United States Patent

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[54] **LIGHT REFLECTOR SYSTEM**

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[52] **U.S. Cl.**..........**240/103 R**, 240/41.35, 240/51.11

[51] **Int. Cl.**..**F21v 7/00**

[58] **Field of Search**....240/103, 104, 41.35, 41.35 E, 240/41.36, 78 G, 78 LD, 78 LE, 51.11, 78 LK, 41.35 F; 350/292, 299; 219/347, 349

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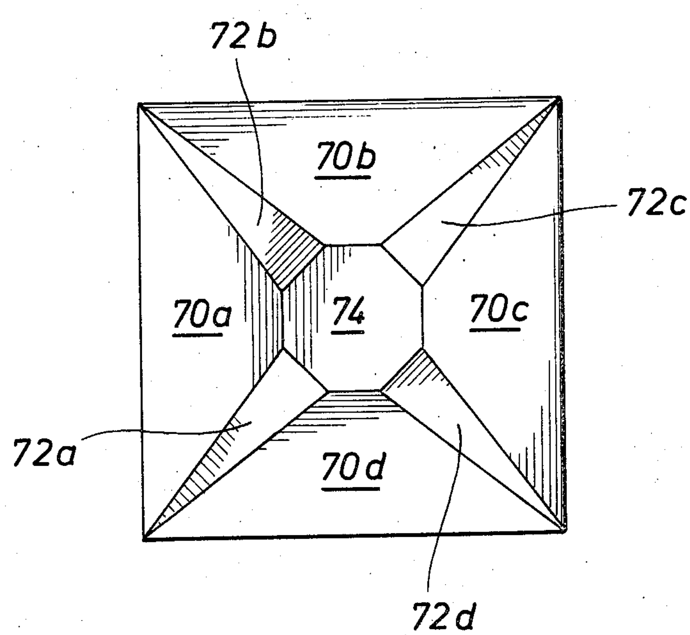
[57] **ABSTRACT**

A light reflector for a light source having flat sided reflecting surfaces, the corners also being reflecting surfaces, each corner having its smallest dimension in the plane of the reflector opening and gradually widening toward the base of the reflector along lines permitting primary reflections emitting from the corners to pass directly through the reflector opening without further reflection. Additional slanted, flat side and corner pieces provide for further primary reflection emissions. Also, approximately placed light shields screen direct emissions from the light source and from primary emissions near the reflector edges without interferring with direct emissions through the center of the reflector opening.

26 Claims, 9 Drawing Figures



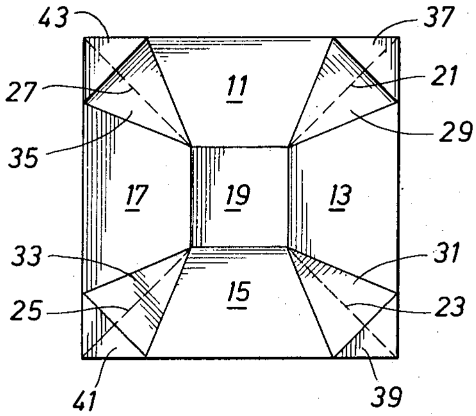


FIG. 1
PRIOR ART

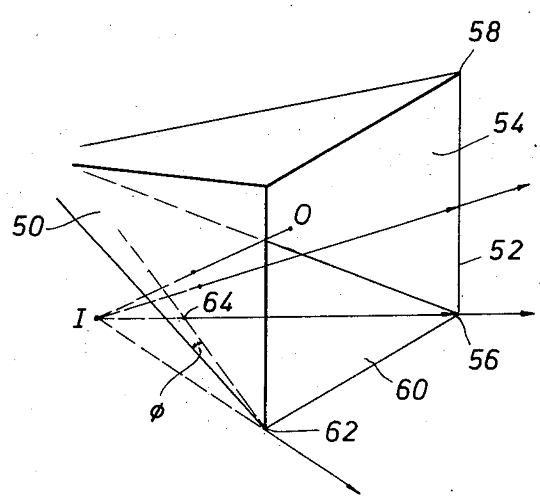


FIG. 2

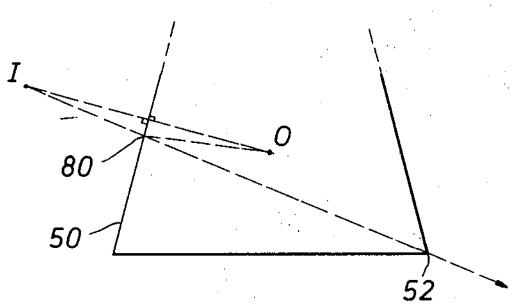
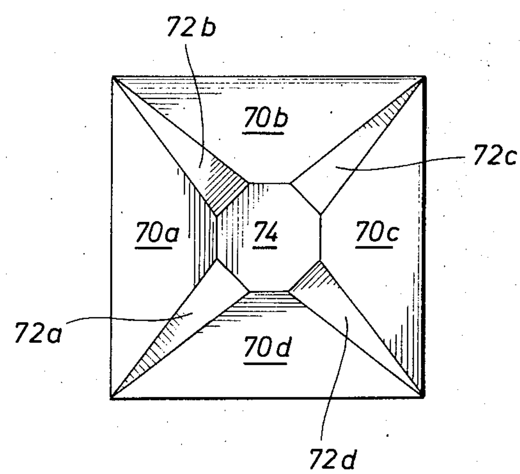


FIG. 3

FIG. 4



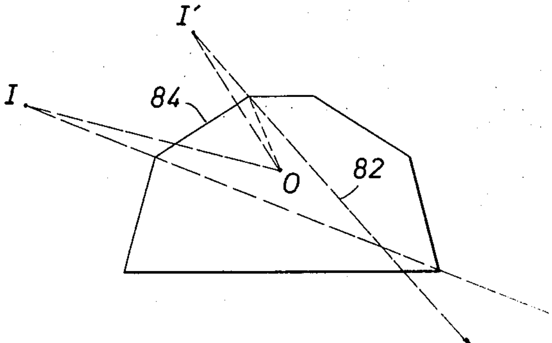


FIG. 5

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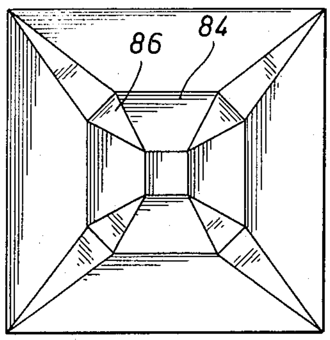

FIG. 6

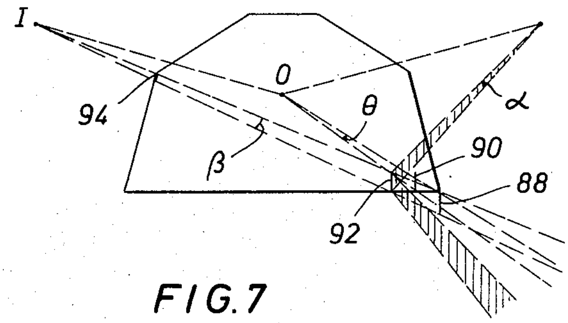

FIG. 7

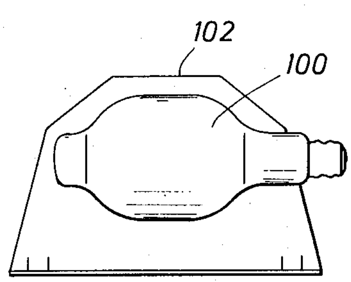

FIG. 8

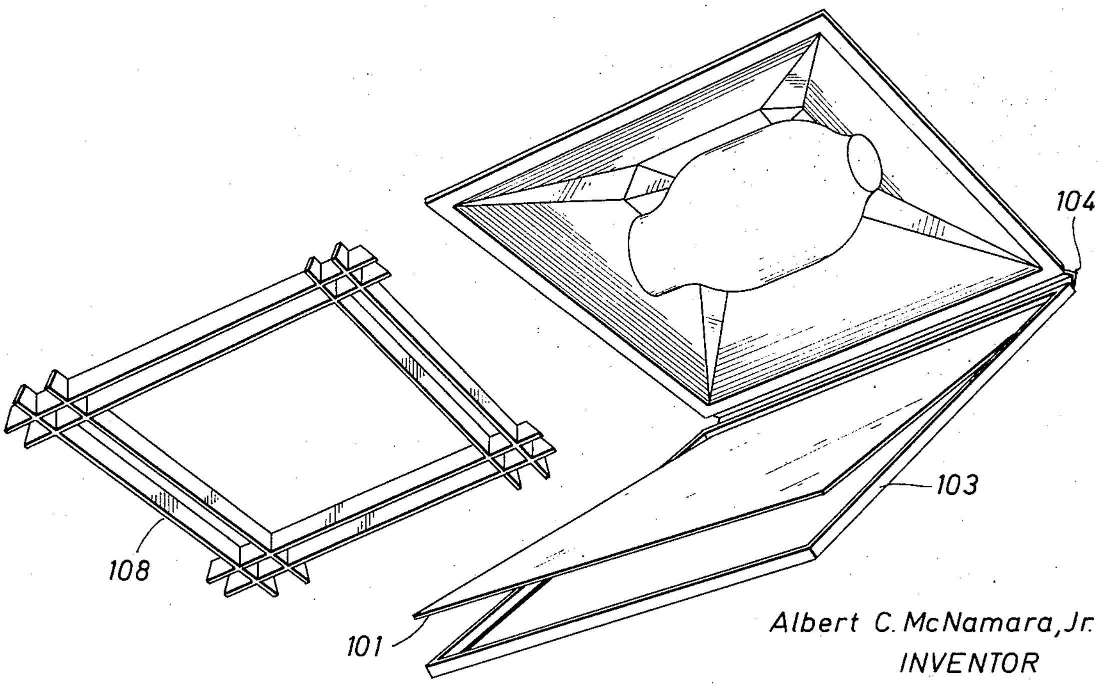

FIG. 9

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LIGHT REFLECTOR SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to lighting reflectors and more specifically to such reflectors having flat sided reflecting surfaces causing at least some primary reflections to be emitted through the opening of the reflector.

2. Description of the Prior Art

It has long been standard to equip light bulbs, both incandescent and vapor types, with reflectors to concentrate light in a generally desired direction.

The most efficient of these prior art reflectors are those reflectors which are concave in shape so as to permit all light emanating from the light and reflector system to be either the direct light from the source or to be the primary reflective light. Primary reflective light is that light which is reflected only once from the source before the light is emitted from the light and reflector system. Such a light and reflector system that typifies this arrangement is the ordinary flash light reflector.

Fabrication of curved surfaces, however, make the use of such reflectors extremely expensive in many applications, particularly in systems where the reflectors are somewhat large, as for mounting mercury vapor lamps. Heretofore, flat sided reflectors slanting backwardly from the opening have been used in such applications, usually presenting a rectangular or square opening through which much of the primary reflections are emitted. Such reflectors are relatively cheap to fabricate and assemble. However, not all of the reflections from such a reflector system are primary reflections and therefore there is great loss in efficiency. For instance, all light which is not reflected initially forward is not emitted before being reflected at least a second time. Further, even forward reflected light which is cut off by the exit pupil of the reflector must be reflected at least a second time before emission. Finally, no light directed at the corners, either direct or from a primary reflection, is emitted from the reflector without undergoing at least secondary reflection.

Lack of light reflection from the corner of square reflectors has resulted in the use of corner inserts. The conventional method of modifying a square-shaped reflector to provide corner reflectors is to use inserts which start at a point at the corner of a square base of the reflector and flares so that at the opening the insert is at its widest dimension. Such a structure effectively changes the square opening into a reduced sized octogan opening and hence creates "dead" corner spaces which are not useful reflection surfaces.

It is also desirable in many installations to shield the light emissions shining forth from the edges of the fixture, particularly when the bulb or bulbs in the fixture are not deeply recessed in the reflector. It has been conventional to place smoked or otherwise translucent glass over the opening or to place egg-crate type louvers over the entire opening. A translucent glass covering for diffusing the light over the entire area decreases the overall efficiency of the system, requiring bigger bulbs to create the same amount of light emission. The egg-crate structures have the same effects, not only causing the desirable light diffusion at the edges, but also causing undesirable light diffusion all across the opening. In addition, the egg-crate structures accumulate dust and dirt, further reducing the amount of light reflected from the louver surfaces as time goes by. Because of their many compartments, such structures are also exceedingly difficult to clean.

It is therefore a feature of this invention to provide an improved lighting reflector system comprised of flat sided segments that provide optimum direct and primary reflections.

It is another feature of this invention to provide an improved rectangular lighting reflector having corner pieces therein that utilize the space of the reflector to an optimum amount and for producing more efficient direct and primary reflection emissions than from prior art flat sided reflectors.

It is still another feature of the present invention to provide improved light shields for covering the opening of a light reflector, which shields effectively block direct light and also the primary reflections from the light source in the reflector near the edges of the reflector opening without interfering with the emissions from the center of the reflector.

SUMMARY OF THE INVENTION

A preferred embodiment of the present invention comprises a light reflector in which a light source may be installed and in which the side reflectors are flat sided, the side reflectors establishing a rectangular opening for light emissions. The side reflectors are slanted to cause primary reflection emissions. The corners of the reflectors are also flat sided to permit primary reflection from those portions which would otherwise be cut off by the exit pupil dimension of the side reflectors. These corner pieces allow the full rectangular dimension of the opening to be utilized. Back side and back corner pieces are also preferably included which are installed at a greater slanted angle (more parallel to the plane of the opening) than the side and corner pieces to which they are attached. These back slanted pieces cause primary reflections of the light that would ordinarily be directed toward the back of the reflector to be instead directed toward the opening.

Louvers are preferably inserted at the edges of the reflector for shielding direct light and primary reflected light without disturbing the light emissions from the center of the opening.

BRIEF DESCRIPTION OF THE DRAWINGS

So that the manner in which the above-recited features, and various advantages and objects of the invention which will become apparent, are attained and can be understood in detail, more particular description of the invention briefly summarized above may be had by reference to the embodiments thereof which are illustrated in the appended drawings, which drawings form a part of this specification. It is to be noted, however, that the appended drawings illustrate only typical embodiments of the invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

In the drawings:

FIG. 1 is a plan view of a prior art lighting reflector.

FIG. 2 is an oblique view schematically showing how the dimensions of the corner pieces in a preferred embodiment of the present invention are derived.

FIG. 3 is a schematic representation showing how the exit pupil dimension is derived for developing the size and placement of various reflector pieces in the present invention.

FIG. 4 is a plan view of a preferred embodiment of the present invention.

FIG. 5 is a schematic representation of another embodiment of the present invention.

FIG. 6 is a plan view of the same embodiment of the present invention as shown in FIG. 5.

FIG. 7 is a schematic representation of the shields used to block direct and primary reflected light near the edges of the embodiments of the invention shown in FIGS. 5 and 6.

FIG. 8 is a schematic representation of how an embodiment of the present invention may be used with a mercury vapor light source.

FIG. 9 is an exploded pictorial representation of an embodiment used with the mercury vapor light source that is shown in FIG. 8.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to the drawings and first to FIG. 1, a light reflector is shown which has previously been preferred for optimizing light reflections from a reflector having a square opening. In such a reflector, side pieces 11, 13, 15 and 17 are slanted back from the opening to terminate in a rectangular base 19 at the back of the reflector which is generally parallel with the plane of the opening through which the light is emitted. It may be assumed for purposes of discussion that the reflector is uniformly dimensioned so that each of the side reflectors are of the same dimension and base 19 is square.

Were it not for the corner pieces to be described below, the side pieces would have respectively met each other at corners 21, 23, 25 and 27, respectively (as shown by the dotted lines). Light from a source located in the center of the reflector and emitting light in all directions would not reflect light off of a side reflector through the opening at the corners and therefore a reflector without corner pieces at all is extremely inefficient in its corner emissions.

As is shown, increased efficiency can be developed by the insertion of conventional type corner pieces 29, 31, 33 and 35. Corner piece 21 located between side pieces 11 and 13 is in the shape of an isosceles triangle. The corner between the two equal length sides is secured at a corner of base 19 and the other two corners terminate at the plane of the opening, one corner with adjacent side piece 11 and the other corner with adjacent side piece 13, each being displaced at the opening an equal distance from corner 21.

Each of corner pieces 31, 33 and 35 are similar in construction to corner piece 29. It has been demonstrated that such a structure with the corner pieces as described is more efficient in its light emission than a structure without such corner pieces since more primary emission is developed.

It should be noted that for what was originally a square shaped reflector opening, the corner pieces have reduced the effective opening area by the amount of corner spaces 37, 39, 41 and 43. These spaces are the triangular spaces between the edge of the corner piece and the edge of the side pieces in the plane of the opening.

In accordance with the present invention, side pieces are developed, as shown in FIG. 4, which reflect primary light from the source through the reflector opening and which utilize the entire square opening of the reflector.

As may be shown in FIG. 2, a theoretical point source is located at O having an image I with respect to side 50. That is, a right angle projection from point O to the plane of side 50 results in point I being established an equal distance from plane 50 but on the opposite side thereof from point O. As may be shown in FIG. 3, a cross-sectional view of plane 50 shows clearly the right angle relationship between plane 50 and the projection line, O-to-I.

As previously explained, the exit pupil is the edge of the opening on one side of which primary reflections from a light source are allowed to pass and on the other side of which light rays are blocked. The exit pupil ray, therefore, is a ray along the line drawn between point I and the escape edge of the opening. The exit pupil edge is identified with reference numeral 52.

Now turning again to FIG. 2, it is illustrated that the exit pupil rays from point I which are allowed to escape past opposite side 54 after being reflected from side 50 are allowed to escape at corner 56 and corner 58 of side 54 in the plane of the opening. Of course, rays also escape at all points between corners 56 and 58 along exit pupil edge 52.

Exit pupil rays are also permitted to escape from side 60 adjacent side 50 at corner 62 between sides 50 and 60 in the plane at the opening and along the edge between corners 62 and 56.

It will be seen that there are rays within an angle ϕ which are not permitted to be emitted through the opening without being further reflected from side piece 60. This angle may be determined by drawing a line from image point I to corner 56, marking the intersection point 64 between that line and plane 50, and then drawing a straight line from corner 62 through point 64.

In similar fashion it is possible to determine the angle ϕ for establishing the other seven lines, such as shown in FIG. 4. That is, there will be two lines along the planes of each side reflector, one drawn to each of the opening corners. If the reflector opening is symmetrical, and further, provided the sides all have a similar slant, then ϕ will be equal for all eight lines.

Now referring to FIG. 4 in more detail, it will be seen that corner pieces may be inserted, each corner piece being defined by two of the eight lines in adjacent side pieces. For example, corner piece 72*a* lies between side pieces 70*a* and 70*d* and is defined by the two lines, one on each side piece, drawn to the common corner between side pieces 70*a* and 70*d*. As shown in FIG. 4, corner pieces 70*a*, 70*b*, 70*c* and 70*d* and side pieces 72*a*, 72*b*, 72*c* and 72*d* meet in an octogon shaped base 74.

It has been demonstrated that the configuration shown in FIG. 4 is approximately 3 to 5 percent more efficient in emitting light than the configuration shown in FIG. 1.

Now turning again to FIG. 3, it should be noted that all rays which are projected at least as forward as the exit pupil ray are allowed to escape at edge 52 (that is, all rays that are at least as forward as the ray from point O intersecting plane 50 at point 80). These rays are all allowed to be emitted through the opening of the reflector following only one reflection, a primary reflection. This point 80 is determined by making the angle of incidence from point O to plane 50 equal to the angle of reflection such that the reflected ray passes through point 52. As is well known in optical theory, by placing I on the opposite side of plane 50 from O, but at the same perpendicular distance therefrom, a line from I to point 52 intersects plane 50 at point 80. There is no need for the reflecting surface in plane 50 to extend beyond point 80 for this phenomenon to apply.

Rays emitted from point O behind point 80 (that is, blocked by escape edge 52), require at least a second bounce to be emitted. Therefore, it is required to insert reflecting surfaces which are at a lesser angle with respect to the opening plane than are the original side pieces which intersect the original side pieces at point 80 to produce further primary reflections from the side. This is shown in FIG. 5 by exiting ray 82. That is, a projection from O perpendicular with back side reflector 84 establishes an image point I′ from which primary exit pupil ray 82 clearly leaves the reflector opening after only a primary reflection from the light source.

When back pieces 84 are complemented with back corner pieces 86, a plan view of the overall reflector will appear as shown in FIG. 6.

It has been demonstrated that the configuration shown in FIG. 6 is approximately 6 to 10 percent more efficient in emitting light than the configuration shown in FIG. 2 (FIG. 1 type of structure without any corner reflections).

It should be noted that the reflector which is made up of all flat pieces may be fabricated without working the metal. Normally the reflective surfaces of a reflector are made of specular Alzak, which becomes dull the more it is worked. Cutting it into appropriate shapes does not dull the surface as does conforming the surface to a molded configuration.

Now turning to FIG. 7, a consideration will be made of eliminating or shielding the exiting light rays near the edge of the reflector by appropriate shields.

Assume that it is desired to block rays of light from the theoretical point source at O as follows: direct light throughout an angle θ and indirect light over angle β. For the shield location to block the direct light over angle θ and the indirect light over the angle β, appropriate louvered shields may be located at position 88 outside of the reflector. Alternatively, shields may be located at position 90 inside the reflector for blocking direct light over angle θ and at position 92 inside the reflector, both shields being directly in the path of the ray desired to be blocked, and wide enough so as to block the rays of light over the entire angle to be blocked.

For the primary reflection rays over angle beta, three locations are possible: position 88 outside of the reflector, position 92 inside the reflector and position 94 on the surface of the reflector itself.

It may be noted that since the rays emanating from source O are different from the rays appearing to emanate from image point I, the location of louvers inside the reflectors at positions 90 and 92 will establish placement at two different places, as previously discussed. It should be further noted that it is really impractical to darken the reflector at position 94 since a practical light source is not a point and darkening part of the reflector as indicated is not as complete a shield as can be done with louvers located either outside or inside the reflector itself. Moreover, such darkening of the reflector is only effective in primary reflections and not against direct light.

Since the purpose of such louvers are to primarily block light rays over angles θ and β, light reflections on the back side of the louvers from the opposite side are also blocked, but inadvertently. Therefore, it is desirable to darken the reflector at the side receiving the direct rays and the primary reflection rays desired to be blocked, but to have a reflecting surface on the opposite side of each louver, that is the side closest to the side emitting primary rays which were not intended to be blocked. These are the rays from angle α which are reflected off the louver in position 92 as shown in FIG. 7.

As to the desirability of placing the louvers inside versus placing them outside, there are two advantages of placing them inside. The first is that the louvers may be somewhat smaller in dimension since they are located closer to the sources of emission which are desired to be blocked. Second, it is possible to cover the entire opening with a clear glass or plastic sheet so as to prevent buildup of dirt and dust on the surfaces of the louvers, particularly the reflecting surface just described. In fact, buildup of dirt and dust on an adsorptive (darkened) surface causes such dark surface to be less adsorptive than original. Hence, it is important to prevent such buildup on both sides of the louvers. The advantage of locating the louvers on the outside of the opening are also primarily two-fold. First, only one louver at each edge may be required. Second, there is no inadvertent back side reflection, as discussed above. The greater overall depth added to the reflector, however, usually dictates the inside placement of the shielding louvers.

The general principle that is demonstrated in FIG. 7 is that when the reflector is flat sided, as opposed to being curved, and is producing primary reflections in a determinable direction, it is possible to predict the paths for these primary reflections and to place shields, such as louvers, in desired light-blocking locations. Typically, these shields are to block the light emissions from the edge of the reflector system, but for some applications it may be desirable to locate the shields elsewhere to block any predetermined angular portion of the primary reflections from any of the flat sided reflector surfaces.

Now turning to FIGS. 8 and 9, a practical embodiment is illustrated showing a mercury vapor lamp as it may be actually carried by the reflector. Lamp 100 is shown inserted through an opening in the reflector in one of the side reflector pieces, although it might be as well inserted from the back side or base 102. As is particularly shown in FIG. 9, the fixture may have a hinged frame 103 swung at hinge 104 into which a clear glass 106 may be inserted. At installation, louvers 108, of an inside mounting character, just described, may be inserted into the reflector opening so that the glass and frame may be closed and secured to hold the louvers within the reflector.

It should be further noted that the louver structure is comprised of eight identical pieces to fit snugly against the slanting sides of the reflectors, the louvers being notched to receive each other and to locate the individual louvers at the appropriate position as described above. Further, the edges of the louvers are slightly bevelled to match the mating contour of the reflector surfaces.

Although particular embodiments of the invention have been shown, it will be understood that the invention is not limited thereto, since many modifications may be made and will become apparent to those skilled in the art. For example, the reflector has been described as being rectangular, or even preferably, square. The principles described, however, are also applicable to any multi-sided reflector system. Also, each of the corner pieces have been described as merging in a corner point. In an actual structure, it may be desired to have that point be a phantom point for ease of construction, operation of the reflector being functionally similar to that described.

What is claimed is:

1. A light reflector for carrying a mounted light source therein and having a rectangular opening through which light from the source is emitted, comprising

flat first and second reflectors slanted to cause at least some primary reflections of the source to be emitted through the opening,

said reflectors aligned substantially at a right angle to each other and meeting along a line and defining a first corner at the opening,

a flat third reflector opposite said first reflector and meeting along a line and defining a second corner with said second reflector at the opening,

a flat fourth reflector opposite said second reflector and meeting along a line and defining a third corner with said first reflector at the opening,

the primary reflection exit pupil ray of said light source to said second corner intersecting said first reflector at a first point,

the primary reflection exit pupil ray of said light source to said third corner intersecting said second reflector at a second point, and

a corner reflector defined by the plane at least approximately consisting of said first corner and said first and second points.

2. A light reflector as described in claim 1, wherein said opening is substantially square, and

another corner reflector substantially identical to said defined corner reflector is located between said second and third reflectors, yet another corner reflector substantially identical to said defined corner reflector is located between said third and fourth reflectors, and still another corner reflector substantially identical to said defined corner reflector is located between said fourth and first reflectors.

3. A light reflector as described in claim 1, and further including back side reflectors intersecting said first, second and corner reflectors at lines approximately on the intersection of the primary reflection exit pupil rays of said source and said first, second and corner reflectors.

4. A light reflector as described in claim 1, and further including shields for blocking the direct light from the source and the primary reflective light near the edges of the opening without disturbing the light emanating from the center of the opening.

5. A light reflector as described in claim 4, wherein said shields are louvers located inside the opening.

6. A light reflector as described in claim 5, wherein said shields are light absorptive on the side receiving the direct light and the primary reflective light.

7. A light reflector as described in claim 6, wherein said shields are light reflective on the side opposite the side receiving the direct light and the primary reflective light.

8. A light reflector for carrying a mounted light source therein and having a rectangular opening through which light from the source emanates, comprising

four reflectors slanted inwardly from the plane of said opening to cause at least some primary reflections of the source to emanate through the opening, said reflectors aligned successively and substantially at right angles to each other in the plane of the opening, and

four corner reflectors being disposed one between each of said right angle aligned pairs and extending inwardly from the plane of said opening,

said corner reflectors being wedge-shaped with the smallest dimension thereof at the opening and progressively becoming larger away from said opening.

9. A light reflector as described in claim 8, wherein said corner reflectors are flat and are attached to ajoining flat reflectors.

10. A light reflector as described in claim 9, and further including back reflectors intersecting said flat and corner reflectors at lines approximately on the intersection of the primary reflection exit pupil rays of said source and said flat and corner reflectors.

11. A light reflector as described in claim 9, and further including shields for blocking the direct light from the source and the primary reflective light near the edges of the opening without disturbing the light emanating from the center of the opening.

12. A light reflector as described in claim 11, wherein said shields are louvers located inside the opening.

13. A light reflector as described in claim 12, wherein said shields are light absorptive on the side receiving the direct light and the primary reflective light.

14. A light reflector as described in claim 13, wherein said shields are light reflective on the side opposite the side receiving the direct light and the primary reflective light.

15. A light reflector for carrying a mounted light source therein and having an opening through which light from the source is emitted, comprising

at least first and second adjacent reflectors meeting to form a part of said opening through which light from the source is emitted and being oriented to cause at least some primary reflections of said light source to be emitted through the opening, and

a third reflector extending inwardly from the plane of said opening, being adjacent at least one of said first and second reflectors and having sides merging toward a point at a corner of said opening, the exit pupil of each of said two adjacent reflectors permitting the forwardly directed primary light reflections of said light source from said third reflector to emanate through said opening without secondary reflection.

16. A light reflector as described in claim **15**, wherein

said first and second reflectors are slanted inwardly from said opening.

17. A light reflector as described in claim **16**, and further including

at least one back reflector disposed in angular relation with said first and second reflectors for emanating with only primary reflection a substantial amount of light initially directed from said source away from said opening.

18. A light reflector as described in claim **16**, and further including

at least one shield for blocking the direct light from the source and the primary reflected light near the edges of the opening without disturbing the light emanating from the center of the opening.

19. A light reflector as described in claim **18**, wherein

said shield is a louver located inside the opening.

20. A light reflector as described in claim **16**, wherein

said third reflector is adjacent said first reflector and not adjacent said second reflector such that the forwardly directed primary reflections from said third reflector directed toward the meeting of said first and second adjacent reflectors define a boundary between said first reflector and said third reflector.

21. A light reflector for carrying a mounted light source and having a multisided opening through which light from the source is emitted, comprising

a plurality of successively adjacent reflectors meeting to form said opening and being slanted inwardly from the plane of said opening, and

a plurality of corner reflectors between at least some of said successively adjacent reflectors and extending inwardly from the plane of said opening, said corner reflectors having sides merging toward a point at a corner of said opening and being oriented to reflect light from said source forwardly through said openings,

the exit pupil of each of said successively adjacent reflectors at said opening permitting primary light reflections of said light source from each of said corner reflectors to emanate forwardly through said opening without secondary reflection.

22. A light reflector as described in claim **21**, and further including back reflectors each being disposed adjacent respective ones of said successively adjacent reflectors for emanating with only primary reflection a substantial amount of light initially directed from said source away from said opening.

23. A light reflector as described in claim **21**, and further including shields for blocking the direct light from the source and the primary reflected light near the edges of the opening without disturbing the light emanating from the center of the opening.

24. A light reflector as described in claim **23**, wherein

said shields are louvers located inside the opening.

25. A light reflector as described in claim **21**, wherein

said plurality of successively adjacent reflectors includes first and second reflectors meeting at said opening, and

said plurality of corner reflectors includes a reflector adjacent said first reflector and not adjacent said second reflector such that the forwardly directed primary reflections from said flat corner reflector directed toward the meeting of said first and second reflectors define a boundary between said first reflector and said flat corner reflector.

26. A light reflector as described in claim **25**, wherein

said plurality of successively adjacent reflectors includes a third reflector meeting with said first reflector at said opening, and

said plurality of corner reflectors includes a second corner reflector adjacent said first reflector and not adjacent said third reflector such that the forwardly directed primary reflections from said second corner reflector directed toward the meeting of said first and third reflectors define a boundary between said first reflector and said second corner reflector.

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