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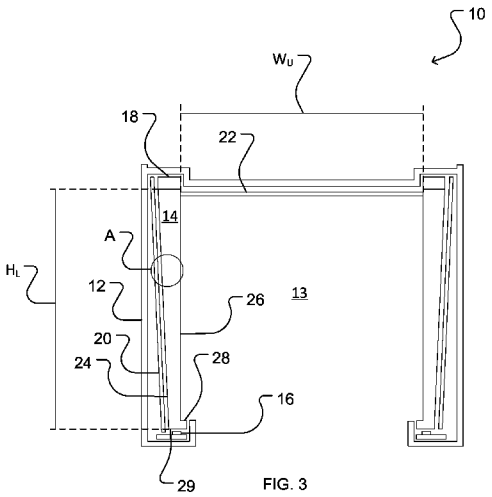

FIG. 3

(57) Abstract: A light emitting panel assembly is provided. The light emitting panel assembly includes: a housing; a light guide within the housing, the light guide having a first major surface with a plurality of extraction elements, a second major surface, a lower surface, an upper surface, a light source adjacent to the lower surface of the light guide; and an upper guide reflector having a diffuse reflective surface adjacent to and facing the upper surface of the light guide, whereby light from the light source traveling through the light guide toward the upper guide reflector spreads within the light guide, and whereby the upper guide reflector homogenizes the light before the light is redirected to the light guide. A luminaire comprising such a light emitting panel assembly is also provided.

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LIGHT EMITTING PANEL ASSEMBLIES WITH BOTTOM-MOUNTED LIGHT SOURCE AND LIGHT GUIDES THEREFOR

Technical Field

[0001] This invention relates to light emitting panel assemblies, and in particular light emitting panel assemblies with light guides. The light emitting panel assemblies may for example be luminaires.

Background

[0002] Light emitting panel assemblies use light guides to transmit light from point light sources such as light emitting diodes (LEDs) to extraction elements where the light is extracted. Luminaires are an example of light emitting panel assemblies.

[0003] One objective in lighting is to provide even illuminance on a work plane, which can be achieved by providing a lighting distribution known in the art as a "batwing" distribution. Another objective in lighting is to eliminate or reduce glare. Glare is an effect of luminance at high vertical angles that can cause visual discomfort to users.

[0004] Luminance of a light emitting panel assembly is determined by dividing luminous intensity by projected area at a particular angle.

[0005] Conventional light emitting panel assemblies are horizontally oriented, i.e., the light emitting panel assembly is wider than it is tall. This configuration allows light to leave towards the work plane from traditional sources such as fluorescent and incandescent light sources. A challenge with this configuration is that projected area shrinks as the angle increases so increasing luminous intensity in order to provide even illuminance would create unacceptable levels of high vertical angle luminance, i.e., glare. Baffling is one measure that may be used to mitigate glare in horizontally-oriented light emitting panel assemblies.

[0006] Vertically oriented light emitting panel assemblies are advantageous because projected area is smaller at low vertical angles where less luminous intensity is required and projected area increases as the vertical angle increases, as illustrated for example in Figures 1 and 2A to 2D. This configuration allows luminous intensity to be higher at higher vertical angles compared to that of a horizontally oriented light emitting panel assembly, avoiding the problem of glare which would otherwise require resorting to additional measures such as baffling. A challenge with this configuration is that the small projected area at low vertical angles results in high luminance at these angles, as illustrated for example in Figure 2A. While light emitting panel assemblies are typically installed above users and not in their direct field of view, too much luminance at low vertical angles can still cause visual discomfort in their peripheral field of view. Minimizing luminous intensity at lower vertical angles is thus desirable for vertically oriented light emitting panel assemblies.

[0007] A further objective in lighting is to emit visually homogenous light. Light travels through the light guide by way of total internal reflection until it is extracted. In conventional light guides light is internally reflected through the guide in an uninterrupted linear path in the plane perpendicular to the normal of the flat sides of the light guide. In conventional light guides, when the light is extracted by extraction elements the light can appear to the viewer as undesirable visible lines of light emanating from the light sources. The visual definition of these lines, or "head lamping", can vary depending on the type of extraction elements used, the distance between the extraction elements and the light source(s), and the width or thickness of the light guide. Reducing or eliminating these visible lines of light, and emitting light which is more visually homogenous across the emitting surface, are desirable.

Summary

[0008] The inventions described herein have many aspects, some of which relate to light emitting panel assemblies, such as luminaires.

[0009] In one aspect, a light emitting panel assembly is provided. The light emitting panel assembly comprises: a housing; a light guide within the housing, the light guide comprising a first major surface comprising a plurality of extraction elements, a second major surface, a lower surface, an upper surface, a light source adjacent to the lower surface of the light guide; and an upper guide reflector comprising a diffuse reflective surface adjacent to and facing the upper surface of the light guide, whereby light from the light source traveling through the light guide toward the upper guide reflector spreads within the light guide, and whereby the upper guide reflector homogenizes the light before the light is redirected to the light guide.

[0010] The upper guide reflector may be pressed against the upper surface of the light guide. The upper guide reflector may be laminated or coated to the upper surface of the light guide. The upper guide reflector may be co-extruded with the light guide. The upper guide reflector may be linearly diffuse, wherein a cross section of the upper guide reflector parallel to the first major surface and the second major surface is ridged or rippled.

[0011] The light emitting panel assembly may further comprise a side guide reflector adjacent to the first major surface. The side guide reflector may be semi-specular, specular or white. The side guide reflector may angle away from the light guide and the opposing light guide in the downward direction at angle of 2 to 15 degrees. The side guide reflector may comprise a lower extension extending horizontally toward the light source.

[0012] The light guide may be vertically oriented or may be angled away from the vertical.

[0013] The light emitting panel assembly may further comprise: an opposing light guide within the housing positioned in lateral opposition to the light guide, wherein the light guide and the opposing light guide define lateral boundaries of a cavity therebetween, the opposing light guide comprising: a first major surface comprising a plurality of extraction elements, a second major surface, a lower surface, an upper surface, an opposing light source adjacent to the lower surface of the opposing light guide; an opposing upper guide reflector comprising a diffuse reflective surface adjacent to and facing the upper surface of the opposing light guide; and an upper reflector defining an upper boundary of the cavity. The opposing upper guide reflector may be pressed against the upper

surface of the opposing light guide, laminated or coated to the upper surface of the opposing light guide, or co-extruded with the opposing light guide. The opposing upper guide reflector may be linearly diffuse, wherein a cross section of the opposing upper guide reflector parallel to the first major surface and the second major surface of the opposing light guide is ridged or rippled. The light emitting panel assembly may further comprise an opposing side guide reflector adjacent to the first major surface of the opposing light guide. The opposing side guide reflector may be semi-specular, specular or white. The upper reflector may comprise a diffuse surface, and is semi-specular, specular or white. A width of the upper reflector may be at least twice a height of the light guide. A lower section of each of the light guide and the opposing light guide comprises an integral or separate lower lip may extend horizontally toward the cavity, wherein the lip comprises a diffuse upper surface and/or a diffuse lower surface for homogenizing light from the light source and directed at the upper reflector. The light guide and the opposing light guide may be vertically oriented or may be angled away from the vertical.

[0014] Each of the plurality of extraction elements may comprise an upper face and a lower face that define an inwardly extending depression in the first major face. The lower face may be shorter than the upper face, whereby a width of the light guide decreases in a downward direction. An angle of the lower face relative to a plane of the first major face may be less than an angle of the upper face relative to the plane of the first major face, whereby a width of the light guide decreases in a downward direction. A height of the plurality of extraction elements may increase in a downward direction. A distance between each of the plurality of extraction elements may decrease in a downward direction.

[0015] Each of the plurality of extraction elements may be configured such that light extracted while travelling upward in the light guide and the opposing light guide is limited to leaving at an angle high enough to remain within the cavity.

[0016] Each of the plurality of extraction elements may comprise a step narrowing the light guide and the opposing light guide in the downward direction, whereby only light travelling downward in the light guide or the opposing light guide is extracted from the plurality of extraction elements.

A height of the plurality of extraction elements may increase in a downward direction. A distance between each of the plurality of extraction elements may decrease in a downward direction. Angles of the step relative to a plane of the first major surface may increase in a downward direction. The light guide and the opposing light guide may be vertically oriented or may be angled away from the vertical.

[0017] The lower surface of the light guide and the light source may be spaced apart to define a triangular gap wherein an open side of the triangular gap faces the side guide reflector.

[0018] The second major surface may comprise a plurality of extraction elements. Each of the plurality of extraction elements of the first major surface and the second major surface may comprise a step narrowing the light guide in the downward direction, whereby only light travelling downward in the light guide is extracted from the plurality of extraction elements. A height of the plurality of extraction elements may increase in a downward direction. A distance between each of the plurality of extraction elements may decrease in a downward direction. Angles of the step relative to a plane of the first major surface may increase in a downward direction. The light emitting assembly may further comprise a convex upper reflector, wherein the light guide is disposed below a middle region of the convex upper reflector.

[0019] In another aspect, a light emitting panel assembly is provided. The light emitting panel assembly comprises: a housing; a plurality of light guides within the housing, each light guide comprising a first major surface comprising a plurality of extraction elements, a second major surface, a lower surface, an upper surface, a plurality of light sources, each one of the light sources adjacent to the lower surface of a corresponding one of the light guides; and a plurality of upper guide reflectors, each upper guide reflector comprising a diffuse reflective surface adjacent to and facing the upper surface of a corresponding one of the light guides, whereby light from the light sources traveling through the light guides toward the upper guide reflectors spreads within the light guides, and whereby the upper guide reflectors homogenize the light before the light is redirected to the light guides. The plurality of light guides may comprise three light guides in a triangular arrangement. The plurality of light guides may comprise two pairs of opposing light guides in a

square or rectangular arrangement. The plurality of light guides may comprise a plurality of pairs of opposing light guides in a polygonal arrangement.

[0020] In another aspect, a light emitting panel assembly is provided. The light emitting panel assembly comprises: a housing; a hollow cylindrical light guide within the housing, the light guide comprising a first major surface comprising a plurality of extraction elements, a second major surface, a lower surface, an upper surface, a circumferentially arranged light source adjacent to the lower surface of the light guide; and a circumferentially arranged upper guide reflector comprising a diffuse reflective surface adjacent to and facing the upper surface of the light guide, whereby light from the light source traveling through the light guide toward the upper guide reflector spreads within the light guide, and whereby the upper guide reflector homogenizes the light before the light is redirected to the light guide. The hollow cylindrical light guide may be a hollow circular cylindrical light guide.

[0021] In another aspect, a luminaire comprising a light emitting panel assembly as described above is provided.

[0022] The foregoing discussion merely summarizes certain aspects of the inventions and is not intended, nor should it be construed, as limiting the inventions in any way.

Brief Description of the Drawings

[0023] In drawings which show non-limiting embodiments of the invention:

Figure is 1 is an isometric view of a vertically oriented light guide;

Figures 2A to 2D are end views of the light guide of Figure 1illustrating projected area at progressively higher angles;

Figure 3 is a cross-sectional view of a light emitting panel assembly according to an example embodiment;

Figure 4A is a close-up view of section A of the embodiment shown in Figure 3;

Figures 4B to 4D are close-up cross-section views of extraction elements according to example embodiments;

Figures 5A and 5B show paths of exemplary light rays initially internally reflecting off a lower portion of an extraction element of the embodiment shown in Figure 3;

Figures 6A and 6B show paths of exemplary light rays initially refracting off a lower portion of an extraction element of the embodiment shown in Figure 3;

Figures 7A and 7B show paths of exemplary light rays initially refracting off a lower lip of the light guide of the embodiment shown in Figure 3;

Figures 8A and 8B show paths of exemplary light rays initially internally reflecting to a top of the light guide of the embodiment shown in Figure 3;

Figures 9A and 9B show paths of exemplary light rays initially internally reflecting to a top of the light guide of the embodiment shown in Figure 3;

Figure 10 is an optical distribution plot of light emitted at various luminous intensities (in candelas) from the embodiment shown in Figure 3 in accordance with Figures 8A, 8B, 9A and 9D, that is, without the contribution of reflectance off the upper reflector;

Figure 11 shows exemplary simulated light ray traces that produce the optical distribution plot of light according to Figure 10;

Figure 12 shows exemplary simulated light ray traces of two ray reactions in the embodiment shown in Figure 3;

Figure 13 shows exemplary simulated light ray traces of four ray reactions in the embodiment shown in Figure 3;

Figure 14 shows exemplary simulated light ray traces of one hundred ray reactions in the embodiment shown in Figure 3;

Figure 15 is an optical distribution plot of light emitted at various luminous intensities (in candelas) from the embodiment shown in Figure 3;

Figure 16 is a cross-sectional view of a light emitting panel assembly according to an example embodiment;

Figure 17 is a close up of a lower section of one side of the embodiment shown in Figure 16;

Figure 18 is a close-up view of section B shown in Figure 17 of the embodiment shown in Figure 16;

Figures 19A and 19B show paths of exemplary light rays initially internally reflecting to a top of the light guide of the embodiment shown in Figure 16;

Figures 20A and 20B show paths of exemplary light rays initially internally reflecting to a top of the light guide of the embodiment shown in Figure 16;

Figures 21A and 21B show paths of exemplary light rays initially reflecting off lower sections of the side reflector of the embodiment shown in Figure 16;

Figure 22 shows exemplary simulated light ray traces of ray reactions of the embodiment shown in Figure 16;

Figure 23 is an optical distribution plot of light emitted at various luminous intensities (in candelas) from the embodiment shown in Figure 16;

Figure 24 shows exemplary simulated light ray traces of ray reactions at a lower section of one side of the embodiment shown in Figure 16;

Figure 25 is an optical distribution plot of light emitted at various luminous intensities (in candelas) from the embodiment shown in Figure 16 except with the top portion of the housing and top reflector removed;

Figure 26 is a cross-sectional view of a light emitting panel assembly according to an example embodiment;

Figure 27 is a close up of a central section of one side of the embodiment shown in Figure 16;

Figure 28 shows exemplary simulated light ray traces of ray reactions of the embodiment shown in Figure 26; and

Figure 29 shows a close of the exemplary simulated light ray traces of ray reactions at a central section of the embodiment shown in Figure 26;

Figure 30(a) shows a cross-sectional view of a lower section of a light emitting panel assembly according to an example embodiment;

Figure 30(b) shows a partial isometric view of spacer elements and a lip element of the light emitting panel assembly shown in Figure 30(a); and

Figure 31 shows a cross-sectional view of a light emitting panel assembly according to an example embodiment.

Description

[0024] Throughout the following description, specific details are set forth in order to provide a more thorough understanding of the invention. However, the invention may be practiced without these particulars. In other instances, well known elements have not been shown or described in detail to avoid unnecessarily obscuring the invention. Accordingly, the specification and drawings are to be regarded in an illustrative, rather than a restrictive, sense.

[0025] The term "adjacent" as used in this specification refers to being near or adjoining. Adjacent features can be spaced apart from one another or can be in direct contact with one another. In some instances, adjacent features can be connected to one another or can be formed integrally with one another.

[0026] The term "inwardly" as used in this specification refers to a direction toward the cross-sectional center of the light guide.

[0027] The term "outwardly" as used in this specification refers to a direction away from the cross-sectional center of the light guide.

[0028] The terms "upper", "upward", and like terms as used in this specification refers to a direction away from where the light source is located.

[0029] The terms "lower", "downward", and like terms as used in this specification refer to a direction toward where the light source is located.

[0030] The term "low angle" as used in this specification refers to an angle of approximately 0 to 15 degrees from the vertical.

[0031] The term "peak angle" as used in this specification refers to an angle of approximately 10 to 50 degrees from the vertical.

[0032] Figure 3 shows a light emitting panel assembly 10 according to an embodiment of the invention. Light emitting panel assembly 10 has a housing 12. Light guides 14 are vertically

disposed on both sides of housing 12. Light guides 14 partially define a cavity 13 between them. Light emitting panel assembly 10 also includes light sources 16, upper guide reflectors 18, side guide reflectors 20, and upper reflector 22.

[0033] Light source 16 is a light emitting diode (LED) or an array of LEDs. In some embodiment light source 16 may be any other point source emitter of light, including laser diodes and the like. Light source 16 is adjacent to a lower surface 29 of light guide 14. In some embodiments light source 16 squarely faces lower surface 29. In some embodiments light source 16 may be in contact with lower surface 29. In some embodiments light source 16 may be spaced apart from lower surface 29. For example, spacer elements disposed between individual LEDs may be used to space light source 16 apart from lower surface 29. The space or lack thereof between light source 16 and lower surface 29 determines the quantity of light entering light guide 14 in the upward direction and conversely the amount of light illuminating upper reflector 22 directly. In some embodiments lower surface 29 of light guide 14 may have a diffuse surface to homogenize light entering light guide 14.

[0034] Light guide 14 is generally planar, and has a first major surface 24 facing away from cavity 13 and a second major surface 26 facing toward cavity 13.

[0035] Light guide 14 decreases in width in the downward direction. In the embodiment shown, the decrease in width is due to the shape of extraction elements 30 on first major surface 24; for example, and with reference to Figure 4A, the decreasing width may be achieved by lower face 34 being shorter than upper face 32 and/or by angle A_L being less than angle A_U. The individual sections between extraction elements 30 along first major surface 24 are parallel to second major surface 26. The downward decrease in width of light guide 14 results in a greater capacity for light extraction from a lower region of light guide 14 (see Figures 5 and 6), and lesser capacity for light extraction from an upper region of light guide 14 (see Figures 8 and 9). This balances out the greater amount of light available for extraction at the upper region of light guide 14 (after reflecting off upper guide reflector 18), resulting in a more even extraction of light from the top to the bottom of light guide 14. This even extraction of light contributes to the desirable peaks of the angle batwing distribution shown in Figures 10 and 15.

[0036] In some embodiments light guide 14 may not decrease in width in the downward direction, that is, first major surface 24 and second major surface 26 may extend parallel to one another.

[0037] Light guide 14 also has a lower lip 28 extending toward cavity 13. In some embodiments, lower lip 28 may be absent. In some embodiments the lip may be a separate part. In some embodiments the lip may have a diffuse upper and/or lower surface to homogenize light travelling upward through the lip and illuminating upper reflector 22.

[0038] Upper guide reflector 18 is adjacent to upper surface 32 of light guide 14. Upper guide reflector 18 has a diffuse reflective surface facing upper surface 32. In some embodiments the upper guide reflector 18 may be partially specular. For example, upper guide reflector 18 may be a highly reflective white film. Diffuse reflection homogenizes the light from light guide 14. In some embodiments, upper guide reflector 18 is pressed against upper surface 32. In some embodiments upper guide reflector 18 is integrated with upper surface 32, for example by lamination or coating. In some embodiments, upper guide reflector 18 may be co-extruded with light guide 14. Integration of upper guide reflector 18 with upper surface 32 of light guide 14 reduces boundary losses of light by avoiding having the light exit and re-enter light guide 14.

[0039] In some embodiments, upper guide reflector 18 may be textured to reflect more light back into light guide 14 at a lower angle from the vertical, to facilitate even emission of light down the vertical extent of light guide 14. For example, upper guide reflector 18 may be linearly diffuse such that a cross sectional plane of upper guide reflector 18 parallel to first major surface 24 and second major surface 26 is ridged or rippled.

[0040] Side guide reflector 20 extends parallel and adjacent to first major surface 24. In some embodiments, the distance D_S between side guide reflector 20 and first major surface 24 is minimized, that is, less than 5 mm, or 2 mm, or 1 mm. Side guide reflector 20 may be specular, semi-specular or white. In some embodiments side guide reflector 20 may be pressed against or laminated to first major surface 24 such that the only space between them would be at the extraction elements.

[0041] Side guide reflector 20 angles inwardly as it extends downward, in parallel to the decreasing width of first major surface 24 in the downward direction. In embodiments wherein first major surface 24 does not decrease in width in the downward direction, side guide reflector 20 may angle inwardly as it extends downward, or go straight downward. The inward angling of side reflector 20 is to compensate for light refracting out extraction elements 30 on first major surface 24, as shown for example in Figure 9, at a lower angle than light internally reflecting off extraction elements 30, as shown for example in Figure 8. In some embodiments the angle of side guide reflector 20 may be 2 to 15 degrees from the vertical.

[0042] Upper reflector 22 spans between upper sections of opposing light guides 14. Upper reflector 22 has a fully diffuse surface. Upper reflector 22 may be specular, semi-specular or white. Upper reflector 22 defines an upper boundary of cavity 13. In some embodiments, for example wherein light emitting panel assembly 10 is very narrow, upper reflector 22 may be absent.

[0043] As best shown in Figure 4A, first major surface 24 has a plurality of extraction elements 30 and second major surface 26 has no extraction elements. In some embodiments second major surface 26 may have extraction elements. Extraction elements 30 are shaped to extract both light travelling upward and light travelling downward within light guide 14. Each extraction element 30 has an upper face 32 and lower face 34 that together define an inwardly extending depression in first major face 24. In some embodiments, relative to plane P_F parallel to first major face 24, upper face 32 angles inwardly at an angle A_U of 2 to 25 degrees, or 10 to 20 degrees, or about 15 degrees, and lower face 34 angles inwardly at an angle A_L of 2 to 25 degrees, or 10 to 20 degrees, or about 15 degrees. In some embodiments, upper face 32 and lower face 34 may be symmetrical, that is, their dimensions may be identical and angles A_U and A_L may be identical.

[0044] In some embodiments, upper face 32 and lower face 34 may not be symmetrical. For example, as mentioned above, lower face 34 is shorter than upper face 32 and/or A_L is less than A_U to facilitate even extraction of light along light guide 14. As another example, angles A_U and A_L may different in order to ensure an even distribution of light across upper reflector 22.

[0045] Extraction element 30 has a height H_E. In some embodiments, height H_E is negatively correlated to a height H_L of light guide 14; that is, the taller the light guide, the smaller the extraction elements since they would need to release less light, and vice versa.

[0046] In some embodiments height H_E of extraction elements 30 increases in the downward direction along light guide 14. In some embodiments the distance D_E between extraction elements 30 decreases in the downward direction along light guide 14 to increase the density of extraction elements 30 in a lower region of light guide 14. The foregoing features, individually and in combination, provide greater light extraction capacity at a lower region of light guide 14 compared to an upper region of light guide 14, resulting in more even extraction of light from the top to the bottom of light guide 14 and thus contributing to the desirable peak angle batwing distribution shown in Figures 10 and 15.

[0047] In some embodiments, extraction element 30 may have a shape different than that illustrated in Figure 4A, but still extract light travelling upward and downward in light guide 14. Figures 4B to 4D are non-limiting examples of other possible shapes of extraction element 30.

[0048] Figures 5A, 5B, 6A, 6B, 7A, 7B, 8A, 8B, 9A and 9B illustrate exemplary paths of rays of light emitted from light source 16 of light emitting panel assembly 10.

[0049] Figure 5A and 5B illustrate rays of light which internally reflect off an extraction element 30 of first major surface 24 in a lower region of light guide 14, refract out of second major surface 26 into cavity 13 toward upper reflector 22, and reflect off upper reflector 22 into cavity 13 to a workspace.

[0050] Figures 6A and 6B illustrate rays of light which refract out of an extraction element 30 of first major surface 24 in a lower region of light guide 14, reflect off of side guide reflector 20, refract through first major surface 24 and second major surface 26 into cavity 13 toward upper reflector 22, and reflect off upper reflector 22 into cavity 13 to a workspace.

[0051] Figures 7A and 7B illustrate rays of light which refract through lower lip 28 into cavity 13 toward upper reflector 22, and reflect off upper reflector 22 into cavity 13 to a workspace.

[0052] Light rays such as those generally following the paths illustrated in Figures 5A, 5B, 6A, 6B, 7A and 7B combine to illuminate upper reflector 22 to create a homogenous luminance surface. Light leaving this surface provides the low angle light distribution of the light distribution shown in Figure 15. Figure 10 shows a light distribution of light emitting panel assembly 10 without upper reflector 22, that is, without the contribution of light rays generally following the paths illustrated in Figures 5A, 5B, 6A, 6B, 7A and 7B.

[0053] Figures 8A and 8B illustrate rays of light which internally reflect up to the top of light guide 14, reflect off upper guide reflector 18, internally reflect down light guide 14, internally reflect off extraction element 30 in an upper region of light guide 14, and refract out of second major surface 26 into cavity 13 to a workspace.

[0054] Figures 9A and 9B illustrate rays of light which internally reflect up to the top of light guide 14, reflect off upper guide reflector 18, internally reflect down light guide 14, refract out of an extraction element 30 in a upper region of light guide 14, reflect off of side guide reflector 20, and then refract through first major surface 24 and second major surface 26 into cavity 13 to a workspace.

[0055] Light rays such as those generally following the paths illustrated in Figures 8A, 8B, 9A and 9B advantageously mix and spread with light rays from adjacent LEDs from the LED array as they travel from light source 16 to upper guide reflector 18. Light reflecting off upper guide reflector 18 is homogenized, eliminating "head lamping" effects, and reenters light guide 14. These light rays contribute to the desirable peak angle batwing distribution shown in Figures 10 and 15.

[0056] Figure 11 shows exemplary simulated light ray traces of light emitting panel assembly 10 without upper reflector 22. Figures 12 to 14 show exemplary simulated light ray traces of light emitting panel assembly 10 of two ray reactions, four ray reactions, and one hundred ray reactions respectively according to example embodiments. The two ray reaction shown in Figure 12 isolates the simulation to rays primarily such as those rays shown in Figures 5A, 5B, 6A, 6B, 7A and 7B, that is, light refracting out of a lower region or lower lip 28 of light guide 14 upward toward upper

reflector 22 to illuminate upper reflector 22. The four ray reaction shown in Figure 13 is similar to the two ray reaction of Figure 12 but also begins to show some reflections off upper reflector 22. The one hundred ray reaction shown in Figure 14 demonstrates full optical reactions to light emitting panel assembly 10, and the optical distribution of these reactions is plotted in Figure 15.

[0057] Thus in light emitting panel assembly 10, light from light source 16 traveling through light guide 14 toward upper guide reflector 18 spreads within light guide 14, and upper guide reflector 18 homogenizes the light before the light is redirected to light guide 14 to be extracted by extraction elements 30 at angles visible in the lower hemisphere. In addition to allowing for improved optical distributions, the foregoing features of the present invention allow for larger spacing between individual lights within light source 16 (e.g. spacing between LEDs), resulting in cost savings with respect to light source 16.

[0058] Figure 16 shows a light emitting panel assembly 100 according to an embodiment. Light emitting panel assembly 100 has a housing 112 defining a cavity 113. A pair of light guides 114 is vertically disposed on the sides of housing 112. Light emitting panel assembly 100 also includes light sources 116, upper guide reflectors 118, side guide reflectors 120, and upper reflector 122. Compared to light emitting panel assembly 10, light emitting panel assembly 100 has a significantly wider upper reflector 122 and other differences to facilitate even distribution of light across the wider upper reflector 122. In some embodiments, width W_U of upper reflector 122 is at least twice the height H_L of light guides 114.

[0059] Light guide 114 and light source 116 are substantially similar to light guide 14 and light source 16 of light emitting panel assembly 10 except that lower surface 129 of light guide 114 and light source 116 are spaced apart to define a gap 117. Gap 117 is shaped to allow a predetermined amount of light from light source 116 to first reflect off side guide reflector 120 before hitting light guide 114. In some embodiments, a first edge 119 of light source 116, defined as the edge of light source 116 further from side guide reflector 120, is closer to lower surface 129 of light guide 114 than an opposite second edge 121 of light source 116. In some embodiments, first edge 119 is adjacent to, and may abut, lower surface 129. In the embodiment shown, light source 116 is angled in the direction of side guide reflector 120 to define a triangular gap 117 between light source 116

and lower surface 129. In some embodiments, an angle A_L between a major plane P_L of light source 116 and a horizontal plane P_H ranges from or 20 to 70 degrees, or 35 to 55 degrees, or 40 to 45 degrees. In some embodiments, light source 116 is horizontal (i.e., major plane P_L of light source 116 lies in horizontal plane P_H) but lower surface 129 is angled to define a triangular gap 117. In some embodiments, both light source 116 and lower surface 129 are angled to define a triangular gap 117.

[0060] Side guide reflector 120 angles away from light guide 114 in the downward direction. In some embodiments the angle of side guide reflector 20 may be 2 to 15 degrees from the vertical. Similar to side guide reflector 20, the angling of side reflector 120 is to compensate for light refracting out extraction elements 130 on first major surface 124, as shown for example in Figure 20, at a lower angle than light which internally reflects off extraction elements 130, as shown for example in Figure 19.

[0061] Side guide reflector 120 includes a lower extension 125. In some embodiments lower extension 124 extends horizontally in the direction of light source 116. In some embodiments lower extension 125 spans at least half of a gap 123 defined between a bottom region of side guide reflector 120 and a bottom region of light source 116. In some embodiments lower extension 125 may be formed as a separate reflector from the rest of side guide reflector 120. Gap 123 provides distance between light source 116 and side guide reflector 120 to perform at least two functions: (i) increases optical control over the distribution of light for illuminating upper reflector 122; and (ii) reduces the amount of light reflected back at light source 116 and thereby wasted.

[0062] As shown in Figure 18, first major surface 124 has a plurality of extraction elements 130. In some embodiments, second major surface 126 has no extraction elements. Extraction elements 130 are configured to only extract light travelling downward in light guide 114; this advantageously preserves light for peak angle distribution as described in relation to Figures 19A, 19B, 20A, and 20B below. Each extraction element 30 comprises an angled step 133 that widens light guide 114 in the upward direction. In some embodiments, relative to plane P_F parallel to first

major face 124, angled step 133 angles outwardly at an angle A_A of 2 to 25 degrees, or 10 to 20 degrees, or about 15 degrees.

[0063] Other aspects of extraction elements 130 such as their dimensions and distribution are similar to extraction elements 30 previously discussed. For example, height H_S of extraction elements 130 increases in the downward direction along light guide 114. In some embodiments the distance D_S between extraction elements 130 decreases in the downward direction along light guide 114 to increase the density of extraction elements 130 in a lower region of light guide 114. In some embodiments angle A_A of extraction elements 130 increases in the downward direction along light guide 114. The foregoing features, individually and in combination, provide for greater light extraction capacity at a lower region of light guide 114 compared to an upper region of light guide 114, resulting in more even extraction of light from the top to the bottom of light guide 114 and thus contributing to the desirable peak angle batwing distribution shown in Figure 23.

[0064] Figures 19A, 19B, 20A, 20B, 21A and 21B illustrate exemplary paths of rays of light emitted from light source 116 of light emitting panel assembly 100.

[0065] Figure 19A and 19B illustrate rays of light which internally reflect up to the top of light guide 114, reflect off upper guide reflector 118, internally reflect down light guide 114, internally reflect off extraction element 130, and refract out of second major surface 126 into cavity 13 to a workspace.

[0066] Figures 20A and 20B illustrate rays of light which internally reflect up to the top of light guide 114, reflect off upper guide reflector 118, internally reflect down light guide 114, refract out of an extraction element 130, reflect off of side guide reflector 120, and then refract through first major surface 124 and second major surface 126 into cavity 13 to a workspace.

[0067] Light rays such as those generally following the paths illustrated in Figures 19A, 19B, 20A and 20B advantageously mix and spread with light rays from adjacent LEDs from the same LED array as they travel from light source 116 to upper guide reflector 118. Light reflecting off upper guide reflector 118 is homogenized, eliminating “head lamping” effects, and reenters light guide

114. These light rays contribute to the desirable peak angle batwing distribution shown in Figures 23.

[0068] Figures 21A and 21B illustrate rays of light which leave light source 116 at angles at or near the horizontal such that they travel through gap 117 and gap 123 and are reflected by side guide reflector 120 (or lower extension 125 and side guide reflector 120) before refracting through first major surface 124 and second major surface 126 at a lower region of light guide 114 at an upward angle through cavity 113 to upper reflector 122. Side guide reflector 120 may include a bottom face 127 that is angled slightly upward to reflect light through a lower region of light guide 114 toward upper reflector 122 to facilitate even spreading of light on upper reflector 122. The light rays exemplified by Figures 21A and 21B create a homogenous luminance surface on upper reflector 122, and the light leaving this surface provides the low angle light distribution of the light distribution shown in Figure 23.

[0069] Figure 22 shows exemplary simulated light ray traces of ray reactions of light emitting panel assembly 100. Figure 24 shows exemplary simulated light ray traces of ray reactions at a lower section of one side of light emitting panel assembly 100. Figure 25 is an optical distribution plot of light emitted from light emitting panel assembly 100 except with the top portion of the housing 112 and upper reflector 122 removed.

[0070] Figures 26 and 27 shows a light emitting panel assembly 200 according to an embodiment. Light emitting panel assembly 200 includes a centrally positioned light guide 214 having a first major surface 224 and second major surface 226. Each of first major surface 224 and second major surface 226 have extraction elements (not shown) similar in features and functions to extraction elements 130 of light emitting panel assembly 100. For example, the extraction elements are configured to only extract light travelling downward in light guide 214, advantageously preserving light for peak angle distribution. Because both major surface 224 and second major surface 226 have extraction elements, downward travelling light is extracted out of both sides of light guide 214. Light emitting panel assembly 200 also includes a light source 216, upper guide reflector 218, a pair of convex reflectors 222 a pair of lips 228, and a lower surface 229, each of which are similar

in feature and function to corresponding features of light emitting panel assemblies 10 and 100, except in the case of reflector 222 which is convex rather than flat.

[0071] Figures 28 and 29 shows exemplary simulated light ray traces of ray reactions of light emitting panel assembly 200. Figure 28 shows exemplary simulated light ray traces of ray reactions of the entire light emitting panel assembly 200. Figure 29 shows a close up of exemplary simulated light ray traces of ray reactions of the light emitting panel assembly 200.

[0072] This application is intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.

[0073] As an example of a variation, Figure 30(a) show the lower section of light emitting panel assembly 200', a variation of light emitting panel assembly 200. Assembly 200' has two light guides 214', each with an array of light sources 216' facing respective lower surfaces 229', spacer elements 217' between individual light sources 216' to space light sources 216' from lower surface 229', and a lip element 228' on each side being a distinct component from light guide 214'. The upper surface and/or lower surface of each lip element 228' may be diffuse for homogenizing light from light source 216' that illuminates the convex reflectors 222' above (not shown). In the embodiment shown, lip elements 228' are injection molded lenses with a textured, i.e., diffuse, lower surface. Figure 30(b) shows an isolated view of a lip element 228' with spacer elements 217'.

[0074] As another example of variations, while the light sources, light guides and upper guide reflectors in the embodiments of the light emitting panel assemblies described above are generally aligned vertically, in some embodiments these features may be aligned along an angle other than the vertical for example as shown in Figure 31.

[0075] Figure 31 shows a light emitting panel assembly 300 according to an embodiment. Light emitting panel assembly 300 has a housing 312 defining an interior cavity 313. A pair of light

guides 314 is disposed on the sides of housing 312. Light emitting panel assembly 300 also includes light sources 316, upper guide reflectors 318, side guide reflectors 320, and upper reflector 322.

[0076] In contrast to the light guides of assemblies 10, 100 and 200, light guides 314 in assembly 300 are angled off from the vertical. In the embodiment shown in Figure 30, light guides 314 are angled approximately 20 degrees off from the vertical. In some embodiments, light guides 314 may be angled off from the vertical by up to 20 degrees, 40 degrees, 60 degrees, or 90 degrees (i.e., horizontal).

[0077] First major surfaces 324 of light guides 314 comprise extraction elements 330. In some embodiments, extraction elements 330 are similar in structure and function to extraction elements 130 of assembly 100, and therefore only extract light travelling downward in light guide 314, i.e., after being reflected by upper guide reflector 318.

[0078] In some embodiments, extraction elements 330 are similar in structure and function to extraction elements 30 of assembly 10, and therefore extract light travelling upward and downward in light guide 314. Extraction elements 330 are configured such that light extracted while travelling upward in light guide 314 is limited to light leaving at an angle high enough to strike the opposing arm 315, 315' and thereby stay within the confines of interior 313. Preventing light travelling upward in the light guide from leaving at a low enough angle to escape interior 313 eliminates the possibility of un-homogenized light (which causes headlamping) from being visible from below assembly 300.

[0079] Assembly 300 also has a secondary optic 350 adjacent each second major surface 326 of light guides 314. Secondary optic 350 may, for example, bend light toward the normal, or away from the normal, as required by the application. In some embodiments, secondary optic 350 may be a transflective optic. In some embodiments, secondary optic 350 may be absent.

[0080] As a further example of variations, while assemblies such as assemblies 10, 100 and 300 are two-sided and define a cavity therebetween, other configurations are possible. For example,

some embodiments may be three-sided (triangular from a top plan view), four-sided (square or rectangular from a top plan view), multi-sided (polygonal from a top plan view), round (circular from a top plan view), oval (oval from a top plan view) and the like, each defining a centrally-located cavity.

[0081] Embodiments of the invention include luminaires comprising light emitting panel assemblies 10, 100, 200 and/or 300 and therefore specifically exclude image display devices.

[0082] This application is intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims. Accordingly, the scope of the claims should not be limited by the preferred embodiments set forth in the description, but should be given the broadest interpretation consistent with the description as a whole.

Claims:

1. A light emitting panel assembly comprising:
a housing;
a light guide within the housing, the light guide comprising:
a first major surface comprising a plurality of extraction elements,
a second major surface,
a lower surface,
an upper surface,
a light source adjacent to the lower surface of the light guide; and
an upper guide reflector comprising a diffuse reflective surface adjacent to and facing the upper surface of the light guide
whereby light from the light source traveling through the light guide toward the upper guide reflector spreads within the light guide, and whereby the upper guide reflector homogenizes the light before the light is redirected to the light guide.

2. A light emitting panel assembly according to claim 1 wherein the upper guide reflector is pressed against the upper surface of the light guide.

3. A light emitting panel assembly according to claim 1 wherein the upper guide reflector is laminated or coated to the upper surface of the light guide.

4. A light emitting panel assembly according to claim 1 wherein the upper guide reflector is co-extruded with the light guide.

5. A light emitting panel assembly according to any one of claims 1 to 4 wherein the upper guide reflector is linearly diffuse, wherein a cross section of the upper guide reflector parallel to the first major surface and the second major surface is ridged or rippled.

6. A light emitting panel assembly according to any one of claims 1 to 5 further comprising a side guide reflector adjacent to the first major surface.

7. A light emitting panel assembly according to claim 6 wherein the side guide reflector is semi-specular, specular or white.

8. A light emitting panel assembly according to any one of claims 1 to 7 wherein the light guide is vertically oriented.

9. A light emitting panel assembly according to any one of claims 1 to 7 wherein the light guide is angled away from the vertical.

10. A light emitting panel assembly according to any one of claims 1 to 9 further comprising:
an opposing light guide within the housing positioned in lateral opposition to the light guide, wherein the light guide and the opposing light guide define lateral boundaries of a cavity therebetween, the opposing light guide comprising:
a first major surface comprising a plurality of extraction elements,
a second major surface,
a lower surface,
an upper surface,
an opposing light source adjacent to the lower surface of the opposing light guide;
an opposing upper guide reflector comprising a diffuse reflective surface adjacent to and facing the upper surface of the opposing light guide; and
an upper reflector defining an upper boundary of the cavity.

11. A light emitting panel assembly according to claim 10 wherein the opposing upper guide reflector is pressed against the upper surface of the opposing light guide, laminated or coated to the upper surface of the opposing light guide, or co-extruded with the opposing light guide.

12. A light emitting panel assembly according to claim 10 or 11 wherein the opposing upper guide reflector is linearly diffuse, wherein a cross section of the opposing upper guide reflector parallel to the first major surface and the second major surface of the opposing light guide is ridged or rippled.

13. A light emitting panel assembly according to any one of claims 10 to 12 further comprising an opposing side guide reflector adjacent to the first major surface of the opposing light guide.

14. A light emitting panel assembly according to claim 13 wherein the opposing side guide reflector is semi-specular, specular or white.

15. A light emitting panel assembly according to any one of claims 10 to 14 wherein the upper reflector comprises a diffuse surface, and is semi-specular, specular or white.

16. A light emitting panel assembly according to any one of claims 10 to 15 wherein a lower section of each of the light guide and the opposing light guide comprises an integral or separate lower lip extending horizontally toward the cavity, wherein the lip comprises a diffuse upper surface and/or a diffuse lower surface for homogenizing light from the light source and directed at the upper reflector.

17. A light emitting panel assembly according to any one of claims 10 to 16 wherein each of the plurality of extraction elements comprises an upper face and a lower face that define an inwardly extending depression in the first major face.

18. A light emitting panel assembly according to claim 17 wherein the lower face is shorter than the upper face, whereby a width of the light guide decreases in a downward direction.

19. A light emitting panel assembly according to claim 17 or 18 wherein an angle of the lower face relative to a plane of the first major face is less than an angle of the upper face relative to the plane of the first major face, whereby a width of the light guide decreases in a downward direction.

20. A light emitting panel assembly according to any one of claims 17 to 19 wherein a height of the plurality of extraction elements increases in a downward direction.

21. A light emitting panel assembly according to any one of claims 17 to 20 wherein a distance between each of the plurality of extraction elements decreases in a downward direction.

22. A light emitting panel assembly according to any one of claims 17 to 21 wherein the light guide and the opposing light guide are vertically oriented.

23. A light emitting panel assembly according to any one of claims 17 to 21 wherein the light guide and the opposing light guide are angled away from the vertical.

24. A light emitting panel assembly according to claim 23 wherein each of the plurality of extraction elements are configured such that light extracted while travelling upward in the light guide and the opposing light guide is limited to leaving at an angle high enough to remain within the cavity.

25. A light emitting panel assembly according to any one of claims 10 to 16 wherein each of the plurality of extraction elements comprises a step narrowing the light guide and the opposing light guide in the downward direction, whereby only light travelling downward in the light guide or the opposing light guide is extracted from the plurality of extraction elements.

26. A light emitting panel assembly according to claim 25 wherein a height of the plurality of extraction elements increases in a downward direction.

27. A light emitting panel assembly according to claim 25 or 26 wherein a distance between each of the plurality of extraction elements decreases in a downward direction.

28. A light emitting panel assembly according to any one of claims 25 to 27 wherein angles of the step relative to a plane of the first major surface increases in a downward direction.

29. A light emitting panel assembly according to any one of claims 25 to 28 wherein the light guide and the opposing light guide are vertically oriented.

30. A light emitting panel assembly according to any one of claims 25 to 29 wherein the light guide and the opposing light guide are angled away from the vertical.

31. A light emitting panel assembly according to any one of claims 10 to 30 wherein a width of the upper reflector is at least twice a height of the light guide.

32. A light emitting panel assembly according to claim 31 wherein the lower surface of the light guide and the light source are spaced apart to define a triangular gap wherein an open side of the triangular gap faces the side guide reflector.

33. A light emitting panel assembly according to claim 31 or 32 wherein the side guide reflector angles away from the light guide and the opposing light guide in the downward direction at angle of 2 to 15 degrees.

34. A light emitting panel assembly according to any one of claims 31 to 33 wherein the side guide reflector comprises a lower extension extending horizontally toward the light source.

35. A light emitting panel assembly according to any one of claims 1 to 9 wherein the second major surface comprising a plurality of extraction elements.

36. A light emitting panel assembly according to claim 35 wherein each of the plurality of extraction elements of the first major surface and the second major surface comprises a step narrowing the light guide in the downward direction, whereby only light travelling downward in the light guide is extracted from the plurality of extraction elements.

37. A light emitting panel assembly according to claim 36 wherein a height of the plurality of extraction elements increases in a downward direction.

38. A light emitting panel assembly according to claim 36 or 37 wherein a distance between each of the plurality of extraction elements decreases in a downward direction.

39. A light emitting panel assembly according to any one of claims 36 to 38 wherein angles of the step relative to a plane of the first major surface increases in a downward direction.

40. A light emitting panel assembly according to any one of claims 36 to 39 further comprising a convex upper reflector, wherein the light guide is disposed below a middle region of the convex upper reflector.

41. A light emitting panel assembly comprising:

a housing;

a plurality of light guides within the housing, each light guide comprising:

a first major surface comprising a plurality of extraction elements,

a second major surface,

a lower surface,

an upper surface,

a plurality of light sources, each one of the light sources adjacent to the lower surface of a corresponding one of the light guides; and

a plurality of upper guide reflectors, each upper guide reflector comprising a diffuse reflective surface adjacent to and facing the upper surface of a corresponding one of the light guides

whereby light from the light sources traveling through the light guides toward the upper guide reflectors spreads within the light guides, and whereby the upper guide reflectors homogenize the light before the light is redirected to the light guides.

42. A light emitting panel assembly according to claim 41 wherein the plurality of light guides comprises three light guides in a triangular arrangement.

43. A light emitting panel assembly according to claim 41 wherein the plurality of light guides comprises two pairs of opposing light guides in a square or rectangular arrangement.

44. A light emitting panel assembly according to claim 41 wherein the plurality of light guides comprises a plurality of pairs of opposing light guides in a polygonal arrangement.

45. A light emitting panel assembly comprising:

a housing;

a hollow cylindrical light guide within the housing, the light guide comprising:

a first major surface comprising a plurality of extraction elements,

a second major surface,

a lower surface,

an upper surface,

a circumferentially arranged light source adjacent to the lower surface of the light guide; and

a circumferentially arranged upper guide reflector comprising a diffuse reflective surface adjacent to and facing the upper surface of the light guide

whereby light from the light source traveling through the light guide toward the upper guide reflector spreads within the light guide, and whereby the upper guide reflector homogenizes the light before the light is redirected to the light guide.

46. A light emitting panel assembly according to claim 45 wherein the hollow cylindrical light guide is a hollow circular cylindrical light guide.

47. A luminaire comprising a light emitting panel assembly according to any one of claims 1 to 46.

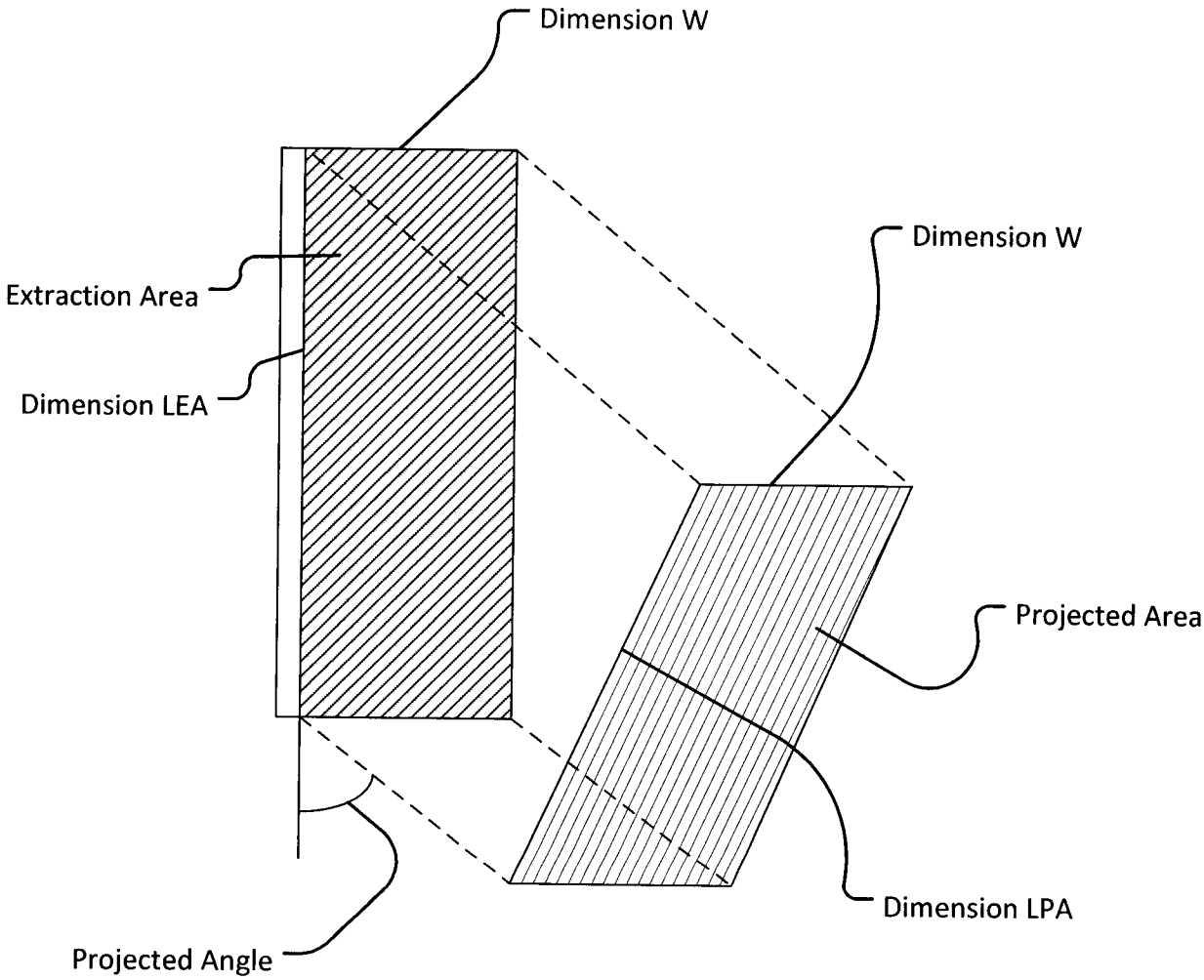
Dimension W
Extraction Area
Dimension LEA
Dimension W
Projected Area
Dimension LPA
Projected Angle

FIG. 1

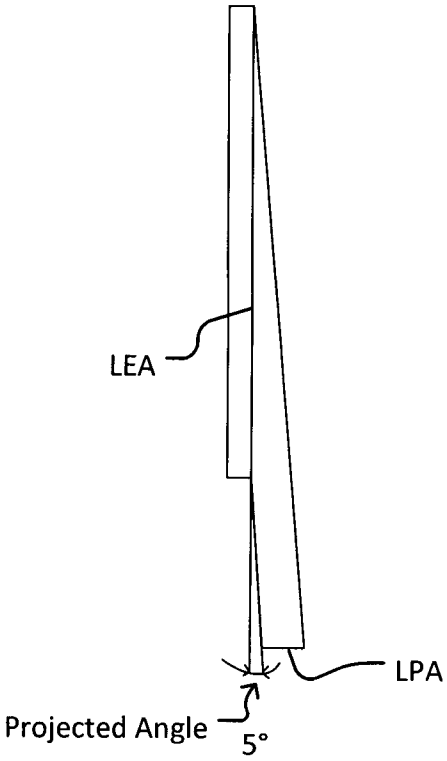

FIG. 2A

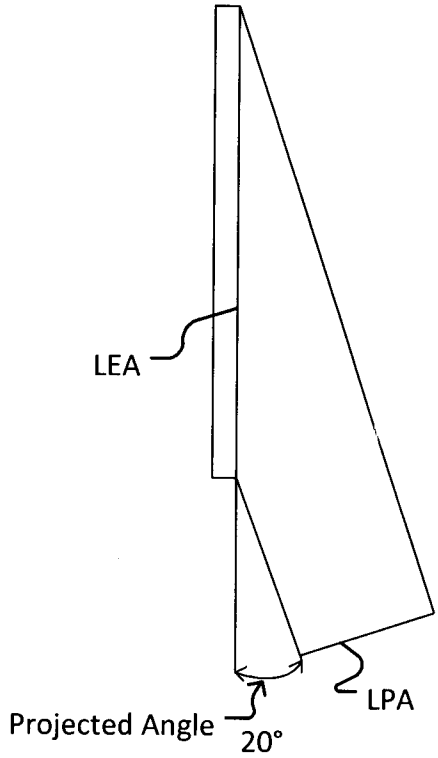

FIG. 2B

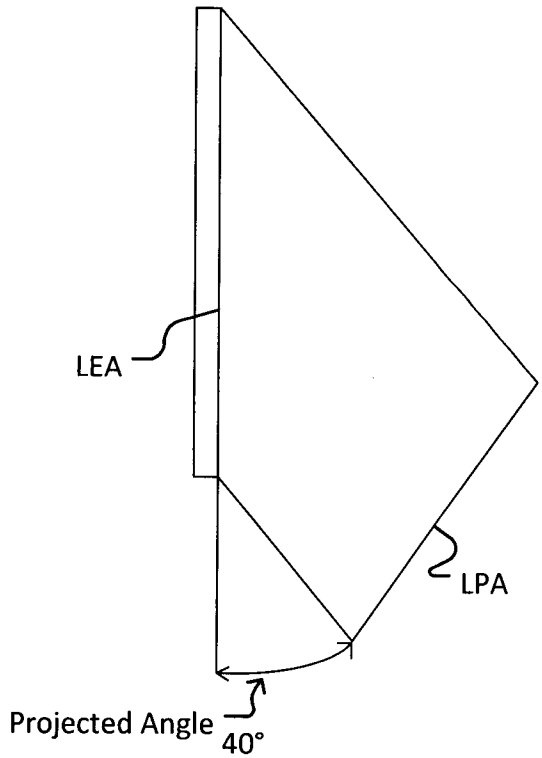

FIG. 2C

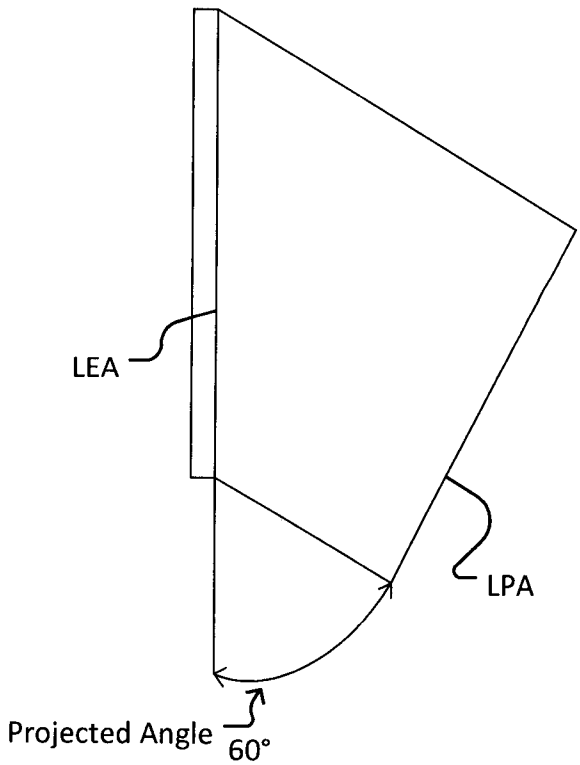

FIG. 2D

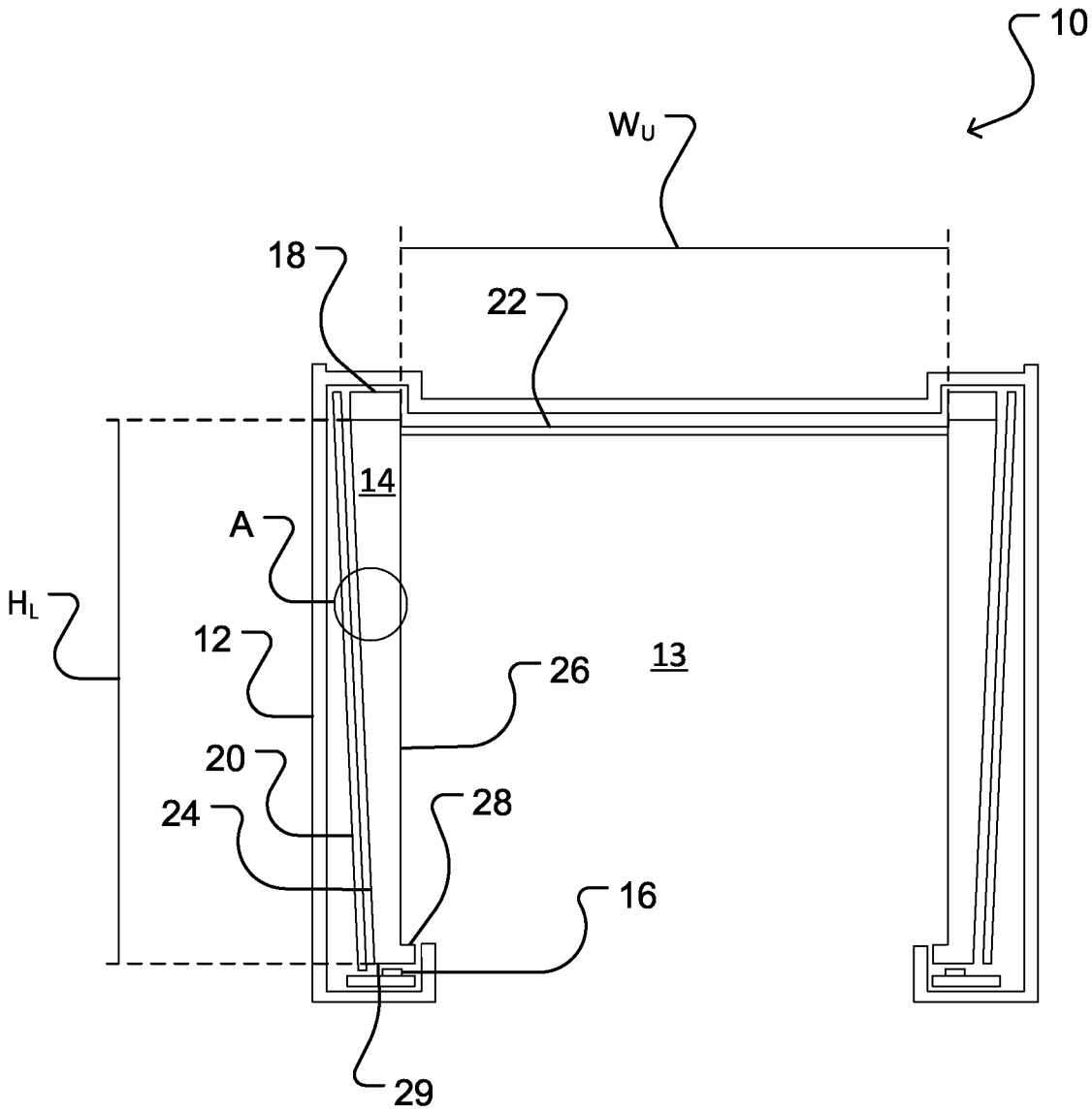

FIG. 3

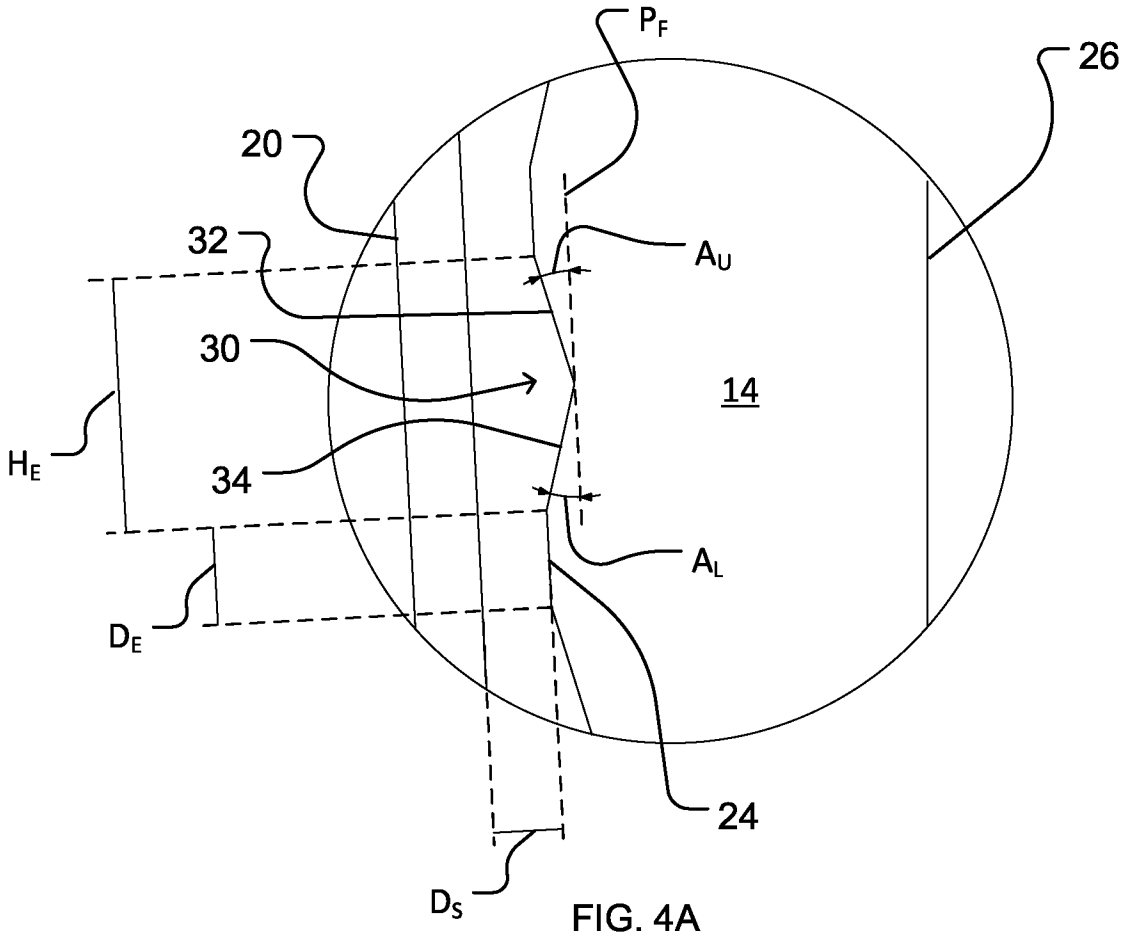

FIG. 4A

FIG. 4B

FIG. 4C

FIG. 4D

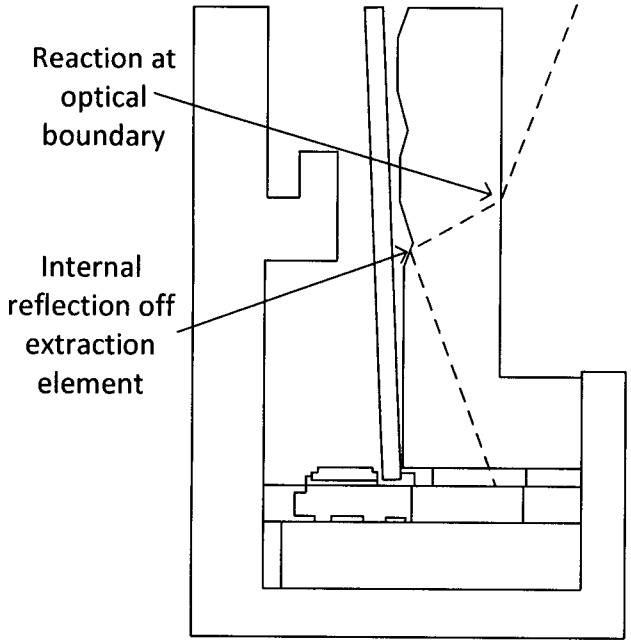

FIG. 5A

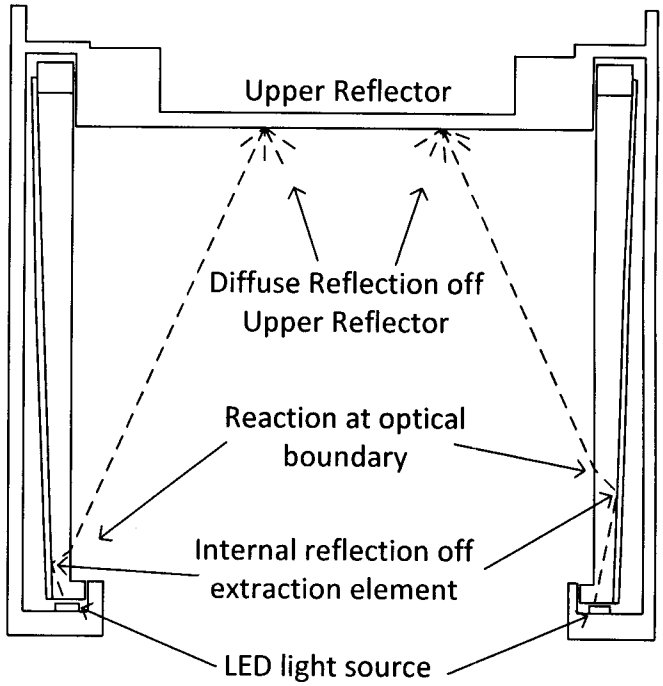

FIG. 5B

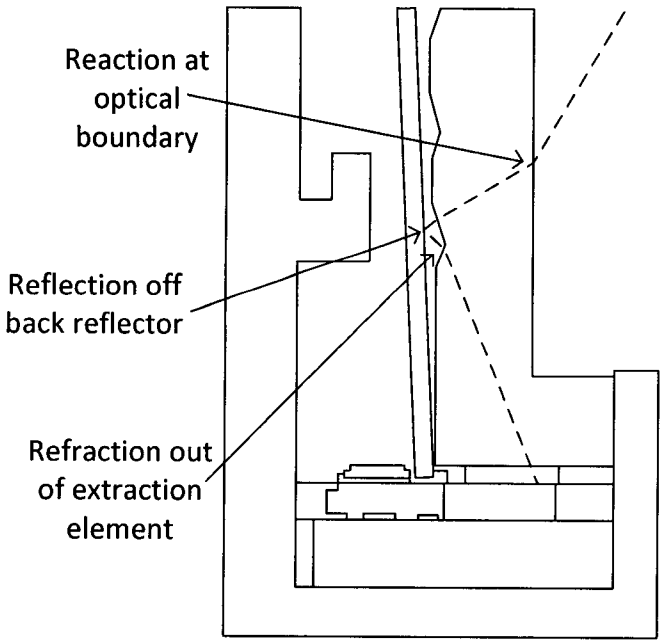

FIG. 6A

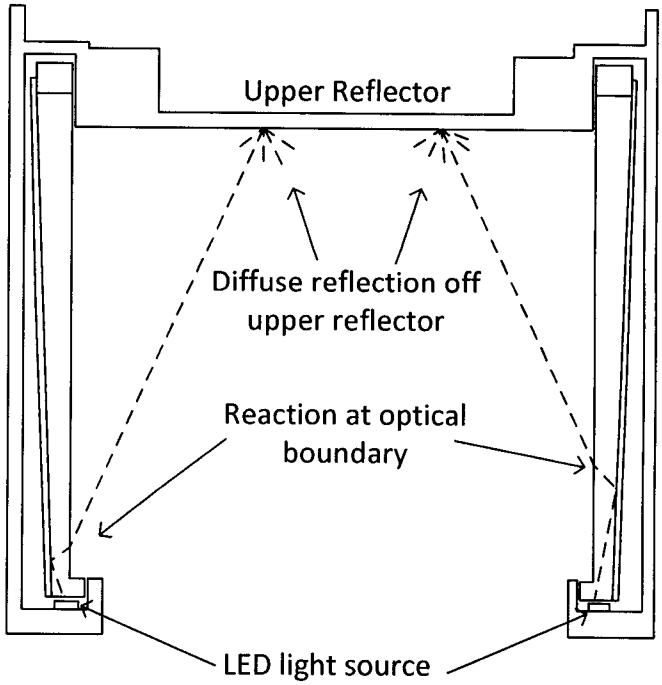

FIG. B

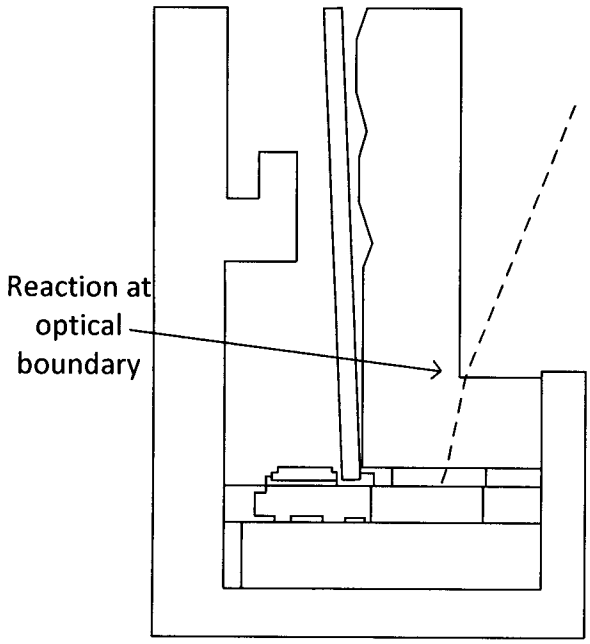

FIG. 7A

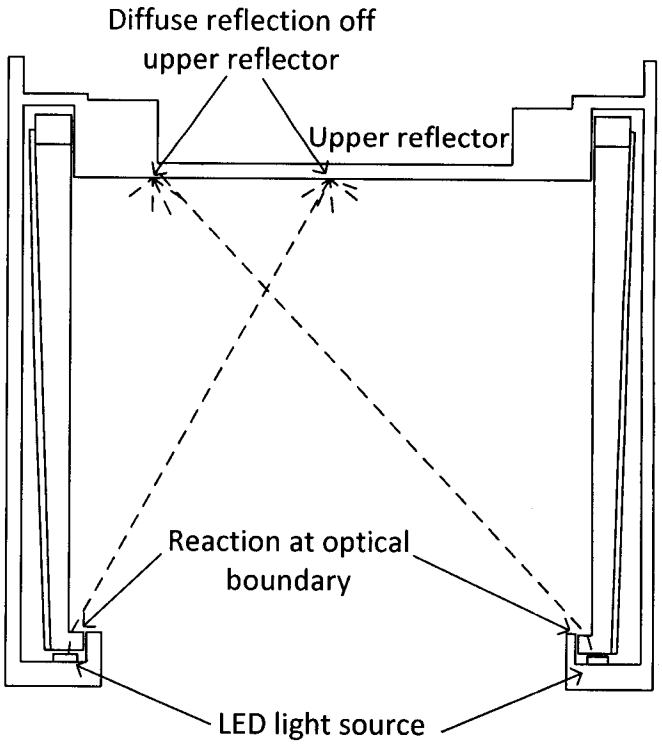

FIG. 7B

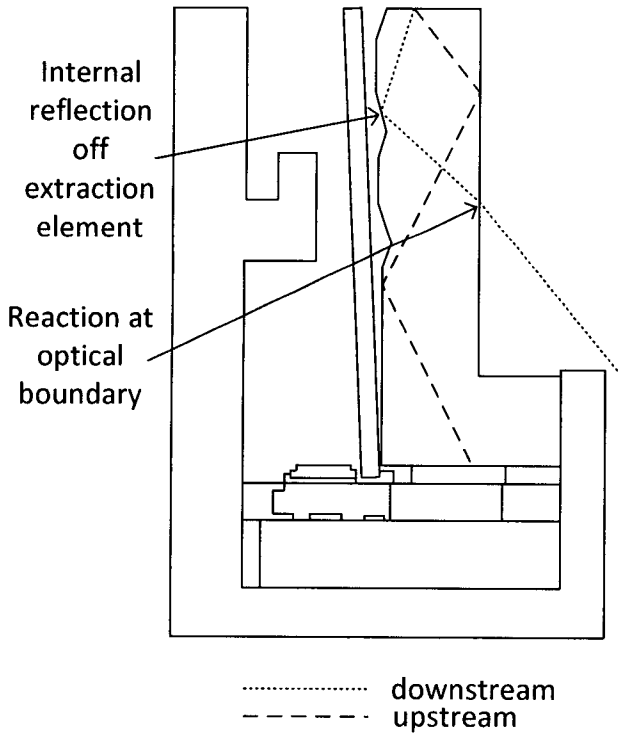

FIG. 8A

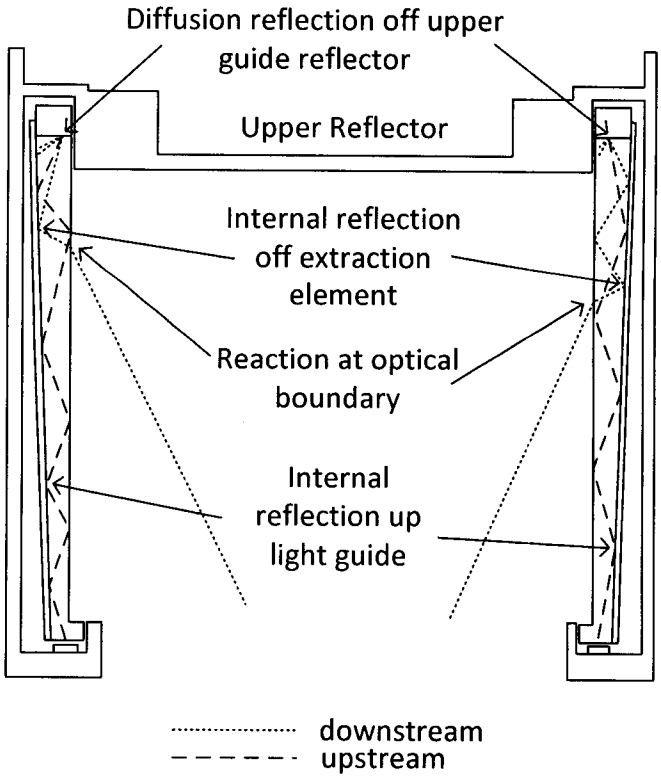

FIG. 8B

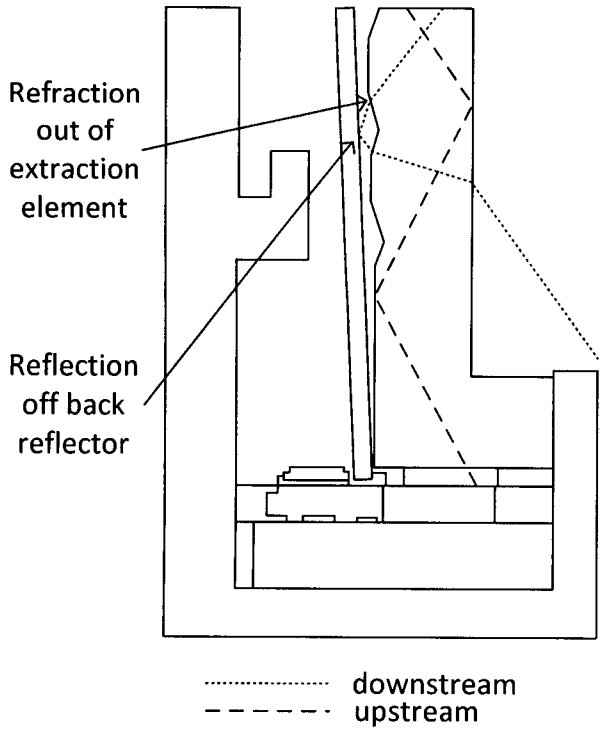

FIG. 9A

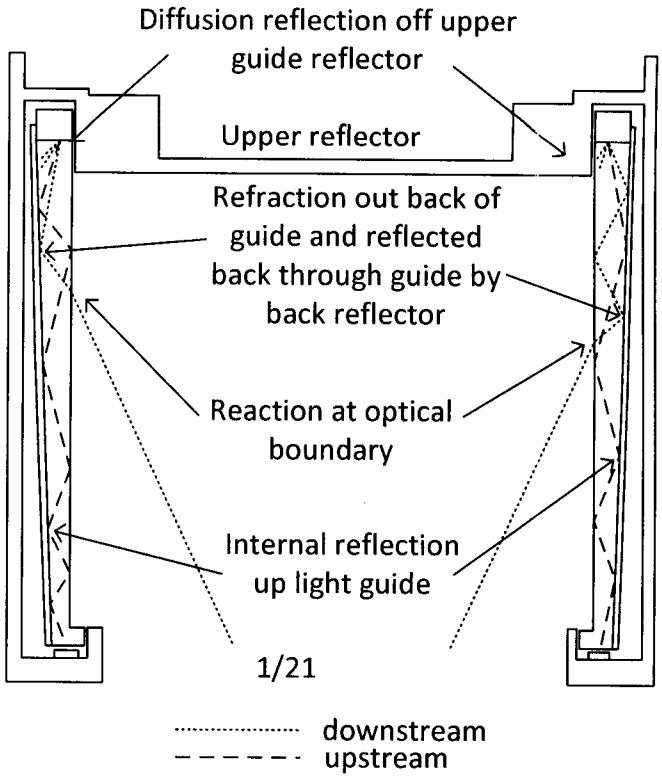

FIG. 9B

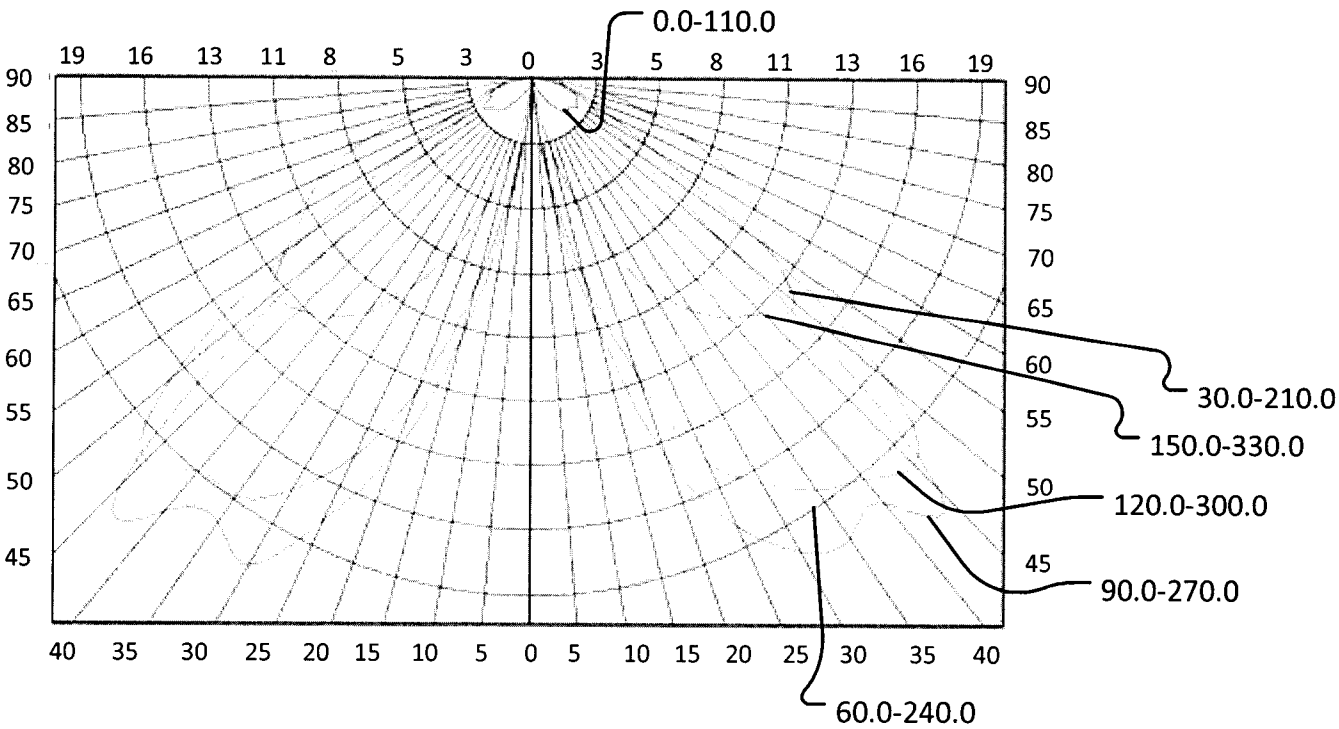

FIG. 10

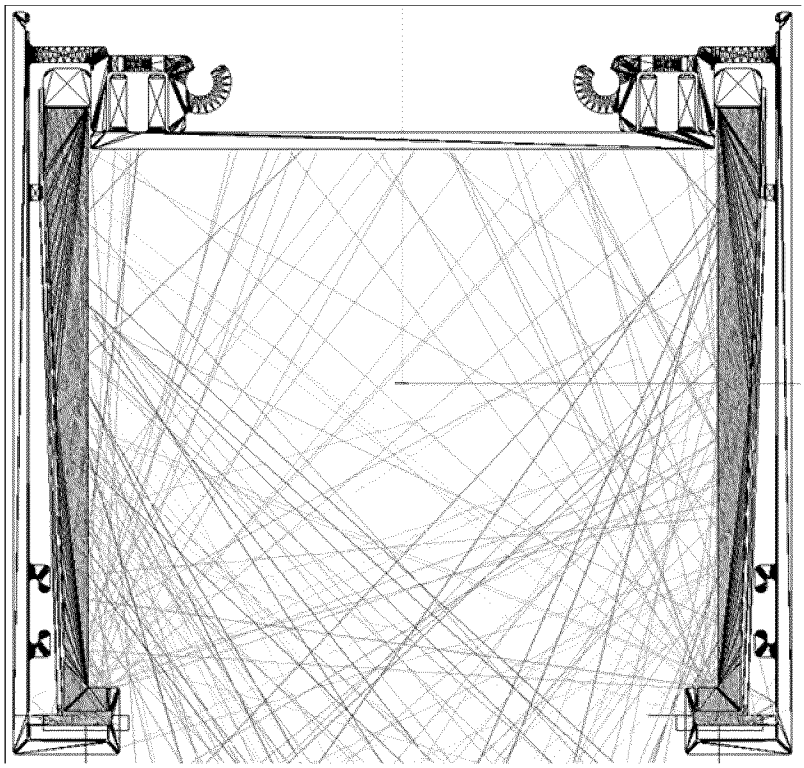

FIG. 11

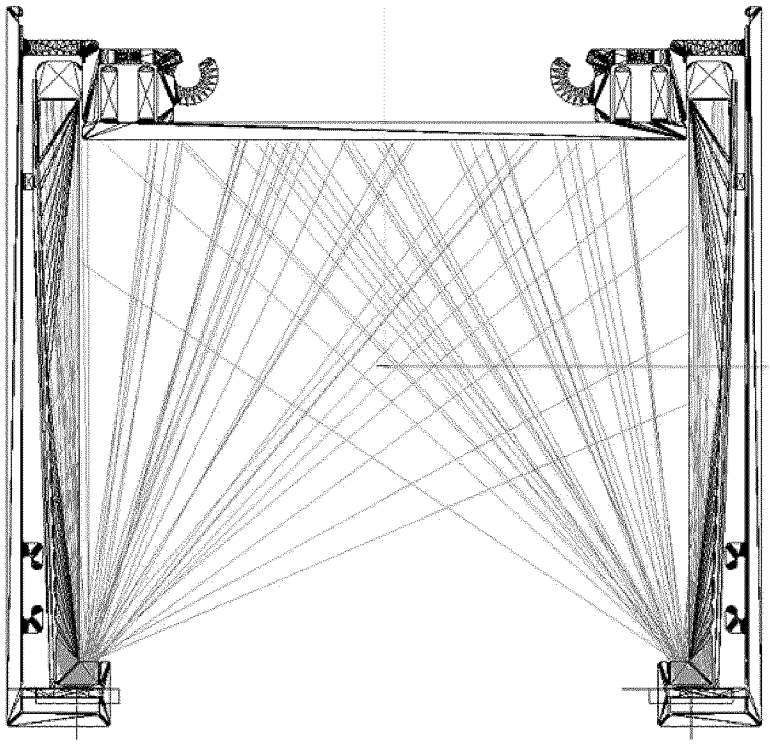

FIG. 12

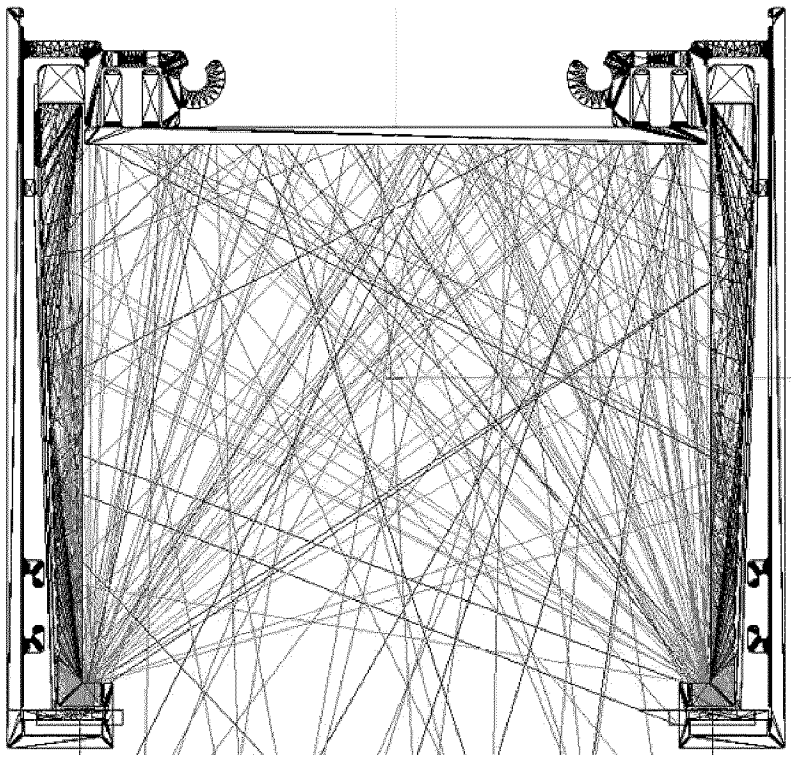

FIG. 13

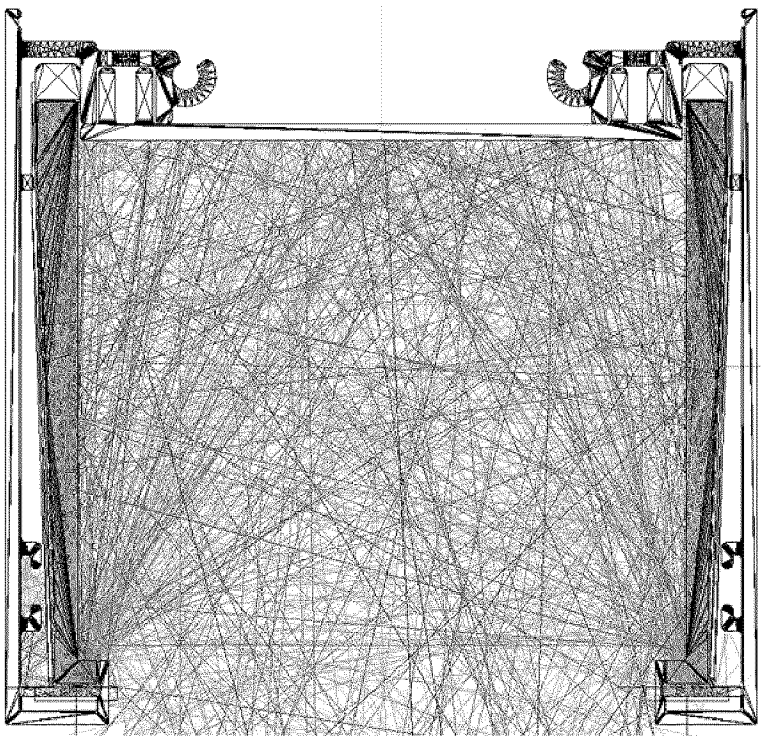

FIG. 14

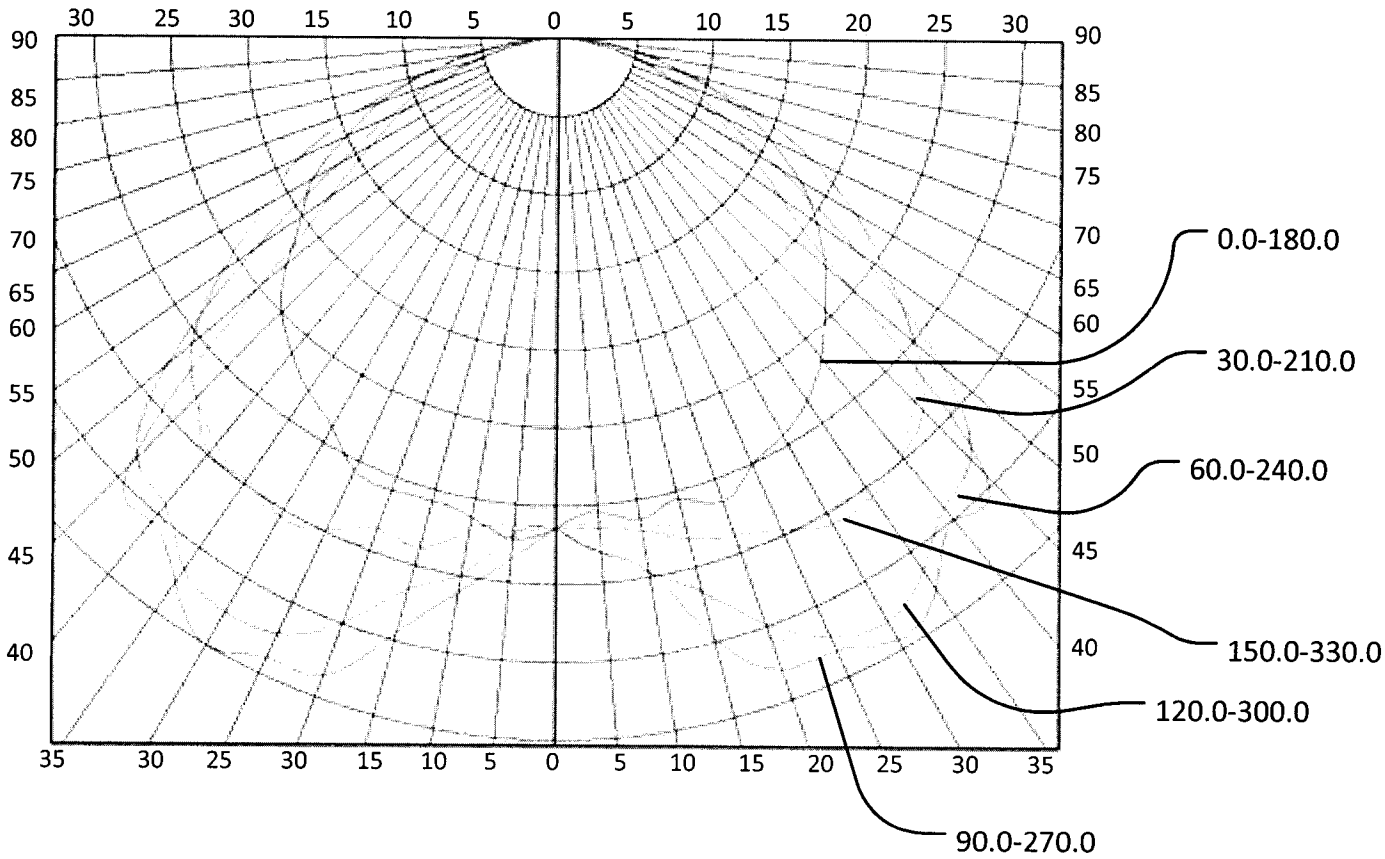
30 25 30 15 10 5 0 5 10 15 20 25 30
90
85
80
75
70
65
60
55
50
45
40
35 30 25 30 15 10 5 0 5 10 15 20 25 30 35
0.0-180.0
30.0-210.0
60.0-240.0
150.0-330.0
120.0-300.0
90.0-270.0

FIG. 15

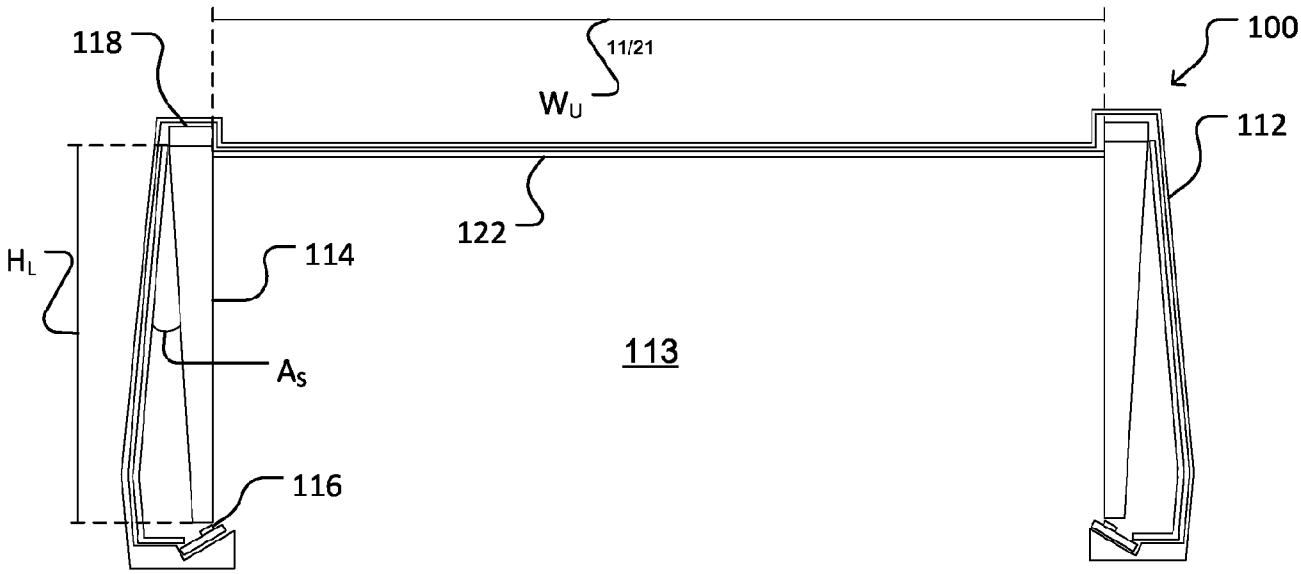
118
11/21
W_U
100
112
122
H_L
114
A_S
113
116

Fig. 16

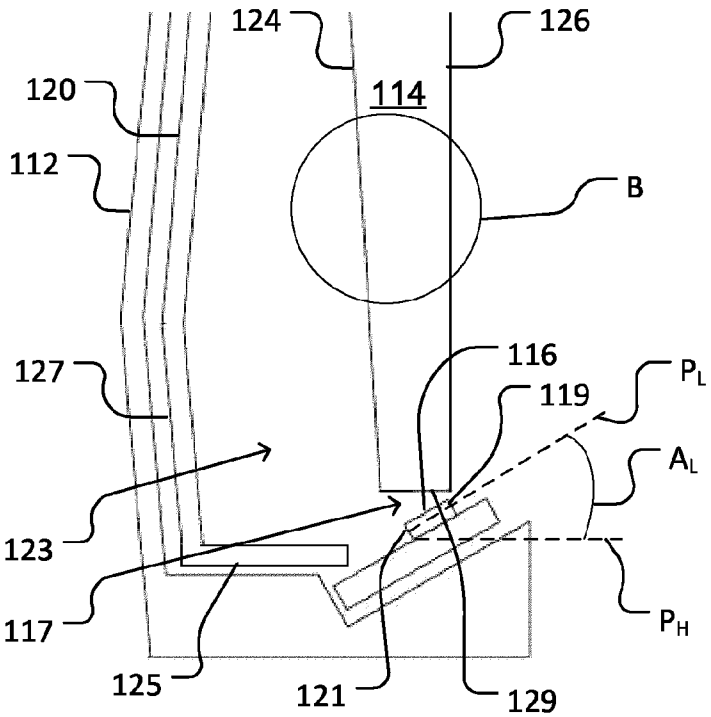
124
126
120
114
112
B
127
116
P_L
119
A_L
123
117
P_H
125
121
129

Fig. 17

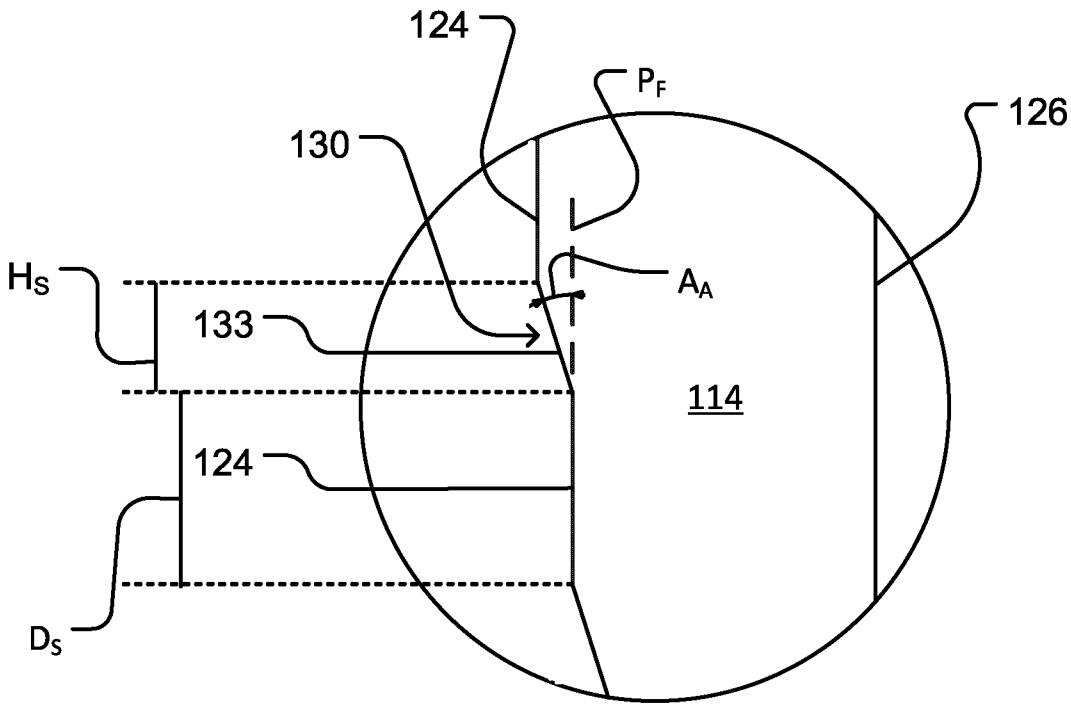

Fig. 18

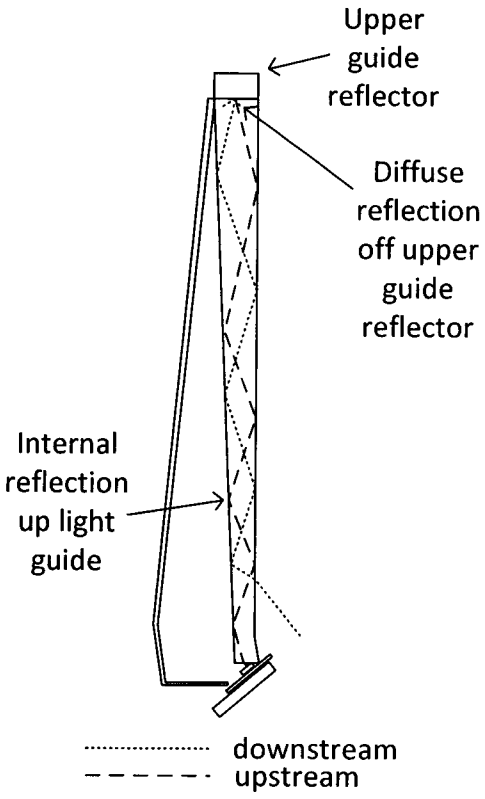

FIG. 19A

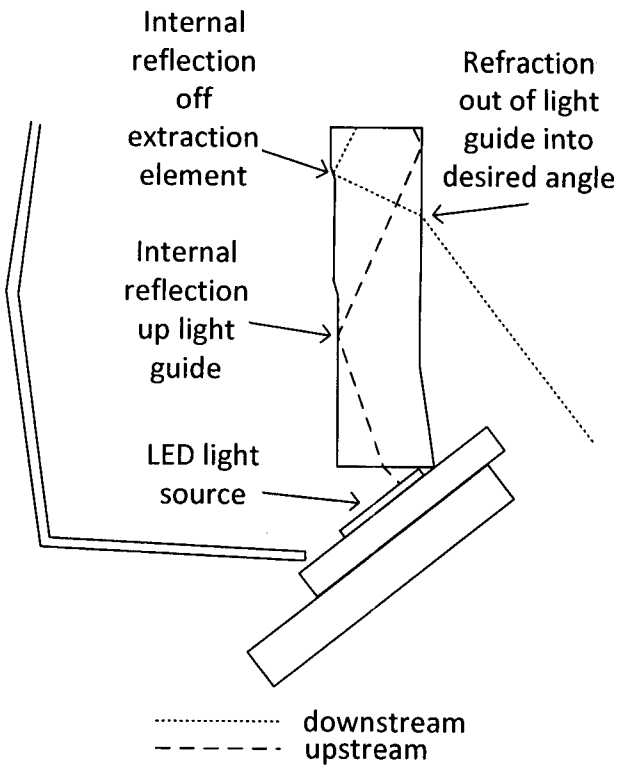

FIG. 19B

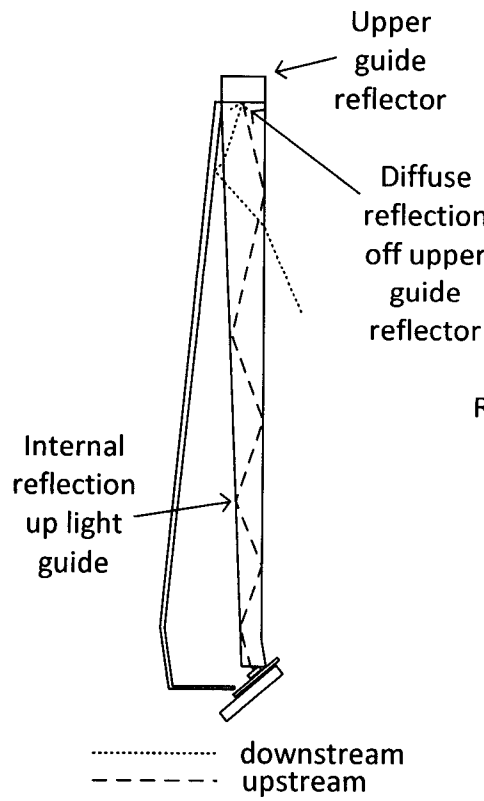

FIG. 20A

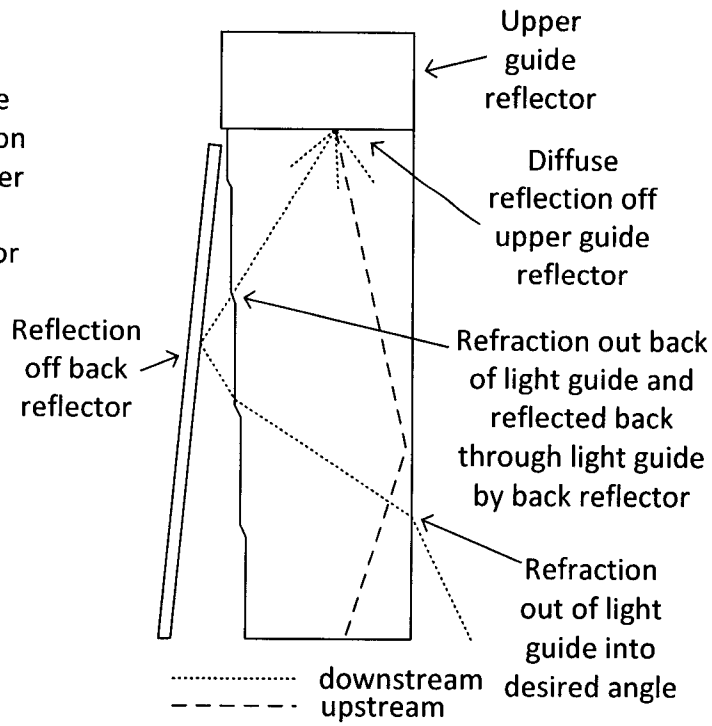

FIG. 20B

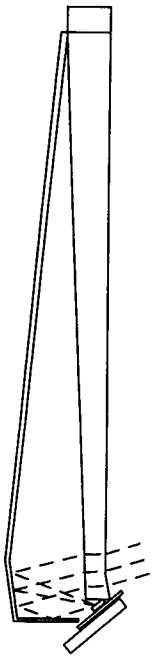

FIG. 21A

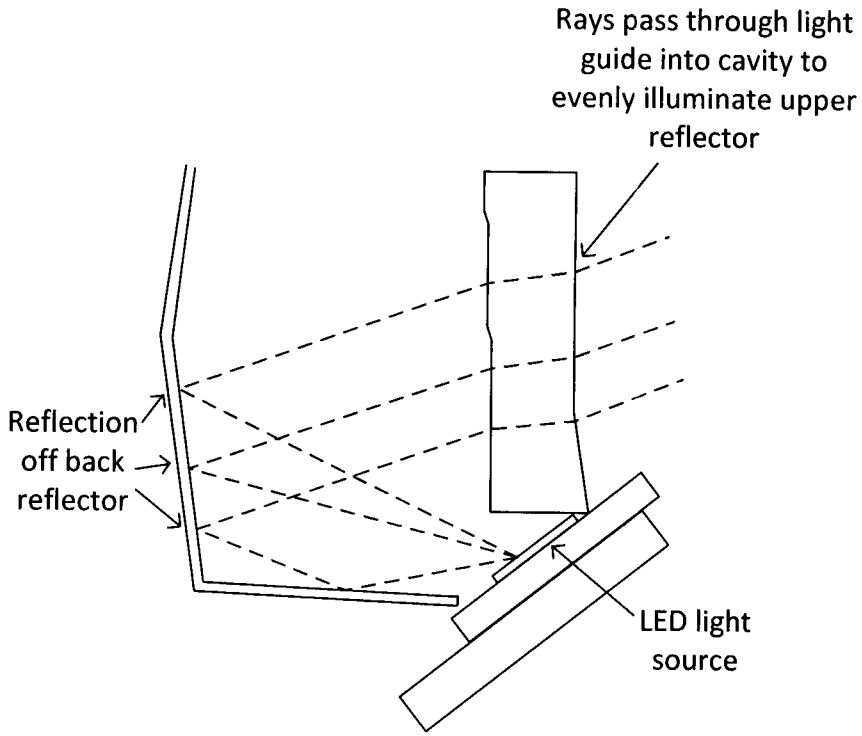

FIG. 21B

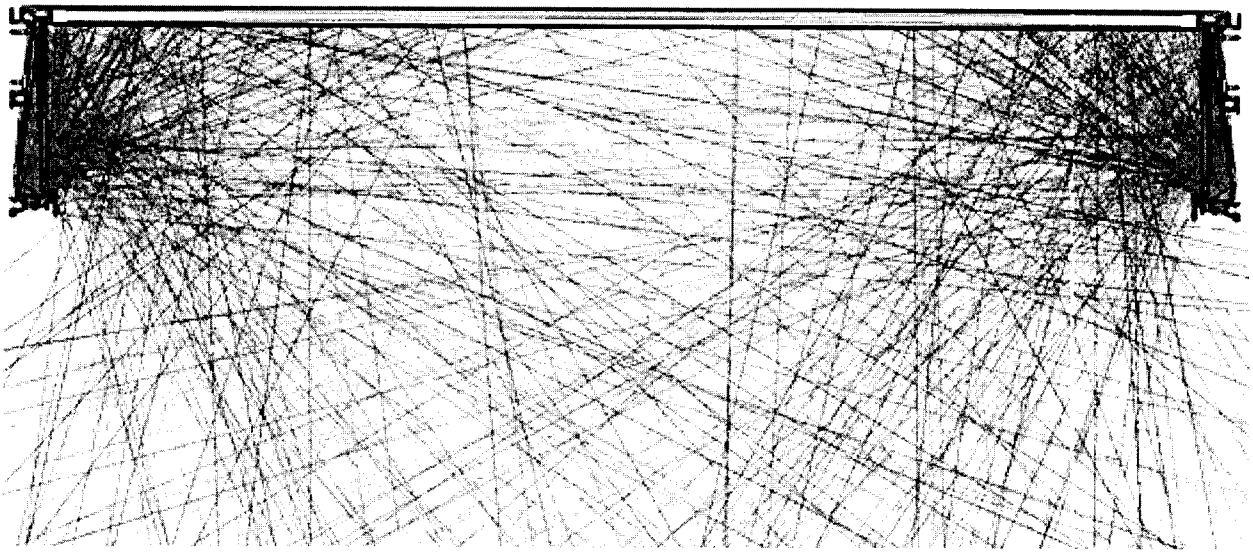

FIG. 22

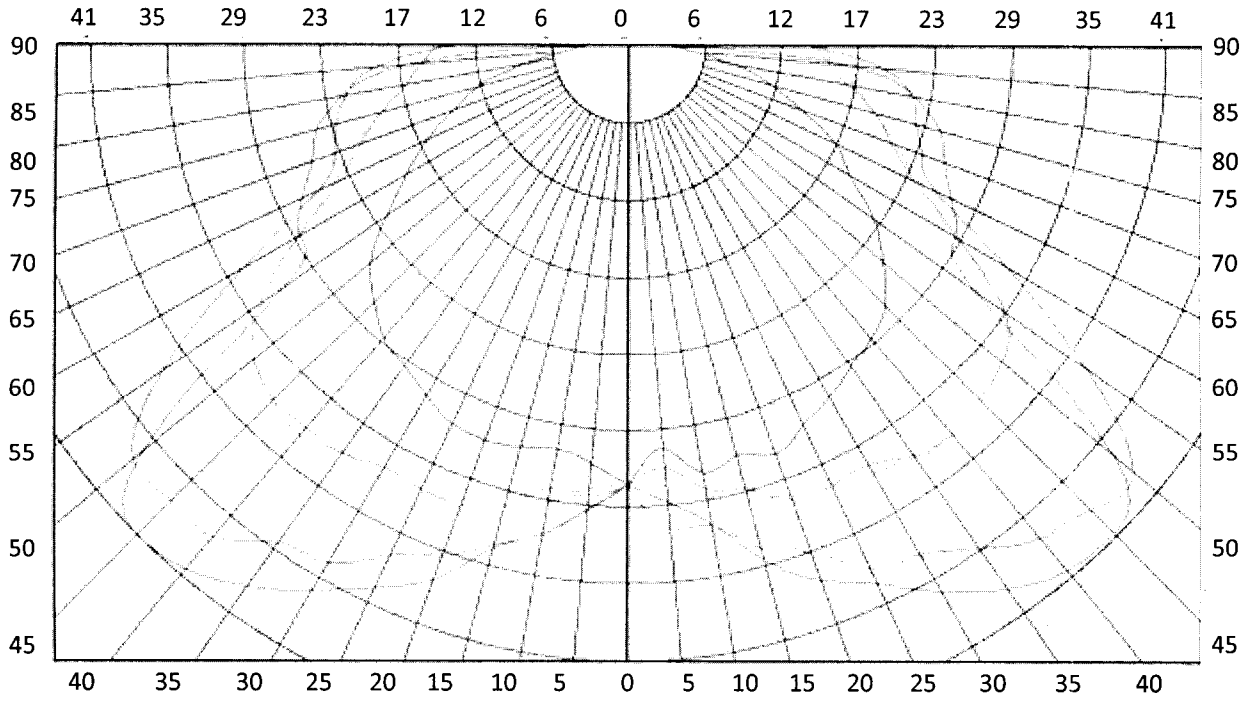
41 35 29 23 17 12 6 0 6 12 17 23 29 35 41
90 85 80 75 70 65 60 55 50 45
40 35 30 25 20 15 10 5 0 5 10 15 20 25 30 35 40

FIG. 23

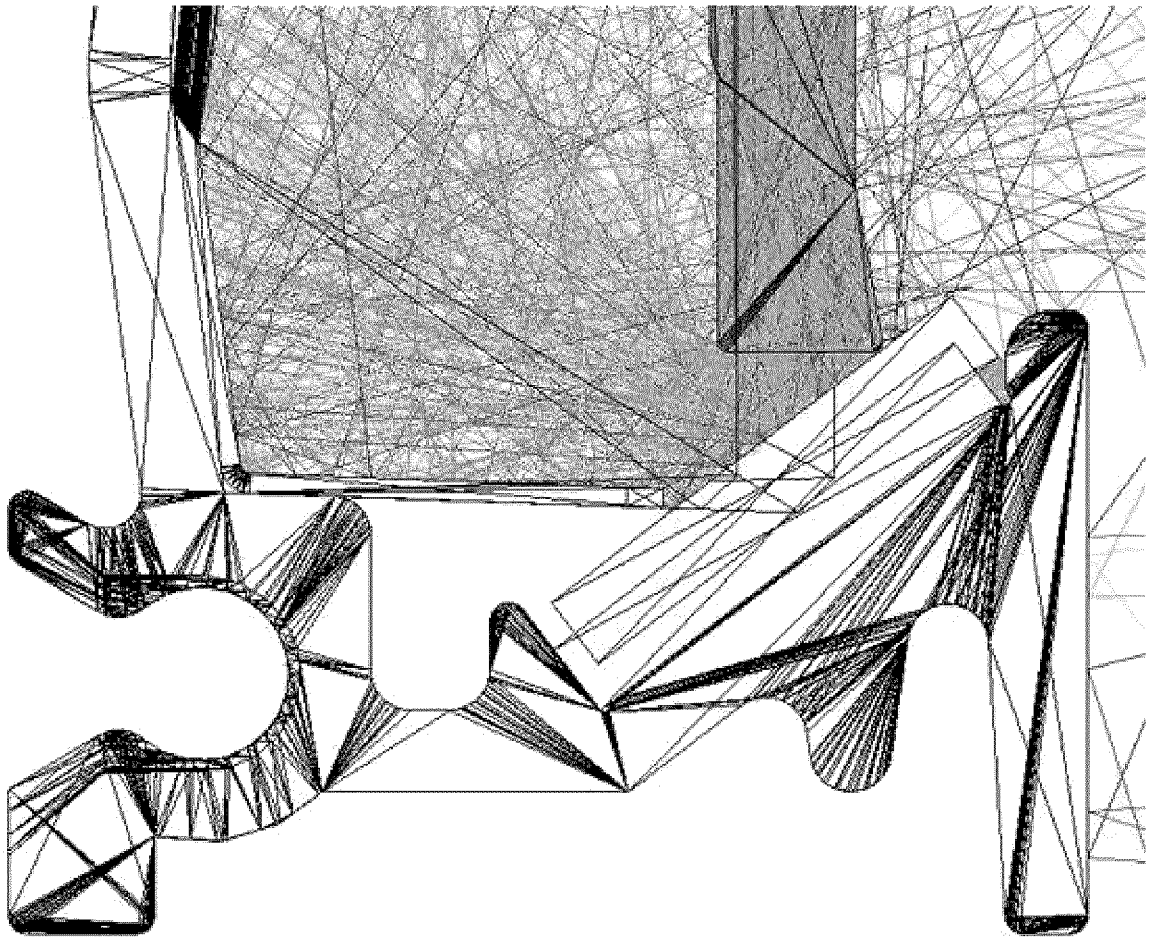

FIG. 24

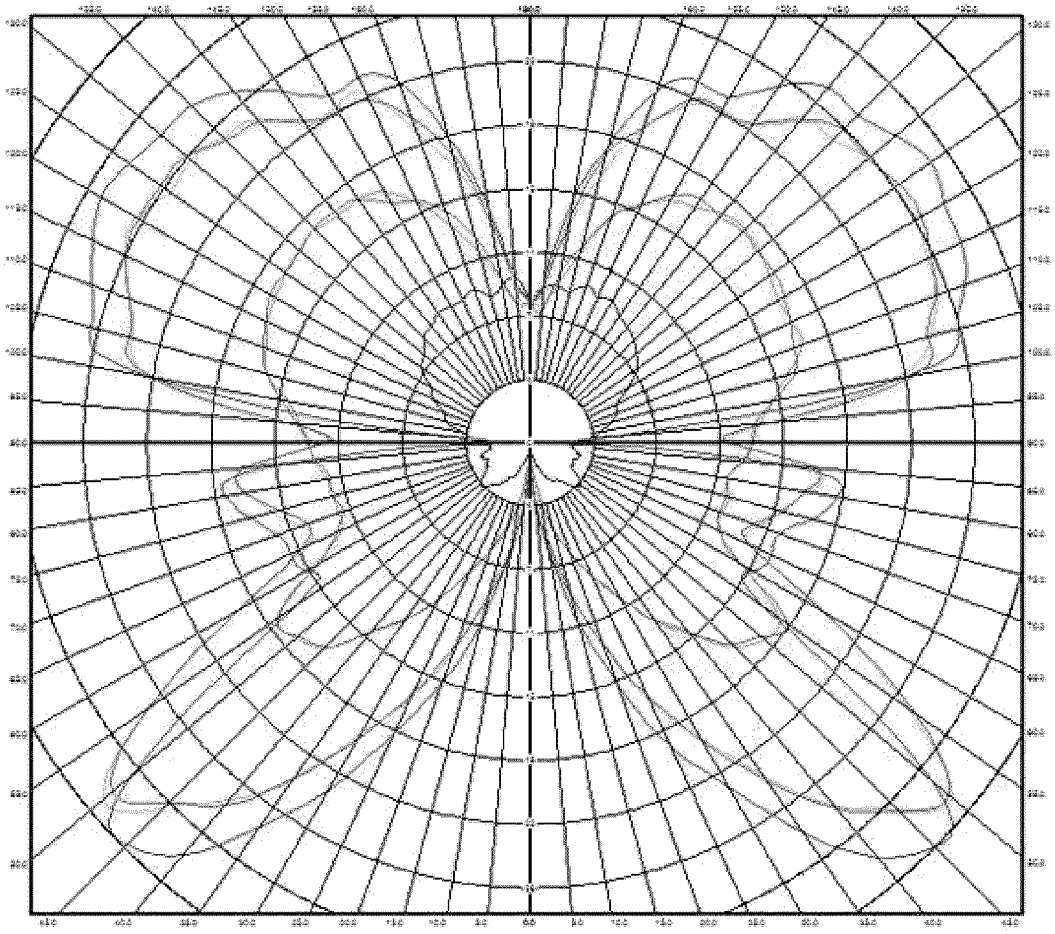

FIG. 25

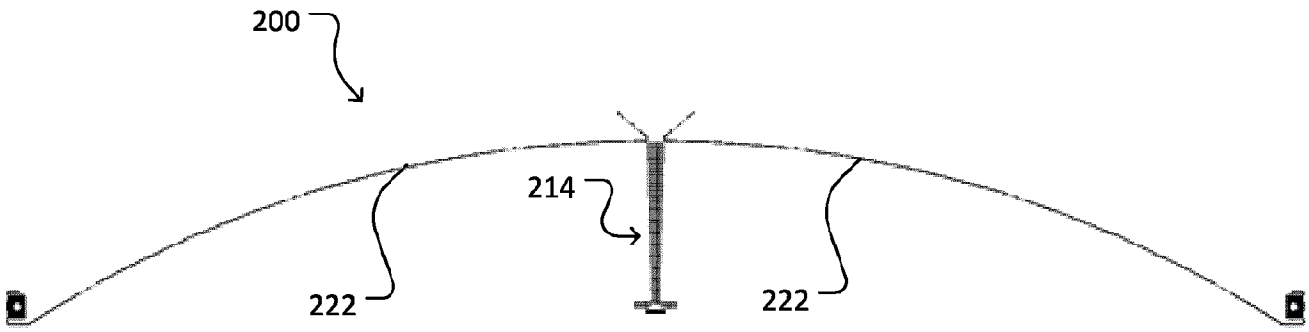

FIG. 26

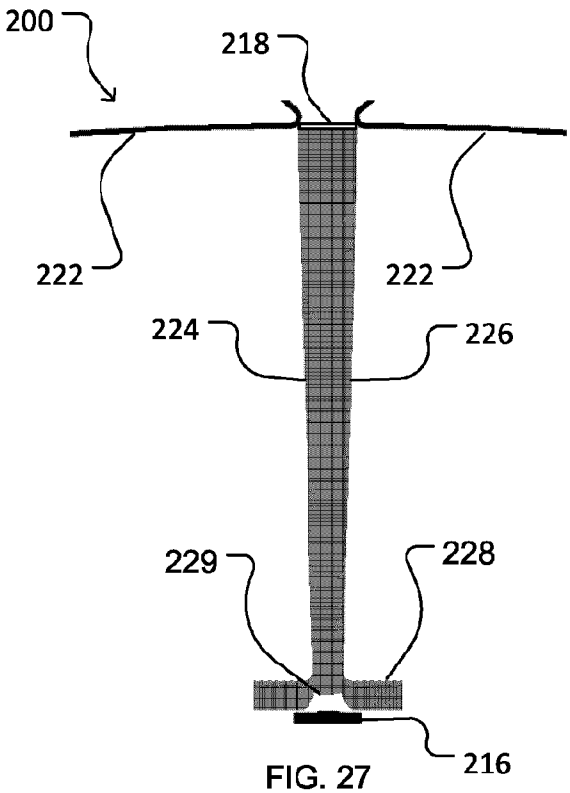

FIG. 27

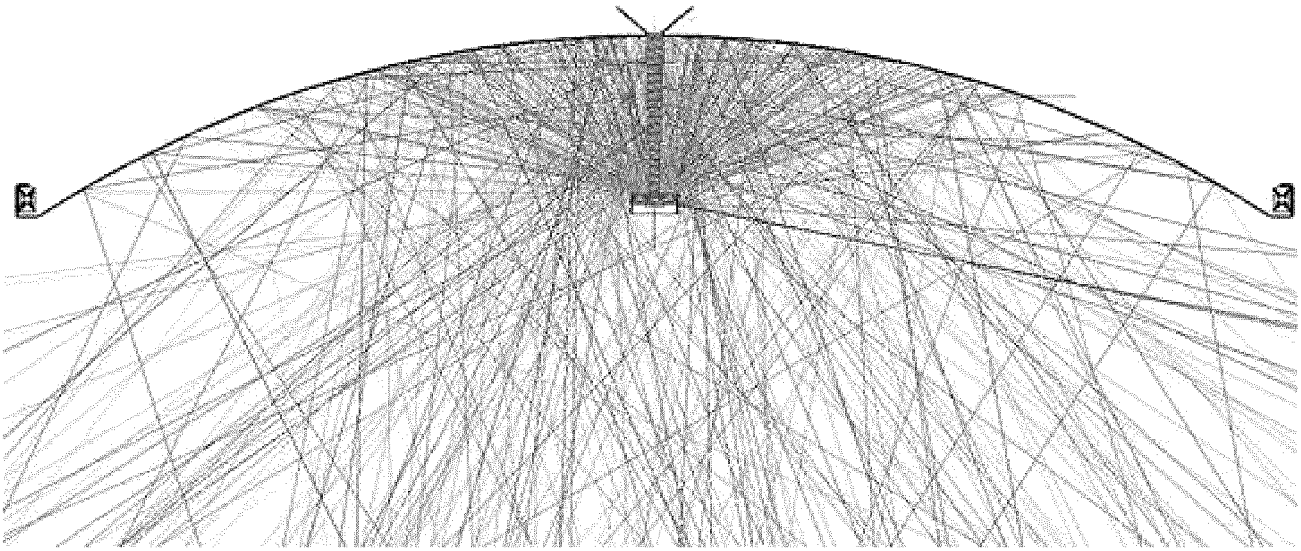

FIG. 28

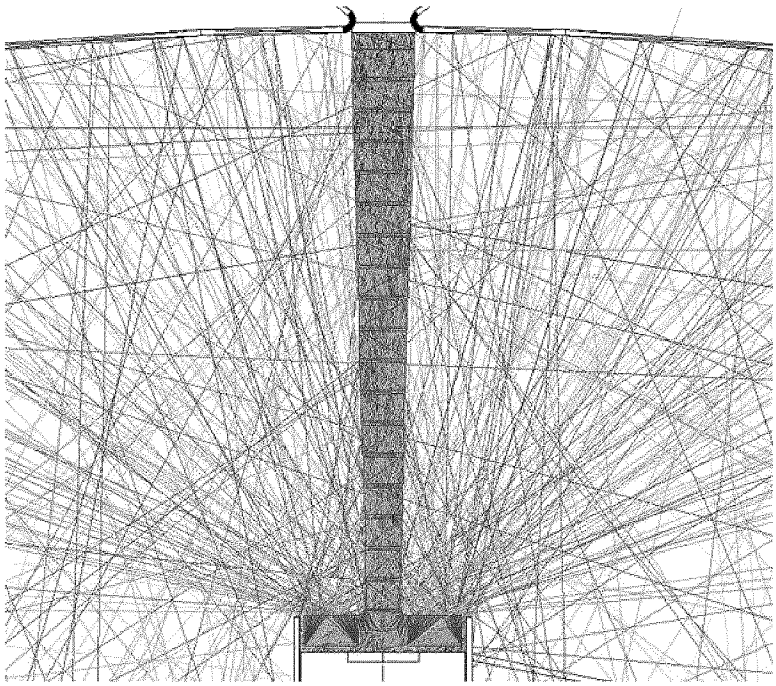

FIG. 29

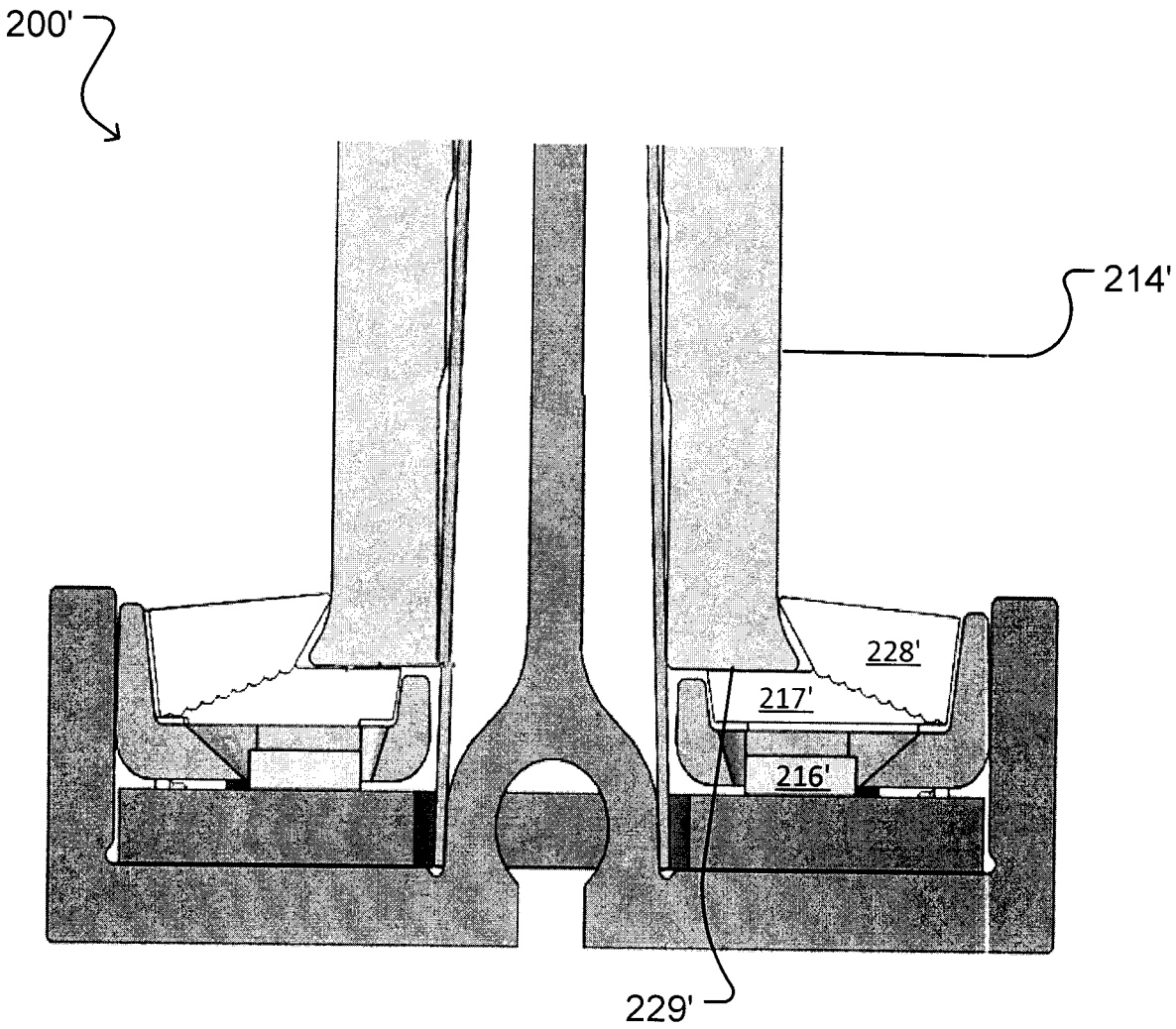

FIG. 30(a)

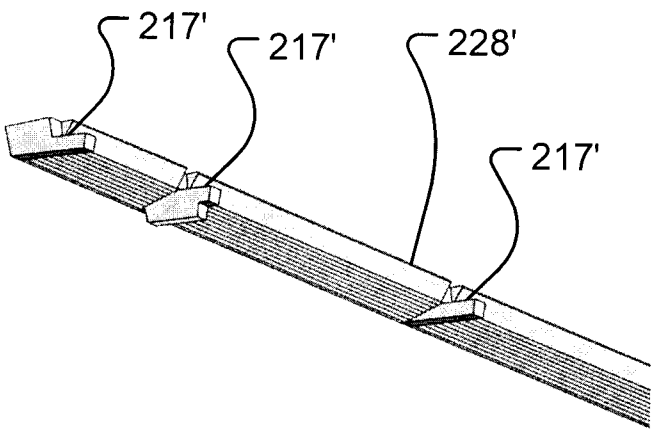

FIG. 30(b)

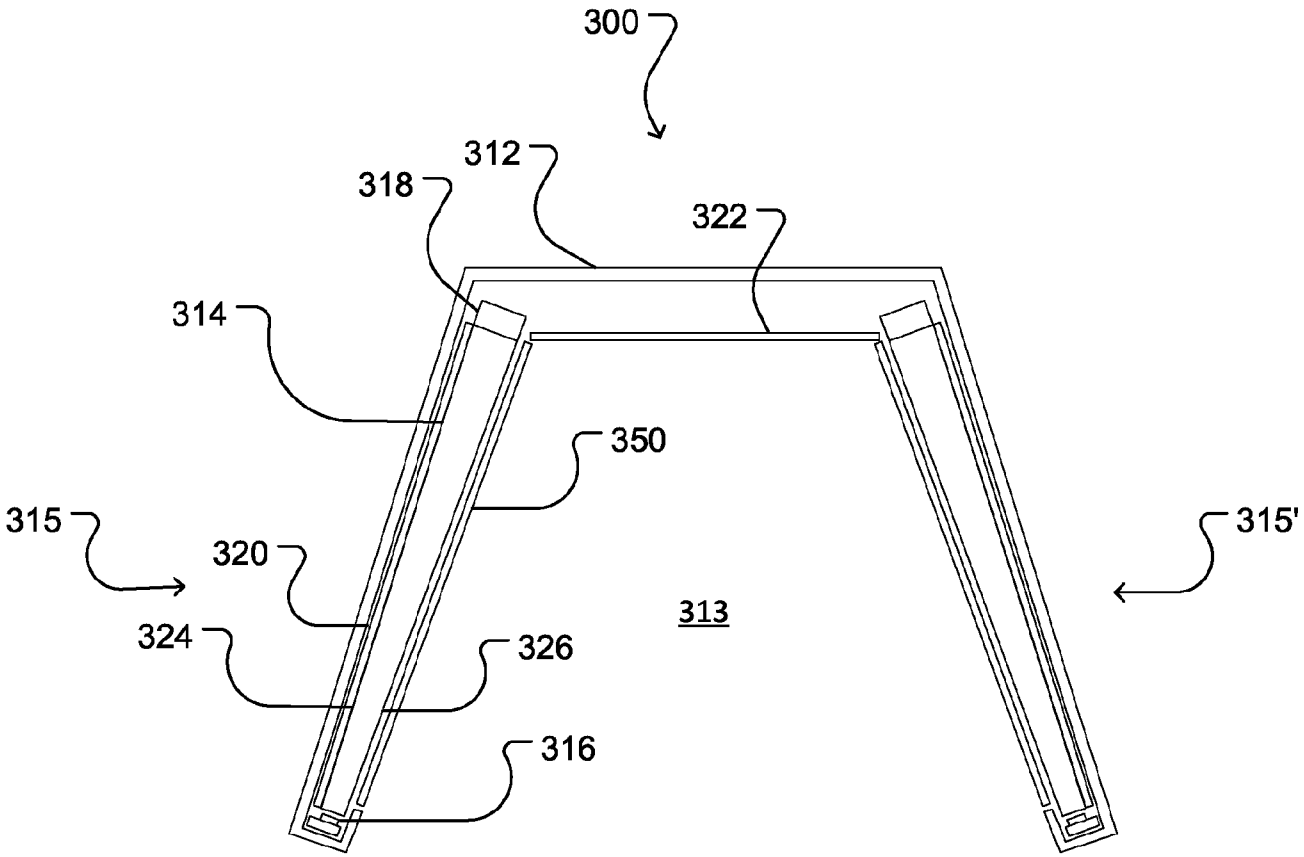

FIG. 31

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2016/050536

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***F21V 8/00*** (2006.01), ***F21V 7/00*** (2006.01), ***G02B 6/10*** (2006.01), *F21K 9/00* (2016.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: **F21V 8/00 , F21V 7/00, G02B 6/10 , F21K 9/00**

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
FAM PAT (QUESTEL ORBIT)
CANADIAN PATENT DATA BASE (INTELLECT)
Keywords: panel, guide, extraction, extract, deflection

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages		Relevant to claim No.
A	US 2014/0140084 A1 (ZWICK, H) The entire document	22 May 2014 (22-05-2014)	1 to 47
A	CA 2702685 A1 (COLEMAN, Z. et al.) The entire document	01 November 2010 (01-11-2010)	1 to 47
A	WO 2005/114045 A1 (HAMADA, T. et al.) The entire document	01 December 2005 (01-12-2005)	1 to 47
A	WO 2012/075352 A1 (THOMSON, D. S. et al.) The entire document	07 June 2012 (07-06-2012)	1 to 47
A	WO 2010/149583 A1 (KROLL, B. et al.) The entire document	29 December 2010 (29-12-2010)	1 to 47

☐ Further documents are listed in the continuation of Box C.

☑ See patent family annex.

*	Special categories of cited documents:
"A"	document defining the general state of the art which is not considered to be of particular relevance
"E"	earlier application or patent but published on or after the international filing date
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O"	document referring to an oral disclosure, use, exhibition or other means
"P"	document published prior to the international filing date but later than the priority date claimed
"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&"	document member of the same patent family

Date of the actual completion of the international search 04 August 2016 (04-08-2016)	Date of mailing of the international search report 12 August 2016 (12-08-2016)
Name and mailing address of the ISA/CA Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 819-953-2476	Authorized officer Malgorzata Samborski (819) 639-7895

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CA2016/050536

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		US2012092750A1	19 April 2012 (19-04-2012)
		US8711466B2	29 April 2014 (29-04-2014)