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(54) AUTOMOTIVE LIGHTING APPLIANCE AND METHOD OF MAKING THE SAME

(57) An automotive lighting appliance (1) comprising a lighting device (2) provided with a multi-lens array module (9) comprising a plurality of projection micro-channels (9a) each extending along a longitudinal axis (A) alongside at least one adjacent projection micro-channel (9a). The multi-lens array module (9) further comprises shielding barriers (12), each of which is interposed between two adjacent projection micro-channels (9a) and is configured to shield one projection micro-channel (9a) from the rays of the light ray beam (F1) that pass through the other projection micro-channel (9a), and vice versa.

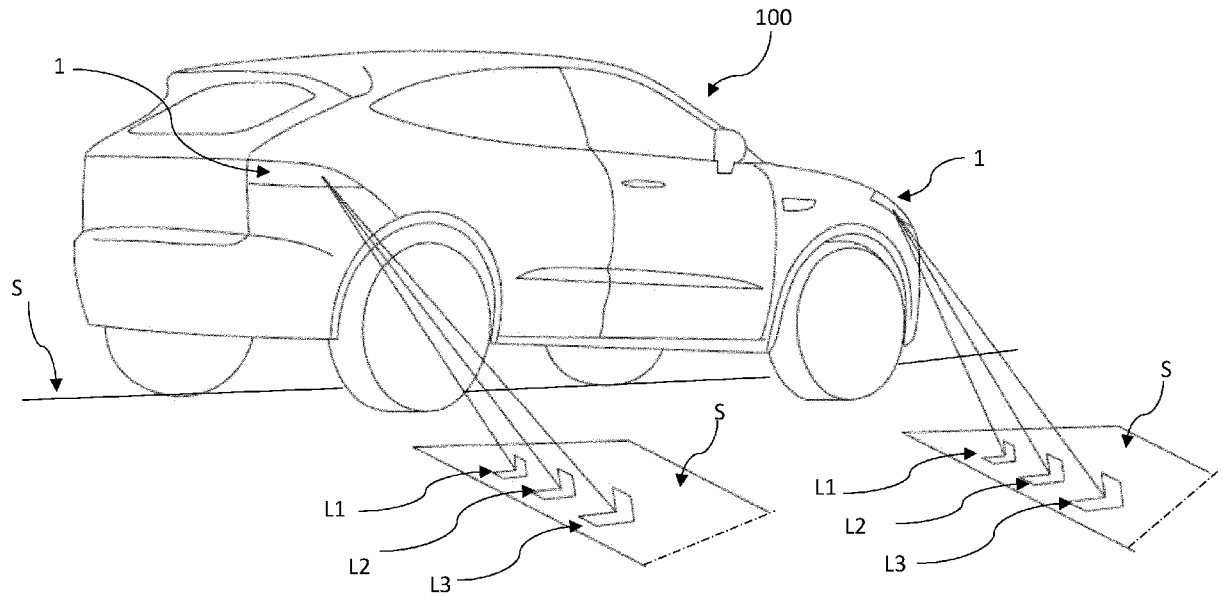

Fig. 1

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Description

FIELD OF THE ART

[0001] The present invention relates to an automotive lighting appliance and the method of making the same.

[0002] Automotive lighting appliances are known to be provided with a lighting device comprising a multi-lens array module or MLA (acronym for Multi Lens Array) module, which is configured to perform near-field ground projections and projections around the vehicle of predetermined light images.

[0003] Such a lighting appliance is described, for example, in the Applicant's patent application EP 3 982 037 A1 and involves the use of a multi-lens array module. In particular, the multi-lens array module comprises an optical body structured to comprise a plurality of projection channels that are arranged side-by-side and are structured to operate in accordance with the Kohler illumination method, also commonly known as "Kohler illumination".

[0004] In this case, the projection channels of the multi-lens array module are structured to project on the ground respective light images that are superimposed to form a main light image.

[0005] The Applicant carried out laboratory tests on the above-mentioned automotive lighting appliance on the basis of which it found out some technical issues in obtaining a main light image with homogeneous brightness. By means of the above-mentioned tests, the Applicant has in fact found out that the main light image can have, under certain conditions, an insufficiently homogeneous brightness due to the presence of so-called "ghost" images, due to an incorrect path of the light rays within the multi-lens array module, which generate undesired projections, albeit of a lower intensity than the main ones, on the ground.

DISCLOSURE OF THE INVENTION

[0006] Thus, the object of the present invention is to realise an automotive lighting appliance provided with a multi-lens array module, which is capable of overcoming the above-described technical problem, i.e., it is capable of reducing and/or suppressing the projection of ghost images so as to suppress the light inhomogeneity in the main projected light image caused by the superimposition of ghost images.

[0007] According to the present invention, an automotive lighting appliance is thus realised as set out in the accompanying claims.

[0008] The claims describe preferred embodiments of the present invention and form an integral part of the present description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The present invention will now be described with reference to the attached drawings, which show a non-limiting embodiment thereof, wherein:

Figure 1 is a schematic view of a motor vehicle which is provided with an automotive lighting appliance made according to the principles of the present invention,

Figure 2 is a perspective view, with parts removed for clarity, of an automotive lighting appliance made according to the principles of the present invention,

Figure 3 is an exploded view, with parts removed for clarity, of the automotive lighting appliance shown in Figure 2,

Figure 4 is a front perspective view, with parts removed for clarity, of a lighting device comprised in the automotive lighting appliance shown in Figure 3,

Figure 5 is a side elevation perspective view, with parts removed for clarity, of the lighting device shown in Figure 4,

Figure 6 is a rear perspective view, with parts removed for clarity, of the lighting device shown in Figures 4 and 5,

Figures 7 and 8 are schematic perspective views, with parts removed for clarity, of a lighting device comprised in the automotive lighting appliance made in accordance with an embodiment of the present invention,

Figure 9 is a front perspective view, with parts removed for clarity, of the lighting device shown in Figures 7 and 8,

Figure 10 is a rear view of a multi-lens array module of the lighting device shown in Figure 9,

Figure 11 is a schematic longitudinal section of a lighting device comprised in the automotive lighting appliance made in accordance with an embodiment of the present invention,

Figure 12 is a schematic longitudinal section of a lighting device comprised in the automotive lighting appliance made according to a different possible embodiment of the present invention.

[0010] The present invention will now be described in detail with reference to the accompanying Figures to enable a skilled person to realize and use it.

[0011] Various modifications of the described embodiment will be immediately clear to the skilled person and the general principles disclosed can be applied to other embodiments and applications without departing from the protection scope of the present invention, as defined in the attached drawings.

[0012] Therefore, the present invention must not be considered as limited to the described and shown embodiments, however it must be granted the widest protection scope complying with the herein described and claimed principles and features.

[0013] With reference to Figure 1, reference number 1 illustrates an automotive lighting appliance (also referred to as headlamp or motor vehicle headlamp assembly) as

a whole, which is arranged on the vehicle 100. The vehicle 100 may be any motor vehicle, such as a car, truck, bus, or any similar motor vehicles.

[0014] The automotive lighting appliance 1 is structured so that it can be (stably) coupled to, and/or incorporated into, the vehicle 100, at the front, and/or at the side, and/or at the rear.

[0015] According to an embodiment shown in Figure 1, the automotive lighting appliance 1 can correspond to an automotive lighting appliance arranged on the rear side of the vehicle 100 (rear lamp). However, it is understood that, as shown in Figure 1, the present invention is not limited to a rear automotive lighting appliance, but can be applied in a completely analogous manner to any automotive lighting appliances, such as a front lamp and/or a side lamp of a motor vehicle.

[0016] With reference to Figure 1, according to the present invention, the automotive lighting appliance 1 is configured to project on the ground S around the motor vehicle 100, i.e., outside the motor vehicle 100, one or more main light images. In the following discussion, the term "ground" S means any planes on which the motor vehicle 100 rests and surrounds it, and can comprise, for example, a road, terrain, etc.

[0017] According to a preferred embodiment, the automotive lighting appliance 1 comprises at least one lighting device 2, which has an axis A and is configured to conveniently selectively project on the ground S around the motor vehicle 100 (outside) one or more main light images.

[0018] The light images projected on the ground S by the lighting device 2 comprise, for example, predefined shapes, pictograms and/or symbols and/or the like. The main light images projected on the ground S by the automotive lighting appliance 1 can be static (still or stationary) and/or dynamic (animated images and/or moving images).

[0019] According to the embodiment shown in Figure 1, the lighting device 2 is configured to project on the ground surface S a plurality of main images, three of which are depicted and denoted by L1, L2 and L3. In the embodiment shown in Figure 1, the predetermined light images L1, L2 and L3 projected on the ground S represent arrow-shaped symbols.

[0020] It is understood that the present invention is not limited to the projection of three main light images Li having the symbols depicted in Figure 1, but may relate to a number of main light images and shapes that are different from those represented in Figure 1 and vary according to the light communication function to be performed.

[0021] With reference to a possible exemplifying embodiment shown in Figures 2 and 3, the automotive lighting appliance 1 can comprise an open housing or casing 3 containing the lighting device 2. In the example illustrated, the casing 3 is preferably, but not necessarily, cup-shaped so as to have at least one internal cavity to accommodate the lighting device 2. The casing 3 may be structured, for example, in such a way that it may preferably, but not necessarily, be arranged, i.e., recessed, for example, within a compartment (not illustrated) formed in/on the body of the vehicle 100 (Figure 1). The casing 3 is shaped and/or sized to contain the lighting device 2 therein.

[0022] As shown in Figure 3, the automotive lighting appliance 1 can also preferably comprise at least one lenticular body 4, e.g., front side. The lenticular body 4 can be made, for example, at least partially of transparent or semitransparent material. The lenticular body 4 can be structured in such a way that it can be coupled to the casing 3, for example, at the mouth of the casing 3, so as to close it.

[0023] According to a possible embodiment shown in Figures 2, 3, the lighting device 2 comprises a source module 5, an optical module 6, and a multi-lens array device 7. In the example illustrated, the lighting device 2 preferably comprises a support plate 8. Conveniently, the support plate 8 is arranged within the casing 3, and is structured in such a way that it supports/accommodates the multi-lens array module 9 in a predetermined position. For example, the support plate 8 can have a through opening shaped to accommodate the multi-lens array module 7.

[0024] The source module 5 can comprise at least one light source 5a configured to emit at least one light ray beam F1 towards the optical module 6.

[0025] With reference to the exemplary embodiment shown in Figures 1-6 in which three predetermined images L1, L2 and L3 have to be projected, the light source 5a comprises a plurality of LEDs (Light Emitting Diodes), in this case three LEDs (not illustrated), capable of selectively emitting, on the basis of a command, respective light beams F1. It is understood that light source 5a is not limited to a LED-equipped source, but can alternatively and/or additionally comprise other types of sources, such as OLED, LASER sources or the like. It is also understood that the number and/or arrangement of LEDs may vary based on the architecture of the lighting device 2.

[0026] In the example illustrated in the attached Figures, the light source 5a is supported by, housed in, an electronic board 5b, i.e., a PCB (Printed Circuit Board).

[0027] The optical module 6 faces the light source 5a to receive the light beam F1 emitted by it and is configured to rectify the received light beam F1 into a substantially parallel light ray beam F1. In the example illustrated in Figures 2-7, the optical module 6 is mechanically coupled to the circuit board 5b in such a way that it is adjacent to the light source 5a.

[0028] With reference to the exemplary embodiment shown in Figures 2-7 in which the lighting device 2 is configured to project three predetermined images L1, L2 and L3, the optical module 6 comprises three collimating optical devices 6a. It is to be understood that the present invention is not limited to the use of an optical module 6 provided with three collimating optical devices 6a, but

may provide for a different number of collimating optical devices 6a, variable according to the architecture of the lighting device 2, for example variable according to the number of main images to be projected.

[0029] It is further understood that the collimating optical devices 6a used in the present invention are not limited to the outline shown in Figure 11, but other outlines/shapes of the collimating optical devices 6a may be contemplated. Figure 12 shows an example where the collimator optical device 6a has a different shape from Figure 11 and corresponds to an optics with a Fresnel structure.

[0030] The multi-lens array device 7 comprises one or more multi-lens array modules 9 which are configured to: receive the light ray beam F1 from the optical module 6, form secondary light images corresponding to respective main light images, and project the secondary light images on the ground S in a superimposed way to form the respective main light images according to a Kohler illumination.

[0031] Referring to the exemplary embodiment shown in Figures 3-8 in which three predetermined images L1, L2 and L3 have to be projected, the multi-lens array device 7 comprises three multi-lens array modules 9 arranged side-by-side, which are configured to form/generate and project respective predetermined light images on the ground S. In the illustrated example, the multi-lens array modules 9 are arranged adjacent to, and aligned with, the respective collimating optical devices 6a so as to receive light ray beams F1 from them.

[0032] In order to increase the clarity of exposition of the present invention, Figures 7 to 11 show a simplified embodiment of the lighting device 2 in which the source module 5 comprises a light source 5a, the optical module 6 comprises a single collimating optical device 6a and the multi-lens array device 7 comprises a multi-lens array module 9.

[0033] With reference to Figures 7 to 11, the multi-lens array module 9 extends along a longitudinal axis A and comprises a plurality of projection micro-channels 9a. In the example shown, each of the projection micro-channels 9a extends alongside one or more adjacent projection micro-channels 9a. The multi-lens array module 9 comprises an entry surface K1 receiving the beam F1 and an exit surface K2 structured to project the light image on the ground S.

[0034] The multi-lens array module 9 further comprises an imaging structure 10 which is arranged upstream of the exit surface K2 and is provided with light-crossing windows 11 which are shaped to form the predetermined images Li to be projected on the ground S. Preferably, the light-crossing windows 11 may be formed on a layer of opaque (to light) material covering the entry surface K1. The opaque material layer of the imaging structure 10 can then be deposited on the entry surface K1 so as to cover it. The light-crossing windows 11 are cut into the layer of opaque material deposited on the entry surface K1 that forms the light entry side of the multi-lens array module 9.

[0035] Each light-crossing window 11 is formed on the opaque material layer of a respective portion of the entry surface K1 of a multi-lens array module 9.

[0036] Conveniently, the entry surface K1 of the projection microchannels 9a of the multi-lens array module 9 has no field lenses. Conveniently, the entry surface K1 formed by the entry surface portions of the beam F1 in the projection microchannels 9a of the multi-lens array module 9 is flat and orthogonal to the axis A.

[0037] According to a preferred embodiment, the light-crossing windows 11 can be realised on the surface of the multi-lens module array 9 by a LASER removal process of a previously deposited opaque material. Alternative processes can be pad printing, in-mould decoration, and LASER-induced carbonisation.

[0038] According to the present invention, the multi-lens array module 9 further comprises shielding barriers 12 which are configured/structured to shield each projection micro-channel 9a from light passing through an adjacent projection micro-channel 9a, and vice versa. Conveniently, each shielding barrier 12 is interposed between two adjacent projection micro-channels 9a.

[0039] The shielding barrier 12 separating a first projection microchannel 9a from a second adjacent microchannel 9a is configured so that the light entering the first projection microchannel 9a through the surface K1 does not pass through the second projection microchannel 9a and vice versa.

The technical effect of the screening barrier 12 arranged between two adjacent projection micro-channels 9a is to reduce the formation of ghost light images on the predetermined light image Li.

The Applicant has in fact found out that ghost light images are generated when light rays exiting the optical module 6 enter a projection micro-channel 9a through the entry surface K1 in a direction not parallel to the longitudinal axis A of the multi-lens array module 9. In such a condition, the light rays travelling through the projection microchannel 9a tend to enter laterally into an adjacent projection microchannel 9a and exit through the surface portion K2 of the latter, resulting in an erroneous projection of the ray with an attenuated light intensity.

In order to suppress this technical inconvenience, the Applicant therefore introduced the barriers 12 between the projection microchannels 9a so as to form separation screens preventing light that passes through one projection microchannel 9a from penetrating into the adjacent projection microchannel(s) 9a.

[0040] In the embodiment shown in Figures 7-11, the multi-lens array module 9 comprises a single (solid) body made of transparent material. Conveniently, the transparent material can be based on a polymer material or glass. In the realisation example shown in the attached Figures, the multi-lens array module 9 has an approximately parallelepiped shape and extends along the longitudinal axis A. In the embodiment example shown in the appended Figures, the projection microchannels 9a forming the multi-lens array module 9 each have an

approximately parallelepipedal oblong shape, an approximately quadrangular cross-section to the axis A, and extend side-by-side along respective axes parallel to axis A.

[0041] In the realisation example shown in the attached Figures, each projection micro-channel 9a has side walls extending parallel to axis A and internally delimiting the body of the projection micro-channel 9 with their entry K1 and exit K2 surface portions for the beam F1.

[0042] In the implementation example shown in the attached Figures, the projection microchannels 9a are arranged side-by-side so as to form a matrix of rows and columns.

[0043] Conveniently, the shielding barriers 12 can be made by means of respective shielding partitions or layers 13. The shielding layers 13 are thin, extend within the single body of the multi-lens array module 9 and form the sidewalls of the projection micro-channels 9a of the multi-lens array module 9.

[0044] Conveniently, the shielding layers 13 forming the shielding barriers 12 are made of opaque (non-transparent) material. The opaque material from which a shielding layer 13 is made is structured so that it cannot be crossed by light, i.e., to prevent light from passing through it. According to one possible embodiment, the opaque material from which a shielding partition 13 is made is of grey or black colour or the like.

[0045] According to a preferred embodiment, the shielding layers 13 can be made within the single body forming the multi-lens array module 9 by means of a laser deep printing process.

[0046] The Applicant found out that the shielding barriers 12 made in the body of the multi-lens array module 9 by means of a laser deep printing process are particularly effective in adequately shielding the projection micro-channels 9a.

[0047] With reference to Figure 11, the exit surfaces of the projection microchannels 9a are shaped so as to form respective projection lenses 14. The projection lenses of the projection microchannels 9a are shaped so as to project respective secondary images superimposed on the ground S so as to form the predetermined main light image.

[0048] The method for making an automotive lighting appliance 1 described above will be described below.

[0049] The method comprises the steps of arranging at least one source module 5 provided with the light source 5a, arranging at least one multi-lens array device 7 provided with at least one multi-lens array module 9, and forming the shielding barriers 12 on the multi-lens array module 9, such that each shielding barrier 12 is interposed between two adjacent projection microchannels 9a so that, in use, light passing through one projection microchannel 9a does not pass through the other projection microchannel 9a, and vice versa. In other words, each shielding barrier 12 is interposed between two adjacent projection microchannels 9a to prevent light that passes through one projection microchannel 9a from passing through the other projection microchannel 9a, and vice versa.

[0050] Conveniently, the method comprises the step of forming 9 the shielding barriers 12 within the single body of the multi-lens array module 9 along the sides separating the projection micro-channels 9a.

[0051] Preferably, the method comprises the step of forming the shielding barriers 12 within the single body of the multi-lens array module 9 by a laser deep printing method.

[0052] The method also comprises the step of arranging and assembling in the casing 3: the source module 5, the optical module 6, the multi-lens array device 7 and the lenticular body 4.

[0053] The advantages of the automotive lighting appliance are obvious: the shielding barriers integrated in the body of the multi-lens array module make it possible to strongly attenuate the formation of ghost light images in the light image projected on the ground S thereby increasing the optical performance of the lighting appliance.

Claims

1. An automotive lighting appliance (1) configured to be installed in a motor vehicle (100),
the automotive lighting appliance comprises a lighting device (2) which has a longitudinal axis (A) and is configured to project on the ground (S) around the motor vehicle (100) and outside the same at least one predetermined main light image composed of a plurality of secondary superimposed light images so as to form a Kohler illumination,

wherein said lighting device (2) comprises:

at least one source module (5) configured to emit a light ray beam (F1),
at least one optical module (6) configured to receive said light ray beam (F1) and output said light ray beam (F1) wherein the rays are collimated and approximately parallel to said longitudinal axis (A),
at least one multi-lens array module (9) comprising an entry surface (K1) receiving the light ray beam (F1) from said source module (5), an imaging structure (10) having a plurality of light-crossing windows (11) shaped to form said secondary images, and an exit surface (K2) configured to project said secondary images on the ground (S) in a superimposed way,

said multi-lens array module (9) comrpises

a plurality of projection micro-channels (9a)

each extending along an axis substantially parallel to said longitudinal axis (A) alongside at least one adjacent projection micro-channel (9a), and

shielding barriers (12), each of which is interposed between two adjacent projection micro-channels (9a) and is configured to shield one projection micro-channel (9a) from the rays of the light ray beam (F1) passing through the other projection micro-channel (9a), and vice versa.

2. The automotive lighting appliance according to claim 1, wherein said multi-lens array module (9) consists of a monoblock made of transparent material,
each shielding barrier (12) is comprised/integrated into said monoblock and comprises a shielding layer (13) of non-transparent material extending into said monoblock.

3. The automotive lighting appliance according to claim 2, wherein said shielding barrier (12) comprises a non-transparent layer made within said monoblock of the multi-lens array module (9) by means of a laser deep printing.

4. The automotive lighting appliance according to any one of the previous claims, wherein the entry surface (K1) of said multi-lens array module (7) has no field lenses.

5. The automotive lighting appliance according to any one of the previous claims, wherein the entry surface (K1) of said multi-lens array module (9) is flat and approximately orthogonal to said longitudinal axis (A), said imaging structure (10) being made to cover/coat said entry surface (K1) .

6. The automotive lighting appliance according to any one of the previous claims, wherein the exit surface (K2) of said multi-lens array module (9) is opposed to the entry surface (K1) and is shaped so as to form respective projection lenses of said secondary images.

7. The automotive lighting appliance according to any one of the previous claims, wherein said monoblock is made of transparent polymer material.

8. A method for making an automotive lighting appliance (1) which is configured to be installed in a motor vehicle (100) and comprises a lighting device (2) which has a longitudinal axis (A) and is configured to project on the ground (S) around said motor vehicle (100), outside the same, at least one predetermined main light image composed of a plurality of secondary superimposed light images so as to form a Kohler illumination,

wherein the method comprises the steps of:

providing at least one source module (5) configured to emit a light ray beam (F1),

providing at least one optical module (6) configured to receive said light ray beam (F1) and output said light ray beam (F1) in which the rays are approximately parallel to said longitudinal axis (A),

providing at least one multi-lens array module (9) comprising an entry surface (K1) receiving the light ray beam (F1) from said source module (5), an imaging structure (10) having a plurality of light-crossing windows (11) shaped to form said secondary images, and an exit surface (K2) configured to project said secondary images on the ground (S) in a superimposed way, said multi-lens array module (9) further comprising a plurality of projection micro-channels (9a) each extending along an axis approximately parallel to said longitudinal axis (A) alongside at least one adjacent projection micro-channel (9a),

making shielding barriers (12), each of which is interposed between two adjacent projection micro-channels (9a) and is configured to shield one projection micro-channel (9a) from the rays of the light ray beam (F1) passing through the other projection micro-channel (9a), and vice versa.

9. The method according to claim 8, wherein said multi-lens array module (7) comprises a monoblock made of transparent material,
said method comprising the step of making each shielding barrier (12) in said monoblock by means of a shielding layer (13) of non-transparent material extending into said monoblock.

10. The method according to claims 8 or 9, comprising the step of making a laser deep printing on said multi-lens array module (7) so as to form said shielding barrier (12) of the multi-lens array module (7).

11. A lighting device (2) configured to be installed in an automotive lighting appliance (1) of a motor vehicle (100), the lighting device (2) having a longitudinal axis (A) and being configured to project on the ground (S) around the motor vehicle (100) and outside the same at least one predetermined main light image (Li) comprising a plurality of secondary superimposed light images so as to form a Kohler illumination,

said lighting device (2) comprises:

at least one source module (5) configured to emit a light ray beam (F1),

at least one optical module (6) configured to receive said light ray beam (F1) and output said light ray beam (F1) in which the rays are approximately parallel to said longitudinal axis (A),
at least one multi-lens array module (9) comprising an entry surface (K1) receiving the light ray beam (F1) from said source module (5), an imaging structure (10) having a plurality of light-crossing windows (11) shaped to form said secondary images, and an exit surface (K2) configured to project said secondary images on the ground (S) in a superimposed way,

said multi-lens array module (9) comprises

a plurality of projection micro-channels (9a) each extending along an axis substantially parallel to said longitudinal axis (A) alongside at least one adjacent projection micro-channel (9a), and
shielding barriers (12), each of which is interposed between two adjacent projection micro-channels (9a) and is configured to shield one projection micro-channel (9a) from the rays of the light ray beam (F1) passing through the other projection micro-channel (9a), and vice versa.

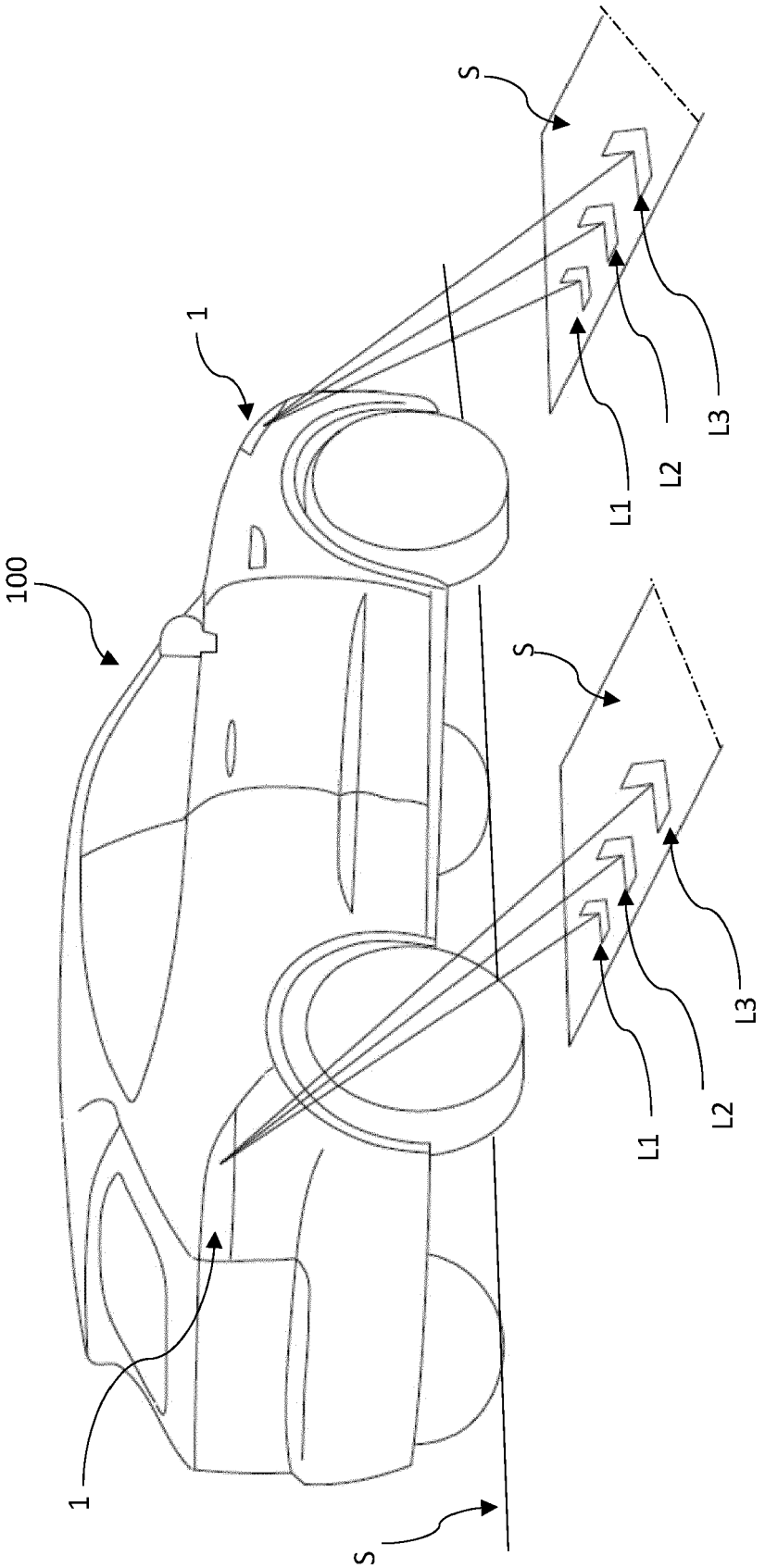


Fig. 1

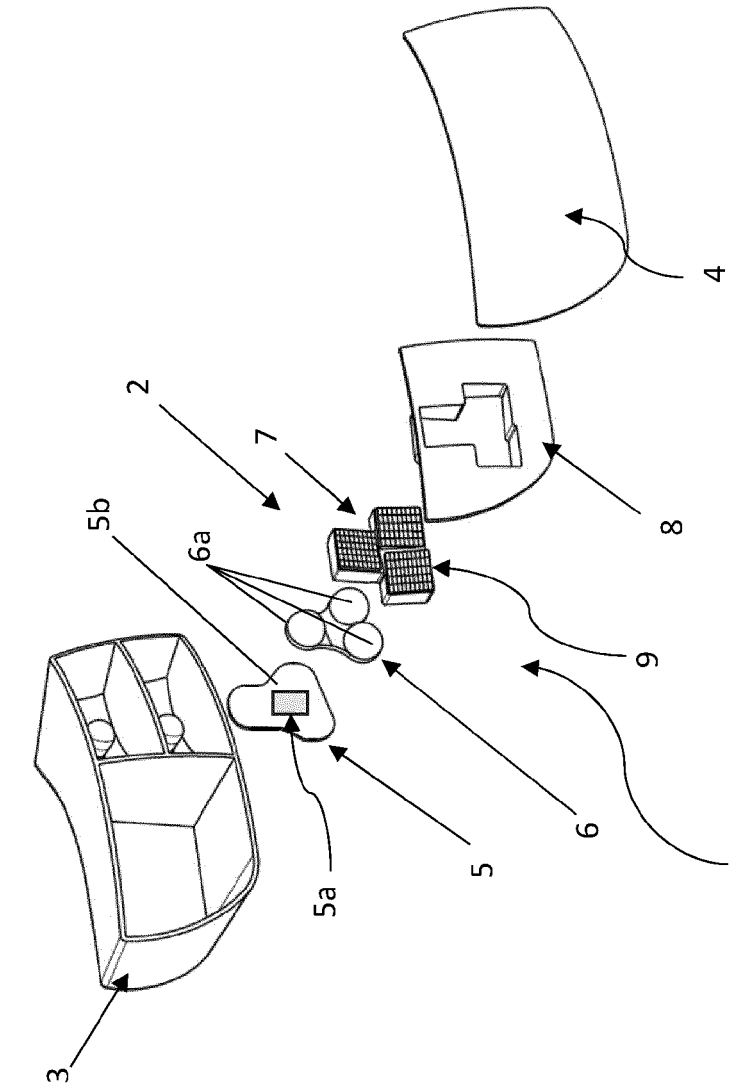


Fig. 3

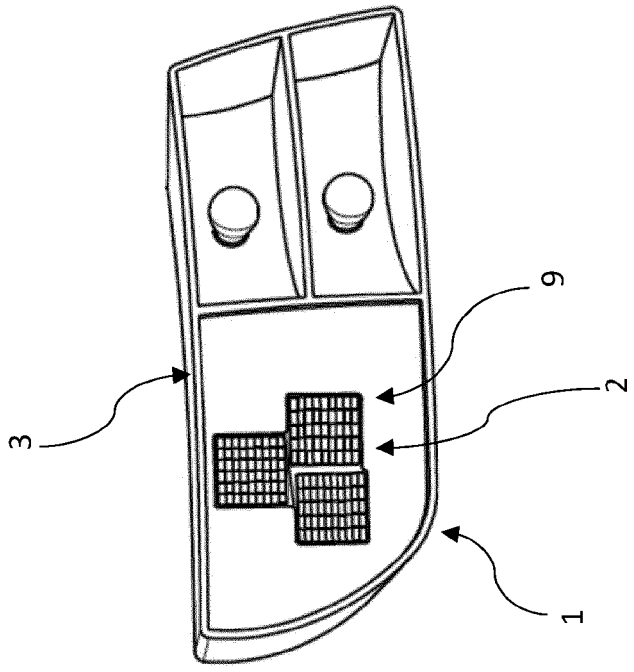


Fig. 2

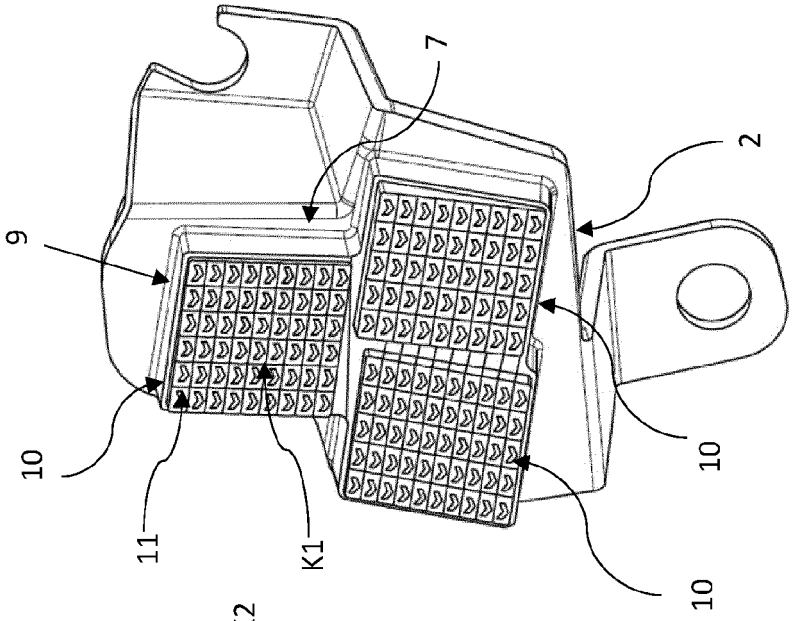


Fig. 6

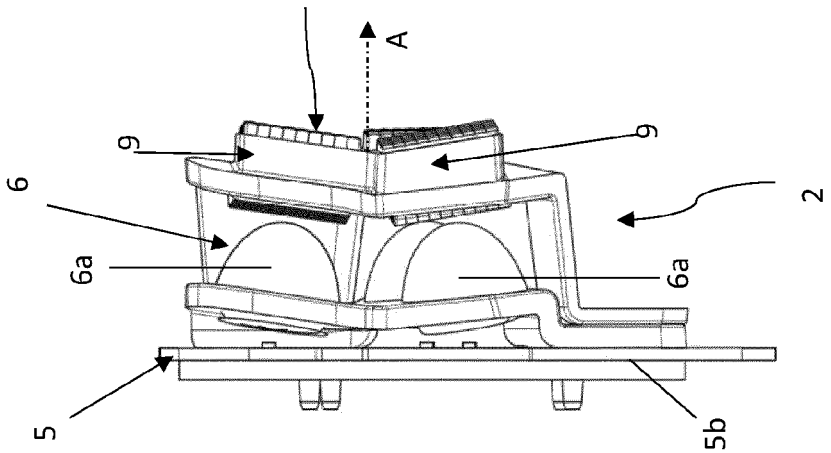


Fig. 5

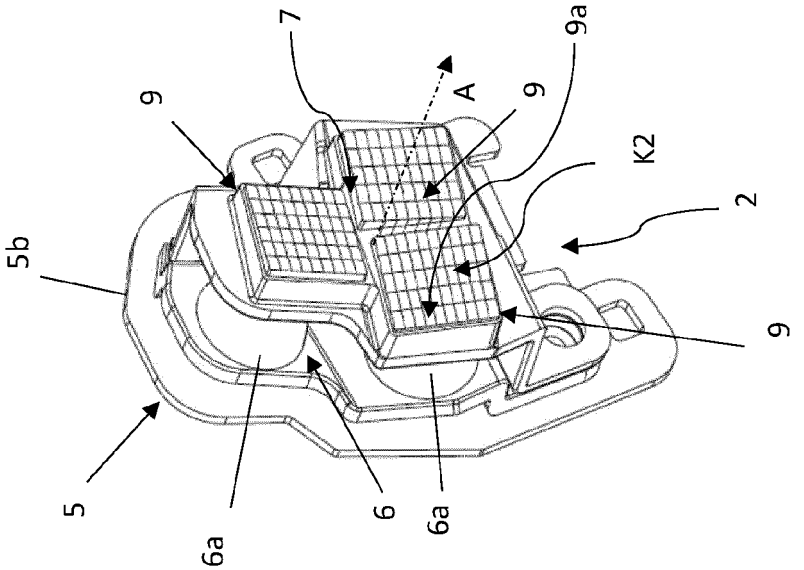


Fig. 4

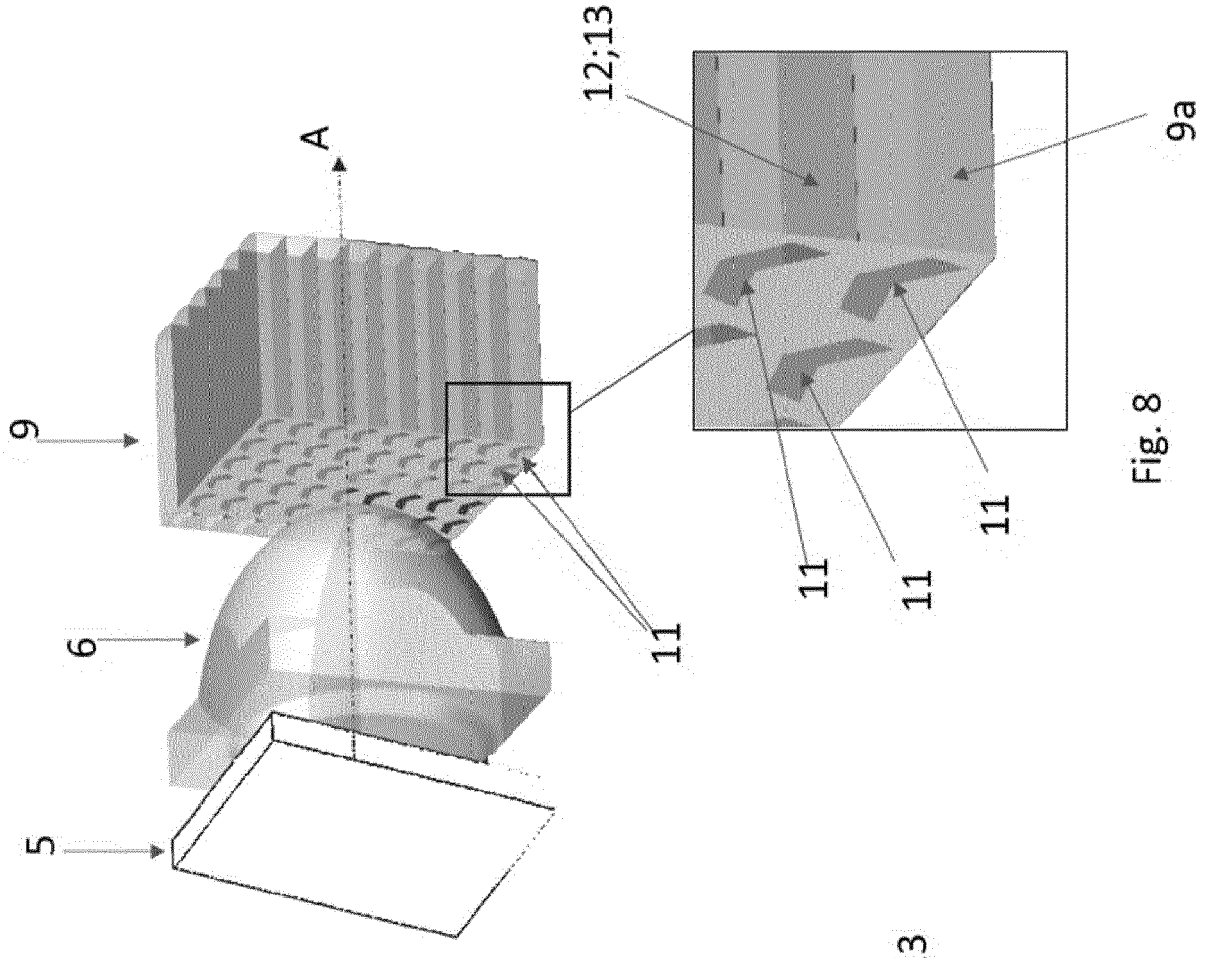


Fig. 8

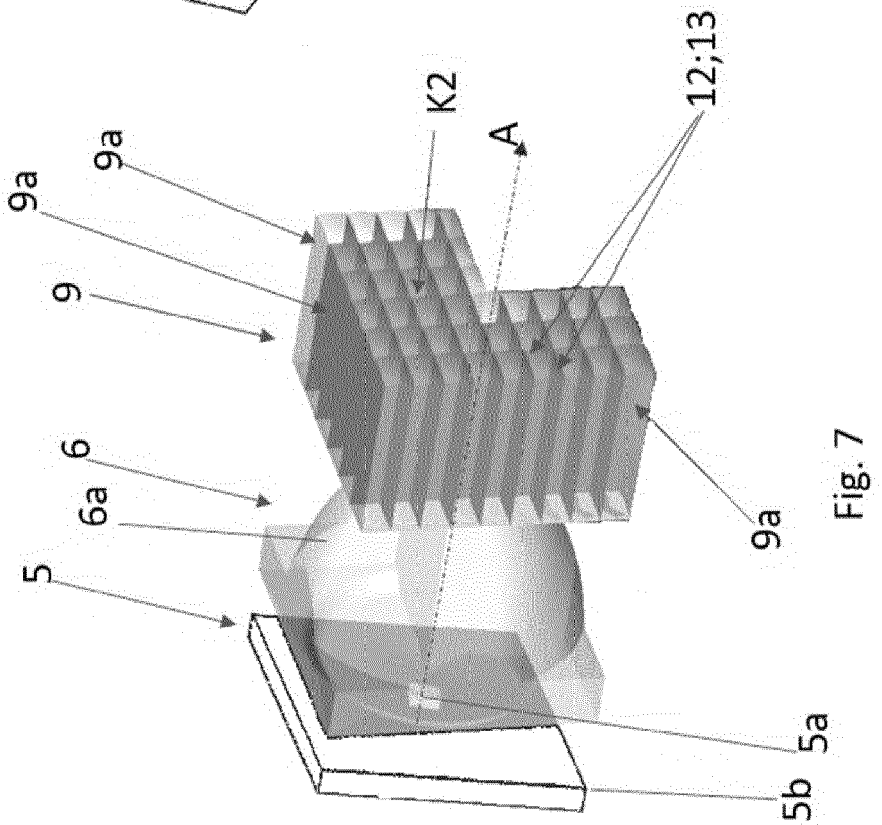


Fig. 7

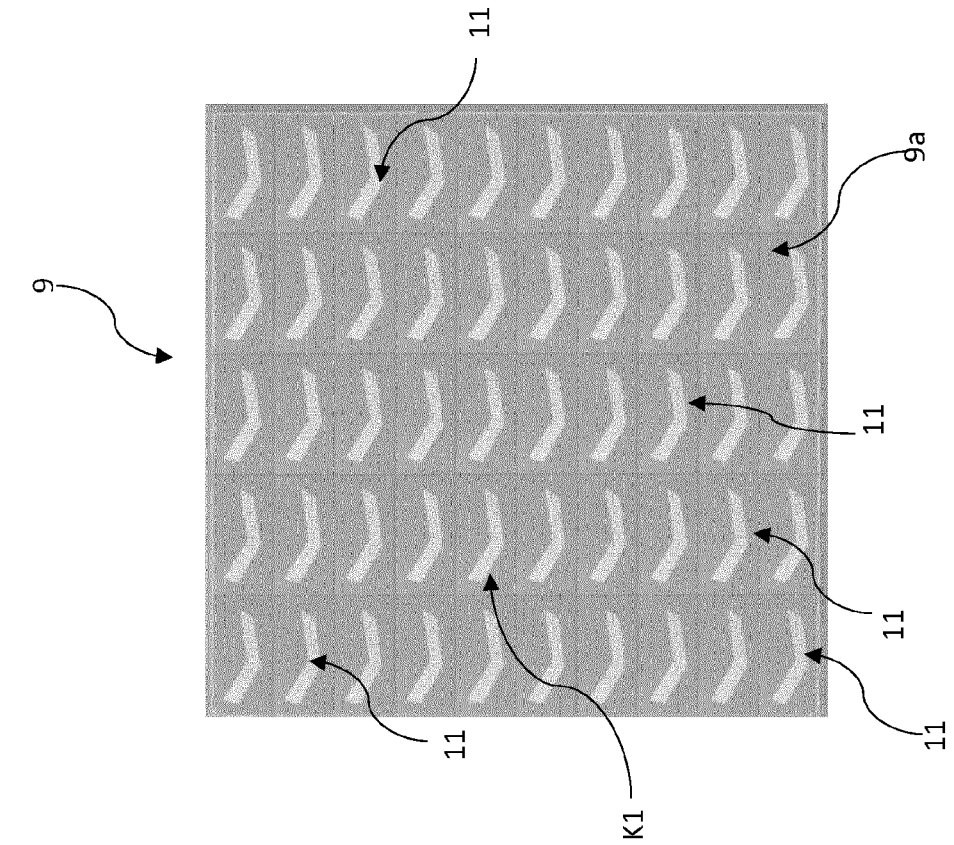


Fig. 10

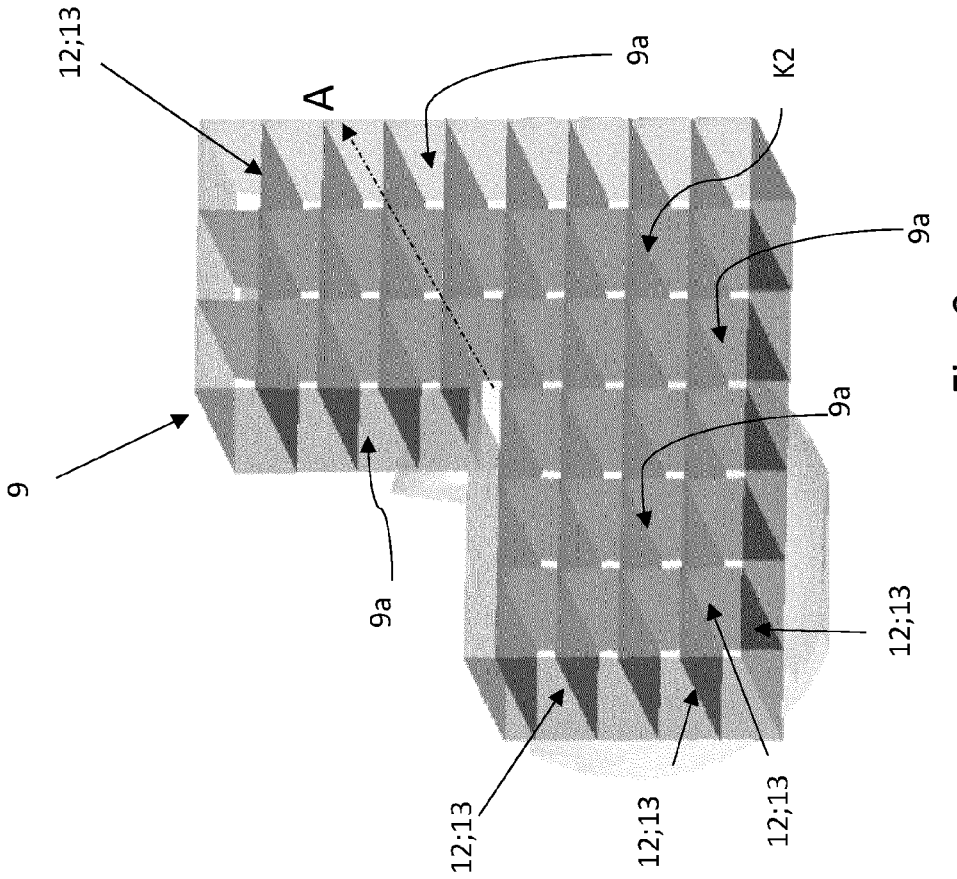
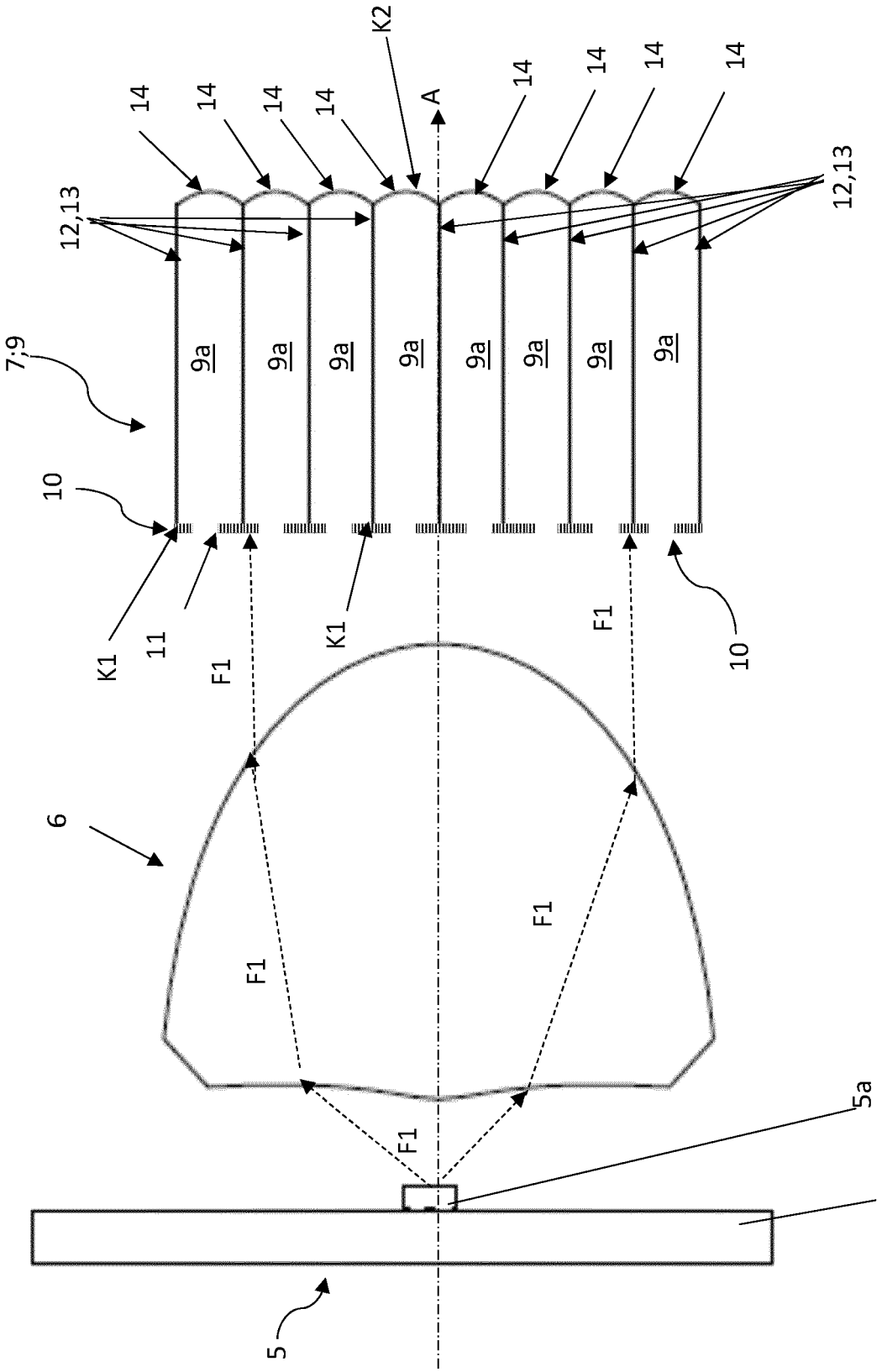


Fig. 9


K2
A
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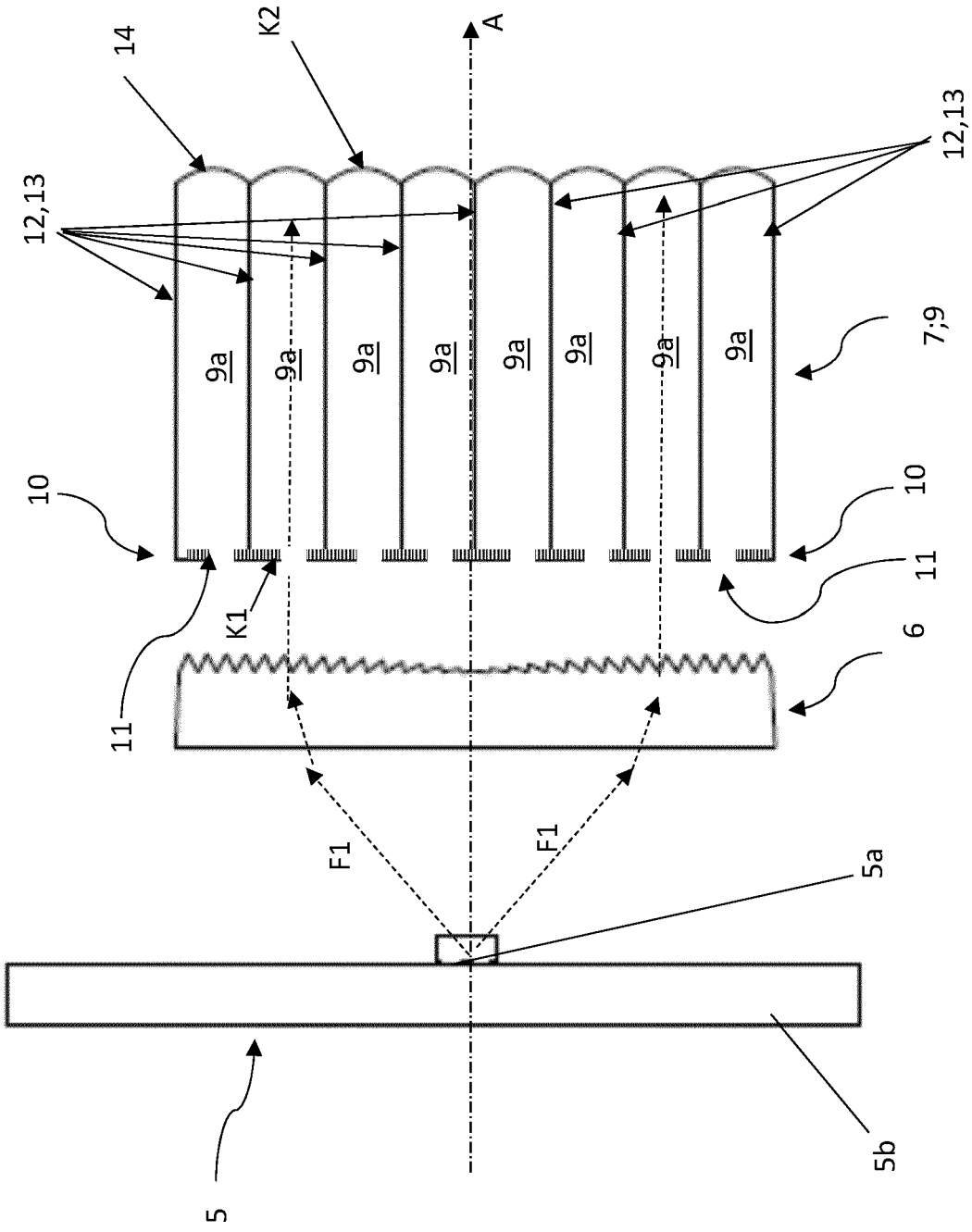
14
14
14
14
14
14
14
12,13
12,13
7;9
9a
9a
9a
9a
9a
9a
9a
9a
10
10
K1
K1
11
F1
F1
F1
F1
F1
6
5
5a
5b

Fig. 11


14
K2
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12,13
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9a
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9a
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7;9
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K1
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6
F1
F1
5a
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5b

Fig. 12

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