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(54) **LIGHTING DEVICE**

(57) The invention refers to a lighting device for an automotive vehicle. The lighting device comprises a plurality of individual modules (1), each comprising a laser light source; and a thermally conductive structure (2) comprising a plurality of receiving housings (21), so that each receiving housing (21) houses one of the individual modules (1).

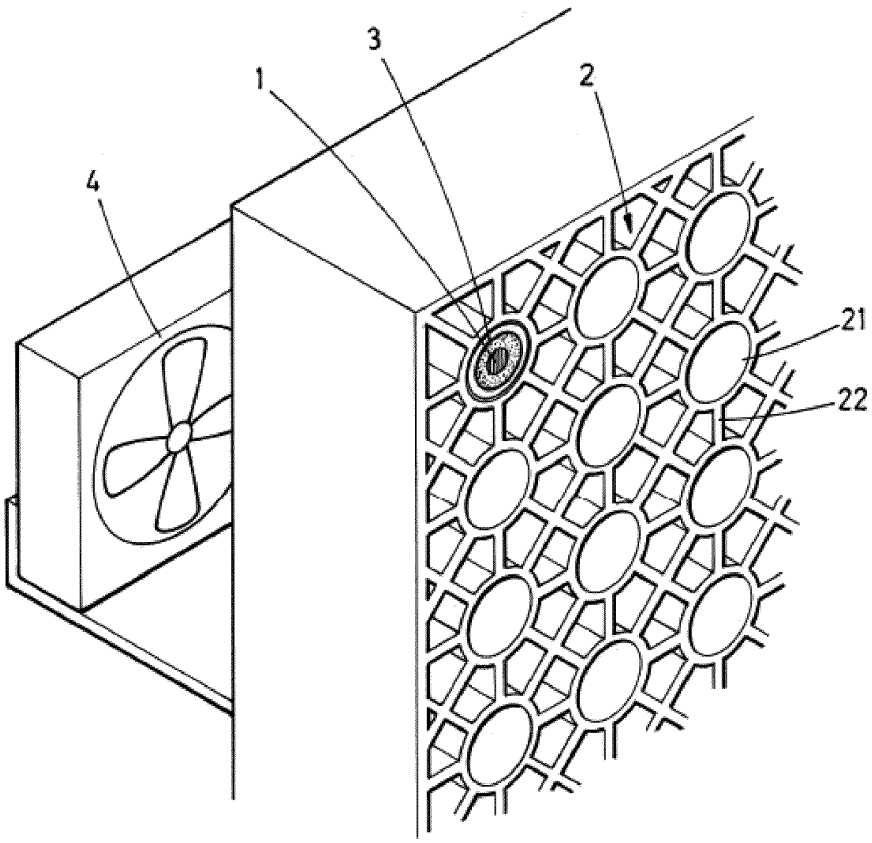

FIG.1

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Description

TECHNICAL FIELD

[0001] This invention is related to the field of automotive headlamps, and more specifically to an adaptive high beam arrangement for an automotive headlamp.

STATE OF THE ART

[0002] Modern headlamps use LEDs as light sources to produce individual square or rectangular light segments. One of the applications of these segments is to form a grid containing a great amount of small light sources, the operation of which may be individually controlled to provide an adaptive light beam, which may be useful, e.g., for providing this lighting device with an anti-glare function.

[0003] On the other side, laser technology is at present only used to provide a round spot function, which is not very useful in the current scenario, as this kind of lighting is not subject under national lighting regulations.

[0004] Laser light sources are not used in a grid, due to heat dissipation requirements, which are far more severe than in the case of LEDs. However, laser light sources are more efficient and powerful than LED light sources, so they would fit well in this high beam scenario.

DESCRIPTION OF THE INVENTION

[0005] The invention provides a solution for this problem by means of a lighting device according to claim 1. Preferred embodiments of the invention are defined in dependent claims.

[0006] In an inventive aspect, the invention provides a lighting device for an automotive vehicle, the lighting device comprising

> a plurality of individual modules each comprising a laser light source; and
> a thermally conductive structure comprising a plurality of receiving housings, so that each receiving housing houses one of the individual modules.

[0007] Advantageously, this lighting device is capable of using a laser source for its use in an adaptive high beam.

[0008] In some particular embodiments, the thermally conductive structure is at least partially made of metal. In some still more particular embodiments, this metal comprises aluminium or an aluminium alloy.

[0009] Metallic embodiments provide very good behaviour in heat dissipation. Aluminium is chosen as a particular example due to its performance and its low weight in an application which is not very structurally demanding.

[0010] In some particular embodiments, the thermally conductive structure comprises a plurality of thermally conductive elements, in such a way that each receiving housing is defined by at least two thermally conductive elements.

[0011] This arrangement provides a lightweight and effective structure for housing the individual modules and dissipating heat produced by them. This structure is also easy to manufacture and to assemble.

[0012] In some particular embodiments, the receiving housings form a grid structure, which may be square.

[0013] This regular pattern is beneficious for effectiveness and turns out to be easier to control, since a desired light pattern may be obtained by choosing which individual modules of the grid structure should emit light and which of them should not. Other regular patters are also suitable for this aim.

[0014] In some particular embodiments, the lighting device further comprises a thermally conductive element located between a receiving housing and an individual module housed therein.

[0015] This thermally conductive element is aimed to improve thermal conduction between the receiving housing and the individual module.

[0016] In some particular embodiments, each individual module comprises a sealed thermally conductive light housing, which is in thermal contact with one of the receiving housings, either directly or by means of a thermally conductive element. This conductive light housing may be substantially cylindrical.

[0017] This arrangement is more effective, since a round contact surface between the individual modules and the receiving housing provides a good heat dissipation rate and the sealed light housing is a safe way of providing laser lighting. The thermal contact may be direct or by means of the interposition of the thermally conductive element.

[0018] In some particular embodiments, each individual module further comprises an internal heatsink with fins which extend to one end of the individual module.

[0019] Such an internal heatsink improves heat dissipation of the individual module, which is a very important issue when using laser light sources.

[0020] In some particular embodiments, the lighting device further comprises fan means, adapted to create an air flow crossing the thermally conductive structure, in order to improve heat dissipation by this thermally conductive structure.

[0021] Fan means always improve the heat dissipation efficiency. In this case, the fan provides a synergic effect when it is associated with the thermally conductive elements, which leaves hollow spaces where the air flow dissipates more heat.

[0022] In some particular embodiments, each individual module comprises an inner optical means, such as a lens, shaped in such a way that the individual module is adapted to produce a rectangular light segment.

[0023] This inner optical means which makes the outer light segment be shaped as a rectangle is especially useful when there is a grid of light sources, since a pattern

of rectangles may be used to form any final shape, by choosing a determined number of rectangles.

[0024] In some particular embodiments, each individual module comprises a light conversion element, such as a phosphor, suitable for converting a laser light into a white light.

[0025] This light conversion element makes the outer light beam have a colour which is suitable for its use in automotive applications.

[0026] In some particular embodiments, each individual module further comprises

- safety means, such as a photodiode arranged to measure light intensity, and
- emergency cut-off means, adapted to disconnect an individual module depending on information received by the safety means.

[0027] This provision of safety means and emergency cut-off means is necessary in the event of laser light sources, since they may be very harmful if some light beam uncontrolledly exits the individual module.

[0028] In some particular embodiments, the lighting device further comprises projection means, such as a lens for projecting the light segments produced by the module in front of the vehicle.

[0029] This projection means is useful for providing an acceptable final light beam.

[0030] In some particular embodiments, the distance and/or the orientation between two adjacent individual modules is such that light, especially light segments, emitted by said adjacent individual modules overlap when projected outside the lighting device.

[0031] This arrangement is advantageous because it eliminates any black spaces between the light beams emitted by the individual modules.

[0032] In some particular embodiments, the lighting device further comprises

- scanning means, for detecting obstacles around the lighting device, and
- control means for individually controlling the laser light sources of the individual modules using information received from the scanning means.

[0033] These two additional elements provide the lighting device with the ability to select which individual modules are best for each driving situation. When an object is detected by the scanning means (which may be, e.g., a radar or an ultrasound emitter-receiver), control means may disable the individual modules which are performing a high beam role, in order to avoid glaring this object (a person or a car).

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] To complete the description and in order to provide for a better understanding of the invention, a set of drawings is provided. Said drawings form an integral part of the description and illustrate an embodiment of the invention, which should not be interpreted as restricting the scope of the invention, but just as an example of how the invention can be carried out. The drawings comprise the following figures:

Figure 1 shows part of a lighting device according to the invention.

Figure 2 shows a cut view of an individual module comprised in a lighting device according to the invention.

Figure 3 shows a complete lighting device according to the invention, although some of its elements cannot be seen.

DETAILED DESCRIPTION OF THE INVENTION

[0035] Figure 1 partially shows a lighting device according to the invention. This lighting device comprises:

- a plurality of individual modules 1; and
- a thermally conductive structure 2 made of aluminium, and comprising a plurality of receiving housings 21, so that each receiving housing 21 houses one of the individual modules 1.

[0036] The thermally conductive structure 2 comprises a plurality of thermally conductive elements 22, in such a way that each receiving housing 21 is defined by at least two thermally conductive elements 22. In this case, each thermally conductive element 22 comprises a bar and part of a housing, in such a way that when several thermally conductive elements 22 join, a complete receiving housing 21 is formed, with several bars projecting from this receiving housing 21.

[0037] As may be seen in this figure, the receiving housings form a square grid structure, but there are more thermally conductive elements 22 apart from this square grid structure, which stiffen this thermally conductive structure. In this figure, they are seen as diagonal thermally conductive elements, although other arrangements are possible in different embodiments.

[0038] Also in this figure, a thermally conductive element 3 may be seen between a receiving housing 21 and an individual module 1 housed therein. This thermally conductive element 3 improves thermal conduction between the receiving housing 21 and the individual module 1. Other embodiments do not need this thermally conductive element 3.

[0039] This lighting device further comprises fan means 4, adapted to create an air flow crossing the thermally conductive structure 2, in order to improve heat dissipation of this thermally conductive structure 2.

[0040] Figure 2 shows a cut view of an individual laser module comprised in a lighting device according to the

invention. The individual module comprises a cylindrical sealed thermally conductive light housing 11, which has been cut to see the interior thereof.

[0041] This light housing 11 is in thermal contact with one of the receiving housings 21, either directly or by means of the thermally conductive element 3 seen in the previous figure.

[0042] Each individual module 1 comprises

a laser light source 12, which is a laser diode;
inner optical means 13, which is a lens, shaped in such a way that the individual module 1 is adapted to produce a rectangular light beam;
a light conversion element 14, such as a phosphor, suitable for converting a laser light into a white light beam;
safety means 15, such as a photodiode arranged to measure light intensity, and
emergency cut-off means, adapted to disconnect an individual module depending on information received by the safety means.

[0043] Figure 3 shows a complete lighting device according to the invention, although some of its elements cannot be seen.

[0044] This figure shows a projection means 5, such as a lens, for projecting the light segments produced by the individual modules 1 in a forward direction.

[0045] As may be seen in this figure, the distance between two adjacent individual modules 1 is such that light emitted by said adjacent individual modules 1 overlap before reaching the projection means 5.

[0046] This figure also shows scanning means 6, for detecting obstacles around the lighting device, and control means for individually controlling the laser light sources of each of the individual modules 1 using information received from the scanning means 6.

Claims

1. Lighting device for an automotive vehicle, the lighting device comprising

   a plurality of individual modules (1) each comprising a laser light source; and
   a thermally conductive structure (2) comprising a plurality of receiving housings (21), so that each receiving housing (21) houses one of the individual modules (1).

2. Lighting device according to claim 1, wherein the thermally conductive structure (2) is at least partially made of metal.

3. Lighting device according to claim 2, wherein the metal comprises aluminium or an aluminium alloy.

4. Lighting device according to any of the preceding claims, wherein the thermally conductive structure (2) comprises a plurality of thermally conductive elements (22), in such a way that each receiving housing (21) is defined by at least two thermally conductive elements (22).

5. Lighting device according to any of the preceding claims, wherein the receiving housings form a grid structure.

6. Lighting device according to any of the preceding claims, wherein between a receiving housing (21) and an individual module (1) housed therein there is a thermally conductive element (3) which improves thermal conduction between the receiving housing (21) and the individual module (1).

7. Lighting device according to any of the preceding claims, wherein each individual module (1) comprises a sealed thermally conductive light housing (11), which is in thermal contact with one of the receiving housings (21), either directly or by means of a thermally conductive element (22).

8. Lighting device according to any of the preceding claims, wherein each individual module (1) further comprises an internal heatsink with fins which extend to one end of the individual module (1).

9. Lighting device according to any of the preceding claims, further comprising fan means (4), adapted to create an air flow crossing the thermally conductive structure (2), in order to improve heat dissipation of this thermally conductive structure (2).

10. Lighting device according to any of the preceding claims, wherein each individual module (1) comprises an inner optical means (13), such as a lens, shaped in such a way that the individual module (1) is adapted to produce a rectangular light segment.

11. Lighting device according to any of the preceding claims, wherein each individual module (1) comprises a light conversion element (14), such as a phosphor, suitable for converting a laser light into a white light beam.

12. Lighting device according to any of the preceding claims wherein each individual module (1) further comprises

    safety means (15), such as a photodiode arranged to measure light intensity, and
    emergency cut-off means, adapted to disconnect an individual module depending on information received by the safety means.

13. Lighting device according to any of the preceding claims, further comprising projection means (5), such as a lens, for projecting the light segments produced by the individual module (1) in a forward direction.

14. Lighting device according to claim 13, wherein the distance and/or the orientation between two adjacent individual modules (1) is such that light, especially light segments, emitted by said adjacent individual modules (1) overlap when projected outside the lighting device.

15. Lighting device according to any of the preceding claims, further comprising

scanning means (6), for detecting obstacles around the lighting device, and
control means for individually controlling the laser light sources of each of the individual modules (1) using information received from the scanning means (6).

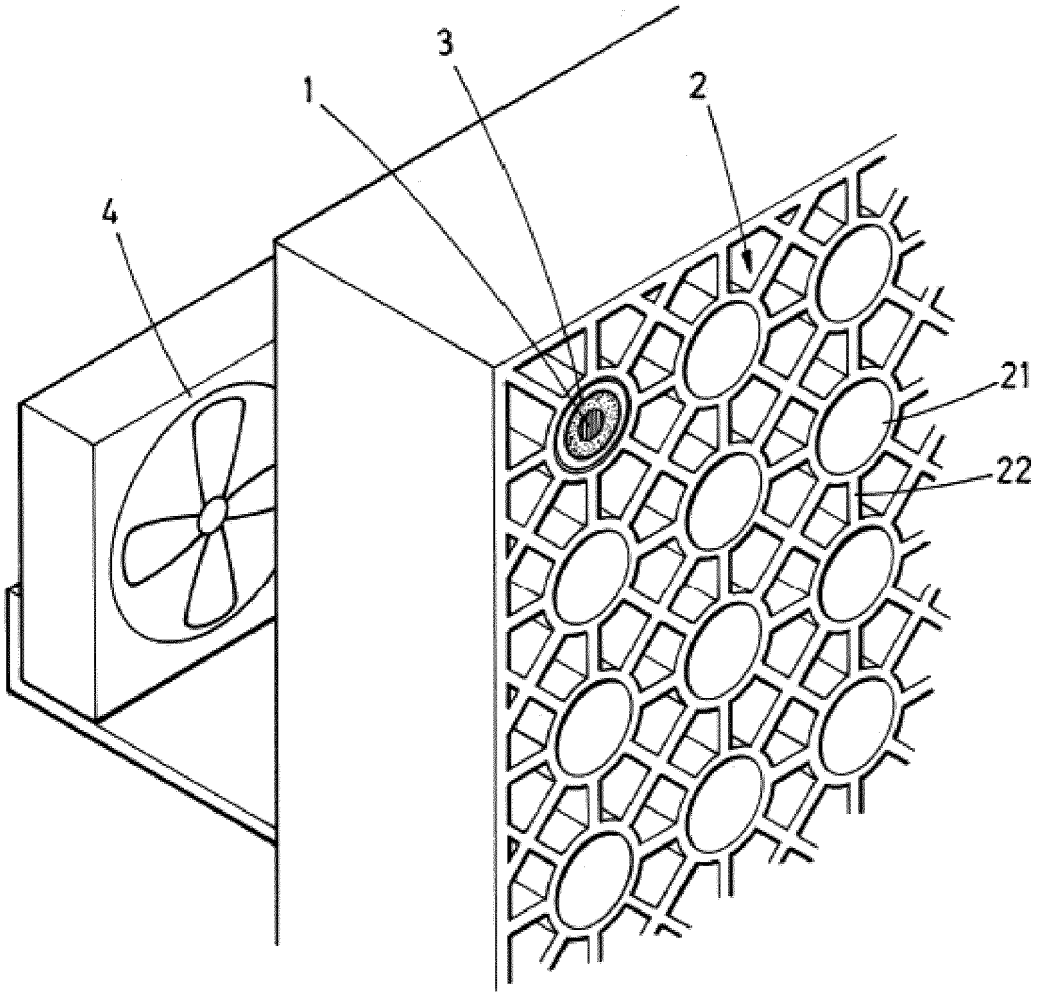

FIG.1

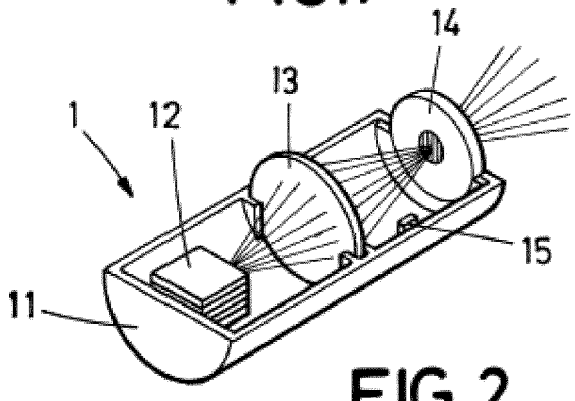

FIG.2

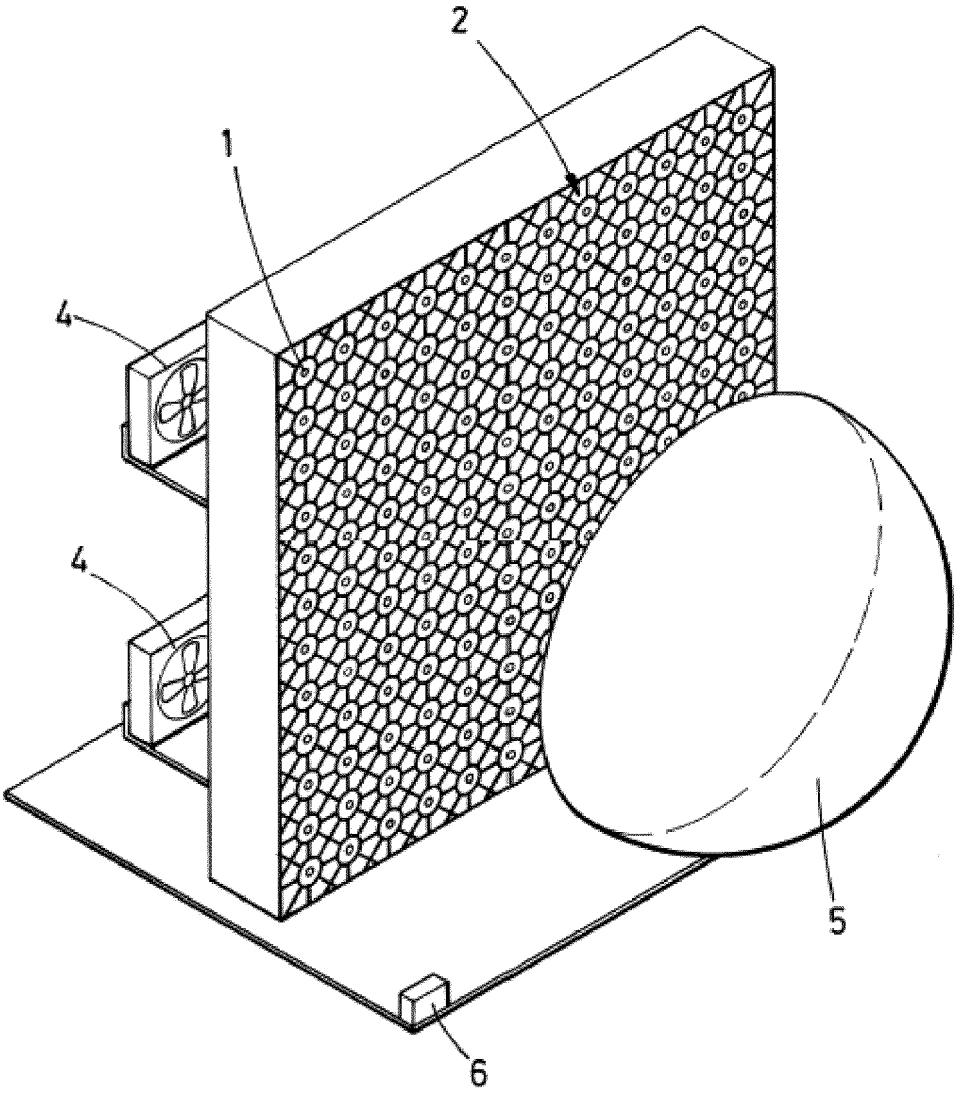

FIG.3

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EUROPEAN SEARCH REPORT

Application Number
EP 17 38 2089

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	DE 10 2013 217597 A1 (OSRAM GMBH [DE]) 5 March 2015 (2015-03-05) * paragraph [0030] - paragraph [0034] * * paragraph [0045] * * figure 1 *	1,8-15	INV. F21S8/10 ADD. F21Y115/30
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A	US 2010/202144 A1 (CHEN GAO-SHAN [TW]) 12 August 2010 (2010-08-12) * paragraph [0021] - paragraph [0024] * * figure 4 *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC) F21S F21Y

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	23 August 2017	Schulz, Andreas

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 17 38 2089

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
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23-08-2017

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