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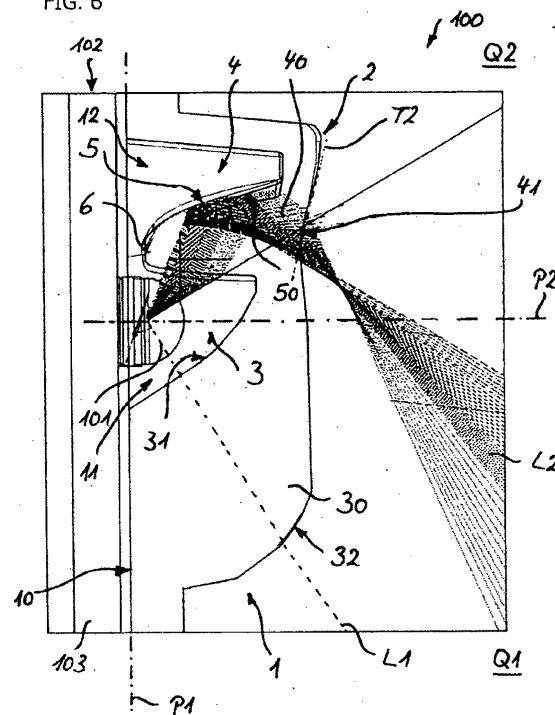
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(54) **OPTICAL ELEMENT, LUMINAIRE AND LIGHTING SYSTEM**

(57) The present invention is directed to an optical element (1) for controlling a light distribution pattern of a light source (101) radiating first light beams (L1) to a first geometric quarter-space (Q1) and second light beams (L2) to a second geometric quarter-space (Q2), the first and second geometric quarter-spaces (Q1, Q2) being defined by mutually perpendicular first and second geometric planes (P1, P2) so that the first geometric plane (Pi) constitutes a boundary between the first and second geometric quarter-spaces (Q1, Q2). The optical element (1) is made of a transparent piece (2). The optical element (1) comprises a first cavity (3) for receiving the light source (101), a second cavity (4) being delimited by a reflection surface (5) of the transparent piece (2) towards the first cavity (3) for controlling at least part of the second light beams (L2) by reflecting the at least part of the second light beams (L2) to the first geometric quarter-space (Q1), and a lens-section (30) of the transparent piece (2) at least partially bordering the first cavity (3) for acting as a lens for controlling a light distribution pattern of the first light beams (L1). The reflection surface (5), in a sectional view with a sectional plane being perpendicular to the first and second geometric planes (P1, P2) and when viewed parallel to the first and second geometric planes (P1, P2), has an arcuate contour (50), and in a sectional view with a sectional plane parallel to the second geometric plane (P2) and when viewed orthogonally to the second geometric plane (P2), has a wing shaped contour (51) with a central convex section (52) protruding towards the first cavity (3) or the first geometric plane (Pi), and at each side of the central convex section (52) along the first geometric plane (Pi), a concave section (53, 54)

bulged away from the first cavity (3) or the first geometric plane (P1), so that a total internal reflection takes place at the reflection surface (5) when the at least part of the second light beams (L2) arrive, from inside the transparent piece (2), at the reflection surface (5).

FIG. 6



Description

[0001] The present invention is directed to an optical element for controlling a light distribution pattern of a light source, a luminaire, like a street light, comprising said optical element and a light source, and a lighting system comprising the luminaire and a post for carrying the luminaire at a location of operation.

[0002] Usually, light sources emit their light upon operation over a wide range. For many lighting purposes it is required to direct the light into a particular direction or range. This can be done by blocking the light emission directions which are not required. For increase of lighting efficiency it is known to redirect light being emitted in a non-desired direction towards a desired light emission direction. Therefore, reflectors can be used to redirect the light to the desired direction. Redirection of light may also be obtained by total internal reflection (TIR) particularly in cases where optical elements like lenses are used for light control.

[0003] There exist luminaires using lenses to emit light in a main (e.g. forward) direction. Such lights are, for instance, street lights which are usually fixed at a raised position and intended to emit most of their light to a downward direction with respect to a horizontal plane. As these luminaires are usually positioned at a side of a street or footpath, it is often required to redirect light, which is emitted by the light source away from the street (e.g. back light), so that also most of this part of the light is directed towards or across the street. It is also required to emit the light sideways - i.e. along a direction along the street - preferably to obtain a continuous combined light pattern of neighboring luminaires; e.g. along the street.

[0004] Fig. 1 shows an example for light distribution of a known street light luminaire. As can be seen, the light distribution pattern is generally designed to emit light as good as possible across the street and at the same time as far as possible along the street. The frame indicated as TTA shows a typical area where the light from optical elements using the TIR function of backlight is reflected to. Such optical elements often use cavities in the lens body to provide surfaces which allow TIR function. These surfaces usually have a horizontal cross section extending linearly while having a slightly curved layout in a vertical direction to allow for the TIR function. The surface may further be structured to increase the distribution pattern. These diffused or scattered functions, however, do not allow a fine controlled reflection. The TIR function may also be combined with a second control stage at a complex designed outer surface of the lens, which results in increased dimensions of the optical element and further complicate the lens production.

[0005] It is thus an object of the present invention to provide an optical element as well as a luminaire and a lighting system being equipped with said optical element, which allow for an increased accuracy in light reflection and thus control of a desired light distribution pattern with improved lighting efficiency.

[0006] These and other objects, which become apparent upon reading the description, are solved by the subject-matter of the independent claims. The dependent claims study further the central idea of the present invention.

[0007] According to a first aspect the present invention is directed to an optical device for controlling a light distribution pattern of a light source radiating first light beams to a first geometric quarter-space and second light beams to a second geometric quarter-space. The first and second geometric quarter-spaces are defined by mutually perpendicular first and second geometric planes so that the first geometric plane constitutes a boundary between the first and second geometric quarter-spaces. The optical element is made of a transparent piece. The optical element comprises a first cavity for receiving the light source, a second cavity, and a lens-section. The second cavity is delimited by a reflection surface of the transparent piece preferably towards the first cavity for controlling at least part of the second light beams by reflecting the at least part of the second light beams to the first geometric quarter-space. The lens-section of the transparent piece at least partially borders the first cavity for acting as a lens for controlling a light distribution pattern of the first light beams. The reflection surface has an arcuate contour in a sectional view with a sectional plane being perpendicular to the first and second geometric planes and when viewed parallel to the first and second geometric planes. The reflection surface has a wing shaped contour in a sectional view with a sectional plane parallel to the second geometric plane and when viewed orthogonally to the second geometric plane. The wing shaped contour comprises a central convex section protruding towards the first cavity or the first geometric plane, and, at each side of the central convex section along the first geometric plane, a concave section which is bulged away from the first cavity or the first geometric plane, so that a total internal reflection takes place at the reflection surface when the at least part of the second light beams arrive, from inside the transparent piece, at the reflection surface.

[0008] The reflective surface shaped in a way as described allows for a fine three-dimensional variation in the TIR function to thus provide a combination of free form shapes to accurately control the light distribution pattern in a manner to lead the reflected light in any desired direction and particularly in most efficient areas as desired. This allows for any back light (i.e. second light beams) to be controlled more easily and more efficiently which may result in a power reduction by increasing the utilization factor so that less flux is needed to reach the minimal lighting level. The optical element thus allows for energy saving in particular for long term installations such as outdoor luminaires. As mentioned, this can be obtained by defining the shape of the reflection surface to thus adapt the light distribution pattern accurately, e.g. for wide areas or narrow streets or the like. Also, lateral spread of the light to both sides (i.e. in the C0-C180 C-

planes; left-right direction) can also be easily controlled particularly by the design of the wing shaped contour. This allows for an accurate control of the light distribution pattern and increases the accuracy to the required C-plane and/or gamma angle to improve the lighting efficiency as, for instance, indicated in Fig. 1 with the WTA frame showing the wished target for lighting efficiency. Hence, for instance, a control in a desired Cmax plane (see Fig. 1B)' can be easily and accurately obtained by the defined contour of the reflective surface resulting in a corresponding free form shape to lead the reflected light in a desired and/or most efficient area.

[0009] The first cavity and the second cavity may be separated by a wall of the transparent piece comprising the reflection surface. Providing only a single wall between these two cavities results in a comparably simple structure of the optical element and thus simplified production thereof. Also, this wall allows for an easy and efficient light control towards the reflection surface. As the reflection surface is provided by this wall, provision of the reflection surface and thus the structure of the transparent piece can be simplified as well.

[0010] The reflection surface preferably has a saddle-shaped contour. Such a three-dimensional contour allows for smooth transitions over the whole surface as well as a highly accurate control of the light reflection.

[0011] The arcuate contour preferably becomes more distant from the first geometric plane with increased distance from the second geometric plane. This allows for an easy control of the light, e.g., a fine control of the light distribution regarding a desired gamma angle.

[0012] Preferably, tangents of the arcuate contour and a normal of the second geometric plane, respectively, enclose an angle α , which becomes smaller with increased distance from the second geometric plane. This feature allows for a fine control of the light distribution particularly with respect to the gamma angles and also allow for a highly efficient TIR function.

[0013] The arcuate contour preferably has a parabolic or at least partially parabolic form, like a half parabolic form. This smooth contour allows for an easy production of the lens, easy control of the TIR function and thus accurate and efficient lighting control.

[0014] The concave sections each have an apex between the central convex section and a most distant end of the concave section with respect to the convex section. Hence, with increased distance from the central convex section, a tangent of the concave section first encloses an increasing angle with respect to the second geometric plane which then decreases again and becomes negative. For instance, the concave section may have an arc-shape. This shape of the concave sections allow for a fine control of the light distribution and even allows for a fine control of back light being emitted closer to the Co and C180 planes with reference to Fig. 1B.

[0015] The optical element or at least its reflection surface can be substantially symmetric with respect to a third geometric plane perpendicular to the first and sec-

ond geometric planes. The third geometric plane may preferably cross the central convex section. Such a symmetric layout of the optical element on the one hand allows for an easy production of the same. On the other hand, a defined symmetrical light distribution pattern can thus be easily obtained which may, for instance, be preferably used for a street lighting purpose.

[0016] The optical element may further comprise a second lens-section of the transparent piece, preferably at least partially bordering the second cavity, for acting as a lens for further controlling the light distribution pattern of the at least part of second light beams after being reflected by the reflection surface. Even though the particular shape of the reflection surface already allows for a highly accurate light distribution pattern, the light output section of the transparent piece, i.e. its outer surface, may also be used and designed, e.g. for a kind of fine tuning the light output, to thus increase accuracy of the light distribution pattern.

[0017] The second lens-section may comprise an outer bordering surface of the transparent piece having, in a sectional view with a sectional plane being perpendicular to the first and second geometric plane and when viewed parallel to the first and second geometric planes, an angled and/or curved contour. The angled and/or curved contour can preferably be slanted towards the first geometric quarter-space. Alternatively or additionally, tangents of the angled and/or curved contour can preferably be angled with respect to the second plane (preferably along its extension). Hence, the outer surface of the transparent piece can be used to further improve the light distribution control while not or not severely changing (e.g. increasing) the dimensions of the optical element.

[0018] A first surface of the optical device may comprise pits constituting the first and second cavities. This allows for an easy production of the optical element. The first surface may be substantially planar at least on regions surrounding the pits. This allows for an accurate positioning of the optical element, e.g., with respect to a light source. The first surface may preferably extend parallel to the second plane. This allows for an easy production of the optical element and an easy attachment of the same on a desired device.

[0019] The transparent piece can preferably be made of one of the following: acrylic plastic, polycarbonate, optical silicone, glass, or combinations thereof. These materials allow for an accurate light control, light passing, and a long term use.

[0020] According to a further aspect, the present invention is directed to a luminaire, like a street light, comprising an optical element according to the present invention as well as a light source being provided - preferably received in the first cavity - so as to emit the first and second light beams. Hence, a luminaire can be easily provided in which light emitted by the light source can be easily controlled to allow for a desired light distribution pattern.

[0021] The light source can be a light emitting diode (LED). LEDs have small dimensions, high light output and can efficiently be operated.

[0022] The luminaire may further comprise an LED-module comprising an LED as the light source. In this case, the optical device may be attached to part of the LED-module, preferably to a circuit board (e.g. printed circuit board; PCB) of the LED-module. Hence, a luminaire can be provided in a most compact manner, which can be easily handled.

[0023] According to a further aspect, the present invention is directed to a lighting system comprising a luminaire according to the present invention as well as a post, like a pole, for carrying the luminaire at a location of operation. This preferably such that the luminaire is oriented with the second geometric plane in a horizontal and, preferably, with the first geometric quarter-space being directed away from a vertical section of the post and/or being positioned below the second geometric plane. With this lighting system, the luminaire can be easily provided at any required location of operation. Also, the light distribution pattern may be controlled such that light emission mainly takes place away from the post to thus allow for a most efficient light emission.

[0024] Further features, advantages and objects of the present invention will become apparent for the skilled person when reading the following detailed description of embodiments of the invention and when taking in conjunction with the figures of the enclosed drawings.

- Fig. 1 shows a light distribution pattern of a common street light according to the prior art (A: gamma angles; B: C-planes),
- Fig. 2 shows a lateral cross-sectional side view of an optical element according to a first embodiment of the present invention,
- Fig. 3 shows a lateral side view of the optical element according to Fig. 2 indicating a total internal reflection (TIR) profile,
- Fig. 4 shows a bottom view of the optical element of Fig. 2,
- Fig. 5 shows a top view of a luminaire according to the present invention with an optical element according to Fig. 2 and exemplary light distribution paths,
- Fig. 6 shows a lateral side view of the luminaire according to Fig. 5,
- Fig. 7 shows a front view of a luminaire according to another embodiment of the present invention with an optical element according to a second embodiment of the present invention and exemplary light distribution paths,

Fig. 8 shows a top view of the luminaire according to Fig. 7,

Fig. 9 shows a lateral side view of the luminaire according to Fig. 7, and

Fig. 10 shows a sectional bottom view of the optical element of the luminaire according to Fig. 7.

[0025] The figures show different embodiments of an optical element 1 according to the present invention. The optical element 1 preferably is a lens. The optical element 1 is made of a transparent piece 2. The transparent piece 2 can be made of acrylic plastic, polycarbonate, optical silicone, glass, or combinations thereof.

[0026] The optical element 1 is provided for controlling a light distribution pattern of a light source 101 radiating first light beams L1 to a first geometric quarter-space Q1 and second light beams L2 to a second geometric quarter-space Q2. The first and second geometric quarter-spaces Q1, Q2 are defined by mutually perpendicular first and second geometric planes P1, P2 so that the first geometric plane P1 constitutes a boundary between the first and second geometric quarter-spaces Q1, Q2 as can exemplarily be seen in Figs. 2, 3, 6 and 9.

[0027] The optical element 1 comprises a first cavity 3 for receiving the light source 101 as can be clearly seen in Fig. 6 and 9.

[0028] The optical element 1 further comprises a second cavity 4 being delimited by a reflection surface 5 of the transparent piece 2 here preferably towards the first cavity 3 for controlling at least part of the second light beams L2 by reflecting the at least part of the second light beams L2 to the first geometric quarter-space Q1.

[0029] A first surface 10 of the optical element 1 may comprise pits 11, 12 constituting the first and second cavities 3, 4. The first surface 10 can be substantially planar at least on regions surrounding the pits 11, 12. The first surface 10 may preferably extend parallel to the second geometric plane P2, as can be seen in Figs. 2, 3, 6, 7 and 9.

[0030] The optical element 1 further comprises a lens-section 30 of the transparent piece 2 at least partially bordering the first cavity 3 for acting as a lens for controlling a light distribution pattern of the first light beams L1. The lens-section 30 can have any shape. Particularly, the inner surface 31 of the lens-section 30 bordering the first cavity 3 as well as the outer surface 32 of the lens-section 30 can be designed such that they allow for a desired light control.

[0031] The reflection surface 50, in a sectional view with a sectional plane being perpendicular to the first and second geometric planes P1, P2 and when viewed parallel to the first and second geometric planes, has an arcuate contour as can be seen, for instance, in Figs. 6 and 9. The arcuate contour 50 preferably becomes more distant from the first geometric plane P1 with increased distance from the second geometric plane P2. Tangents

T1 of the arcuate contour 50 and a normal N of the second geometric plane P2, respectively, may enclose an angle α , which becomes smaller with increased distance from the second geometric plane P2. This is exemplarily shown in Fig. 2. As can be seen in the enclosed exemplary embodiments, the arcuate contour 50 preferably has a parabolic or partially parabolic (here a half-parabolic) form. The arcuate contour 50 thus preferably allows for an accurate control of the light with respect to the gamma angles, as exemplarily shown in Fig. 1A.

[0032] The reflection surface 5, in a sectional view with a sectional plane parallel to the second geometric plane P2 and when viewed orthogonally to the second geometric plane P2, has a wing shaped contour 51. This is exemplarily shown in Fig. 4 and may also be gathered likewise from Figs. 5, 8 and 10. The wing shaped contour 51 has a central convex section 52 protruding towards the first cavity 3 or the first geometric plane Pi, and at each side of the central convex section 52 along the first plane Pi, a concave section 53, 54 bulged away from the first cavity 3 or the first geometric plane P1.

[0033] As can be gathered from Fig. 4, the concave sections 53, 54 may each have an apex 55, 56 between the central convex section 52 and a most distant end 57, 58 of the respective concave sections 53, 54 with respect to the convex section 52. This results in a somewhat arc-shaped contour of the concave sections 53, 54 as can be seen, for instance, in Fig. 4.

[0034] The reflection surface 5 has the arcuate contour 50 and the wing shaped contour 51 with its central convex section 52 and concave sections 53, 54, so that a total internal reflection takes place at the reflection surface 5 when the at least part of the second light beams L2 arrive, from inside the transparent piece 2, at the reflection surface 5, as exemplarily shown in Figs. 5 to 9.

[0035] As can be seen in Figs. 6 and 9, the first cavity 3 and the second cavity 4 can be separated by a wall 6 of the transparent piece 2. The wall 6 thus preferably comprises the reflection surface 5.

[0036] As can be gathered mainly from Figs. 4, 5 and 8, the reflection surface 5 may have a saddle shape.

[0037] As can be seen from Figs. 5, 7 and 8, the optical element 1 or at least its reflection surface 5 can be substantially symmetric with respect to a third geometric plane P3 being perpendicular to the first and second geometric planes P1, P2. The third geometric plane P3 preferably crosses the central convex section 52, as can be clearly gathered from Fig. 5.

[0038] The optical element 1 may further comprise a second lens-section 40 of the transparent piece 2 for acting as a lens for further controlling the light distribution pattern of the at least part of second light beams 2 after being reflected by the reflection surface 5. The second lens-section preferably at least partially borders the second cavity 4. This can be gathered, for instance, from Figs. 6 and 9.

[0039] The second lens-section 40 may comprise an outer bordering surface 41 of the transparent piece 2

having, in a sectional view with a sectional plane being perpendicular to the first and second geometric planes Pi, P2 and when viewed parallel to the first and second geometric planes Pi, P2, an angled and/or curved contour, wherein the angled and/or curved contour is preferably slanted towards the first geometric quarter-space Q1 and/or tangents T2 of the angled and/or curved contour are preferably angled with respect to the second plane P2 along its extension.

[0040] With particular reference to Figs. 5 to 10, a luminaire 100, like a street light, may be provided comprising an optical element 1 according to the present invention and as described herein above in detail. The luminaire 100 further comprises a light source 101. The light source 101 is preferably received in the first cavity 3 or at least positioned to emit light into the first cavity 3; i.e. provided so as to emit/radiate the first and second light beams Li, L2. The light source 101 may be an LED. The luminaire 100 may comprise an LED-module 102 comprising an LED as the light source 101 as, for instance, shown in Figs. 6, 7 and 9. The optical element 1 may preferably be attached to part of the LED-module 102, preferably to a circuit board 103 of the LED-module 102.

[0041] The present invention is further directed to a lighting system comprising the luminaire 100 according to the present invention as well as a post 200, like a pole, for carrying the luminaire 100 at a location of operation. Just as an example, it is kindly referred to the lighting systems as shown in Figs. 1A and 1B. The post 200 preferably carries the luminaire 100 at the location of operation such that the luminaire 100 is oriented with the second geometric plane P2 in a horizontal and, preferably, with the first geometric quarter-space Q1 being directed away from a vertical section 201 of the post 200 and/or being positioned below the second geometric plane P2.

[0042] The present invention is not limited to the described embodiments as long as being covered by the appended claims. All the features of the embodiments described hereinabove can be combined in any possible way and be provided interchangeably.

Claims

1. An optical element (1) for controlling a light distribution pattern of a light source (101) radiating first light beams (L1) to a first geometric quarter-space (Q1) and second light beams (L2) to a second geometric quarter-space (Q2), the first and second geometric quarter-spaces (Q1, Q2) being defined by mutually perpendicular first and second geometric planes (Pi, P2) so that the first geometric plane (Pi) constitutes a boundary between the first and second geometric quarter-spaces (Q1, Q2), wherein the optical element (1) is made of a transparent piece (2) and comprises:

- a first cavity (3) for receiving the light source

- (101),
- a second cavity (4) being delimited by a reflection surface (5) of the transparent piece (2) towards the first cavity (3) for controlling at least part of the second light beams (L2) by reflecting the at least part of the second light beams (L2) to the first geometric quarter-space (Q1), and
 - a lens-section (30) of the transparent piece (2) at least partially bordering the first cavity (3) for acting as a lens for controlling a light distribution pattern of the first light beams (L1), wherein the reflection surface (5),
 - in a sectional view with a sectional plane being perpendicular to the first and second geometric planes (Pi, P2) and when viewed parallel to the first and second geometric planes (Pi, P2), has an arcuate contour (50), and
 - in a sectional view with a sectional plane parallel to the second geometric plane (P2) and when viewed orthogonally to the second geometric plane (P2), has a wing shaped contour (51) with
 - a central convex section (52) protruding towards the first cavity (3) or the first geometric plane (P1), and
 - at each side of the central convex section (52) along the first geometric plane (P1), a concave section (53, 54) bulged away from the first cavity (3) or the first geometric plane (Pi), so that a total internal reflection takes place at the reflection surface (5) when the at least part of the second light beams (L2) arrive, from inside the transparent piece (2), at the reflection surface (5).
2. The optical element (1) according to claim 1, wherein the first cavity (3) and the second cavity (4) are separated by a wall of the transparent piece (2) comprising the reflection surface (5).
 3. The optical element (1) according to any one of the preceding claims, wherein the reflection surface (5) has a saddle shape.
 4. The optical element (1) according to any one of the preceding claims, wherein the arcuate contour (50) becomes more distant from the first geometric plane (P1) with increased distance from the second geometric plane (P2).
 5. The optical element (1) according to any one of the preceding claims, wherein tangents (T1) of the arcuate contour (50) and a normal (N) of the second geometric plane (P2), respectively, enclose an angle α , which becomes smaller with increased distance from the second geometric plane (P2).
 6. The optical element (1) according to any one of the preceding claims, wherein the arcuate contour (50) has a parabolic or at least partially parabolic form.
 7. The optical element (1) according to any one of the preceding claims, wherein the concave sections (53, 54) each have an apex (55, 56) between the central convex section (52) and a most distant end (57, 58) of the respective concave section (53, 54) with respect to the central convex section (52).
 8. The optical element (1) according to any one of the preceding claims, wherein the optical element (1) or at least its reflection surface (5) is substantially symmetric with respect to a third geometric plane (P3) perpendicular to the first and second geometric planes (Pi, P2), wherein the third geometric plane (P3) preferably crosses the central convex section (52).
 9. The optical element (1) according to any one of the preceding claims, further comprising a second lens-section (40) of the transparent piece (2), preferably at least partially bordering the second cavity (4), for acting as a lens for further controlling the light distribution pattern of the at least part of second light beams (L2) after being reflected by the reflection surface (5).
 10. The optical element (1) according to claim 9, wherein the second lens-section (40) comprises an outer bordering surface (41) of the transparent piece (2) having, in a sectional view with a sectional plane being perpendicular to the first and second geometric planes (P1, P2) and when viewed parallel to the first and second geometric planes (P1, P2), an angled and/or curved contour, wherein the angled and/or curved contour is preferably slanted towards the first geometric quarter-space (Q1) and/or tangents (T2) of the angled and/or curved contour are angled with respect to the second plane (P2) along its extension.
 11. The optical element (1) according to any one of the preceding claims, wherein a first surface (10) of the optical element (1) comprises pits (11, 12) constituting the first and second cavities (3, 4), wherein the first surface (10) preferably is substantially planar at least on regions surrounding the pits (11, 12) and/or the first surface (10) preferably extends parallel to the second plane (P2).
 12. The optical element (1) according to any one of the preceding claims, wherein the transparent piece (2) is made of one of the following: acrylic plastic, polycarbonate, optical silicone, glass, or combinations thereof.
 13. A luminaire (100), like a street light, comprising an

optical element (1) according to any one of the preceding claims and a light source (101) being received in the first cavity (3).

14. The luminaire (100) according to claim 14, further comprising an LED-module (102) comprising an LED as the light source (101), wherein the optical element (1) preferably is attached to part of the LED-module (102), preferably to a circuit board (103) of the LED-module.
15. A lighting system comprising a luminaire (100) according to claims 13 and 14 as well as a post (200), like a pole, for carrying the luminaire (100) at a location of operation, preferably such that the luminaire (100) is oriented with the second geometric plane (P2) in a horizontal and, preferably, with the first geometric quarter-space (Q1) being directed away from a vertical section (201) of the post (200) and/or being positioned below the second geometric plane (P2).

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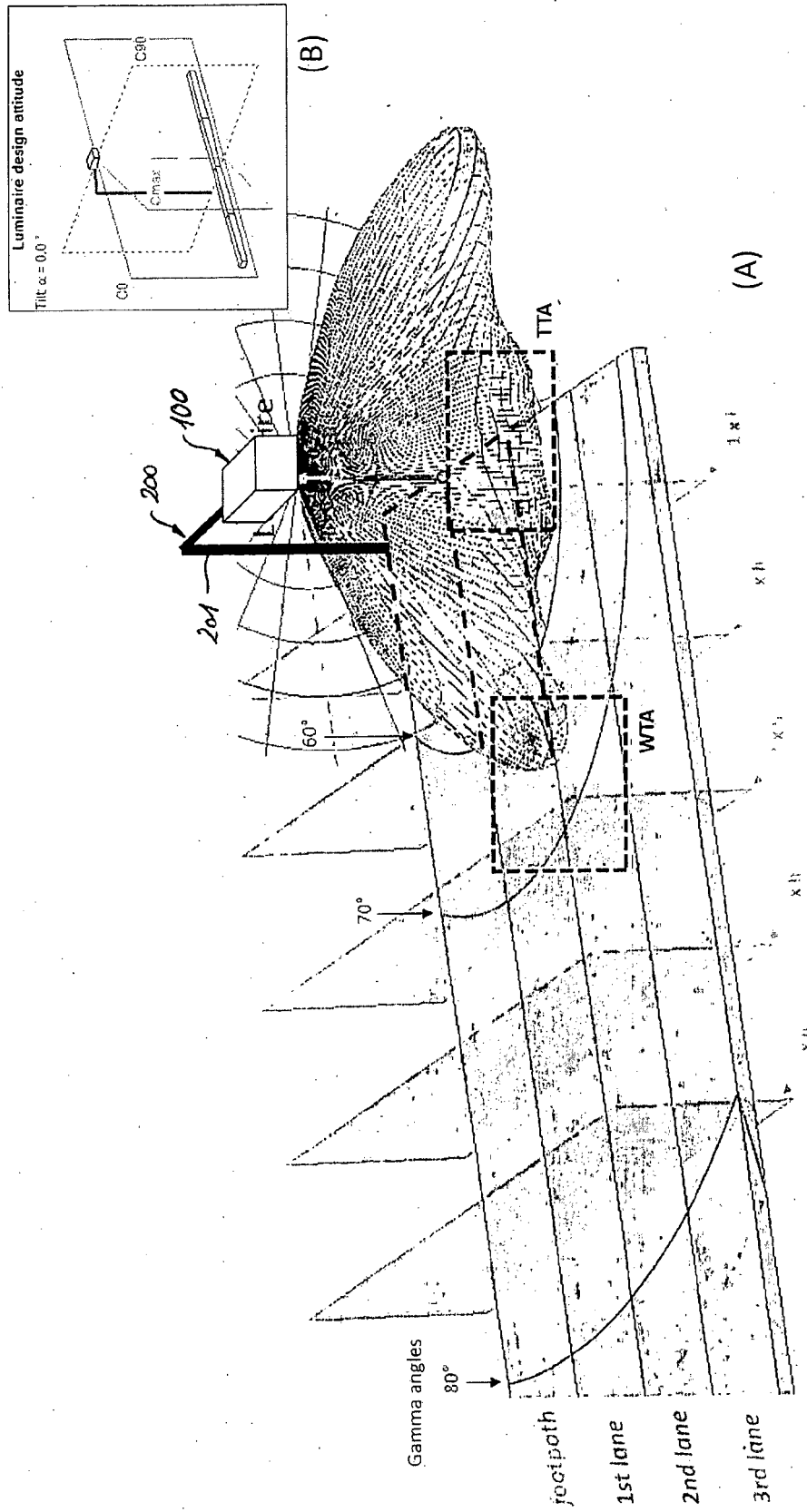


FIG. 2

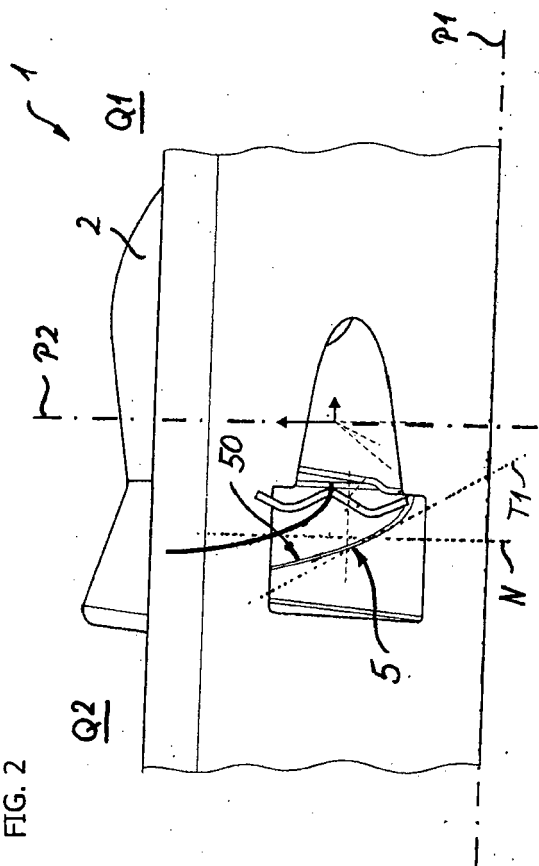


FIG. 3

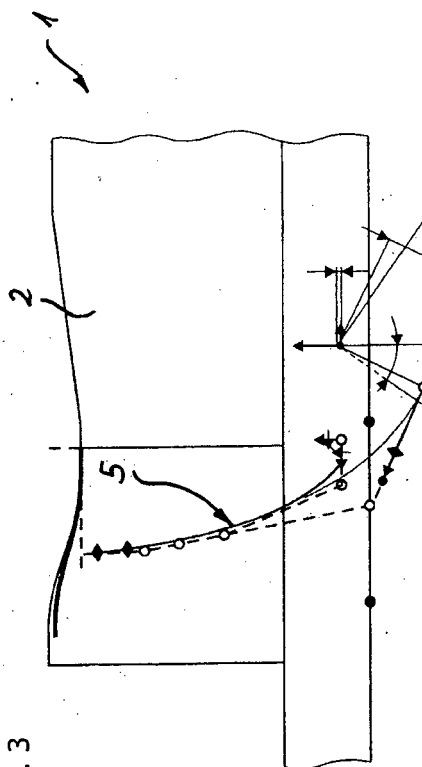
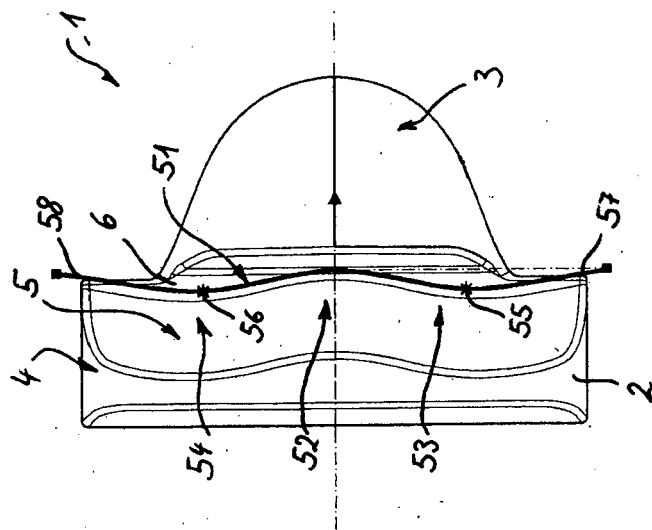


FIG. 4



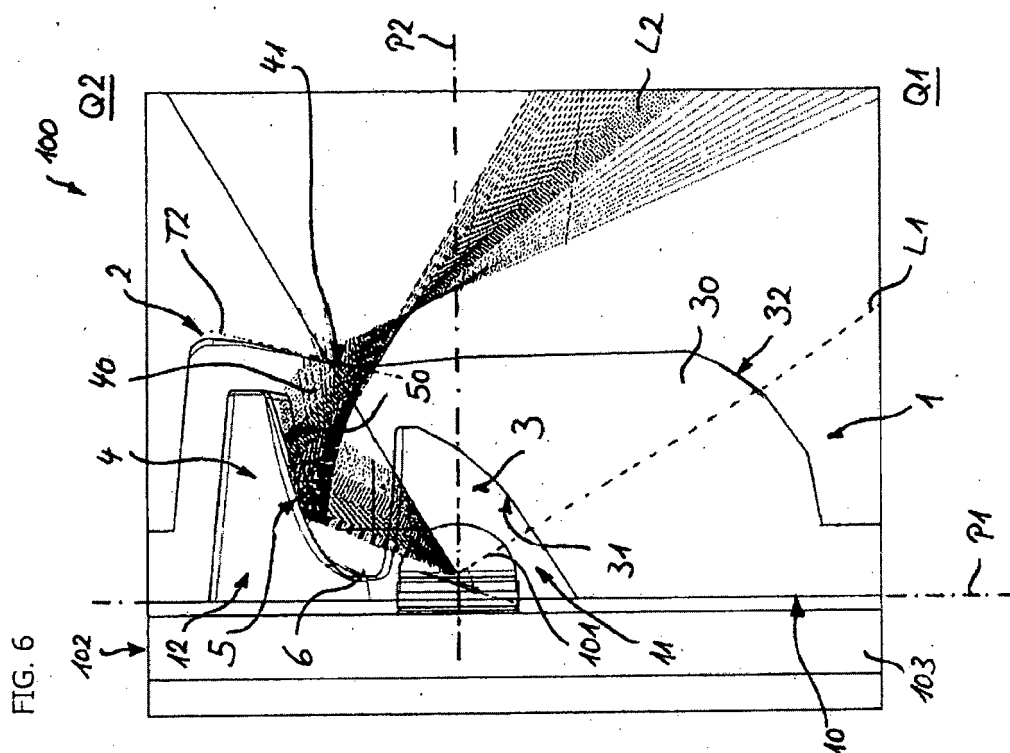


FIG. 6

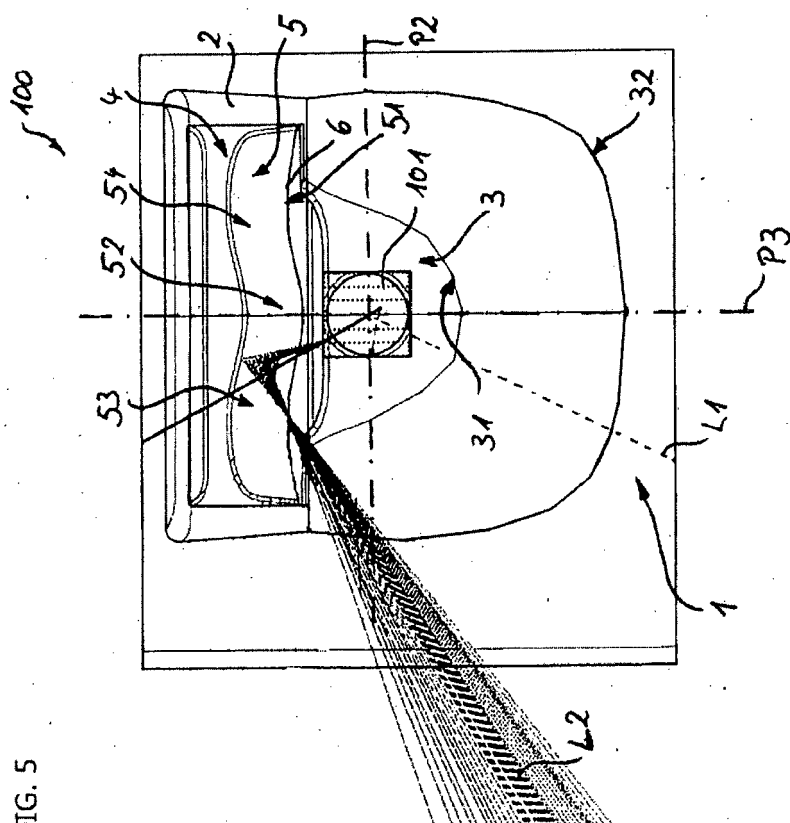
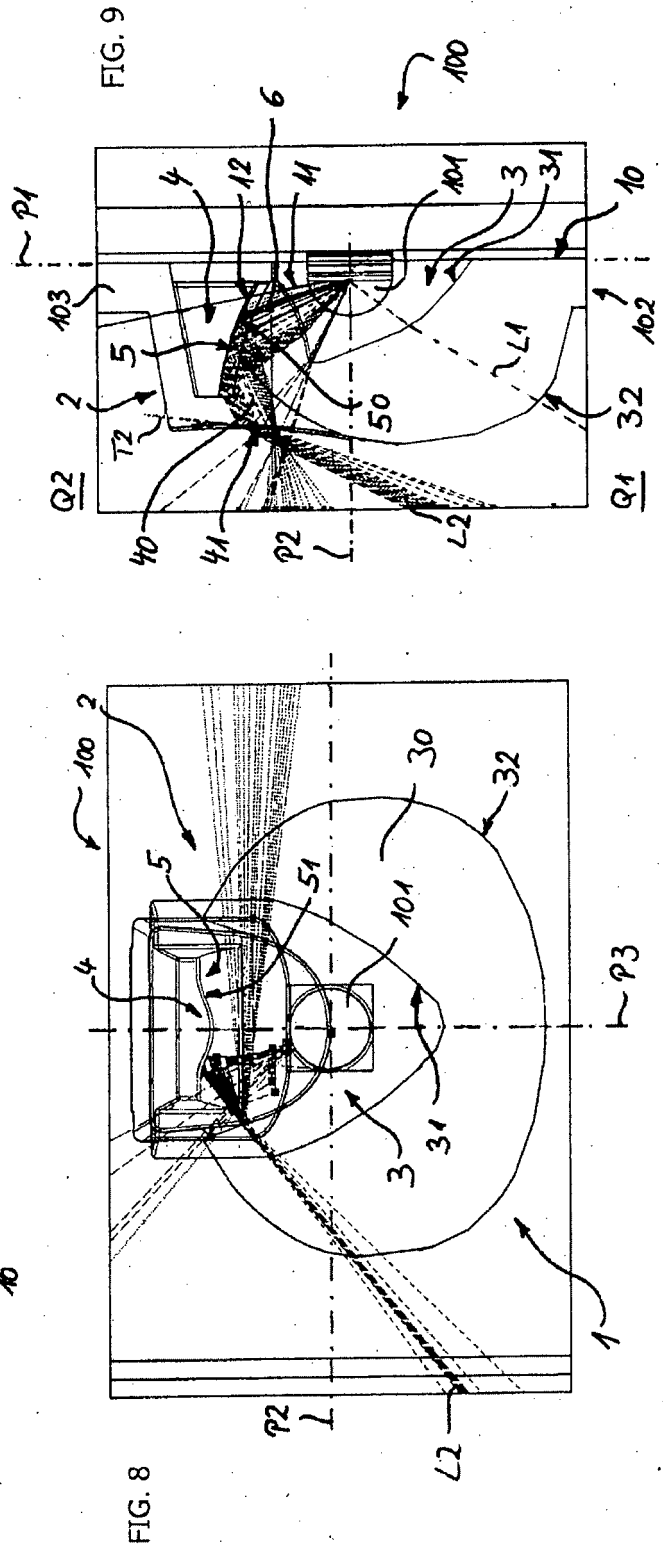
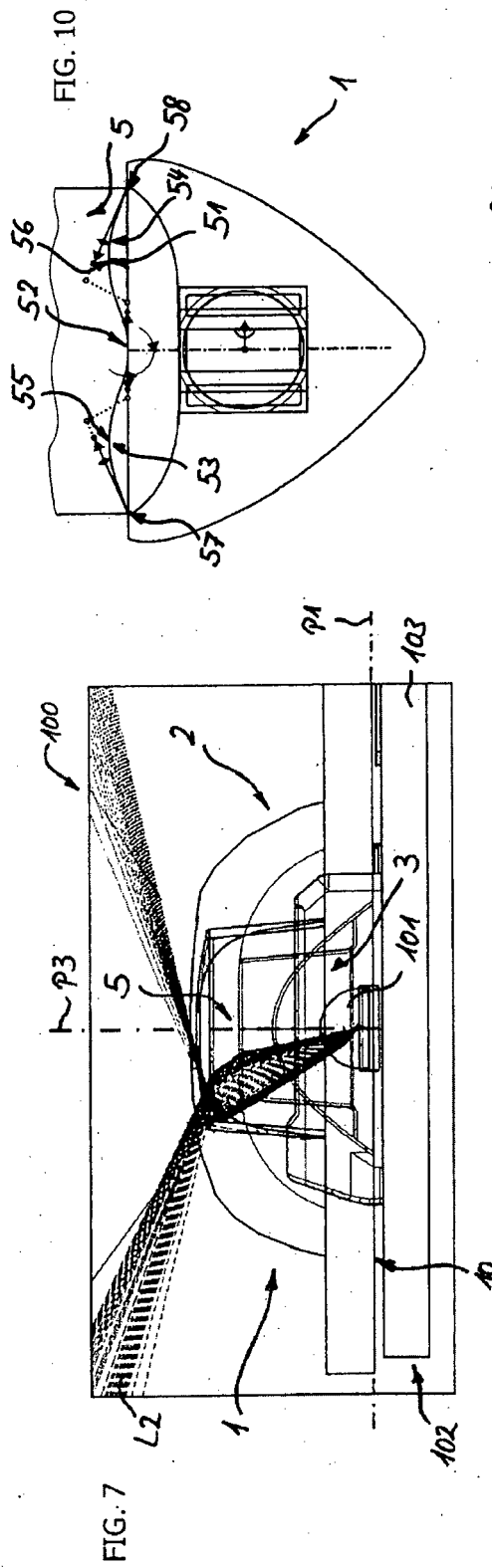


FIG. 5





EUROPEAN SEARCH REPORT

 Application Number
 EP 21 29 0007

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EPO FORM 1503 03.02 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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