(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 894 395 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
07.04.2021 Bulletin 2021/14

(51) Int Cl.:
F21V 7/09 *(2006.01)*

(21) Application number: **14368007.2**

(22) Date of filing: **10.01.2014**

(54) **Lighting device for illumination tunnels, underpasses or subways**

Beleuchtungsvorrichtung zur Beleuchtung von Tunneln, Unterführungen oder Fußgängertunneln

Dispositif d'éclairage pour tunnels, voies souterraines ou passages souterrains

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(43) Date of publication of application:
15.07.2015 Bulletin 2015/29

(73) Proprietor: **ZG Lighting France S.A.**
75002 Paris (FR)

(72) Inventors:
- **Rocard, Florian**
  95800 Cergy Le Haut (FR)
- **Mulin, Alice**
  25170 Noironte (FR)

(74) Representative: **Kiwit, Benedikt**
Mitscherlich PartmbB
Patent- und Rechtsanwälte
Sonnenstraße 33
80331 München (DE)

(56) References cited:
EP-A1- 2 375 130 **WO-A1-2013/136217**

EP 2 894 395 B1

Printed by Jouve, 75001 PARIS (FR)

Description

1. Field of the invention

[0001] The present invention relates to a lighting device for illuminating tunnels, underpasses or subways, as well as to a corresponding lighting system for illuminating tunnels, underpasses or subways.

2. Technical background

[0002] From the prior art lighting devices for illuminating tunnels, underpasses or subways are well-known, for example from documents EP 2 375 130 A1 or EP 2 148 129 A1, wherein document EP 2 148 129 A1 discloses a lighting system comprising two light sources, wherein the first light source is provided for the illumination of an upper section of the tunnel and a second light source is provided for the illumination of a lower section of a tunnel.

[0003] In view of the known prior art, it is an object of the present invention to provide a new lighting device for illuminating tunnels, underpasses or subways with which a wide and homogeneous distribution of the light emitted by the lighting device is reached. These and other objects, which become apparent upon reading the following description, are solved by the subject-matter of the independent claims. The dependent claims refer to preferred embodiments of the invention.

3. Summary of the invention

[0004] According to the invention, a lighting device for illuminating tunnels, underpasses or subways is provided, comprising: at least a first lighting arrangement for illuminating a lower section of a tunnel, underpass or subway and a second lighting arrangement for illuminating an upper section of a tunnel, underpass or subway, wherein at least one of the lighting arrangements comprises: at least one light source comprising at least one light emitting diode; at least one reflector comprising an essentially saddle-shaped reflection surface; wherein the light source is arranged such that at least a part of the emitted light is directed to the reflection surface of the reflector; and wherein the light is reflected by the reflection surface in such a way that a wide light distribution of the lighting device is provided at least in a direction parallel to a surface to be illuminated and perpendicular to a main axis of the reflection surface.

[0005] The term saddle-shaped has to be understood as any structure having a mainly rounded shape with an elevated area and two laterally arranged indentations (i.e. two minima in the reflection surface) extending there from, thereby providing a surface/structure commonly known from a saddle.

[0006] By means of an arrangement comprising the above-mentioned at least one light source, which is preferably arranged/mounted at a central area with respect to the reflection surface, and the above-mentioned specifically shaped reflector a wide light distribution (i.e. a relatively broad light distribution) in a direction parallel to the surface to be illuminated and perpendicular to a main axis of the reflection surface (e.g. a symmetry line of the saddle-shaped reflection surface) can be provided. Moreover, the present invention provides a lighting device with which in principle the entire cross-section of a tunnel can be illuminated with only one lighting device.

[0007] Preferably, both the first lighting arrangement and the second lighting arrangement comprise: at least one light source comprising at least one light emitting diode; at least one reflector comprising an essentially saddle-shaped reflection surface; wherein the light source is arranged such that at least a part of the emitted light is directed to the reflection surface of the reflector. Thereby, both the upper portion and the lower portion of a tunnel can be illuminated with a wide and homogeneous light distribution.

[0008] Preferably, the reflection surface is mirror symmetrical with respect to the main axis of the reflection surface. Thereby, an essentially homogenous distribution of the light emitted by the lighting device can be provided in a direction parallel to the surface to be illuminated.

[0009] It is preferred that in top view, the reflection surface has a shape corresponding to a sector of a circle, preferably having an interior angle between 90° and 220° DEG, more preferably between 150° and 200° DEG, and even more preferably between 170° and 190° DEG. It is further preferred that in top view, the main axis of the reflection surface (i.e. the center of the elevated area) halves the reflection surface.

[0010] At least two indentations/minima of the reflection surface are provided at an angle between +/- 50° and +/- 90° DEG, preferably between +/- 60° and +/-85° DEG, and more preferably between +/- 70° and +/- 80° DEG with respect to the main axis of the reflection surface. By the positions of the minima (i.e. the indentations), the maximum width (i.e. the maximum angle) of the light distribution in a direction parallel to a surface to be illuminated and perpendicular to the main axis of the reflection surface is provided.

[0011] It is further preferred that the reflection surface does not comprise any jump discontinuities. Thereby, it is possible to provide a relatively homogenous light distribution, since thereby no overlap of the emitted light occurs.

[0012] Preferably, in top view, the light is distributed with an angle greater than +/-50° DEG preferably greater than +/- 70° DEG, and more preferably greater than +/- 75° DEG with respect to the main axis of the reflection surface. In other words, the light is essentially distributed over the entire shape of the reflection surface (i.e. over the entire sector of a circle).

[0013] Preferably, perpendicular to the surface to be illuminated, the light is distributed with an angle greater than 60° DEG preferably greater than 70° DEG, and more preferably greater than 80° DEG, and most preferably

the light is distributed with an angle of about 85° DEG; preferably measured at most from a horizontal plane downwards. Thereby, not only a wide light distribution of the lighting device in a direction parallel to a surface to be illuminated and perpendicular to the main axis of the reflection surface can be provided, but also a wide light distribution perpendicular to the surface to be illuminated can be provided.

[0014] It is further preferred that adjacent to the reflector at least one baffle is arranged, wherein the at least one baffle preferably comprises an inward reflection surface for redirecting light to the reflection surface of the reflector. The baffle is preferably arranged such that it at least partially surrounds the light source in a horizontal plane and, if necessary, also above the light source (*i.e.* opposite to the reflection surface with respect to the light source). By means of the inward reflection surface, the respective part of the emitted light is redirected to the reflection surface, thereby further usable for an illumination. Notably, depending on the respective application, further baffles can be used for adjusting the shape and dimension of the emitted light.

[0015] Preferably, the lighting device comprises a housing in which the reflector and the at least one light source are housed. Preferably, the reflection surface is arranged (preferably downwards) inclined (*e.g.* in the housing) with its main - axis with respect to the horizontal plane, preferably with an angle between 20° and 60° DEG, more preferably between 30° and 50° DEG and most preferably between 35° and 45° DEG. Notably, many experiments have been carried out in order to establish that the above-mentioned light distribution ranges can be provided using a saddle-shaped reflection surface which is arranged inclined with respect to the horizontal line, wherein a respective angle is dependent from the mounting height of the lighting device and from the respective surface to be illuminated.

[0016] Further, it is preferred that the light source is a directional light source emitting light essentially only in the direction to the reflection surface of the reflector. Thereby, light losses can be minimized and also any dazzling of a vehicle driver can be avoided.

[0017] Preferably, the at least one light source is arranged above the main axis of the reflection surface, preferably in the center of the sector of a circle. The light source preferably comprises a high brightness light emitting diode, a light emitting diode, a ray/cluster and/or a chip on board light emitting diode arrangement. By such an arrangement of the light source above the main axis, the light emitted by the light source is split and widen by means of the reflection surface, wherein about a half of the emitted light is directed to each symmetry part of the reflection surface. However, it can be further preferred that the lighting device comprises at least two light sources arranged with an offset with respect to the main axis of the reflection surface such that each light source emits light to a half of the mirror symmetrical shaped reflection surface. Thereby, it is possible to assign respective light sources to a specific part of the reflection surface, wherein thereby an essentially homogenous distribution of the emitted light is still provided. Such an arrangement also provides the possibility to increase the light quantity emitted by a lighting device.

[0018] The present invention further relates to a lighting system for illuminating tunnels, underpasses or subways comprising a lighting device as explained above.

4. Description of the preferred embodiments

[0019] In the following, the invention is described exemplarily with reference to the enclosed figures in which

Figure 1 is a schematic cross-section view of a first embodiment of the invention;

Figure 2 is a schematic cross-section view of a second embodiment of the invention;

Figure 3 is a schematic view of a reflector comprising an essentially saddle-shaped reflection surface;

Figure 4 is a schematic top view of the reflector shown in figure 3;

Figure 5 is a schematic side view of the reflector shown in figure 3;

Figure 6 is a cross-section view along a main axis of the reflection surface;

Figure 7 is a schematic top view of the reflector shown in figure 3 together with a light source arranged thereby;

Figure 8 is a schematic view of a light distribution obtained by a using the reflector shown in figure 3;

Figure 9 is a schematic view of a light distribution of the first embodiment of the invention shown in figure 1;

Figure 10 is a schematic view of a light distribution of the second embodiment of the invention shown in figure 2;

[0020] Figure 1 is a schematic view of a first embodiment of a lighting device 100 comprising a first lighting arrangement 101 and a second lighting arrangement 102, wherein the first lighting arrangement 101 is provided to illuminate a lower section of a tunnel and the second lighting arrangement 102 is provided to illuminate an upper section of a tunnel. The lighting arrangements 101, 102 respectively comprise a reflector 120, 125 and an associated light source module 220, 225. As can further

be taken from figure 1, in front of the second lighting arrangement 102 a baffle 140 is arranged preventing that light is emitted dazzling a vehicle driver. Notably, the lighting arrangements 101, 102 of the lighting device 100 are oriented to the same side sharing one optical enclosure 104 (i.e. a transparent housing part) which can be provided by an integral part or by two separate parts. Moreover, in the shown preferred embodiment, the two lighting arrangements 101, 102 have, in principle, a similar structure.

[0021] Figure 2 is a schematic view of a second embodiment of a lighting device 100' comprising a first lighting arrangement 101' and a second lighting arrangement 102'. Also here, the first lighting arrangement 101'is provided to illuminate a lower section of a tunnel and the second lighting arrangement 102' is provided to illuminate an upper section of a tunnel. The lighting arrangements 101', 102' respectively comprise a reflector 120', 125' and an associated light source module 220, 225. In contrast to the lighting device 100 shown in figure 1, the first and second lighting arrangements 101', 102' of the lighting device 100' shown in figure 2 are not oriented to the same side, but to opposite sides. However, as the case maybe, both arrangements can be oriented as desired by the respective illumination requirements. Moreover, due to the shown orientation, no baffle is required in order to prevent a dazzling of a vehicle driver. In figures 9 and 10 the illumination distribution of the different orientation of the second lighting arrangements 102, 102' are illustrated.

[0022] The first lighting arrangements 101, 101' of the lighting devices 100, 100' distribute light vertically (i.e. perpendicular) to the surface to be illuminated (i.e. on the road) with an angle 135 greater than 60° DEG. In other embodiments of the lighting device, light can be distributed in such direction with an angle preferably greater than 70° DEG and more preferably greater than 80° DEG, and most preferably, the light is distributed with an angle of 85° DEG. Preferably, this angle is measured from a horizontal plane downwards. Notably, the angle of the light distribution perpendicular to the surface to be illuminated can be adjusted by means of the inclined arrangement of the reflector 120 and/or by means of the specific geometry of the reflector 120 (*e.g.* by means of the specific height of the elevation) and/or by further optical means like a baffle as described in the following.

[0023] The lighting devices 100, 100' are adapted to be mounted at a height of about 0.95 m. Notably, the lighting devices 100, 100' are preferably mounted at a height lower than the height of a driver of a vehicle, such that the driver is not dazzled by any light laterally emitted by the lighting devices 100, 100'. However, to ensure that a driver is not dazzled by a lateral light, the lighting devices 100, 100' can comprise one or more of the baffles 140, preferably arranged at least partially surrounding the light source.

[0024] Notably, depending on the occurring heat energy, the frame of the lighting devices 100, 100' can be provided as a heat sink (e.g. by providing the frame from a metallic material). Moreover, if needed, further heat sinks can be provided within the housing of the lighting devices 100, 100'.

[0025] Figure 3 shows a schematic view of a reflector used in the preferred embodiments of the invention, wherein exemplarily the reflector 120 arranged in the first lighting arrangement 101 of the lighting device 100 is explained. According to the invention, at least the first lighting arrangements 101, 101' provided to illuminate a lower section of a tunnel comprise such a reflector 120, wherein it is preferred that also the second lighting arrangements 102, 102' comprise such a saddle-shaped reflector (but not necessarily identical with the saddle-shaped reflector 120).

[0026] As can be taken from figure 3, the reflector 120 comprises an upper reflection surface 150 having an essentially saddle-shape surface. Notably, the term saddle-shape according to the present invention is to be understood as a structure having a kind of a wave form with a wave crest (*i.e.* provided by the elevation) positioned at the main axis 160 and two laterally arranged wave troughs (*i.e.* provided by indentations), wherein the wave crest and the wave troughs convert together, preferably at a central section 170 of the reflection

[0027] Figure 4 is a schematic top view of the reflector 120. As can be taken from figure 4, the reflection surface 150 has a shape corresponding to a sector of a circle having a center point in the center section 170, wherein in the shown preferred embodiment, the sector of a circle has an interior angle of about 190° DEG (indicated by the angle 180). Preferably, this interior angle is between 90° and 220° DEG, more preferably between 150° and 200° DEG, and even more preferably between 170° and 190° DEG. As already mentioned, by the positions of the minima (i.e. the indentations), the maximum width (*i.e.* the maximum angle) of the light distribution in a direction parallel to a surface to be illuminated and perpendicular to the main axis of the reflection surface is provided.

[0028] As can be further taken from figure 4, the reflection surface 150 is preferably mirror symmetrical with respect to the main axis 160 of the reflection surface 150.

[0029] In figure 4, the minima (*i.e.* the indentations) are highlighted by auxiliary lines 190. Thus, in the shown preferred embodiment, the two minima are provided at an angle of about +/- 80° DEG with respect to the main axis 160 of the reflection surface 150. Notably, in case a light source is arranged above the central section 170 of the reflection surface 150, light is essentially distributed between both minima, thus providing in the preferred embodiment a light distribution in a direction parallel to a surface to be illuminated and perpendicular to the main axis 160 of the reflection surface 150 with an angle of about 160° DEG. However, depending on the specific application, the minima can be provided at an angle between +/- 50° and +/- 90° DEG, preferably between +/- 60° and +/- 85° DEG, and more preferably between +/- 70° and +/- 80° DEG with respect to the main axis 160

of the reflection surface. Thereby, a wide and homogeneous light distribution can be achieved, preferably with an angle greater than +/- 50° DEG, preferably greater than +/- 70° DEG, and even more preferably greater than + /-75° DEG.

[0030] Figure 5 is a side view of the reflector 120 as shown in figures 4. As can be taken from figure 5, the reflection surface 150 does not comprise any jump - discontinuities. In fact, starting from a rearward edge 200, the outer circumference of the reflection surface 150 runs downwards to the shown minimum and runs subsequently upwards to the front-tip 210 of the reflection surface 150. Since in the preferred embodiment, the reflection surface 150 is mirror symmetrical with respect to the main axis 160, the circumference at the not shown other side is equally provided.

[0031] Figure 6 is a cross-section view along the main axis 160 of the reflection surface 150. As can be taken from figure 6, the main axis 160 is provided by a flat curve slightly directed downwardly from the rear edge 200 to a minimum and then slightly directed upwardly to the front-tip 210.

[0032] Figure 7 is a schematic top view of the reflector 120, wherein above the center section 170 of the reflection surface 150, a light module 220 comprising a high brightness light emitting diode is arranged. The light module 220 is preferably a light source having only a directional light emitting light essentially only in the direction to the reflection surface 150 of the reflector 120. However, as an alternative or in addition also a radiator having a spherical light emission can be used. Notably, the use of a high brightness light emitting diode preferred, however, also light emitting diode arrays/clusters and/or chip on board light emitting diode arrangements can be used depending on the specific application. As an alternative or in addition to the arrangement of the light module 220 above the center section (*i.e.* above the main axis 160 of the reflection surface 150), it is also possible to arrange two light sources with an offset with respect to the main axis 160 such that each light source emits light to a predetermined area of the reflection surface 150 (*e.g.* one light source is arranged slightly left of the main axis 160 and a further light source is arranged slightly right of the main axis 160) such that the emitted light of each light sources is directed and assigned to a half of the mirror symmetrical shaped reflection surface 150. Figure 8 illustrates a light distribution obtained by a using the reflector 120.

[0033] Figure 9 is a schematic view of the light distribution provided by the lighting device 100. As can be taken from figure 9, the lighting device 100 having two lighting arrangements 101, 102 oriented in the same direction can be preferably used in case the tunnel has a curved upper section.

[0034] Figure 10 is a schematic view of the light distribution provided by the lighting device 100'. As can be taken from figure 10, the lighting device 100' having two lighting arrangements 101, 102 oriented in opposite directions can be preferably used in case the tunnel has a planar upper section.

[0035] It should be clear to a skilled person that the above shown embodiments are preferred embodiments, but that, however, also different shapes of the reflection surface can be used, as long as the shape of the reflection surface is essentially saddle-shaped. In particular, the specific use of a lighting device may require that the reflection surface has to be provided with different gradients, thereby adjusting the emitting light cone. Moreover, even if it is preferred that the reflection surface does not comprise any jump discontinuities, the reflection surface may be provided by discrete surface areas, as long as the transitions between these areas provide an essentially uniform distribution of the light.

Claims

1. Lighting device (100; 100') for illuminating tunnels, underpasses or subways, comprising:

   - at least a first lighting arrangement (101; 101') for illuminating a lower section of a tunnel, underpass or subway and a second lighting arrangement (102; 102') for illuminating an upper section of a tunnel, underpass or subway, wherein at least one of the lighting arrangements (101, 102; 101', 102') comprises:
   - at least one light source (220, 225; 220', 225') comprising at least one light emitting diode;
   - at least one reflector (120, 125; 120', 125') comprising an essentially saddle-shaped reflection surface (150);
   wherein the light source (220) is arranged such that at least a part of the emitted light is directed to the reflection surface (150) of the reflector (120, 125; 120', 125'); and wherein the light is reflected by the reflection surface (150) in such a way that a wide light distribution of the lighting device is provided at least in a direction parallel to a surface to be illuminated and perpendicular to a main axis (160) of the reflection surface (150),
   - wherein the reflection surface (150) of the reflector (120, 125; 120', 125') comprises at least two minima (190) provided at an angle between +/- 50° and +/- 90° DEG with respect to the main axis (160) of the reflection surface (150).

2. Lighting device (100; 100') according to claim 1, wherein both the first lighting arrangement (101; 101') and the second lighting arrangement (102; 102') comprise:

   - at least one light source (220, 225; 220', 225') comprising at least one light emitting diode;
   - at least one reflector (120, 125; 120', 125') com-

prising an essentially saddle-shaped reflection surface (150);

wherein the light source (220, 225; 220', 225') is arranged such that at least a part of the emitted light is directed to the reflection surface (150) of the reflector (120, 125; 120', 125').

3. Lighting device (100, 100') according to any of the preceding claims, wherein the lighting arrangements (101, 102; 101', 102') are oriented to the same direction or to opposite directions.

4. Lighting device (100; 100') according to claim 1 or 2, wherein the reflection surface (150) is mirror symmetrical with respect to its main axis (160).

5. Lighting device (100; 100') according to any of the preceding claims, wherein in top view the reflection surface (150) has a shape corresponding to a sector of a circle, preferably having an interior angle between 90° and 220° DEG, more preferably between 150° and 200° DEG, and even more preferably between 170° and 190° DEG.

6. Lighting device (100; 100') according to any of the preceding claims, wherein the at least two minima (190) are provided at an angle, between +/- 60° and +/-85° DEG, and preferably between +/- 70° and +/- 80° DEG with respect to the main axis (160) of the reflection surface (150).

7. Lighting device (100; 100') according to any of the preceding claims, wherein the reflection surface (150) does not comprise any jump discontinuities.

8. Lighting device (100; 100') according to any of the preceding claims, wherein the reflector (120, 125; 120', 125') is designed and arranged such that in top view, the light is distributed with an angle greater than +/- 50° DEG, preferably greater than +/- 70° DEG, and more preferably greater than +/- 75° DEG with respect to the main axis (160) of the reflection surface (150).

9. Lighting device (100; 100') according to any of the preceding claims, wherein the reflector (120, 125; 120', 125') is designed such that perpendicular to the surface to be illuminated, the light is distributed with an angle greater than 60° DEG, preferably greater than 70° DEG, and more preferably greater than 80° DEG, and most preferably the light is distributed with an angle of about 85° DEG.

10. Lighting device (100; 100') according to any of the preceding claims, wherein adjacent to at least one of the reflectors (125) at least one baffle (140) is arranged at least partially surrounding the light source preferably in a horizontal plane, wherein the at least one baffle (140) preferably comprises an inward reflection surface for redirecting light to the reflection surface (150) of the reflector (125).

11. Lighting device (100; 100') according to any of the preceding claims, wherein the lighting device (100; 100') comprises a housing in which the reflector (120, 125; 120', 125') and the at least one light source (220, 225; 220', 225') are housed.

12. Lighting device (100; 100') according to any of the preceding claims, wherein the reflector (120, 125; 120', 125') is arranged inclined with its main axis (160) with respect to the horizontal plane, preferably with an angle between +/- 20° and +/- 60° DEG, more preferably between +/- 30° and +/- 50° DEG and most preferably between +/- 35° and +/- 45° DEG.

13. Lighting device (100; 100') according to any of the preceding claims, wherein the light source (220, 225; 220', 225') is a directional light source emitting light essentially only in the direction to the reflection surface (150) of the reflector (120,125; 120', 125').

14. Lighting device (100; 100') according to any of the preceding claims, wherein the at least one light source (220, 225; 220', 225') is arranged above the main axis (160) of the reflection surface (150), preferably in the center of the sector of a circle.

15. Lighting device (100; 100') according to any of the preceding claims, wherein the lighting device (100; 100') comprises at least two light sources arranged with an offset with respect to the main axis (160) of the reflection surface (150) such that each light source emits light to a predetermined area of the reflection surface (150).

16. Lighting device (100; 100') according to any of the preceding claims, wherein the light source (220, 225; 220', 225') comprises a high brightness light emitting diode, a light emitting diode array/cluster, a color module and/or a chip on board light emitting diode arrangement, wherein optionally the lighting device further comprises diffuser means like diffuser plates, discs or chambers.

17. Lighting system for illuminating tunnels, underpasses or subways, comprising a lighting device (100; 100') according to any of the claims 1 to 16.

Patentansprüche

1. Beleuchtungsvorrichtung (100; 100') zur Beleuchtung von Tunneln, Unterführungen oder Fußgängertunneln, umfassend:

- mindestens eine erste Beleuchtungsanordnung (101; 101') zum Beleuchten eines unteren Abschnitts eines Tunnels, einer Unterführung oder eines Fußgängertunnels und eine zweite Beleuchtungsanordnung (102; 102') zum Beleuchten eines oberen Abschnitts eines Tunnels, einer Unterführung oder eines Fußgängertunnels, wobei mindestens eine der Beleuchtungsanordnungen (101, 102; 101', 102') umfasst:
- mindestens eine Lichtquelle (220, 225; 220', 225'), die mindestens eine Leuchtdiode umfasst;
- mindestens einen Reflektor (120, 125; 120', 125'), der eine im Wesentlichen sattelförmige Reflexionsfläche (150) umfasst;
wobei die Lichtquelle (220) derart angeordnet ist, dass mindestens ein Teil des emittierten Lichts auf die Reflexionsfläche (150) des Reflektors (120, 125; 120', 125') gerichtet ist; und
wobei das Licht von der Reflexionsfläche (150) derart reflektiert wird, dass eine breite Lichtverteilung der Beleuchtungsvorrichtung mindestens in einer Richtung parallel zu einer zu beleuchtenden Oberfläche und senkrecht zu einer Hauptachse (160) der Reflexionsfläche (150) bereitgestellt wird,
- wobei die Reflexionsfläche (150) des Reflektors (120, 125; 120', 125') mindestens zwei Minima (190) umfasst, die in einem Winkel zwischen +/-50° und +/-90° Grad in Bezug auf die Hauptachse (160) der Reflexionsfläche (150) bereitgestellt werden.

2. Beleuchtungsvorrichtung (100; 100') nach Anspruch 1, wobei sowohl die erste Beleuchtungsanordnung (101; 101') als auch die zweite Beleuchtungsanordnung (102; 102') umfassen:

- mindestens eine Lichtquelle (220, 225; 220', 225'), die mindestens eine Leuchtdiode umfasst;
- mindestens einen Reflektor (120, 125; 120', 125'), der eine im Wesentlichen sattelförmige Reflexionsfläche (150) umfasst;
wobei die Lichtquelle (220, 225; 220', 225') derart angeordnet ist, dass mindestens ein Teil des emittierten Lichts auf die Reflexionsfläche (150) des Reflektors (120, 125; 120', 125') gerichtet ist.

3. Beleuchtungsvorrichtung (100, 100') nach einem der vorstehenden Ansprüche, wobei die Beleuchtungsanordnungen (101, 102; 101', 102') in die gleiche Richtung oder in entgegengesetzte Richtungen ausgerichtet sind.

4. Beleuchtungsvorrichtung (100; 100') nach Anspruch 1 oder 2, wobei die Reflexionsfläche (150) spiegelsymmetrisch zu ihrer Hauptachse (160) ist.

5. Beleuchtungsvorrichtung (100; 100') nach einem der vorstehenden Ansprüche, wobei die Reflexionsfläche (150) in Draufsicht eine einem Kreissektor entsprechende Form aufweist, vorzugsweise mit einem Innenwinkel zwischen 90° und 220° Grad, mehr bevorzugt zwischen 150° und 200° Grad und noch mehr bevorzugt zwischen 170° und 190° Grad.

6. Beleuchtungsvorrichtung (100; 100') nach einem der vorstehenden Ansprüche, wobei die mindestens zwei Minima (190) in einem Winkel zwischen +/-60° und +/-85° Grad und vorzugsweise zwischen +/-70° und +/-80° Grad in Bezug auf die Hauptachse (160) der Reflexionsfläche (150) bereitgestellt werden.

7. Beleuchtungsvorrichtung (100; 100') nach einem der vorstehenden Ansprüche, wobei die Reflexionsfläche (150) keine Sprungstellen umfasst.

8. Beleuchtungsvorrichtung (100; 100') nach einem der vorstehenden Ansprüche, wobei der Reflektor (120, 125; 120', 125') derart gestaltet und angeordnet ist, dass das Licht in Draufsicht mit einem Winkel größer als+ /-50° Grad, vorzugsweise größer als +/-70° Grad und mehr bevorzugt größer als +/-75° Grad in Bezug auf die Hauptachse (160) der Reflexionsfläche (150) verteilt wird.

9. Beleuchtungsvorrichtung (100; 100') nach einem der vorstehenden Ansprüche, wobei der Reflektor (120, 125; 120', 125') derart gestaltet ist, dass das Licht senkrecht zu der zu beleuchtenden Oberfläche mit einem Winkel größer als 60° Grad, vorzugsweise größer als 70° Grad und mehr bevorzugt größer als 80° Grad verteilt wird, und am meisten bevorzugt das Licht mit einem Winkel von etwa 85° Grad verteilt wird.

10. Beleuchtungsvorrichtung (100; 100') nach einem der vorstehenden Ansprüche, wobei angrenzend an mindestens einen der Reflektoren (125) mindestens eine Blende (140) die Lichtquelle vorzugsweise in einer horizontalen Ebene teilweise umgebend angeordnet ist, wobei die mindestens eine Blende (140) vorzugsweise eine nach innen gerichtete Reflexionsfläche zum Umlenken von Licht zu der Reflexionsfläche (150) des Reflektors (125) umfasst.

11. Beleuchtungsvorrichtung (100; 100') nach einem der vorstehenden Ansprüche, wobei die Beleuchtungsvorrichtung (100; 100') ein Gehäuse umfasst, in dem der Reflektor (120, 125; 120', 125') und die mindestens eine Lichtquelle (220, 225; 220', 225') untergebracht sind.

12. Beleuchtungsvorrichtung (100; 100') nach einem der vorstehenden Ansprüche, wobei der Reflektor (120, 125; 120', 125') mit seiner Hauptachse (160) in Bezug auf die horizontale Ebene geneigt angeordnet ist, vorzugsweise mit einem Winkel zwischen +/-20° und +/-60° Grad, mehr bevorzugt zwischen +/-30° und +/-50° Grad und am meisten bevorzugt zwischen +/-35° und +/-45° Grad.

13. Beleuchtungsvorrichtung (100; 100') nach einem der vorstehenden Ansprüche, wobei die Lichtquelle (220, 225; 220', 225') eine gerichtete Lichtquelle ist, die Licht im Wesentlichen nur in Richtung der Reflexionsfläche (150) des Reflektors (120, 125; 120', 125') emittiert.

14. Beleuchtungsvorrichtung (100; 100') nach einem der vorstehenden Ansprüche, wobei die mindestens eine Lichtquelle (220, 225; 220', 225') oberhalb der Hauptachse (160) der Reflexionsfläche (150), vorzugsweise im Mittelpunkt eines Kreissektors, angeordnet ist.

15. Beleuchtungsvorrichtung (100; 100') nach einem der vorstehenden Ansprüche, wobei die Beleuchtungsvorrichtung (100; 100') mindestens zwei Lichtquellen umfasst, die in Bezug auf die Hauptachse (160) der Reflexionsfläche (150) derart versetzt angeordnet sind, dass jede Lichtquelle Licht auf einen vorbestimmten Bereich der Reflexionsfläche (150) emittiert.

16. Beleuchtungsvorrichtung (100; 100') nach einem der vorstehenden Ansprüche, wobei die Lichtquelle (220, 225; 220', 225') eine Leuchtdiode mit hoher Helligkeit, ein Leuchtdiodenarray/-cluster, ein Farbmodul und/oder eine Chip-on-Board-Leuchtdiodenanordnung umfasst, wobei die Beleuchtungsvorrichtung optional ferner Diffusormittel wie Diffusorplatten, -scheiben oder -kammern umfasst.

17. Beleuchtungssystem zur Beleuchtung von Tunneln, Unterführungen oder Fußgängertunneln, umfassend eine Beleuchtungsvorrichtung (100; 100') nach einem der Ansprüche 1 bis 16.

Revendications

1. Dispositif d'éclairage (100 ; 100') pour éclairer des tunnels, passages souterrains ou métros, comprenant :

   - au moins un premier agencement d'éclairage (101 ; 101') pour éclairer une section inférieure d'un tunnel, passage souterrain ou métro et un deuxième agencement d'éclairage (102 ; 102') pour éclairer une section supérieure d'un tunnel, passage souterrain ou métro, dans lequel au moins l'un des agencements d'éclairage (101, 102 ; 101', 102') comprend :
   - au moins une source de lumière (220, 225 ; 220', 225') comprenant au moins une diode électroluminescente ;
   - au moins un réflecteur (120, 125 ; 120', 125') comprenant une surface de réflexion sensiblement en forme de selle (150) ;
   dans lequel la source de lumière (220) est agencée de telle sorte qu'au moins une partie de la lumière émise est dirigée vers la surface de réflexion (150) du réflecteur (120, 125 ; 120', 125') ; et dans lequel la lumière est réfléchie par la surface de réflexion (150) d'une manière telle qu'une distribution large de lumière du dispositif d'éclairage est fournie au moins dans une direction parallèle à une surface à éclairer et perpendiculaire à un axe principal (160) de la surface de réflexion (150),
   - dans lequel la surface de réflexion (150) du réflecteur (120, 125 ; 120', 125') comprend au moins deux minima (190) fournis à un angle entre +/- 50° et +/- 90° DEG par rapport à l'axe principal (160) de la surface de réflexion (150).

2. Dispositif d'éclairage (100 ; 100') selon la revendication 1, dans lequel tant le premier agencement d'éclairage (101 ; 101') que le deuxième agencement d'éclairage (102 ; 102') comprennent :

   - au moins une source de lumière (220, 225 ; 220', 225') comprenant au moins une diode électroluminescente ;
   - au moins un réflecteur (120, 125 ; 120', 125') comprenant une surface de réflexion sensiblement en forme de selle (150) ;
   dans lequel la source de lumière (220, 225 ; 220', 225') est agencée de telle sorte qu'au moins une partie de la lumière émise est dirigée vers la surface de réflexion (150) du réflecteur (120, 125 ; 120', 125').

3. Dispositif d'éclairage (100, 100') selon l'une quelconque des revendications précédentes, dans lequel les agencements d'éclairage (101, 102 ; 101', 102') sont orientés vers la même direction ou vers des directions opposées.

4. Dispositif d'éclairage (100 ; 100') selon la revendication 1 ou 2, dans lequel la surface de réflexion (150) présente une symétrie de miroir par rapport à son axe principal (160).

5. Dispositif d'éclairage (100 ; 100') selon l'une quelconque des revendications précédentes, dans lequel en vue de haut la surface de réflexion (150) a une forme correspondant à un secteur d'un cercle,

ayant de préférence un angle intérieur entre 90° et 220° DEG, plus préférablement entre 150° et 200° DEG et encore plus préférablement entre 170° et 190° DEG.

6. Dispositif d'éclairage (100 ; 100') selon l'une quelconque des revendications précédentes, dans lequel les au moins deux minima (190) sont fournis à un angle, entre +/- 60° et +/- 85° DEG et de préférence entre +/- 70° et +/- 80° DEG par rapport à l'axe principal (160) de la surface de réflexion (150).

7. Dispositif d'éclairage (100 ; 100') selon l'une quelconque des revendications précédentes, dans lequel la surface de réflexion (150) ne comprend aucune discontinuité de saut.

8. Dispositif d'éclairage (100 ; 100') selon l'une quelconque des revendications précédentes, dans lequel le réflecteur (120, 125 ; 120', 125') est conçu et agencé de telle sorte qu'en vue de haut, la lumière est distribuée avec un angle supérieur à +/-50° DEG, de préférence supérieur à +/- 70° DEG et plus préférablement supérieur à +/- 75° DEG par rapport à l'axe principal (160) de la surface de réflexion (150).

9. Dispositif d'éclairage (100 ; 100') selon l'une quelconque des revendications précédentes, dans lequel le réflecteur (120, 125 ; 120', 125') est conçu de telle sorte qu'il est perpendiculaire à la surface à éclairer, la lumière est distribuée avec un angle supérieur à 60° DEG, de préférence supérieur à 70° DEG et plus préférablement supérieur à 80° DEG et le plus préférablement la lumière est distribuée avec un angle d'environ 85° DEG.

10. Dispositif d'éclairage (100 ; 100') selon l'une quelconque des revendications précédentes, dans lequel adjacent à au moins l'un des réflecteurs (125) au moins un déflecteur (140) est agencé entourant au moins partiellement la source de lumière de préférence dans un plan horizontal, dans lequel l'au moins un déflecteur (140) comprend de préférence une surface de réflexion vers l'intérieur pour rediriger la lumière vers la surface de réflexion (150) du réflecteur (125).

11. Dispositif d'éclairage (100 ; 100') selon l'une quelconque des revendications précédentes, dans lequel le dispositif d'éclairage (100 ; 100') comprend un logement dans lequel le réflecteur (120, 125 ; 120', 125') et l'au moins une source de lumière (220, 225 ; 220', 225') sont logés.

12. Dispositif d'éclairage (100 ; 100') selon l'une quelconque des revendications précédentes, dans lequel le réflecteur (120, 125 ; 120', 125') est agencé incliné avec son axe principal (160) par rapport au plan horizontal, de préférence avec un angle entre +/- 20° et +/- 60° DEG, plus préférablement entre +/- 30° et +/- 50° DEG et le plus préférablement entre +/- 35° et +/- 45° DEG.

13. Dispositif d'éclairage (100 ; 100') selon l'une quelconque des revendications précédentes, dans lequel la source de lumière (220, 225 ; 220', 225') est une source de lumière directionnelle émettant sensiblement de la lumière seulement dans la direction vers la surface de réflexion (150) du réflecteur (120, 125 ; 120', 125').

14. Dispositif d'éclairage (100 ; 100') selon l'une quelconque des revendications précédentes, dans lequel l'au moins une source de lumière (220, 225 ; 220', 225') est agencée au-dessus de l'axe principal (160) de la surface de réflexion (150), de préférence dans le centre du secteur d'un cercle.

15. Dispositif d'éclairage (100 ; 100') selon l'une quelconque des revendications précédentes, dans lequel le dispositif d'éclairage (100 ; 100') comprend au moins deux sources de lumière agencées avec un décalage par rapport à l'axe principal (160) de la surface de réflexion (150) de telle sorte que chaque source de lumière émet de la lumière vers une zone prédéterminée de la surface de réflexion (150).

16. Dispositif d'éclairage (100 ; 100') selon l'une quelconque des revendications précédentes, dans lequel la source de lumière (220, 225 ; 220', 225') comprend une diode électroluminescente à luminosité élevée, un réseau/groupement de diodes électroluminescentes, un module de couleur et/ou un agencement de diodes électroluminescentes à puce sur carte, dans lequel facultativement le dispositif d'éclairage comprend en outre un moyen de diffusion comme des plaques, disques ou chambres de diffusion.

17. Système d'éclairage pour éclairer des tunnels, passages souterrains ou métros, comprenant un dispositif d'éclairage (100 ; 100') selon l'une quelconque des revendications 1 à 16.

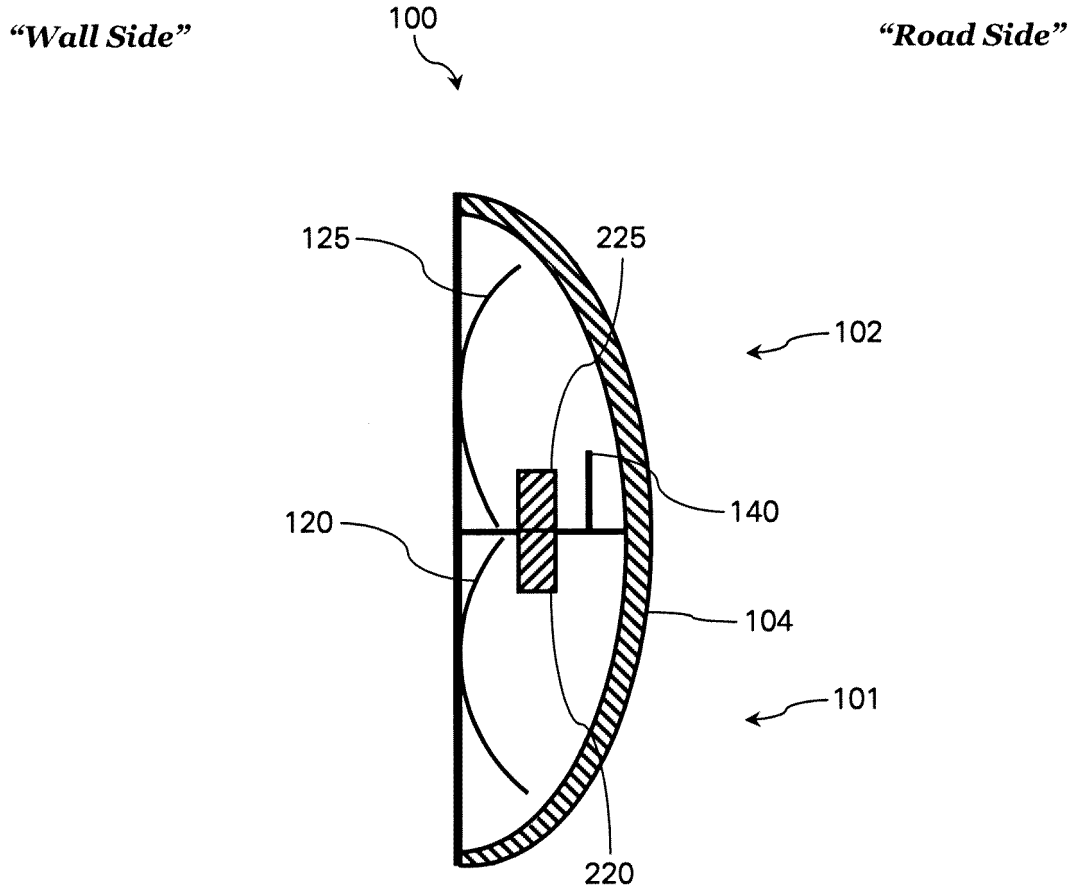

Fig. 1

"Wall Side" *"Road Side"*

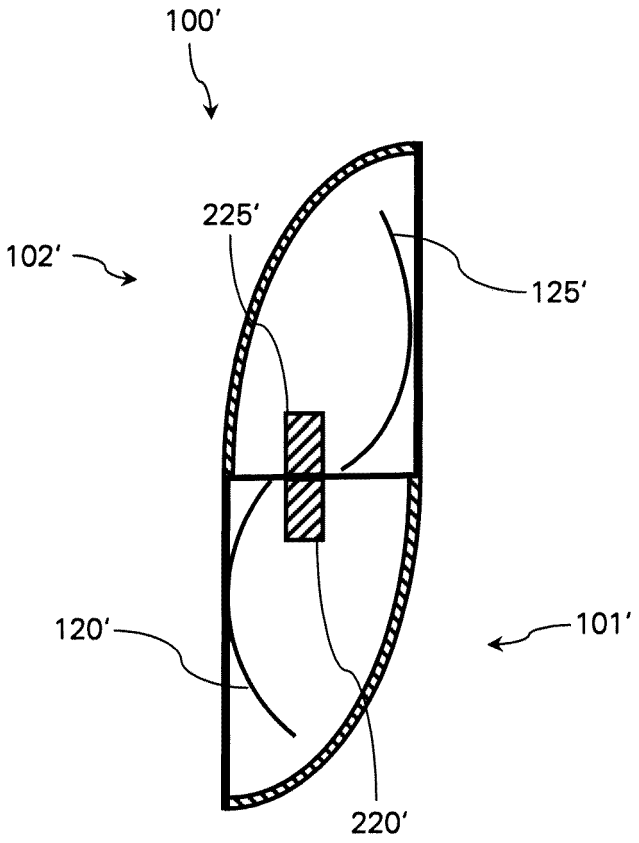

Fig. 2

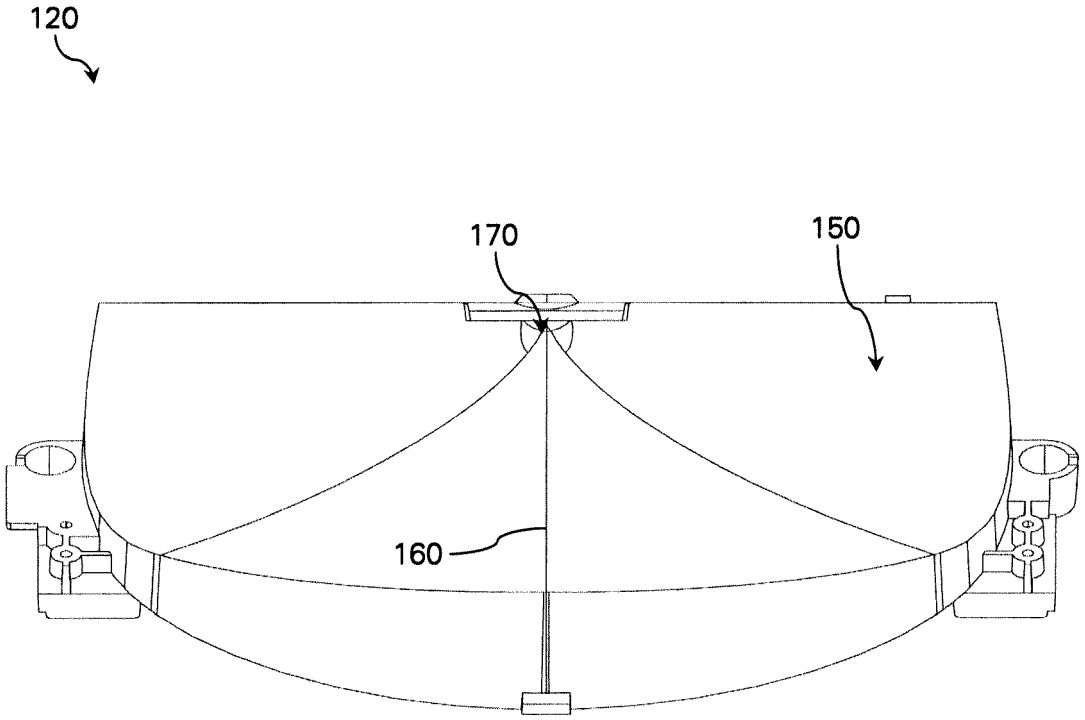

Fig. 3

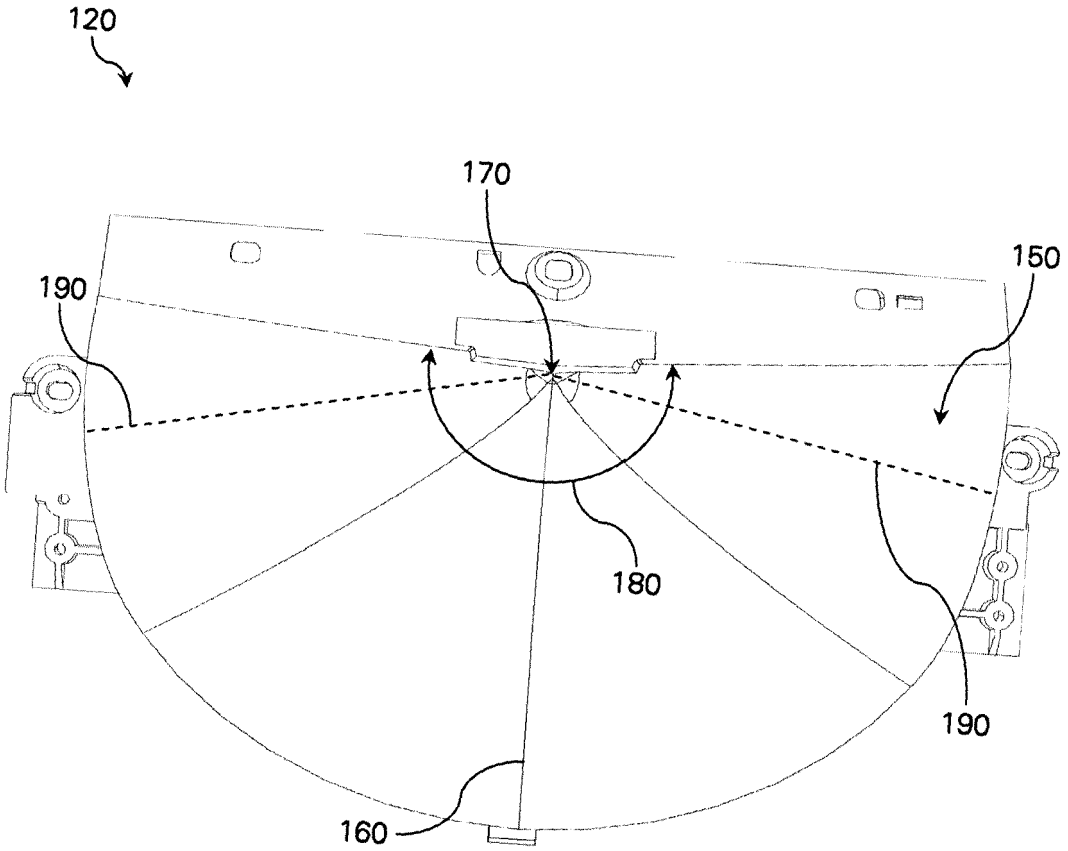

Fig. 4

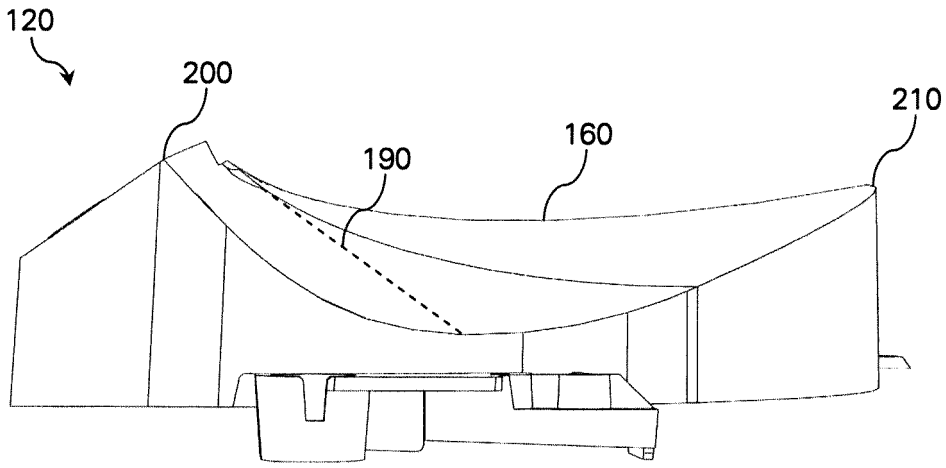

Fig. 5

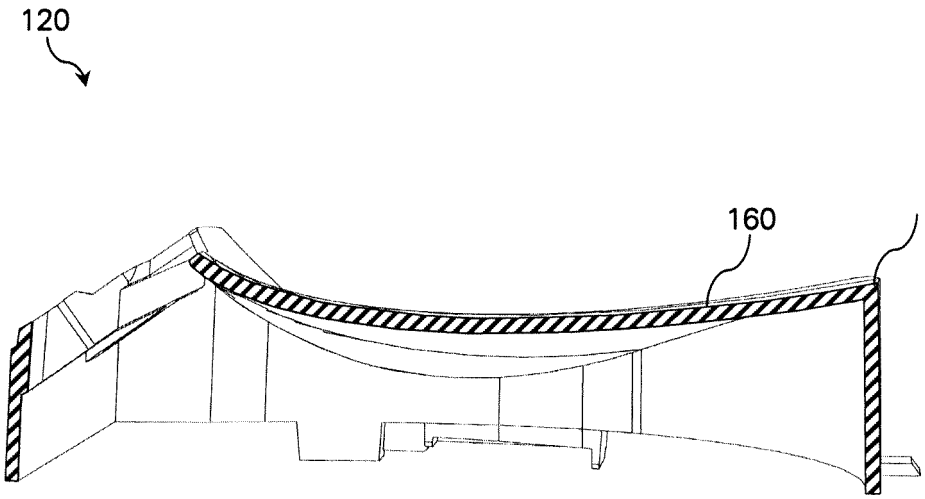

Fig. 6

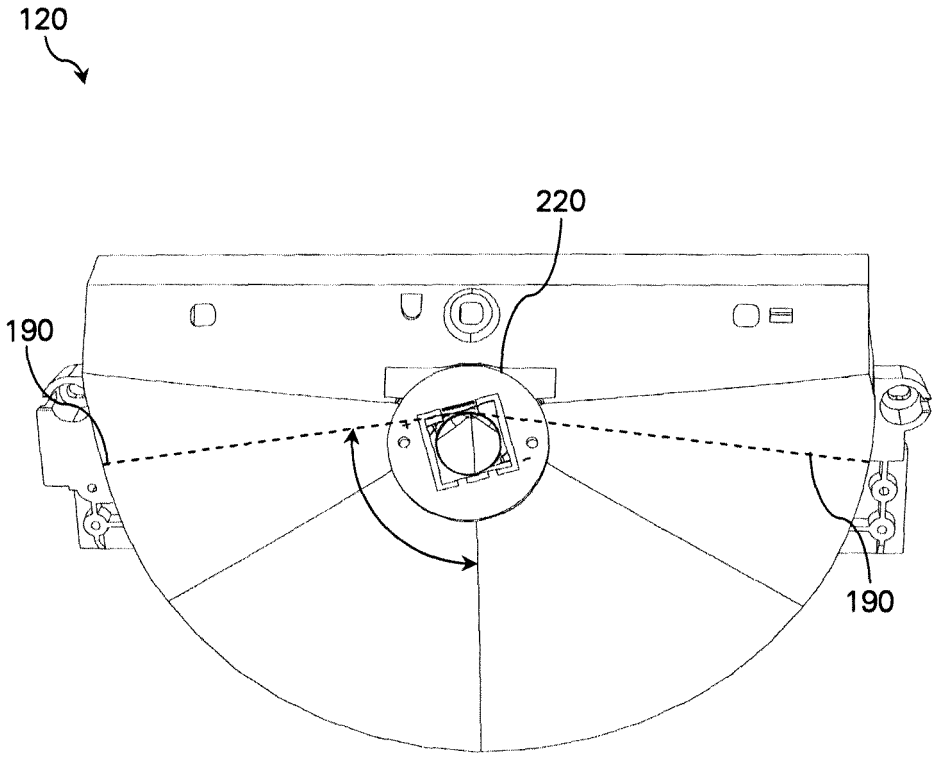

Fig. 7

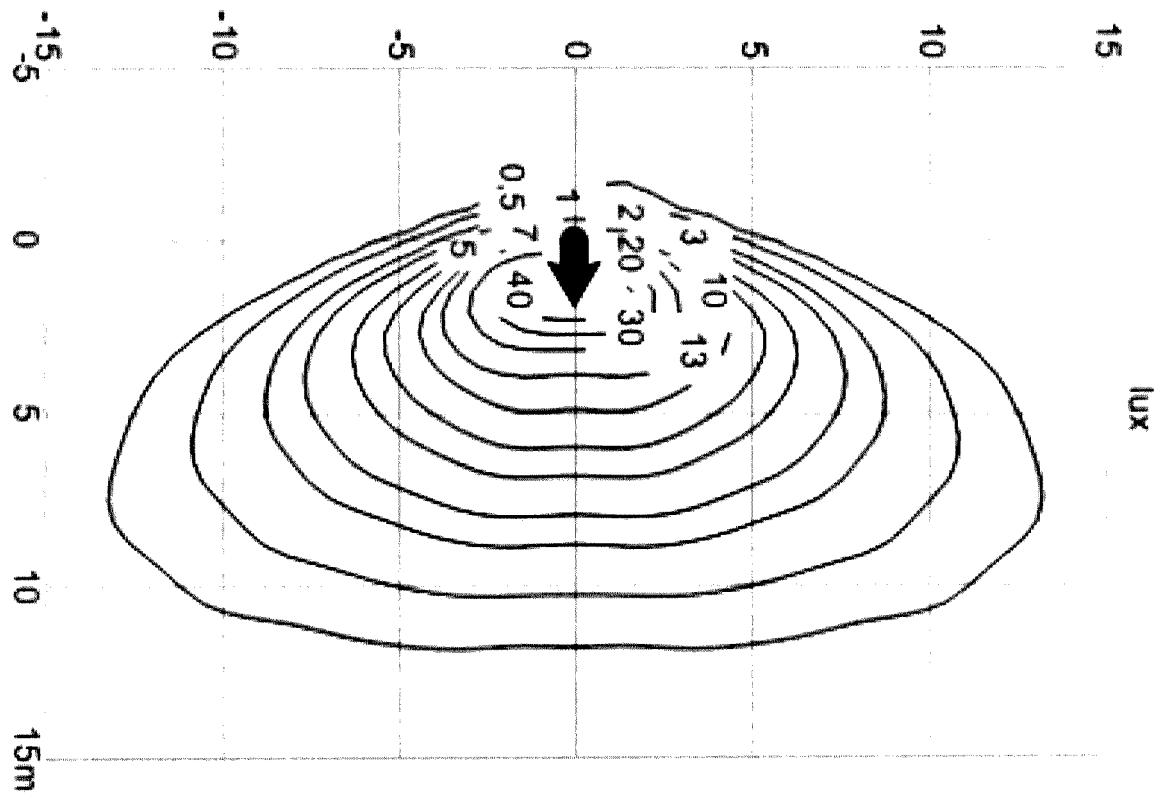

Fig. 8

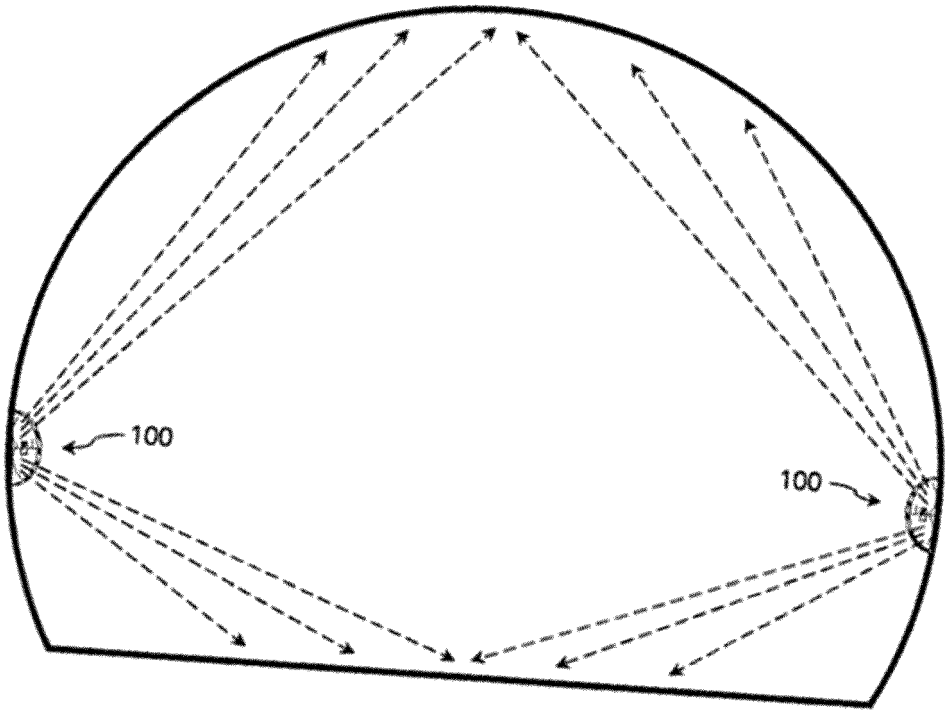

Fig. 9

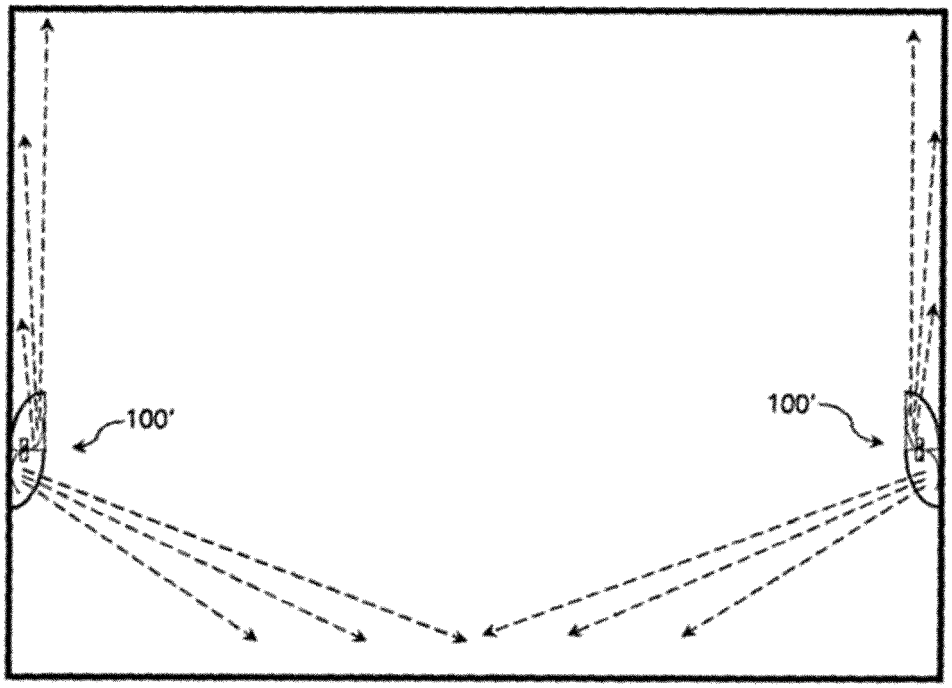

Fig. 10

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 2375130 A1 **[0002]**
- EP 2148129 A1 **[0002]**