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Shadwick

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[45] **Mar. 26, 1974**

[54] **POSITIVE PRISMATIC LIGHT SHIELD**

[75] Inventor: **Jan Shadwick,** Newark, Ohio

[73] Assignee: **Holophane Company, Inc.,** New York, N.Y.

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[21] Appl. No.: **275,606**

Related U.S. Application Data

[63] Continuation of Ser. No. 1,683, Jan. 4, 1970, abandoned.

[52] **U.S. Cl.** .... **240/106 R,** 240/25, 240/93

[51] **Int. Cl.** **F21v 5/00**

[58] **Field of Search** 240/25, 41.33, 92, 93, 240/106, 106.1, 107

[56] **References Cited**

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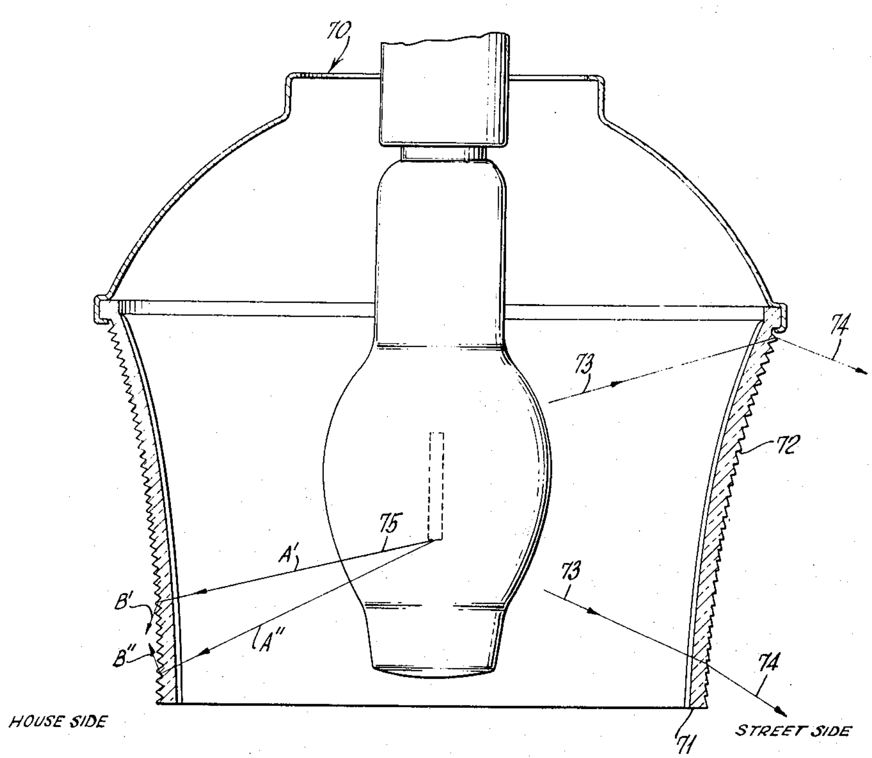
Primary Examiner—Richard M. Sheer
Attorney, Agent, or Firm—Holophane Company, Inc.

[57] **ABSTRACT**

A street lighting luminaire refractor including a light refracting sector and a light shielding sector. The light shielding sector includes a plurality of exterior prisms for preventing the passage of light through the light shielding sector and interior flutes for uniformly distributing light along and between the prisms.

1 Claim, 6 Drawing Figures



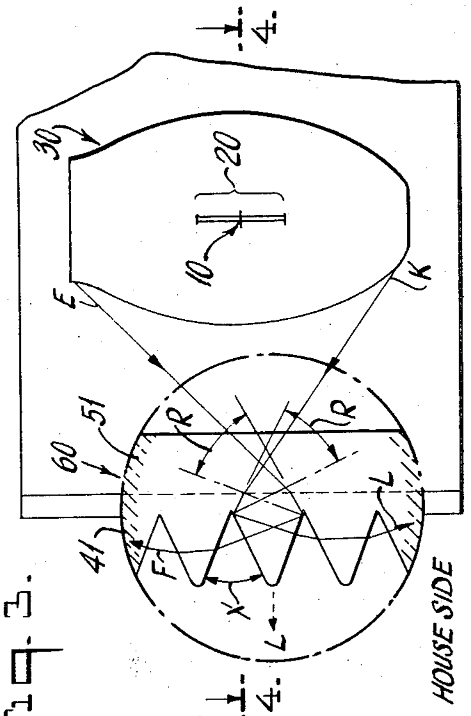


Fig. 3.

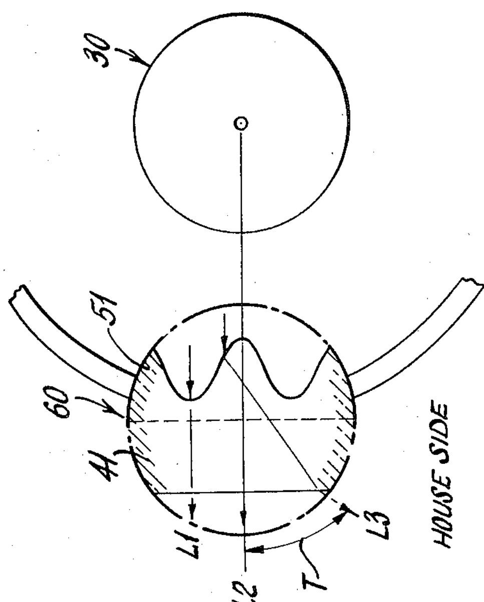


Fig. 4.

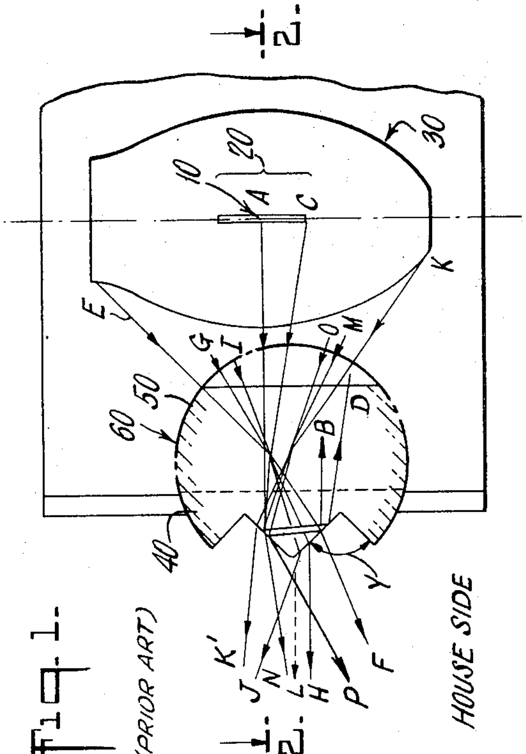


Fig. 1.
(PRIOR ART)

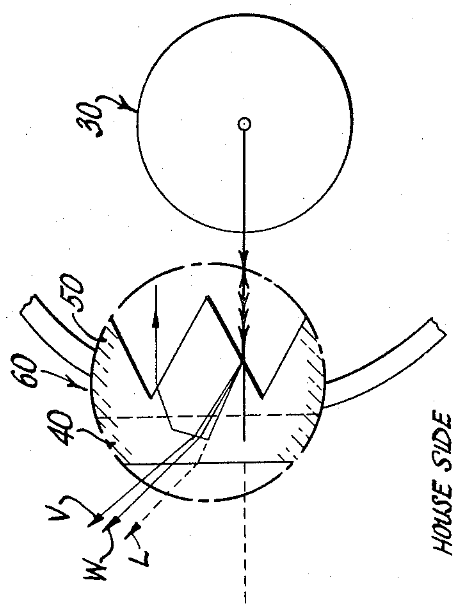


Fig. 2.

INVENTOR
JAN SHADWICK

BY [signature]

ATTORNEYS

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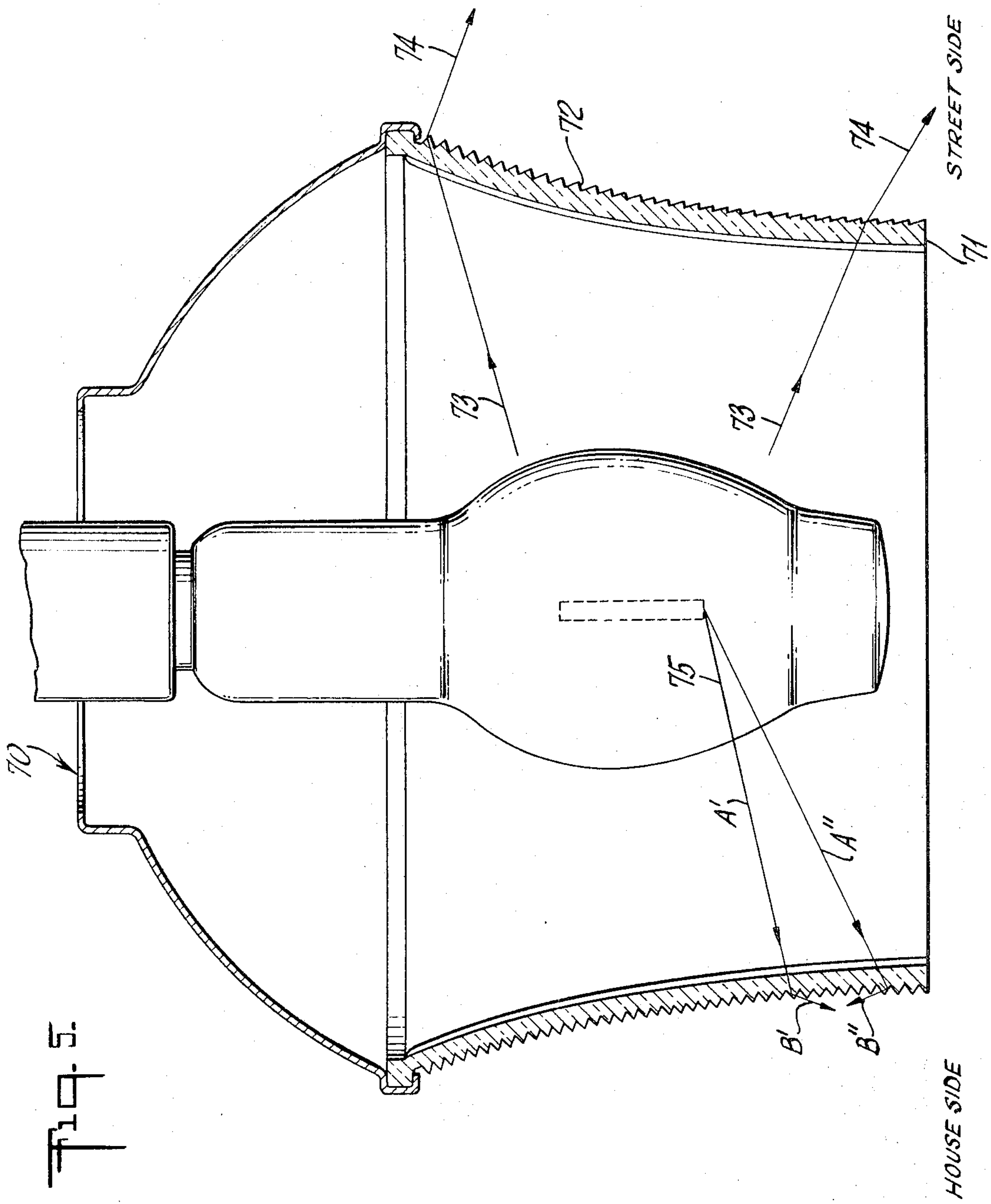
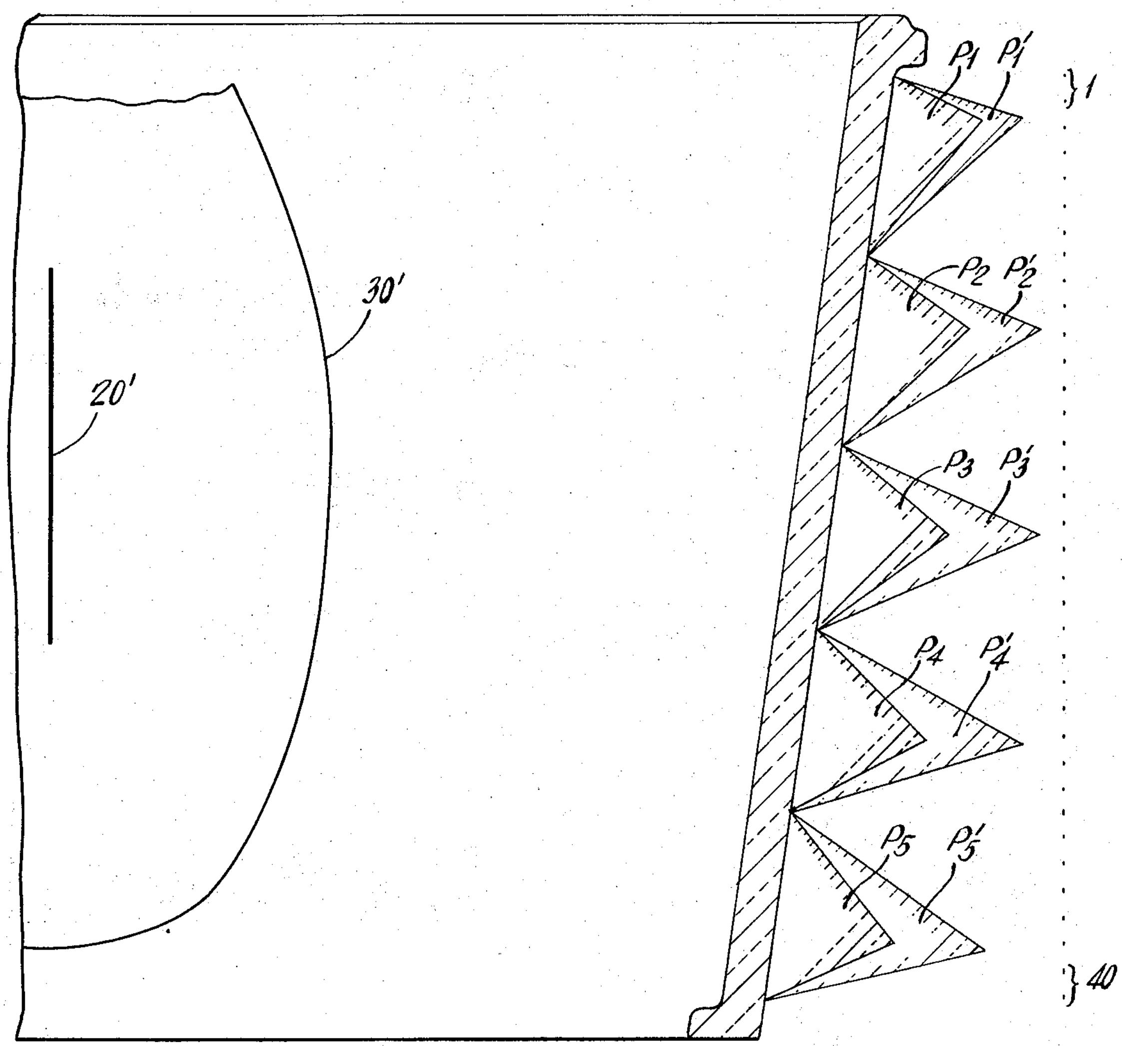
Fig. 5



INVENTOR
JAN SHADWICK
BY [signature]
ATTORNEYS

Fig. 6.



INVENTOR
JAN SHADWICK
BY
Nolte & Nolte
ATTORNEYS

POSITIVE PRISMATIC LIGHT SHIELD

This application is a continuation of application Ser. No. 1,683, filed Jan. 9, 1970, now abandoned, which application is a continuation of application Ser. No. 854,527, filed Sept. 2, 1969 which is now abandoned.

The present invention relates to positive prismatic light shielding for use in street lighting luminaires and other similar applications where light shielding is desirable.

The present shielding practice for luminaire refractors is exemplified by the refractor disclosed in U.S. Pat. No. 3,278,743. The light sources which have normally been utilized with regard to these shielding refractors have been in the form of a point or a short line. Today, light sources are being designed and utilized which are two and three dimensional in form and varied in shape. In addition, these light sources whether a point, linear, two dimensional, or three dimensional, are often movable on an optical train so that more than one light distribution can be obtained from a given light source — refractor combination. While present shielding practice has achieved thoroughly satisfactory results in the past when point and short linear sources were being utilized, when these new sources are utilized, shielding performance has been found to be not satisfactory.

Furthermore, while the present light source — refractor shielding combination theoretically (when used with a proper light source) reflects 100 percent of the light incident upon it, in actuality, the limitations of the mold making process make it impossible to make the prismatic surfaces with mathematical precision at the apices and in the valleys of such prisms. As a result, the apices and valleys tend to be rounded. Light rays incident on the curved surfaces of these apices, which act as condensing lenses, are transmitted and converged by them into a streak or streaks which are noticeable from the house side of the luminaire. Since this transmission of light involves leakage of a substantial amount of the total light flux and since the light is emitted from narrow regions, the light rays which are emitted have a relatively high brightness and are referred to as "hot streaks." As a result, the ratio of the maximum to average brightness of the shield when the shield is viewed from the house side of the luminaire is very high and this is undesirable.

Accordingly, it is an object of the present invention to provide light shielding which will not be limited by the actual or effective shape, size, nature, or orientation of the light source utilized.

It is a further object to provide a light shield which does not depend on the shape of the prismatic light controlling device or luminaire.

It is a further object to provide a means whereby the light leakage resulting from the rounded prism peaks and valleys can be substantially uniformly distributed over the entire shielding area.

It is a further object to provide a means whereby the degree of luminance, uniformly distributed, can be varied.

The present invention will be described with the aid of the accompanying drawings which illustrate present practice as compared to the practice as defined by the invention wherein:

FIG. **1** is a diagrammatic partial elevational cross-sectional view, partially magnified, showing a prior art luminaire incorporating shielding means;

FIG. **2** is a sectional view taken along axis **2 — 2** of FIG. **1**;

FIG. **3** is a diagrammatic view similar to FIG. **1**, but showing an embodiment of the present invention;

FIG. **4** is a sectional view taken along axis **4 — 4** of FIG. **3**;

FIG. **5** is a side view in section of a street lighting luminaire according to the present invention; and

FIG. **6** is a side view of a street lighting luminaire according to the present invention with the prism structure of the shielding means diagrammatically illustrated.

Referring to the drawings: FIGS. **1** and **2** illustrate how current 90° totally reflecting prisms **40**, which are horizontally positioned on the external surface of a refractor **60**, function to shield light when used with a point light source **10**, a linear light source **20** and a three dimensional light source **30**.

Earliest utilization of prismatic light shielding means positioned on the house side sector in luminaire fixtures was with regard to point sources of light. For these sources, it was found that by utilizing 90° reflecting prisms on the exterior of the refractor substantially all light rays which were incident on the refractor would be totally reflected back upon themselves by the light shielding prisms and that therefore the house side of the luminaire would be totally shielded from this emitted light. When line sources of light were developed, it was found that the light shielding did not function as efficiently as it was known to function with point sources of light because of the vertical broadening of angles of incident light upon the refractor. Consequently, 90° reflecting prisms on the exterior of the refractor were utilized in combination with transverse interior refracting prisms which latter prisms tended to converge wide angled light into angles readily handled by the shielding prisms. This combination again achieved satisfactory results with the shielding means reflecting light incident thereon. As the sources of light having linear configuration became longer and longer and as two and three dimensional sources of light were designed and utilized, it was found that the modified shielding means then being utilized did not function as efficiently as it was known to function with smaller actual or effective sized light sources.

As the problem of improper shielding became more and more significant with the ever enlarging light sources, attempts were made to improve the shielding ability of the then utilized shield. It was known that by reducing the apex angle of the interior transverse prisms greater shielding efficiency could be achieved. But it was also important that the light which was emitted by the luminaire light source and which was reflected by the shield be reflected by the shield back upon itself into the light source where it either is absorbed by the light source or is passed through the light source in rays which had identical direction to the light which was emitted by the light source and which was being already controlled by the design of the luminaire reflector-refractor combination. Reflected rays having any other direction could not be controlled by the luminaire and as a result the desired light distribution pattern would be interfered with. Consequently while it was important to have efficient shielding it was equally important to have the rays reflected from the shield back upon themselves. Therefore, efficient shielding for large, actual or effective, linear, planar or three dimensional sources was felt to be impossible.

In FIGS. **1** and **2**, the problems presently existing as a result of larger light source usage are defined and illustrated. When a point light source **10** is utilized, 90° reflecting prisms **40** will reflect any light ray AB, within its effective angular range of incidence, back in the same direction as its incident direction. Similarly, in linear light sources **20**, whenever a ray CD emanating from the source will lie within a particular angular range, it will be refracted by prisms **50** and reflected by prisms **40** back upon itself. But when this is not the case, whether in a linear source **20** or a three dimensional source **30**, light rays incident without this range (EF, GH, IJ, KK', MN, OP, V, W) will not be reflected, but will be refracted by the external prism **40** and will pass through the shield **60** into the area which is desired to be shielded therefrom.

The present invention effects total shielding of all incident light regardless of the shape, size, nature or orientation of the light source and is independent of the shape or size of the prismatic light controlling device and functions regardless of whether or not a reflector is used in the luminaire.

As will become evident, once a prism shield is designed for a specific light source (point, linear, area or three dimensional), it will work for any other source which lies within the size limits (boundaries) of the source to which shielding was designed. The depth and angulation of the external prisms are not fixed as they are fixed at 90° in present practice but the angulation of each prism, at least a plurality of which have acute apex angles, depends on the light source or sources to be used.

The method by which the maximum inclination of each surface of each of the plurality of prisms which comprise the shielding for the luminaire is designed for a particular light source is illustrated for the arbitrary embodiment of the three dimensional source **30** illustrated in FIGS. **1** through **4**. In FIG. **3**, light ray KL, the highest direct ray from the light source **30**, due to the size, shape and lateral or vertical movements of the source **30**, will establish the smallest angle of incidence with the top surface of the prism **41**. The inclination of the surface is such that if a normal is drawn at a point where this ray KL is incident on the top surface the angle between this normal and ray KL will be equal to the critical angle for a particular prism material. Every other ray emerging from the source will be lower and therefore all other angles established by rays incident on that surface and normal to that surface will be larger than the critical angle and as a result, the upper surface will totally reflect all the light which is directly incident thereon.

The lower surface of each shielding prism **41** is designed to reflect the lowest direct light ray EF that will ever be intercepted by this surface. The maximum inclination of the bottom prism surface is therefore established in the same way that the maximum inclination is established for the top surface thereof.

This method of designing shielding prisms is accordingly a radical departure over the prior art wherein normally all shielding prisms are given substantially a 90° apex angle. In the present construction, each shielding prism structure in accordance with the invention is dependent upon the configuration of the light source for which it is designed and upon its disposition relative to the source.

A practical, preferred structure is diagrammatically illustrated in FIG. **6**, where instead of changing each prism apex, groups of eight are given a "compromise" apex angle. As can be seen from FIG. **5**, the shielding or house side of the refractor is comprised of forty horizontally extending elongated prisms which are counted from top to bottom (see FIG. **6**). An extremely satisfactory light shield is made in accordance with the teachings of the present invention by defining groups of shielding prisms with all prisms in a particular group having the same configuration and apex angle. As illustrated in FIG. **6** five groups are defined in this embodiment for the linear light source **20'** (**P1** – **P5**) and five groups of prisms are defined for a three dimensional light source **30'** (**P1'** – **P5'**) and the prisms in a single group are represented by a single prism. Prisms numbered **1** – **9** constitute groups (**P1, P1'**), numbered **10** – **16** constitute groups (**P2, P2'**), numbered **17** – **24** constitute groups (**P3, P3'**), numbered **25** – **32** constitute groups (**P4, P4'**) and numbered **33** – **40** constitute groups (**P5, P5'**). The configuration and apex angle for each group of prisms is chosen based upon the individually determined configuration and apex angles of the individual prisms. If no light should be distributed to the house side the apex angle of a particular group should be less than the smallest apex angle of any individual prism within the group. If some light is to be distributed to the house side area the apex angle of a group can be increased slightly.

As can be seen from the drawings the inclination of the lower prism surface increases from bottom to top whereas the prism upper surface inclination decreases from bottom to top.

FIG. **5** illustrates an open bottom luminaire **70** which has a construction similar to that disclosed in the above cited U.S. Pat. No. 3,278,743 except where modifications are effected in accordance with the present subject matter. The refractor element **71** has a house side and a street side. The street side refractor **71** includes a sloped vertical wall, the slope of which decreases from the bottom of the refractor to the top. The refractor is designed to control the light reaching it directly from the light source. Since the rays emitted by the light source at angles greater than 78° from nadir must in all cases be depressed by the street side refractor, the contour of the upper portion of the refractor is shaped to assist downward deflection of the light.

Refractor **71** includes horizontal circular refractor prisms **72** on the outer surface of the street side section of the refractor. Prisms **72** provide vertical redirection of rays **73** into rays **74** as diagrammatically illustrated in FIG. **5**. The rays as shown in FIG. **5** are redirected downwardly and emerge as rays **74**. Prisms **72** are progressively inclined from the upper through the lower section of the refractor to thereby direct substantially all of the light toward the surface of the street below.

The house side refractor is designed according to the present subject matter as already defined and as illustrated by rays A', B' and A'', B''. The house side refractor redirects light incident thereon from the light source away from the house side where shielding is desired. Some rays FL (FIG. **3**) will be redirected back into the luminaire while others (B', B'') FIG. **5** will emerge from the light refractor but will be directed away from the area which is desired to be shielded from emergent light.

As hereinbefore discussed mold making limitations result in prismatic surfaces having rounded valleys and apices. The light incident upon these prism apices is condensed by these apices which act as condensing lenses and is transmitted and converged by them into a streak or streaks. These "hot-streaks" result in a very high maximum to average brightness ratio for the shield distribution and this is undesirable. In prism systems where no inside prisms are utilized, this "hot-streak" consists of one streak and by utilizing inside prisms this "hot-streak" may be split into two streaks, but relatively uniform light leakage has not been previously obtainable.

For all practical purposes, the light intercepted by the shielding prisms **41** (FIG. 3) will be prevented from passing therethrough into areas where light is not desired. All the light will be transmitted upwardly or downwardly leaving the range of non-illumination within the desired limits.

Therefore, it can be seen that light rays AB, CD, GH, IJ, MN and OP of FIGS. **1** and **2** will also therefore be shielded by the prisms **41** of FIGS. **3** and **4** and in fact any light source which lies within the boundaries of the light source for which the luminaire was designed will have all its emitted light totally shielded by the prism shield.

The present invention utilizes transverse interior flutes **51** as shown in FIGS. **3** and **4** on the inside of the shield transverse to the exterior prisms **41.** The method by which its shape is determined depends on the desired luminance of a particular shield. By spreading the light leakage over an angle T in FIG. **4,** the luminance of the shield can be varied, the greater the angle T, the lesser the shield luminance. This spread angle T is dependent upon the depth of the internal fluted prism. The deeper the prism, the greater will be the spread angle. This improvement, in the form of the flute, as shown in FIG. **4,** achieves the peculiar effect that the escaped light L (FIG. **3**) is spread uniformly between no deviation at peak and valley (rays L1 and L2 of FIG. **4**), to the required maximum deviation T (ray L3 of FIG. **4**) somewhere in between the peak and the valley. By designing the contour of each flute in such a way that light losses in transmission will be substantially balanced by the varying extent of light transmission in a particular direction substantial light leakage uniformity is achievable, and the maximum shield brightness can be reduced substantially thereby maximizing light leakage uniformity and substantially eliminating the "hot streak."

This uniformity of luminance is illustrated in the following table.

COMPARATIVE LUMINANCE

Open bottom refractor as illustrated in Fig. 5 in residential street luminaire improved shielding vs. prior art design 175 W., H39-22KB clear mercury lamp 7,500 lumens

[Luminances measured in foot Lamberts]

	Improved shielding			Prior art design		
Vertical angles	Maximum luminance	Average luminance	Maximum average	Maximum luminance	Average luminance	Maximum average
45	1,200	590	2.0	18,550	1,590	11.7
60	2,250	1,140	2.0	28,650	3,210	8.9
65	2,810	1,470	1.9	25,150	3,300	7.6
70	2,570	1,660	1.5	20,500	2,960	6.9
75	2,740	1,700	1.6	15,650	2,500	6.3
80	2,740	1,670	1.6	11,450	1,960	5.8
85	2,740	1,620	1.7	10,100	1,810	5.6
90	2,490	1,490	1.7	11,500	1,770	6.5

As can been seen from the table, present shielding practice for the tested luminaire resulted in a maximum to average brightness ratio ranging from 5.6 to 11.7, whereas when the present invention is utilized, this ratio varies from 1.5 to 2.0. This produces excellent shield luminance uniformity.

What I claim is:

1. A refractor for use in a luminaire having an extended light source of predetermined size, the light source having a longitudinal axis extending substantially vertically, said refractor having a light shielding sector extending, when in use, in planes substantially parallel to the light source axis and at least one light refracting sector, means positioned on said light refracting sector for redirecting light from the source outwardly of the luminaire, means extending, when in use, substantially in planes at right angles to the light source axis and positioned on substantially the entire exterior surface of said light shielding sector for reflecting substantially all of the light emitted from said light source and incident thereon back through said light shielding sector, said light shielding sector extending a substantial distance between the top and bottom of said refractor, said reflecting means consisting of a plurality of prisms projecting outwardly from said exterior surface and each having elongated prismatic surfaces defining an acute apex angle, the apex angle of each said prism varying from prism to adjacent prism throughout said light shielding sector, whereby to constitute the surfaces of each of said prisms as means for receiving light from any point along and about the axis of the light source at and above the critical angle of reflection and to thereby constitute all of said prisms as means for preventing the passage of light through said light shielding sector, and flute means on the interior surface of said light shielding sector for uniformly distributing light along said apices and along the valleys of said reflecting means.

* * * * *