

March 3, 1964

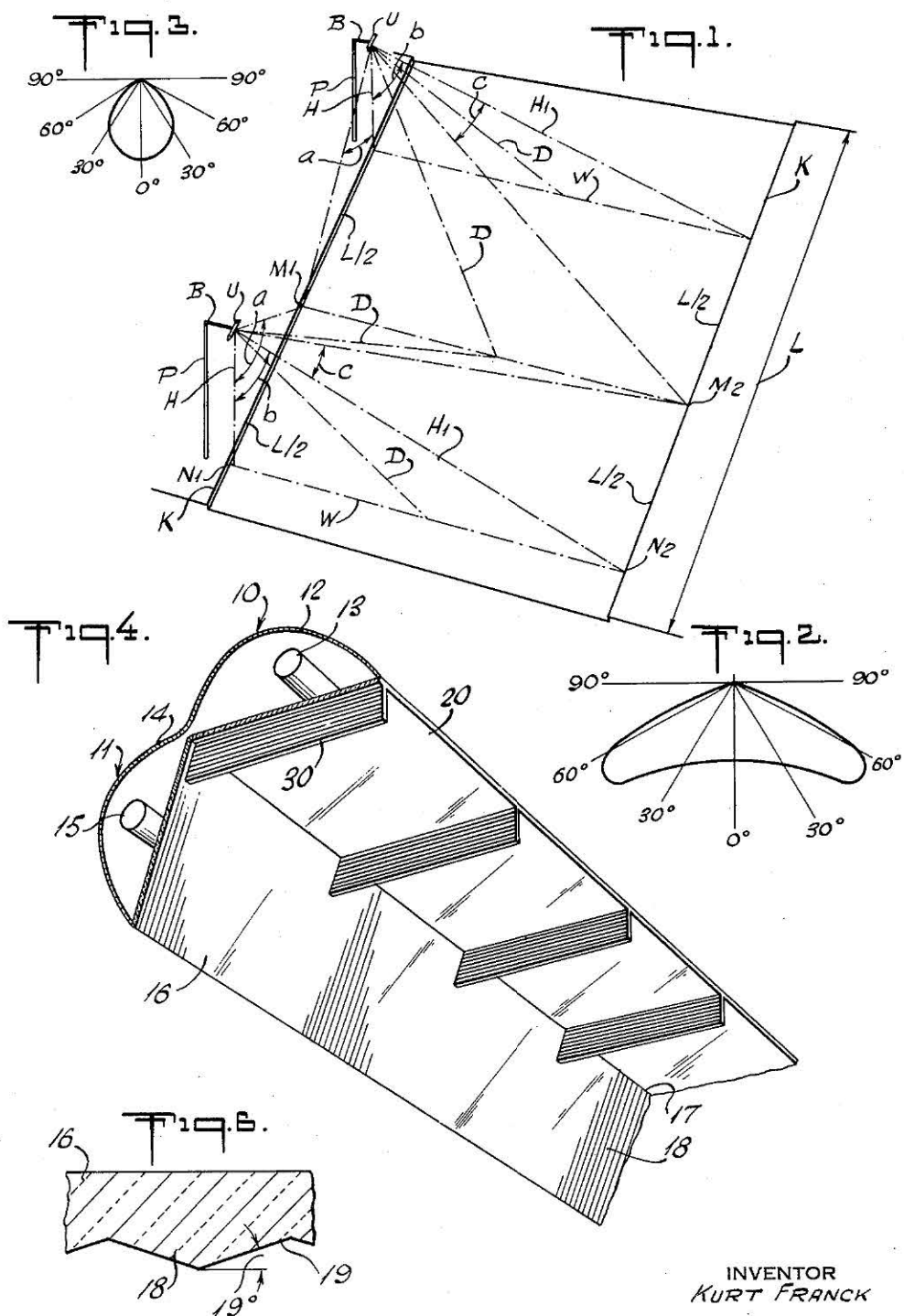
K. FRANCK

3,123,308

FLUORESCENT STREET LIGHTING SYSTEM

Filed June 10, 1957

4 Sheets-Sheet 1



INVENTOR
KURT FRANCK
BY
Moses, Polte, & Polte
ATTORNEYS

March 3, 1964

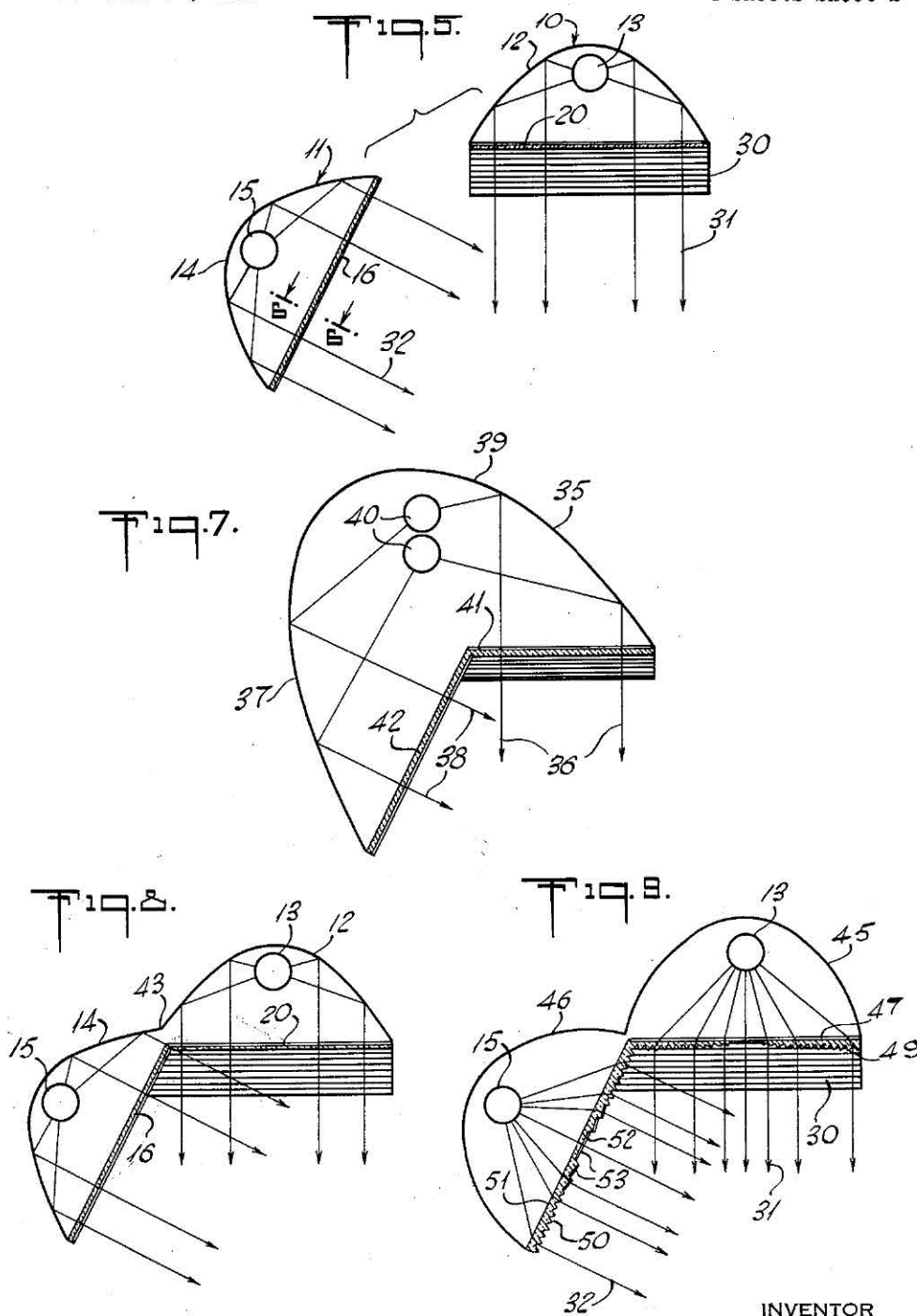
K. FRANCK

3,123,308

FLUORESCENT STREET LIGHTING SYSTEM

Filed June 10, 1957

4 Sheets-Sheet 2



INVENTOR
KURT FRANCK

BY
Moses, Galt, & Galt
ATTORNEYS

March 3, 1964

K. FRANCK

3,123,308

FLUORESCENT STREET LIGHTING SYSTEM

Filed June 10, 1957

4 Sheets-Sheet 3

Fig. 10.

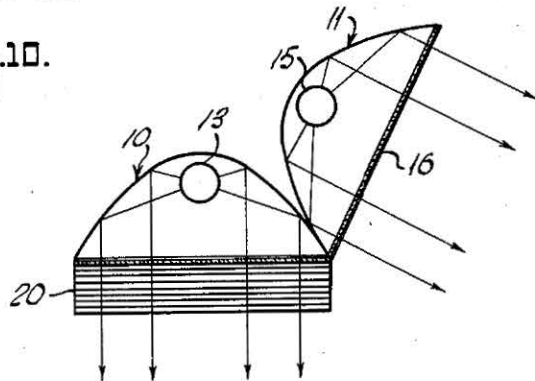


Fig. 11.

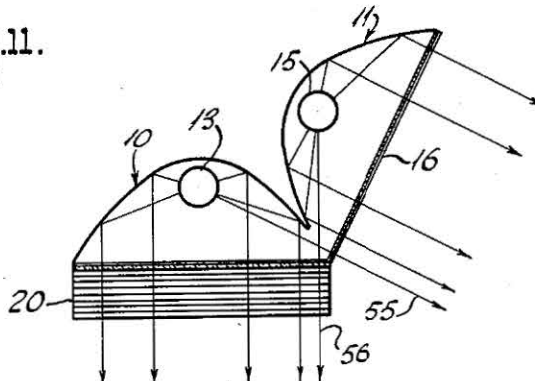


Fig. 13.

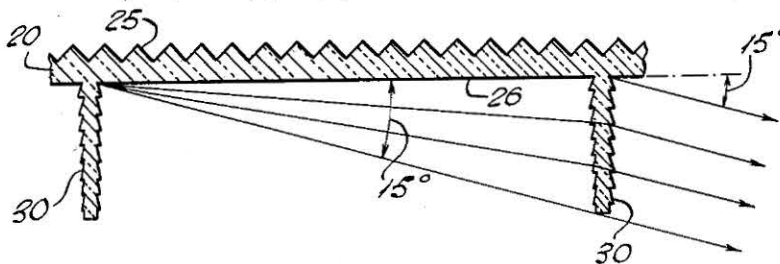
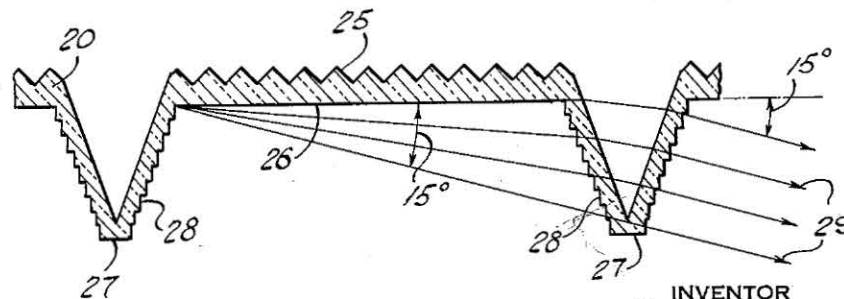


Fig. 12.



INVENTOR
KURT FRANCK

BY
Moses, Meltz & Meltz
ATTORNEYS

March 3, 1964

K. FRANCK

3,123,308

FLUORESCENT STREET LIGHTING SYSTEM

Filed June 10, 1957

4 Sheets-Sheet 4

Fig. 14.

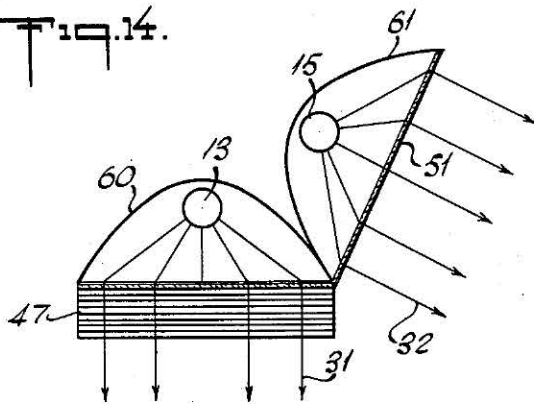


Fig. 15.

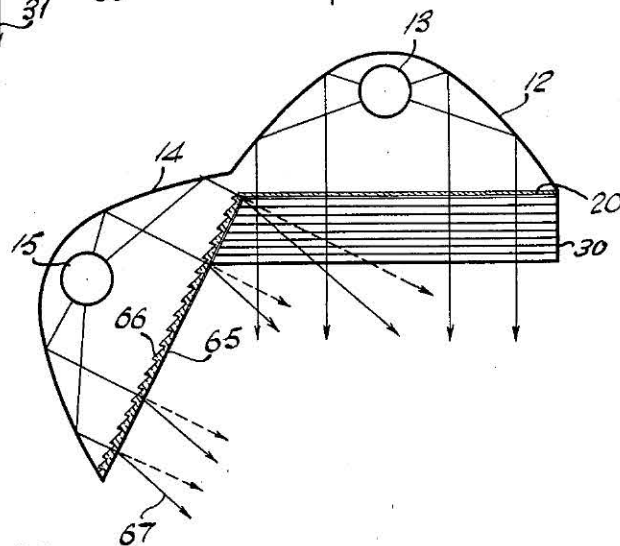
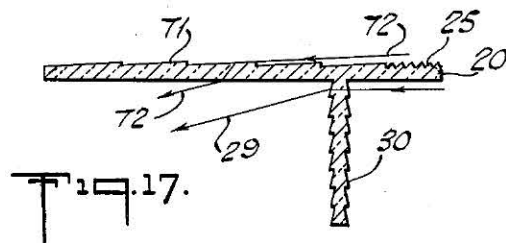
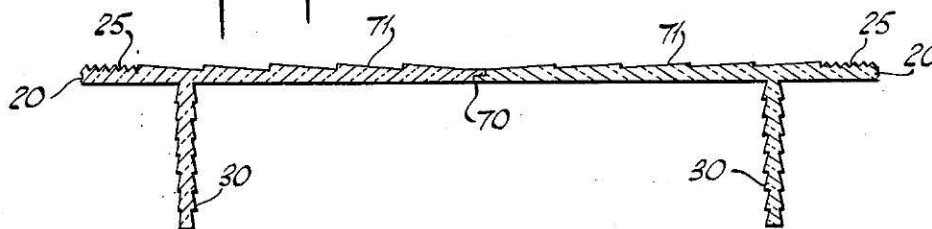


Fig. 16.



INVENTOR
KURT FRANCK
BY
Moses, Noltz, & Noltz
ATTORNEYS

1

3,123,308

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

Filed June 10, 1957, Ser. No. 664,625

25 Claims. (Cl. 240-25)

The present invention relates to improved lighting of extended areas and particularly to fluorescent luminaires for lighting a street.

The invention contemplates improved luminaires particularly for linear fluorescent lamps. The luminaires are mounted horizontally in a direction parallel to the street along one curb thereof. Each luminaire comprises two reflecting surfaces and a refracting plate associated with each reflecting surface. Both reflecting surfaces or each of them, may be in the form of a reflecting trough extending along the fluorescent lamp. One of the refracting plates is mounted substantially horizontally and illuminates the region of the street along the near curb and the other refracting plate is mounted obliquely facing the far curb, and illuminates the region of the street therealong. Where both reflecting surfaces form a single trough, the two refracting plates are arranged to close the mouth of the trough and where the reflecting surfaces are provided by separate troughs, each reflecting plate closes the mouth of one of the two troughs. In either case, the trough or troughs and the refracting plates enclose the fluorescent lamps to prevent the entrance of dirt, which would impair the reflecting surfaces and the refracting plates. The refracting plates are provided with means for reducing the transmission of light at high angles in longitudinal directions, in order to avoid high brightness near horizontal directions along the street.

It has been found that when a flat prismatic plate is used for spreading light in a region along the near curb as well as a region along the far curb, the amount of light control necessary in the two regions differs greatly and that it is not feasible to obtain a desirable light distribution in both regions. This difficulty is overcome by using instead of a single flat prismatic plate, a pair of refracting plates, one of which is horizontal and the other is tilted. The horizontal refracting plate confines nearly all of the light traversing it to a region along the near curb and the tilted refracting plate sends substantially all of the light traversing it to a region along the far curb. Each plate and its associated reflector is then capable of producing a desired illumination of its individual region of the street.

An object of the invention to provide improved street lighting utilizing fluorescent lamp luminaires extending parallel to and along one curb of the street.

Other objects and advantages of the invention will be apparent to those skilled in the art from the following description and the drawing in which:

FIG. 1 is a digram illustrating the installation of the luminaires along the side of the street;

FIGS. 2 and 3 are diagrams of light distribution;

FIG. 4 is a perspective view of a luminaire according to the invention;

FIG. 5 is a cross sectional view of another luminaire;

FIG. 6 is a sectional view taken along line 6-6 of FIG. 5;

FIG. 7 is a cross sectional view of a luminaire using a single trough;

FIG. 8 is a cross sectional view of another luminaire;

FIGS. 9, 10 and 11 are cross sectional views showing three other embodiments of the invention;

FIG. 12 is an enlarged cross sectional view of a portion of another type of horizontal refracting plate;

2

FIG. 13 is an enlarged cross sectional view of a portion of another type of horizontal refracting plate;

FIGS. 14 and 15 are cross sectional views of two other embodiments of the invention; and

FIGS. 16 and 17 are cross sectional views of the end portions of horizontal refracting plates.

In FIG. 1, the elongated area to be lighted is a street having curb lines at K, K. The luminaires U may be mounted on brackets B on poles P along the side of the street. As shown in FIG. 1, the luminaires may be fluorescent street lights located above the near curb of the street at a mounting height H. They are spaced lengthwise of the street at a distance L, the width of the street being W.

Along line M_1-M_2 , which runs transverse of the street midway between lighting units, each of the two units must obviously contribute the same amount of illumination. In the vertical plane containing unit U and the near curb, the angle toward mid-point M_1 is given in right-angle triangle UM_1N_1 as "a" in FIG. 1; in the inclined plane containing unit U and the far curb, the corresponding angle toward mid-point M_2 is given in right-angle triangle UM_2N_2 as angle "c" in FIG. 1. The significant fact that angle "a" is considerably greater than angle "c," calls for corresponding different angular directions and amounts of candlepower from units U toward midway line M_1-M_2 , depending on whether analysis is made along the near curb (triangle UM_1N_1) or far curb (triangle UM_2N_2).

For a concrete example, as it may occur in practice, for a mounting height H of 30', spacing L of 75' and street width W of 60', angle "a" comes out to be 51.3°, angle "c" to be 29.3°. The candlepower distribution curve for this example, to provide uniform illumination along the near curb toward midpoint M_1 , is shown by distribution curve FIG. 2, giving wide angle distribution; the corresponding distribution curve for the inclined plane toward the far curb is shown by distribution curve FIG. 3, having a comparatively narrow curve.

It can be seen that the longitudinal light distributions required along the near curb and the far curb regions differ greatly. The desired longitudinal distribution can not be obtained simply with a tilted or horizontal refracting plate which illuminates both the near curb and the far curb regions. According to the present invention, the desired light distribution is obtained by causing one of the refracting plates to provide essentially the distribution required along the near curb and causing the other refracting plate to provide essentially the proper distribution for the far curb side of the street. In practice, it has been found that the two separate light distributions can be made to merge well along the middle of the street to give an even illumination across the width of the street, with each light distribution giving about half the illumination at the center in the plane of lines D, D, as that at the vicinity of the near and the far curbs.

The luminaire as shown for example in FIG. 4, comprises two essentially separate elements or lighting systems 10 and 11. The element 10 comprises a specular reflector 12 mounted above a linear light source 13 which may consist of one or more fluorescent lamps extending horizontally along substantially the entire length of reflector 10. Where several fluorescent lamps are used side by side, they are preferably positioned near the focal line of the reflector. The reflector may be parabolic for producing a parallel beam directed straight downward toward the near curb. The mouth of reflector 12 is in a horizontal plane and is closed by a refracting plate 20. The refractor 20 may be of the type shown and described in the application of Kurt Franck et al., Serial No. 497,188, filed March 28, 1955, now abandoned, being provided with transverse light splitting prisms.

3

upper surface for producing the light distribution of FIG. 2, and having on its lower surface glare controlling prismatic louvers 30. The refractor 20 will be described in greater detail hereinafter.

The other element 11 of the luminaire comprises a cylindrical parabolic reflector 14, having a linear light source 15 which again may consist of a fluorescent lamp or a plurality of fluorescent lamps placed side by side and close together, substantially along the focal line of reflector 14. Reflector 14 concentrates the light into a substantially parallel beam transverse of the street and in a direction toward the far curb. The mouth of reflector 14 lies in an oblique plane and is substantially closed by the refracting plate 16. Refracting plates 16 and 20 are joined together along a line 17. To provide the longitudinal light distribution shown in FIG. 3, it is necessary to limit the high angle emission of light lengthwise of the unit. This is done by forming transversely extending cut-off prisms 18 on refractor plate 16. The prisms are designed as described in Patent 2,474,317 and as shown in FIG. 6. The sides 19 of the prisms preferably form an angle of 19° with the horizontal. It will be understood that prisms 18 may have a different angle such as approximately 32° , as described in said patent.

In FIG. 5, the two elements 10 and 11 of the luminaire are shown as being separate. The element 10 transmits the light downwardly toward the near curb as indicated by the rays 31, while element 11 is tilted toward the far curb and transmits rays 32 to a region of the street along the far curb. Refractor plate 16 forms a closure for reflector 14 and likewise refractor 20 forms a closure for reflector 12.

FIG. 7 shows a luminaire in which one reflecting surface 35 produces a downwardly directed parallel beam 36 and a second reflecting surface 37 produces a parallel beam 38 transverse to the street and directed toward the far curb. The reflectors 35 and 37 form a single trough 39. Within the trough, one or more fluorescent lamps 40 extend longitudinally thereof. The mouth of the trough is closed by a horizontal refractor 41 and a tilted refractor 42 similar to refracting plates 16 and 20 of FIGS. 4 and 5. Refractors 41 and 42 may be integral or separate plates in abutment at their juncture. Any number of refractor plates may be placed end to end to produce a luminaire of the required length.

FIG. 8 shows a luminaire similar to that illustrated in FIG. 4. The troughs 12 and 14 are integral and may be formed of a single sheet of metal or joined together along the line 43. The mouths of both troughs are closed by refractors 16 and 20. The two elements of the luminaire function in the same manner as those of FIGS. 4 and 5.

In FIG. 9 the troughs 45 and 46 have diffuse reflecting surfaces. The mouth of reflector 45 is substantially closed by refractor plate 47 lying in a horizontal plane and providing the illumination along the near curb. Refractor 47 has light splitting prisms on its upper surface and louvers 30 extending from its lower surface, such as illustrated in FIGS. 4, 12 and 13. On the bottom surface of refractor 47 there are longitudinally extending prisms 49 for concentrating the light in a transversely parallel beam as indicated by the rays 31. These prisms 49 have increasing refracting power as they proceed from the longitudinal center line of the refractor toward the edges thereof. The inclined refracting plate 51 also has longitudinal light concentrating prisms 40 of varying refracting power on its outer surface. The inner surface of this refracting plate is substantially smooth. The deeper prisms 50 along the edge portion of the refracting plates provide a desired longitudinal shielding as explained in Patent No. 2,648,763. Where, however, the longitudinal prisms are shallow or disappear entirely, as at the central section 52 of the refracting plate, they provide no longitudinal control. In this region, transverse cut-off prisms 53 are superimposed on the shallow

4

longitudinal prisms. The cut-off prisms are formed as shown in Patent 2,474,317 and FIG. 6. As indicated in FIG. 9, the direct light from lamps 13 and 15 will be concentrated by refracting plates 47 and 51 into two substantially parallel beams 31 and 32 for lighting the near and far curb regions of the street. In order to augment the direct light rays from the lamps, however, it is preferred to provide diffuse reflecting housings 45 and 46 round the lamps.

FIGS. 10 and 11 show luminaires in which the element 11 for lighting the far curb region of the street is mounted above and to the right of luminaire element 10. In FIG. 10, the two luminaire elements are distinct. In FIG. 11 the troughs or reflectors for elements 10 and 11 are joined together in such a way that some of the light from the lamp 13 from the near curb luminaire element is transmitted through the inclined refracting plate 16 as indicated by the ray 55 and a portion of the light from lamp 15 is transmitted downwardly through refracting plate 20 of luminaire element 10, as indicated by the ray 56.

FIG. 14 shows a luminaire similar in configuration to that of FIG. 10, but having diffuse reflectors 60, 61. Refracting plates 47 and 51 having the prisms arrangements shown in FIG. 9 are provided. Direct light from lamps 13 and 15 is formed into two substantially parallel beams 31 and 32. The direct light is augmented by the diffuse light provided by the reflectors.

FIG. 15 shows a luminaire similar to that shown in previous figures, but in which the inclined refracting plate 65 is provided with light lowering prisms 66 on its inner side. Prisms 66 bend the light downwardly as shown by the rays 67.

The closure plate 20 is preferably made of transparent material of a width to extend across the mouth of the reflector and a length (for example, two feet) so that several molded units will close off the mouth of a long reflector. As shown in FIGS. 12 and 13, the upper or light incident surface of these light transmitting units is occupied by a series of light splitting ribs or prisms 25 opposite a smooth, light emergent surface 26. Such ribs tend to divert light from the nadir, as will be more fully explained below, but the smooth surface 26 opposite them permits light rays to escape up to 90° from the nadir, or horizontally.

To intercept this high angle, longitudinally emitted light from the bottom surface 26, the closure plate of FIG. 12 has V-shaped ribs 27 preferably of a depth and spacing to intercept all light within 15° of the horizontal and provided with prisms 28, 28 to deviate the intercepted light so that it is emitted at angles of 15° below the horizontal, as shown by rays 29. These ribs are symmetrical about the median plane, in order to handle light coming from the right or the left. They are thin walled, as shown, to facilitate pressing.

The closure shown in FIG. 13 has thin prismatic ribs 30 at spaced intervals and integral with or suitably secured to the flat plate. Ribs 30 have light lowering prisms for refracting light to 15° from the horizontal.

As the light splitting prisms 25 receive light from the left as well as from the right, the prisms should be symmetrical about vertical planes through their apices. Each side face of such a series of prisms will receive from above a zone of light extending from the horizontal up to the cut-off line provided by the prisms surface. The light rays farthest to the right from zenith, i.e., those grazing the left incident surface of the prism, will be refracted into the critical angle for the medium and again refracted by the emergent surface 26. The horizontal limiting rays will be refracted by the incident surface and reflected by the other sloping surface of the prisms and reflectively transmitted by the emergent surface 26. The effect of prisms 25 is to spread the light longitudinally.

Where the horizontal refractor consists of a plurality of plates 20 placed end to end, the ends of the plate are

5

preferably formed, as shown in FIG. 16, to provide an overlapping joint 70. The ends of plates 20, adjacent and beyond the last louver 30, are provided with prisms 71 on their upper surfaces. Prisms 71 are formed so as to bend nearly horizontal rays 72 (FIG. 17) downwardly to, say, angle of 15° to the horizontal, so as to cause these rays to approach parallelism with the rays 29 passing through the louvers. Without prisms 71, the end of plate 20 beyond the last louver would transmit light at angles close to the horizontal.

Regardless of whether the light concentrating system of FIGS. 4, 5, 7, 8, 10, 11 or FIG. 9 is used, it may in practice be desirable not to direct the transverse beams of the two elements exactly at the near curb and far curb. Because of the relatively large light emitting area of the fluorescent lamp, it may at times be desirable to direct the beam toward the near curb somewhat forward of the near curb and the beam toward the far curb somewhat inside of the far curb, so as to contain the emitted light on the street surface. It may also be desirable, and again mostly for reasons of the large light emitting area of the fluorescent lamp, not to make both elements of the unit of exactly the same size or even equipped with the same number of lamps. In order to emit enough light across the street, it may be advantageous to provide a larger area for the tilted element of the units, or even to use two lamps in the tilted section, while making the horizontal section narrower and equipped with, say, one lamp only. Quite generally, while the figures show the use of two lamps, the invention is, of course, not limited to such an arrangement. It is feasible to use more than one lamp for each element of the unit, provided that the general principle of approximate transverse concentration of light into two beams, one essentially toward the near curb and the other essentially toward the far curb, is carried through.

I have described what I believe to be the best embodiment of my invention. I do not wish, however, to be confined to the embodiment shown, but what I desire to cover by Letters Patent is set forth in the appended claims.

I claim:

1. A lighting system for longitudinally extended areas comprising a plurality of luminaires supported above the area and spaced laterally from the longitudinal center line through said area, said luminaires each including linear, horizontal, longitudinally extending parallel light sources and cylindrical reflectors having axes parallel to the light sources and extending round the light sources, means including one of said reflectors and a horizontal prismatic refracting plate for controlling the longitudinal distribution of the light and directing substantially all the light traversing said plate in substantially vertical planes through a wide distribution angle into a region along the near side of said area and substantially confining the light through said plate to said region, and second means including another of said reflectors and a second inclined prismatic refracting plate for directing substantially all light traversing said second plate in planes substantially perpendicular to said second plate and through a narrow distribution angle into a second region along the far side of said area and adjacent said first region and substantially confining the light passing through the second refracting plate to said second region, the refracting plates extending across and closing the mouths of the reflectors.

2. A light system according to claim 1, in which the light sources of each luminaire are closely spaced and said first and second reflectors are opposite surfaces of a single trough the mouth of which is closed by the first and second refracting plates.

3. A system according to claim 1, in which the first and second reflectors are substantially parabolic troughs each enclosing one of said light sources, the first refracting plate substantially closing the mouth of the first

6

reflector and second refracting plate substantially closing the mouth of the second reflector.

4. A system according to claim 1, in which said first and second reflectors are substantially separate troughs having diffuse reflecting surfaces and the refracting plates include longitudinal extending prisms having refracting powers which increase from a minimum value along the longitudinal center line of the plate to a maximum value at the longitudinal outer edges of the plates.

5. A system according to claim 4, wherein a central longitudinal section of one of the plates has transversely extending cut-off prisms arranged for preventing the transmission of light above a predetermined angle to the nadir.

6. A system according to claim 5, wherein the sides of the cut-off prisms extend at an angle of substantially 19° to the plane of said plate.

7. A system according to claim 5, wherein the cut-off prisms extend at an angle of substantially 32° to the plane of each plate.

8. A system according to claim 1, wherein the horizontal plate includes a plurality of spaced downwardly projecting louvers on its bottom face for intercepting high angle light rays.

9. A system according to claim 1, wherein the horizontal refracting plate has transversely extending symmetrical light splitting prisms for spreading the light longitudinally along said areas.

10. A system according to claim 1, wherein the horizontal refracting plate has longitudinally spaced downwardly extending light interceptors having horizontally extending light refracting prisms which depress high angle light emitted from the plate between the interceptors.

11. A system according to claim 10, wherein the portion of the horizontal refracting plate between an end thereof and the last light interceptor thereon is provided with transversely extending light lowering prisms.

12. A system according to claim 1, in which the horizontal refracting plate has a substantially flat bottom surface and a series of spaced downwardly extending light transmitting and refracting elements having a depth such as to eclipse all light above substantially 15° below the horizontal and said elements having horizontal refracting ribs which depress the intercepted light substantially 15° below the horizontal.

13. A system according to claim 12, wherein the downwardly extending elements are of V-shaped cross-section.

14. A street lighting luminaire including a first rectilinear lamp, a cylindrical reflecting trough above the lamp and co-axial therewith, the trough having a horizontal mouth below the lamp, a first horizontal refracting plate substantially closing the mouth of said trough, said refracting plate receiving light from said trough in substantially vertical planes and having means for redirecting it lengthwise of said lamp through a wide distribution angle, a second rectilinear lamp parallel to the first mentioned lamp, a second cylindrical reflecting trough having a mouth in a plane inclined to the horizontal, a second inclined refracting plate substantially closing the mouth of said second trough, said second refracting plate receiving light substantially perpendicularly to its surface from said second reflecting trough and having means for redirecting it lengthwise of said second lamp through a narrow distribution angle.

15. A luminaire according to claim 14, wherein the horizontal plate includes symmetrical light splitting prisms on its upper surface extending transversely to said first lamp for spreading the light longitudinally.

16. A luminaire according to claim 14, in which the second refracting plate includes transversely extending cut-off prisms on its outer surface for preventing the transmission of light within a predetermined angle to the horizontal.

17. A luminaire according to claim 16, in which said cut-off prisms have sides making angles of substantially 19° with the plane of the second refracting plate

18. A luminaire according to claim 16, in which said cut-off prisms have sides making angles of substantially 32° with the plane of the second refracting plate.

19. A luminaire according to claim 14, wherein the first refracting plate includes a series of spaced downwardly extending transverse elements of a depth such as to intercept all light above substantially 15° below the horizontal and having horizontal refracting ribs which depress the intercepted light to substantially 15° below the horizontal.

20. A luminaire according to claim 14, in which the troughs are shaped so that a portion of the light from the first lamp is transmitted to the second refracting plate perpendicularly thereto and a portion of the light from the second lamp is transmitted vertically to the horizontal refracting plate.

21. A luminaire according to claim 14, in which the second trough and second refracting plate are located above the first refracting plate on the street side thereof.

22. A street lighting luminaire mounted above and at one side of the street including linear, horizontal, longitudinally extending light sources and cylindrical reflectors having axes parallel to the light sources and extending round the light sources, means including one of said reflectors and a horizontal prismatic refracting plate for directing substantially all the light traversing said plate in substantially vertical planes and redirecting the light lengthwise of the light sources through a wide distribution angle into a region along the near side of the street and second means including another of said reflectors and a second inclined prismatic refracting plate for directing substantially all light traversing said second plate in planes substantially perpendicular to said second plate and redirecting the light lengthwise of the light sources through a narrow distribution angle into a second region along the far side of said street, the refracting plates extending across and closing the mouths of the reflectors.

23. A street lighting luminaire mounted above and at one side of the street including linear, horizontal, longitudinally extending light sources and cylindrical reflectors having axes parallel to the light sources and extending round the light sources, means including one of said reflectors and a horizontal prismatic refracting plate for directing the light traversing said plate in substantially vertical planes and having transversely extending light spreading prisms redirecting the light lengthwise of the light sources through a wide distribution angle into a

first region along the near side of the street and second means including another of said reflectors and a second inclined prismatic refracting plate for directing the light traversing said second plate through a narrow distribution angle into a second region along the far side of said street and contiguous to the first region, the refracting plates extending across the mouths of the reflectors.

24. A street lighting system comprising a plurality of luminaires supported above the street and spaced laterally from the longitudinal center line through said street, said luminaires each including linear longitudinally extending light sources and two elongated trough shaped reflectors extending round the light sources, means including one of said reflectors and a substantially horizontal prismatic refracting plate for directing substantially all the light traversing said plate through a wide distribution angle into a first elongated region along the near side of the street and substantially confining the light through said refracting plate to said first region and spreading the light along the street in said first region, and second means including the other reflector and a second inclined refracting plate for spreading the light longitudinally of the street and directing substantially all light traversing said inclined plate through a narrow distribution angle into a second elongated region along the far side of said street contiguous to said first region and substantially confining the light passing through the second refracting plate to said second region, the refracting plates extending across and substantially closing the mouths of the reflectors.

25. A system according to claim 24, wherein said horizontal refracting plate has transversely extending light splitting prisms on one side thereof and longitudinally extending prisms having refracting powers which increase from a minimum value along the longitudinal center line of said horizontal plate to a maximum value at the longitudinal outer edges of the plate.

References Cited in the file of this patent

UNITED STATES PATENTS

1,943,609	Hyatt	Jan. 16, 1934
2,242,872	Rolph	May 20, 1941
2,366,356	Rolph	Jan. 2, 1945

FOREIGN PATENTS

194,934	Great Britain	Mar. 22, 1923
198,816	Great Britain	June 14, 1923
419,091	Great Britain	Nov. 6, 1934
918,462	Germany	Sept. 27, 1954