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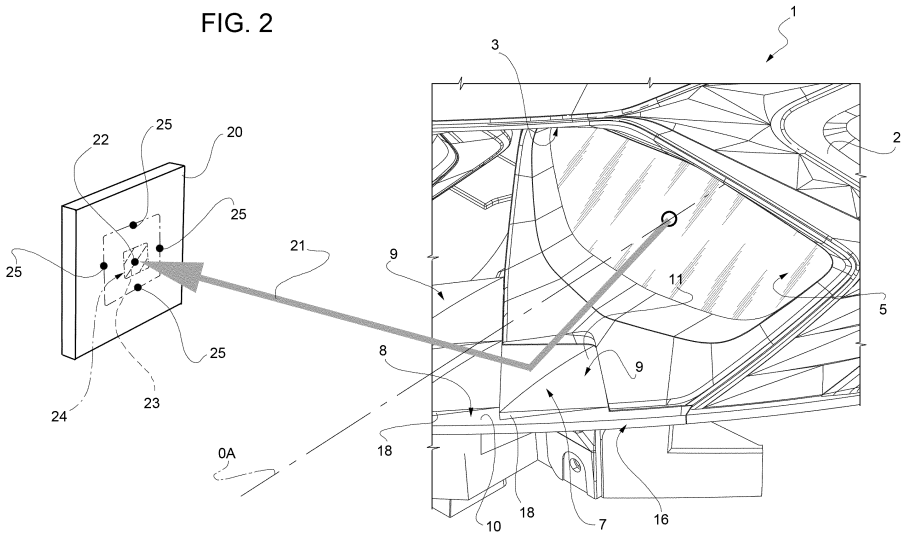
(54) LIGHTING DEVICE FOR VEHICLES HAVING AN AESTHETIC MASK

(57) Lighting device (1) for a vehicle including a cup-shaped housing body (2) having a front inlet opening (3, at least one lighting module (5,6) arranged inside the housing body spaced apart from the inlet opening (3), and an aesthetic mask (7) to cover a gap between the inlet opening and the light module; wherein the aesthetic mask (7) is delimited by an upper surface (8) facing towards the at least one lighting module (5,6) and formed by a plurality of individual surface portions (9,10) arranged adjacent to one another; at least part of the individual surface portions (9) being bulged upwards and delimited by at least one continuous complex curved surface (11) defined by the convolution of a first and a second spline curve (12,13) and generated by the translation of the second spline curve (13) along the first spline curve (12) or vice-versa.

FIG. 2



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Description

Technical field of the invention

[0001] The present invention relates to a lighting device equipped with at least one lighting module and with an aesthetic mask.

Technical Background

[0002] Lighting devices for vehicles provided with multiple optical modules are known in the art.

[0003] EP2957822 discloses a lighting device including a rotating module including a fixed reflector, a fixed light source aligned with an axis, and a couple of opposite screens rotating around the axis under the action of a motor actuator; the two screens embody two lenses, e.g. one provided with prisms and one neutral, in order to change the light distribution provided by the light source and the reflector when each of the screens is selectively rotated in front of the reflector.

[0004] The lighting devices of the prior art provided with one or more rotating modules like e.g. that one of EP2957822 need actuation mechanisms to operate the rotating modules. Unfortunately, those mechanisms may be seen from the outside due to the fact that the modern lighting devices are generally provided with outer transparent covers/lens through which the lighting modules are visible. The lighting devices need therefore to be provided with an aesthetic mask to cover the actuating mechanisms.

[0005] An aesthetic mask may be also necessary in lighting devices having one or more stationary lighting modules in order to join the profile of each lighting module with the overall profile of the lighting device, which generally have to follow the aesthetic profile of the vehicle, and/or to cover possible gaps caused by the mounting in the same housing body of the lighting device of different lighting modules.

[0006] Such aesthetic masks are usually placed between the lighting modules and the outer transparent cover to close a gap between the lighting modules and the outer profile of the housing body and may be provided with metallized surfaces which may be reflective.

[0007] When one or more lighting modules are switched on, parasite light rays may be generated by the reflective surfaces of the aesthetic mask. The parasite rays may cause undesired light distributions or even the dazzling of the drivers of other vehicles.

Summary of the invention

[0008] The object of the present invention is to provide a lighting device for vehicles having an housing body, one or more lighting modules arranged therein, which are visible from the outside of the housing body, and at least one aesthetic mask arranged in a gap between the lighting modules and an outer profile of the housing body, wherein the risk of dazzling of crossing vehicles due to parasite rays is avoided or at least greatly reduced when one or more lighting modules are switched on.

[0009] According to the invention, a lighting device for vehicles is provided having the features set out in the appended claims.

Brief description of the drawings

[0010] Further features and advantages of the present invention will become more apparent from the following description of one non-limiting embodiment thereof, made with reference to the figures in the accompanying drawings, in which:

- figure 1 shows schematically a perspective front elevation view of a lighting device for a vehicle, with parts removed for simplicity, realized according to the invention;
- figure 2 shows schematically in an enlarged scale a detail of the lighting device of figure 1 and depicts schematically the principle of operation of the invention;
- figure 3 shows schematically and further in an enlarged scale a perspective view of a geometrical surface embodied in the lighting device of the invention; and
- figure 4 shows schematically and further in an enlarged scale a detail of figure 2.

Detailed description

[0011] With reference to figures 1 and 2, reference numeral 1 indicates as a whole a lighting device for vehicles consisting, in the non-limiting embodiment shown, in a vehicle headlight, which is only in part and only schematically shown. It is however to be intended that what will be described can be applied to any vehicle lighting device.

[0012] The lighting device 1 comprises a generally cup-shaped housing body 2 designed to be mounted on a vehicle, known and not shown for sake of simplicity. Housing body 2 is made of synthetic plastic material by injection molding and has a front inlet opening 3 in use facing opposite to the vehicle and towards a driving or march direction of the vehicle, closed by a transparent cover, preferably consisting in a transparent lens not provided with optical functions ("terse" lens), well known and not shown for sake of simplicity.

[0013] The housing body 2 carries at the interior thereof at least one (or more) first lighting module 5, which is in the embodiment shown the main lighting module of the lighting device 1, e.g. is a cross-beam light or high beam light, and, possibly, a plurality of secondary lighting modules 6, well known and shown in dotted line and only schematically for sake of simplicity; the secondary lighting modules 6, when present, are designed to provide additional optical functions, all together or singularly, and

may be either stationary or rotatable about an axis transverse to an optical axis OA (figure 2) of the main lighting module 5.

[0014] For "optical axis" it is intended herein and below a geometrical axis according with the light rays generated by the lighting module 5 are delivered.

[0015] The lighting modules 5,6 are all visible from the outside through the inlet opening 3 and the transparent cover, and are arranged side by side facing the inlet opening 3.

[0016] The lighting modules 5,6 are spaced apart from the inlet opening 3 so that the lighting device 1 also comprises an aesthetic mask 7 to cover a gap G arranged between the inlet opening 3 and the lighting modules 5,6.

[0017] The aesthetic mask 7 extends parallel to the aforementioned gap G in a substantially horizontal direction and along the full width of the inlet opening 3, transverse the optical axis OA of the first (main) lighting module 5, which optical axis OA is oriented in use in the driving direction of the vehicle.

[0018] The aesthetic mask 7 is delimited towards the lighting modules 5,6 by an upper surface 8 which hides the gap G. According to one main aspect of the present invention, the upper surface 8 is formed by a plurality of individual surface portions 9,10 arranged adjacent to one another, wherein at least part of the individual surface portions, namely portions 9 in the example shown, are bulged upwards.

[0019] The individual surface portions 9 bulged upwards are delimited by at least one first complex curved surface 11 which is continuous.

[0020] With reference to figure 3, where an example of a surface 11 is shown only schematically and out of scale, the first complex curved surface 11 of each bulged surface portion 9 is defined by the convolution of a first spline curve 12 and a second spline curve 13, each first complex curved surface 11 having been generated by the translation of the second spline curve 13 along the first spline curve 12; it is also possible the contrary, according to the circumstances, i.e. each first complex curved surface 11 may be generated by the translation of the first spline curve 12 along the second spline curve 13.

[0021] Here and below, for "spline curve" it is intended a geometrical curve generated by graphic interpolation of a set of pre-established points. In mathematics, a spline is a numeric function that is piecewise-defined by polynomial functions, and which possesses a high degree of smoothness at the places where the polynomial pieces connect (which are known as knots). In interpolation problems, spline interpolation is often preferred to purely polynomial interpolation, because it yields similar results to interpolating with higher degree polynomials while avoiding instability due to Runge's phenomenon. In computer graphics, parametric curves whose coordinates are given by splines are popular because of the simplicity of their construction, their ease and accuracy of evaluation, and their capacity to approximate complex shapes through curve fitting and interactive curve design.

[0022] The most commonly used splines are cubic splines, i.e., of order 3 - in particular, cubic B-spline, which is equivalent to C2 continuous composite Bézier curves.

[0023] In the preferred embodiment shown, all the individual surface portions 9 bulged upwards are delimited by the one first complex curved surface 11 and by one second complex curved surface 14, which is continuous and which is also defined by the convolution of a first and a second complex curved surfaces, like as schematically shown in figure 3; however, according to an aspect of the present invention, the first and second complex curved surfaces (not shown) defining the complex curved surface 14 have curvatures opposite to those of the curves 12 and 13, so that the first and second complex curved surfaces 11,14 have opposite curvatures.

[0024] With reference to figure 4 too, the second complex curved surface 14 of each bulged surface portion 9 is arranged immediately adjacent to the first complex curved surface 11 and is separated therefrom by a mathematical discontinuity (a cusp) forming a separation edge 15 between the first and the second complex curved surfaces.

[0025] The separation edge 15 is also curved and defines the top of each individual bulged surface portion 9; the separation edges 15 of the bulged surface portions 9 are all oriented substantially parallel to the optical axis OA of the lighting module 5, namely in the travel direction of the vehicle on which the lighting device 1 is mounted.

[0026] In the example shown, where substantially the whole width of the inlet opening 3 is occupied by the lighting modules 5,6, the whole upper surface 8 of the aesthetic mask 7 bears the individual bulged surface portions 9, which constitute almost the whole upper surface 8; the remaining of the upper surface 8 is constituted in the non-limiting embodiment shown by a single surface portion 10 which is substantially flat and plane and which define a forward rim 16 of the aesthetic mask 7.

[0027] The individual bulged surface portions 9 are arranged in a checkerboard configuration, along at least two parallel rows, as well shown in figure 1, running in the direction of the width of the front inlet opening 3.

[0028] Moreover, according to a further aspect of the invention, each individual bulged surface portion 9 defines with another adjacent individual bulged surface portion 9 a separation step 18; all the separation steps are oriented forwards and their height increases progressively in the forward direction, as well shown in figure 4, so that each bulged surface portion 9 is flush with the surface portion 10 on the side facing the lighting modules 5,6 and then progressively raises above the surface portion 10, raising more at the separation edge 15.

[0029] The separation steps 18 also separate the forward row of adjacent bulged surface portions 9 by the flat surface portion 10.

[0030] The upper surface 8 of the aesthetic mask 7 is preferably reflective, e.g. it has been metallized, since the mask 7 is usually made in synthetic plastic material

by injection molding, and the bulged surface portions are of a generally prismatic shape owing to a polygonal, e.g. square, shape in plant and owing to the presence of the separation edges 15 and the separation steps 18, so that the whole upper surface 8 has a diamond-like appearance.

[0031] According to a further aspect of the invention (figure 4) surface 11 of each bulged surface portion 9 is convex close to the separation step 18 and becomes concave on the opposite side, forming a mathematical flex. Surface 14 is opposite, being concave close to the separation step 18 and becomes convex on the opposite side, also forming a mathematical flex.

[0032] In figure 2 is also schematically represented how the invention works.

[0033] With reference number 20, it is indicated a standard test screen, only schematically represented. This test screen, as it is well known to the skilled in the art, is an opaque screen set in front of the lighting device under test and at 25 m distance therefrom, upon which the light rays generated by the lighting device under test are projected. On the test screen 20, therefore, it is reproduced the light distribution obtainable by the lighting device under test.

[0034] When the lighting module 5 is switched on, if the upper surface 8 is made reflective (usually both for aesthetic and technical reasons) some light rays 21 emitted by the lighting devices 5,6 may hit the surface 8 and are reflected by the same: in the schematic example shown one such light ray 21 may form on the screen 20 a projection point 22.

[0035] If the upper surface 8 was flat, or even if it was shaped to have a diamond-like aspect and the surfaces 11,14 of the bulged surface portions 9 were inclined but flat, the light rays 21 reflected by the surface 8 would be almost parallel and therefore they would form on the test screen 20 a projection 23 quite small (they would be close to each other) and accordingly having more light concentration: in this condition, if the light rays were reflected upwards, they would possibly dazzle incoming drivers even if only position lights or dipped beam lights were switched on.

[0036] According to the invention, on the contrary, the surfaces 11,14, are calculated in order to continuously vary the orientation of the normal (line perpendicular) to each point of the surface, so that the light rays possibly reflected by the upper surface 8 are spread upon a larger surface and so form a larger projection 24 on the test screen 20; projection 24 has a light concentration so low that no dazzling effect may occur.

[0037] In order to calculate surfaces 11,14, the following method may be used.

1) Firstly a first point of the surface under calculation is arbitrary chosen, and for this first surface point is calculated the position on the test screen 20 of the projection point 22 of a light rays reflected by it in the hypothesis e.g. of switching on lighting module 5.

2) Secondly, it is established the position on the test screen of at least four projection points 25 taken in such a manner to be at the edge of an hypothetic light projection having no dazzling effects.

3) For these four projection points it is calculated which would have to be the inclination of the normal to the reflective surface to be calculated at the first point of such surface previously selected at item 1) above.

4) Then a set of second points of the surface to be calculated are determined having their normal to the surface oriented in such a manner to have projection points on the screen 20 arranged within the hypothetic light projection having no dazzling effects.

5) On the basis of the orientation of the normal previously determined and of the position of the second points, curves 12,13 are calculated by spline interpolation.

6) Finally, the whole surface 11,14 is calculated by making the curve 12 translate along curve 13 or viceversa.

[0038] In this manner it may be obtained an aesthetic mask which is reflective and has a diamond-like appearance, without any risk that the switching on of the lighting modules 5,6 may provoke any dazzling effect. Moreover, also a desired lighting effect may be obtained when e.g. the DRL or position lights are switched on and their light rays are also spread according to a desired distribution by the mask 7.

[0039] All the aims of the invention are therefore accomplished.

Claims

1. Lighting device (1) for a vehicle comprising a cup-shaped housing body (2) designed to be mounted on a vehicle body and having a front inlet opening (3) facing in use a forward march direction of the vehicle, at least one lighting module (5) arranged inside the housing body facing the inlet opening and spaced apart from the inlet opening (3), the lighting module (5;6) being visible from the outside through the inlet opening (3), and an aesthetic mask (7) to cover a gap (G) between the inlet opening and the at least one light module, the aesthetic mask (7) extending parallel to said gap in a substantially horizontal direction and being delimited towards the at least one lighting module (5;6) by an upper surface (8) which hides the gap (G); **characterized in that**:

i)- the upper surface (8) is formed by a plurality of individual surface portions (9,10) arranged adjacent to one another;
ii)- at least part of said individual surface portions (9) are bulged upwards, and
iii)- the individual surface portions (9) bulged up-

wards are delimited by at least one first complex curved surface (11) which is continuous and which is defined by the convolution of a first (12) and a second (13) spline curve,
iv)- each first complex curved surface (11) having been generated by the translation of the second spline curve (13) along the first spline curve (12) or vice-versa.

2. Lighting device (1) according to claim 1, **characterized in that** all the individual surface portions bulged upwards (9) are delimited by said one first complex curved surface (11) and by one second complex curved surface (14) which is continuous and which is also defined by the convolution of a first and a second spline curve (12,13); the second complex curved surface (14) being arranged immediately adjacent to the first one (11) and being separated from the first one by a mathematical discontinuity forming a separation edge (15) between the first and the second complex curved surfaces.

3. Lighting device according to claim 2, **characterized in that** the separation edge (15) define the top of each individual bulged surface portion and is oriented substantially parallel to an optical axis (OA) of the at least one lighting module.

4. Lighting device according to claim 2 or 3, **characterized in that** the first and second complex curved surfaces (11,14) have opposite curvatures.

5. Lighting device according to anyone of the preceding claims, **characterized in that** the whole upper surface (8) of the aesthetic mask (7) bears said individual bulged surface portions (9).

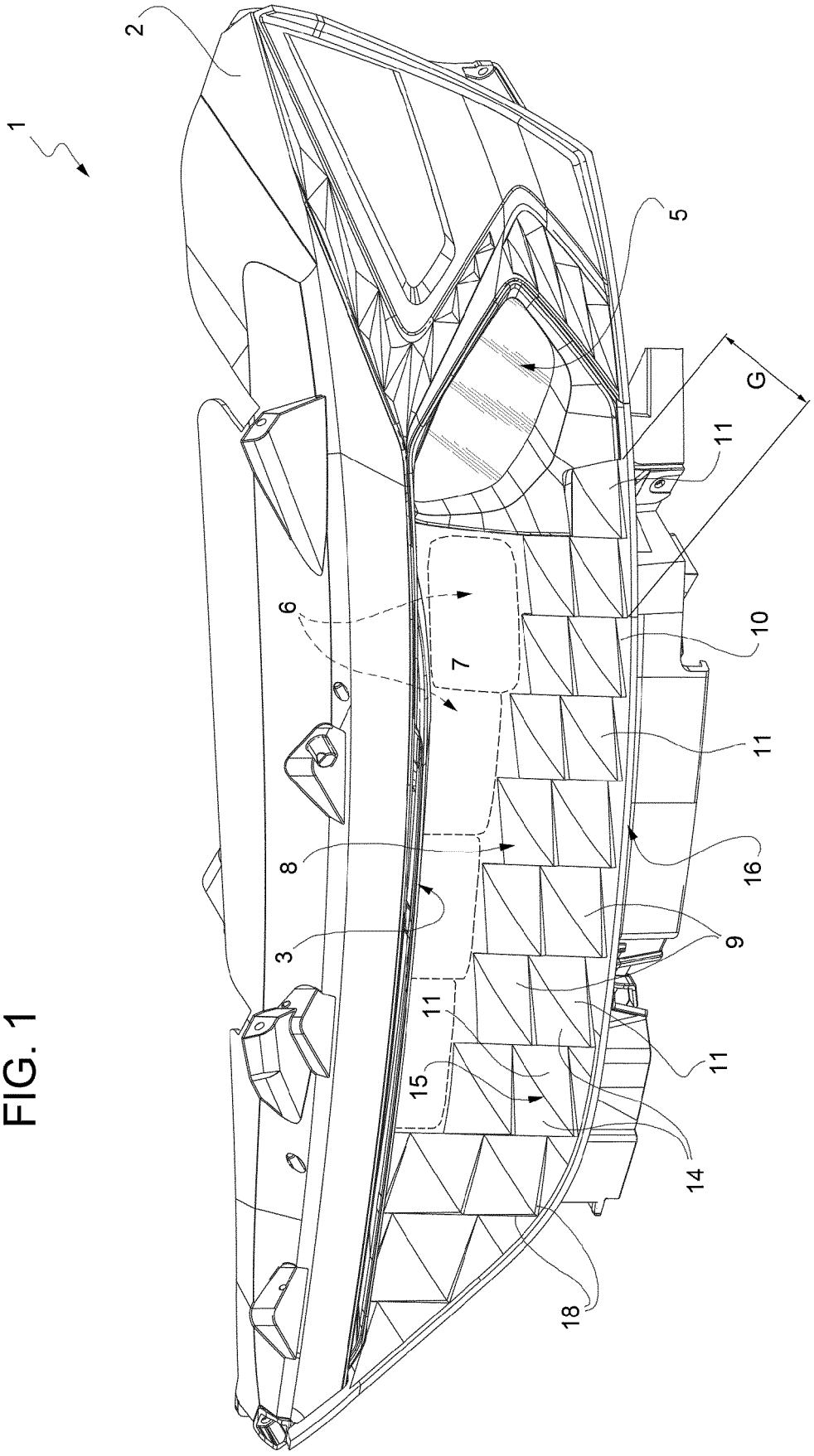
6. Lighting device according to claim 5, **characterized in that** the individual bulged surface portions (9) are arranged in a checkerboard configuration, along at least two parallel rows running in the direction of the width of said front inlet opening (3).

7. Lighting device according to anyone of the preceding claims, **characterized in that** each individual bulged surface portion (9) define with another adjacent individual bulged surface portion (9) a separation step (18); all the separation steps (18) being oriented forwards.

8. Lighting device according to anyone of the preceding claims, **characterized in that** the upper surface (8) of the aesthetic mask (7) is reflective.

9. Vehicle provided with a lighting device (1) according to claim 1.

FIG. 1



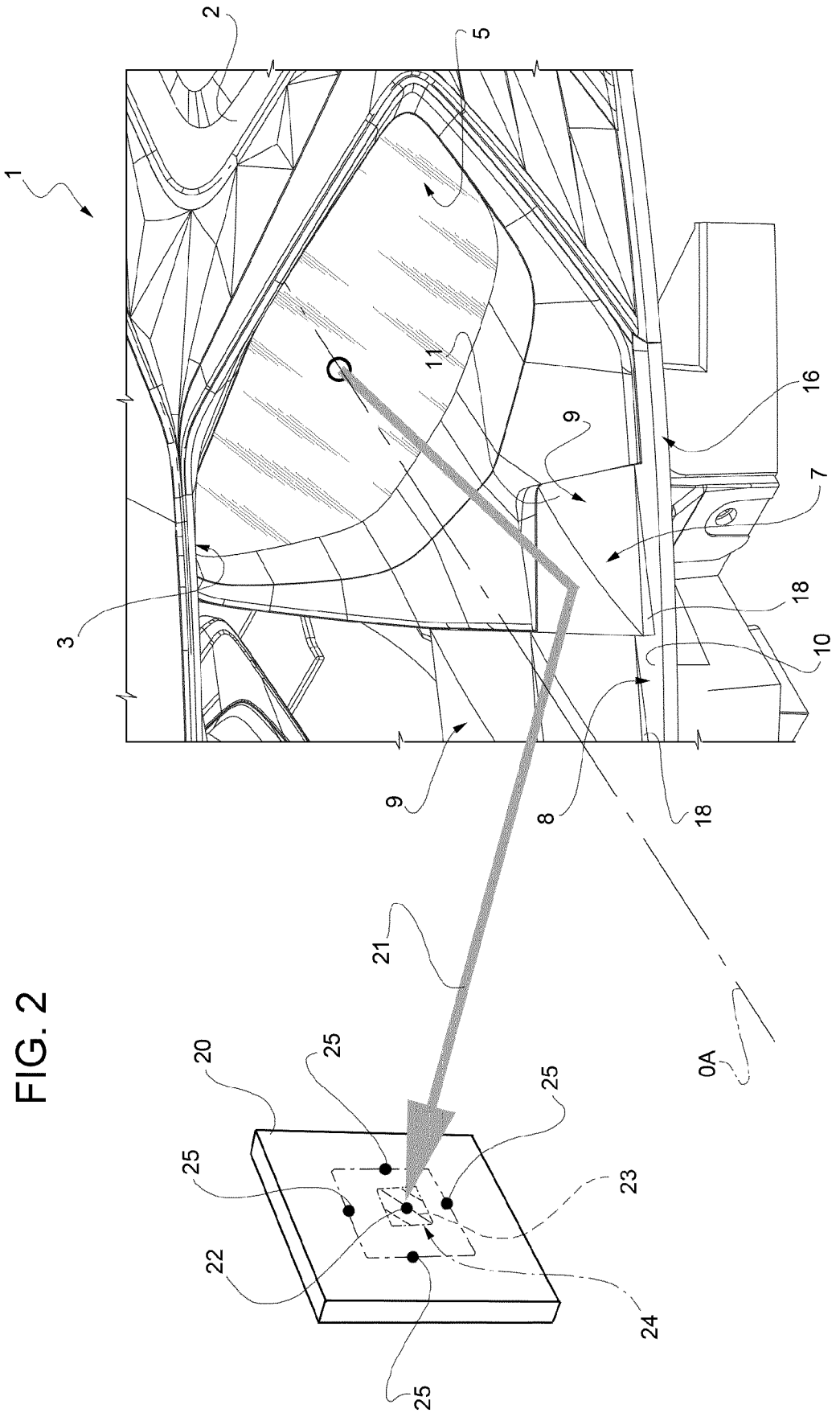


FIG. 2

FIG. 4

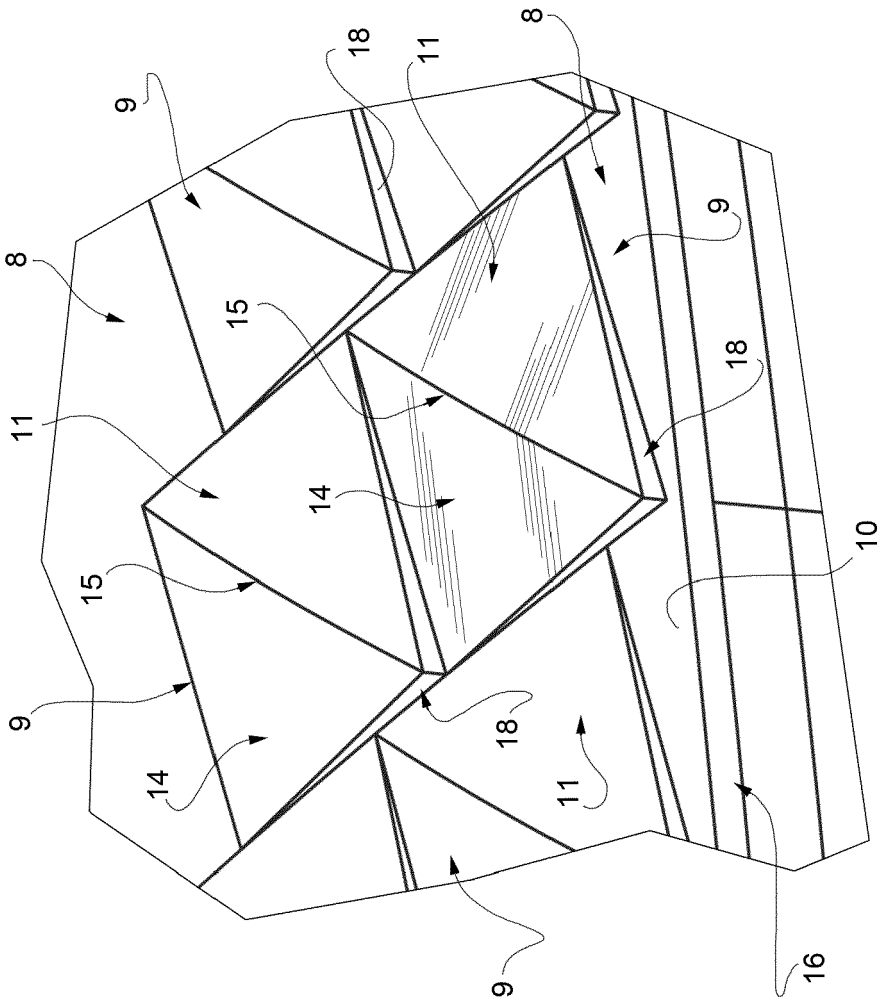
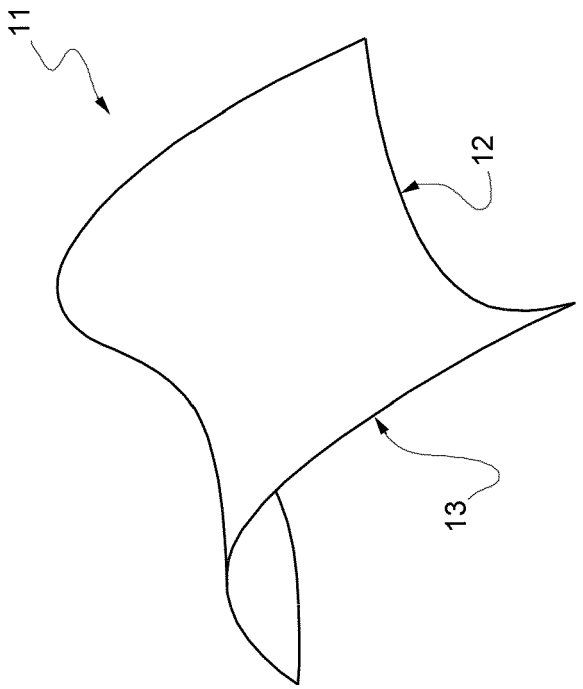


FIG. 3



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EUROPEAN SEARCH REPORT

Application Number
EP 17 15 4080

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	14 July 2017	Giraud, Pierre

CATEGORY OF CITED DOCUMENTS

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