

July 2, 1963

C. J. T. YOUNG

3,096,024

MARKER LIGHT

Filed April 26, 1961

3 Sheets-Sheet 1

FIG-1

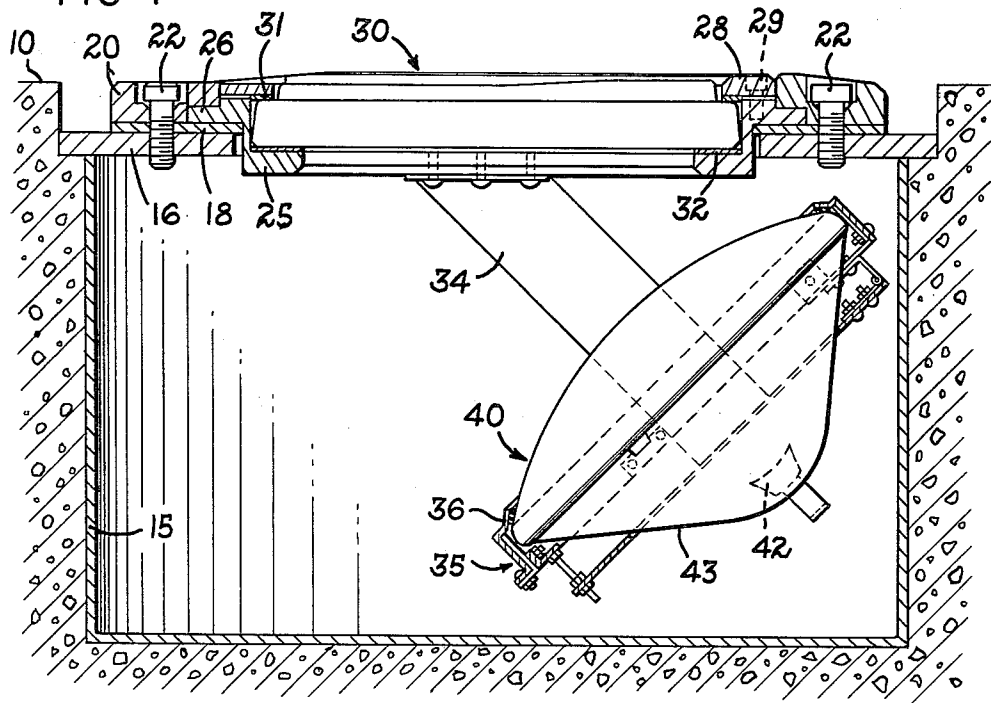
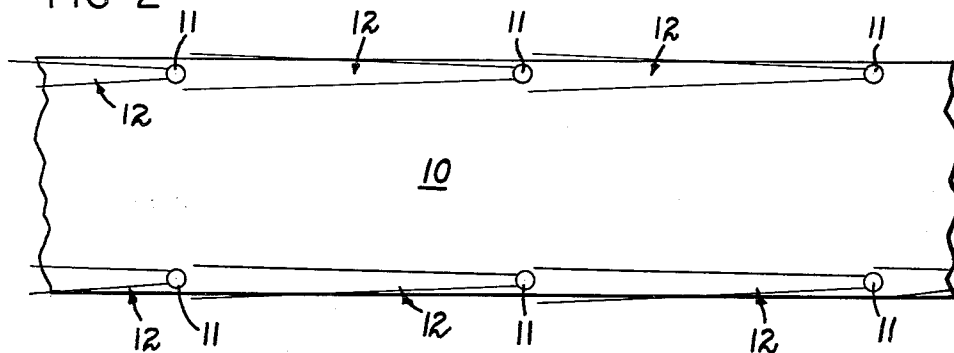


FIG-2



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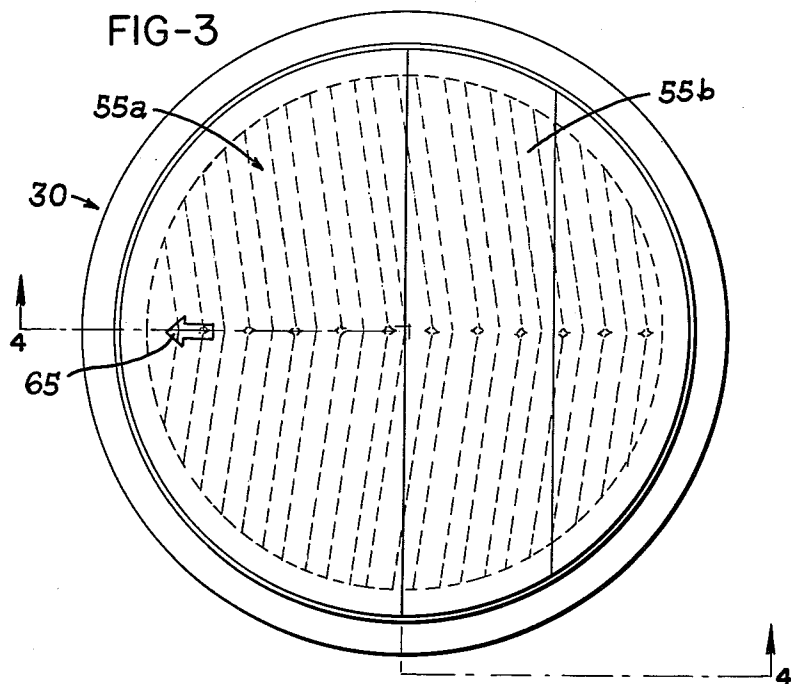
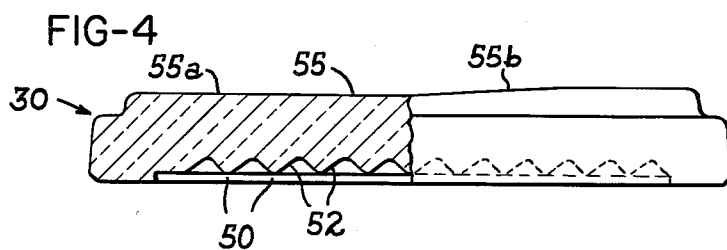
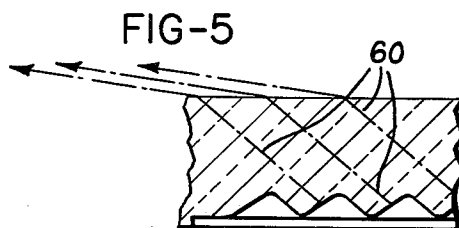
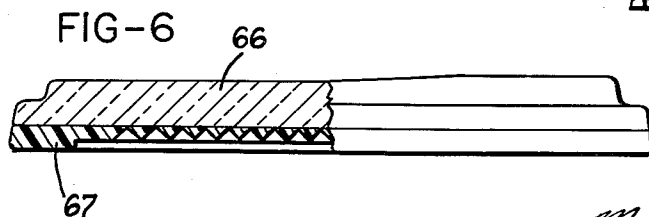
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

FIG-7

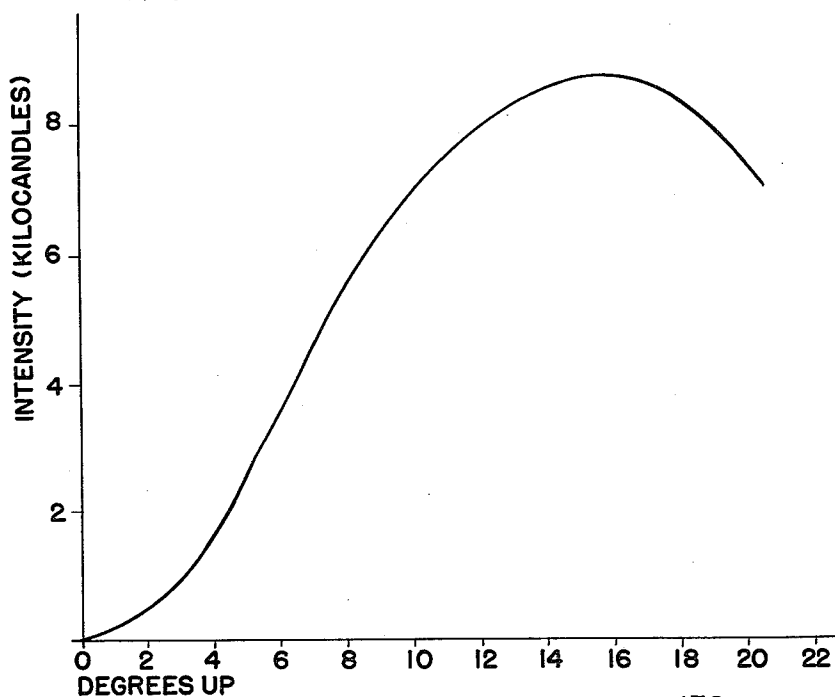


FIG-8

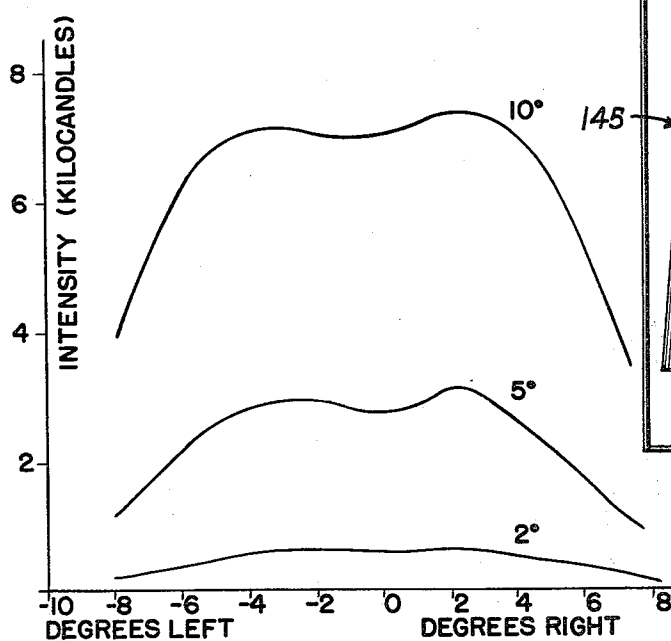
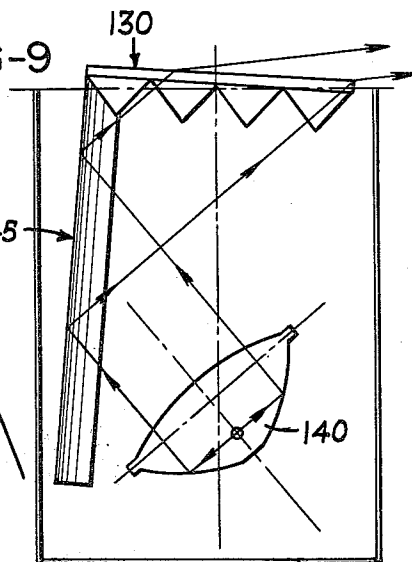


FIG-9



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3,096,024

MARKER LIGHT

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6 Claims. (Cl. 240—1.2)

This invention relates to a marker light, particularly a light capable of directing a concentrated beam along and over the surface of a runway, while presenting an essentially flush surface with respect to the runway surface.

The present invention is adaptable to use with roadways, and structures defining a path of travel of that type, and is particularly suitable in providing light beams directed along the surface of airport runways, providing a direction-indicating beam which has its major intensity at such an acute angle with respect to the runway surface that the beam will be visible to the eyes of a pilot guiding an aircraft toward the runway at low altitude. Since these marker lights are mounted either in the runway surface or directly alongside the surface, it is desirable that the lights themselves present an essentially flush top with respect to the runway surface, to avoid creating a bump or obstruction, while at the same time such top must of course be translucent and must be capable of withstanding considerable load in case aircraft or the like are run over the lights. For example, one typical requirement for such a light is a capacity to withstand a static loading of several hundred p.s.i. At the same time, the marker light should be capable of projecting a well defined or concentrated beam along the runway, and while of course the beam will disperse somewhat along its length away from the source, its top rays (of any substantial intensity) should be at a low angle, preferably not over about 16–20° with respect to the ground from the light source.

Such marker lights are often required to direct a beam of light of substantial intensity, for example in the range of 10 to 50 kilocandles peak intensity at its center, and lamps which give light of such intensity normally can be expected to generate substantial radiation in the infrared or near infrared portion of the spectrum. Thus, substantial amounts of heat will be generated, and usually in a confined space of, for example, less than two cubic feet. Since the marker light will normally be closed at its top, by the refracting lens which directs the light beam as desired and which is sealed to the recessed housing so as to protect the light from weather, the thermal load upon such a lens will be considerable, and special lens constructions are provided by this invention for use under such circumstances.

Accordingly, the primary object of this invention is to provide a novel marker light construction for roadways, runways, and the like, which is capable of flush mounting with respect to the runway surface while directing a beam over the surface in a predetermined direction and at an acute or low angle with respect to the runway surface.

Another object of this invention is to provide a novel marker light for runways, roads, and the like, which is capable of delivering a high intensity beam of light concentrated in a particular direction over the runway surface.

A further object of this invention is to provide a novel optical element which is capable of withstanding substantial heat, while retaining a precise form, and which is particularly useful in runway marker light constructions.

An additional object of the invention is to provide a novel refracting lens capable of concentrating and bend-

2

ing a light beam to emerge as close as possible from a surface thereof.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

In the drawings—

FIG. 1 is a vertical section, with some parts shown in elevation, taken through a marker light constructed in accordance with the invention;

FIG. 2 is a diagram showing a typical placement and use of such marker lights along a runway;

FIG. 3 is a plan view of a refracting lens used in the marker light;

FIG. 4 is a view partly in section and partly in elevation, taken along line 4—4 in FIG. 3;

FIG. 5 is an enlarged partial section view including also portions of a ray diagram;

FIG. 6 is a view similar to FIG. 4, showing another type of refracting lens which is particularly useful in applications where the lens is subjected to considerable heating;

FIGS. 7 and 8 are charts demonstrating the beam directing capabilities of the marker light; and

FIG. 9 is a view of a modified form of marker light in accordance with the invention.

Referring to the drawings, which illustrate preferred embodiments of the invention, and particularly with respect to FIGS. 1 and 2, marker lights are shown as arranged serially along opposite sides of a runway having a surface 10, and each light 11 directs a relatively concentrated beam 12 along the sides of the runway to define the margins thereof and the direction in which the runway extends. As shown in FIG. 1, the marker lights are housed within recessed pots or wells 15 formed or placed in the runway, and having adjacent their upper end a mounting ring 16. This ring is preferably set somewhat below the runway surface to accommodate the lens structure of the marker light, as will be explained, in essentially flush relation with respect to the runway surface. It is understood that a suitable electrical supply (not shown) is connected into the well 15, and this of course may be controlled from some remote location in any desired manner.

The mounting ring 16 carries a sealing gasket 18 on its upper surface, and over this ring there is placed a clamping ring 20 which is removably secured to the mounting ring by a plurality of bolts 22. The main support ring of the light, indicated generally at 25, includes an outwardly extending lip 26 which is secured between clamp ring 20 and gasket 18. The ring 25 in turn includes a smaller lens clamping ring 28 which is fastened by bolts 29 (one shown in FIG. 1) to the main ring 25, and which serves to hold the refracting or beam directing lens element 30 in position. Preferably, gasket 31 is placed between ring 28 and the lens, as shown, and a gasket 32 is placed between the underside of the lens element and ring 30.

A pair of straps 34, one of which is shown in FIG. 1, extend from the main mounting ring 25 downwardly and laterally to support a lamp mounting adapter 35, and this adapter includes a removable clamp ring 36 which holds in place, as shown, a light source which may conveniently be in the form of a "sealed beam" electrical lamp 40. Such lamps are commercial items, and include the usual filament 42 mounted properly with respect to a reflector portion 43 of the lamp to produce a beam of light having substantially little vertical spread as it issues from the lamp. This light beam is directed against the undersurface of the refracting lens 30.

The lens has an under or inner surface, against which the light from the lamp is directed, in the form of a

plurality of substantially parallel prismatic configurations 50 (FIG. 4) and each of these configurations includes a beam receiving surface 52 which extends at a predetermined angle with respect to the plane of the upper or outer surface 55 of the lens. In the particular configuration shown, the upper surface 55 is not entirely flat, although it can be. It has been found that additional intensity in the horizontally directed light can be attained by having one surface 55a, that surface closest to the direction in which the beam emerges, essentially flat while the other surface 55b at the opposite side of the lens slants slightly upward. The slope of this latter surface may be very slight, for example between 2 and 3° with respect to surface 55a. Thus the entire upper surface of the lens element is essentially flat, within a few degrees of being entirely horizontal, and when mounted presents an essentially continuous surface formation with the runway surface 10 as shown in FIG. 1.

The majority of the light from the lamp 40 is directed so as to intersect the beam receiving surfaces 52 at right angles, and these surfaces are in turn constructed at an angle, with respect to outer surface 55, slightly less than the critical angle of incidence for the transparent or light transmitting material of which the lens element 30 is constructed. Because of the slight inclined upper surface 55b, the beam receiving surfaces therebeneath may be at a slightly different angle from those beneath the surface 55a, in the particular configuration shown. This difference will be such that, for glass or other material of the index of refraction used, the refracted beams will have a difference in direction equal to the angle between 55a and 55b. Thus the peak of each part of the beam can strike its final surface at substantially the critical angle. However, in any event the beam receiving surfaces are all nearly parallel to each other, and are all constructed in planes which intersect the upper surface of the lens element at an angle close to the critical angle of incidence.

The mounting adapter 35 is so arranged with respect to the main lens supporting link 25 that, when the lamp 40 is clamped in place and the lens is properly seated in ring 25, a major portion of the rays of the light beam from the lamp intersect the beam receiving surfaces 52 of the lens undersurface approximately at right angles, there being some slight difference because of the differences required to assure that the rays intersect the surfaces 55a and 55b close to the critical angle. The rays of light, shown schematically at 60 in FIG. 5, thus pass through the lens element 30 and emerge from the upper or outer surface 55 thereof at an angle near to grazing over the surface of the lens element. In other words, the rays of the beam are refracted the maximum amount possible without exceeding the critical angle of incidence, at which of course the rays would be reflected from the upper surface 55 and directed back into the lens element.

Therefore, the resultant direction-indicating beam from the marker light is a beam projected close to the runway surface, for example the beam has considerable intensity at around 8 to 10° from the runway surface. FIGS. 7 and 8 illustrate the results obtained from a prototype lamp embodying the features of the invention. Maximum intensity along a vertical plane through the center of the beam was in excess of 8 kilocandles at between about 13° to about 18° above the runway surface, and the intensity reduced to approximately 7 kilocandles at about 10° to 12° above the runway surface and at about 20° above the surface.

As shown particularly in FIG. 3, in order to obtain better horizontal distribution of the beam it is desirable to construct the lens element as a symmetrical member about the center line along which the beam is directed. The prismatic configurations 50, and therefore the beam receiving surfaces 52, fan outwardly and forwardly from such center line with respect to the direction in which

the emerging beam is projected. This direction preferably is indicated by a marker arrow 65 on the lens element to aid in proper installation. Therefore, the light is refracted also toward the longitudinal center line of the lens element, the two halves of the beam crossing a few feet from the exit surface, giving a greater horizontal spread of the emerging beam. The opposite initial effect on the beams can be obtained by arranging the configurations to fan in the opposite direction. Also, similar prism configurations can be used to obtain variation of these constructions.

FIG. 8 is a graph illustrating the variation in intensity of the beam on opposite sides of the directional center line, the different curves being developed from readings taken at different vertical angles of traverse, or in other words at different elevations with respect to the runway surface, passing an intensity measuring instrument through a beam from a prototype lamp. It will be seen from this graph that maximum intensity spread of the beam at any particular elevation was confined to about 6° to the right and left of the center, and beyond that the illumination dropped significantly. Thus, comparing the curves derived from intensity measurements at different angles of traverse, it will be noted that a beam of light was formed over the ground surface having significant horizontal spread of only about 12°.

It will be appreciated from the foregoing that the emerging beam from novel flush, or almost flush, marker lights provided by this invention can be a well concentrated or well defined beam and that the maximum intensity of the beam can be obtained along a path of less than about 20° elevation with respect to the runway surface. It will be also be appreciated that the beam can be concentrated or spread along the directional center line as desired.

As mentioned previously, and as will be appreciated from the foregoing example of a typical construction of marker light, the lamp 40 may be of fairly high power, in order to give a beam of desired intensity. The entire structure, on the other hand, is completely enclosed within the well 15, and the top of the well is covered by the various adapter and mounting rings as well as the lens element 30. Of course, since these lights are exposed to all types of weather conditions it is not desirable to provide for any interior ventilation, since to do so would allow the well to fill with water and lead to electrical short circuits. On the other hand, the high powered lamp emits considerable heat, and in fact such lamps generally emit considerable radiation in the infrared or near infrared part of the spectrum. The lens element 30 can be formed of pressed glass, but the prism configurations in particular have been discovered to have uneven surfaces and rounded corners. This results in scattering of rays striking such surfaces and resultant reduction in efficiency of the lens element. Various known optical plastics can be cast or molded to give a suitable surface configuration, but they will not withstand temperatures of more than about 200° F.

The present invention also provides a novel optical construction, as shown particularly in FIG. 6, which exhibits markedly improved temperature resistance characteristics, and which is capable of withstanding temperatures up to about 400° F. The lens element in the particular form suitable for use in the marker light, preferably is formed of a glass upper section 66 which may have a flat bottom surface and a top or outer surface which may include the slightly sloped area similar to the top surface portion 55b as shown in FIG. 4. Against the bottom of the glass member there is an essentially transparent optical coating or casting 67 preferably formed of an organosiloxane polymer, commonly referred to as silicone resin. This member is in the form of a rubbery or gummy material, in the nature of an unfilled silicone rubber, and is normally incapable of maintaining a precise configuration, having a relatively low tensile strength and not being rigid. However, when this mate-

rial is cast, molded, or otherwise formed on the under surface of the rigid member 66, it retains its shape sufficiently to maintain the desired prismatic configuration, as discussed previously, and the material is sufficiently clear, when properly cast, to have good optical properties.

One material which has been employed in the manufacture of such a lens element is a silicone resin supplied by Dow Corning Corporation under their designation No. Q-3-0105, and identified by that company as being a mixed methyl polysiloxane polymer. This material is obtained as a viscous fluid and will cure at room temperature after addition of a catalyst such as a di-organo tin salt in quantities of 2 to 4%, the resultant product being a clear gum. It has been found that by using a minimum amount of catalyst, and thus the maximum curing time, a gum is obtained which is essentially free of air bubbles and thus of the best possible configuration for optical purposes.

Another material which has been found suitable for molding parts of the type shown at 66 is a so-called type K interlayer resin, also supplied by Dow Corning Corporation is uncured sheets under that designation, and identified by that company as being a mixed organo polysiloxane polymer which may be heat cured. In some instances this is a particularly desirable material for the present purpose, since it has high adhesion to glass.

Other materials which have been employed in combination with the Dow Corning Corporation resin No. Q-3-0105, for the purpose of increasing the adhesion of that resin to the glass, are as follows. A viscous fluid resin supplied by Dow Corning Corporation under their designation No. Q-3-0040, and identified by that company as being a dimethyl polysiloxane polymer which is cured on exposure to moisture, with liberation of acetic acid in catalyst quantities. It has been found that this material is useful in very thin sections or coatings, in the order of a few hundredths of an inch, particularly to increase the adhesion of the main resin body to the glass lens element.

Another material used for its adhesion properties is that supplied by Dow Corning Corporation, designated its No. A-4094 primer. This is a liquid material identified by that company as being essentially a complex mixture of various alkoxy silicates in a naphtha solvent. This material again has been used as a bonding agent between the number Q-3-0105 resin and the glass element.

These silicone resins when cast or molded against the upper lens element 66 will be transparent, will retain their shape as noted, and exhibit a good resistance to temperature up to about 400° F. They also have desirable transmission characteristics in parts of the infrared and near infrared regions, and thus permit rays in this part of the spectrum to pass through to the exterior of the light unit.

Obviously, such combined optical elements as shown in FIG. 6 have utility in other applications where good optical properties and relatively high heat resistance are required. Accordingly, in this regard it is not intended to limit the scope of this disclosure to the use of such combination optical elements in the specific marker light constructions disclosed herein. However, such a combined element is of particular utility herein, where there are requirements of structural strength, supplied by the glass, and a highly finished surface with adequate heat resistance, afforded by the silicone resin with its ability to retain proper shape for optical purposes when supported by the glass.

Another important feature of the composite optical element, particularly important in connection with the novel marker light constructions disclosed herein, is gained from an advantage obtained from the silicone resin prisms, resulting from the sharper edges which can be obtained in their formation. Because of this, the prisms can be smaller than are possible in the ordinary construction with pressed glass, without losing any more

light. In the ordinary unitary glass construction (i.e. as shown in FIG. 4) the thickness above the prism configurations contributes most of the physical strength. Moreover, in a unitary glass element the prism configurations on the bottom will reduce the overall strength of the element because they are regions of stress concentration when a downward load is applied putting the bottom surface under tension, and because during manufacture heat-flow conditions around a groove make it a difficult place to chill suddenly in tempering to obtain maximum strength. By permitting greater glass thickness and by allowing the bottom of the glass to be flat, use of the combination lens element increases the load bearing capacity of the unit.

It should also be understood that the present invention, particularly as far as the composite optical elements are concerned, is not limited to a glass member for the part contributing physical strength and rigidity, since other suitable rigid optical elements or materials can be used, for example to obtain a desired spectral transmission quality. The rigid or load bearing part of the composite element need not include a flat surface, either, since it is possible to form suitable composite elements according to the invention wherein the load bearing or rigid member is of concave or convex configuration, for example.

FIG. 9 shows a modified form of marker light in accordance with the invention, embodying a reflector between the light source and the reflecting lens element. Thus, the lamp 140 is mounted to direct light rays into the reflector 145, and thence the light rays pass to the refracting lens element 130, which may be of any of the aforementioned types, including an arrangement for directing the light rays such that they intersect the top surface of the lens element close to the critical angle of incidence for the material. The reflector can be formed to control the spread of the beam entering the lens element.

Also, in some configurations it is unnecessary to confine the protrusions of the lens element to a very small measurement (for example a fraction of an inch) above the surrounding surface. Thus, it may be possible to mount the lens element 130 at a somewhat greater angle to horizontal, within the limits of the particular design configuration, and this will of course result in a beam emerging closer to the ground, and with its maximum intensity closer to the ground surface.

While the forms of apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise forms of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. A flush mounted marker light capable of directing a light beam along runways and the like and adjacent to the runway surface, comprising means providing a well member arranged for mounting in said runway surface, a mounting adapter fastened to said well member and extending about the upper end thereof approximately flush with the runway surface, a light source providing a concentrated beam of light from within said well member, a light transmitting lens member mounted in said adapter to close said well member and having an essentially flat upper surface extending across said well member approximately flush with the runway surface, said lens member being formed of material capable of withstanding thermal shock resulting from heat from such light source as accumulated within said well member due to enclosure of said light source therein and to the proximity of said light source of said lens member, and said lens member having an undersurface subdivided into a plurality of beam receiving surfaces extending essentially parallel to each other and angularly arranged with respect to said light source and said lens upper surface to direct a substantial portion

of light rays from said source through said lens member to intersect said upper surface thereof at an angle slightly less than the critical angle of incidence of the lens member causing refraction of the beam of light and directing the refracted beam issuing from said lens member at an acute angle with respect to said upper surface.

2. A flush mounted marker light capable of directing a light beam along runways and the like and adjacent to the runway surface, comprising means providing a well member adapted for mounting in said runway surface, a mounting adapter fastened to said well member and extending about the upper end thereof approximately flush with the runway surface, a light source providing a concentrated beam of light from within said well member, a light transmitting lens member mounted in said adapter to close said well member and having an essentially flat upper surface extending across said well member approximately flush with the runway surface, said lens member being formed of heat resistant material capable of withstanding thermal shock resulting from heat from such light source as accumulated within said well member due to enclosure of said light source therein and to the proximity of said light source to said lens member, and means on said lens member cooperating with said light source directing the majority of light rays from said source through said lens member to impinge on said upper surface thereof at an angle near the critical angle of incidence of the lens member with a substantial portion of the rays intersecting said upper surface below the critical angle causing refraction of a substantial portion of the beam of light and directing the refracted beam issuing from said lens member at an acute angle of less than 20° with respect to said upper surface.

3. In a flush mounted marker light capable of projecting a beam of substantial intensity in a predetermined direction and at a predetermined relatively low elevation, comprising a light source having an intensity in the order of several kilocandles, a refracting lens formed of heat resistant material capable of withstanding the heat and possible thermal shock from such light source in a small closed space and also capable of withstanding substantial static loads, means providing an open top well member adapted for mounting with its top slightly beneath the ground surface, means mounting said lens extending across said open top of said well member enclosing the interior thereof, said lens having an outer surface of essentially flat and continuous configuration adapted to face outwardly of said well member, an opposite surface in the form of a plurality of substantially parallel prismatic configurations each having a beam-receiving surface extending in a plane generally parallel to the other beam-receiving

surfaces and each such plane intersecting said outer surface of said lens at an angle related to the critical angle of incidence for the material of which said lens is constructed, and means mounting said light source relative to said opposite surface of said lens such that rays of the beam from said source are directed through said beam-receiving surfaces to intersect said outer surface at an angle slightly less than the critical angle of incidence for the lens causing a substantial portion of said beam to emerge from said lens at an acute angle relative to the surface surrounding said well member.

4. A marker light as defined in claim 3 in which the critical angle of incidence of the lens member and the relative mounted positions of the lens member and the light source are such that the refracted beam issuing from the lens member is of peak intensity at an elevational angle of less than 20° measured from the lens member with respect to the surface surrounding the well member.

5. A flush mounted marker light as defined in claim 3, wherein said lens member includes beam-receiving surfaces divided into symmetrical sets on opposite sides of a vertical plane through the center of said lens in the direction along which an exiting beam is projected, the respective sets of beam-receiving surfaces being disposed in angularly diverging relation with respect to said vertical plane and in the direction of the exiting beam to cause refraction of light rays received from said light source toward said plane as well as at an acute angle with respect to said outer surface of said lens member.

6. A flush mounted marker light as defined in claim 3, wherein said beam-receiving surfaces are formed of transparent silicone resin material having relatively little independent rigidity but capable of being cast to precise configurations and having sufficient heat resistance to avoid deformation of the resin material resulting from heating within the closed well member.

References Cited in the file of this patent

UNITED STATES PATENTS

1,572,214	McEwing et al.	Feb. 9, 1926
2,257,127	Roper et al.	Sept. 30, 1941
2,284,878	McDowell	June 2, 1942
2,544,413	Bouwers	Mar. 6, 1951
2,831,394	Heenan et al.	Apr. 22, 1958
2,848,597	Knottnerus	Aug. 19, 1958
2,934,633	Cumming	Apr. 26, 1960

OTHER REFERENCES

"Fundamentals of Optics," by Jenkins & White, second edition, published by McGraw-Hill Book Co., Inc., in 1950 (pages 275 and 276, section 14.11).