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(54) **Lighting module for tunnel, road or street light**

(57) Lighting module (11, 21) for tunnel, road or street lighting, comprising a LED (13, 23), and a lens body (12, 22) adapted to distribute the light emitted by the LED (13, 23), wherein the LED (13, 23) is attached to a front side (14, 24) of said lens body (12, 22) and wherein the lens body (12, 22) is adapted to distribute the light in a direction generally opposite to the light emitting direction of the LED (13, 23).

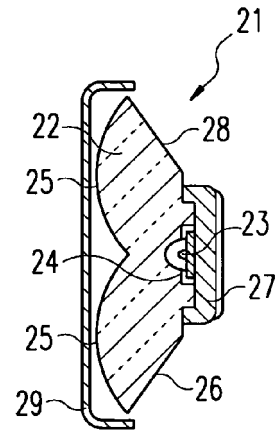


Fig. 6

Description

[0001] The present invention relates to a lighting module for the lighting of tunnels, roads and streets, which is positioned at a low mounting height level on one or both sides of a tunnel, a road or a street.

[0002] In the past for the lighting of roads, streets and also pedestrian areas, street lights with conventional masts were normally used. On the other hand, for the lighting of tunnels and underpasses, luminaires were used which were fixed on the ceiling of the tunnel or underpass and provided the required light down to the road and the walls of the tunnel or the underpass.

[0003] In the recent past more and more lighting systems appeared with the concept of "Flat Beam" lighting where the mounting height of the luminaires is preferable between 0.5 meters and 1.5 meters, through which no conventional masts are anymore needed for the lighting of roads, streets and pedestrian areas, and in tunnels and underpasses the luminaires have not to be fixed to the ceiling anymore. Such a lighting system is described in the European patent application EP 2 148 129 A1. This document describes lighting units which are positioned at the side walls of a tunnel or an underpass in a height of e.g. 1 meter. Each lighting unit holds two lighting means, which on the one hand light the road surface of the tunnel or the underpass and on the other hand light the sidewalls of the tunnel or the underpass. This lighting system therefore fulfils two main functions in the interior zone of a tunnel, namely visibility and guidance. Before, for each function one dedicated system has been usually used.

[0004] At present, luminaires as described in EP 2 148 129 A1 are often equipped when mounted in streets with HID lamps and when mounted in tunnels with HPS or fluorescent lamps. The use of such lamps, however, leads to a big size of the luminaires and a quite poor optical efficiency. To reduce the luminaires' size and to increase the optical performance, the use of LEDs as light sources is described in EP 2 148 129 A1.

[0005] When using LEDs it is, however, necessary to include a cooling device for the LEDs, e.g. a heat sink, in the luminaire. As a result of the desired light directions of the luminaire, the heat sink, the LEDs and one or more reflectors has to be arranged in a particular way to achieve the desired light direction. This for example leads to the problem that at least some parts of the heat sink have to be positioned in the luminaire at the side where the luminaire is fixed to the sidewall and therefore the cooling of the heat sink is not as effective as possible.

[0006] It is therefore the object of the present invention to propose a lighting module for tunnel, road or street lighting, where the positioning of the different parts in the lighting module is more flexible.

[0007] This object is achieved by means of the features of the independent claim. The dependent claims develop further the central idea of the present invention.

[0008] The present invention relates to a lighting mod-

ule for tunnel, road or street lighting that comprises at least one LED as a light source and a lens body which is adapted to distribute the light emitted by the LED. According to the invention the LED is attached to a front side of the lens body and the lens body is adapted to distribute the light in a direction generally opposite to the light emitting direction of the LED.

[0009] In view of this arrangement, it is now possible that the LED or a cluster of LEDs can be positioned in such a way that the emitting side is oriented opposite to the road way or lit area.

[0010] The lens body furthermore may comprise a reflective surface being arranged at a side opposite of the LED. This reflective surface can be concavely formed in a longitudinal direction of a tunnel, road or street to be lit or comprises - seen in the longitudinal direction of a tunnel, road or a street to be lit - two convexly formed portions.

[0011] The lens body can in addition comprise a light emitting surface being arranged below the LED and furthermore a second light emitting surface being arranged above the LED. When the lens body only comprises a light emitting surface being arranged below the LED, the lighting module lights the road surface and therefore the lighting module is not only but mainly used for the lighting of roads, streets and pedestrian areas. When the lens body further comprises a second light emitting surface being arranged above the LED the lighting module lights not only a road surface but also for example a side wall of a tunnel or an underpass.

[0012] In case of the two light emitting surfaces arranged at the lens body the reflective surface may comprise in vertical direction two convexly formed surface portions.

[0013] Furthermore the lighting module may comprise a heat sink being arranged at the backside of the LED and preferably covering completely the LED. The heat sink can comprise electrical connection means for connecting the LEDs to power supply means.

[0014] In this embodiment of the invention it is now possible that a heat sink can be positioned away from for example a sidewall of a tunnel and therefore the cooling of this heat sink is in particular effective.

[0015] The lighting module furthermore may comprise a plurality of LEDs whereas the LEDs being arranged at the center portion of the front side of the lens body.

[0016] These and other aspects and advantages of the present invention will become more apparent when studying the following detailed description, in connection with the figures, in which

Fig. 1 shows a lighting of a road with the lighting modules according to the invention;

Fig. 2 shows a lighting of a tunnel with the lighting modules according to the invention;

Fig. 3 shows a perspective view of a first embodiment

- of the lighting module according to the invention;
- Fig. 4 shows two transversal views - partly different formed - of a first embodiment of the lighting module according to the invention;
- Fig. 5 shows a perspective view of a second embodiment of the lighting module according to the invention;
- Fig. 6 shows a transversal view of a second embodiment of the lighting module according to the invention;
- Fig. 7 shows two longitudinal views of lighting modules according to the invention;
- Fig. 8 shows a polar intensity curve of the road lighting distribution of a first embodiment of the lighting module in transversal plane;
- Fig. 9 shows a polar intensity curve of the road lighting distribution of a second embodiment of the lighting module in transversal plane;
- Fig. 10 shows a polar intensity curve of the road lighting distribution in longitudinal plane.

[0017] Fig. 1 and 2 show the lighting of a street and a tunnel. In those variations the lighting modules 11, 21 according to the invention are positioned at a low mounting height level of preferable 0.5 - 1.5m, e.g. 1 meter or 1.25m. In Fig. 1 the lighting modules 11 are placed on the roadside on poles or short masts and only light the surface of the road. In difference thereto in Fig. 2 the lighting modules 21 are fixed to the sidewalls of the tunnel and light not only the surface of the road in the tunnel but also the sidewalls of the tunnel. However, it is also possible, that the lighting modules only light the surface of the road in the tunnel. The distance between each lighting module can be between 5 - 15m.

[0018] In the following the lighting modules 11, 21 according to the invention are described in detail.

[0019] Fig. 3 and 5 each show a perspective view of one embodiment of a lighting module according to the present invention. The lighting module 11 in Fig. 3 is formed to light the road surface and therefore will particularly be used for the lighting of roads, streets and pedestrian areas as already described above. As can be seen in Fig. 3 and 4 (Fig. 4 shows two transversal views of the lighting module 11 of Fig. 3, which are partly different formed as explained in detail later), the lighting module 11 comprises a lens body 12, at least one LED 13 and a heat sink 17. The heat sink 17 also comprises electrical connection means for connecting the LED 13 to power supply means which are not shown. Preferably high power LEDs are used and the lens body 12 is man-

ufactured in injected plastic or moulded glass.

[0020] The LED 13 or a cluster of LEDs is attached to a front side 14 of the lens body 12, whereby the heat sink 17 which is arranged at a backside of the LED 13 can be also fixed to the lens body 12. The LED 13 may be glued directly to the front side 14 of the lens body 12 with the help of an optical gel that ensures the continuity of the light beam through the lens body 12. In view of this arrangement of the lens body 12, the heat sink 17 and the LED 13 it is possible that the lighting module 11 fulfills the requirements of IP67.

[0021] For the distribution of the light in a direction generally opposite to the light emitting direction of the LED 13, the lens body 12 furthermore comprises a reflective surface 15 which is arranged at a site opposite to the front side 14 where the LED 13 is attached to the lens body 12. This reflective surface 15 can for example be formed in vertical direction convexly. Due to this construction it is therefore now possible that the light emitting direction of the LED 13 is oriented opposite to the road way or lit area.

[0022] For emitting the light to the road surface that has been reflected in the lens body 12 from the reflective surface 15, the lens body 12 additionally comprises a light emitting surface 16 arranged below the LED 13. This light emitting surface 16 can comprise a torical or conical portion. Two different forms of the light emitting surface 16 are also shown in the transversal views in Fig. 4.

[0023] In difference thereto the lighting module 21 in Fig. 5 and 6 (Fig. 6 shows a longitudinal view of the lighting module 21 of Fig. 5) comprises a lens body 22 which is formed in such a way that the lighting module 21 can not only light a road surface but also a sidewall for example of a tunnel. Therefore the lens body 22 again has a reflective surface 25. This reflective surface 25, however, comprises in vertical direction two convexly formed surface portions. In addition, the lens body 22 offers beside the light emitting surface 26 arranged below the LED 23, a second light emitting surface 28 which is arranged above the LED 23. The light from the LED 23 reflected by the surface 25 to the second light emitting surface 28 is then for lighting the sidewall of a tunnel.

[0024] The LED 23 is again attached to the front side 24 of the lens body 22 as already described in view of Fig. 3 and 5. Also the heat sink 27 is arranged at the back side of the LED 23, however, the form of the heat sink 27 differs in that it is now possible that the lighting module 21 light also the sidewall of a tunnel. The heat sink 27 again comprises electrical connection means for connecting the LED 23 to power supply means which are not shown.

[0025] The LED 23 is positioned on the front side 24 of the lens body 22 in such a way that preferable 2/3 of the light emitted by the LED 23 is directed to the light emitting surface 26 and therefore to the road surface and 1/3 is directed to the second light emitting surface 28 and therefore to the sidewalls of a tunnel.

[0026] For the mounting of the lighting module 21 to a

tunnel wall a normal mounting element 29 is used. A similar mounting element can be used for the lighting module 11 in the Fig. 3 and 3 to mount the lighting module 11 on a short mast or pole.

[0027] The reflective surface 15 of the lens body 12 (lighting module 11 in Fig. 3 and 4) and the reflective surface 25 of the lens body 22 (lighting module 21 of Fig. 5 and 6) can be both formed concavely in longitudinal direction as can be seen in Fig. 7 left side. Another opportunity for the form of the reflective surface 15,25 in longitudinal direction is that the reflective surface 15, 25 comprises two convexly formed portions which can be seen in Fig. 7 right side. Both forms help to control the light distribution vertically and also to obtain a narrow beam through the transversal plane.

[0028] Fig. 8, 9 and 10 show the preferred lighting distribution of the lighting module 11 of Fig. 3 and 4 and the lighting module 21 of Fig. 5 and 6.

[0029] In fig. 8 the polar intensity curve in the transversal plane for the lighting module 11 of Fig. 3 and 4 and therefore for the lighting of the road surface is shown. For a good guidance and visibility and to avoid glare the preferred light angle is between 45° and 88°, e.g. 85°.

[0030] Fig. 9 shows the polar intensity curve in transversal plane for the lighting module 21 of Fig. 5 and 6. In addition to Fig. 8, Fig. 9 also shows the light distribution for lighting the sidewalls of a tunnel. Here a preferred angle is 145°.

[0031] Fig. 4 shows a polar intensity curve in the longitudinal plane for the light emitted to the road surface and for the light emitted to the side wall. A preferred angle is here 70°.

[0032] The lighting module 11, 21 according to the invention is not limited to one LED 13, 23. As can be seen from Fig. 7, a plurality of LEDs is also possible, which can then be arranged at a center portion of the front side 14, 24 of the lens body 12, 22.

Claims

1. Lighting module (11, 21) for tunnel, road or street lighting, comprising at least one light source formed by an LED (13, 23), and a lens body (12,22) adapted to distribute the light emitted by said at least one LED (13, 23), wherein said at least one LED (13, 23) is attached to a front side (14, 24) of said lens body (12, 22) and wherein said lens body (12, 22) is adapted to distribute the light in a direction generally opposite to the light emitting direction of said LED (13, 23).
2. Lighting module according to claim 1, wherein said lens body (12, 22) comprises a reflective surface (15, 25) being arranged at a side opposite to said at least one LED (13, 23).
3. Lighting module according to claim 2, wherein said reflective surface (15, 25) is concavely formed in a longitudinal direction of a tunnel, road or street to be lit.
4. Lighting module according to claim 2, wherein said reflective surface (15, 25) comprises - seen in a longitudinal direction of a tunnel, road or street to be lit - two convexly formed portions.
5. Lighting module according to one of claims 2 to 4, wherein said lens body (12, 22) comprises a light emitting surface (16, 26) being arranged below said LED (13, 23).
6. Lighting module according to claim 5, wherein said lens body (12, 22) comprises a second light emitting surface (28) being arranged above said LED (13, 23).
7. Lighting module according to claim 6, wherein said reflective surface (15, 25) comprises in vertical direction two convexly formed surface portions.
8. Lighting module according to one of the preceding claims, comprising further heat sink (17, 27) being arranged at a back side of said LED (13, 23) and preferably covering completely said LED (13, 23).
9. Lighting module according to claim 8, wherein said heat sink (17,27) comprises electrical connection means for connecting the LED (13, 23) to power supply means.
10. Lighting module according to one of the preceding claims, wherein said module (11, 21) comprises a plurality of LEDs (13, 23), said LEDs (13, 23) being arranged at a center portion of the front side (14, 24) of said lens body (12, 22).

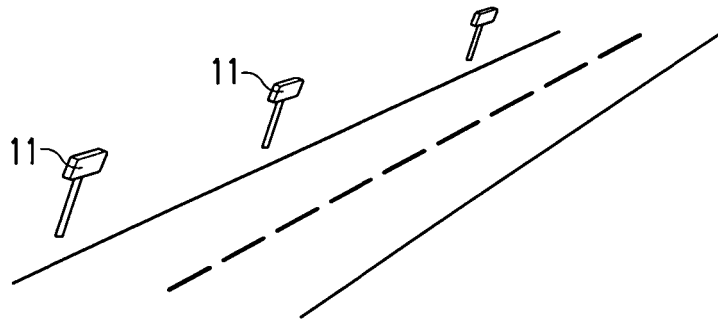


Fig. 1

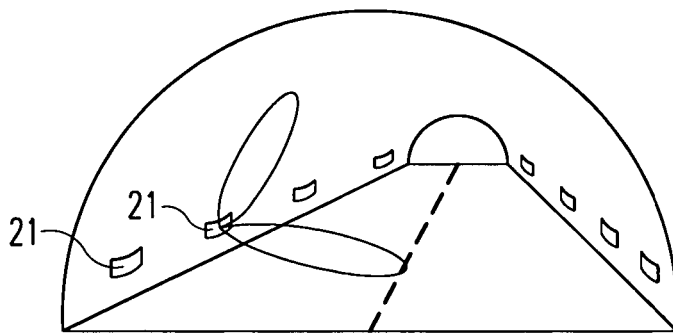


Fig. 2

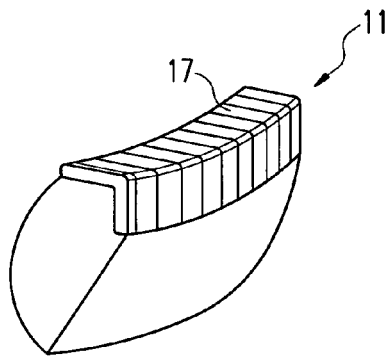


Fig. 3

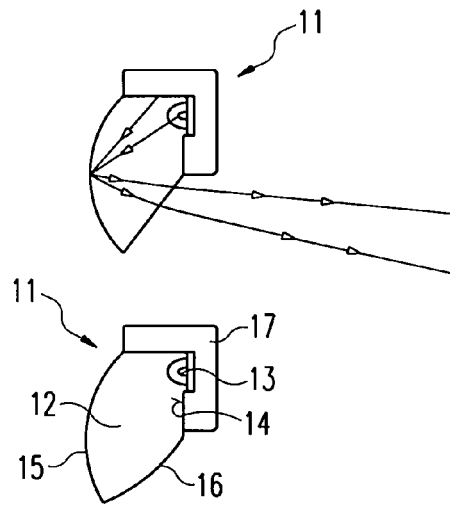


Fig. 4

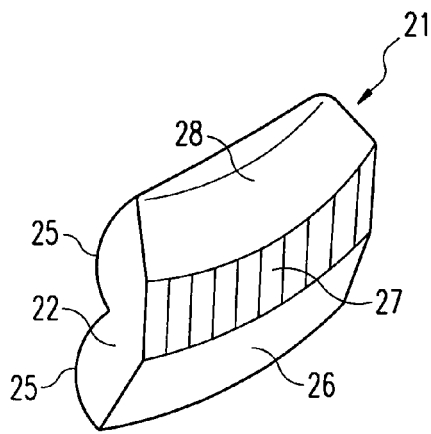


Fig. 5

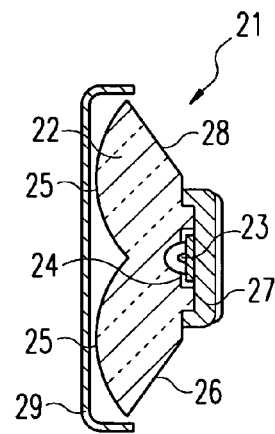


Fig. 6

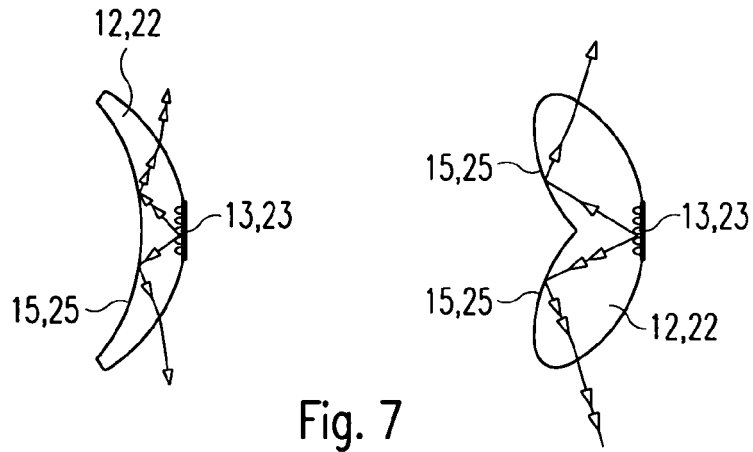


Fig. 7

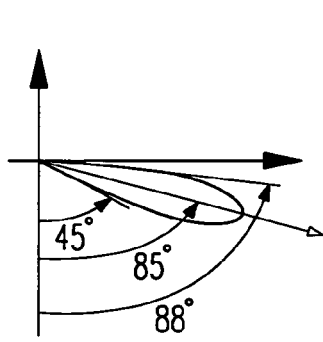


Fig. 8

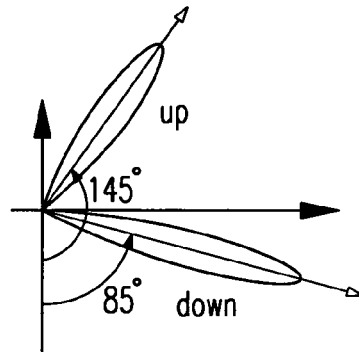


Fig. 9

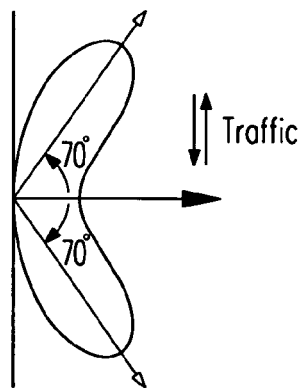


Fig. 10



EUROPEAN SEARCH REPORT

Application Number
EP 10 29 0189

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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			F21S F21V
Place of search		Date of completion of the search	Examiner
Munich		31 August 2010	Arboreanu, Antoniu
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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