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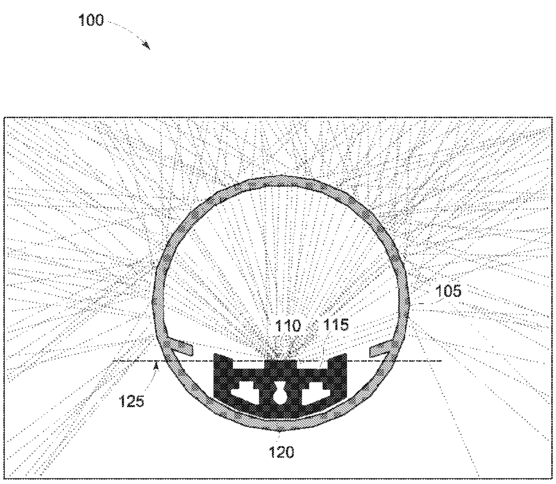

FIG. 1

(57) Abstract: An apparatus including a solid state light source emitting light therefrom in a direction away from a horizontal plane containing the solid state light source; and optics disposed adjacent to and above the solid state light source to reflect, utilizing total internal reflection (TIR) mechanisms, at least a portion of the light emitted from the solid state light source below the horizontal plane containing the solid state light source.

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METHOD AND SYSTEM FOR LED LAMP INCORPORATING INTERNAL OPTICS FOR EXTENDED LIGHT DISTRIBUTION

BACKGROUND

[0001] Tubular-shaped fluorescent lamps are well known. Their omni-directional light distribution is also well-known, expected, and favored by a great many people. Solid state light sources are increasing being used to replace fluorescent lamps. However, solid state light sources typical project light in a relatively directional manner. While replacement for fluorescent lamps have been previously proposed, the light therefrom is not typically omni-directional in nature.

[0002] Therefore, it would be desirable to provide improved methods and apparatus for efficiently providing a replacement lamp having a solid state light source that substantially replicates the light output exhibited by a traditional fluorescent lamp.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] Features and advantages of some embodiments of the present invention, and the manner in which the same are accomplished, will become more readily apparent upon consideration of the following detailed description of the invention taken in conjunction with the accompanying drawings, wherein:

[0004] FIG. 1 is an illustrative cross-sectional view of a tube lamp;

[0005] FIG. 2 is a cross-sectional view of a tube lamp having internal optics, according to some embodiments herein;

[0006] FIG. 3 is a detailed view of a cross-section of a tube lamp having internal optics, in accordance with some embodiments herein;

[0007] FIG. 4 is a cross-sectional view of another tube lamp having internal optics, in accordance with some embodiments herein;

[0008] FIG. 5 is cross-sectional view of yet another tube lamp having internal optics, according to one embodiment herein;

[0009] FIG. 6 is a cross-sectional view of a tube lamp having internal optics side illustrating component dimensions, according to some embodiments herein;

[0010] FIG. 7 is a cross-sectional view of another tube lamp having internal optics side illustrating component dimensions, according to some embodiments herein;

[0011] FIG. 8 is an optical distribution chart, according to some embodiments herein;

[0012] FIG. 9 is an efficiency plot, according to some embodiments herein;

[0013] FIG. 10 is a spill intensity plot, according to some embodiments herein;

[0014] FIG. 11 is a spill intensity plot, according to some embodiments herein;

[0015] FIG. 12 is an illustrative depiction of an apparatus, including a reference coordinate system, in accordance with some aspects and embodiments herein; and

[0016] FIG. 13 is an illustrative depiction of a light distribution plot, including a reference coordinate system, for an apparatus in accordance with some aspects and embodiments herein.

DETAILED DESCRIPTION

[0017] FIG. 1 is an illustrative diagram of a cross-sectional view of a LED tube lamp 100. The lamp shown in FIG. 1 may be designated as a replacement of a T8 fluorescent lamp based on its construction and configuration, as understood by those knowledgeable and skilled in the art of lighting. Lamp 100 is an illustrative depiction of a known replacement fluorescent tube lamp. Lamp 100 includes a tube-shape diffuser 105, a light emitting diode (LED) light source 110 that is connected to a printed circuit board (PCB) 115. PCB 115 is supported by a heat dissipating structure or heat sink 120. LED 110, PCB 115, and heat sink 120 are located against an interior surface of diffuser wall 105 in a lower or bottom portion of the lamp, given the orientation of lamp 100. Of course, lamp 100 may be used in any orientation. As used herein, LED when employed singly, may also refer to a plurality or an array of light emitting diodes.

[0018] FIG. 1 also depicts simulated rays of light (not individually labeled) emanating from LED 110 when the LED is energized. As illustrated, light from LED 110 is relatively directional, directed outwards from a front-facing portion of the LED. In particular, very little to no light is directed below the horizontal plane 125 including the LED. The light from LED 100 travels in straight paths toward diffuser wall 105, exits, and distributes in, roughly, a lambertian pattern.

[0019] Given the directional nature of light from LED 110, the light distribution from lamp 100 is not omni-directional, as it may be in a lamp such as , for instance, a traditional fluorescent tube lamp. Accordingly, the light distribution from a solid state light source replacement lamp, such as but not limited to lamp 100, is not the same as or similar to the familiar traditional omni-directional, volumetric fill provided by a fluorescent tube lamp positioned within, for example, a troffer luminaire.

[0020] FIG. 2 is a cross-sectional view of a tube lamp 200 having internal optics, according to some embodiments herein. Lamp 200 includes a tubular-shape diffuser 205, a solid state light source 210 (e.g., a LED), a PCB 215 supporting the LED and providing an interface or electrical connections to an electrical energy source for energizing the LED, and a heat sink 220 in thermal communication with PCB 215. As oriented , LED 210, PCB 215, and heat sink 220 are positioned at or near the bottom of the interior of diffuser 205. Lamp 200 further includes a pair of optics 225, 230 disposed within the diffuser. Optics 225 and 230 are positioned above the horizontal plane 235 containing the solid state light source 210. The term "optic" is generally synonymous with "optical element".

[0021] Optics 225 and 230 may comprise a one piece component in combination with diffuser 205 as shown in FIG. 2. Such a configuration may facilitate an efficient manufacturing process. In some embodiments, optics 225 and 230 may comprise more than one piece component, for example two components entirely separate from diffuser 205. In some instances, optics 225 and 230 may be discrete component(s) separate from other components of the lamp or integral to, at least in part, some of the other components of the lamp. Per FIG. 2, optics 225 and 230 are shown as one piece with the diffuser.

[0022] In some aspects, the optics herein may be constructed of a plastic, such as a polycarbonate, polymethyl methacrylate (PMMA), glass, and other natural and synthetic materials, without limit or loss of generality.

[0023] Inclusion of optics 225 and 230 in lamp 200 alter or redirect the pathway of the light illuminated from solid state light source 210, as illustrated by the simulated representative light rays shown in FIG. 2. As shown, optics 225 and 230 are internal (completely) to lamp 200. Furthermore, optics 225 and 230 reflect light rays incident thereupon below the equator of the lamp. Rays of light incident upon optics 225 and 230 on either side of LED 210 encounter a vertical face of the optics 227, 232 and is refracted to a certain extent. The refracted light continues through the body of the optical element until the light rays encounter the horizontal face 229, 234, where the light rays will be reflected by virtue of total internal reflection mechanisms (TIR) below the horizon 235 of the LED if incident upon the horizontal face 229, 234 at an angle greater than a critical angle as determined by the material of the internal optic 225, 230. The optics 225, 230 in FIG. 2 have approximately 90 degree or squared surfaces. Optics 225 and 230 include a single planar TIR feature (i.e., each of horizontal faces 229 and 234). However, the shape of the internal optics disclosed herein may vary, in accordance with other aspects herein.

[0024] FIG. 3 is a detailed view of a cross-section of a tube lamp 300 having internal optics, in accordance with some embodiments herein. Lamp 300 includes a diffuser 305 and an optic 310 located adjacent to one side of a solid state light source (not shown). The optic includes a vertical face 315 and a horizontal face 320, similar to the optics of FIG. 2. As shown, a light ray incident upon vertical face 315 may be refracted slightly and continue through the body of the optical element until encountering horizontal face 320. Also shown, light rays incident upon horizontal face 320 may be totally internally reflected such that the light rays pass through diffuser 305 at some point below the equator including the LED (not shown).

[0025] FIG. 4 is a cross-sectional view of another tube lamp 400 having internal optics, in accordance with some embodiments herein. Lamp 400 includes a tubular-shape diffuser 405, a solid state light source 410 (e.g., a LED), a PCB 415 supporting the LED and providing electrical connections to an electrical energy source for energizing the LED, and a heat sink 420 in thermal communication with PCB 415. As oriented, LED 410, PCB 415, and heat sink 420 are positioned at or near the bottom of the interior of diffuser 405. Lamp 400 includes a pair of optics 435, 460 disposed within the diffuser. Optics 435 and 460 are positioned above the horizontal plane (not separately labeled, but in a similar general position as plane 235 in FIG. 2), containing the solid state light source 410.

[0026] Optics 435 and 460 may comprise a one piece component in combination with diffuser 405 as shown in FIG. 4, although it is not limited to such a construction. As shown in FIG. 4, optics 435 and 460 each includes a vertical face (e.g., 465, 470) and a horizontal face (e.g., 455, 475) adjacent thereto and forming a juncture with the vertical face. The juncture may comprise a vertex of about 90°. Optics 435 and 460 also each includes a triangular-shaped extension on the horizontal face thereof. The triangular-shaped extension includes two (2) facets, although more may be included in some embodiments. Optic 435 includes facets 425 and 430 and optic 460 includes facets 445 and 450. As illustrated by the simulated light rays of FIG. 4, optics 435 and 460 placed adjacent to LED 410 operate to alter the light incident thereupon to reflect at least a portion of the incident light below the equator of the LED. In some aspects, the multiple facets of optics 435 and 460 serve to cast at least a portion of the incident light at a higher vertical angle (i.e., lower in FIG. 4, backwards towards the bottom of diffuser 405). Optics 435 and 460 include an example of a multiple facet total-internal-reflection (TIR) optical element.

[0027] FIG. 5 is a cross-sectional view of another tube lamp 500 having internal optics, in accordance with some embodiments herein. Lamp 500 includes a tubular-shape diffuser 505, a solid state light source 510 (e.g., a LED), a PCB 515 supporting the LED, and a heat sink 520 in thermal communication with PCB 515. As orientated, LED 510, PCB 515, and heat sink 520 are positioned at or near the bottom of the interior of diffuser 505. Lamp 500 includes a pair of optics 525 and 530 disposed within the diffuser. Optics 525 and 530 are positioned above the horizontal plane containing the solid state light source 510.

[0028] Optics 525 and 530 may comprise a one piece component in combination with diffuser 505 as shown in FIG. 5, although it is not limited to such a construction. As shown in FIG. 5, optics 525 and 530 each includes a vertical face (e.g., 555, 560) and adjacent thereto forming a juncture with the vertical face a face or surface including a first facet (e.g., 535, 545) and an extension that may be approximated by multiple facets (e.g., extension 540, 550). Although curved in appearance and shape, the extension may be approximated by a large number (e.g., > 24) of adjacent facets.

[0029] Optics 525 and 530 include an example of a curved TIR plane. As illustrated by the simulated light rays of FIG. 5, optics 525 and 530 placed adjacent to LED 510 operate to alter the light incident thereupon to reflect at least a portion of the incident light below the equator or horizontal plane of the LED. In some aspects, the curved extension surface of optics 525 and 530 serve to evenly cast or distribute at least a portion of the incident light at a higher vertical angle (i.e., lower in FIG. 4, backwards towards the bottom of diffuser 405), as compared to, for example, the lamps of FIGS. 2 and 4.

[0030] FIG. 6 is a cross-sectional view of a tube lamp 600 having internal optics, in accordance with some embodiments herein. Lamp 600 includes a tubular-shape diffuser 605, a solid state light source 610 (e.g., a LED), a PCB 615 supporting the LED, and a heat sink 620 in thermal communication with PCB 615. As oriented, LED 610, PCB 615, and heat sink 620 are positioned at or near the bottom of the interior of diffuser 605. Lamp 600 includes a pair of optics 625 and 630 disposed within the diffuser. Optics 625 and 630 are positioned above the horizontal plane containing the solid state light source 610.

[0031] FIG. 6 provides a reference of the dimensions that are used in some aspects herein. A "source width", SW, is shown and corresponds to the width of the solid state light source 610. As used herein, it is assumed that the solid state light source includes an array (e.g., a one dimensional linear array) of discrete light sources. A reflector width, W, refers to the measurement of the gap between the reflecting surfaces of the optics 625 and 630. A reflector height, H, refers to the measurement from the emitting face of the solid state light source to an apex of the optic. Additionally, dimensional ratios of a reflector height/source width (H/SW) and a reflector width/source width (W/SW) may be discussed herein. The ratio "H/SW" is also referred to as "height ratio", and the ratio "W/SW" is also referred to as the "width ratio".

[0032] FIG. 7 is a cross-sectional view of a tube lamp 700 having internal optics, in accordance with some embodiments herein. Lamp 700 is similar in configuration in many aspects to lamp 600. Accordingly, the diffuser, solid state light source, PCB, and heat sink of FIG. 7 are not individually referenced since an understanding of same may be had by referencing FIG. 6. Lamp 700 includes a pair of optics 705 and 710 disposed within the diffuser. Optics 705 and 710 are positioned above the horizontal plane containing the solid state light source.

[0033] FIG. 7 provides an illustrative example of the reference dimensions for a lamp have the optics 705 and 710. Shown are the dimensions for the source width, SW; the reflector width, W; and the reflector height, H.

[0034] FIG. 8 is an optical distribution chart 800, according to some embodiments herein. In particular, optical distribution chart 800 illustrates a "spill intensity" metric, in accordance with some embodiments herein. As used herein, spill intensity is defined as the ratio of the intensity of light from the light source at an angle above the horizon (X°) to the peak intensity of light from the light source at 0°. This metric is used herein to approximate a measure of omni-directionality of a light source. Optical distribution chart 800 corresponds to a simulation using a lamp having optics such as those depicted in FIG. 6. That is, optical distribution chart 800 is representative of a lamp having a single plane TIR optic.

[0035] Note that vertical axis 820 in the direction of 815 is the 0° angle reference herein and horizontal axis 810 is considered 90° offset from the vertical axis. As illustrated, substantial spill light was observed in the area of 100° – 160°. As further shown, peak intensity was observed at 0°, as expected for a directional light source located at 805. Also observed was a significant distribution of light behind the light source located at 805 (i.e., above the horizontal axis 810 of FIG. 8). Regarding FIG. 8, the lamp therein exhibited an efficiency loss of 4%. In the following disclosure of an analysis related to the lamp of FIG. 8, the analysis will primarily concern the light distribution at 115° (825) and 135° (820).

[0036] FIG. 9 is an efficiency plot related to the lamp of FIG. 8 having a single TIR plane, according to some embodiments herein. FIGS. 2, 3, and 6 herein illustrate examples of a lamp having a single TIR plane (e.g., surface 229, 234 of FIG. 2; and surface 320 of FIG. 3). As illustrated, the observed efficiency loss response throughout the design space including optics with the noted height ratio (horizontal axis) and the width ratio (vertical axis) is about < 4% with respect to baseline simulations of a similar lamp that does not include the internal optics disclosed in some embodiments herein. This amount of efficiency loss is typically acceptable in the lighting industry. As a result, some embodiments herein with

Height Ratios between about 0.55 and 2.55 and Width Ratios between about 2.33 and 4.55 yield about <4% optical efficiency loss. This region is bounded by the border in FIG. 9.

[0037] FIG. 10 is a spill intensity plot related to the lamp of FIG. 8 having a single TIR plane, according to some embodiments herein. FIGS. 2, 3, and 6 herein illustrate examples of a lamp having a single TIR plane (e.g., surface 229, 234 of FIG. 2; and surface 320 of FIG. 3). As illustrated, the observed spill intensity response at 135° throughout the design space including optics with the noted height ratio (horizontal axis) and the width ratio (vertical axis) is greater than about 6%. The higher the spill intensity number, the greater the amount of light reflected back towards (i.e., behind) the light source. This represents a significant improvement over a replacement lamp without the internal optics disclosed here. As a result, some embodiments herein with Height Ratios between about 0.70 and about 2.55 and Width Ratios between about 2.33 and about 3.80 would yield about >6% improvement in spill intensity at an angle of 135° .

[0038] FIG. 11 is a spill intensity plot related to the lamp of FIG. 8 having a single TIR plane, according to some embodiment herein. FIGS. 2, 3, and 6 herein illustrate examples of a lamp having a single TIR plane (e.g., surface 229, 234 of FIG. 2; and surface 320 of FIG. 3). As illustrated, the observed spill intensity response at 115° throughout the design space including optics with the noted height ratio (horizontal axis) and the width ratio (vertical axis) is about > 25%. Hereto, the higher the spill intensity number, the greater the amount of light reflected back towards (i.e., behind) the light source. This represents a significant improvement over a replacement lamp without the internal optics disclosed here. As a result, some embodiments herein with Height Ratios between about 0.70 and about 2.55 and Width Ratios between about 2.33 and about 4.30 would yield about >25% improvement in spill intensity at an angle of 115° .

[0039] FIG. 12 is an illustrative depiction of an apparatus 1200 in accordance with some aspects and embodiments herein. The apparatus shown in FIG. 12 includes a solid state light source 1205. Axes of a coordinate system are depicted in FIG. 12 to further illustrate the coordinate system used herein when references are made to various planes and angles. FIG. 12 shows an axis 1210 coincident with the (horizontal) plane containing the solid state light source. FIG. 12 further includes an axis 1215 that is perpendicular to axis 1210. As referenced herein, axis 1215 is at 0° in the coordinate system and axis 1210 is at 90°. Angles greater than 90° are located behind the (horizontal) plane containing the solid state light source.

[0040] FIG. 13 is an illustrative depiction of a light distribution plot for an apparatus in accordance with some aspects and embodiments herein. The light distribution plot shown in FIG. 13 is representative of a light distribution pattern 1305 for a lamp apparatus embodiment herein having a solid state light source positioned at the center location of the plot. Axes of a coordinate system are depicted in FIG. 13 to further illustrate the coordinate system used herein when references are made to various planes and angles. FIG. 13 shows an axis 1310 coincident with the (horizontal) plane containing the solid state light source (not shown). FIG. 13 further includes an axis 1315 that is perpendicular to axis 1310. As referenced herein, axis 1315 is at 0° in the coordinate system and axis 1310 is at 90°. Angles greater than 90° are located behind the (horizontal) plane containing the solid state light source.

[0041] Embodiments have been described herein solely for the purpose of illustration. Persons skilled in the art will recognize from this description that embodiments are not limited to those described, but may be practiced with modifications and alterations limited only by the spirit and scope of the appended claims.

WHAT IS CLAIMED IS:

1. An apparatus comprising:

a solid state light source emitting light therefrom in a direction away from a horizontal plane containing the solid state light source; and

optics disposed adjacent to the solid state light source to reflect by total internal reflection (TIR) at least a portion of the light emitted from the solid state light source below the horizontal plane containing the solid state light source.

2. The apparatus of claim 1, further comprising a diffuser, wherein the optics are disposed internally within the diffuser.

3. The apparatus of any one of the preceding claims, comprising the optics disposed laterally adjacent to and above the solid state light source on both sides thereof.

4. The apparatus of claim 2, wherein the diffuser is tube-shaped.

5. The apparatus of any one of the preceding claims, wherein the optics comprise a unitary component.

6. The apparatus of any one of the preceding claims, wherein the optics comprise at least two discrete components.

7. The apparatus of any one of the preceding claims, wherein the optics comprise:

a first planar surface; and

a second planar surface adjacent to and forming a juncture with the first planar surface.

8. The apparatus of claim 7, wherein at least a portion of the light emitted from the solid state light source is reflected from the second planar surface by TIR.

9. The apparatus of claim 7, wherein the juncture comprises a vertex of about 90 degrees.

10. The apparatus of any one of the preceding claims, wherein the optics comprise:

a first planar surface; and

a second planar surface adjacent to and forming a juncture with the first planar surface, the second planar surface having a triangular extension thereon.

11. The apparatus of claim 10, wherein at least a portion of the light emitted from the solid state light source is reflected from the second planar surface by TIR.

12. The apparatus of any one of the preceding claims, wherein the optics comprise:

a first planar surface;

a first faceted surface adjacent to and forming a juncture with the first planar surface; and

a second faceted surface, the second faceted surface including a plurality of facets.

13. The apparatus of any one of the preceding claims, wherein the apparatus exhibits, during an operation thereof, an optical efficiency loss of about less than four percent.

14. The apparatus of any one of the preceding claims, wherein the apparatus exhibits, during an operation thereof, a spill intensity improvement of about greater than 6 percent, where the spill intensity is measured at about an angle of 135 degrees with respect to a reference angle of zero degrees that is perpendicular to the horizontal plane containing the solid state light source.

15. The apparatus of any one of the preceding claims, wherein the apparatus exhibits, during an operation thereof, a spill intensity improvement of about greater than 25 percent, where the spill intensity is measured at about an angle of 115 degrees with respect to a reference angle of zero degrees that is perpendicular to the horizontal plane containing the solid state light source.

16. The apparatus of any one of the preceding claims, further comprising an interface to an electrical energy source to energize the solid state light source.

17. The apparatus of any one of the preceding claims, wherein the solid state light source comprises a light emitting diode.

18. The apparatus of any one of the preceding claims, wherein the optics comprises a pair of discrete optic components, one each disposed on opposing sides adjacent to and above the solid state light source to reflect, utilizing TIR mechanisms, at least a portion of the light emitted from the solid state light source below the horizontal plane containing the solid state light source.

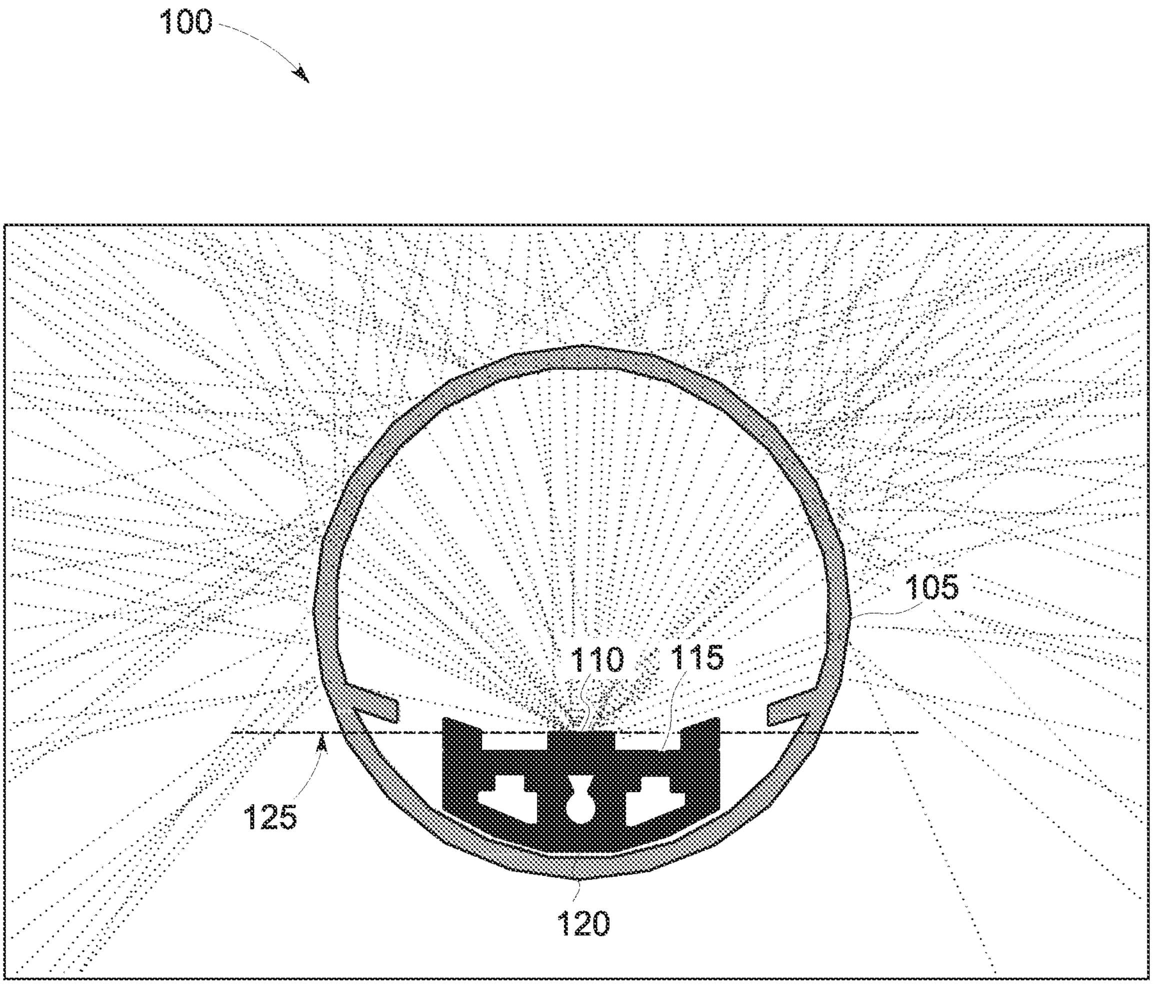


FIG. 1

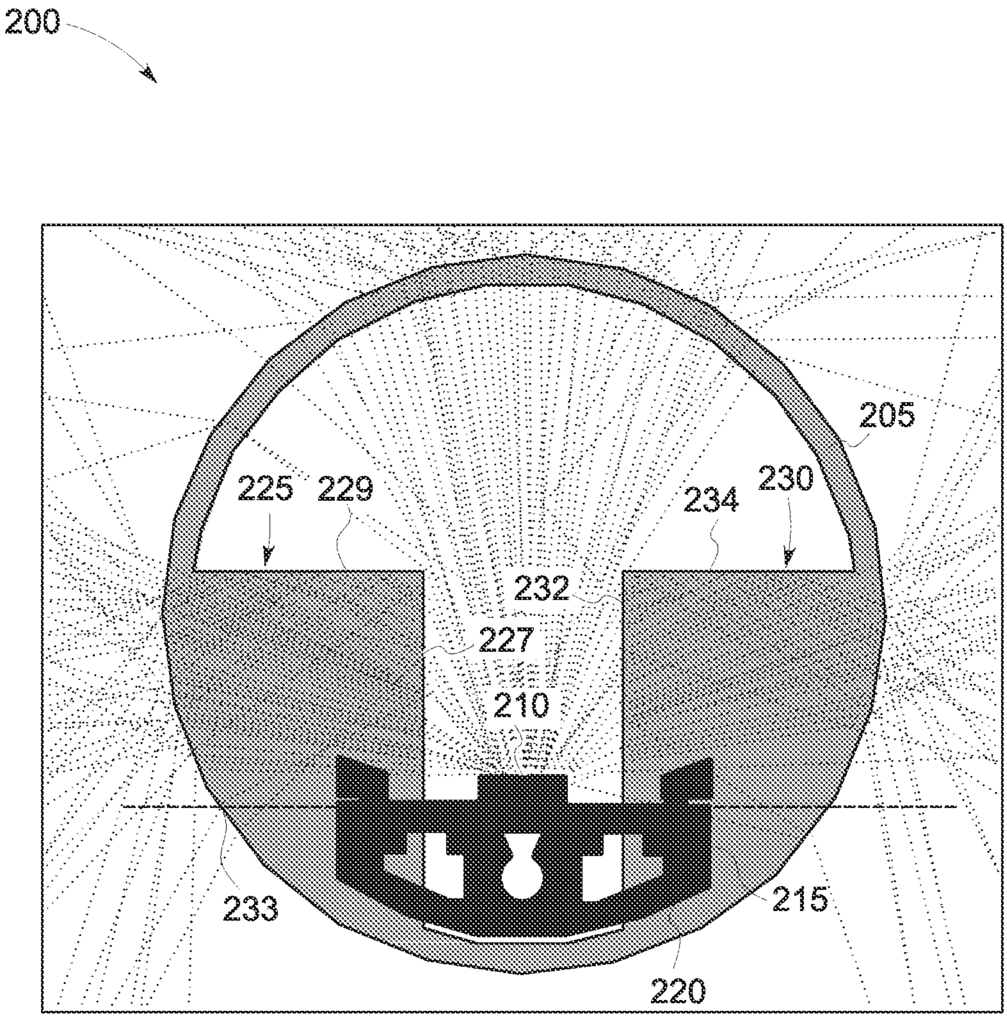


FIG. 2

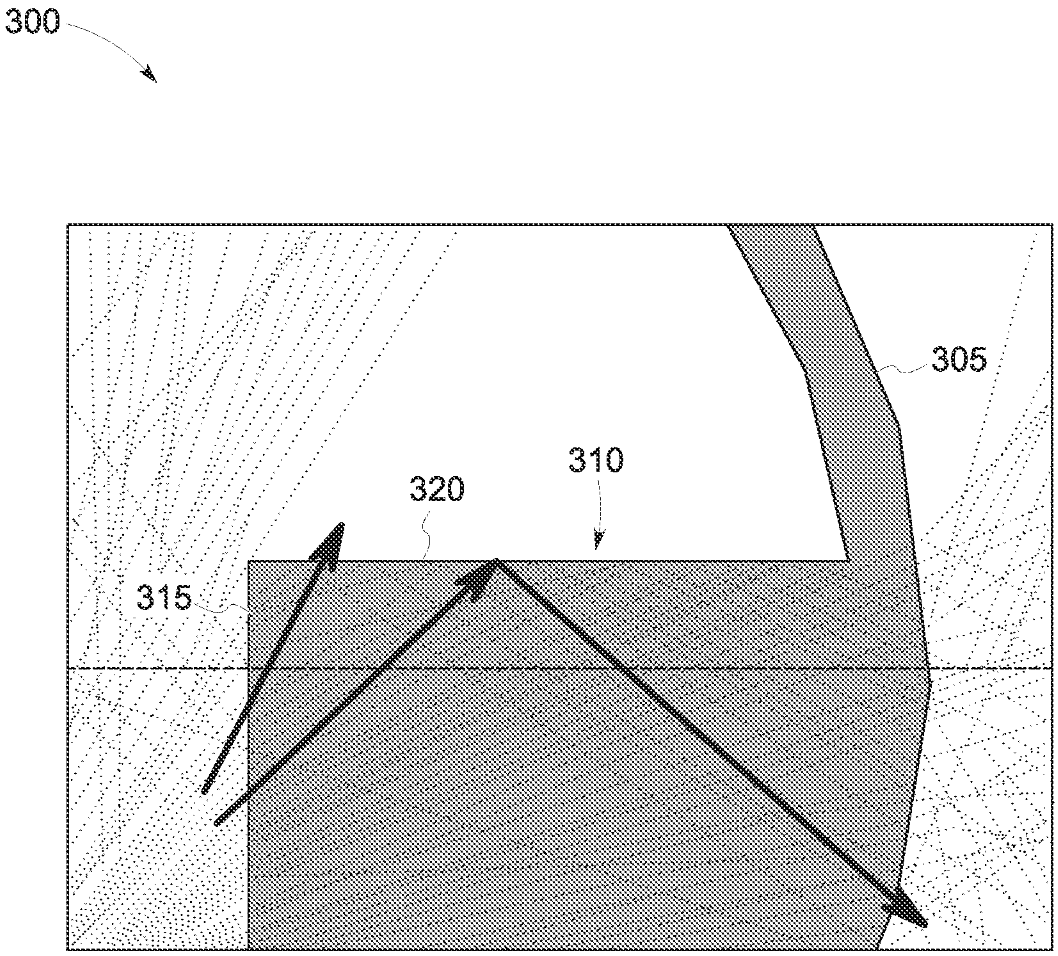


FIG. 3

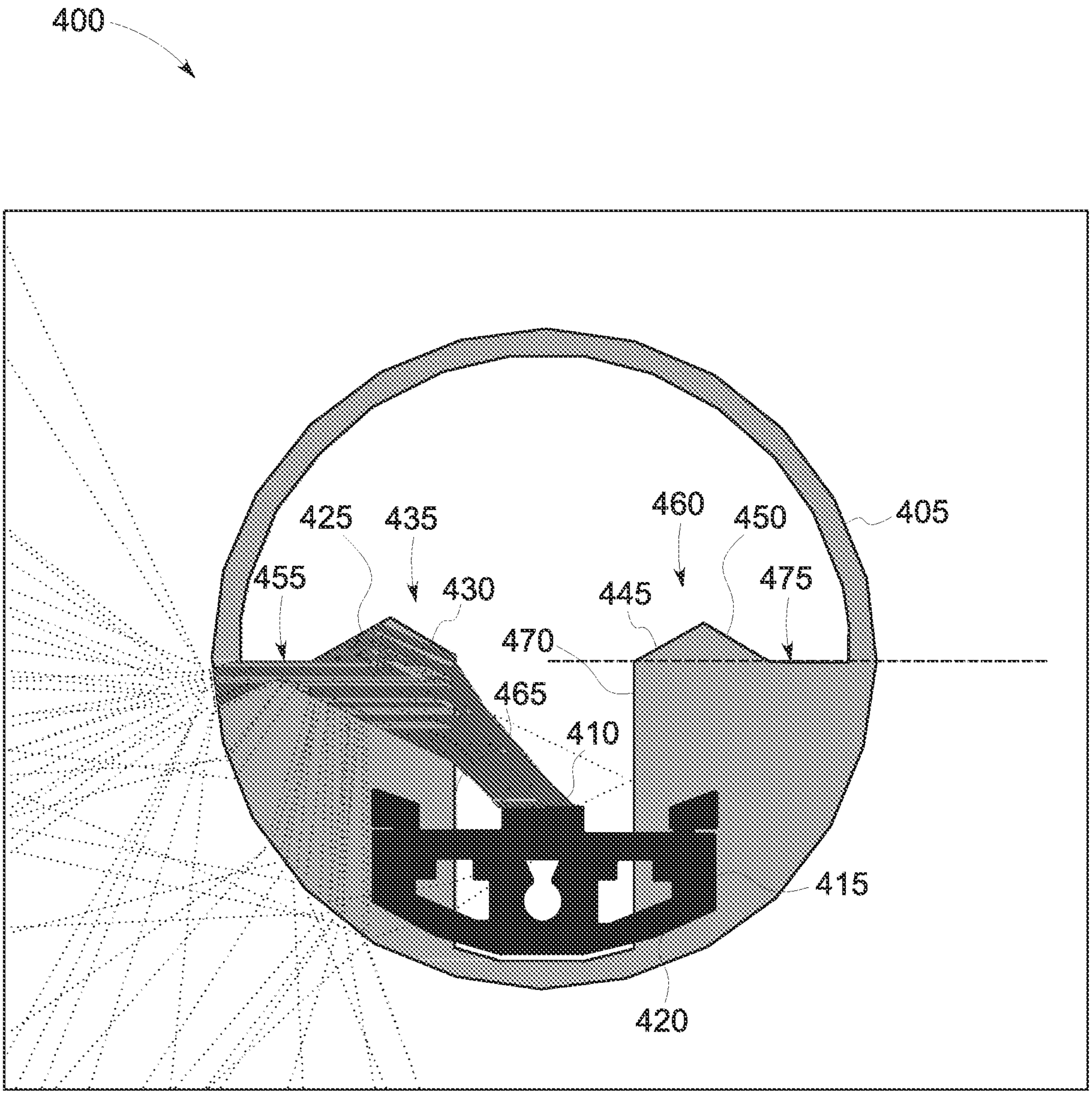


FIG. 4

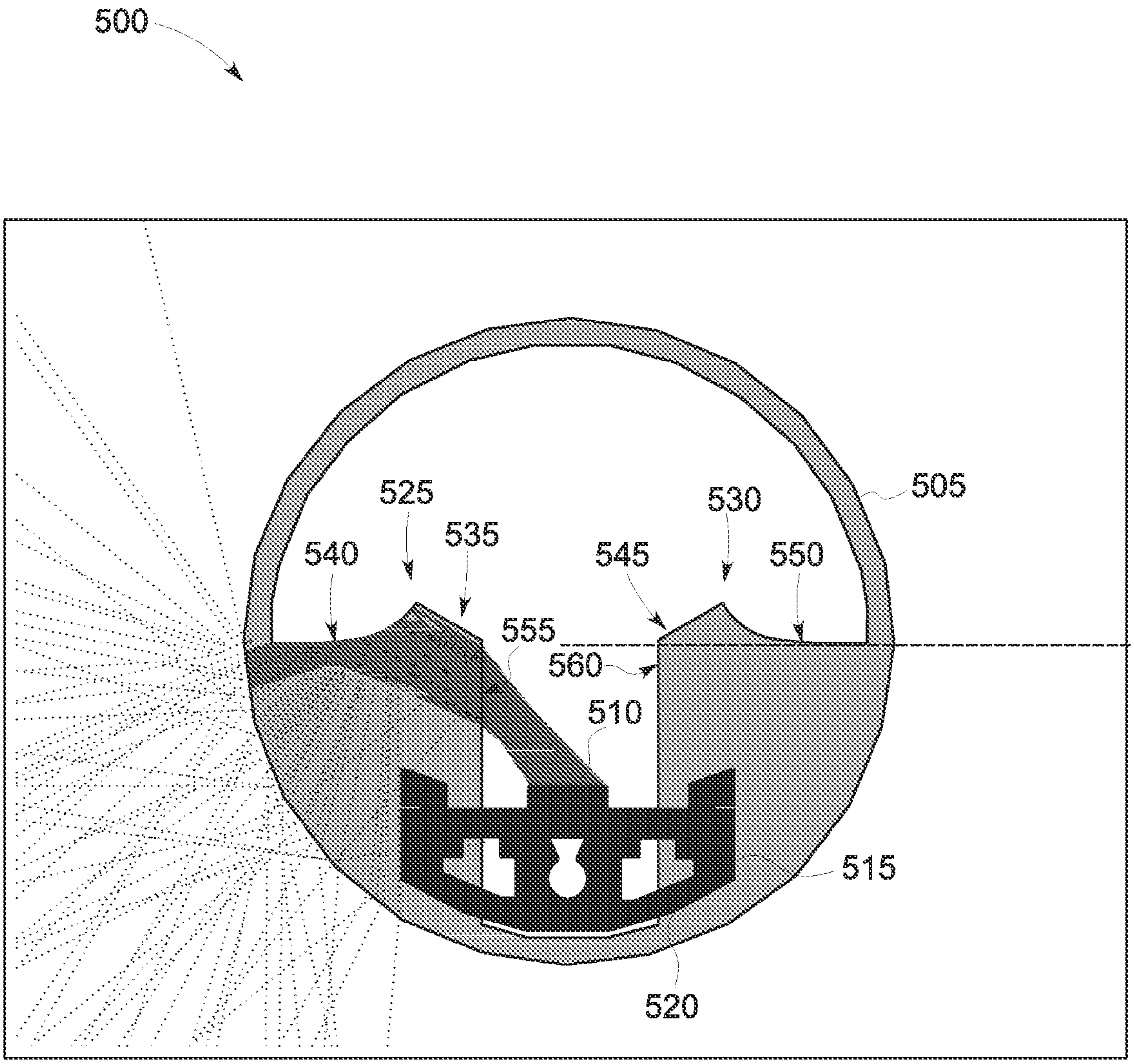


FIG. 5

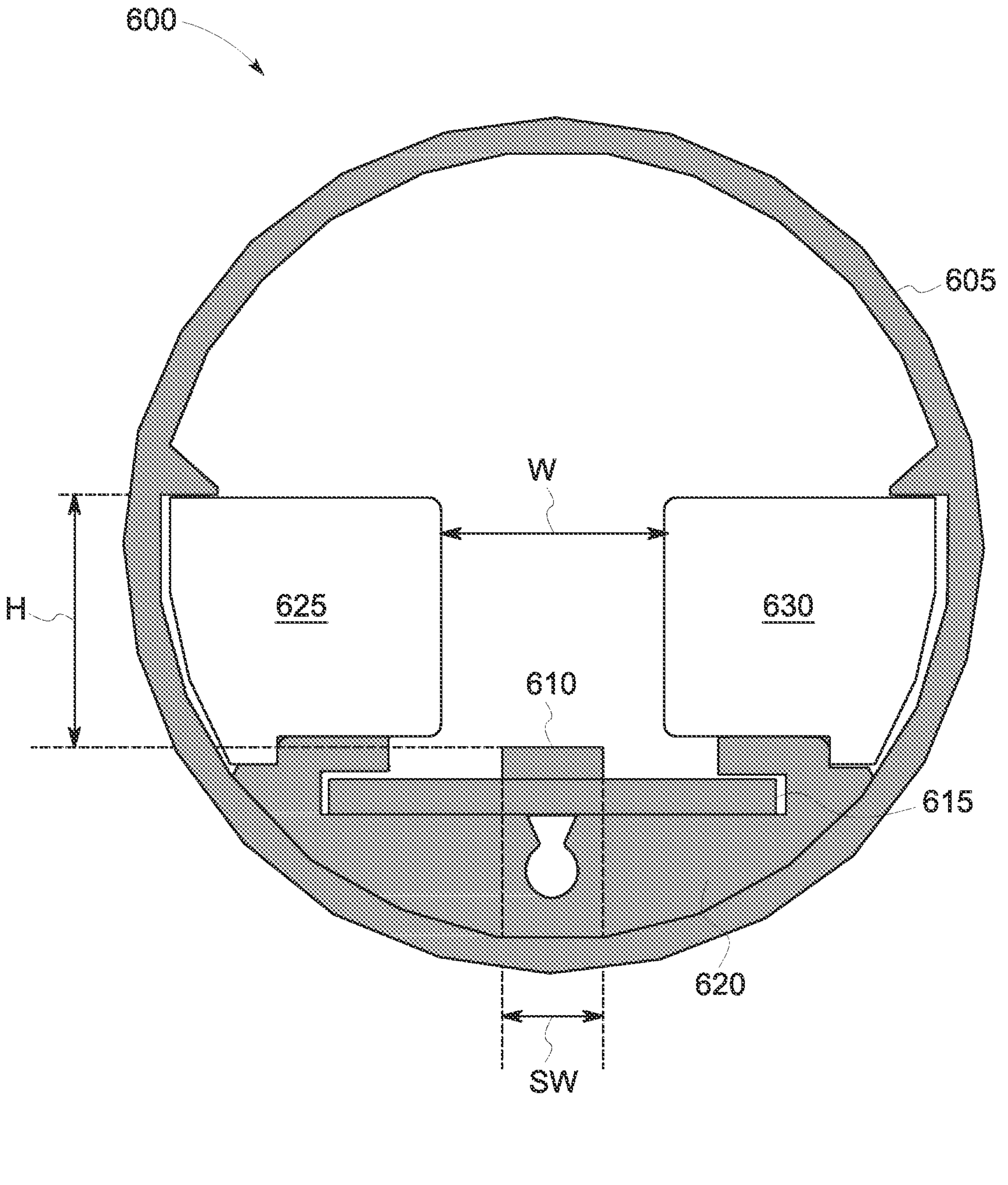


FIG. 6

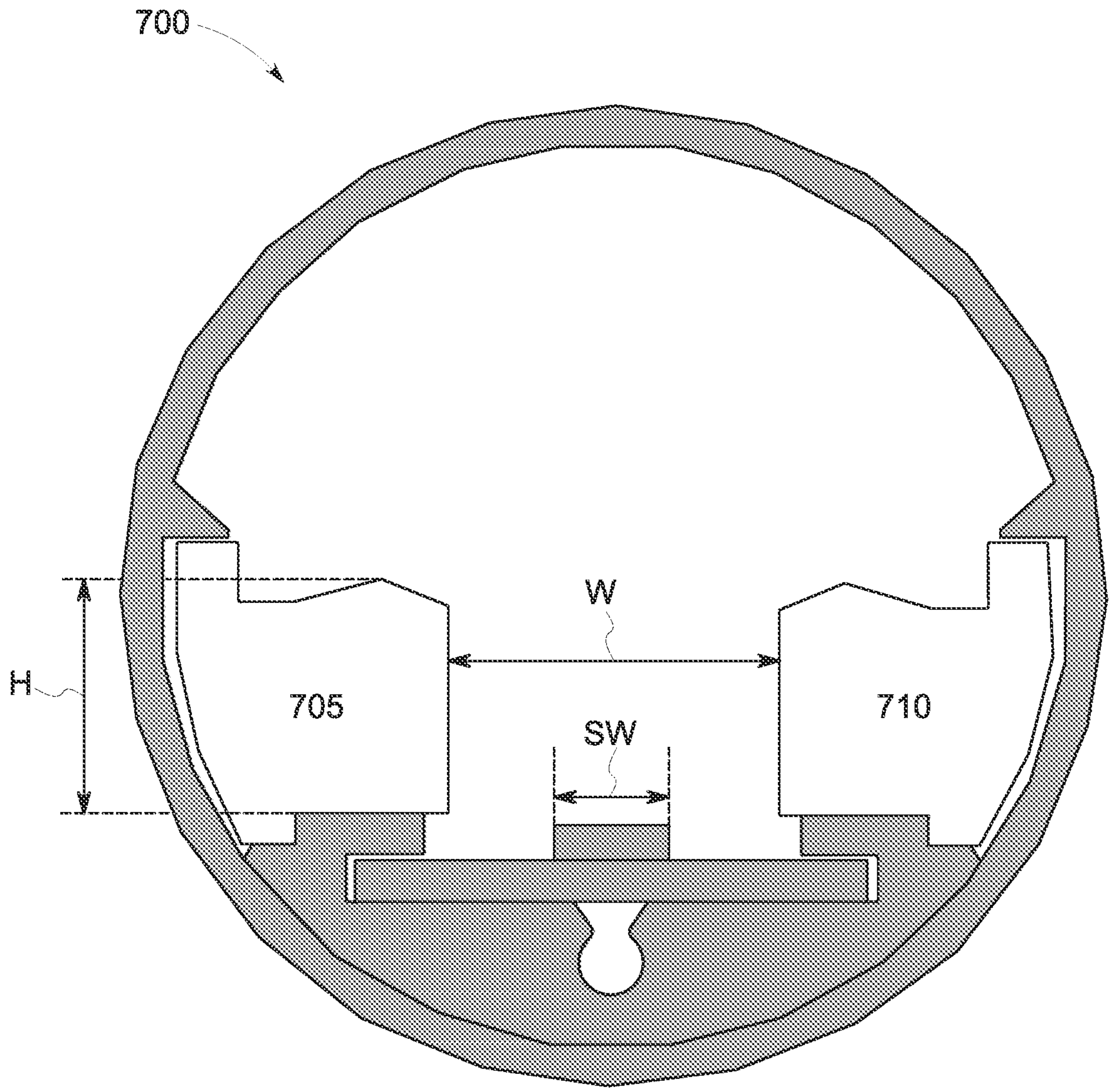


FIG. 7

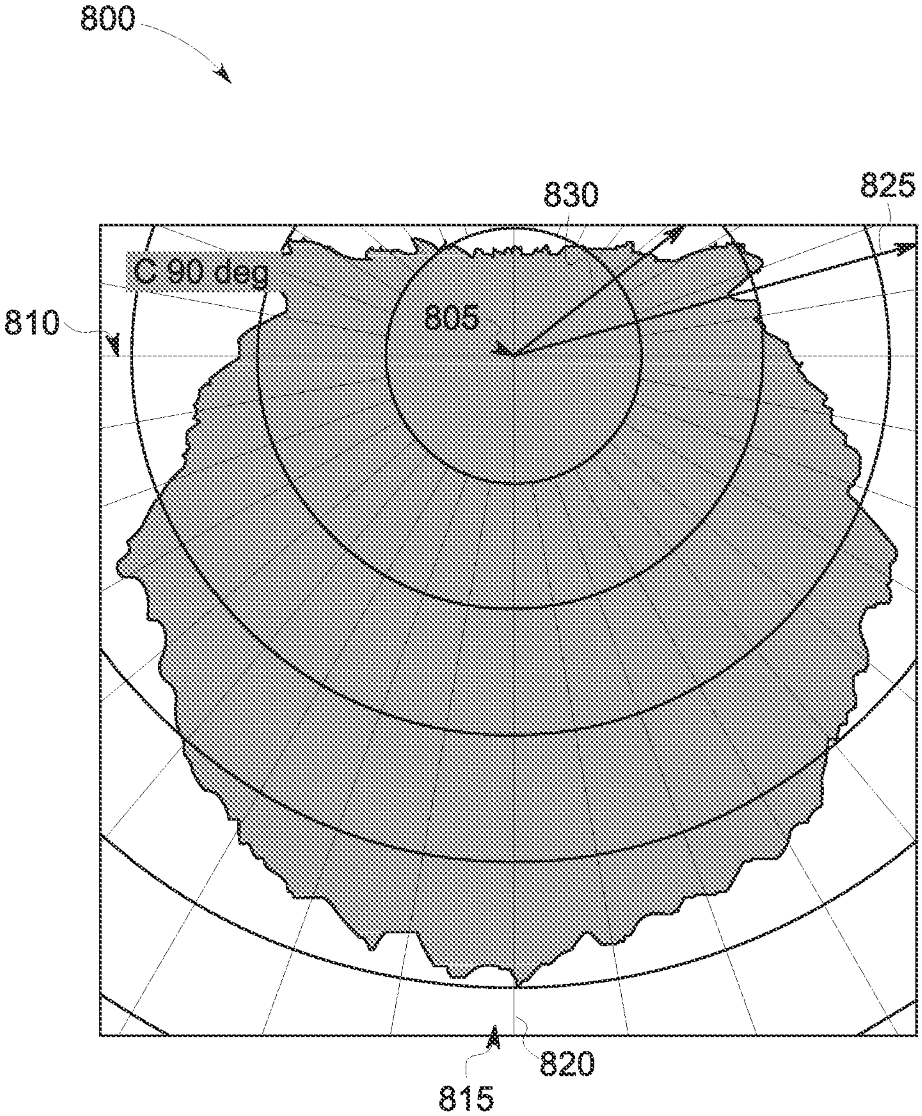


FIG. 8

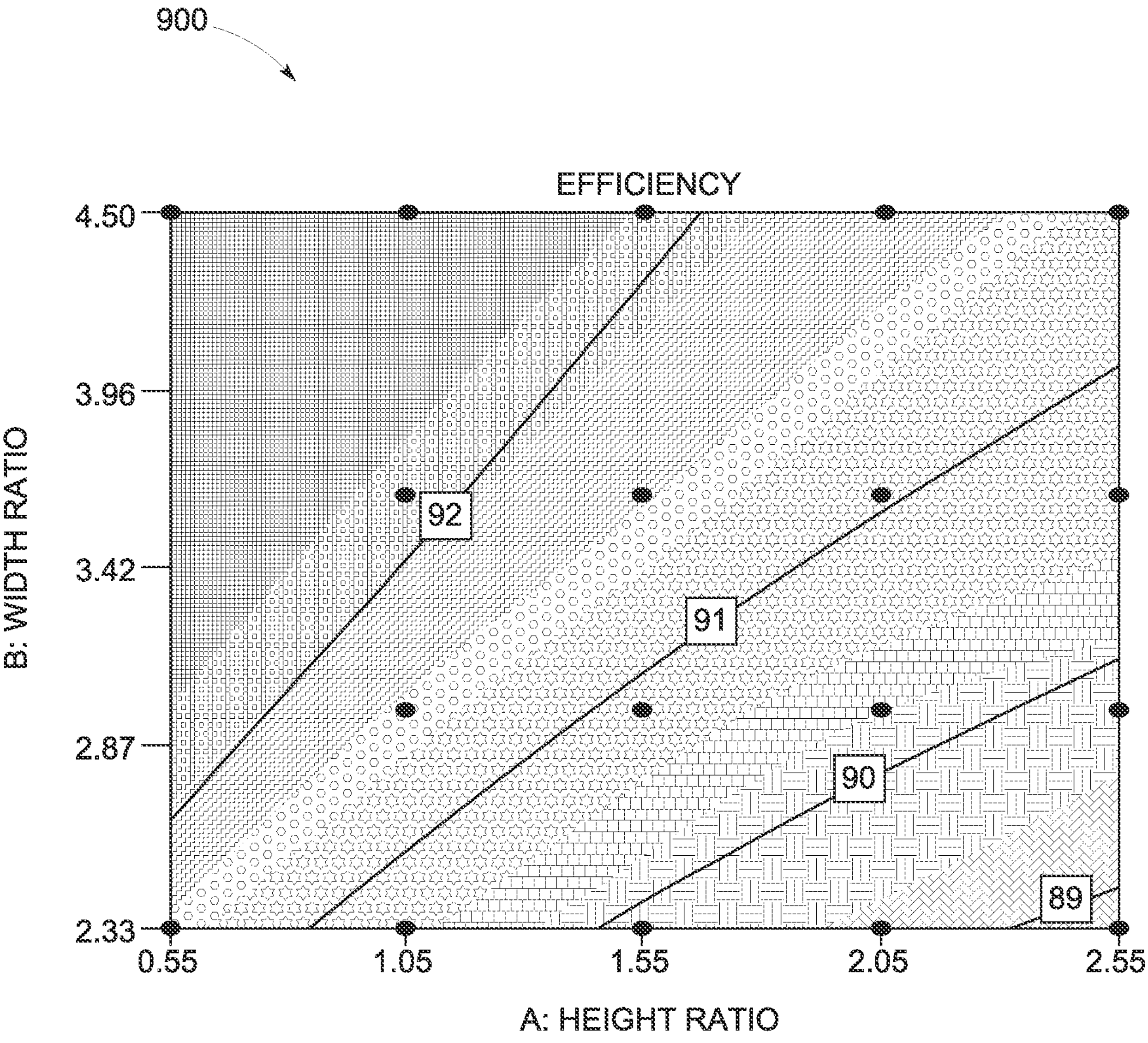
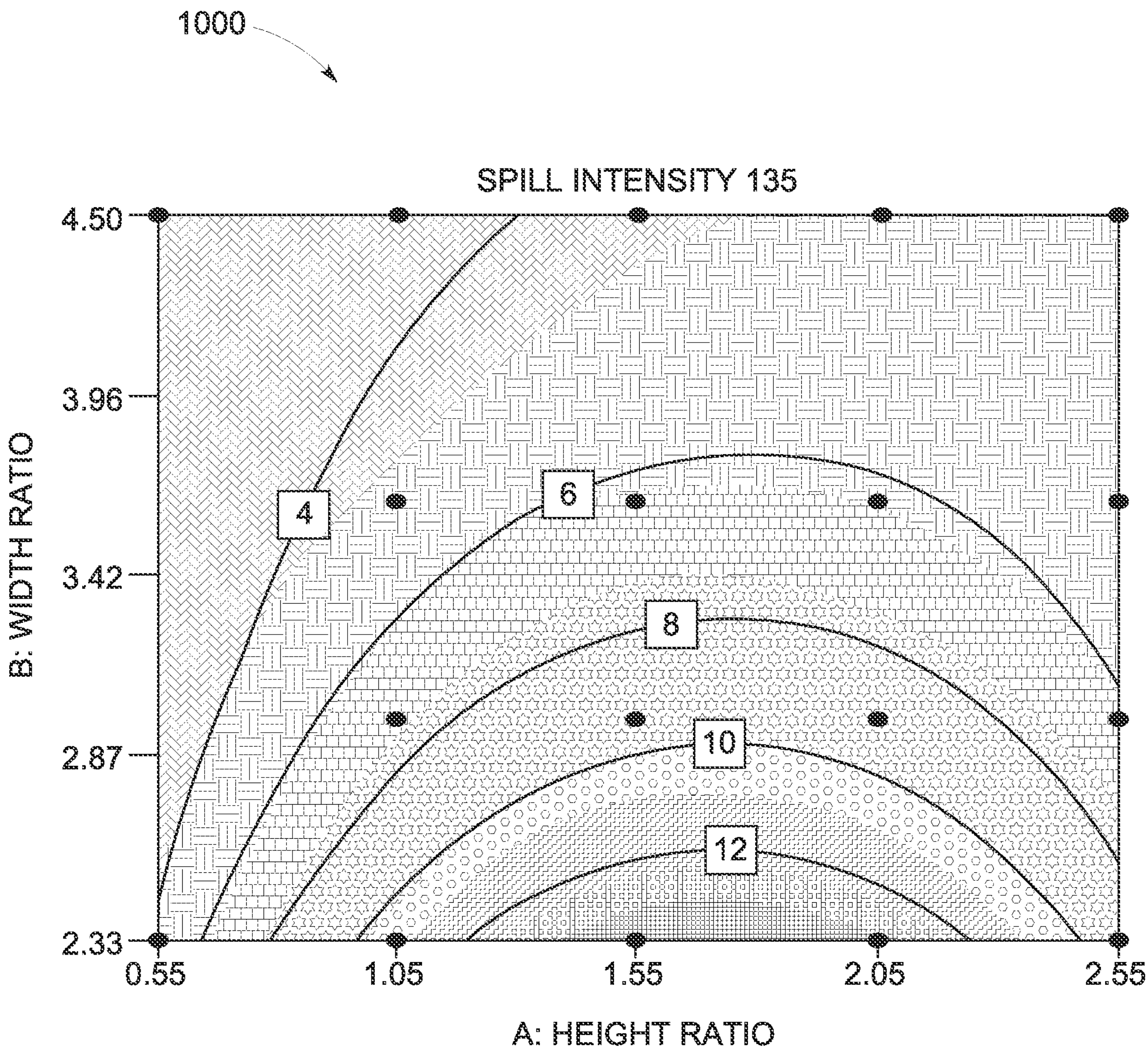

900
EFFICIENCY
4.50
3.96
3.42
2.87
2.33
B: WIDTH RATIO
92
91
90
89
0.55
1.05
1.55
2.05
2.55
A: HEIGHT RATIO

FIG. 9


1000
SPILL INTENSITY 135
4.50
3.96
3.42
2.87
2.33
B: WIDTH RATIO
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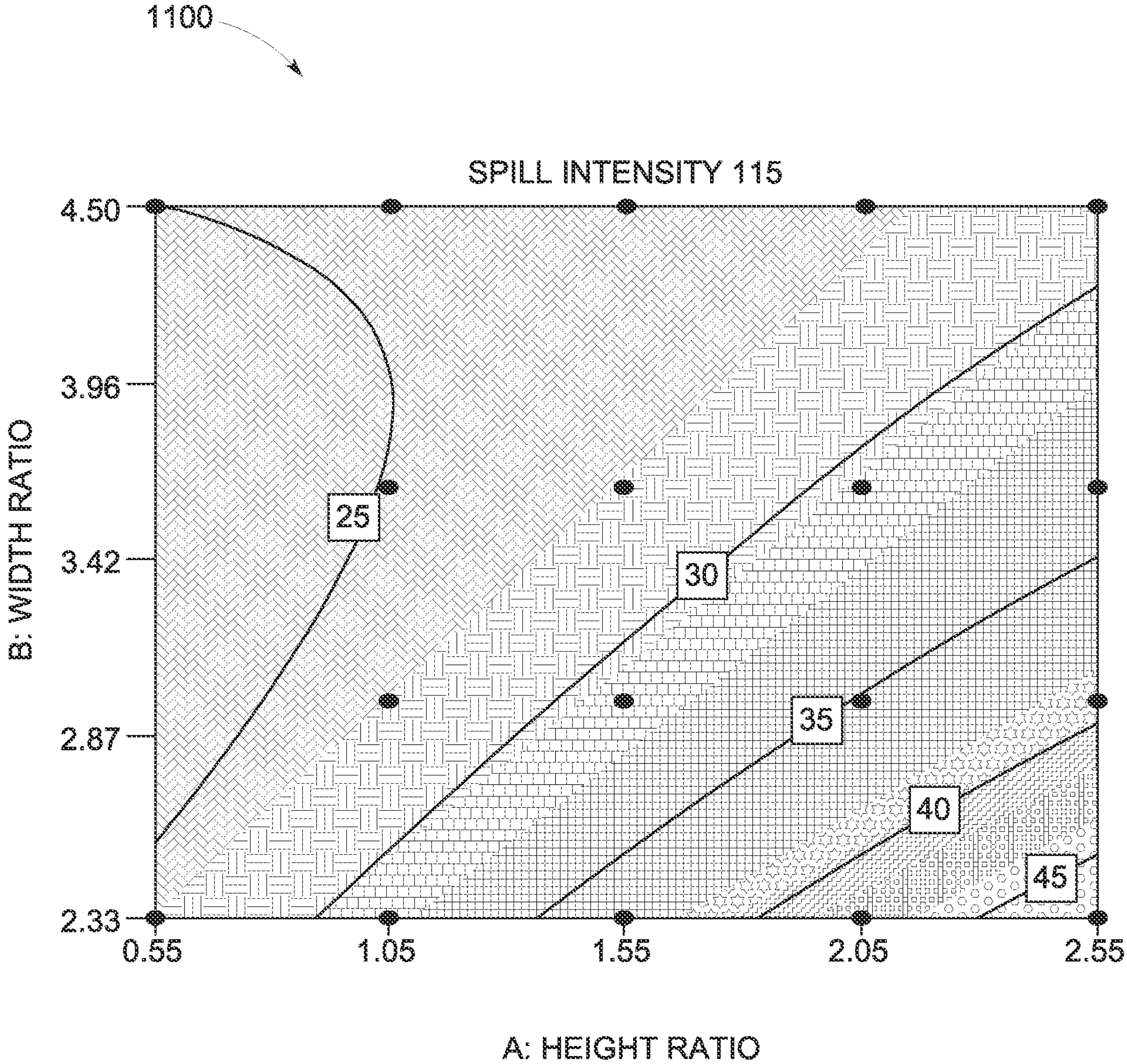
6
8
10
12
0.55
1.05
1.55
2.05
2.55
A: HEIGHT RATIO

FIG. 10


1100
SPILL INTENSITY 115
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3.96
3.42
2.87
2.33
B: WIDTH RATIO
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0.55
1.05
1.55
2.05
2.55
A: HEIGHT RATIO

FIG. 11

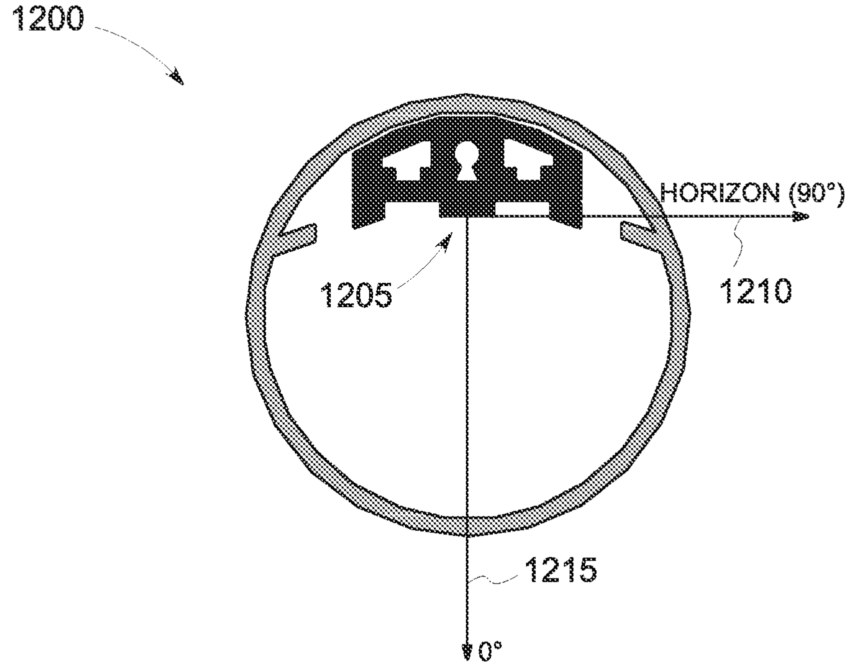
1200
HORIZON (90°)
1205
1210
1215
0°

FIG. 12

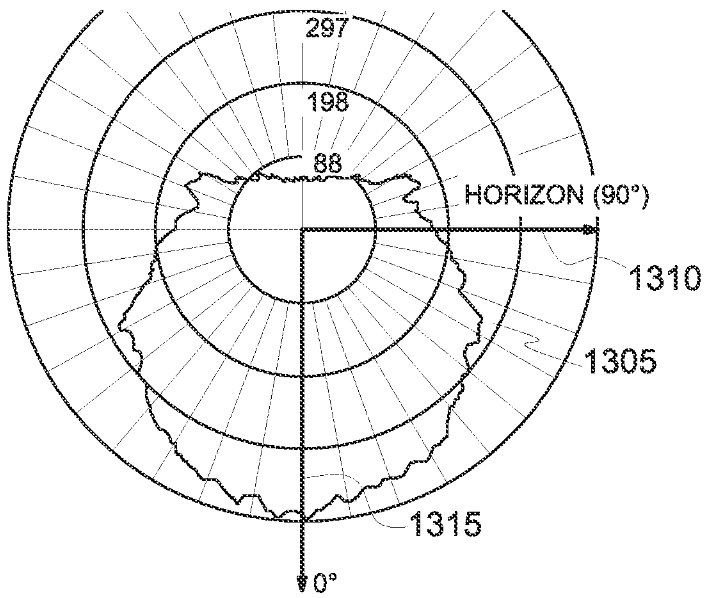
297
198
88
HORIZON (90°)
1310
1305
1315
0°

FIG. 13

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2015/029874

A. CLASSIFICATION OF SUBJECT MATTER
INV. F21K99/00 F21V3/04 F21V7/00 F21V8/00
ADD.

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)
F21K F21V G02B F21Y

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/155072 A1 (CHANG SHAO-HAN [TW]) 21 June 2012 (2012-06-21)	1-5, 7-11, 13-17
Y	figures 4, 5, 7 paragraph [0015] - paragraph [0027] -----	18
X	US 2012/287668 A1 (RICHARDSON BRIAN E [US] ET AL) 15 November 2012 (2012-11-15)	1,6-17
Y	figures 1-8 paragraph [0014] - paragraph [0068] -----	18
X	EP 2 546 565 A2 (SITECO BELEUCHTUNGSTECH GMBH [DE]) 16 January 2013 (2013-01-16) figures 1-4 paragraph [0019] - paragraph [0033] -----	1,5,7-17

☐ 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

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"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	Date of mailing of the international search report
25 June 2015	02/07/2015

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2015/029874

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012155072 A1	21-06-2012	CN 102072428 A	25-05-2011
		US 2012155072 A1	21-06-2012
US 2012287668 A1	15-11-2012	TW 201300702 A	01-01-2013
		US 2012287668 A1	15-11-2012
		WO 2012158444 A2	22-11-2012
EP 2546565 A2	16-01-2013	DE 102011107427 A1	17-01-2013
		EP 2546565 A2	16-01-2013