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

(11) **EP 4 071 402 A1**

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
12.10.2022 Bulletin 2022/41

(21) Application number: **22166515.1**

(22) Date of filing: **04.04.2022**

(51) International Patent Classification (IPC):
F21S 43/14 *(2018.01)* ***F21S 43/15*** *(2018.01)*
F21S 43/239 *(2018.01)* ***F21S 43/243*** *(2018.01)*
F21S 43/249 *(2018.01)* ***F21S 43/20*** *(2018.01)*
F21S 43/31 *(2018.01)* ***F21S 43/40*** *(2018.01)*

(52) Cooperative Patent Classification (CPC):
F21S 43/14; F21S 43/15; F21S 43/239; F21S 43/243; F21S 43/249; F21S 43/26; F21S 43/315; F21S 43/40

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

(30) Priority: **09.04.2021 IT 202100008909**

(71) Applicant: **Marelli Automotive Lighting Italy S.p.A. Con Socio Unico**
10078 Venaria Reale (TO) (IT)

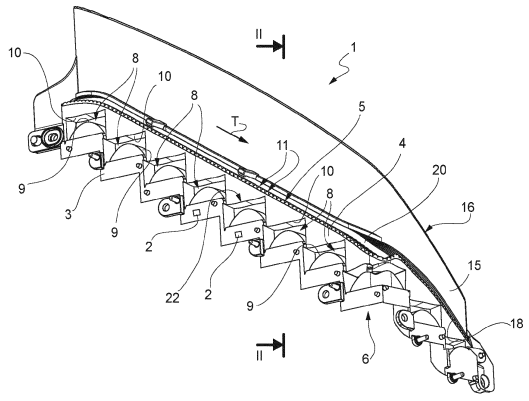
(72) Inventors:
- **VAIRA, Alessandro**
  10078 VENARIA REALE (TO) (IT)
- **CLERICI, Francesca**
  10078 VENARIA REALE (TO) (IT)
- **CERONE, Roberto**
  10078 VENARIA REALE (TO) (IT)

(74) Representative: **Studio Torta S.p.A.**
Via Viotti, 9
10121 Torino (IT)

(54) LIGHTING DEVICE FOR VEHICLES, IN PARTICULAR WITH LEDS

(57) A lighting device (1) including a plurality of light sources (2) arranged side-by-side and spaced from one another along a predetermined trajectory (T) and a blade-shaped first lighting body (4), delimited longitudinally between a front face (5) and a rear face (6) parallel to the predetermined trajectory; between the front and rear faces (5,6) first air lenses (8) are present, each being arranged at a light source (2) and including a first and a second collimating optical element (9,10); the front face (5) being provided with divergent optics (11) configured to form on the front face (5) a plurality of virtual light sources (14) arranged spaced from one another with a pitch smaller than the first light sources (2); a second blade lighting body (15) being arranged in front of the front face (5) of the first illuminating body (4), spaced from it by a second air lens (20).

FIG. 1



EP 4 071 402 A1

(Cont. next page)

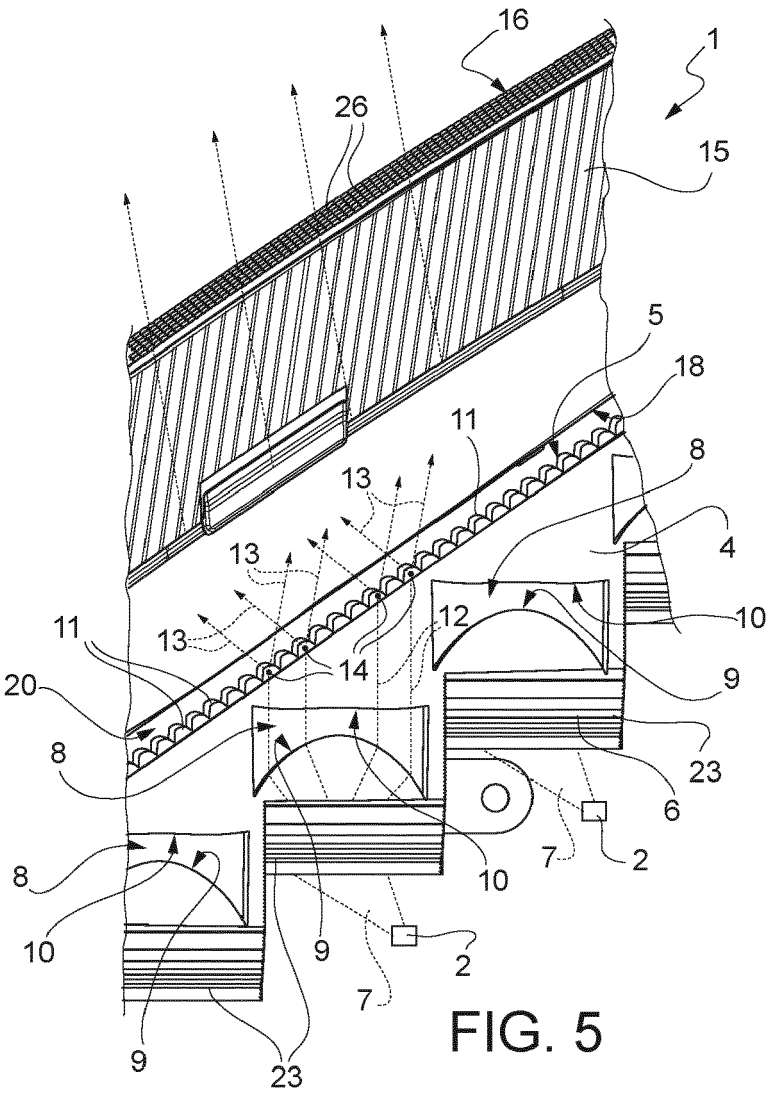


FIG. 5

Description

Cross-reference to related applications

[0001] This patent application claims priority from Italian patent application no. 102021000008909 filed on April 9, 2021.

Technical field of the invention

[0002] The present invention relates to a lighting device for vehicles, in particular a signalling device for vehicles, for example motor vehicles, such as a lamp, wherein the light source consists of a LED or a LED battery.

Prior art

[0003] As known, on modern vehicles, in particular motor vehicles, headlights or, more often, lamps are often adopted, both for technical and stylistic reasons, in which the lighting body is formed by a blade-shaped flat light guide, rectilinear or more often curved, known with the term "light blade" or "blade of light."

[0004] In this type of lighting device, a series of light sources arranged side-by-side and generally formed by LEDs are activated, simultaneously or sequentially, and feed light into a first end of the blade-shaped light guide; the light is then emitted through a second end of the light guide, opposite to the first end. A lighting device of this type is illustrated in EP3248840.

[0005] This type of solution has the drawback that the light emitted from the second end is not homogeneous, at worst to the point that it is still possible to distinguish individual light sources.

[0006] This drawback can be attenuated, and even suppressed, by increasing the number of light sources arranged side-by-side and/or by extending the depth of the light blade, i.e. the distance between the first and second ends of the light guide constituting the lighting body.

[0007] However, it is clear that increasing the number of light sources is expensive and often difficult to implement, especially when they are arranged on a flexible printed circuit arranged facing the first end of the light guide, parallel thereto. Likewise, extending the depth of the "light blade" is often not possible due to dimension reasons.

[0008] The problem is only partly attenuated by interposing additional optical elements between the first and second ends of the light guide, as described in EP3502551.

Summary of the invention

[0009] The object of the present invention is to provide a lighting device for vehicles, in particular for use in motor vehicle lamps, in which the light source is formed by a plurality of LEDs and which has not the drawbacks of the state of art, in particular that can provide high uniformity and homogeneity of output lighting, together with high compactness, therefore with small dimensions, relatively low manufacturing and assembly costs and high shape adaptability, so as to be able to equip vehicles with stylistic profiles that are very different from each other, but operating on the basis of a single operation principle.

[0010] Therefore, the present invention relates to a lighting device for vehicles having the characteristics as set forth in the appended claims.

[0011] Particularly, the lighting device for vehicles according to the invention consists preferably, but not exclusively, of a signalling device usable in a motor vehicle headlight or lamp.

[0012] The lighting device of the invention comprises a plurality of first light sources arranged side-by-side, spaced from one another along a predetermined trajectory, with a constant or non-constant pitch, and a first lighting body substantially blade-shaped and delimited longitudinally between a front face and a rear face thereof, opposite to one another, the first lighting body being configured to receive light in the form of a plurality of light beams from the first light sources on the side of the rear face (working in TIR - *Total Internal Reflection),* which is arranged parallel to the aforementioned predetermined trajectory, and to emit light through the front face.

[0013] Between the front and rear faces of the first lighting body, a plurality of first air lenses are present, each being arranged substantially at a first light source, and each being composed of a first and second collimating optical elements.

[0014] In combination, the front face of the first lighting body is provided with a layer of divergent optics configured to receive a plurality of collimated light beams by the first air lenses and transform them into divergent light beams so as to form on the front face of the first lighting body a plurality of second virtual light sources arranged side-by-side and spaced from one another with a pitch, whether constant or not, smaller than the one present between the first light sources.

[0015] The lighting device of the invention further comprises a blade-shaped second lighting body and delimited longitudinally between a front face thereof and a rear face thereof, the latter facing and being parallel to the front face of the first lighting body and being spaced therefrom by a second air lens.

[0016] The first and second lighting bodies are configured to constitute total internal reflection light guides between the respective rear and front faces.

[0017] The first light sources each consist of a LED or a LED battery. Hereinafter, "LED battery" means the set of at least two adjacent LEDs having different lighting functions and/or colours.

[0018] The first lighting body is delimited between its front and rear faces by an upper face and by an opposite lower face, both flat, and the first light sources are arranged on the side of the upper face and so as to emit

the plurality of light beams transversely to the upper face and towards the rear face.

[0019] In a preferred embodiment, the rear face of the first lighting body is defined by a plurality of curved refractive surfaces, preferably of a parabolic type, each facing a single first light source and configured to collect the plurality of light beams emitted by the first light sources to collimate them towards the front face in a direction transverse, preferably perpendicular, to the upper and lower faces.

[0020] The first and second optical elements of each first air lens are thus configured to collimate the plurality of light beams refracted by the rear face in a direction perpendicular to the collimation direction determined by said curved refractive surfaces delimiting the rear face.

[0021] In use, the upper and lower faces are arranged substantially horizontally.

[0022] Essentially, then, while the curved refractive surfaces collimate the light beams emitted by the LEDs constituting the first light sources in a vertical direction, the optical elements of the first air lenses perform a double collimation (complex collimation) in a horizontal direction.

[0023] The LEDs of the first light sources are arranged offset from one another in a direction of light propagation between the rear and front faces of the first lighting body and are arranged discretely aligned along the aforementioned predetermined trajectory and all at the same distance from the front face of the first lighting body.

[0024] Essentially, the LEDs are preferably carried by a single "ladder"- or "zigzag"-shaped printed circuit configured to position the stepped LEDs along the aforementioned predetermined trajectory, and which is fixed on the upper face of the first lighting body. Of course, the printed circuit could have any other convenient shapes.

[0025] The first optical element of each first air lens is constituted by a curved, concave or convex lens; the second optical element of each first air lens is instead constituted by a lens even only partially curved, in particular curved at least at its respective opposite ends, which are arranged transversely to the direction of light propagation between the rear and front faces of the first lighting body.

[0026] The layer of divergent optics is formed by a plurality of preferably cylindrical optics arranged side-by-side and adjacent, parallel to one another, in a direction transverse, preferably perpendicular, to the respective upper and lower faces.

[0027] The second lighting body is fixed integrally in front of the first lighting body and, according to a first embodiment, is obtained integral in a one piece with the first lighting body for moulding in a synthetic plastic resin; in a second embodiment, the second lighting body is obtained as an element independent of the first lighting body but mechanically connected to the latter, preferably at opposite transversal ends of the first and second lighting bodies which flank on opposite sides the light sources.

[0028] Finally, the invention also extends to a vehicle comprising such a lighting device.

Brief description of the drawings

[0029] Further characteristics and advantages of the present invention will become clearer from the following description of its non-limiting embodiments, made with reference to the figures of the accompanying drawings, wherein:

- figure 1 schematically illustrates a perspective three-quarter view from above, but tilted 180° for better understanding, of a lighting device made according to the invention;
- figure 2 schematically illustrates and in an enlarged scale a plan view from below and sectioned according to a trace plane II-II of the lighting device of figure 1;
- figure 3 schematically illustrates a three-quarter perspective view from below of the lighting device of figure 1;
- figure 4 schematically illustrates in an enlarged scale a perspective view of a detail of figure 3;
- figure 5 schematically illustrates in a further enlarged scale a plan view from below of a portion of the lighting device of figure 1 and schematically the principle of operation thereof; and
- figure 6 schematically illustrates a three-quarter perspective view from below of a different embodiment of the lighting device of the invention.

Detailed description

[0030] With reference to figures 1 to 5, reference number 1 as a whole indicates a lighting device for a known vehicle, in particular a motor vehicle, not illustrated for simplicity.

[0031] In the illustrated non-limiting but preferred example, the lighting device 1 is a signalling device that can be inserted/integrated into a headlight or lamp, otherwise known and not illustrated for simplicity, or mounted in a specific seat directly obtained on the body of the aforementioned known and not illustrated vehicle.

[0032] The lighting device 1 comprises a plurality of first light sources 2, only two of which are shown, and only schematically as blocks, in figures 1 and 5. In figure 1 the light sources 2 are illustrated, as will be seen, in the correct assembling position.

[0033] In figure 5, for purely exemplary purposes and to better illustrate the principle of operation of the lighting device 1 according to the invention, the light sources 2 are instead illustrated arranged in a fictitious position, offset with respect to the correct assembling position, since in such correct assembling position they would not be visible.

[0034] The light sources 2 are arranged side-by-side and spaced from one another along a predetermined trajectory T, straight or curved, with fixed or variable curvature, depending on the stylistic needs to be met. The light

sources 2 are spaced from one another with a preferably constant pitch, but if necessary, the pitch could also be variable, i.e. the distance between two adjacent light sources 2 could not always be the same.

[0035] Preferably, the light sources 2 each consist of a LED or a LED battery. Hereinafter, "LED battery" means the set of at least two adjacent LEDs, for example in pairs, arranged in the same position along the trajectory T, for example having different lighting functions and/or colours, as will be seen.

[0036] In the illustrated non-limiting but preferred example, the LEDs 2 are carried by a single substantially rigid, "ladder"- or "zigzag"-shaped printed circuit 3 (or printed circuit board) so as to extend as a whole parallel to the trajectory T, but in a discrete manner, i.e. in portions, and configured to position the stepped LEDs 2 along the aforementioned predetermined trajectory T. Obviously, the printed circuit 3 could also have any other convenient shapes.

[0037] The lighting device 1 further comprises a first lighting body 4 substantially blade-shaped and longitudinally delimited between a front face 5 thereof and a rear face 6 thereof, opposite one another.

[0038] Hereafter, the terms "front" and "rear" are understood as referred to the positions assumed in use by the faces 5 and 6 on the vehicle, where the rear face 6 faces the interior of the vehicle, whereas the front face 5 faces the exterior of the vehicle. Generally, in use, the faces 5 and 6 are further arranged in a generally vertical direction, i.e. perpendicular or transversely inclined to the horizontal plane.

[0039] The first lighting body 4 is configured to receive the light in the form of a plurality of light beams 7 (figure 5) from the first light sources 2 from the side of the rear face 6, which is arranged as a whole parallel to the aforementioned predetermined trajectory T, and to emit light through the front face 5.

[0040] According to a first aspect of the invention, between the front face 5 and the rear face 6 of the first lighting body 4, there are a plurality of first air lenses 8 each arranged substantially at a first light source 2 and each composed of a first collimating optical element 9 and a second collimating optical element 10.

[0041] In combination, the front face 5 of the first lighting body 4 is provided with a layer of divergent optics 11 configured to receive (figure 5) a plurality of collimated light beams 12 by the first air lenses 8 and transform them into divergent light beams 13 so as to form on the front face 5 of the first lighting body 4 a plurality of second virtual light sources 14 (schematized with a dot in figure 5) arranged side-by-side and spaced from one another with a pitch, whether constant or not, smaller than the one present between the first light sources 2.

[0042] Essentially, according to the invention, the lighting body 4 is configured with the air lenses 8 and its faces 5 and 6 to create, from the real light sources 2, a plurality of virtual light sources 14 arranged much closer together than the light sources 2, which can thus be reduced in number and more spaced from one another than in known art, with great economic savings and constructive simplification.

[0043] In order to complete the lighting device 1 of the invention, it further comprises a blade-shaped second lighting body 15 longitudinally delimited between a front face 16 thereof and a rear face 18 thereof (where the terms "front" and "rear" have to be understood as specified above) .

[0044] The face 18 is arranged facing and parallel to the front face 5 of the first lighting body 4 and is spaced therefrom by a second air lens 20.

[0045] The first and second lighting bodies 4 e 15 are configured to constitute total internal reflection light guides between the respective rear and front faces 5,6 and 16,18, respectively.

[0046] The first lighting body 4 is further delimited between its front face 5 and rear face 6 by an upper face 21 (figure 3) and by an opposite lower face 22 (figure 1), both flat.

[0047] In a preferred embodiment, the rear face 6 of the first lighting body 4 is defined by a plurality of curved refractive surfaces 23, preferably of a parabolic type, each facing a respective first light source 2 and configured to collect the plurality of light beams 7 emitted by the first light sources 2 (figure 5) to collimate them towards the front face 5 in a direction transverse, preferably perpendicular, to the upper face 22 and the lower face 23.

[0048] The curved surfaces 23 are also arranged longitudinally stepped/offset side-by-side to one another (i.e. in the direction of emission of the light beams 7 and which goes from the rear face 6 to the front face 5) as the light sources 2 mounted on the "ladder"-shaped printed circuit 3, so as to discretely follow (in the mathematical meaning of the term) the trajectory T.

[0049] In the illustrated non-limiting example of the embodiment, the light sources 2 are further arranged on the side of the upper face 22 and so as to emit the plurality of light beams 7 transversely to the upper face 22 and towards the rear face 6.

[0050] For this purpose, the printed circuit 3 is carried integrally by the upper face 22.

[0051] The first and second optical elements 9, 10 of each first air lens 8 are instead configured, according to a further aspect of the invention, to collimate the plurality of light beams 7, already refracted by the rear face 6, in a direction perpendicular to the direction of the previous collimation determined for each beam 7 by a respective curved refractive surface 23 locally delimiting the rear face 6 at each light source or LED 2.

[0052] In use, the upper face 21 and the lower face 22 are arranged substantially horizontally.

[0053] Essentially, while each curved refractive surface 23 collimates the light beams 7 emitted by the LEDs constituting the first light sources 2 in a vertical direction, the optical elements 9, 10 of the first air lenses 8 perform a double collimation (complex collimation - that makes light homogeneous) in a horizontal direction.

[0054] The LEDs 2 constituting the first light sources are arranged, as already indicated, offset from one another in the direction of light propagation between the rear face 6 and the front face 5 of the lighting body 4 and are arranged discretely aligned along the aforementioned predetermined trajectory T and preferably all at a same distance from the front face 5 of the first lighting body 4, where possible based on the envisaged stylistic shape therefor.

[0055] The first optical element 9 of each first air lens 8 is constituted by a curved, concave or convex lens; the second optical element 10 of each first air lens 8 is instead constituted by a lens even only partially curved, in particular curved at least at its respective opposite lateral ends 24 (figure 4).

[0056] The lateral ends 24 are arranged transversely to the direction of light propagation between the rear face 6 and the front face 5 of the first lighting body 4.

[0057] According to a preferred embodiment of the invention, the layer of divergent optics 11 is formed by a plurality of cylindrical optics 11 arranged side-by-side and adjacent, parallel to one another, in a direction transverse, preferably perpendicular, to the respective upper face 21 and lower face 22 of the lighting body 4.

[0058] The second lighting body 15 is fixed integrally in front of the first lighting body 4 and, according to a first embodiment of the invention, is obtained integral in a one piece with the first lighting body 4, having been moulded together with it in a one piece and with a single operation in a synthetic plastic resin.

[0059] In a second possible embodiment, schematically illustrated in figure 6 and indicated with the reference number 100, the remaining details similar or identical to those already described being indicated with the same numbers for simplicity, the second lighting body 15 is obtained as an independent element from the first lighting body 4, but mechanically connected to the latter, preferably at opposite transversal ends 25 of the first and second lighting bodies 4 and 15, which flank the light sources 2 from opposite sides (not illustrated in figure 6, only a lateral part of the printed circuit board 3 is visible).

[0060] In both embodiments 1 and 100, the lighting device of the invention may comprise further optical elements, if necessary. In particular, the front face 16 of the second lighting body 15 may be provided with lenses or prisms or holograms 26 (figures 5 and 6). Similarly, other additional optical elements may be provided on the rear face 18, at the air lens 20.

[0061] On the basis of what has been described, it is apparent that, thanks to the presence of two blade-shaped lighting bodies such as the light guides 4 and 15, coupled to each other and to the air lenses 8 and 20, a relatively limited number of LEDs 2 spaced from one another generate on the face 18 the same input lighting that would be generated by a much greater amount of light sources, in this case represented by the virtual light sources 14, much closer together, in a lighting device of the known art.

[0062] In addition, the LEDs 2 can be easily collected on a single rigid printed circuit 3.

[0063] Finally, the invention also extends to a vehicle comprising one or more lighting devices 1 or 100.

[0064] All the objects of the invention are achieved.

Claims

1. A lighting device (1;100) for a vehicle comprising a plurality of first light sources (2) arranged side-by-side, spaced from one another along a predetermined trajectory (T), with a constant or non-constant pitch, and a first lighting body (4) substantially blade-shaped and delimited longitudinally between a front face (5) thereof and a rear face (6) thereof, opposite to one another, the first lighting body (4) being configured to receive light in the form of a plurality of light beams (7) from said first light sources (2) on the side of the rear face (6), which is arranged parallel to said predetermined trajectory (T), and to emit light through the front face (5); **characterised in that** between the front and rear faces (5, 6) of the first lighting body (4) a plurality of first air lenses (8) are present each being arranged substantially at a first light source (2) and each formed by a first collimating optical element (9) and by a second collimating optical element (10); **and in that,** in combination, the front face (5) of the first lighting body (4) is provided with a layer of divergent optics (11) configured to receive a plurality of collimated light beams (12) from the first air lenses (8) and to transform them into divergent light beams (13) in order to form, on the front face (5) of the first lighting body (4), a plurality of second virtual light sources (14), arranged side-by-side and spaced from one another with a constant or non-constant pitch, smaller than that present between the first light sources (2); the lighting device (1;100) furthermore comprising a second blade-shaped lighting body (15) longitudinally delimited between a front face (16) thereof and a rear face (18) thereof, the latter being arranged in front of and parallel to the front face (5) of the first lighting body (4) and spaced therefrom by means of a second air lens (20).

2. The lighting device according to claim 1, **characterised in that** the first light sources (2) each consist of an LED or an LED battery (2).

3. The lighting device according to claim 1 or 2, **characterised in that** the first lighting body (4) is delimited between said front (5) and rear (6) faces by an upper face (21) and by an opposite lower face (22), both flat, the first light sources (2) being arranged on the side of the upper face (21) and so as to emit said plurality of light beams (7) transversely to the upper face (21) and towards the rear face (6).

4. The lighting device according to claim 3, **characterised in that** the rear face (6) of the first lighting body is defined by a plurality of side-by-side curved refractive surfaces (23), preferably of a parabolic type, each facing a respective first light source (2) and configured to collect said plurality of light beams (7) to collimate them towards the front face (5) in a direction transverse, preferably perpendicular, to said upper and lower faces (21,22).

5. The lighting device according to claim 4, **characterised in that** the first and second optical elements (9,10) of each first air lens (8) are configured to collimate said plurality of light beams refracted by the rear face (6) in a direction perpendicular to the previous collimation direction determined by said curved refractive surfaces (23) delimiting the rear face (6).

6. The lighting device according to one of the preceding claims, **characterised in that** said light sources (2) are arranged staggered between one another along a light propagation direction between said rear (6) and front (5) faces and arranged aligned in a discrete manner along said predetermined trajectory (T) and preferably all at a same distance from the front face (5).

7. The lighting device according to one of the preceding claims, **characterised in that** the first optical element (9) of each first air lens (8) is formed by a curved, concave or convex lens; and **in that** the second optical element (10) of each first air lens is formed by a lens which is curved at least at respective opposite ends (24) thereof arranged transversely to a light propagation direction between said rear and front faces (6,5).

8. The lighting device according to one of the preceding claims, **characterised in that** said layer of divergent optics (11) is formed by a plurality of cylindrical optics (11) arranged side-by-side, adjacent and parallel to one another and in a direction transverse, preferably perpendicular, to respective upper and lower faces (21,22), both flat, delimiting the first lighting body (4) between said front and rear faces.

9. The lighting device according to one of the preceding claims **characterised in that** the second lighting body (15) is fixed integral in front of the first lighting body (4) and is either obtained integral in a one piece with the same, by moulding with a synthetic plastic resin, or is obtained as an element independent of the first lighting body (4) but mechanically connected to the latter, preferably at opposite transversal ends (25) of the first and second lighting bodies (4,15) which flank on opposite sides said light sources (2).

10. A vehicle comprising a lighting device (1;100), headlight or lamp, according to one of the preceding claims.

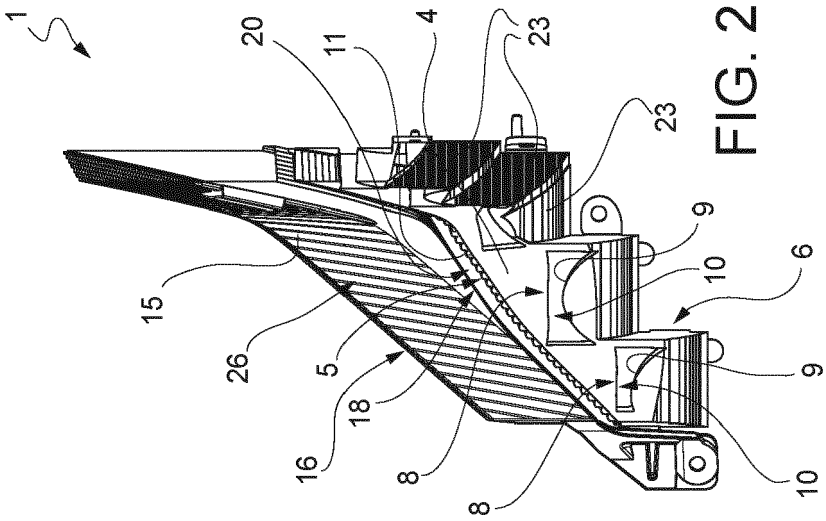

1
20
11
4
23
23
9
10
6
9
10
15
26
5
18
16
8
8

FIG. 2

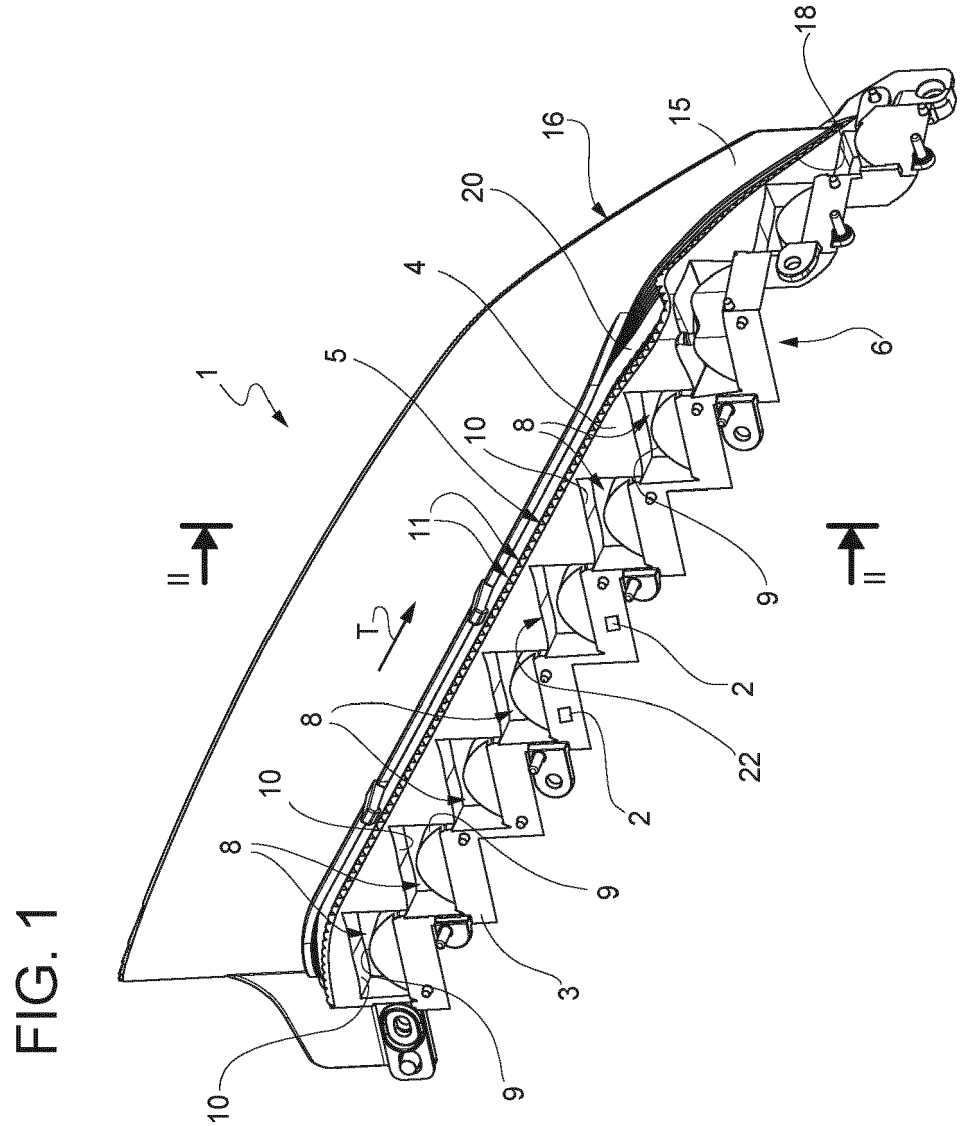

18
15
16
20
4
5
6
1
10
8
11
II
II
T
9
2
22
8
10
2
8
9
3
10
9

FIG. 1

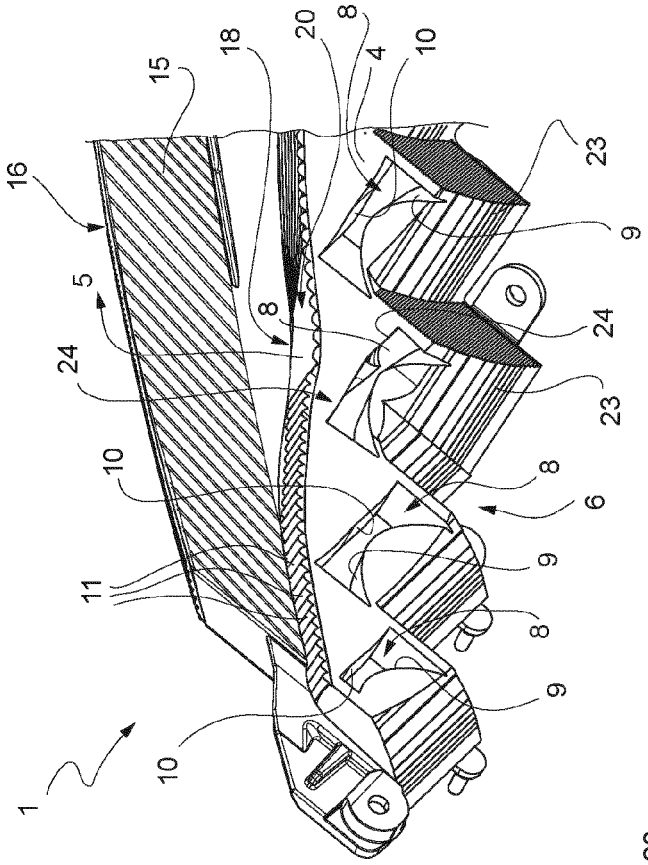

1
16
15
18
20
8
4
10
23
9
5
24
8
24
23
10
8
6
11
9
8
9
10

FIG. 4

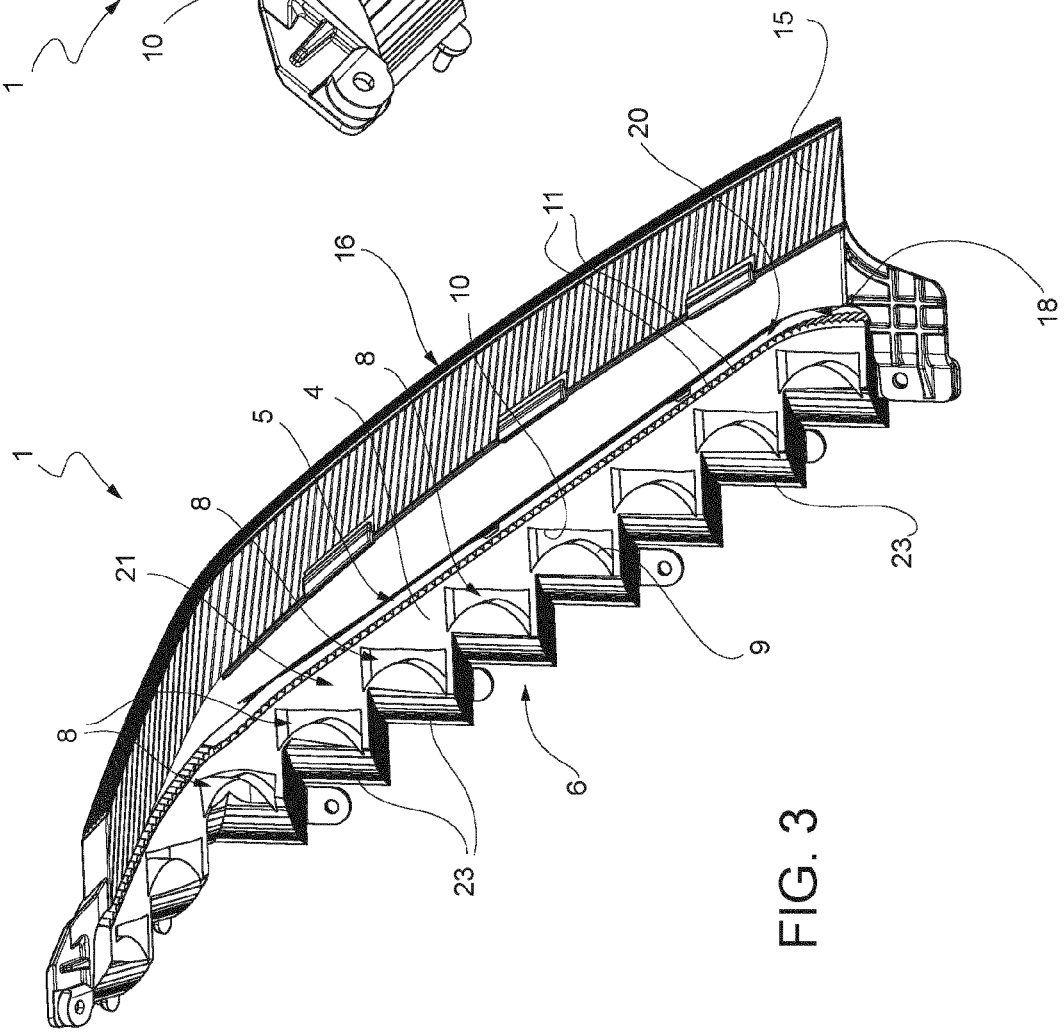

1
15
20
11
16
10
8
18
5
4
8
8
21
23
9
8
6
23

FIG. 3

FIG. 6

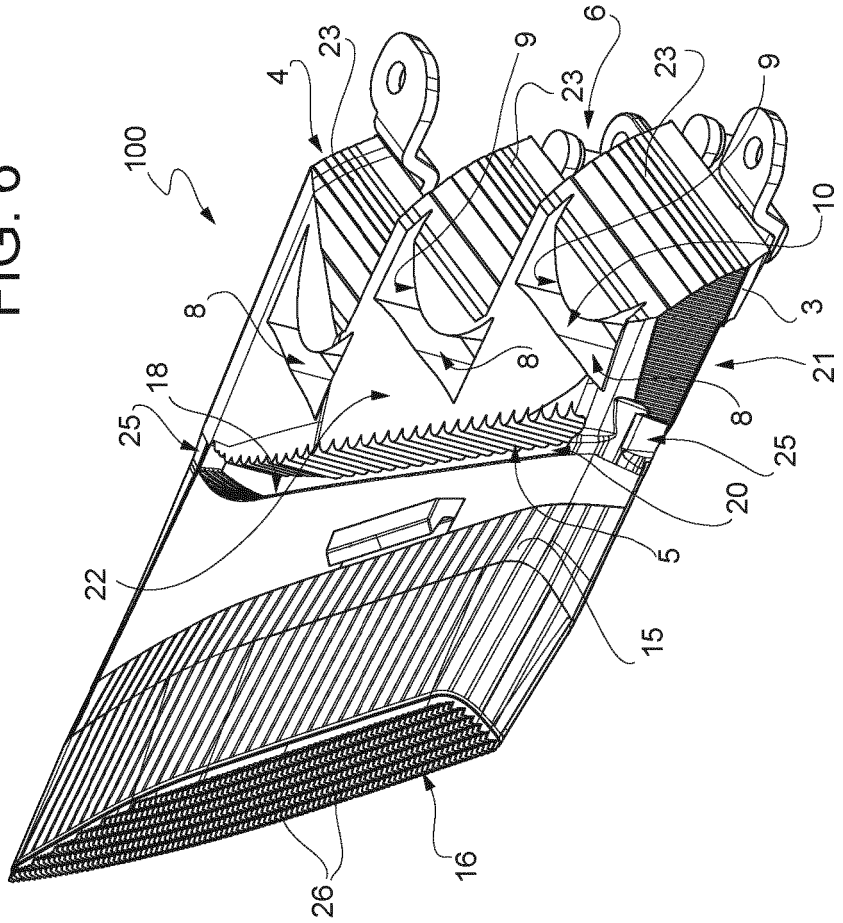
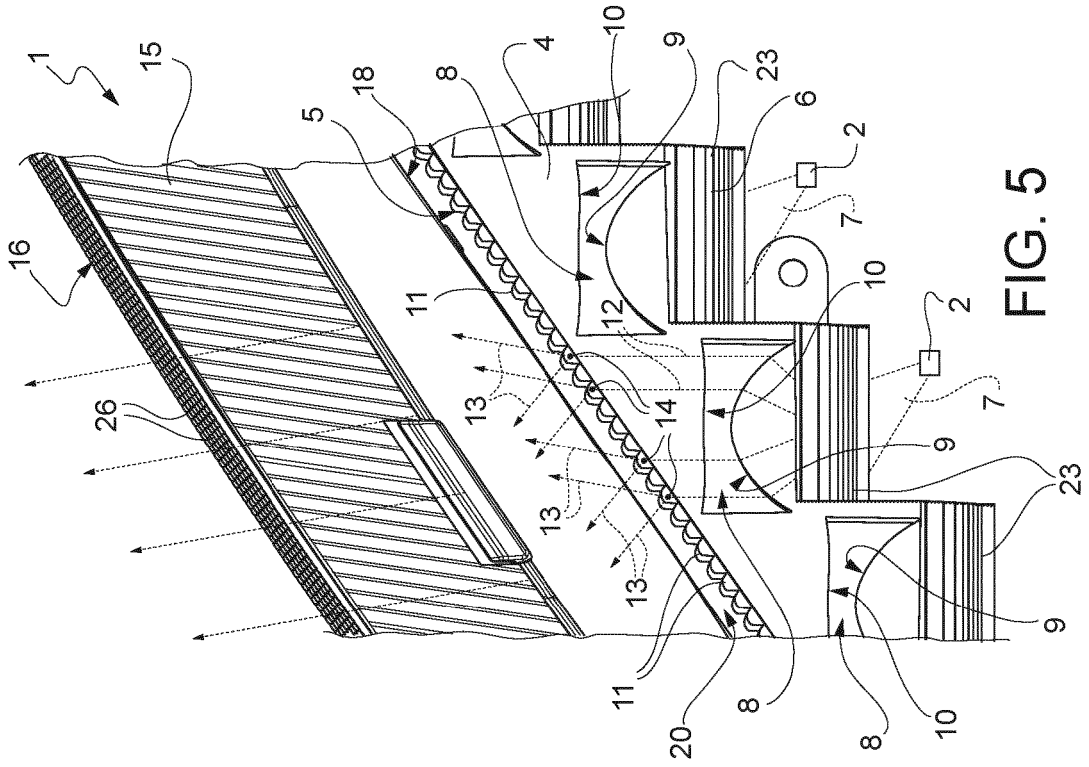

100
4
23
9
6
23
23
9
10
3
21
8
8
8
18
25
25
20
5
22
15
16
26

FIG. 5


1
15
16
26
5
18
8
4
10
9
23
6
2
7
11
12
13
14
13
13
11
20
8
8
10
9
23
9

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 22 16 6515

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	EP 1 895 228 A1 (VALEO VISION [FR]) 5 March 2008 (2008-03-05) * paragraphs [0001], [0017] - [0024]; figures 1-6B *	1-3,8-10 4-7	INV. F21S43/14 F21S43/15 F21S43/239 F21S43/243 F21S43/249 F21S43/20 F21S43/31 F21S43/40
Y	WO 2014/203061 A2 (KOITO MFG CO LTD [JP]; TOYOTA MOTOR CO LTD [JP]) 24 December 2014 (2014-12-24) * figures 1-5 *	4,5	
Y	JP 2015 167124 A (KOITO MFG CO LTD) 24 September 2015 (2015-09-24) * see attached machine translation; paragraphs [0028] - [0072]; figures 1-4 *	6,7	
A	CN 112 178 585 A (MAGNETI MARELLI AUTOMOTIVE COMPONENTS WUHU CO LTD) 5 January 2021 (2021-01-05) * see attached machine translation; figures 1-9 *	1-10	
A	US 2019/271447 A1 (CHOO DONG-HOON [KR] ET AL) 5 September 2019 (2019-09-05) * paragraphs [0002], [0056] - [0078]; figures 2-6 *	1-10	TECHNICAL FIELDS SEARCHED (IPC) F21S
A	JP 2015 201278 A (KOITO MFG CO LTD) 12 November 2015 (2015-11-12) * see attached machine translation; paragraphs [0025] - [0105]; figures 1-9 *	1-4,6,8, 10	
A	EP 2 818 791 A1 (AUTOMOTIVE LIGHTING REUTLINGEN [DE]) 31 December 2014 (2014-12-31) * paragraphs [0029] - [0058]; figures 1-13 *	1-5,7,8, 10	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 July 2022	Goltes, Matjaz

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

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 16 6515

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

21-07-2022

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1895228 A1	05-03-2008	AT 430898 T	15-05-2009
		EP 1895228 A1	05-03-2008
		ES 2324925 T3	19-08-2009
		FR 2905448 A1	07-03-2008
WO 2014203061 A2	24-12-2014	CN 105308384 A	03-02-2016
		DE 112014002880 T5	03-03-2016
		JP 5814302 B2	17-11-2015
		JP 2015002148 A	05-01-2015
		US 2016138772 A1	19-05-2016
		WO 2014203061 A2	24-12-2014
JP 2015167124 A	24-09-2015	NONE	
CN 112178585 A	05-01-2021	NONE	
US 2019271447 A1	05-09-2019	CN 110230799 A	13-09-2019
		DE 102018130425 A1	05-09-2019
		KR 20190105395 A	17-09-2019
		US 2019271447 A1	05-09-2019
JP 2015201278 A	12-11-2015	NONE	
EP 2818791 A1	31-12-2014	CN 104251443 A	31-12-2014
		DE 102013212352 A1	31-12-2014
		EP 2818791 A1	31-12-2014
		US 2015003094 A1	01-01-2015

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- IT 102021000008909 **[0001]**
- EP 3248840 A **[0004]**
- EP 3502551 A **[0008]**