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(71) Applicant: **HELLA GMBH & CO. KGAA** [DE/DE]; Rixbecker Straße 75, 59552 Lippstadt (DE).

(72) Inventors: **DRÜPPEL, Mathias**; Lange Straße 44, 59555 Lippstadt (DE). **FISCHER, Bernd**; Reelsberg 1, 33184 Altenbeken (DE). **KAUP, Marc**; Penzlinger Str. 19, 33102 Paderborn (DE).

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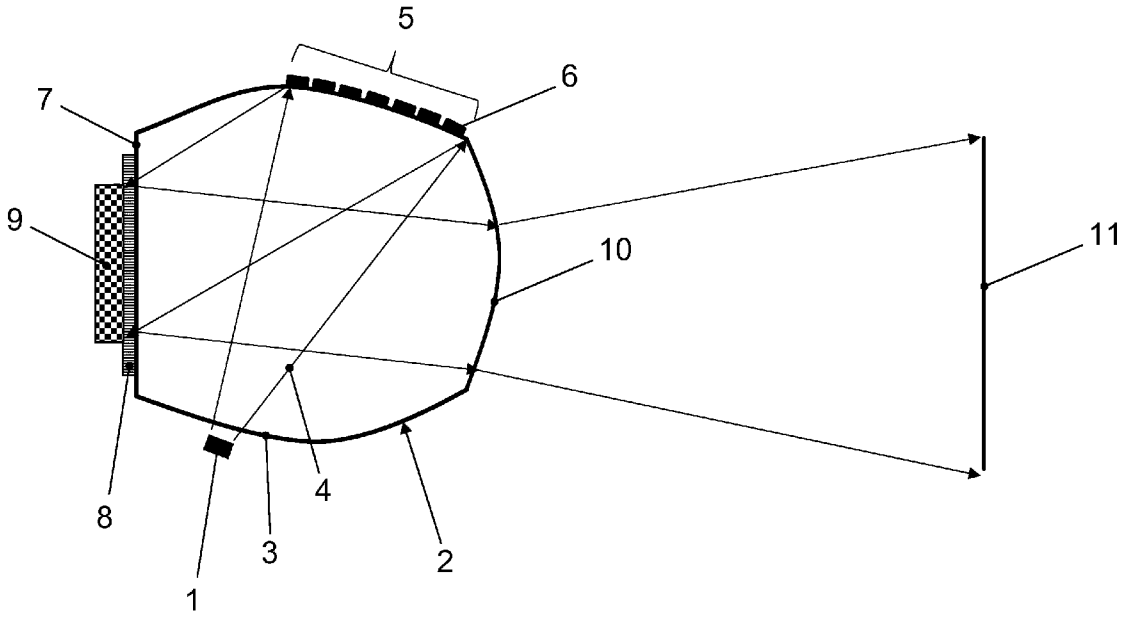
(54) Title: A LIGHTING DEVICE FOR A MOTOR VEHICLE

Fig. 1



(57) Abstract: A Lighting device for a motor vehicle, in particular a headlamp for a motor vehicle, comprising at least one light source (1) from which light (4) is emitted during operation of the lighting device, an optical component (2) into which the light (4) emanating from the at least one light source (1) enters, light influencing means (9) having an active surface for selectively influencing individual pixels or groups of pixels of the light (4), the light influencing means (9) reflecting or deflecting light (4) incident thereon in such a way that it emerges at least partially from the lighting device, and illumination optics, which is formed on or in the optical component (2), and the light (4) being reflected or deflected by the illumination optics during operation of the lighting device onto the active surface of the light influencing means (9), wherein the light influencing means (9) being arranged outside the optical component (2) in such a way that light (4) emanating from the illumination optics emerges from the optical component (2), impinges on the active surface of

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the light influencing means (9), is reflected or deflected by the latter and then re-enters into the optical component (2).

A lighting device for a motor vehicle

Description

The present invention concerns a lighting device for a motor vehicle, in particular a headlamp for a motor vehicle, according to the preamble of claim 1.

High-resolution headlamp projection modules according to the state of the art use a large number of optically relevant components, which have to be adjusted to each other. These are, for example, light influencing means serving as imaging elements, such as a digital micro-mirror device (DMD) or an LCoS (Liquid Crystal on Silicon) or LC display, as well as illumination optics for illuminating the imaging element. The imaging element can specifically reflect or shadow or deflect individual pixels or groups of pixels of light in such a way that it emerges at least partially from the lighting device. Furthermore, decoupling optics are usually used to image an active surface of the light influencing means into the traffic area.

A lighting device of the type mentioned above is known from DE 10 2018 115 045 A1. The lighting device described therein may be designed as a high-resolution headlamp. The lighting device comprises two monolithic components made of a transparent material, one of which serves as illumination optics and the other as decoupling optics. The lighting device also includes a digital micro-mirror device which serves as an imaging element and is located between the first monolithic component and the second monolithic component.

The purpose of the present invention is to create a lighting device of the aforementioned kind, which has a smaller number of optical components.

This is achieved, in accordance with the invention, by means of a lighting device of the aforementioned kind with the characterizing features of claim 1. The subclaims concern preferred forms of the invention.

Claim 1 provides that the light influencing means being arranged outside the optical component in such a way that light emanating from the illumination optics emerges from the optical component, impinges on the active surface of the light influencing means, is reflected or deflected by the latter and then re-enters into the optical component. In contrast to the state of the art, this reduces the adjustment effort for the lighting device. In particular, a high-resolution headlamp projection module with a smaller number of components can be realized.

The light influencing means may be in direct or indirect contact with an outside of the optical component, in particular in direct or indirect contact with a refractive surface of the optical component, through which light can exit from the optical component and enter the optical component. It is possible that a connecting layer, for example made of liquid silicone rubber (LSR), is arranged between the outside of the optical component and the light influencing means. Light losses can be reduced by the connecting layer.

It may be provided that the light influencing means are designed as a digital micro-mirror device or as an LCoS or as an LC display, or that the light influencing means comprise a digital micro-mirror device or an LCoS or an LC display The light influencing means may be designed to reflect portions of the light emitted from the optical component back to the optical component. An example of this is a reflective LC display.

It is possible for the illumination optics to comprise a reflector having a single uninterrupted mirror surface or a plurality of mirror elements. For example, the reflector may have a concave curved base surface. Preferably, the reflector can be formed by a reflecting surface of the optical component, which can in particular have at least one reflecting layer applied to the outside of the component. The optical component can be compactly dimensioned by folding the beam path inside the optical component as a result of the reflection.

The lighting device preferably comprises decoupling optics through which the light emitted by the influencing means emerges from the lighting device during operation of the lighting device. It may be provided that the decoupling optics are integrated into the optical component, in particular are realized by a refractive exit surface of the optical component. The exit surface can be aspherically curved and/or designed as a free-form surface. By the formation of the decoupling optics on or in the optical component, the number of parts of the lighting device to be adjusted to each other is further reduced. This is the first time that a combination of illumination optics, an imaging element and decoupling optics has been combined on or in a single prefabricated component, eliminating the need to adjust several optically relevant components to each other in headlamp finishing.

It is possible that the optical component is a monolithic component consisting of glass or polycarbonate (PC), for example. A prefabricated monolithic or one-piece component is robust and compact.

It may be provided that at least one light source is a laser light source, especially a semiconductor laser, or a light-emitting diode. It is also possible to use several semiconductor lasers or several light-emitting diodes or to combine at least one semiconductor with at least one light-emitting diode.

The invention is explained in more detail below on the basis of the attached drawings. And shows

Fig. 1 a schematic view of an example of a lighting device according to the invention.

The illustrated example of a lighting device comprises a light source 1, which is designed in particular as a semiconductor laser or light-emitting diode. It is possible to provide more than one semiconductor laser and/or more than one light-emitting diode.

The lighting device also includes a monolithic component 2 made of glass or polycarbonate, for example. The optical component 2 has a refractive entry surface 3 through which the light 4 emitted by light source 1 can enter the optical component 2.

On the side of optical component 2 opposite the entry surface 3, a reflector 5 is arranged, which is formed in particular as a facetted reflecting region with a plurality of mirror elements 6. However, it is possible to provide the reflector 5 with a single, uninterrupted mirror surface.

The reflector 5 is formed by a reflecting surface of optical component 2, which may in particular have at least one reflecting layer applied to the outside of optical component 2. The reflecting surface forming the reflector 5 can be curved, in particular concave curved, or plane.

The refractive entry surface 3 and the reflector 5 form illumination optics from which the light 4 emitted by the light source 1 is directed onto the light influencing means 9 described below in detail.

The reflector 5 is inclined in such a way that the light 4 is reflected by the reflector 5 onto a refractive surface 7 of optical component 2 different from the entry surface 3. On the outside of this refractive surface 7, the light influencing means 9 are coupled. The coupling of the light influencing means 9 is realized via a connecting layer 8, which is arranged between the refractive surface 7 and the light influencing means 9. The connecting layer can, for example, consist of liquid silicone rubber (LSR).

The light influencing means 9 serve as an imaging element and can be designed, for example, as a digital micro-mirror device (DMD) or as an LCoS (Liquid Crystal on Silicon) or as an LC display. An active surface of the light influencing means 9 is designed in such a way that it reflects parts of the light 4 emitted from the refractive surface 7 back to the refractive surface 7.

Through the refractive surface 7, the parts of the light 4 reflected by the active surface of the light influencing means 9 are coupled back into optical component 2. A refractive exit surface 10 of the optical component 2 is arranged on the side of the optical component 2 opposite to the surface 7, which serves as decoupling optics. The exit surface 10, for example, can be aspherically shaped and/or designed as a free-form surface. The exit surface 10 images the active surface of the light influencing means 9 into a projection plane 11 in the traffic space.

List of reference symbols

1	light source
2	optical component
3	entry surface
4	light emitted by the light source
5	reflector
6	mirror element
7	refractive surface
8	connecting layer
9	light influencing means
10	exit surface
11	projection plane

Patent Claims

1. A Lighting device for a motor vehicle, in particular a headlamp for a motor vehicle, comprising
   - at least one light source (1) from which light (4) is emitted during operation of the lighting device,
   - an optical component (2) into which the light (4) emanating from the at least one light source (1) enters,
   - light influencing means (9) having an active surface for selectively influencing individual pixels or groups of pixels of the light (4), the light influencing means (9) reflecting or deflecting light (4) incident thereon in such a way that it emerges at least partially from the lighting device,
   - illumination optics, which are formed on or in the optical component (2), and the light (4) being reflected or deflected by the illumination optics during operation of the lighting device onto the active surface of the light influencing means (9),

   characterized in that the light influencing means (9) being arranged outside the optical component (2) in such a way that light (4) emanating from the illumination optics emerges from the optical component (2), impinges on the active surface of the light influencing means (9), is reflected or deflected by the latter and then re-enters into the optical component (2).

2. The lighting device according to claim 1, **characterized in that** the light influencing means (9) are in direct or indirect contact with an outside of the optical component (2), in particular in direct or indirect contact with a refractive surface (7) of the optical component (2), through which light (4) can exit from the optical component (2) and enter the optical component (2).

3. The lighting device according to claim 2, **characterized in that** a connecting layer (8), for example made of liquid silicone rubber (LSR), being ar-

ranged between the outside of the optical component (2) and the light influencing means (9).

4. The lighting device according to one of claims 1 to 3, **characterized in that** the light influencing means (9) are designed as a digital micro-mirror device or as an LCoS or as an LC display, or that the light influencing means (9) comprise a digital micro-mirror device or an LCoS or an LC display.

5. The lighting device according to one of claims 1 to 4, **characterized in that** the illumination optics comprise a reflector (5) having a single uninterrupted mirror surface or a plurality of mirror elements.

6. The lighting device according to claim 5, **characterized in that** the reflector (5) has a concave curved base surface.

7. The lighting device according to one of claims 5 or 6, **characterized in that** the reflector (5) is formed by a reflecting surface of the optical component (2), which can in particular have at least one reflecting layer applied to the outside of the optical component (2).

8. The lighting device according to one of claims 1 to 7, **characterized in that** the lighting device comprises decoupling optics through which the light (4) emitted by the light influencing means (9) emerges from the lighting device during operation of the lighting device.

9. The lighting device according to claim 8, **characterized in that** the decoupling optics are integrated into the optical component (2), in particular are realized by a refractive exit surface (10) of the optical component (2).

10. The lighting device according to claim 9, **characterized in that** the exit surface (10) being aspherically curved and/or being designed as a free-form surface.

11. The lighting device according to one of claims 1 to 10, **characterized in that** the optical component (2) is a monolithic component.

12. The lighting device according to one of claims 1 to 11, **characterized in that** the optical component (2) consists of glass or polycarbonates (PC).

13. The lighting device according to one of claims 1 to 12, **characterized in that** the at least one light source (1) is a laser light source, in particular a semiconductor laser, or a light-emitting diode.

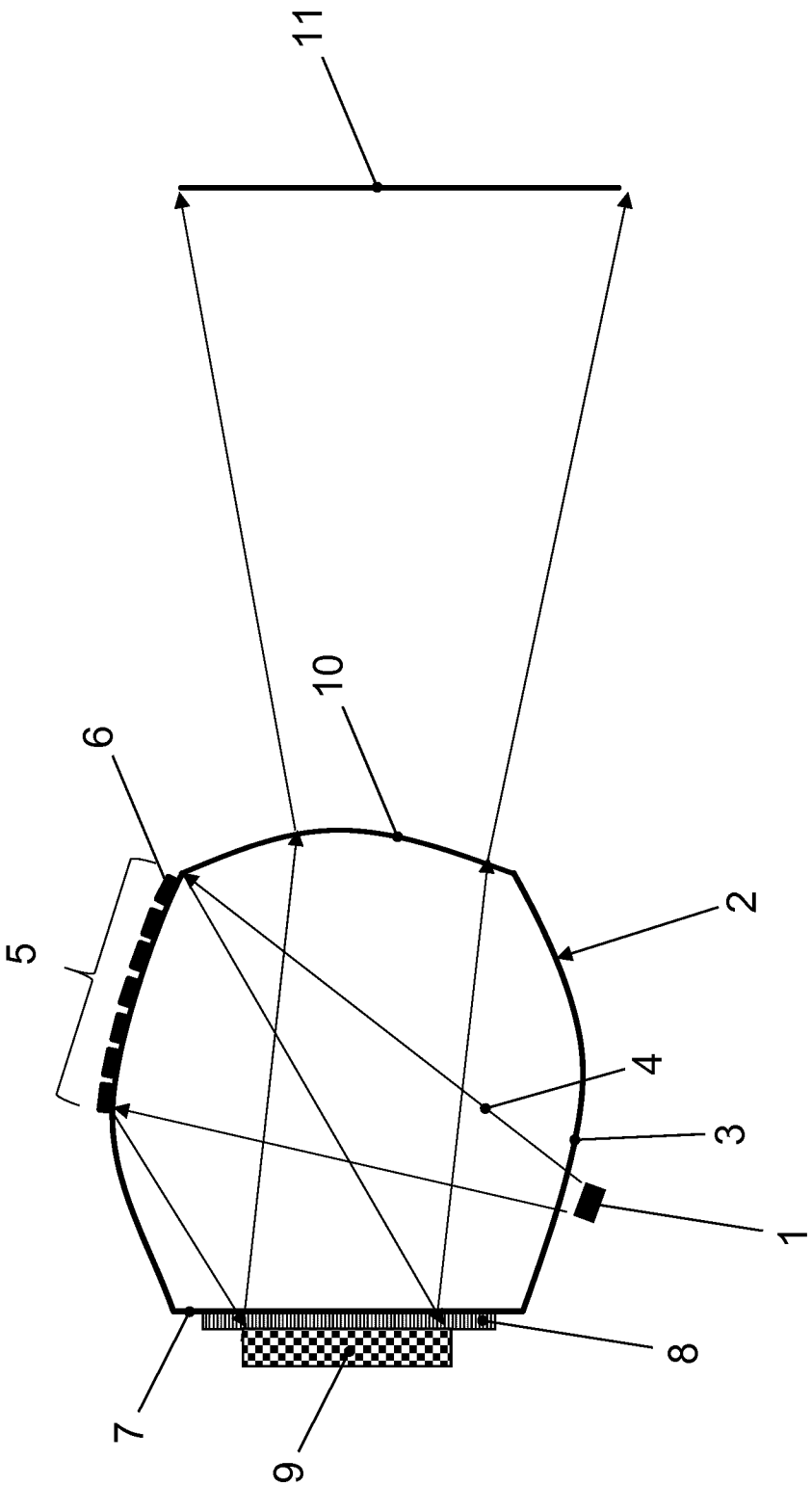

Fig. 1

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
INV. F21S41/20 F21S41/365
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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F21S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 03/056876 A2 (DIGITAL OPTICS INTERNAT CORP [US]) 10 July 2003 (2003-07-10) figures 17-33	1-9, 11-13
X	US 2010/208478 A1 (FANG YI-CHIN [TW] ET AL) 19 August 2010 (2010-08-19) figure 1	1-5,8-13
X	WO 98/52386 A1 (LIGHT & SOUND DESIGN LTD [GB]; HEWLETT WILLIAM [GB] ET AL.) 19 November 1998 (1998-11-19) figure 3	1-4,8-13
X	US 2015/377430 A1 (BHAKTA VIKRANT R [US]) 31 December 2015 (2015-12-31) figures 8, 9	1-4,8-13

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Sarantopoulos, A

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/059757

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10 2013 215374 A1 (OSRAM OPTO SEMICONDUCTORS GMBH [DE]) 5 February 2015 (2015-02-05) figures 1-5	1-5,8-13
A	FR 3 055 980 A1 (VALEO VISION [FR]) 16 March 2018 (2018-03-16) the whole document	1-13
A	FR 3 057 336 A1 (VALEO VISION [FR]) 13 April 2018 (2018-04-13) the whole document	1-13
A	US 2004/201904 A1 (TOGINO TAKAYOSHI [JP]) 14 October 2004 (2004-10-14) the whole document	1-13

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2019/059757

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 03056876 A2	10-07-2003	AU 2002359708 A1	15-07-2003
		EP 1461645 A2	29-09-2004
		EP 2397875 A2	21-12-2011
		EP 2402797 A2	04-01-2012
		EP 2410357 A2	25-01-2012
		EP 2420872 A2	22-02-2012
		EP 2420873 A2	22-02-2012
		EP 2423717 A2	29-02-2012
		JP 2006504116 A	02-02-2006
		US 2004080938 A1	29-04-2004
		US 2006152931 A1	13-07-2006
		WO 03056876 A2	10-07-2003
US 2010208478 A1	19-08-2010	NONE	
WO 9852386 A1	19-11-1998	AU 7294998 A	08-12-1998
		DE 69838808 T2	30-10-2008
		DK 0986935 T3	31-03-2008
		EP 0986935 A1	22-03-2000
		EP 1898679 A2	12-03-2008
		US 6188933 B1	13-02-2001
		US 6622053 B1	16-09-2003
		US 2001047212 A1	29-11-2001
		US 2004160198 A1	19-08-2004
		US 2006187532 A1	24-08-2006
		US 2008225372 A1	18-09-2008
		US 2010110520 A1	06-05-2010
		US 2011121737 A1	26-05-2011
		US 2013050796 A1	28-02-2013
		US 2015330608 A1	19-11-2015
		WO 9852386 A1	19-11-1998
US 2015377430 A1	31-12-2015	US 2015377430 A1	31-12-2015
		US 2018135823 A1	17-05-2018
DE 102013215374 A1	05-02-2015	DE 102013215374 A1	05-02-2015
		DE 112014003609 A5	12-05-2016
		JP 6212218 B2	11-10-2017
		JP 2016528695 A	15-09-2016
		KR 20160040190 A	12-04-2016
		US 2016195231 A1	07-07-2016
		WO 2015018729 A1	12-02-2015
FR 3055980 A1	16-03-2018	CN 109716196 A	03-05-2019
		EP 3513234 A1	24-07-2019
		FR 3055980 A1	16-03-2018
		US 2019264885 A1	29-08-2019
		WO 2018050594 A1	22-03-2018
FR 3057336 A1	13-04-2018	NONE	
US 2004201904 A1	14-10-2004	NONE	