Oct. 11, 1966 K. FRANCK 3,278,743

STREET LIGHT REFRACTOR

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Fig. 1.

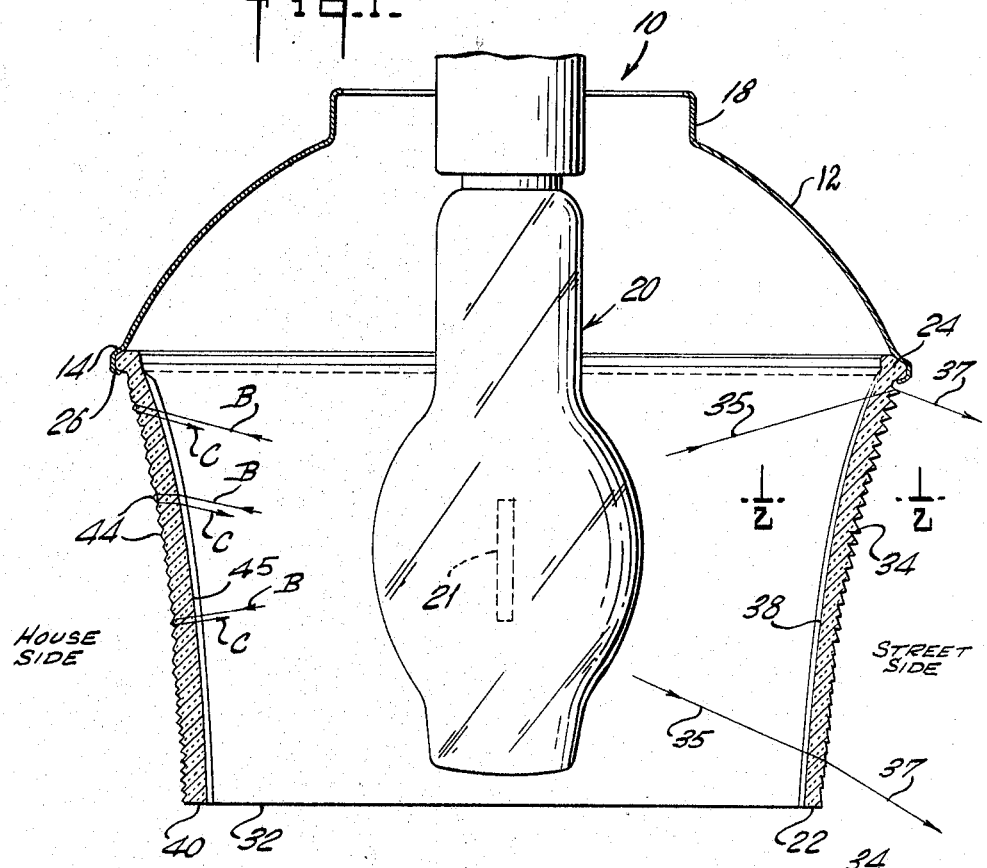

Fig. 2.

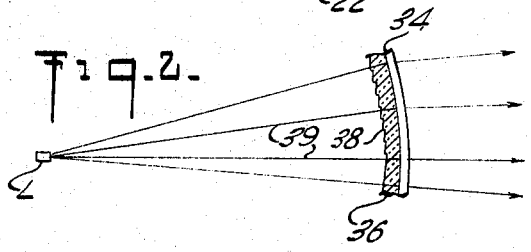

Fig. 3.

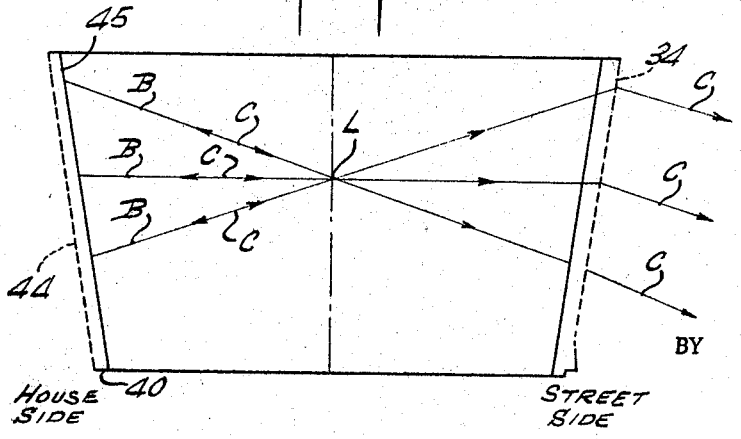

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Fig. 4.

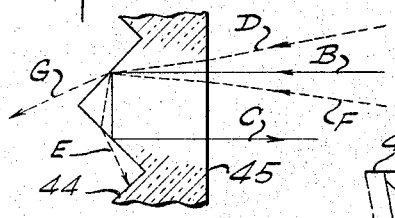


Fig. 5.

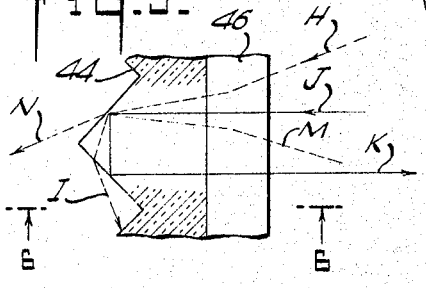


Fig. 6.

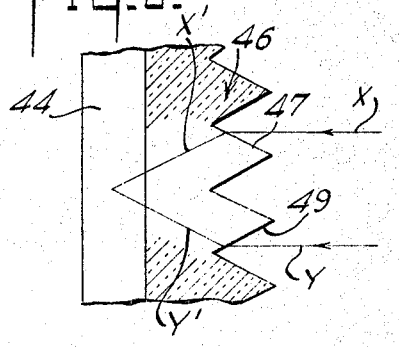


Fig. 7.

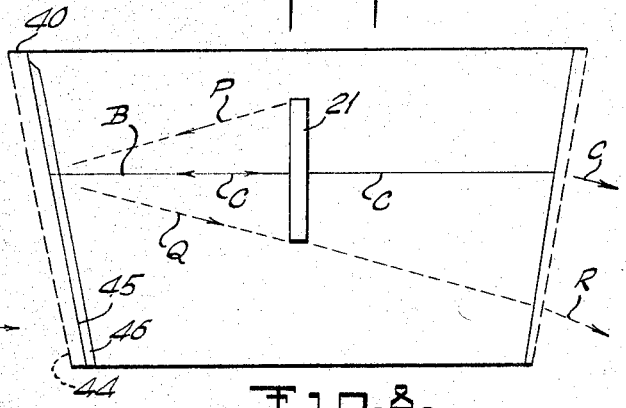


Fig. 8.

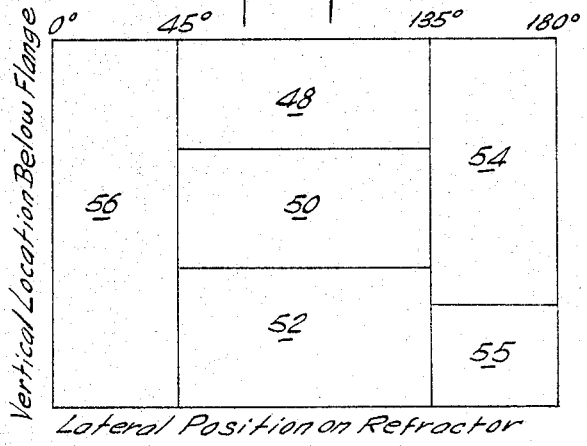
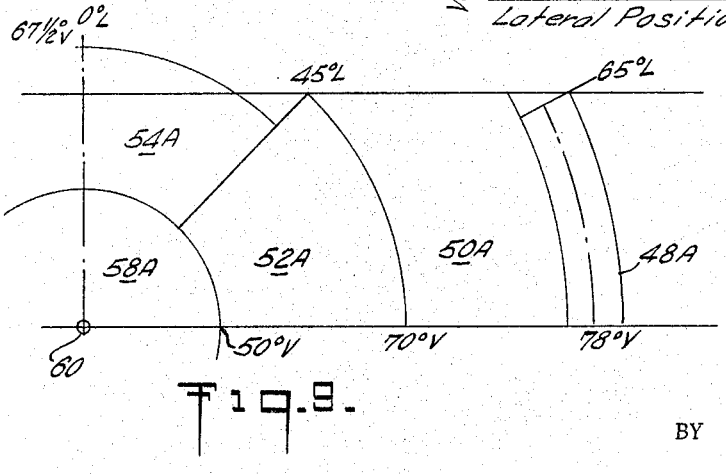


Fig. 9.



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3,278,743

STREET LIGHT REFRACTOR

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Filed Dec. 16, 1963, Ser. No. 330,815
3 Claims. (Cl. 240—25)

This invention relates to open bottom refractors. More particularly, this invention relates to open bottom refractors for use in luminaires which are primarily intended for street lighting purposes.

The basic refractor to which the invention pertains is known as an open bottom refractor. Such refractors do not necessarily have an open bottom, and it will be obvious to one skilled in the art that the present invention is equally applicable to open bottom type refractors wherein the bottom is actually covered by a transparent plate or the like. The term "open bottom refractor" as used in the following specification and claims should thus be defined to include such an additional closure member without departing from the spirit of the invention.

A principal advantage of open bottom refractors is in facilitating relamping of the luminaire, but there are other advantages such as improved cooling characteristics, simplified manufacturing processes, and the inherent prevention of an accumulation of water and insects.

The prior art has provided such refractors with various prisms for controlling the directivity of the light emanating from the source, whereby the major portion of the illumination is directed toward the street and away from the house side of the luminaire. In this respect, it is known to provide the exterior of the street side of the refractor with a plurality of horizontal refracting prisms which direct light downwardly and onto the street, while the exterior surface of the house side of the refractor is provided with a plurality of horizontal reflecting prisms, which reflect most of the light, directed toward the house side back through the street side of the refractor. However, this construction has been found incapable of achieving desired light distribution characteristics in certain instances. For example, when a vertical linear light source (e.g. a mercury lamp) is employed, the light rays arrive at the house side reflecting prisms over a wide range of angles. Accordingly, a relatively high percentage of the light cannot be reflected and, instead, is refracted through the house side of the luminaire, which is undesirable. In addition, the prior art unit provides substantially only a single distribution characteristic which obviously may not be suitable in all situations.

Accordingly, the main object of the present invention is to provide an open bottom refractor having improved light distribution characteristics.

A further object of the invention is to provide an improved open bottom refractor in which the amount of light reflected from the house side of the refractor to the street side may be controlled within considerable limits.

Another object is to provide an open bottom refractor suitable for use with a vertically arrayed linear light source.

According to the invention, the objects of the invention are achieved by providing the interior surface of the house side of the refractor with a plurality of light refracting prisms which alter the angle of incidence of the rays that strike the exterior reflecting prisms to permit reflection of light rays arriving over a relatively wide range of incident angles. By changing the angles of the surfaces of such interior refracting prisms, the amount of reflected light may be varied considerably. In a preferred embodiment, each surface of these additional refracting prisms is designed so that the light rays refracted thereby will be substantially parallel to the opposite surface.

The manner in which the above and other objects of the invention are accomplished will be described in greater detail below with reference to the following drawings, wherein:

FIG. 1 is a side view in section of a luminaire according to the present invention.

FIG. 2 is a section along line **2**—**2** of FIG. 1.

FIG. 3 is a diagrammatic view of the refractor in FIG. 1 showing typical ray paths through the refractor when the light is emitted from a point source.

FIG. 4 is an enlarged transverse view of a section on the house side of the refractor of FIGS. 1 and 3.

FIG. 5 is an enlarged view of a section of the house side of the refractor of FIG. 7.

FIG. 6 is a section taken along line **6**—**6** of FIG. 5.

FIG. 7 is a diagrammatic view of the invention showing typical ray paths for a vertically arrayed linear light source.

FIGS. 8 and 9 are diagrammatic representations of a typical street side lighting pattern.

Referring in detail to the drawings, wherein similar reference numerals identify corresponding parts throughout the several views, an open bottom luminaire is indicated at **10**. A standard aluminum reflector **12** encompasses the topmost portion of the luminaire. Reflector **12** is of a generally hemispherical shape and includes a lower flange **14** and top cap member **18** integrally formed therewith. A lamp **20**, e.g. a mercury lamp, is secured within luminaire **10** in a conventional manner. The actual source of the light, which is slightly elongated, is indicated at **21**.

The reflecting surface of reflector **12** is not polished, and, therefore, incident rays are reflected in all directions in the known pattern of any diffuse surface. Such rays produce a uniform glow over the entire surface of a refractor **22**, the purpose of which is to direct light from source **21** into a desired pattern. Refractor **22** includes an outwardly directed flange **24** positioned circumferentially about the upper portion of the refractor. Refractor flange **24** engages reflector flange **14** to hold the refractor in place.

Refractor **22** includes a sloped vertical wall, the slope of which decreases from the bottom of the refractor to the top. The refractor is designed to control the light reaching it directly from the light source, which includes light reflected from the house side of the luminaire back through the light source as explained more fully hereinbelow. Since the rays emitted by the light source at angles greater than seventy-eight degrees from nadir must in all cases be depressed by the refractor, the contour of the upper portion **30** of the refractor is shaped to assist downward deflection of the light. Aperture **32** in the bottom of the refractor is of sufficient diameter to permit the insertion of a conventional lamp changer. The present invention does not attempt to control the light which escapes from aperture **32**, although a closed bottom portion (not shown) could be used if desired.

Refractor **22** includes horizontal circular refractor prisms **34** on the outer surface of the street side section of the refractor. Prisms **34** provide vertical redirection of rays **35** from light source **21** as diagrammatically illustrated in FIG. 1. The rays as shown in FIG. 1 are redirected downwardly and emerge as rays **37**. However, such rays may be redirected upwardly if so desired. Prisms **34** are progressively inclined from the upper through the lower section of the refractor to thereby direct substantially all of the light toward the surface of the stree below. Prisms **34** may be replaced by flutes (not shown) which spread the light vertically without substantially redirecting it. Prisms **34** do not extend completely around refractor **22** since it is not desired to direct light to the house side of the luminaire. Rather,

the house side of the luminaire should be shielded from the light emanating from the source. Specially designed refracting and reflecting surfaces for such shielding are described more fully hereinbelow.

FIG. 2 illustrates a horizontal section of the street side of the refractor wherein the inner surface **36** includes a plurality of longitudinal refractor prisms **38** secured thereto. Radial refractor prisms **38** serve to redirect rays **39** laterally, either to the right or to the left, as desired. Again, as in the instance of the outside prisms, refractor prisms **38** may be re-placed by longitudinal flutes wherever lateral redirection of light is not necessary.

When prisms **34** and **38** are used together, both vertical and lateral deflection of the light emanating from light source **21** will result. However, since the refractive action of the inside prisms affects the vertical deflection caused by the outside prisms, in spite of the mutual perpendicularity of their paths, the slope of the outside prismatic surfaces must be modified to compensate for this phenomenon. This interaction between sets of mutually perpendicular prisms has been fully described in Patent No. 2,329,557 of Rolph, dated September 14, 1943, and will not herein be further considered.

Optimum reflecting conditions are desired both for shielding the house side from the rays of light emanating from the light source, and for redirecting the light reflected from the house side section **40** to the street side of the luminaire. Such reflection may be accomplished by positioning circumferential reflecting prisms **44** on the outside surface of section **40** as shown in FIGS. 1 and 3. Inside surface **45** of section **40** conventionally has a smooth finish whereby rays emanating from a point light source L will be reflected by prisms **44** back through the light source L (FIG. 3) and transmitted through the refracting prisms on the street side of the refractor. Thus rays B transmitted from point light source L are reflected as rays C.

Reflecting prisms **44** are conventional ninety degree totally reflecting prisms, which return incident rays on their own paths. FIG. 4 is a more detailed view of the reflecting operation of prisms **44**. A ray B normally incident upon prisms **44** is reflected as ray C. A downwardly directed ray D is also internally reflected but is transmitted as E. Upwardly directed ray F is not reflected but rather is refracted and emerges as ray G. All of the rays between D and F are totally reflected as at C and the angular range of the totally reflected rays is plus or minus five degrees from perpendicular incidence. Thus, with a point source, the arrangement so far described will reflect most of the light incident on the house side of the refractor. However, when a vertical, elongated source is employed, much of the light may arrive through a range of incident angles considerably greater than ten degrees, in which case a high percentage of the emitted light will emerge from the house side of the refractor.

According to the present invention, the range through which reflection occurs is increased by employing longitudinal refracting prisms **46** (FIGS. 5 and 6) to increase the angle of incidence of the light rays with respect to the reflecting prisms **44**. Each of prisms **46** consists of an upper surface **47** and a lower surface **49** preferably, but not necessarily, designed so that the rays refracted by either surface will be parallel to the other surface. Thus, consider two parallell rays X and Y impinging upon upper surface **47** and lower surface **49**, respectively. Ray X is refracted as ray X' which is parallel to the plane of surface **49**. Similarly, ray Y is refracted as ray Y' parallel to the plane of the upper prism surface **47**.

As seen in FIG. 5, ray M is refracted by prisms **46** and impinges upon prism **44** through which it is refracted to emerge as ray N. Ray J, representing a normal incident ray, enters prisms **46** and continues onto prisms **44** where it is totally reflected and emerges as ray K. Ray H is refracted by prisms **46** onto prisms **44** where it is reflected and then refracted to finally emerge as ray I. However, all of the light rays between rays H and M are reflected by prisms **44** while those outside that range are transmitted through the prisms. Comparison of FIGS. 4 and 5 shows an increase in the range of reflection from plus or minus five degrees (FIG. 4) to plus or minus fourteen degrees (FIG. 5). Thus, prisms **46** increase the angle of incidence at the reflecting prisms by increasing the angular range through which effective reflection takes place. Deepening prisms **46** will further enlarge the angular range through which effective reflection takes place. However, when the angles of prisms **46** are designed according to FIG. 6, with the prism surfaces set so that the refracted rays through one surface are parallel to the other surface, the interior prisms will not interfere with the reflected rays.

FIG. 7 illustrates an application of the house side refractor-reflector combination of the present invention wherein an elongated light source **21** is utilized. Thus, ray P emanating from the top of light source **21** is reflected as ray Q and transmitted through to the sheet side as ray R, while ray B is reflected upon itself and transmitted as ray C. Without refracting prisms **46**, it is apparent that a higher percentage of the light would emerge from the house side of the refractor in cases where a vertically arrayed linear light source was employed.

FIG. 9 is a polar view of a street sectioned into five areas to indicate the make-up of the light directed into these areas by the refractor on the street side of luminaire **60**. FIG. 8 is a schematic diagram of the surface of the refractor of the luminaire and is measured in degrees laterally and distance vertically. FIG. 8 is divided into six panels numbered **48, 50, 52, 54, 55** and **56** which correspond to the illuminated street area indicated in FIG. 9 as **48A, 50A, 52A** and **54A** as explained below. Panel **48** generates the beam which is shown in area **48A** on the street. Panels **50** and **52** fill the areas **50A** and **52A** respectively, under the beam. Panels **48, 50** and **52** are composed of both horizontal outside depressing prisms and vertical inside prisms of varying refractive power. Panel **56** illuminating area **54A** on the street from 0 to 45 degrees, has outside horizontal depressing prisms. The panels marked **54** and **55**, which extend from 135 degrees to 180 degrees, reflect light into the same area **54A**. Panel **54** is covered with circular reflector prisms which return the light through the light center, and panel **55** is covered with radial reflector prisms which reflect light into the area marked **54A** on the street through the open bottom of the refractor. The light escaping directly through the open bottom illuminates area **58A** on the street.

Although a preferred embodiment of the invention has been illustrated and described, the invention is not so limited and should be defined by the following claims.

What is claimed is:

1. In a refractor for use in a street luminaire comprising an inwardly concave reflector element, a light source disposed downwardly of said reflector, and said refractor including means for securing the same adjacent the bottom of said reflector and constructed for surrounding said light source, said refractor having a house side sector and a street side sector, refractor means positioned on said street side sector for illuminating a street, and reflecting means positioned on the exterior surface of said house side sector for reflecting light back through said house and street side sectors, said reflecting means including prisms having surfaces elongated in a first direction; the improvement comprising; means formed on the inner surface of said house side sector and including surface means elongated in a second direction transverse to said first direction, said surface means constituting means for refracting light longitudinally thereof and for increasing the angle of incidence at which the light longitudinally refracted

thereby would otherwise strike said surfaces of said reflecting prisms.

2. In a refractor for receiving the emission of light from a light source, said refractor having a wall for disposition generally laterally of said light source, first prisms formed on said wall on the outer surface thereof, including surface means elongated in a first direction for reflecting light from said source back past said source, and second prisms formed on the inner surface of said wall and including surface means elongated in a second direction transverse to said first direction for refracting light directly incident thereon from said source longitudinally thereof and for causing the refracted light to strike said first named surface means at angles of greater incidence than it would otherwise strike the same, whereby the range through which the reflection occurs via said first named surface means is increased.

3. The refractor of claim 2, wherein said second mentioned prisms each comprise two vertically disposed and inwardly converging surfaces and the light from said source impinging on one of said surfaces is refracted in paths parallel to the other of said surfaces.

References Cited by the Examiner

UNITED STATES PATENTS

1,746,342	2/1930	Dorey et al.	240—106 X
2,818,500	12/1957	Franck	240—106
3,062,953	11/1962	Clark et al.	240—106 X

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