Oct. 31, 1967 K. FRANCK ET AL 3,350,556

STREET LIGHTING LUMINAIRES

Original Filed Nov. 14, 1955 5 Sheets-Sheet 1

Fig. 1.

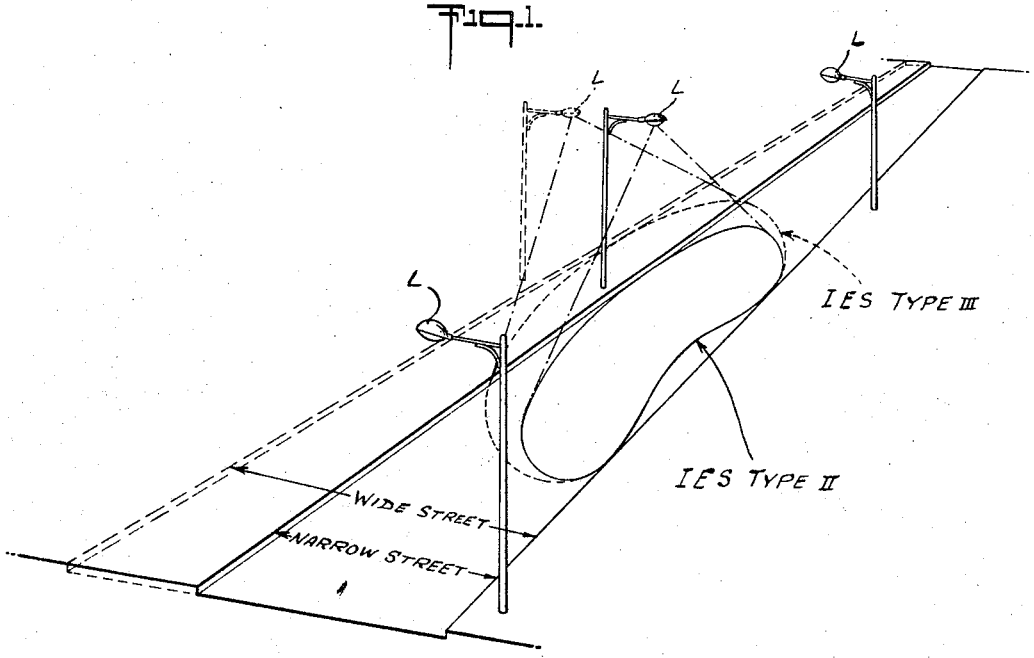
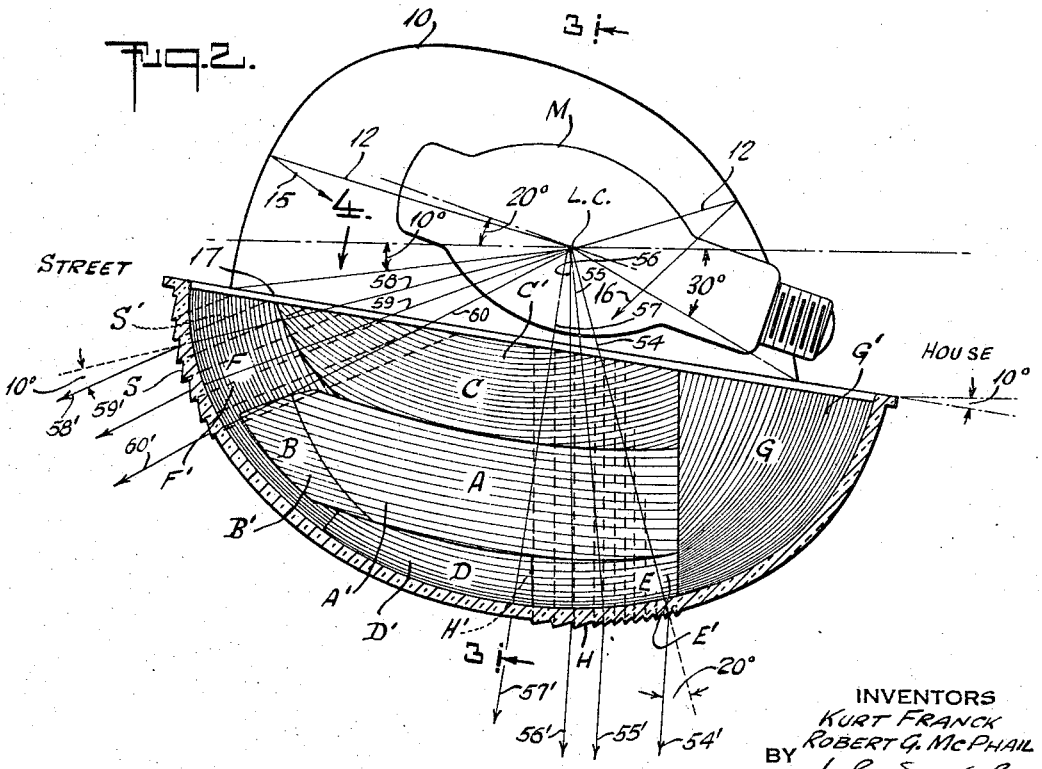


Fig. 2.



INVENTORS
KURT FRANCK
ROBERT G. McPHAIL
BY
ATTORNEY

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Fig. 3.

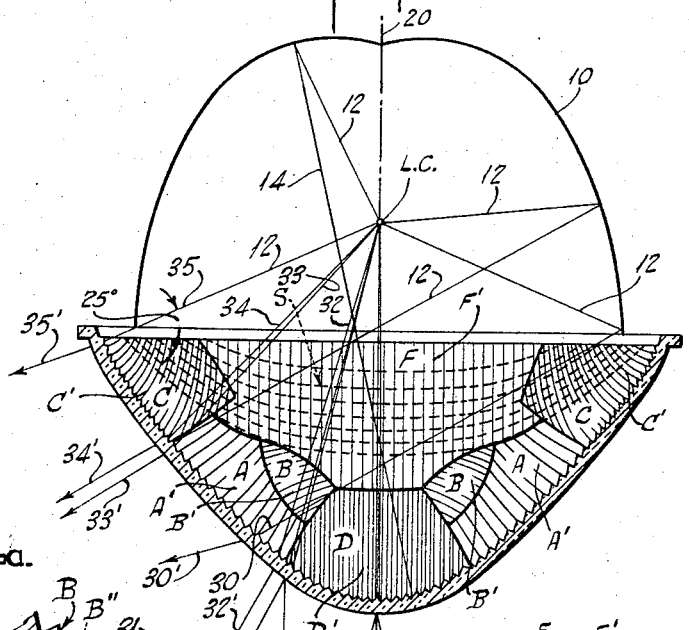

Fig. 3a.

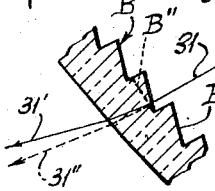

Fig. 4a.

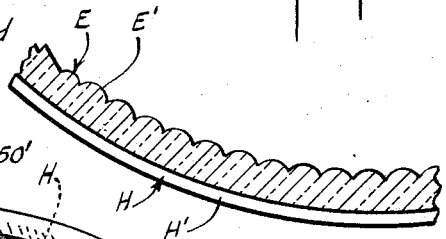

Fig. 4.

INVENTORS
KURT FRANCK
ROBERT G. McPHAIL
BY
John W. Cobb
ATTORNEY

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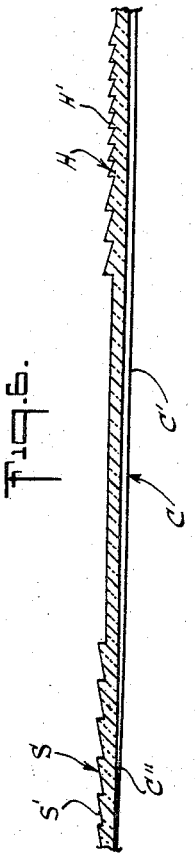

FIG. 6.

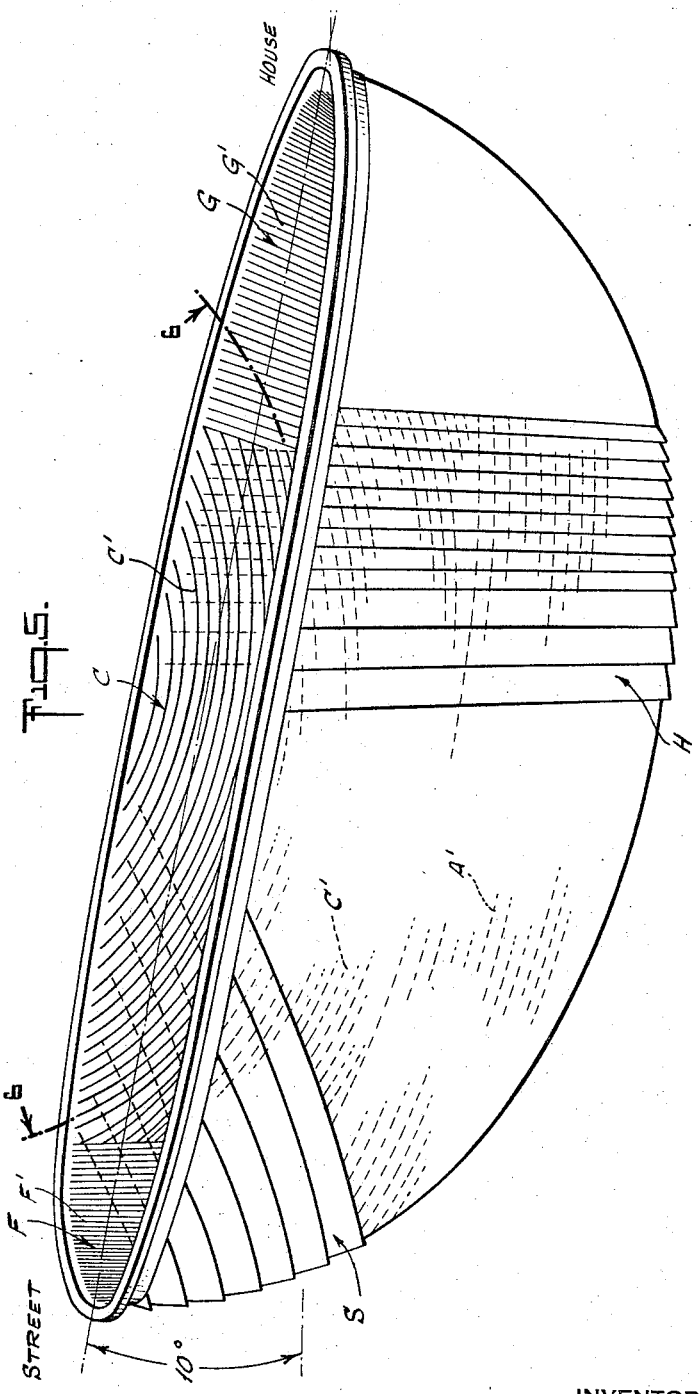

FIG. 5.

INVENTORS
KURT FRANCK
ROBERT G. McPHAIL
BY
ATTORNEY

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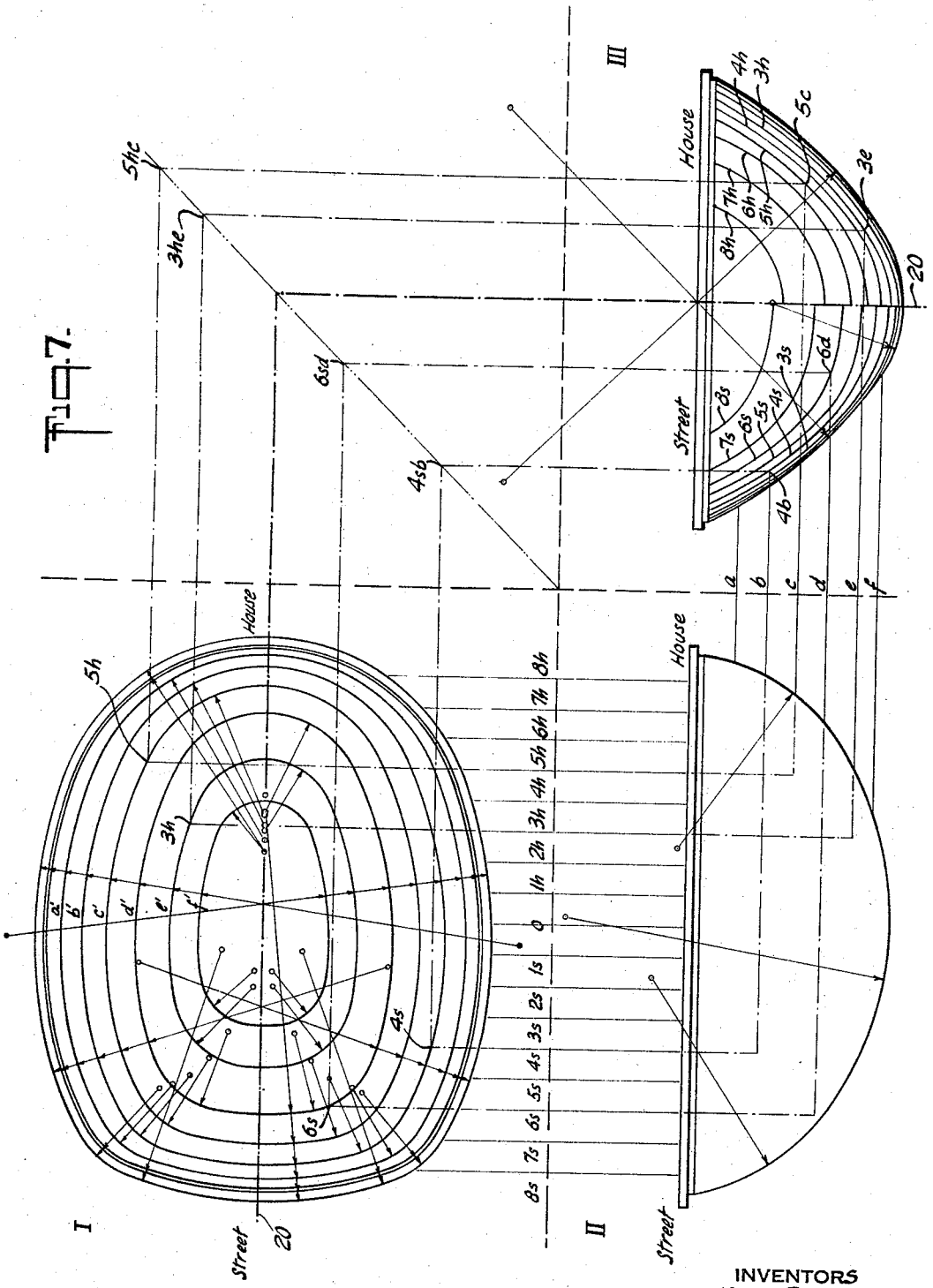
Fig. 7.



INVENTORS
KURT FRANCK
ROBERT G. McPHAIL
BY John M. Cobb
ATTORNEY

Oct. 31, 1967 K. FRANCK ET AL 3,350,556

STREET LIGHTING LUMINAIRES

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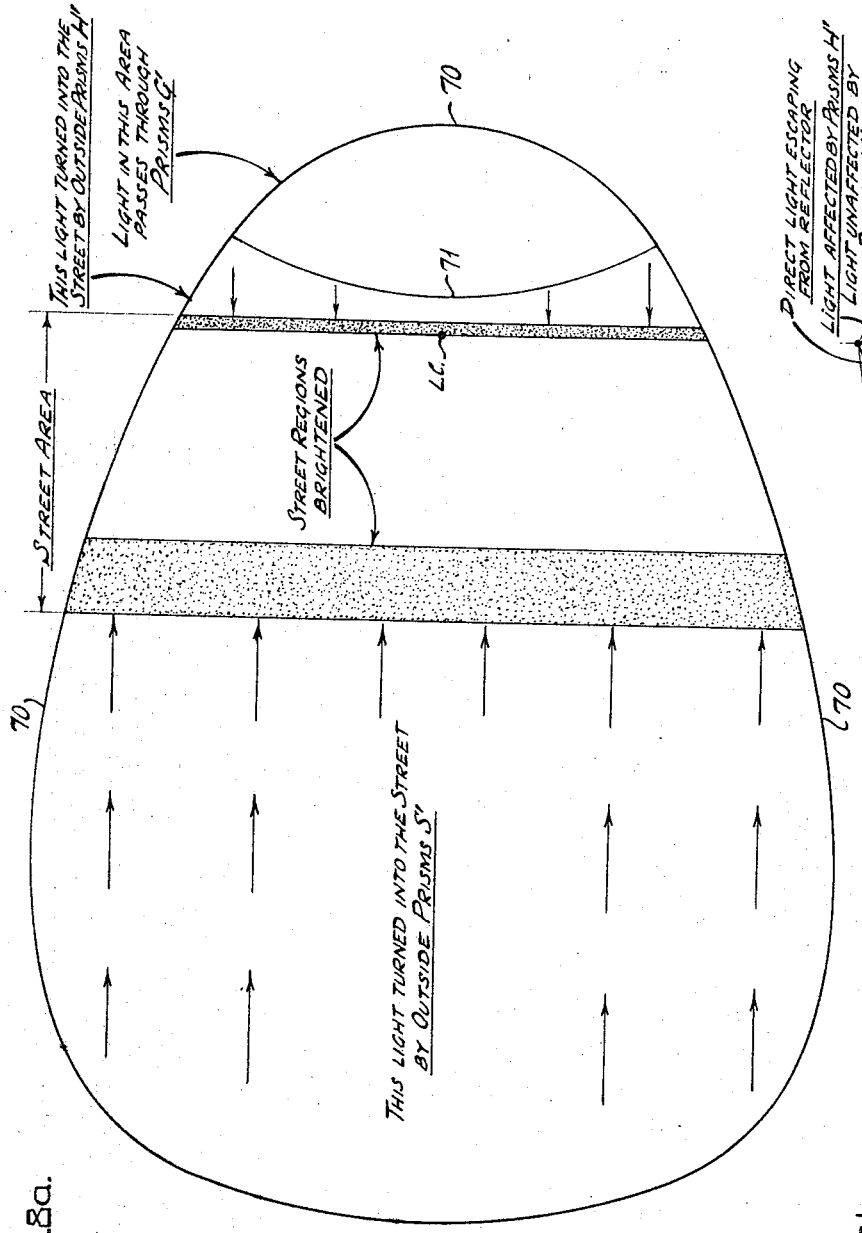

Fig. 8a.

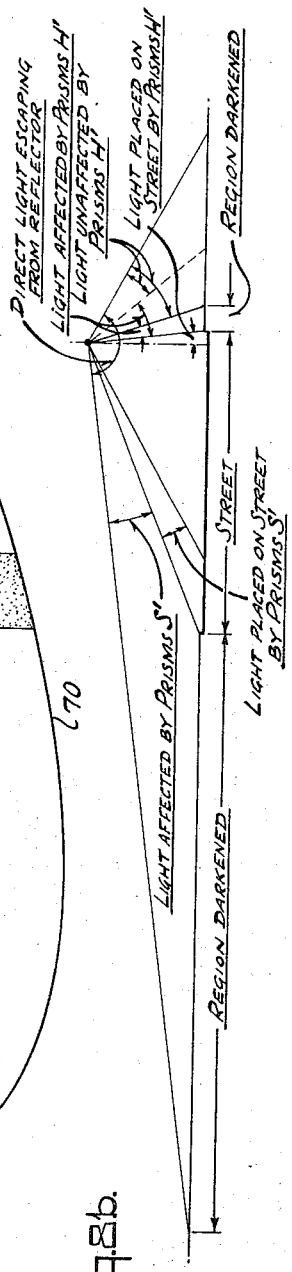

Fig. 8b.

INVENTORS
KURT FRANCK
ROBERT G. McPHAIL
BY John W. Cobb
ATTORNEY

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STREET LIGHTING LUMINAIRES

Kurt Franck and Robert G. McPhail, Newark, Ohio, assignors to Holophane Company Inc., New York, N.Y., a corporation of Delaware

Continuation of application Ser. No. 546,356, Nov. 14, 1955. This application June 28, 1966, Ser. No. 561,286

11 Claims. (Cl. 240—25)

ABSTRACT OF THE DISCLOSURE

A street lighting refractor of ovoidal bowl shape is disclosed for redirecting onto an elongated street surface direct and reflected light from a light source and reflector above the bowl and disposed transverse of the street. The refractor has an oblique mouth which is lower at the house end thereof than at the street end. The refractor has on the inner surface of its sides an upper and a lower system of regressed prisms. The prisms of the lower system are parallel to each other and are substantially parallel to the upper edge of the refractor and of uniform refracting power to lift a band of substantially parallel downwardly oblique reflected rays substantially uniformly. The upper system of prisms have a substantialy concave contour and act to reduce the divergence of downwardly oblique direct light falling thereon and to elevate the same. Moreover, the refractor is equipped with an external vertical band of prisms each extending around the bottom and both sides of the refractor in a transverse vertical plane and crossing the house end portions of the internal prisms.

The application is a continuation of application Ser. No. 546,356, filed Nov. 14, 1955, and now abandoned.

The present invention relates to street lighting luminaires and more particularly to elongated or oval shaped refracting bowls for street lighting.

The design of street lighting equipment for the lighting of streets, roads and parkways from incandescent and mercury sources has utilized the elongated, elliptical or ovoidal reflector and cooperating refractor to secure light distribution suitable for the purpose.

These elongated units are mounted crosswise of the street to secure the advantages of the asymmetric distribution inherently available from an elongated luminaire, for the dominant output can be emitted in the desired street direction and lateral spread for IES type II or type III distribution. When these units use shielding reflectors which extend below the level of the light source, the reflectors cut off direct light in the direction of the street at greater angles below the horizontal than across the street, unless, as has been suggested, they have downwardly extending ends to cut off light and correspondingly shield areas lateral of the units.

Reflector distribution alone cannot, however, be satisfactory, for no additional control is given the direct light or the reflected light. Where the benefits of the refractor are required, it is desirable to provide the reflector with a flat or plane mouth and to provide the refractor with a similar plane or flat mouth or rim. The direct light escaping from the reflector is in a non-circular cone with light escaping at a greater included angle, crosswise of the street direction than in the street direction.

The direct light which escapes from the reflector in either direction beyond the curb or road edge is lost for useful purposes of lighting the street surface unless it can be salvaged and put to use. Heretofore such light has been laterally deflected by vertical prisms so as to spread it away from the logitudinal median plane through the

luminaire and reduce the end-on brightness of the refractor.

The present invention contemplates improvements in refractors of round or elongated shape, according to which substantial portions of the direct light emitted at too high angles in directions across the street to reach the street surfaces, is lowered toward the curb line and street surface, thereby shielding the regions into which it would otherwise be wasted.

A further object of the invention is to provide an elongated refractor having an oblique mouth, higher at the street end than at the house end with systems of prisms arranged to handle the light reflected by a shielding elongated reflector with an oblique mouth of like shape and to handle the direct light which escapes below the reflector and place this light, as well as the salvaged light emitted under the ends of the reflector, on the street surface.

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

In the accompanying drawings:

FIGURE 1 is a perspective view of a street lighted by a number of luminaires mounted at the side of the street;

FIGURE 2 is a vertical, longitudinal, sectional view through the luminaire, taken across the street;

FIGURE 3 is a sectional view on the line **3—3** of FIGURE 2;

FIGURE 3*a* is a fragmentary enlargement of FIGURE 3;

FIGURE 4 is a top plan view of the refractor, taken in the direction of the arrow **4** of FIGURE 2;

FIGURE 4*a* is a fragmentary section on the line 4*a*—4*a* of FIGURE 4;

FIGURE 5 is a perspective view of the refractor;

FIGURE 6 is a section on the line **6—6** of FIGURE 5, illustrating horizontal redistribution of high angled direct light effect by external prisms;

FIGURE 7 is a diagram illustrating in orthographic projection the development of the surface of the refractor form;

FIGURES 8*a* and 8*b* are diagrammatic views illustrating in plan and across the street the spread of direct light escaping the reflector and the rearrangement of spread of the direct light effected by the external refractor prisms.

The luminaire on which the present improved refractor is employed is one normally using a mercury lamp M with a large light source about a light center LC and a downwardly acting ovate reflector **10** with a parabolic profile in vertical planes to reflect the light downwardly in the general direction of the street at angles of about 60° from the nadir and with suitable fluted configurations in horizontal planes to redistribute the dominant reflected light in beams of reflected rays **12** (FIG. 3) with lateral spread of about 25° from the minor axis, suitable for IES type II distribution, or of about 40° for IES type III distribution. Near the top of the reflector it is shaped to reflect the light down, as indicated by ray **14**, FIGURE 3, so as to miss the arc about the light center. The ends of the reflector return light, as indicated at **15** and **16**, FIGS. 2 and 4. The reflector has an oval mouth **17** making an angle of about 10° with the horizontal and providing cut-off angles below the horizontal in the street direction of approximately 25° in the plane of FIGURE 3; and of about 10° across the street and 30° toward the house end, see FIGURE 4. The lamp M is mounted with its axis approximately 20° to the horizontal.

From the foregoing it will be seen that the output of the lamp-reflector combination includes a dominant per-

centage of lumen output of the lamp in beams 60° above the horizontal in the general direction of the surface to be illuminated, but at too low angles for efficient use, together with relatively high angle reflected light on the street, rays **14**, and toward the house and street ends, rays **15** and **16**. The reflector also allows the escape of a cone of downward light spreading 65° each side of nadir, in the street direction, 80° above nadir and beyond the far curb and 60° from nadir and beyond the near curb.

The refractor form (without prisms) is illustrated in the three angle projection view of FIGURE 7. Its outer surface is externally convex and its inner surface internally concave, except for the flat horizontal flange at the top. The refractor form is symmetrical on opposite sides of a median longitudinal plane indicated by the dot and dash line **20—20**. In this figure the side elevational outline of the refractor form is in quadrant II, the top plan in quadrant I, one half of the house end is in quadrant III at the right of the line **20—20**, and one half of the street end, which normally would be to the left of quadrant I to the left of line **20—20**, has been relocated to the left of line **20—20**, to save space. The lines *a*, *b*, *c*, *d*, *e*, *f* indicate horizontal planes through the side and end views of quadrants II and III, corresponding with the curved contour lines *a'*, *b'*, *c'*, *d'*, *e'*, *f'*, respectively, of the plan of quadrant I. The horizontal contours are composed of circular arcs centered as indicated in the plan view, and the side and end profiles of quadrants II and III are also composed of circular arcs, as indicated. The vertical lines **8***s*–**8***h* connecting quadrants I and II indicate vertical planes through the refractor form. The curves **8***s*, **7***s*, **6***s* . . . to the left of **20—20** in quadrant III and the curves **8***h*, **7***h*, **6***h* . . . to the right of **20—20** in quadrant III indicate the shapes of the corresponding vertical sections of the refractor form. The points on these curves are determined by projection, for example, curve **5***h* is secured by projecting points on planes **5***h* at the various levels *a* . . . *f*. These curves are the resultant of the other parameters used and do not follow any simple mathematical equation.

Referring now to FIGURES 2 to 6, it will be seen that the inner surface of the bowl is divided into panels A, A; B, B; C, C on opposite sides of the plane **20—20**, bottom panels D and E and end panels F and G, and that the outer surface has panels H and S with prismatic elements.

The panels A, A are located on the sides of the refractor in wide bands substantially parallel with the refractor mouth and intermediate the top panels C, C and bottom panel D in a position to receive the dominant reflected light at 60° above the nadir and with the horizontal distribution determined by the fluted reflector. Panels A have refracting prisms A', generally parallel with the reflector flange and with a refractive power to lift direct light 15° and 45° from nadir and elevate it so as to be from 30° from nadir. The paths of the reflected rays are indicated in FIGURES 3 and 3*a* by lines 30, 30', 31, 31'. The prisms A' do not, at any point along the entire length, effect any substantial change in azimuth angle of the reflected rays, so that the horzontal distribution of the reflector is not altered, except as the resultant of the elevation of the rays. The paths of direct rays falling on prisms A' are indicated by lines **32, 32'; 33, 33'.**

Panels C receive direct light at higher angles than panel A. They have prisms C' centered about a point above the level of the top of the refractor, as is apparent from the down sweep of the prisms C' shown in FIGURES 2 and 5. These prisms raise the direct light, as indicated by rays **34, 34', 35, 35'**, FIGURE 3, and at the same time reduce its divergence to keep it within the curb line. It will be noted that the direct light from the panels A and C forms a continuous pattern, so that there is no abrupt change in surface brightness as the unit is viewed from the street.

The prisms C' in the street end of panel C are tapered to have less refracting power, as indicated at C'' in the sectional view, FIGURE 6.

Panels B are small and generally triangular in shape toward the street ends of panel A. They are occupied by prismatic elements B' which are optical continuations of prisms A' but are tapered to have lessening refracting power toward the street end as the direct light from the source falling on them would otherwise go beyond the curb. The shallowness of prisms B' and the lower ray path is indicated in FIGURE 3*a* by the dotted line B'' and the ray path **31''**. Higher direct rays such as **38***a* falling on panel C are toed in, as indicated at **38***a'*.

The bottom panel D is occupied by light splitting prisms D'. These prisms receive rather intense light from the upper portions of the reflector which, unless properly handled, would cause a bright spot of considerable magnitude on the street directly in front of the unit.

The prisms in panel D split this light along the street so that the result is substantially uniform illumination. They are double action prisms with refracting power of about 15° and act in opposite directions. These prisms are so designed that at the border between panel D and panel B, the panel D prisms have the same elevating power as the panel B prisms, thus promoting uniformity of distribution. Ray paths are indicated by rays **36***a*, **36***b*, **36***c*, **36***d*.

Panel E carries shallow flutes E' (FIG. 4). The light going through this panel needs no lateral redirection, the flutes producing a small amount of lateral diffusion to further smooth out the light pattern on the street. Panel F carries similar vertical flutes F'.

Panel G carries vertical, or radial prisms G' of refracting power of about 40° to turn the light away from plane **20—20** and toward the street.

In FIGURE 4 direct rays from the light source falling on panels A, B, C and F are indicated by light full lines **37–40**, inclusive, radiating from LC and the azimuth direction of the refracted light by dotted extensions **37'** to **40'**, inclusive, of these lines. Reflected rays from fragments of the reflector **10** are also shown in light full lines **50–53**, inclusive, and the paths of the reflected rays after passing through panels A and B are indicated by dotted extensions **50'–53'**.

The panel H near the house end has a series of external, vertical, parallel prisms H' which extend from the flange on one side around the bottom of the refractor and up to the flange on the other side. These prisms occupy a region about 20° wide in the longitudinal median plane, measured from the vertical through the source, to a width of about 35° near the reflector flange. They have a refracting power which varies from near 0° to 20°, so that direct light which would otherwise fall beyond the near curb is brought toward the vertical plane through the source and caused to fall on the ground in the region of the near curb. The paths of direct rays traversing the prisms H' in the vertical plane of FIGURE 2 are indicated by the lines **54, 54'; 55, 55'; 56, 56'; 57, 57'.** The emergent rays are substantially in the plane of the curb.

The panel S at the street end of the refractor has a series of downwardly sloping prisms S' which occupy a wedge-like region below the reflector flange. These prisms have a refracting power of about 10° at the top and approach 0° at the bottom so that the direct light emitted at high angles is brought toward the street area. The refracting power of these prisms is such that the refracted rays from each prism are in a downwardly concave sheet intersecting the curb line. The paths of the rays traversing the prism S in the vertical plane of FIG. 2 are indicated by the lines **58, 58'; 59, 59'; 60, 60'.**

The overall action of the external prisms H' and S' is illustrated in FIGURES 8 and 8*a*. The drawings indicate the luminaire mounted with the light center 30 feet above a street 75 feet wide and 3 feet from the house side or near curb. The direct light escapes below the reflector in

a non-circular cone, as determined by the location of the light center and the position of the mouth of the reflector. The reflector here illustrated has a transverse, or street direction, cutoff angle of 25° below the horizontal, a house end cutoff angle of about 30° below the horizontal and a street end cutoff angle of about 10° below the horizontal.

The light pattern on the ground produced by such a reflector is illustrated by the area defined by the oval **70**, FIGURE 8. This region extends some 150 feet beyond the far curb and some 200 feet along the ground outside the far curb line. It covers an area of some 50 feet maximum depth beyond the near curb. In the absence of a refractor, the bare source would be visible throughout this area.

The direct light which would otherwise fall on the ground beyond the far curb is intercepted by the prisms S' and shifted to a region some 15 feet wide inside the far curb. This is indicated by lightly stippling the area. Most of this light passes through flutes F' which do not materially affect the downward shift obtained by prisms S'. The light which passes through both S' and C' is additionally pulled into the street.

At the house end direct light which would fall on the region between curved lines **70** and **71** passes through internal prisms G and is laterally deviated as above discussed. This action is omitted from FIGURE 8. The light between the curved line **71** and the vertical plane through the source passes through the prisms H' and is shifted from the plano-concave region to the narrow region inside the near curb, and indicated by light stippling. Such of this light as passes through flutes E' is spread lengthwise of the street near the curb, while the light passing through prisms A' and C' is raised. These effects are omitted from FIGURE 8.

The useful light output of the luminaire employing the external prisms is increased significantly. About 8% more flux is placed into the street than would otherwise be the case. The brightness of the luminaire, particularly when viewed from the street end beyond the curb line, is very low. Also the prisms S' materially reduce the brightness of the end of the refractor when viewed from the side by motorists approaching the luminaire.

Prisms such as H' are well adapted for use on the house side of luminaires with circular refractors and intended for side of street or center of street mounting. Due to the location of these prisms, the tilting of the refractor flange is of no material consequence. Prisms such as S' are well adapted for use in elliptical or oval refractors, with or without tilted mounting flanges. Such prisms would occupy a region of lesser or greater vertical angle.

Since it is obvious that the invention may be embodied in other forms and constructions within the scope of the claims, we wish it to be understood that the particular form shown is but one of these forms, and, various modifications and changes being possible, we do not otherwise limit ourselves in any way with respect thereto.

What we claim is:

1. A street lighting refractor of ovoidal bowl shape for redirecting onto an elongated street surface direct and reflected light from a light source above the bowl in its longitudinal median plane disposed transverse of the street direction and an oval, dome-shaped reflector about the source, symmetrical with respect to said plane. with an oblique mouth lower at the house end thereof than at the street end thereof and acting to cut off direct light at greater angles below the horizontal at the house end than at the street end and to reflect a band of light across the longitudinal median plane at angles too low for efficient street lighting, said refractor having an oblique mouth lower at its house end than at its street end and having on the inner surface of its sides an upper system and lower system of regressed prisms, the prisms of the lower system being parallel with one another, and substantially parallel with the upper edge of the refractor and of uniform refracting power to lift a band of substantially parallel, downwardly oblique rays substantially uniformly, the upper system of prisms being concentric about a center above the refractor mouth and acting to reduce the divergence of downwardly oblique light falling thereon and elevate the same and an external vertical band of prisms each extending round the bottom and both sides of the refractor in a transverse vertical plane and crossing the house end portions of the internal prisms.

2. The refractor of claim **1**, wherein the refracting power of the upper system of prisms is greater near the house end than toward the street end.

3. The refractor of claim **1**, wherein the refracting power of the lower system of prisms is uniform throughout their length, and having toward the street end a system of prisms which extend from the lower system of prisms and of diminishing refracting power along their length.

4. The refractor of claim **1**, having a still lower system of prisms extending lengthwise of the bottom of the bowl for spreading light away from nadir and in the direction of the street.

5. A street lighting refractor of ovoidal, bowl shape and externally convex below its mouth, which is normally disposed in a plane sloping at an angle of approximately 10° from the horizontal, and symmetrical about a vertical longitudinal plane, transverse of the street, the inner surface of the bowl being divided into panels A, B, C, D, E, F, and G located each side of the median plane, the panel G being at the lower, or house end, of the refractor, the panel F at the upper or street end of the refractor, the panels D and E at the bottom with panel D adjacent panel F and panel E adjacent panel G, each panel A above panels D and E, each panel B between the corresponding panel A and F and each panel C above the corresponding panel A and between panels F and G, each panel having a system of regressed prismatic elements which redirect light falling thereon, the prismatic elements of panels A being substantially horizontal and parallel with one another and constructed and arranged to lift a uniform band of downwardly oblique parallel light falling thereon, the prismatic elements of panels B being a continuation of those of the corresponding A panels but with less refracting power, the prismatic elements of each panel C having an upwardly concave contour along their length and acting to lift and reduce the divergence of divergent light falling thereon, the prismatic elements in panels D and E extending longitudinally and acting to spread light, the prismatic elements in panels F and G being vertical ribs acting to deviate light away from the median plane, the refractor having on its external surface opposite the house ends of the prisms of panels A, C and E, a panel of prisms each of which extends around the bottom and sides in a transverse vertical plane, said prisms acting to deviate light toward the directions parallel to the length of the street.

6. The refractor of claim **5** having on its external surface at the street end and about the adjacent side portion a wedge shaped panel of parallel, downwardly acting prisms acting on high angled, downwardly directed light to lower the same.

7. A street lighting refractor of ovoidal bowl shape for redirecting onto an elongated street surface direct and reflected light from a light source above the bowl in its longitudinal median plane disposed transversely of the street direction and from an oval, dome-shaped reflector about the source, symmetrical with respect to said plane, with an oblique mouth lower at the house end thereof than at the street end thereof and acting to cut off direct light at greater angles below the horizontal at the house end than at the street end and to reflect a band of light across the longitudinal median plane at angles too low for efficient street lighting, said refractor having an oblique mouth lower at its house end than at its street end and having on the inner surface of its sides an upper system

and lower system of regressed prisms, the prisms of the lower system being substantially parallel with one another, and substantially parallel with the upper edge of the refractor and comprising prism means of uniform refracting power for lifting a band of substantially parallel, downwardly oblique rays substantially uniformly, the upper system of prisms having upwardly diverging ends and substantially passing through paths substantially concentric about a center above the refractor mouth and comprising means for reducing the divergence of downwardly oblique direct light falling thereon and elevate the same and an external vertical band of prisms each extending round the bottom and both sides of the refractor in a transverse vertical plane and crossing the house end portions of the internal prisms.

8. The refractor of claim **7**, wherein the refracting power of the lower system of prisms is uniform throughout their length, and having toward the street end a system of prisms which extend adjacent the lower system of prisms and of lower refracting power than the prisms of said lower system.

9. A street lighting refractor of ovoidal, bowl shape and externally convex below its month, which is normally disposed in a plane sloping at an angle of approximately 10° from the horizontal, and symmetrical about a vertical longitudinal plane, transverse of a street, the inner surface of the bowl being divided into panels A, B, C, D, E, F, and G located each side of the median plane, the panel G being at the lower, or house end, of the refractor, the panel F at the upper or street end of the refractor, the panels D and E at the bottom with panel D adjacent panel F and panel E adjacent panel G, each panel A above panels D and E, each panel B between the corresponding panel A and F and each panel C above the corresponding panel A and between panels F and G, each panel having a system of regressed prismatic elements which redirect light falling thereon, the prismatic elements of panels A being substantially horizontal and parallel with one another and comprising means for lifting a band of substantially parallel downwardly oblique rays substantially uniformly, panels B being continuations of panels A, the prismatic elements of panels B having less refracting power than the prismatic elements of panel B, the prismatic elements of each panel C having an upwardly substantially concave contour along their length and acting to lift and reduce the divergence of divergent light falling thereon, the prismatic elements in panels D and E extending longitudinally and acting to spread light, the prismatic elements in panels F and G being vertcal ribs acting to deviate light away from the median plane the refractor having on its external surface opposite the house ends of the prisms of panels A, C and E, a panel of prisms each of which extends around the bottom and sides in a transverse vertical plane, said prisms acting to deviate light toward the directions parallel to the length of the street.

10. A street lighting refractor of ovoidal bowl shape for redirecting onto an elongated street surface direct and reflected light from a light source above the bowl in its longitudinal median plane disposed transverse of the street direction and an oval, dome-shaped reflector about the source, symmetrical with respect to said plane, with an ablique mouth lower at the house end thereof than at the street end thereof and acting to cut off direct light at greater angles below the horizontal at the house end than at the street end and to reflect a band of light across the longitudinal median plane at angles too low for efficient street lighting, said refractor having an oblique mouth lower at its house end than at its street end and having on the inner surface of its sides an upper system and lower system of regressed prisms, the prisms of the lower system being parallel with one another, and substantially parallel with the upper edge of the refractor and of uniform refracting power to lift a band of substantially parallel, downwardly oblique rays substantially uniformly, the prisms of the upper system of prisms being substantially continuous and each having a central portion and end portions on opposite sides of said central portion, the end portions sloping upwardly to the mouth of the refractor and terminating at locations spaced from the ends of the refractor, said prisms of said upper system of prisms constituting means for reducing the lateral divergence of downwardly oblique direct light falling thereon and for simultaneously elevating the same.

11. The street lighting refractor of claim **10**, including an external vertical band of prisms each extending round the bottom and both sides of the refractor in a transverse vertical plane and crossing the house end portions of the internal prisms.

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NORTON ANSHER, *Primary Examiner.*

Disclaimer

3,350,556.—*Kurt Franck* and *Robert G. McPhail*, Newark, Ohio. STREET LIGHTING LUMINAIRES. Patent dated Oct. 31, 1967. Disclaimer filed Sept. 28, 1973, by the assignee, *Holophane Company, Inc.*

Hereby enters this disclaimer to claims 1–11 of said patent.

[*Official Gazette November 6, 1973.*]