Dec. 8, 1953

K. FRANCK

YARD AND STREET LIGHTING SYSTEM AND LUMINAIRES FOR USE THEREIN

2,662,165

Filed Nov. 29, 1950

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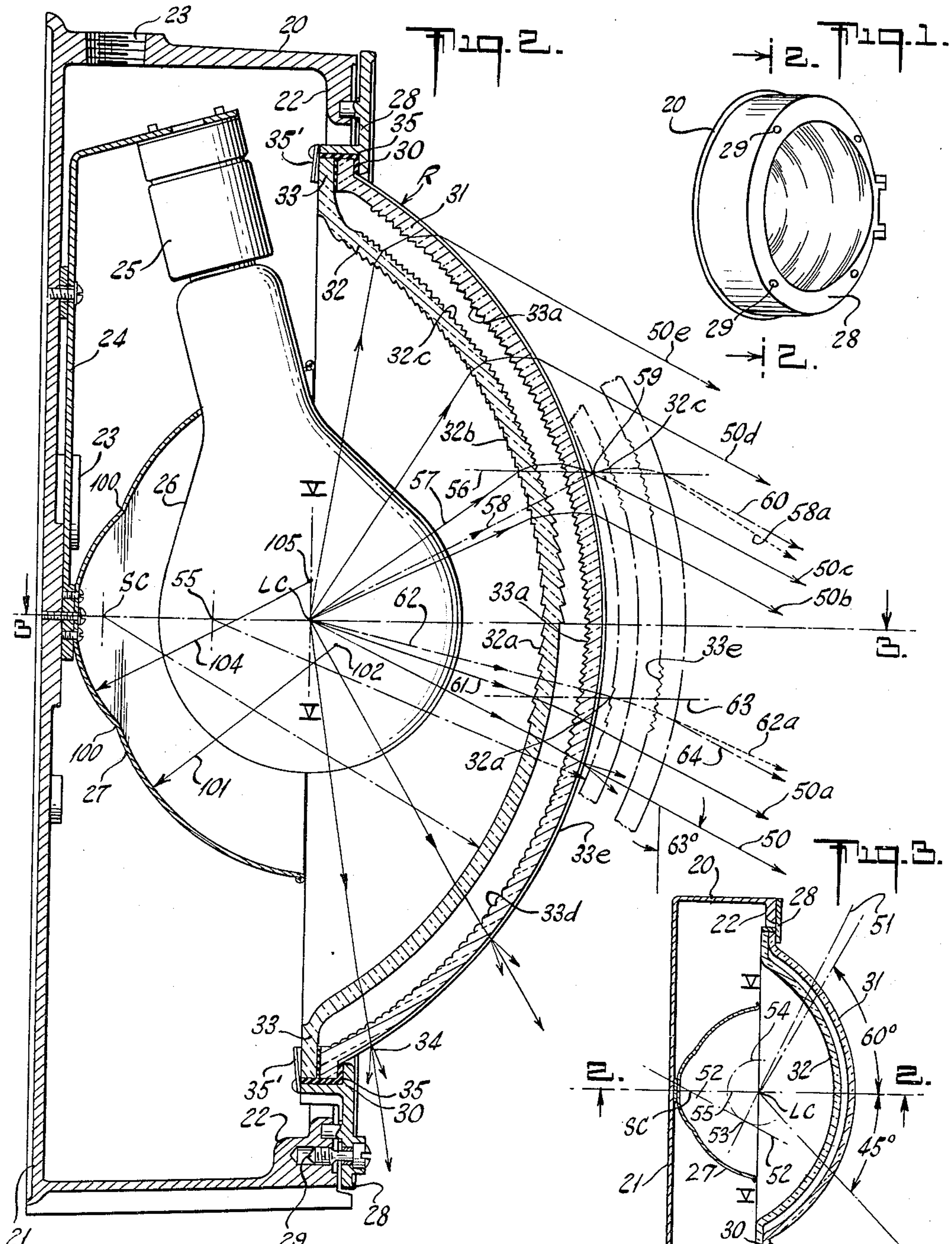

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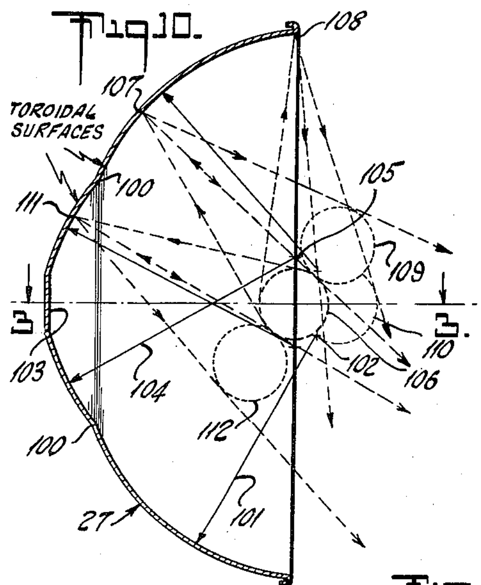
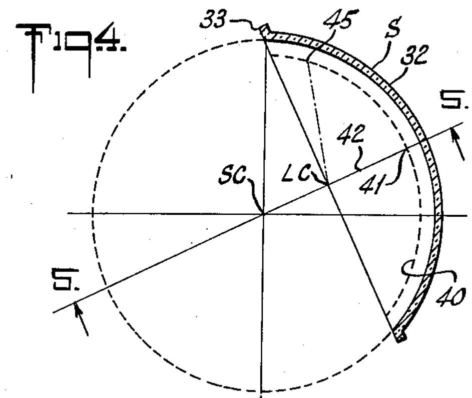
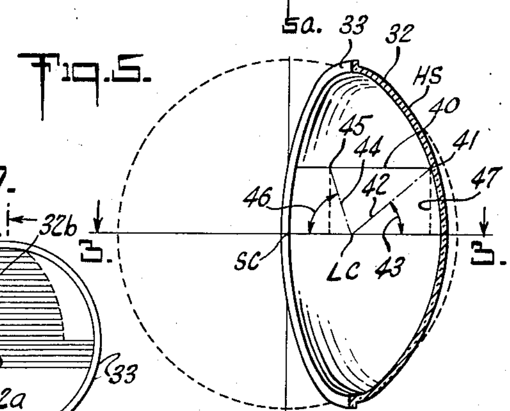
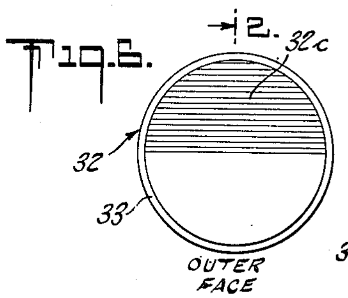
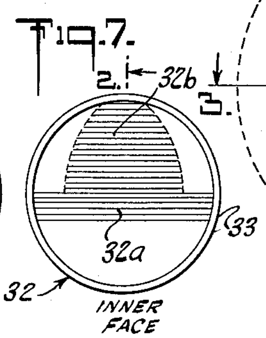
3 Sheets-Sheet 2

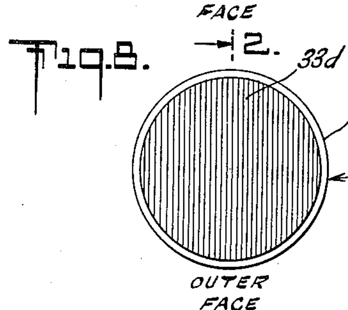


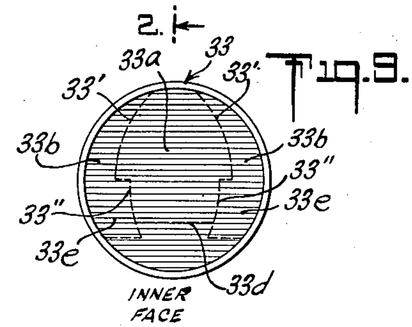












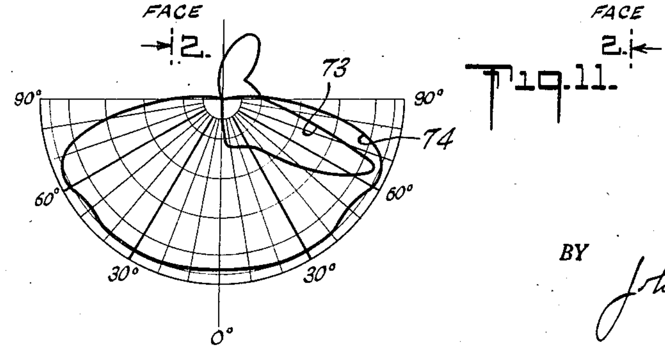


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Fig. 12.

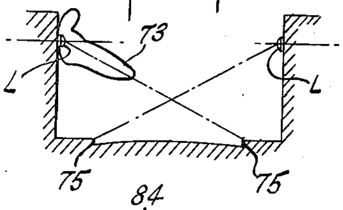


Fig. 14.

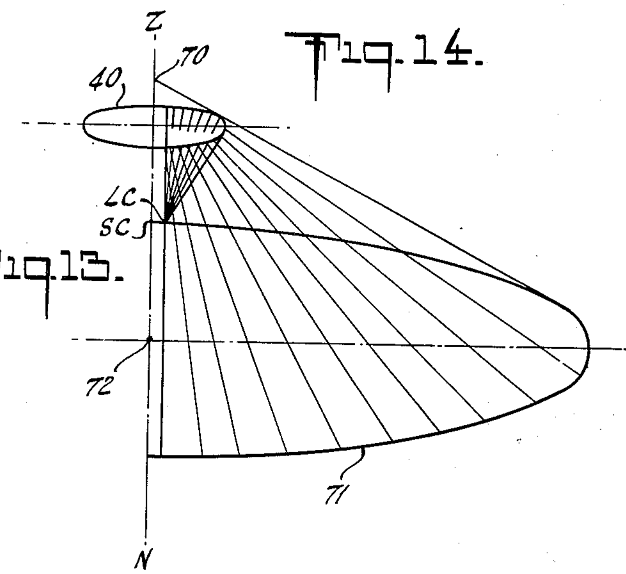


Fig. 13.

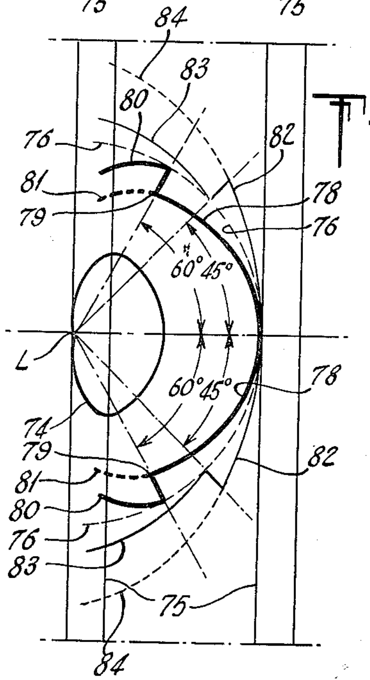
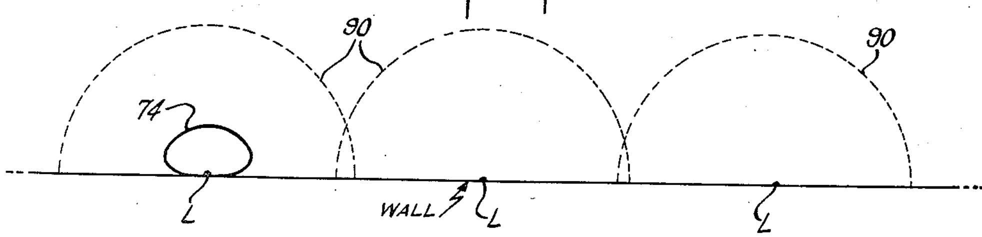


Fig. 15.



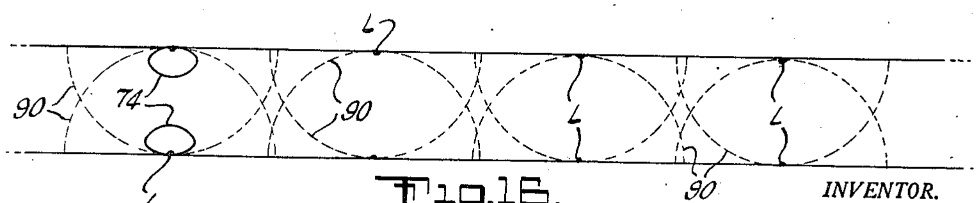


Fig. 16.

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Patented Dec. 8, 1953

2,662,165

UNITED STATES PATENT OFFICE

2,662,165

YARD AND STREET LIGHTING SYSTEM AND LUMINAIRES FOR USE THEREIN

Kurt Franck, Newark, Ohio, assignor to Holophane Company, Inc., New York, N. Y., a corporation of Delaware

Application November 29, 1950, Serial No. 198,187

9 Claims. (Cl. 240—25)

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The present invention relates to and is more particularly directed to lighting systems wherein a plurality of luminaires disposed in a row above and to one side of an elongated area to be illuminated produce, without loss of light in the opposite direction or at too high angles from the nadir to be effective, a broad longitudinally extending region of illumination of limited lateral spread.

According to the present invention, the luminaires, when employed in systems of lighting, are mounted in a row or rows along the side or sides of the area to be illuminated. The luminaires are so arranged that all of the light emitted from them is directed to one side of this vertical plane and none of the light passes in the opposite direction across this vertical plane. In the luminaire, direct light rays are emitted from a source, at or near a point, in a spherical region and those to one side of the vertical (longitudinal) plane are intercepted and returned so that all the light passes toward the other side of the vertical plane. This direct and reflected light is emitted in a hemisphere centered at the light source, within a horizontal angle of approximately 180° and a vertical angle of approximately 180°.

According to the present invention the direct light from the lamp and the reflected light are intercepted by a refractor (preferably a two-piece refractor) which changes the vertical angles of the light without substantial change of horizontal or azimuth angle so that the light is distributed downwardly to cover an area of semi-circular shape, i. e., as though it came from an elevated centrally disposed point. When such luminaires are mounted in a row and have the proper mounting height-spacing ratio, these semi-circular light patterns may be caused to overlap so as to produce an illuminated region alongside a wall, the side of a street or the like, of limited lateral spread, and when two rows of such luminaires are mounted on opposite sides of a street, the street surface receives these semi-circular patterns of light which overlap so as to provide a very even form of street illumination.

The lighting systems contemplated make it possible to mount the luminaires on the side wall of a building or of the buildings along the side of the street and avoid the necessity of the usual lighting standards normally erected near the sidewalk and the use of brackets for supporting the luminaires. The wiring can be carried on the building structures instead of underground or overhead in the street. They may, of course, be mounted on poles, where other means of support are not available.

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While it is contemplated that the direct and reflected light produced by the light source and reflector will be confined to a vertical hemisphere and such light will be redirected into useful directions by refracting prisms, the present invention contemplates the employment for such purposes of a refractor which is concave to the light source but not concentric about the light source.

According to the present invention, the refractor is of pressed glass made in molds, and the prisms have contours which can be formed in molds of machinable contour. Here a spherical contour is most appropriate and the refractor contour or profile shown is a segment of a sphere concave to the source and so disposed as to intercept all the light rays in the hemisphere of direct and reflected light above referred to.

Inasmuch as the light from the light source and the reflector may in the first instance be considered as coming from a point which is at the center of the plane bounding the spherical sector, the light rays intercepted by the refractor at varying azimuths each side of the vertical median plane at common elevations above or below horizontal will have lesser angles of incidence with increased azimuths. The envelope of such a series of rays is in the surface of an oblique cone with circular base.

In order that the light rays emitted from the luminaire will have the desired angle from the nadir in the varying azimuth planes, the present invention contemplates providing the refractor with prisms of varying angle of refraction so as to compensate for the varying vertical angle of the incident light and emit the rays in approximately a right circular cone.

Other and further objects will appear as the description proceeds.

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 drawings:

Figure 1 is a perspective view of the complete luminaire;

Figure 2 is a vertical sectional view on the plane **2—2** of Figure 1;

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

Figure 4 is a diagrammatic horizontal sectional view on the line **3—3** of Figures 2 and 5, and

Figure 5 is a side elevational view of the refractor taken in the direction of the arrow **5a** of Figure 4, the refractor being in section on the line

5—5 of this figure, Figures 4 and 5 showing geometrical development of the refractor and diagrammatically illustrating the paths of direct light rays;

Figures 6 and 7 are diagrammatic views showing respectively the outer face and the inner face of the inner piece of the refractor;

Figures 8 and 9 are views similar to Figures 6 and 7 for the outer piece of the refractor;

Figure 10 is a sectional view on the line 3—3 of Figure 2, showing the reflector;

Figure 11 is a diagram illustrating the photometric light distribution from the luminaire;

Figure 12 is a diagrammatic cross-sectional view through a street illustrating the installation of luminaires;

Figure 13 is a plan view of the street showing the distribution from one luminaire;

Figure 14 is a diagrammatic view illustrating refraction by prisms of the refractor;

Figure 15 is a diagrammatic view illustrating a system employing a series of luminaires along the wall or one side of a street; and

Figure 16 is a diagrammatic view showing the installation of the luminaires on opposite sides of a street.

The structure illustrated in the drawings is one more especially designed for use in street lighting and for attachment to the walls of the buildings extending along the sides of the street so that it is above sidewalk level and back of the sidewalk. Such luminaires along the sides of the street afford excellent street lighting with good distribution of light on the street, good utilization of the energy consumed in the lamps and avoid the use of poles along the curbside. They also make it possible to illuminate the sidewalks and street with light at sufficiently high vertical angles for the purpose and to reduce glare at very high angles in regions approaching the horizontal.

Structurally the luminaire has a round more or less drum-shaped metal body or housing 20 with a flat rear wall 21 adapted to be secured against the side of the building and a relatively narrow inwardly extending front flange 22. The housing is provided with suitable openings such as indicated at 23 for connection to current supply conduits and can be mounted in any convenient manner. The housing carries a strap 24 which supports the obliquely disposed lamp socket 25 adapted to carry an incandescent or mercury lamp 26 whose light center is indicated at LC. The bracket 24 also carries a reflector 27.

A hinged lens ring 28 is secured to the front face of the housing 20 in any suitable manner, as for example by screws indicated as 29. The lens ring is very close to the vertical plane VV through the light center so that the housing limits the spread of light which can escape from it to substantially a hemisphere with the center of the hemisphere at the light source LC. Thus, the housing and reflector make it possible for substantially the entire output of the lamp to escape in a hemisphere to the right of Figure 2 or 3. The lens ring 28 has an inwardly facing recess 30 adapted to receive the two piece refractor designated generally by R. This luminaire, when designed for use with large lamps, such as 1000 watt street lamps, may have a diameter of about 26'' and the housing a depth of about 7'' and the openings in the lens ring may have a diameter of about 19''. Hence, the parts are much larger and heavier than the more conventional types of street lighting equipment.

The refractor, generally designated as R, is

made up of two components in the form of pressed glass members 31 and 32 flanged as indicated at 33 and 34 in the drawings and secured in place by suitable cement gasket material 35 and the clips 35' and held against removal by these clips. These refractor members are segments of the surfaces of concentric spheres having the center at SC (sphere center), Figures 2, 3, 4, 5 and 14. This makes it possible to form all the prism outlines on spherical surfaces in the molds and to provide a unit in which the overall dimension is much less than it would be if the refractors were hemispheres centered on the light source. There is also a great saving in weight of material and better utilization of the light in the desired directions than could be had from a hemispherical refractor.

On account of the offsetting of the light center from the center of the sphere as shown in Figure 1 and the desire to confine the light distribution to the desired pattern, it is necessary to compensate in the prism construction for the changes in angles of incidence and refraction which result from such shifting.

Reference is now made to Figures 4 and 5. Figure 4 is a horizontal section through the inner piece of glass 32 on the horizontal or equatorial plane 3—3, prisms being omitted. The median plane through the spherical segment 5—5 is oblique to the horizontal line of the drawing and in Figure 5 it is assumed that the spherical segment S has been cut in half along the line 5—5 to form a hemispherical segment HS and that this hemispherical segment is viewed in the direction of the arrow 5a so that one sees both the flange 33 of the segment and a section through it. In Figure 5 a horizontal line is drawn at 40 to indicate a parallel and the dotted arc 40 in Figure 4 represents this parallel. If now a line is drawn from LC to the point 41 where the line 40 intersects the inner surface of the hemispheric segment, the vertical angle of the light ray 42 so drawn is indicated at 43. By similarly drawing a line 44 at a wide azimuth angle from the plane 5—5, to intersect 40 at the point 45, one can indicate the path of a ray 44 from the light center to a point on the parallel 40. The vertical angle 46 of the ray 44 is much less than the vertical angle of the ray 42. This does not appear in the perspective drawing, but such is the case because the vertical distance 47 separating the equatorial plane 3—3 and the parallel 40 is constant and the oblique distance from LC to 41 is less than the oblique distance from LC to 45.

The arc 40, Figure 4, may be deemed to be the base of an inverted oblique circular cone with its center at SC. This is also shown diagrammatically and in perspective in Figure 14.

Referring now to Figures 6 and 7, it will be seen that the inner face of the inner refractor 32 is provided with horizontal prisms 32a below the horizontal which extend from flange to flange, and above the center as provided with a series of horizontal prisms 32b which extend to the top of the refractor and diminish in length upwardly. From Figure 6 it will be seen that the outer face of the inner piece 32 has above the horizontal a series of horizontal prisms 32c which extend from flange to flange and all the way to the top. Prisms 32b occupy a horizontal region of approximately 60° width each side of the vertical median plane 2—2. The dotted lines along the ends of the prisms 32b in Figure 7 are meridians 60° from the center.

As shown in Figure 9, the inner surface of the outer piece **33** has a series of horizontal prisms **33***a* located between 60° meridian lines **33'**—**33'** above the horizontal through the center and between 45° meridian lines **33''**—**33''** and for a distance below the horizontal. Laterally of the meridian lines **33'**—**33'**, the inner surface of the refractor **33** has areas of horizontal prisms indicated at **33***b*—**33***b* of less refracting power than those at corresponding elevations in regions **33***a*. Below these horizontal prisms outside lines **33''**—**33''** are horizontal prisms **33***e* of greater refracting power than the ones between **33'** and **33'**. Below these are flutes **33***d*. The horizontal prisms and flutes on the inner face extend all the way to the flanges **34**. The outer surface of the refractor part **33** is provided with shallow vertically extending flutes **33***d*.

In the full line section in Figure 2 taken on the median plane **2**—**2** is shown in light full lines the paths of light rays in that plane. It will be seen that the opposed systems of prisms above the light ray **50** in this plane is such as to refract all the light from LC into downwardly sloping directions parallel with **50** and designated as **50***a*, **50***b*, etc. Here the slope is about 63° from the nadir. Rays of such angles can be obtained from the spherical sector all the way to the top, but could not be obtained from a hemisphere all the way to its pole. The vertical flutes afford a limited lateral diffusion. In the median plane **2**—**2** below the ray **50**, the rays pass through the refractor with vertical diffusion brought about by the horizontal flutes **33***c* and lateral diffusion brought about by the flutes **33***e*. The angle of the rays **50** is selected as the angle into which it is desired to direct the dominant output of the luminaire in the plane **2**—**2**.

As above explained, the vertical angle of light rays falling on the refractor at any particular elevation above the horizontal plane through the center of the refractor varies with the azimuth angle, and if the prisms **32***b*, **33***a* were uniform all the way to the edges of the refractor, the resulting distribution would be considerably distorted from the desired distribution.

In Figure 3, a line **51** is drawn at approximately 63° to the meridian plane and represents a vertical plane intersecting the refractors **32** and **33** beyond the horizontal prisms **32***b* and **33***a*, respectively. From the center of the sphere SC, a perpendicular **52** is dropped to the line **51**, the intersection of these two lines at **53** now representing the center of lesser circles through the spheres in the plane **51**. An arc **54** is then drawn about LC and the intersection of this arc with the line **2**—**2** locates the center **55** about which the intersections of the plane **51** with the refractors may be represented in the plane of Figure 2.

Referring now to Figure 2, it will be seen that dot and dash lines drawn about the center **55** may be used to represent the profiles of the refractors in the plane of line **51** of Figure 3, and the reference characters applied to those lines indicate the prisms in such plane. In Figure 2, a horizontal line **56** is drawn to show the elevation at which a ray such as **57** above the horizontal strikes the refractor in the plane of Figure 2. This line **56** intersects the dotted line indicating the inner surface of the refractor **32**. A ray such as **58** in plane **51** falls on the smooth inner wall of the inner refractor at **59**. Its vertical angle is lower than the vertical angle of the ray **57** for reasons above discussed and hence the ray will have a less angle of incidence on the refractor.

This means that if there were as much deviation of the ray **58** in passing through the refractors as occurred with respect to the ray **57**, that the emitted ray **58***a* shown in dotted lines would have a very much lower vertical angle than the rays **50***a* etc. and would strike the surface to be illuminated closer to the luminaire. By reason of the adjustment of the prismatic action so that less prismatic action takes place at the sides of the lens above the horizontal in plane **51** as well as at greater azimuth angles than this plane, the rays emitted are, as indicated by the dot and dash line **60**, at a higher angle so as to fall on the street farther from the luminaire.

Similarly, the rays **61** and **62** represent two rays in plane **2**—**2** higher than ray **50** and in the plane of line **51**. They fall on the inner refractor at the level of the line **63**. On account of the reversal of optical operations below the horizontal, the ray **62** would, if no compensation took place, be emitted as indicated at **62***a* farther from the nadir than the rays **50***a* and would fall on the street at greater distances from the luminaire. The adjustment of the prisms in the regions **33***e* below the horizontal compensate for this and the emitted rays, such as **64**, are at substantially the same vertical angle as the rays **50***a*.

Referring now to Figure 14, it will be seen that above the horizontal through the light source a horizontal section through the refractor may be represented as a circle **40** with its center SC, the oblique cone of rays from LC to this circular base is represented by the upwardly diverging lines from LC. The optimum condition to obtain equal spread of light from the luminaire would involve redirecting the light in the surface of the right circular cone having its center at a point such as **70** above SC and at the desired angle of 63° from the nadir so that the optimum distribution pattern would be a circle **71** with its center at **72** below the center of the luminaire.

This ideal situation is approximated by the adjustment of the refractor surfaces above discussed and the output of the luminaire may be represented by photometric curves such as shown in Figure 11 in which the curve **73** represents the light distribution in the median plane **5**—**5**. The maximum candle power is at approximately 63° and light is distributed downwardly at lessening intensities to the nadir. The curve **74** illustrates the distribution about the vertical axis through the angle of maximum 63° from the nadir and shows that the distribution throughout a large portion of the horizontal angle approximates very closely a semicircle and that some light is sent down in regions near the supporting wall.

Figure 12 represents a vertical sectional view through a street lined with buildings and carrying luminaires L, photometric curve **73** being applied. The luminaires L are mounted at such height above the street that the angle of maximum distribution across the street reaches approximately to the opposite curb. The curve **74** shows the horizontal distribution of light from the luminaire at the same scale as curve **73** in Figure 12. In the transverse plane of the street all surfaces of the refractor operate to direct the light as much as possible toward the opposite curb at the point indicated at **75**. If one had semicircular distribution such as in the circle **71** of Figure 14, the distribution pattern would follow along the dotted semicircle **76**.

At increasing azimuths each way from the median plane the action differs because of the change of vertical angle of the incident light as above discussed. Above the horizontal plane through the luminaire the uniform angle prisms in the region 32b, 33a will cause the vertical angle of the dominant rays to become less and less as indicated by the heavy lines 78, extending from 75 to 79 in the 60° azimuthal plane. Here the prism angles change to those in the region 33b and the light is again elevated to the 63° angle corresponding with the dotted semicircle 76 and in the region served by the prisms 33b the angle from the nadir falls off so that the pattern of these rays may be indicated by the heavy lines 80. If the compensation had not taken place beyond 60° from the median plane, the distribution would have continued from the heavy line 78 as indicated by the heavy dotted lines 81. It will thus be seen that the effect of the prism adjustment above the horizontal is to elevate the light in the region near the adjacent curb.

Below the horizontal through the light source a reverse action takes place and the light at greater azimuths has greater angle from the nadir as indicated by the light full lines 82. This action continues out of the 45° azimuth angle as indicated in Figure 13 where the prism angle changes as in the region 33e and now the prisms 33e serve to bend the light down lower than it would otherwise have been. The lowered light is indicated by the light full lines 83 and the distribution which would have occurred below the horizontal but for the adjustment is shown by the light dotted lines 84.

As a result of the prism adjustments above discussed, the light distribution at wide angles from the median plane is held relatively close to the desired vertical angle and substantial illumination is provided over areas near the wall such as the sidewalk.

Figure 15 illustrates distribution available from a row of luminaires L placed alongside a wall and spaced so that their substantial circular light patterns 90 intersect near the wall.

Figure 16 illustrates an installation along the street of two rows of luminaires directly opposite one another and indicates how the light patterns may be caused to overlap. Here the luminaires are directly opposite one another, but it is obvious that they can be staggered, if desired.

In the preceding discussion, the light source has been assumed to be a point, but lamps of high wattage output have light sources of substantial physical dimension. The reflection of the light directly back onto the filament as would occur if a spherical reflector were employed, tends to build up excessive filament temperatures and cause early lamp failure. In the construction shown herein, the design of the reflector generally indicated at 27 in the drawings, is so modified as to avoid excessive heating of the filament. Instead of making a spherical reflector, the reflector as shown in detail in Figure 10, has a contour made up of toroidal segments, the large diameter part of the reflector extending from the mouth of the reflector back to the break indicated at 100 in the drawings is a toroid with radius 101 coming from a locus such as 102. The small diameter portion of the reflector from the break 100 back to a flat rear area 103 is generated by a radius 104 from the locus indicated at 105.

The filament of the lamp is indicated by circle 106 where the horizontal plane 3—3 intersects the vertical line of the mouth of the reflector. Light from this filament falling at points such as 107 and 108 of the outer toroidal surface passes outside the filament as indicated by circle 109 and circular arc 110 so that the reflected light from the outer portion of the reflector appears to come from a source slightly in front of the reflector mouth and displaced above or below horizontal axis.

Similarly, light from the filament 106 falling on a point such as 111 of the small portion of the reflector is reflected so that it misses the filament and appears to come from a region indicated by the circle 112.

The effect of the toroidal segment is therefore to reflect the light so that it misses the filament and the apparent light source is larger in diameter in vertical planes and somewhat deeper horizontally than the true source. This will cause variation in vertical and horizontal angles of the light emitted from the prism surfaces without effecting the general direction of the dominant rays. It brings about improved diffusion and makes for longer lamp life.

It will be understood that the light source can be shifted vertically relative to the refractor so as to change the vertical angle of maximum candle power so as to adjust the illumination to the width of the area being lighted.

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

What is claimed is:

1. A lighting system for lighting an extended horizontal surface of predetermined width along a wall or the like, comprising a row of aligned luminaires at a common elevation and facing away from the wall, each luminaire having a concentrated light source, a reflector to direct all the light into a hemispherical region sending it away from the wall and from zenith to nadir, and an inwardly concave refractor of greater diameter than depth for intercepting said hemisphere of direct and reflected light and provided with refracting prisms intercepting direct and reflected light at angles farther from the nadir than the highest angled undeviated light which in the vertical, transverse plane can fall on the surface of the said width and of a refracting power to bend such higher angled light into substantial parallelism with the undeviated light, the refracting power of the prisms above the horizontal plane through the source decreasing with increase of azimuth angle from the median vertical plane to compensate for decrease in vertical angle of corresponding incident light, the refracting power of the prisms below said horizontal plane increasing with increase of azimuth angle from the median vertical plane to compensate for increase in vertical angle of corresponding incident light, the luminaires being spaced approximately twice the said width so that the areas illuminated by adjacent luminaires meet without substantial overlapping.

2. A lighting system for lighting a street surface comprising two rows of luminaires at a common elevation on opposite sides of the street and facing across the street, each luminaire having a concentrated light source, a reflector to direct all the light into a hemispherical region sending it crosswise and lengthwise of the street and from zenith to nadir, and an inwardly concave refractor of greater diameter than depth

for intercepting said hemisphere of direct and reflected light and provided with refracting prisms intercepting direct and reflected light at angles farther from the nadir than the highest angled undeviated light which in the median vertical plane can fall on the street surface opposite the luminaire and of a refracting power to bend such higher angled light into substantial parallelism with the undeviated light, the refracting power of the prisms above the horizontal plane through the source decreasing with increase of azimuth angle from the median vertical plane to compensate for decrease in vertical angle of corresponding incident light, the refracting power of the prisms below said horizontal plane increasing with increase of azimuth angle from the median vertical plane to compensate for increase in vertical angle of corresponding incident light, the luminaires being spaced approximately twice the street width so that lengthwise of the street the areas illuminated by luminaires along one side of the street meet without substantial overlapping.

3. In combination, a light source emitting to one side of a vertical plane light rays in a hemisphere, a refractor intercepting said rays, the refractor being of spherical contour having its center at the same elevation as the light source and occupying a spherical segment of greater radius than the distance from the light source to the refractor whereby the intersections of the refractor by horizontal planes above and below the horizontal plane through the source are circles and light falling thereon is in an oblique circular cone with apex at the source and decreasing vertical angles each side of the vertical median plane, the refractor having opposed horizontal prisms whose refracting power at each elevation varies with the azimuth angle in an amount to compensate for the variation in vertical angle so that the oblique circular cones of rays intercepted by the horizontal prisms are refracted downwardly into a right circular conical region, the said horizontal prisms extending below the horizontal to an angle corresponding with the angle from the nadir to the last mentioned conical region, the portion of the refractor below the horizontal prisms having light diffusing flutes.

4. A refractor for producing from a substantially point light source a substantially semicircular distribution of light with its maximum candlepower at a substantially uniform angle from the nadir, the refractor having the configuration of a spherical segment of substantially less than a hemisphere and terminating substantially in the vertical plane through the light source so as to intercept a hemisphere of light, the refractor being provided with opposed horizontal prisms above the angle of maximum candlepower in the median plane of increasing refracting power to the top thereof for deviating light downwardly to said uniform angle, the portions of the refractor above the horizontal planes through the light source and between meridian planes at a predetermined azimuth angle being uniform whereby the vertical angle of emitted light originating as upward direct light lessens with increase of azimuth angle up to the predetermined azimuth angle, the prisms beyond said predetermined azimuth angle at corresponding elevations having less refracting power to deviate the light to substantially the same angle from the nadir as the light in the median plane, the prisms below said horizontal plane and between meridian planes at a second predetermined azimuth angle being uniform whereby the vertical angle of emitted light originating as downward direct light increases with increase of azimuth angle up to the second predetermined azimuth angle, the prisms beyond said second predetermined azimuth angle at corresponding elevations having greater refracting power to deviate the light to substantially the same angle from the nadir as the light in the median plane, the lower portions of the refractor being provided with opposed light diffusing flutes.

5. A refractor as claimed in claim 4, wherein the first azimuthal plane is substantially 60° from the median plane.

6. A refractor as claimed in claim 4, wherein the second azimuthal plane is substantially 45° from the median plane.

7. A refractor as claimed in claim 4, wherein the first azimuthal plane is substantially 60° from the median plane and the second substantially 45° from the median plane.

8. A refractor as claimed in claim 4, wherein the refractor has an inner and an outer component, the outer component having vertical flutes over its entire outer surface, horizontal prisms over its entire inner surface above the angle of maximum candlepower, and horizontal diffusing flutes below the horizontal prisms, the inner component having opposed prisms below the horizontal through the light source and between the first meridian planes.

9. A refractor for use with a substantially point light source, the refractor being in the form of a spherical segment terminating in a vertical plane with the center at the level of said point and laterally displaced from said point whereby a hemisphere of light may be intercepted by the refractor at increasing angles both vertically and horizontally from the horizontal center line, the refractor having opposed horizontal prisms for intercepting direct light above a predetermined angle below the horizontal of varying refracting power vertically to deviate the emitted light into substantial parallelism in median vertical planes, the refracting power of the horizontal prisms above the horizontal at wide azimuth angles being less than those at less azimuth angles and those below the horizontal at wide azimuth angles being greater than those at less azimuth angles, said differences being in an amount to compensate for the variation of vertical angle with azimuth angle at corresponding elevations.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
679,771	Mygatt	Aug. 6, 1901
1,674,165	Dorey	June 19, 1928
1,731,714	Dorey	Oct. 15, 1929

FOREIGN PATENTS

Number	Country	Date
670,278	Germany	Jan. 16, 1939

OTHER REFERENCES

Publication: "Protective Lighting Puts the Finger on Lawlessness," published by Holophane Co., Inc., 342 Madison Ave., New York city. Copyright 1941.