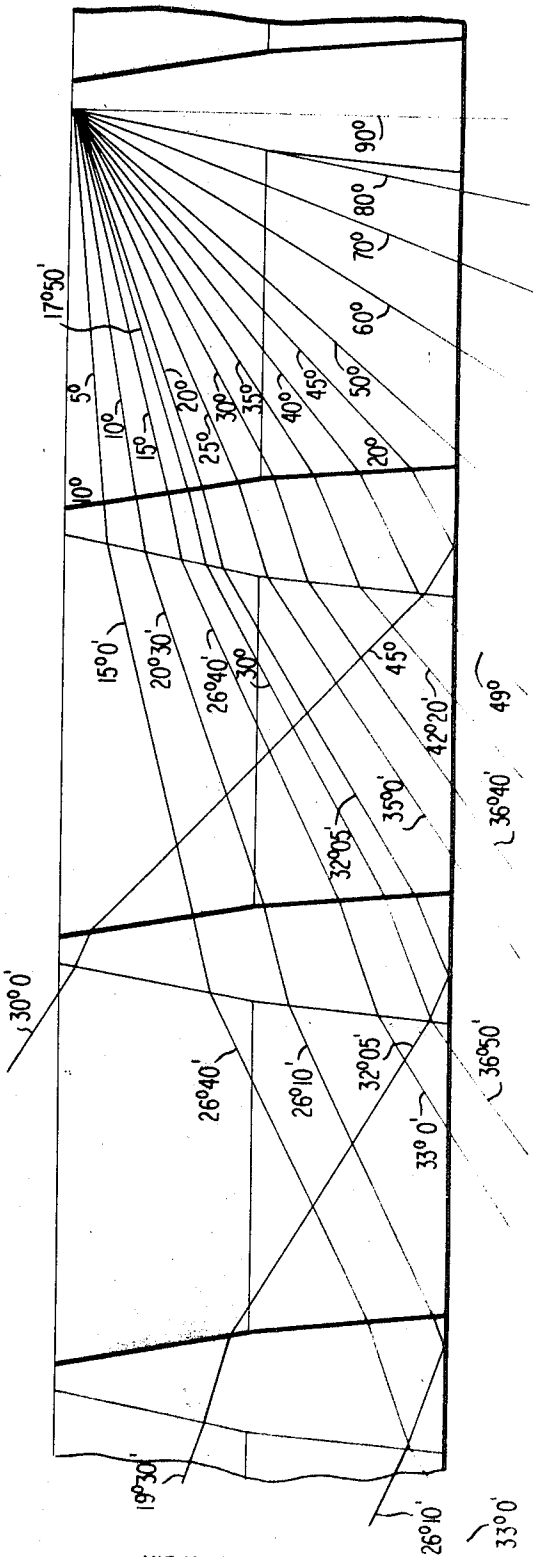


FIG. 4

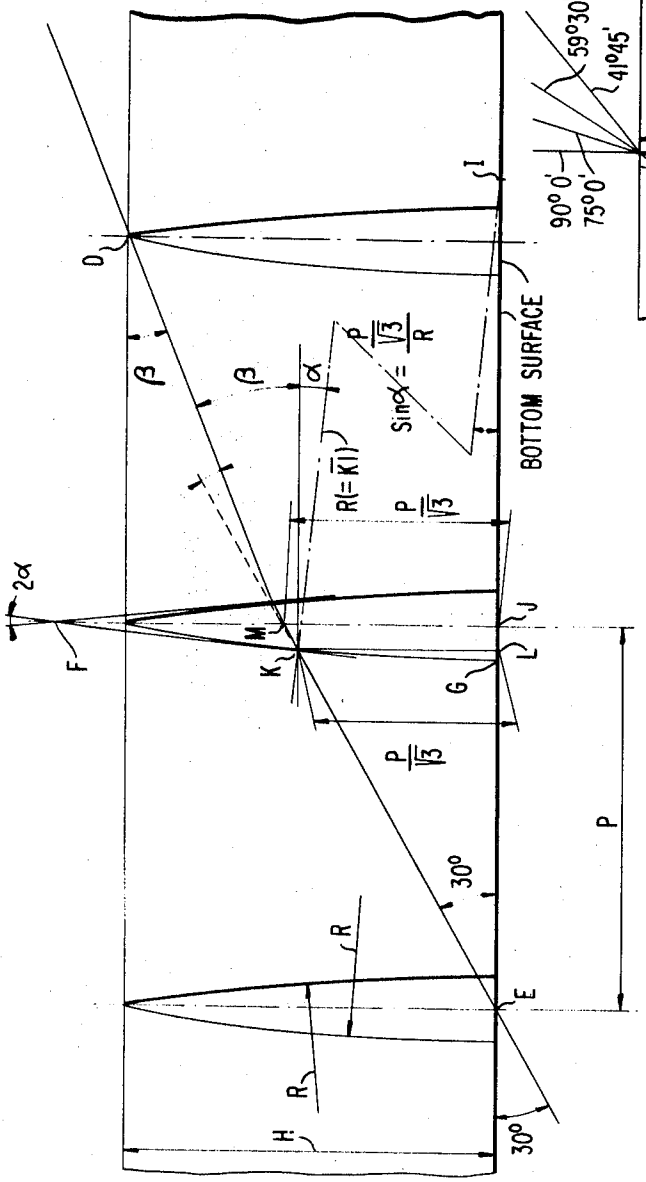


MIZUO OKADA, INVENTOR

BY Sughrue, Rothwell, Mion, Zinn & Macpeak

ATTORNEYS

FIG. 11



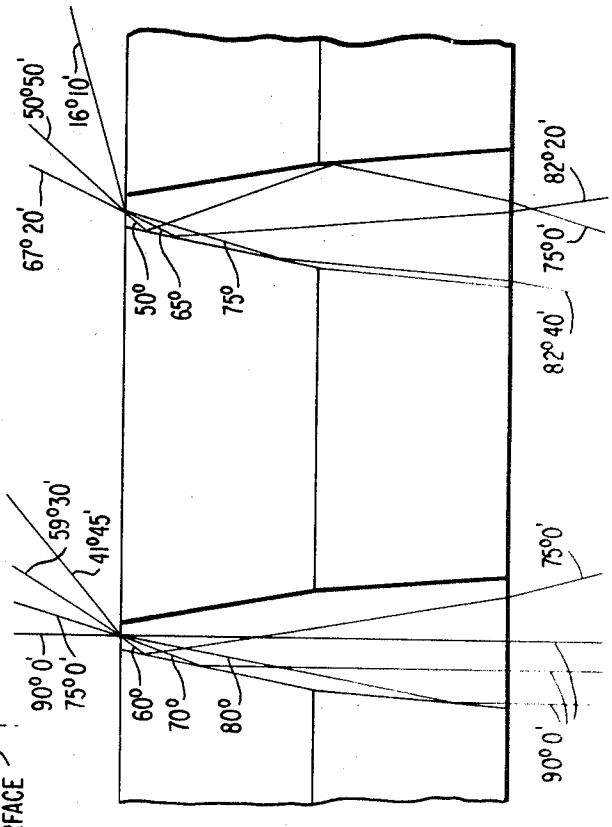


FIG. 5

INVENTOR
MIZUO OKADA

BY Sughrue, Rothwell, Mion, Zinn & Macpeak
ATTORNEYS

FIG. 6

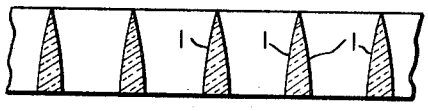


FIG. 7

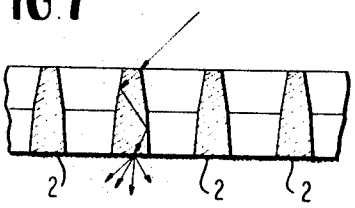


FIG. 8

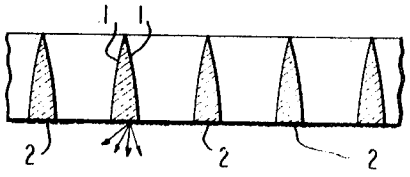


FIG. 9

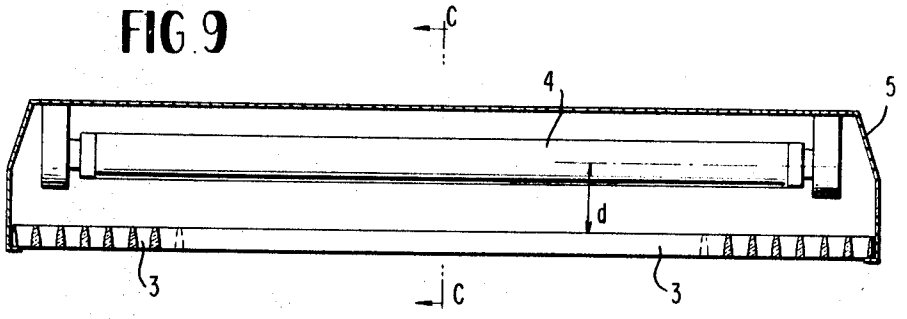
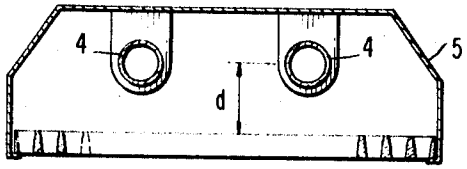


FIG. 10



INVENTOR
MIZUO OKADA

BY Sughrue, Rothwell, Mion, Zinn & Macpeak
ATTORNEYS

FIG.12

LIGHT DISTRIBUTION CURVE.
SAMPLE NUMBER I _ SOURCE BRIGHTNESS OF THE LIGHT 20W x 2LIGHTS
DISTANCE D = 100 mm

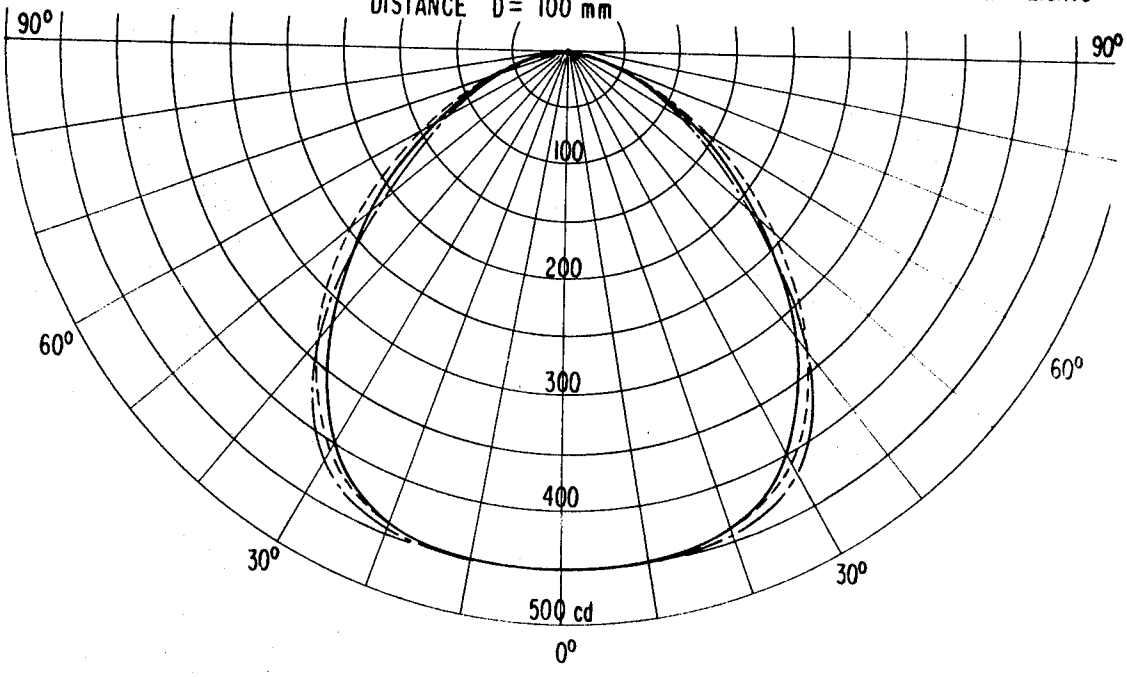
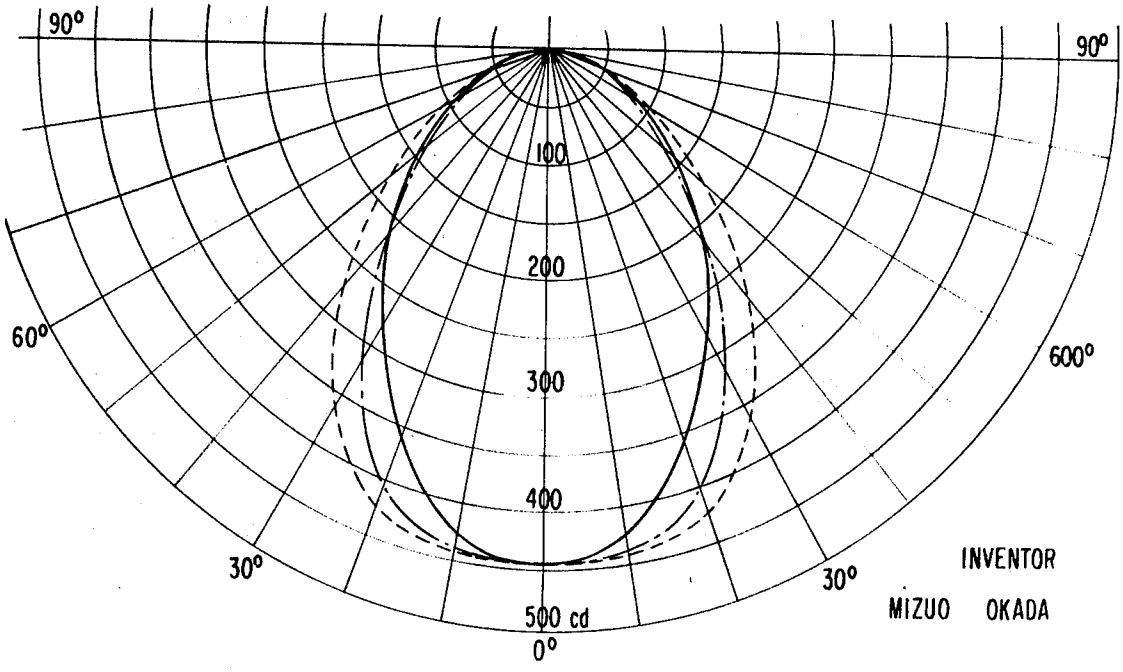


FIG.13

LIGHT DISTRIBUTION CURVE.
SAMPLE LOUVER No I _ SOURCE BRIGHTNESS OF THE LIGHT 20W x 2 LIGHTS
DISTANCE D = 300 mm



INVENTOR
MIZUO OKADA

LOW GLARE LOUVER

BACKGROUND OF THE INVENTION

The present invention relates to a louver by which the light rays from a light source are modified or controlled to lower the glare of the light. In particular the invention is directed to a low glare louver wherein a grid of cells made of transparent material is employed to lower the angle of incidence of the light transmitted from the light source.

In general, a louver is required to remove the glare effect of a light source by refracting the light rays from the light source in a direction inclined at more than 30° from the ceiling face. This is desirable from the viewpoint of human engineering.

In addition, the louver is required to maintain the illuminated surface at a sufficient intensity level. Both of these features should be accomplished without undue absorption of the light.

In the prior art there have been attempts to control the angle of the light at more than 30°, for example the low brightness louver disclosed by U.S. Pat. No. 2,971,083, but the utilization of metallizing on the surface of the beam of the grid has proven to be a deficiency. Owing to the metallizing on the surface of the grid beam, the light intercepted by the beam is reflected onto the ceiling and thereby partly absorbed. Thus the brightness on the illuminated surface is lowered. And moreover, metallizing the louver has proved to be expensive.

In other attempts to solve these problems in the prior art, there has been provided a simple grid-shaped construction made of opaque synthetic resin. This type of louver operates at a disadvantage since the brightness on the illuminated surface is lowered due to absorption of the light by the louver itself.

SUMMARY OF THE INVENTION

A grid of cells made of transparent material is utilized to lower the glare of the light in the louver in accordance with the present invention. In a luminaire having a light source such as fluorescent or incandescent lamps, the light from the light source is refracted in limited directions to achieve the desired condition of illumination. The resulting brightness on the illuminated surface is both uniform and adequate. Since the grid of the louver is constructed of transparent material, the light from the light source is not absorbed by the louver and a high intensity level of brightness is obtained on the illuminated surface.

It is an object of the present invention to provide a low glare louver for producing a uniform brightness on the illuminated surface and lowering the glare of the light.

Another object of the present invention is to provide a low glare louver employing transparent material wherein the light from the light source is not unduly absorbed by the louver and high brightness is obtained on the illuminated surface.

A still further object of the present invention is to provide a low glare louver which is capable of spreading the light from the light source and producing a restful source of light for the eyes.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an explanatory view showing the projected light range produced by the louver in accordance with the present invention;

FIG. 2 is a partial plan view of a louver employing the multiprism lens in accordance with an embodiment of the present invention;

FIG. 3 is an enlarged cross-sectional view of the louver in accordance with the present invention taken along the line A–A or B–B of FIG. 2;

FIGS. 4 and 5 are enlarged explanatory cross section views of the louver showing the transmitting effect on the light rays from the light source;

FIG. 6 is a cross-sectional view of the louver employing cylindrical lens in accordance with the present invention;

FIG. 7 is a cross-sectional view of the louver employing multiprism lens wherein the bottom surface is of a mat finish.

FIG. 8 is a cross-sectional view of a part of the louver employing a cylindrical lens wherein the bottom surface is mat finish;

FIG. 9 is a cross-sectional view of the louver in accordance with the present invention adapted for use on a lighting fixture;

FIG. 10 is a sectional view of the louver with the lighting fixture taken along the line C–C in FIG. 9;

FIG. 11 is an enlarged explanatory view of the cross section of the louver for explaining the formula (1) hereinafter referred to;

FIG. 12 is a diagram showing the light distribution in accordance with the first embodiment of the present invention, and

FIG. 13 is a diagram showing the light distribution in accordance with the second embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, the louver in accordance with the present invention employs beams of grid made of transparent material in the shape of cylindrical lens or multiprism lens. The beam of a grid employed in the present invention is preferred to be made of methyl methacrylate resin which has good transparency, although for example, inorganic glass, styrene resin or vinyl chloride resin could be employed. The side surface 1 of the beam of the grid is required to form a curvature that will have the beam thinner at the upper portion thereof as shown in FIG. 3. Thus, the light from the light source will be directed in a direction inclined at more than 30° with the ceiling face, the range of which is shown in FIG. 1 and the light path of which is shown in FIGS. 4 and 5. The numerals shown in FIGS. 4 and 5 denote the angle in which the light advances respectively through the louver. In this case a natrium D-line of 5893° angstrom wavelength is used as the light with a louver made of methyl methacrylate resin.

The shape of the curve presented by the side surfaces of the beam of the grid is formed into a particular shape represented by the following formulas:

$$H=P\left[\frac{1}{\sqrt{3}}+\tan\left\{\frac{\pi}{6}-2(n-1)\sin^{-1}\left(\frac{1}{\sqrt{3}}\frac{P}{R}\right)\right\}\right] \quad (1)$$

$$\sin^{-1}\left(\frac{1}{\sqrt{3}}\cdot\frac{P}{R}\right)\leqq\frac{\pi}{16} \quad (2)$$

$$3\text{ mm.}\leqq H\leqq 100\text{ mm.} \quad (3)$$

wherein P is the pitch, H is the height of the beam R is a radius of curvature of the cylindrical lens or the circumscribed cylinder about the multiprism lens, and n is the index of refraction of the employed transparent material.

FIG. 11 explains the meaning of the formulae. The light comes into the louver from the point D at the top of the beam having a pitch P, height H, radius of curvature R, and index of refraction n, it travels to the center E of the bottom of the adjacent beam through the center beam M which refracts the light ray. The light is inclined at 30° when it leaves the bottom surface of the beam of the louver. The path of the light and the curvature of the surface of the louver are formularized as follows:

Refraction at the portion M can be regarded as a refraction at a prism having an angle 2α which is in contact with the cylindrical lens at a point K on the surface thereof.

Since the triangle FGJ is similar to the triangle IGK, the angle$<$GIK is equal to α (one-half of the angle of the prism). The distance KL is substantially equal to $P/\sqrt{3}$, since the prism is thin. Therefore, an equation, $\sin\alpha=1/R(P/\sqrt{3})$, is obtained with reference to the triangle IKL.

Thus, the following equation is obtained,

$$\alpha=\sin^{-1}\left(\frac{1}{\sqrt{3}}\cdot\frac{P}{R}\right)$$

The declination of a thin prism having a top angle of 2α is $(n-1)2\alpha$, therefore, the declination at M becomes

$$2(n-1)\cdot\sin^{-1}\left(\frac{1}{\sqrt{3}}\cdot\frac{P}{R}\right)$$

and the angle β becomes

$$\beta=\frac{\pi}{6}-2(n-1)\ \sin^{-1}\left(\frac{1}{\sqrt{3}}\cdot\frac{P}{R}\right)$$

In order for the light which passes through the point E to pass through the point K shown in FIG. **11** the following condition is obtained:

$$H-\frac{P}{\sqrt{3}}=P\tan\beta=P\tan\left\{\frac{\pi}{6}-2(n-1)\ \sin^{-1}\left(\frac{1}{\sqrt{3}}\cdot\frac{P}{R}\right)\right\}$$

which is written as follows

$$(1)\quad H=P\left[\frac{1}{\sqrt{3}}+\tan\left\{\frac{\pi}{6}-2(n-1)\ \sin^{-1}\left(\frac{1}{\sqrt{3}}\cdot\frac{P}{R}\right)\right\}\right]$$

Thus, the formula (1) is obtained.

By this formula, the height of the beam of the louver can be defined. But the optimum designed louver cannot be obtained only from the above condition. In order to control the dispersion caused by the multiprism or cylindrical lens and further to save material, the top angle is required to be in the range shown by the following formula (2)

$$\alpha=\sin^{-1}\left(\frac{1}{\sqrt{3}}\cdot\frac{P}{R}\right)\leqq\frac{\pi}{16}\qquad(2)$$

That is, the top angle 2α is desired to be $\pi/8$ or 22.5° or smaller.

As to the height H in the formula (1), there is a limitation since the louver is apt to be distorted or bent if too low, and apt to be too expensive due to the increase of the amount of the material if too high. Therefore, the height of the louver is required to be limited to the range indicated by the following formula from a practical viewpoint.

$$3\text{ mm.}\leqq H\leqq 100\text{ mm.}\qquad(3)$$

By designing a louver according to the above formulas, a small percent of the light from the light source will be directed in a direction included in the glare zone Z, (indicated with stippling in FIG. **1**). But such a small degree of light will not fatigue the eyes but will rather produce a soft and calm illumination effect.

The bottom surface **2** of the beams of the grid employed in the louver can be mat finished while leaving the other surfaces mirror finished as shown in FIGS. **7** and **8**. By providing this mat finish on the surface of the bottom of the louver in the multiprism or cylindrical lens shape, firstly, the light passing through the louver will be broadly dispersed and thus provides softer illumination effect and, secondly, the light passing through the louver will easily come out from the nadir of the louver walls because of edge-lighting effect and thus provides a high degree of efficiency.

Some embodiments in accordance with the present invention will be described hereinafter, but the invention is not to be considered limited to the following embodiments only.

EMBODIMENT I

Methyl methacrylate resin is employed for the beam of the grid of the louver in which the radius of curvature R is 80 mm., and the pitch P is 15 mm. The height H is calculated to 15.3 mm.

$(n=1.49)$

$$H=P\left[\frac{1}{\sqrt{3}}+\tan\left\{\frac{\pi}{6}-(n-1)\times2\times\sin^{-1}\left(\frac{1}{\sqrt{3}}\cdot\frac{P}{R}\right)\right\}\right]$$

$$15\left[\frac{1}{\sqrt{3}}+\tan\left\{\frac{\pi}{6}-0.49\times2\times\sin^{-1}\left(\frac{1}{\sqrt{3}}\cdot\frac{15}{80}\right)\right\}\right]$$

$$=15[0.576+0.442]\fallingdotseq15.3$$

A louver having a cross section of pentagonal shape was molded into the wedge shape beam of a grid by injection molding. The louver had dimensions fitted to the above formula (width 300mm., length 660mm.).

When the above-described louver was adapted to a fluorescent lamp fixture as shown in FIGS. **9** and **10** (brightness of the lamp 20 w., the distance d 100 mm. between the louver **3** and the two fluorescent lamps **4**, **4**), the light distribution was measured as illustrated in the curves of FIG. **12**, wherein a solid line indicates the light distribution curve in a plane perpendicular to the axis of the lamp tube **4**, broken line indicates the light distribution curve in a plane parallel to the lamp tube **4**, and a dot-dash-line indicates the light distribution curve in a plane inclined at 45° with the lamp tube **4**. Preferably, the distance d between the louver **3** and the lamps **4** is approximately the same as the distance between the lamps.

As shown in the light distribution curves, almost all the light from the light source is projected in the direction where the light range is inclined at more than 30° with respect to the horizontal plane. A small percent of the light falls out of the range, (inclined at 15° to 30° with the horizontal plane) and helps make the louver body appear soft, and gentle to the eyes.

By making the bottom surface of the louver mat finished (320 mesh) as shown in FIG. **7**, the distribution of the light remains as good as the unmatted surface while producing a softer illumination effect.

EMBODIMENT II

Using the same material as employed in the first embodiment with a radius of curvature R of 100 mm., pitch P of 20 mm. and a height calculated as shown hereinafter, a louver having a cylindrical cross section was obtained by injection molding. (width 300mm. length 660mm.)

$$H=P\left[\frac{1}{\sqrt{3}}+\tan\left\{\frac{\pi}{6}-(n-1)\times2\times\sin^{-1}\left(\frac{1}{\sqrt{3}}\cdot\frac{P}{R}\right)\right\}\right]$$

$$=20\left[0.576+\tan\left\{\frac{\pi}{6}-0.492\times2\times\sin^{-1}\left(\frac{1}{\sqrt{3}}\cdot\frac{20}{100}\right)\right\}\right]$$

$$=20[0.576+0.402]=19.5\text{ mm.}$$

When the louver made in accordance with the second embodiment was fitted to the fluorescent light fixture used in the first embodiment with distance d from the light tube to the louver being 300 mm., the light distribution was measured with the results shown in FIG. **13**. Although the diagram of the light distribution curves are egg-shaped due to the deep troffer **5** (reflector box) the light distribution characteristics were almost the same as that of the first embodiment.

When the louver was molded by styrene resin (n=1.59) with the same mold piece, the light from the light source was slightly dispersed into a spectrum due to the higher index of refraction n in comparison with the methyl methacrylate resin, but the control of the light direction was better.

By matting the bottom surface of a louver made of methyl methacrylate resin by means of a sand paper of 0600, a softer louver was obtained.

The invention has been described in detail with particular reference to the above preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention as described hereinabove and as defined in the appended claims.

What I claim is:

1. In a luminaire having a light source, and a low glare louver made of transparent material disposed beneath said light source and comprised of beams forming a grid of cells, each of said beams being formed into a multiprism with the cross section of each beam being thinner in the upper portion closest to the light source and thickest at the nadir, said beams serving to gradually refract the light from the light source as it

passes through a plurality of said beams such that most of the light leaving said louver is inclined in a direction more than 30° from a horizontal plane, the dimension of said beams being given by the formulas

$$H=P\left[\frac{1}{\sqrt{3}}+\tan\left\{\frac{\pi}{6}-2(n-1)\sin^{-1}\left(\frac{1}{\sqrt{3}}\cdot\frac{P}{R}\right)\right\}\right]$$

$$\sin^{-1}\left(\frac{1}{\sqrt{3}}\cdot\frac{P}{R}\right)\leqq\frac{\pi}{16}$$

$$3\text{ mm.}\leqq H\leqq 100\text{ mm.}$$

wherein P is a pitch of the grid of cells, H is the height of said beams, R is the radius of curvature of the circumscribed cylinder about said multiprism, and n is the index of refraction of said transparent material.

2. A low glare louver as defined in claim 1 wherein said multiprism lens is a cylindrical lens, and said R is the radius of curvature of said cylindrical lens.

3. A low glare louver as defined in claim 2 wherein only the bottom surface of said beams is mat finished.

4. A low glare louver as defined in claim 1 wherein only the bottom surface of said beams is mat finished.

5. A low glare louver as defined in claim 1 wherein said transparent material is a synthetic resin.

6. A low glare louver as defined in claim 5 wherein said resin is methyl methacrylate resin.