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

(11) **EP 3 809 040 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
21.04.2021 Bulletin 2021/16

(21) Application number: **19203497.3**

(22) Date of filing: **16.10.2019**

(51) Int Cl.:
F21V 29/70 *(2015.01)* ***F21S 45/47*** *(2018.01)*
F21V 17/10 *(2006.01)* ***F21S 2/00*** *(2016.01)*
F21Y 115/10 *(2016.01)*

(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

(71) Applicant: **Lumileds Holding B.V.**
1118 CL Schiphol (NL)

(72) Inventor: **The designation of the inventor has not yet been filed**

(74) Representative: **ter Heegde, Paul Gerard Michel**
Lumileds Germany GmbH
Philipsstraße 8
52068 Aachen (DE)

(54) **HEAT SINK, LIGHTING DEVICE AND METHOD FOR PRODUCING A LIGHTING DEVICE**

(57) The invention refers to a heat sink (2a) for being mounted to another same heat sink (2b), the heat sink (2a) comprising: at least one receiving portion (12a) for at least one lighting module (6), wherein the at least one lighting module (6) is to be thermally connected to the heat sink (2a), at least one connection portion (14a) for connecting the heat sink (2a) to such at least one connection portion (14b) of the other heat sink (2b), wherein the at least one connection portion (14a) is in thermal contact to such at least one corresponding connection portion (14b) of the other heat sink (2b) when the heat sink (2a) is connected to the other heat sink (2b). The invention further relates to a lighting device (4) and a method employed in the production of the lighting device (4).

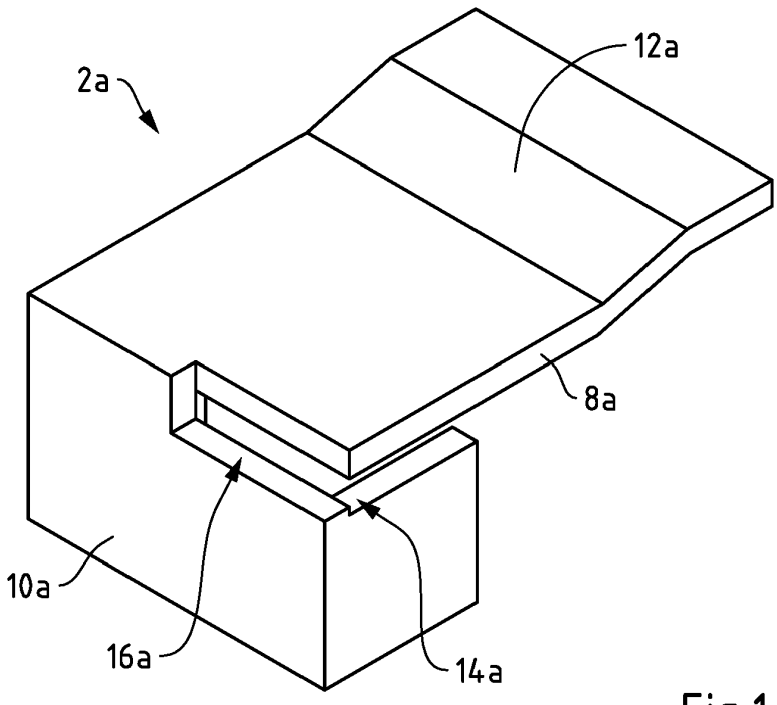

Fig.1

EP 3 809 040 A1

Description

FIELD OF THE INVENTION

[0001] The present disclosure relates to a heat sink, a lighting device comprising such a heat sink and at least one lighting module, in particular in the area of automotive exterior or interior lighting. The present disclosure also relates to a method for producing a lighting device.

BACKGROUND OF THE INVENTION

[0002] Modern lighting devices used as automotive exterior or interior lights usually comprise a heat sink. A light emitting device (for example a LED) is attached to the heat sink so that the heat from the operating lighting module can safely dissipate without inflicting damage to the lighting module. The lighting module attached to the heat sink is connected to an electrical interface via electrical lines so that the lighting module can be externally controlled, in particular switched between functions and/or turned on or off.

[0003] In automotive Lamps, e.g. headlamps or back lights, such heat sinks typically have an "L" shape, caused by the available space behind the optical element(s), e.g. reflector or lens. For enabling multiple functions, in particular a high beam and a low beam function, sometimes multiple units are placed next to each other, while in other cases the units are placed on top of each other. The construction of the heat sink of a dual function module requires a complex die-cast freeform, or consists of a combination of multiple extruded or stamped structures, e.g. one for a side wall of the heat sink, and one or two parts for the forward component. The price for such a die-cast freeform, or a multitude of different components is high since the manufacturing is complex. Additionally, a side wall of such a heat sink prevents a simple mounting of the LED onto the heat sink, as there is a high likelihood that e.g. a placement head used for mounting the LED might hit the heat sink during manufacturing making the mounting of the LED difficult. This is especially the case for LEDs to be mounted in a tilted position versus the side wall.

SUMMARY OF THE INVENTION

[0004] It is therefore an object of the present invention to provide a heat sink, a lighting device, and a method for producing a lighting device which are cost effective and/or enhance manufacturing of the lighting device preventing or at least alleviating aforementioned drawbacks.

[0005] According to a first aspect of present invention, a heat sink for being mounted to another same heat sink is proposed, the heat sink comprising: at least one receiving portion for at least one lighting module, wherein the at least one lighting module is to be thermally connected to the heat sink, at least one connection portion for connecting the heat sink to such at least one connection portion of the other heat sink, wherein the at least one connection portion is in thermal contact to such at least one corresponding connection portion of the other heat sink when the heat sink is connected to the other heat sink.

[0006] According to a second aspect of present invention, a lighting device is proposed, the lighting device comprising: at least two heat sinks according to the first aspect; and at least two lighting modules, wherein each lighting module of the at least two lighting modules is mounted to each respective at least one receiving portion of the at least two heat sinks, and wherein the at least two heat sinks are connected to each other via their respective at least one connection portion of the at least two heat sinks.

[0007] According to a third aspect of present invention, a method for producing the lighting device according to the second aspect is proposed, the method comprising: providing at least one sheet metal; forming the at least one sheet metal into the at least two heat sinks, wherein the respective receiving portions are formed into each respective heat sink of the at least two heat sinks, providing the at least one lighting module for each respective heat sink of the at least two heat sinks; arranging the at least one lighting module in each respective receiving portion of the at least two heat sinks; and connecting the at least two heat sinks, each heat sink of the at least two heat sinks comprising the arranged at least one lighting module in its respective receiving portion, wherein the arranged at least two heat sinks are thermally connected to each other via their respective connecting portions.

[0008] Exemplary embodiments of the first, second and third aspects of the invention may have one or more of the properties described below.

[0009] A heat sink is to be understood as a passive heat exchanger that transfers the heat generated by a light emitting device, e.g. a LED unit comprising at least one LED die, preferably two, three, or more LED dies, to a gaseous or fluid medium, preferably air or a liquid coolant, wherein heat may be dissipated away from the lighting device. A heat sink may thereby allow regulation of the lighting module's temperature at optimal levels. The heat sink is made from a thermally conductive material, preferably a metallic material, particularly preferred from a sheet metal.

[0010] At least one receiving portion configured for receiving the at least one lighting module is formed in the heat sink. The receiving portion may for instance be an opening or a protrusion in the heat sink in or on which a lighting module can be placed. The at least one receiving portion may be a pedestal or a cavity. For instance, the at least one lighting module can be arranged or mounted to the heat sink in the receiving portion. This can insure that the at least one lighting module is accurately positioned on the heat sink. At least one light emitting device may be connected with the heat sink, in particular thermally.

[0011] A light emitting device may for instance be a

single LED die or it may be or comprise a LED unit, as disclosed above. A LED unit may comprise at least one semiconductor element such as a p-n-junction, a diode, and/or a transistor, in particular it may comprise at least one LED die, preferably two or three or more LED dies. Such a LED unit may for instance be arranged or mounted directly to the at least one heat sink. The at least one light emitting device is configured to emit light towards a light-emitting side. The light-emitting side may represent one or more areas of or around the heat sink, wherein an object that is to be illuminated may be brought to the light-emitting side for illumination. The lighting device may be intended for use in a lighting application requiring intense bright light, e. g. an automotive head light. In this case a high amount of heat may be produced when generating light so that the lighting device may reach temperatures of 135°C or more, potentially damaging the lighting device. This heat may be dissipated away from the at least one lighting module by means of a thermal connection to a heat sink. For instance, the lighting module is mounted, e.g. by gluing, on the heat sink using a thermally conductive material such as a thermal paste, thermal glue or thermal pad. Alternatively, the lighting module may be soldered to the heat sink. The lighting module may also be mounted on a lead frame, in particular mounted by soldering, and the lead frame may be in thermal contact with the heat sink.

[0012] The heat sink comprises at least one connection portion for connecting the heat sink to such at least one connection portion of another same heat sink. The heat sink and the other heat sink may form (e.g. two) sub-assemblies which are connectable or joinable to one assembly. The heat sink and the other heat sink may be identical, except from minor differences e.g. of connecting means such as screws fixating one or more certain elements of the respective heat sink.

[0013] According to another exemplary embodiment of the invention, the at least two heat sinks are thermally connected to each other.

[0014] By connecting the heat sink and the other heat sink, e.g. to one assembly, the at least one connection portion of the heat sink is in thermal contact to such at least one corresponding connection portion of the other heat sink. In this way thermal energy, in particular heat, of one heat sink is transferred to the other heat sink, and vice versa. The heat sink and the other heat sink may receive at least one lighting module (e.g. one or more LEDs), wherein the one or more LEDs of the heat sink and the other heat sink share one assembled heat sink after the two heat sinks are connected. The two heat sinks may be considered to represent two sub-assemblies that are thermally connected to each other forming the one assembled heat sink.

[0015] According to another exemplary embodiment of the invention, the heat sink further comprises at least one base plate, and at least one side wall, wherein the at least one base plate and the at least one side wall form a L-shaped form.

[0016] In mounted position of the heat sink, the at least one side wall may for instance represent a vertical section of the lighting device. The at least one base plate may for instance represent a horizontal section of the lighting device. Further, the at least one side wall may comprise basically a U-shaped cross section extending at least partially along the length of the at least base plate of the heat sink.

[0017] According to another exemplary embodiment of the invention, the receiving portion is facing away from the direction in which the at least one side wall of the heat sink is extending. It is enabled that in particular the at least one lighting module can be placed (e.g. mounted) to the respective heat sink easily since it is placed prior to connecting two of such heat sinks according to the first aspect. E.g., in such mounting prior to the heat sinks connection, a placement head of an LED pick-and-place machine has ample moving space for LED placement without any risk of colliding with the side wall extending in the opposite direction from the placement space.

[0018] According to another exemplary embodiment of the invention, the receiving portion for the at least one lighting module is flat or angled in relation to the at least one base plate. The receiving portion of the at least one base plate of the heat sink may form a pedestal for receiving the at least one lighting module. Such a pedestal may be formed in case the at least one base plate is angled or flat. For instance, for an efficient and compact lighting device, it is favorable to tilt or place the at least one lighting module (e.g. one or more LEDs) roughly at an angle of 15°, such that more light from the lighting device reaches an optical element to be mounted to the heat sink. For instance, more light from Lambertian emitting LED(s) can hit a reflector as an optical element with more ease.

[0019] According to another exemplary embodiment of the invention, the connection portion is between the at least one side wall and the at least one base plate and comprises a recess which is connectable to a corresponding recess of the other heat sink (e.g. the recesses may be slid above each other) for forming a combined heat sink which comprises respective receiving portions for respective mounting of at least one lighting modules emitting light in at least two different directions.

[0020] According to another exemplary embodiment of the invention, the at least two heat sinks are connected to each other by sliding the heat sink with its at least one recess above the respective at least one recess of the other heat sink.

[0021] The at least one connection portion may comprise a recess enabling that the heat sink can be connected with the other heat sink (also comprising such a recess). After the heat sink and the other heat sink to be connected to the heat sink are connected, the respective at least one side walls of the heat sink and the other heat sink combine to a single structure side wall together, forming a T-shape with the base plates of the heat sinks, thereby creating a shape matching the ones used in au-

tomotive headlamps or back lights.

[0022] According to another exemplary embodiment of the invention, the at least one base plate comprises at least one alignment element for being connected to a corresponding at least one alignment element of the other heat sink.

[0023] The at least one alignment element may be a protrusion, or a gap, to name but a few non-limiting examples. The at least one alignment element enables connection of the heat sink with the other heat sink to be connected to the heat sink in defined alignment to each other. The at least one alignment element comprised by the heat sink may be formed in one piece with the heat sink. The at least one alignment element may be positioned on at least one edge of the at least one base plate. In particular, the at least one base plate may comprise a first alignment element on a first edge of the base plate, and a second alignment element on a second edge opposite to the first edge of the base plate. The first alignment element may be a protrusion and the second alignment element may be a gap, to name but one non-limiting example. Since the other heat sink to be connected to the heat sink comprises corresponding alignment element(s), the two heat sinks can be connected in relation to each other aligned by the alignment element(s).

[0024] According to another exemplary embodiment of the invention, the at least one base plate further comprises at least one alignment hole for alignment of at least one optical element to be mounted to the heat sink. The at least one optical element may for instance be a reflector or a lens. A mounting surface region may be provided on the heat sink for the at least one optical element to be mounted to the heat sink or lighting device. The at least one optical element may include a mechanical interface for connecting the at least one optical element to the heat sink. The at least one mounting region may be accessible from the outside, i.e. during a step of the production method the mounting surface region is at least partially exposed to the outside, e.g. since it is positioned on the side of the at least one base plate facing away from the direction in which the at least one side wall is extending.

[0025] According to another exemplary embodiment of the invention, the heat sink is formed out of a sheet metal. The heat sink is made by a forming, stamping and/or punching process from a thermally conductive material, preferably from a metallic material, particularly preferred from sheet metal. More preferably, the heat sink comprises or consists of aluminum, copper, and/or aluminum and/or copper based alloys. The thickness of the sheet metal is chosen suitable for the amount of heat to be dissipated, e.g. with a thickness of 0.5 mm to 100 mm. The sheet metal thickness may for instance be 2 to 5mm, preferably 2.5 mm. Further, the heat sink comprised by the lighting device according to the second aspect may for instance be made from one or more parts, which are mechanically and/or thermally connected, in particular from two heat sinks according to the first aspect. The two heat sinks may for instance be additionally secured to each other by different technologies, such as riveting, welding, or a combination thereof, to name but a few non-limiting examples.

[0026] According to another exemplary embodiment of the invention, the heat sink further comprises at least one further receiving portion for at least one further element, wherein the at least one further receiving portion is facing away from the direction in which the at least one side wall of the heat sink is extending.

[0027] The at least one further receiving portion may be accessible prior to connecting a first heat sink with a second heat sink. After the connection, such receiving portions may not be accessible (e.g. by a placement head) anymore. The further receiving portions for further elements may also face away from the direction in which the side wall (e.g. vertical section) of the heat sink is extending.

[0028] According to another exemplary embodiment of the invention, the lighting device further comprises at least one further element mounted to at least one further receiving portion of at least one of the at least two heat sinks, and wherein the respective at least one further element is mounted to the respective at least one heat sink prior to connecting the at least two heat sinks to each other.

[0029] According to another exemplary embodiment of the invention, the heat sink further comprises at least one slot extending in a longitudinal direction of the at least one base plate of the heat sink for receiving at least one circuit board.

[0030] Additionally or alternatively to a mounting of the at least one lighting module (directly) to the heat sink, the at least one lighting module may be mounted to at least one circuit board, the circuit board may be placed or is placed in the receiving portion of the heat sink. The receiving portion, in particular an opening, may comprise a contact region, in particular a contact plane on which a lighting module or a circuit board may be easily mounted, for instance in that a contact plane of the receiving portion corresponds (e.g. in its dimensions) to a plane of the lighting module or the circuit board. For receiving at least one lighting module or at least one circuit board, the receiving portion may be accessible from the outside, wherein the receiving portion is at least partially exposed to the outside during the arranging of the lighting module or the at least one circuit board in the at least one receiving portion. As mounting the circuit board in the receiving portion only requires the circuit board to have a certain shape and then being slid in the at least one slot, no additional requirements may exist regarding the material of the at least one circuit board and/or components that may be placed on or in the circuit board. When at least one circuit board is inserted in the at least one slot, as disclosed above, through this hole, e.g. a control wire or ribbon can be put, e.g. to electrically connect the at least one lighting module with the at least one circuit board.

[0031] For manufacturing of the lighting device according to the second aspect, e.g. by a pick-and-place robot

utilizing a placement head for mounting the at least one lighting module to the heat sink, the at least one lighting module is provided for the heat sink. Then, the at least one lighting module is arranged on the heat sink. These steps are repeated (in sequence or in parallel) for the other heat sink as well. Since the heat sink and the other heat sink are not yet connected to each other, in particular the placement head has easy access to the respective receiving portions for arranging the at least one lighting module. After the lighting modules are separately mounted to the heat sink and the other heat sink, e.g. as described above, the heat sink and the other heat sink are joined by establishing a thermal connection between the heat sink and the other heat sink. Optionally, the heat sink and the other heat sink can be fixed to each other by additional means, e.g. by riveting, welding or using screws to fix them together.

[0032] It is to be understood that the presentation of embodiments of the invention in this section is merely exemplary and non-limiting.

[0033] Other features of the present invention will become apparent from the following detailed description considered in conjunction with the accompanying drawings. It is to be understood, however, that the drawings are designed solely for purposes of illustration and not as a definition of the limits of the invention, for which reference should be made to the appended claims. It should be further understood that the drawings are not drawn to scale and that they are merely intended to conceptually illustrate the structures and procedures described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] Examples of the invention will now be described in detail with reference to the accompanying drawings, in which:

Fig. 1 shows an exemplary embodiment of a heat sink according to the invention in a three dimensional, schematic view;

Fig. 2 shows an exemplary embodiment of a lighting device according to the invention in a three dimensional, schematic view;

Fig. 3 shows another exemplary embodiment of a lighting device according to the invention in a three dimensional, schematic view;

Fig. 4a shows an exemplary embodiment of a heat sink according to the invention in a three dimensional, schematic view; and

Fig 4b shows another exemplary embodiment of a lighting device according to the invention in a three dimensional, schematic view.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0035] Fig. 1 shows a heat sink 2a for a lighting device 4 according to the invention in a perspective view.

[0036] The heat sink 2a is formed from a sheet metal, e.g. by a punching and/or stamping process. When the heat sink 2a is formed, a receiving portion 12a for receiving at least one lighting module 6 (e.g. a LED die, not shown in Fig. 1) is formed into the sheet metal. To the receiving portion 12a at least one lighting module 6 can be thermally connected to the heat sink 2a, e.g. by placing the at least one lighting module 6 (e.g. by a pick-and-place robot) to the receiving portion 12a and then mounting the at least one lighting module 6 in the receiving portion, e.g. by soldering the at least one lighting module 6 to the heat sink 2a.

[0037] The heat sink 2a comprises a base plate 8a which extends basically in a horizontal direction in Fig. 1, and a side wall 10a which extends basically in a vertical direction in Fig. 1. The side wall 10a has a U-shaped form when viewing the side wall 10a in a horizontal cross section.

[0038] The receiving portion 12a is angled in relation to the base plate 8a by a certain amount, e.g. between 10° and 15° to name but a few non-limiting examples. This enhances the emitting of light from the at least one lighting module 6 when being mounted to the heat sink 2a.The receiving portion for the at least one lighting module 6 is located on the base plate 8a on the opposite side from which the side wall 10a extends. This enables easy access for e.g. a pick-and-place robot to mount the at least one lighting module to a respective heat sink since on this side of the base plate 8a there are no obstacles around which such a pick-and-place robot must move or which might obstruct the ability for such a robot to place elements (e.g. lighting module(s)) to be placed to the heat sink.

[0039] The heat sink 2a comprises a connection portion 14a for connecting the heat sink 2a to such at least one connection portion (e.g. connection portion 14b of a heat sink 2b shown in Fig. 2) of another same heat sink (e.g. heat sink 2b of Fig. 2). The connection portion 14a of the heat sink 2a is formed as a recess 16a (e.g. a groove) which extends at least partially between the base plate 8a and the side wall 10a. The recess 16a has the form of a slot enabling to slide another heat sink (e.g. heat sink 2b shown in Fig. 2) into the connection portion 14a to establish a thermal connection between two heat sinks according to the invention.

[0040] Fig. 2 shows a lighting device 4 according to the invention in a perspective view. The lighting device 4 comprises two heat sinks 2a and 2b which are thermally connected. The heat sinks 2a and 2b are identically formed to the heat sink 2a shown in Fig. 1. For connecting the two heat sinks, the heat sink 2b is turned upside down in comparison to the heat sink 2a so that the respective connection portions 14a and 14b can be connected with each other, e.g. by sliding the heat sink 2b in such a way into the heat sink 2a that their respective recesses 16a and 16b of their connection portions 14a, 14b slide above each other.

[0041] The lighting device 4 can comprise at least two

lighting modules 6 emitting light in opposite directions, wherein each lighting module 6 of the at least two lighting modules 6 is mounted to a respective receiving portion 12a, 12b of the heat sinks 2a, 2b. Both of the heat sinks 2a and 2b are being manufactured with at least one lighting module 6 being mounted to their respective receiving portion 12a, 12b prior to connecting the two heat sinks 2a and 2b. When the two heat sinks 2a and 2b are connected with each other, they establish a thermal connection and form one single heat sink 2. Prior to connecting, the heat sinks 2a and 2b can be viewed as sub-assemblies for the single heat sink 2

[0042] Fig. 3 shows another lighting device 4 according to the invention in a perspective view. The perspective view of the lighting device 4 shows the lighting device 4 in a way enabling to show the receiving portion 12a of the heat sink 2a. To the receiving portion 12a of the heat sink 2a, a lighting module 6 is mounted.

[0043] The heat sink 2a comprises on its base plate 8a at least one (at present two) alignment holes 22 which can be utilized to align the heat sink 2 e.g. to at least one optical element, such as a reflector or lens of an automotive headlamp, to name but one non-limiting example.

[0044] Further, the receiving portion 12a comprises a further receiving portion 24, which may be used for a connection between the lighting module 6 and a circuit board (e.g. a PCB) in case such a circuit board shall be used with the heat sink 2. For instance, in case a PCB is inserted into a slot 26 (see Fig. 4a), a respective further receiving portion 24 is present on each heat sink 2a and 2b of the two sinks. The respective further receiving portion 24 may be a hole in the respective base plate 8a, 8b. Through this hole, e.g. a control wire or ribbon can be used to electrically connect the at least one lighting module 6 with a PCB inserted in the slot 26.

[0045] The base plate 8a comprises on both edges respective alignment elements 18 and 20, wherein on the edge being located on the front edge of the base plate 8a of the viewer, the base plate 8a comprises an alignment protrusion 18, and on the opposite edge, the base plate 8a comprises an alignment hole 20 respective alignment gap. The base plate 8b of the other heat sink 2b comprises corresponding alignment elements 18 and 20 enabling to align the two heat sinks 2a and 2b in relation to each other.

[0046] The heat sink 2 can enable at least two (lighting) functions: e.g. low beam, and high beam. Such a heat sink 2 may be used for an automotive headlamp, and/or for an automotive back light. Issues that may arise during manufacturing, e.g. by having to mount lighting modules on both sides of the heat sink 2 can be solved according to the invention since such a mounting can be done prior to connecting the two heat sinks 2a and 2b to form the (single) heat sink 2. The heat sink 2 provides light directed into (at least) two different directions (e.g. top/down, left/right), wherein the heat sink 2 consists of (at least) two primary structures of the heat sinks 2a and 2b.The placement area (the receiving portion 12a, 12b) for the lighting modules 6 (e.g. LED(s) and/or optional other elements) is not obstructed by other features of the heat sink structure according to exemplary aspects of the invention.

[0047] Fig. 4a shows a heat sink 2b according to the invention in a perspective view. Fig. 4b shows a lighting device 4 according to the invention in a perspective view, wherein the lighting device is made out of the heat sink 2b shown in Fig. 4a, and another heat sink 2a which is identical to the heat sink 2b shown in Fig. 4a.

[0048] The heat sink 2b (Fig. 4a) and the heat sink 2 formed out of two heat sinks 2a and 2b (Fig. 4b) further comprise a slot 26 which is formed into the heat sink 2a respectively 2b. The slot 26 extends in a longitudinal direction of the respective base plates 8a and 8b of the heat sinks 2a and 2b. This enables that e.g. after the two heat sinks 2a and 2b are connected, a circuit board (e.g. a PCB) can be slid into the slot 26, e.g. from the backside of the heat sink 2 shown in Fig. 4b.

REFERENCE SIGNS:

[0049]

2	combined heat sink
2a	first heat sink
2b	second heat sink
4	lighting device
6	lighting module
8a, b	base plates
10a, b	side walls
12a, b	receiving portions
14a, b	connection portions
16a, b	recesses
18	alignment protrusion
20	alignment gap
22	alignment hole
24	further receiving portion
26	PCB slot

Claims

1. A heat sink (2a) for being mounted to another same heat sink (2b), the heat sink (2a) comprising:

   - at least one receiving portion (12a) for at least one lighting module (6), wherein the at least one lighting module (6) is to be thermally connected to the heat sink (2a),
   - at least one connection portion (14a) for connecting the heat sink (2a) to such at least one connection portion (14b) of the other heat sink (2b),
   - wherein the at least one connection portion (14a) is in thermal contact to such at least one corresponding connection portion (14b) of the other heat sink (2b) when the heat sink (2a) is

connected to the other heat sink (2b).

2. The heat sink (2a) as claimed in claim 1, further comprising:

- at least one base plate (8a); and
- at least one side wall (10a),
- wherein the at least one base plate (8a) and the at least one side wall (10a) form a L-shaped form.

3. The heat sink (2a) as claimed in claim 1 or claim 2,

- wherein the receiving portion (12a) for the at least one lighting module (6) is flat or angled in relation to the at least one base plate (8a).

4. The heat sink (2a) as claimed in claim 2,

- wherein the receiving portion (12a) is facing away from the direction in which the at least one side wall (10a) of the heat sink (2a) is extending.

5. The heat sink (2a) as claimed in claim 2,

- wherein the connection portion (14a) is between the at least one side wall (12a) and the at least one base plate (8a) and comprises a recess (16a) which is connectable to a corresponding recess (16b) of the other heat sink (2b) for forming a combined heat sink (2) which comprises respective receiving portions (12a, 12b) for respective mounting of the at least one lighting modules (6) emitting light in at least two different directions.

6. The heat sink (2a), as claimed in claim 2,

- wherein the at least one base plate (8a) comprises at least one alignment element (18, 20) for being connected to a corresponding at least one alignment element of the other heat sink (2b).

7. The heat sink (2a) as claimed in claim 2,

- wherein the at least one base plate (8a) further comprises at least one alignment hole (22) for alignment of at least one optical element to be mounted to the heat sink (2a).

8. The heat sink (2a) as claimed in claim 1 or claim 2,

- wherein the heat sink (2a) is formed out of a sheet metal.

9. The heat sink (2a) as claimed in claim 2, further comprising:

- at least one further receiving portion (24) for at least one further element,
- wherein the at least one further receiving portion (24) is facing away from the direction in which the at least one side wall (10a) of the heat sink (2a) is extending.

10. The heat sink (2a) as claimed in claim 2, further comprising:

- at least one slot (26) extending in a longitudinal direction of the at least one base plate (8a) of the heat sink (2a) for receiving at least one circuit board.

11. A lighting device (4) comprising:

- at least two heat sinks (2a, 2b) as claimed in any one of the claims 1 to 10; and
- at least two lighting modules (6);
- wherein each lighting module of the at least two lighting modules (6) is mounted to a respective at least one receiving portion (12a, 12b) of the at least two heat sinks (2a, 2b); and
- wherein the at least two heat sinks (2a, 2b) are connected to each other via their respective at least one connection portions (14a, 14b) of the at least two heat sinks (2a, 2b).

12. The lighting device (4) as claimed in claim 11, further comprising:

- at least one further element mounted to at least one further receiving portion (24) of at least one of the at least two heat sinks (2a, 2b), and
- wherein the respective at least one further element is mounted to the respective at least one heat sink (2a, 2b) prior to connecting the at least two heat sinks (2a, 2b) to each other.

13. The lighting device (4) as claimed in claim 11 or claim 12, wherein the at least two heat sinks (2a, 2b) are connected to each other by sliding the heat sink (2a) with its at least one recess (16a) above the respective at least one recess (16b) of the other heat sink (2b).

14. The lighting device (4) as claimed in claim 11 or claim 12, wherein the at least two heat sinks (2a, 2b) are thermally connected to each other.

15. A method for producing the lighting device (4) as claimed in any one of the claims 11 to 14, the method comprising:

- providing at least one sheet metal;
- forming the at least one sheet metal into the at least two heat sinks (2a, 2b), wherein the re-

spective receiving portions (12a, 12b) are formed into each respective heat sink of the at least two heat sinks (2a, 2b),

- providing the at least one lighting module (6) for each respective heat sink of the at least two heat sinks (2a, 2b);
- arranging the at least one lighting modules (6) in each respective receiving portion (12a, 12b) of the at least two heat sinks (2a, 2b); and
- connecting the at least two heat sinks (2a, 2b), each heat sink of the at least two heat sinks (2a, 2b) comprising the arranged at least one lighting module (6) in its respective receiving portion (12a, 12b), wherein the arranged at least two heat sinks (2a, 2b) are thermally connected to each other via their respective connecting portions (14a, 14b).

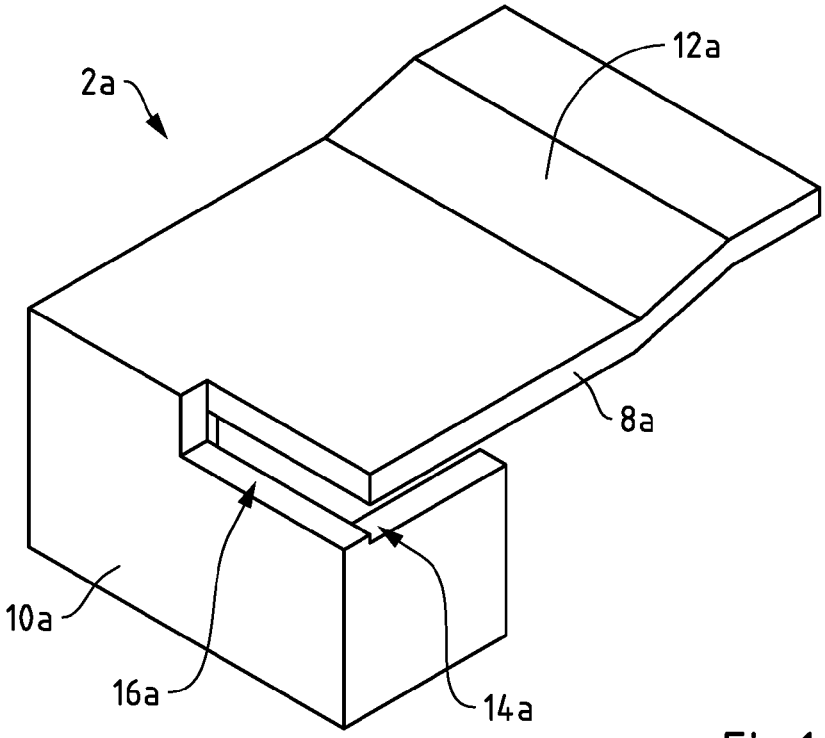

Fig.1

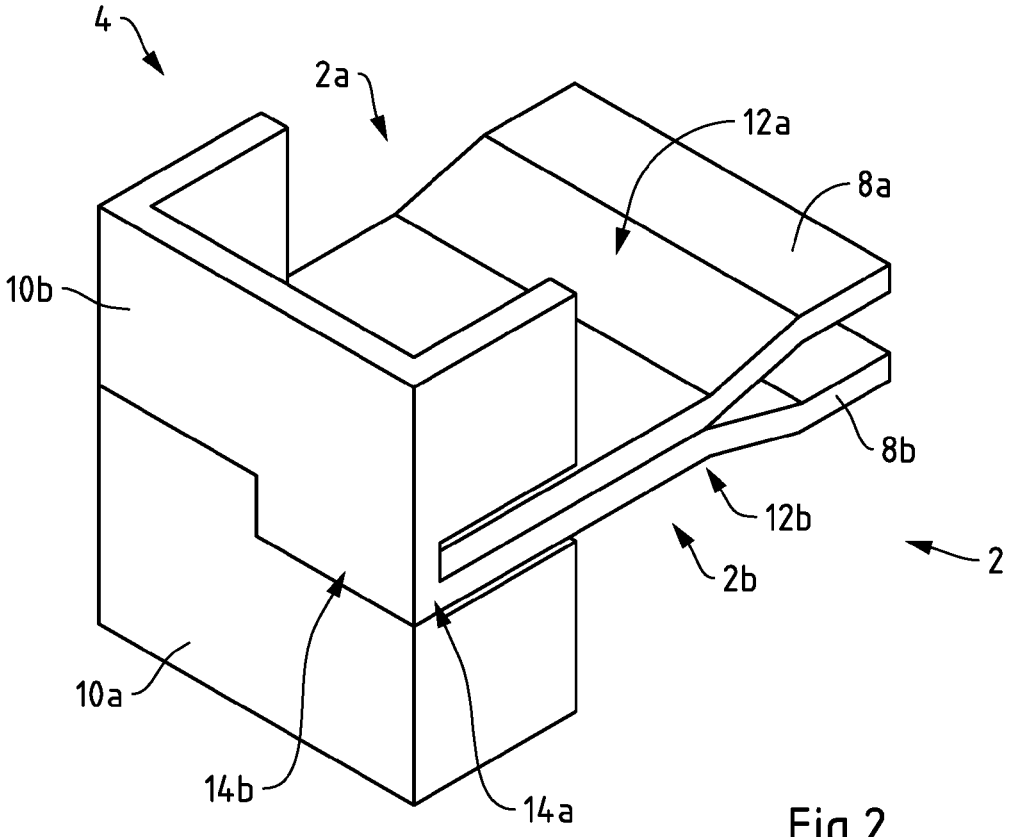

Fig.2

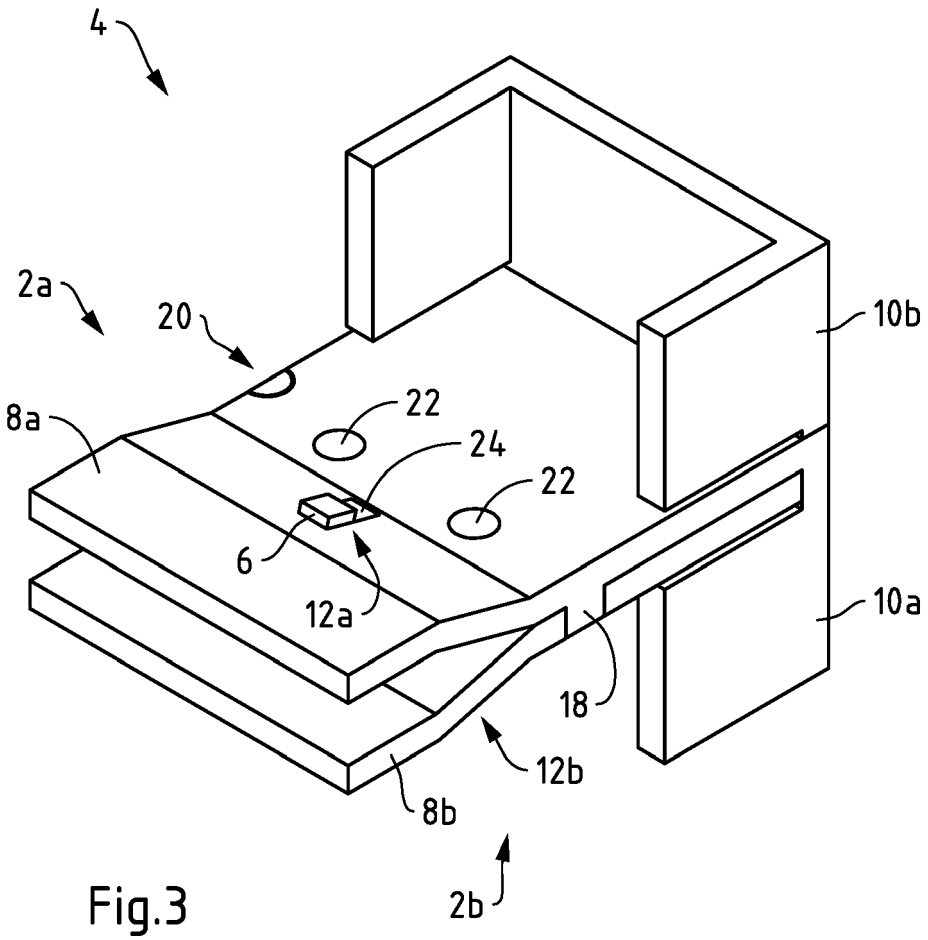

Fig.3

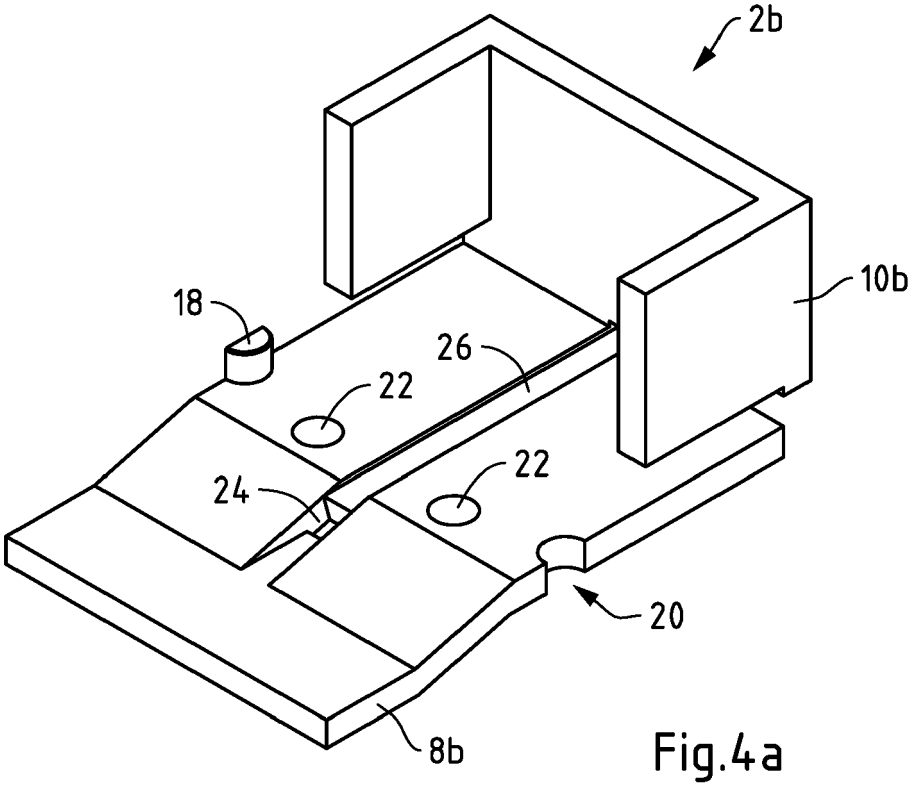

Fig.4a

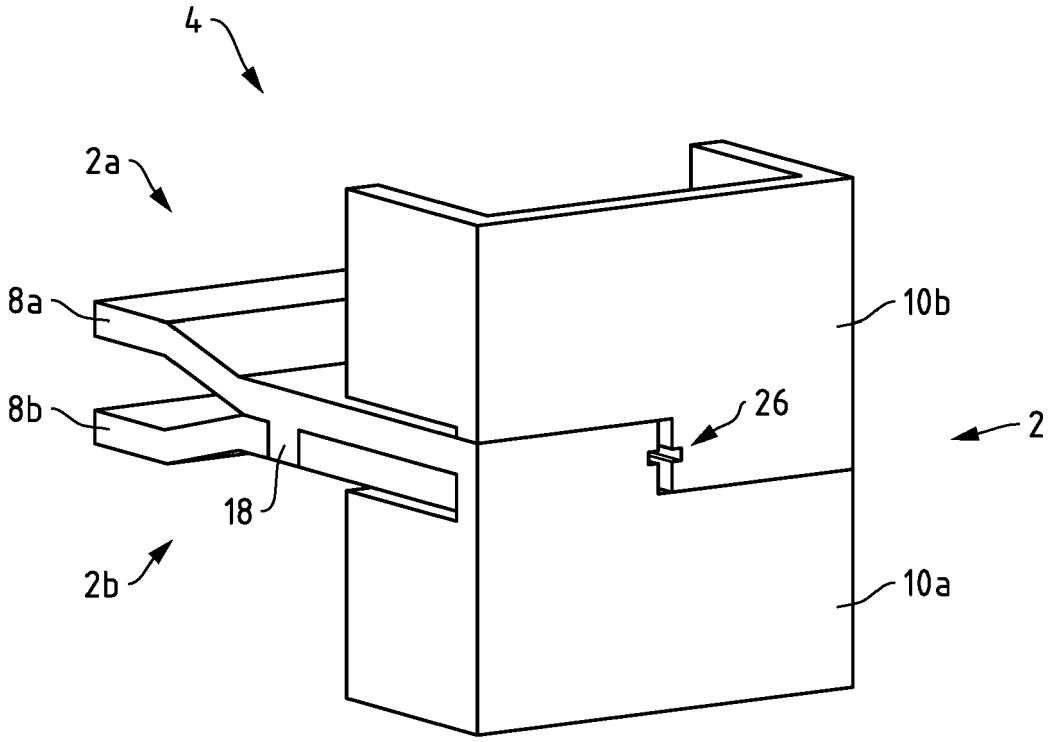

Fig.4b

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 19 20 3497

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	US 2011/281490 A1 (HORIGUCHI TAKASHI [JP] ET AL) 17 November 2011 (2011-11-17) * paragraph [0048] - paragraph [0057] * * figures 1A-2C *	1-4, 6-12,14, 15	INV. F21V29/70 F21S45/47 F21V17/10 F21S2/00
X	EP 2 187 121 A1 (VALEO VISION [FR]) 19 May 2010 (2010-05-19) * paragraph [0040] * * paragraph [0043] - paragraph [0044] * * paragraph [0047] * * paragraph [0051] - paragraph [0055] * * figures 1,2,5-7 *	1-3, 6-12,14, 15	ADD. F21Y115/10
X	US 2019/140155 A1 (KUMS GERARD [NL]) 9 May 2019 (2019-05-09) * paragraph [0018] * * paragraph [0024] * * paragraph [0043] - paragraph [0047] * * figures 1,8,9 *	1-3,6,8, 11,14,15	
X	US 2008/078524 A1 (WILCOX KURT [US] ET AL) 3 April 2008 (2008-04-03) * paragraph [0031] - paragraph [0037] * * figures 1-3 *	1-4,6,7, 9-12,14	TECHNICAL FIELDS SEARCHED (IPC) F21V F21S F21Y
A	US 2018/058657 A1 (DUARTE MARC [FR] ET AL) 1 March 2018 (2018-03-01) * the whole document *	1-15	
A	US 2010/244649 A1 (INABA TETSUAKI [JP]) 30 September 2010 (2010-09-30) * the whole document *	1-15	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	18 February 2020	Soto Salvador, Jesús

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 19 20 3497

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.

18-02-2020

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011281490 A1	17-11-2011	CN 101463960 A	24-06-2009
		DE 102008061431 A1	02-07-2009
		JP 5324778 B2	23-10-2013
		JP 2009151964 A	09-07-2009
		US 2009206719 A1	20-08-2009
		US 2011281490 A1	17-11-2011
EP 2187121 A1	19-05-2010	EP 2187121 A1	19-05-2010
		FR 2938316 A1	14-05-2010
		JP 5596328 B2	24-09-2014
		JP 2010118344 A	27-05-2010
US 2019140155 A1	09-05-2019	CN 109075241 A	21-12-2018
		EP 3453055 A1	13-03-2019
		JP 2019516248 A	13-06-2019
		KR 20190003701 A	09-01-2019
		US 2019140155 A1	09-05-2019
		WO 2017190974 A1	09-11-2017
US 2008078524 A1	03-04-2008	AU 2007221763 A1	17-04-2008
		DE 202007013623 U1	14-02-2008
		NZ 562070 A	28-02-2009
		US 2008078524 A1	03-04-2008
US 2018058657 A1	01-03-2018	CN 108302455 A	20-07-2018
		EP 3290791 A1	07-03-2018
		FR 3055401 A1	02-03-2018
		US 2018058657 A1	01-03-2018
US 2010244649 A1	30-09-2010	CN 101852417 A	06-10-2010
		EP 2236914 A1	06-10-2010
		JP 2010238604 A	21-10-2010
		KR 20100109491 A	08-10-2010
		US 2010244649 A1	30-09-2010

EPO FORM P0459

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