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(54) AUTOMOTIVE LUMINOUS DEVICE

(57) The present invention refers to an automotive luminous device (10) comprising a first substrate and a heatsink element (2). The first substrate (1) comprises on its first face (1a) a light region (11) and an electronic region (12), the light region comprising at least one light source and the electronic region comprising at least one electronic component.

The heatsink element (2) comprises:
- a first portion being arranged on a second face (1b) of the first substrate (1) and in thermal contact with said light region (11), and
- a second portion comprising fins (5) and openings (20) between corresponding fins, the fins presenting a first fin section in contact with the said second face (1b) of the first substrate opposite to the electronic region (12) on the first substrate, so that this opening opens on said second face (1b) of the first substrate.

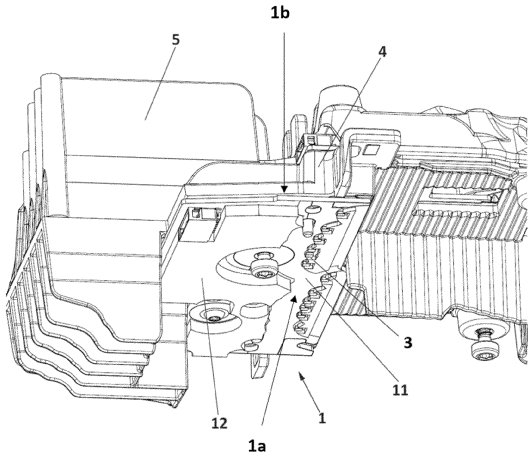

Fig. 1

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Description

TECHNICAL FIELD

[0001] This invention is related to the field of automotive lighting devices, and more particularly, to the internal arrangements of the elements thereof, such as boards and heatsinks.

STATE OF THE ART

[0002] Automotive lighting devices require an increasing amount of electric connections, which are intended to provide control and power supply to the light sources contained therein.

[0003] Further, heat dissipation elements also play a crucial role in the operation of these devices. The performance of solid-state light sources, such as light emitting diodes (LEDs) is heavily affected by temperature, so a good heat evacuation is advantageous for the performance of the light devices.

[0004] However, current heat dissipation elements, known as heatsinks, are bulky and heavy, and the position and size of them have a high impact on design and mass distribution.

[0005] Further, when more than one substrate is involved in the design (such as those light modules configured to provide two different functions), these problems increase, since the position of the substrates is constrained by optical reasons.

[0006] New solutions and designs are therefore sought, to obtain element arrangements which are suitable for optical reasons, design reasons and thermal reasons.

SUMMARY OF THE INVENTION

[0007] The invention provides a solution for this problem by an automotive lighting device. This automotive lighting device comprises:

a first substrate presenting a first face and a second face opposite to the first face, the first substrate comprising on its first face a light region and an electronic region, the light region comprising at least one light source and the electronic region comprising at least one electronic component, wherein the first substrate is comprised in a substrate plane; and
a heatsink element, the heatsink element comprising a first portion and a second portion:

- the first portion being arranged on said second face of the first substrate and opposite to said light region, so that it is in thermal contact with said light region, and the second portion comprising fins and openings arranged between corresponding fins, the fins presenting a first fin section, which is in contact with the said second face of the first substrate, the projections in a direction substantially perpendicular to the substrate plane of the first section of at least two fins and of at least part of the corresponding opening between these two fins over the substrate plane are contained in the electronic region of the first substrate, so that this opening opens on said second face of the first substrate.

[0008] With such an arrangement, the fins leave an open space for the first substrate, to be seen, thus leaving a convection space for air to dissipate the heat produced by the elements of the substrate. This means that, when the first substrate is seen in a direction perpendicular to the substrate plane, at least a portion of the first substrate is seen.

[0009] Furthermore, due to this cut of material, weight is reduced and balanced, since a solid heatsink would cause an unbalanced weight in this portion of the device. Material is also saved, so the cost of this element, in terms of the material used, is lower than in the case of a solid heatsink.

[0010] In some particular embodiments, the fins can be interconnected by portions of the heatsink itself which do not cover the first substrate.

[0011] In some particular embodiments, a portion of the heatsink forms a portion of a frame for the first substrate. This means that the material of the heatsink surrounds a portion of the first substrate also in the substrate plane, around at least a portion of the edge of the first substrate.

[0012] In some particular embodiments, at least a portion of the fins are in direct contact with the first substrate. This improves heat dissipation by direct conduction, which contributes to the thermal performance of the whole heatsink.

[0013] In some particular embodiments, at least two fins present a second fin section, and wherein the projections in a direction substantially perpendicular to the substrate plane of the second fin section of these at least two fins and of the corresponding opening between these two fins over the substrate plane are out of the first substrate, so that air can flows freely between the fins in a direction substantially orthogonal to the substrate plane. Heat dissipation is thus improved.

[0014] In some particular embodiments, the fins are separated between them with interspaces, which form the said openings between corresponding fins, so that for a given pair of fins the openings run transversally from one fin to another. This optimizes the weight reduction while keeping the same surface of fins.

[0015] In some particular embodiments, the heatsink comprises a thermal contact zone surrounded by a groove, the thermal contact zone being configured to be in contact with a portion of the first or the second substrate by the intermediation of a thermal grease. A thermal grease is advantageous to improve the thermal contact between two surfaces. However, when this grease is

used, it is convenient to use a groove to guide the overflowing grease and preventing it from extending uncontrolledly.

[0016] In some particular embodiments, the openings project in a direction perpendicular to the substrate plane out of the thermal contact zone surrounded by said groove. Most heat generating components can be arranged in thermal contact with this thermal contact zone with an improved heat dissipation. For example, the groove can be arranged such that it projects in a direction perpendicular to the substrate plane around the light region.

[0017] In some particular embodiments, at least some of openings end at a front edge, which is adjacent to the groove and which is at the rear of this groove when looking in the direction of light emission by the automotive luminous device. Less material is thus used to design the heatsink.

[0018] In some particular embodiments, the automotive luminous device further comprises a second substrate which comprises at least one light source. Each substrate will usually contribute to different lighting or signalling functions. For example the first substrate can be arranged to contribute to a matrix beam or pixelated beam function. The second substrate can be arranged to contribute to a low beam or a flat beam function.

[0019] In some particular embodiments, the second substrate is arranged in a plane parallel to the substrate plane. This parallel arrangement is easier for light projection and cooperation between the light sources of the two different substrates.

[0020] In some particular embodiments, the first portion of the heatsink element is in thermal contact with the second substrate. With this arrangement, the heatsink operates on the heat dissipation of both substrates.

[0021] In some particular embodiments, the electronic region of the first substrate is offset at least partially towards the rear compared to the second substrate. This longitudinal offset of the two substrates is advantageous to allow a better combination of the light projected by each substrate. In some particular embodiments, the second substrate provides a low beam lamp function, and this requires different focal points and configurations from other lighting functions, so having the possibility of setting these two substrates with a longitudinal offset improves the design and combination of both light elements.

[0022] In some particular embodiments, the heatsink comprises a support plate, the first substrate being on one side of the support plate and the second substrate being on the opposite side of the support plate. This support plate provides mechanical stability for a complex system where two different light arrangements are present.

[0023] In some particular embodiments, the electronic region of the first substrate comprises at least one through hole, which creates air communication between the first face and the second face of the first substrate, said air communication being offset rearward with the second substrate, the through hole communicating with at least one of the openings. Since the top portion of the first substrate is communicated with the exterior, without the interposition of any element, creating an air flow between the bottom portion and the top portion enables a convective air flow which improves heat dissipation. Moreover, this contributes to create a chimney effect, which is advantageous for heat dissipation from the lower part of the luminous device.

[0024] In some particular embodiments, the luminous device further comprises a housing which encloses at least the electronic portion of the first substrate on its first side, such that the air communication between the through hole of the electronic region of the first substrate and the hole of the heatsink element enables vent of this enclosed electronic portion.

[0025] In some particular embodiments, the light source is a solid-state light source, such as a light emitting diode.

[0026] The term "solid state" refers to light emitted by solid-state electroluminescence, which uses semiconductors to convert electricity into light. Compared to incandescent lighting, solid state lighting creates visible light with reduced heat generation and less energy dissipation. The typically small mass of a solid-state electronic lighting device provides for greater resistance to shock and vibration compared to brittle glass tubes/bulbs and long, thin filament wires. They also eliminate filament evaporation, potentially increasing the lifespan of the illumination device. Some examples of these types of lighting comprise semiconductor light-emitting diodes (LEDs), organic light-emitting diodes (OLED), or polymer light-emitting diodes (PLED) as sources of illumination rather than electrical filaments, plasma or gas.

[0027] In some particular embodiments, the automotive luminous device further comprises at least one optical element configured to receive the light emitted by the light sources and project it outside the luminous device. The optical element and the said housing can be made in one piece.

[0028] An optical element is an element that has some optical properties to receive a light beam and emit it in a certain direction and/or shape, as a person skilled in automotive lighting would construe without any additional burden. Reflectors, collimators, light guides, projection lenses, etc., or the combination thereof are some examples of these optical elements which are useful for transforming the light beams emitted by the light source into an acceptable light pattern for the functionality chosen for the lighting device. All of these optical elements define a focus area, which is the area where the light emitted by the light source is most effectively transmitted by the optical element. The focus area can be for example a focus point or a focus line.

[0029] One or several particular embodiments that are above mentioned particular embodiments can be combined.

[0030] Another object of the invention is a headlamp comprising an automotive luminous device according to the invention. In this headlamp, the first substrate and the light source can be configured to provide a matrix beam functionality.

BRIEF LIST OF DRAWINGS AND REFERENCE NUMBERS

[0031] 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 a bottom perspective view of some elements of a first embodiment of an automotive lighting device according to the invention.

Figure 2 shows a top view of the embodiment of Figure 1.

Figure 3 shows the arrangement of a second printed circuit board in the same lighting device as Figure 1.

Figure 4 shows bottom view of the heatsink of the embodiment of the previous figures, showing thermal contact zones and grooves.

Figure 5 shows a detail of figure 4 but with a first printed circuit board added, showing a through hole in the first printed circuit board.

Figure 6 shows a complete view of the automotive lighting device described in the previous figures.

Figure 7 shows a headlamp according to the invention comprising the automotive lighting device of figure 6. This headlamp is installed in an automotive vehicle.

[0032] In these figures, the following reference numbers have been used:

1	First substrate
1a, 1b	Respectively first face and second face of the first substrate
2	Heatsink
3	LEDs
4	First portion of the heatsink
5	Fins of the heatsink
6	Connector of the heatsink
7	Second substrate
8	Thermal contact zone
9	Groove
10	Headlamp
11	Light region of the first substrate
12	Electronic region of the first substrate
13	Rear part of the second substrate
14	Front part of the second substrate
15	Through hole
16	First reflector assembly
17	Second reflector assembly
18	Reflector
19	Front edge of an opening
20	Openings
100	Automotive vehicle

DETAILED DESCRIPTION OF THE INVENTION

[0033] The example embodiments are described in sufficient detail to enable those of ordinary skill in the art to embody and implement the systems and processes herein described. It is important to understand that embodiments can be provided in many alternate forms and should not be construed as limited to the examples set forth herein.

[0034] Accordingly, while embodiment can be modified in various ways and take on various alternative forms, specific embodiments thereof are shown in the drawings and described in detail below as examples. There is no intent to limit to the particular forms disclosed. On the contrary, all modifications, equivalents, and alternatives falling within the scope of the appended claims should be included.

[0035] Figure 1 shows some elements of a first embodiment of an automotive lighting device according to the invention.

[0036] Firstly, a first substrate, here a first printed circuit board 1, hereafter first PCB 1, is located under a heatsink element 2, hereafter the heatsink 2. Figure 1 is a perspective view seen from the bottom, thus enabling to see fully a first face 1a of the first PCB 1. The first PCB comprises also a second face 1b on the opposite side of the first PCB 1, that is to say opposite to its first face 1a.

[0037] This first face 1a of the first PCB 1 comprises two main portions: one first portion, called light region 11, where a plurality of light sources, in this case LEDs 3, are located, and a second portion, called electronic portion 12, where the rest of electronic elements are arranged.

[0038] The heatsink 2 may also divided into a first portion 4 and a second portion, here at the rear of the first portion 4. The first portion 4 is in thermal contact with the second face 1b of the first PCB 1, at the level of the light region 11 of the first PCB 1. In other words, the projection in a direction substantially perpendicular to the substrate plane of this first portion 4 is into the light region 11. Therefore, in this example, the first portion 4 is just above the light region 11 of the PCB 1.

[0039] The second portion of the heatsink 2 comprises a plurality of fins 5.

[0040] Apart from this configuration, a portion of the

heatsink 2 forms a frame which surrounds at least part of the edge of the first PCB 1, thus protecting it and keeping it into position against perturbations.

[0041] Figure 2 shows a top view of the embodiment of Figure 1. In this figure 2, the fins 5 of the heatsink 2 are seen from the top, and it is seen how these fins 5 project over the electronic region 12 of the first printed circuit board 1, leaving empty spaces between fins, so that the electronic region 12 of the printed circuit board 1 is seen from the outside by the empty spaces between fins 5. These spaces are here interspaces which form openings 20.

[0042] According to the invention as in this example, the first portion 4 itself may connect the fins 5 at the front.

[0043] In particular embodiments, such as the illustrated one, the heatsink can comprise joining portions 6, the projection of which over the first PCB 1 falling outside the electronic region 12, preferably outside the first PCB 1, providing mechanical stability for the corresponding fins 5.

[0044] These fins 5 are here in direct contact with the second face 1b of the first PCB 1, just above the electronic portion 12 of the first PCB 1, to increase thermal dissipation efficiency.

[0045] In this example, the first PCB 1 is intended to generate the light rays that contribute to the matrix beam lighting function. This first PCB 1 has the light region 11 in thermal contact with the first portion 4 of the heatsink 2 and the electronic portion 12 in thermal contact with the fins 5.

[0046] Figure 3 is intended to show the arrangement of a second printed circuit board 7, hereafter second PCB 7, in the same automotive lighting device 1 as in figure 1.

[0047] This second PCB 7, which is here located above the first portion 4 of the heatsink 2, is intended, in this example, to contribute to a low beam lighting function.

[0048] This second PCB 7 is arranged parallelly to the first PCB 1. However, there is an offset in a direction belonging to the board plane, between those printed circuit boards. Hence, as can be seen in the figure, the projection of the second PCB 7 over the first PCB 1 has barely a small portion in common with the first PCB 1. In other words, the electronic region 12 of the first PCB 1 is offset at least partially towards the rear compared to the second PCB 7. In a variant, this offset could be bigger, and the electronic region 12 of the first PCB could be completely offset compared to the second PCB 7.

[0049] In this example, this second PCB 7 comprises a rear part 13 and a front part 14, both comprising LEDs 3. The rest of electronic elements could be arranged in the rear part 13.

[0050] With this arrangement, heat is communicated by direct conduction between the light regions 11, 13 of both first and second printed circuit boards 1, 7 and the first portion 4 of the heatsink 2. Heat is transported along the heatsink to the fins 5, where it is evacuated by convection.

[0051] Since the light region of a printed circuit board is the hottest portion, and the most critical in terms of heat behaviour, it is advantageous that they are in direct contact with the heatsink.

[0052] In these embodiments, a thermal grease is interposed between the light portions of each of the printed circuit boards 1, 7 and the corresponding first portion 4 of the heatsink 2. This thermal grease is advantageous because it improves the direct heat dissipation between the corresponding printed circuit board and the first portion 4 of the heatsink 2.

[0053] Figure 4 shows the heatsink alone without the PCB1. However, the references of the light region 11 and the electronic region 12 are indicated to enable to see the portions of the heatsink 2 that will be in contact with these regions 11, 12.

[0054] As shown by figure 4, the grease is located on the bottom side of the heatsink 2, i.e. the side in contact with the first PCB 1. To create the thermal connection with the light region 11, the first portion of the heatsink comprises a face with at least one thermal contact zone 8, which is surrounded by a groove 9. This thermal contact zone 8 is a zone intended to be in contact with a portion of the first face 1b of the first PCB by the intermediation of the thermal grease. This contact is here just above the light region 12 of the first PCB 1.

[0055] In this figure 4, there is just one thermal contact zone 8 corresponding to the area containing the array of LEDs dedicated to generate the rays for the matrix beam. However, there could be more zones, for example in case of several arrays.

[0056] When the grease is deposited in the thermal contact zone 8 and the first PCB 1 is pressed against this thermal contact zone 8, the excess of grease may overflow beyond the edge of the thermal contact zone 8. In such a case, the groove 9 receives the excess of grease. Without this groove, the excess of grease may overflow beyond the edge of the heatsink, thus staining the rest of the elements of the lighting device 1.

[0057] As can be seen in figure 4, the openings 20 present a front edge 19. For some of these openings 20, the corresponding front edges 19 are adjacent to the groove 9, i.e. close to the edge of the groove without opening into the groove. This enables the corresponding openings 20 to be as long as possible and to further reduce the quantity of material, here metal, to manufacture the heatsink 2.

[0058] In the same way, but not illustrated, there can be thermal contact zones, here three, of the heatsink 2 in contact with the second printed circuit board 7.

[0059] Figure 5 shows another detail of the arrangement of the invention. In this case, the first PCB 1 comprises a through hole 15 which is not filled by any element. This through hole 15 is intended to create air communication between the two faces 1a, 1b of the first PCB 1, here in its electronic region 12. Thus the heat may be transferred by convection between these two sides of the first PCB 1, thus improving heat dissipation behaviour.

[0060] According to an embodiment of the invention,

when the through hole 15 communicates with an opening 20, a chimney effect between the corresponding fins 5 may be produced, thus increasing the heat dissipation. As illustrated in figure 5, which is a bottom view of the heatsink 2 covered with the first PCB 1, the bottom of one fin 5 can be seen through one through hole 15. This through hole 15 opens on each side of this fin 5 and therefore on two openings 20.

[0061] In this figure 5, the groove 9 is represented by the schematic dotted line, as it is covered by the first PCB 1.

[0062] In figures 1 to 5, some elements where omitted to illustrate the embodiment. Notably the optical elements where omitted, except in Figure 2 wherein you can see the reflectors collecting the rays emitted by the LEDs 3 of the second PCB 2.

[0063] Figure 6 shows a complete view of automotive lighting device 1 of the embodiment illustrated in figures 1 to 5. According to the invention, as in this example, this automotive lighting device 1 can be a bifunction lighting module.

[0064] This lighting module 1 comprises two reflector arrangements 16, 17, each reflector arrangement comprising reflectors 18 which are intended to reflect the light emitted by each of the LEDs 3 towards a projection lenses assembly, here visible at the front of the lighting module 1.

[0065] Here the reflectors of a first reflector arrangement 17 cooperate with the LEDs 3 of the first PCB 1 and the projection lenses assembly to generate the matrix beam.

[0066] As can be seen in figure 6, the first reflector arrangement 17 can form a housing, which together with the plate part of the heatsink 2 that supports the first PCB 1 encloses the electronic region 12 of the first PCB 1. In this case, the through hole 15 enables to vent this enclosed electronic region 12. This is particularly advantageous as the electronic components of the first PCB 1 are involved in the matrix beam generation and develop more heat.

[0067] Finally, Figure 7 shows a headlamp 10 comprising such the light module 1. This headlamp 10 is installed in an automotive vehicle 100.

Claims

1. An automotive luminous device (10) comprising

a first substrate (1) presenting a first face (1a) and a second face (1b) opposite to the first face, the first substrate comprising on its first face (1a) a light region (11) and an electronic region (12), the light region (11) comprising at least one light source (3) and the electronic region (12) comprising at least one electronic component, wherein the first substrate (1) is comprised in a substrate plane; and

a heatsink element (2), the heatsink element (2) comprising a first portion (4) and a second portion:

- the first portion being arranged on said second face (1b) of the first substrate (1) and opposite to said light region (11), so that it is in thermal contact with said light region (11), and
- the second portion comprising fins (5) and openings (20) arranged between corresponding fins, the fins presenting a first fin section, which is in contact with the said second face (1b) of the first substrate, the projections in a direction substantially perpendicular to the substrate plane of the first section of at least two fins (5) and of at least part of the corresponding opening between these two fins over the substrate plane are contained in the electronic region (12) of the first substrate, so that this opening opens on said second face (1b) of the first substrate.

2. Automotive luminous device (10) according to claim 1, wherein these at least two fins (5) present a second fin section, and wherein the projections in a direction substantially perpendicular to the substrate plane of the second fin section of these at least two fins and of the corresponding opening (20) between these two fins over the substrate plane are out of the first substrate (1), so that air can flows freely between the fins in a direction substantially orthogonal to the substrate plane.

3. Automotive luminous device (10) according to any of the preceding claims, wherein the fins (5) are separated between them with interspaces, which form the said openings (20) between corresponding fins, so that for a given pair of fins the openings run transversally from one fin to another.

4. Automotive luminous device (10) according to any of the preceding claims, wherein the heatsink element (2) comprises a thermal contact zone (8) surrounded by a groove (9), the thermal contact zone being configured to be in contact with a portion of the second face (1b) of the first substrate (1) by the intermediation of a thermal grease.

5. Automotive luminous device (10) according to claim 4, wherein the opening (20) projects in a direction perpendicular to the substrate plane out of the thermal contact zone (8) surrounded by said groove (9).

6. Automotive luminous device (10) according to claim 5, wherein at least some of the openings (20) end at a front edge (19), which is adjacent to the groove (9) and which is at the rear of this groove when looking

in the direction of light emission by the automotive luminous device.

7. Automotive luminous device (10) according to any of the preceding claims, further comprising a second substrate (7) which comprises at least one light source (3).

8. Automotive luminous device (10) according to claim 7, wherein the first portion (4) of the heatsink element (2) is in thermal contact with the second substrate (7).

9. Automotive luminous device (10) according to claim 7 or to claim 8, wherein the electronic region (12) of the first substrate (1) is offset at least partially towards the rear compared to the second substrate (7).

10. Automotive luminous device (10) according to any of claims 7 to 9, wherein the heatsink element (2) comprises a support plate, the first substrate (1) being on one side of the support plate and the second substrate (7) being on the opposite side of the support plate.

11. Automotive luminous device (10) according to any of claims 7 to 10, wherein the electronic region (12) of the first substrate (1) comprises at least one through hole (15), which creates air communication between the first face (1a) and the second face (1b) of the first substrate (1), said air communication being offset rearward with the second substrate (7), the through hole communicating with at least one of the openings (20).

12. Automotive luminous device (10) according to claim 11, further comprising a housing which encloses at least the electronic portion (12) of the first substrate (1) on the side of its said first face, such that the air communication between the through hole of the electronic region of the first substrate and the hole of the heatsink element (2) enables vent of this enclosed electronic portion.

13. Automotive luminous device (10) according to any of the preceding claims, wherein the light source (3) is a solid-state light source.

14. Automotive luminous device (10) according to any of the preceding claims, further comprising at least one optical element (18) configured to receive the light emitted by the light source and project it outside the luminous device.

15. Headlamp comprising an automotive luminous device (10) according to any of the preceding claims.

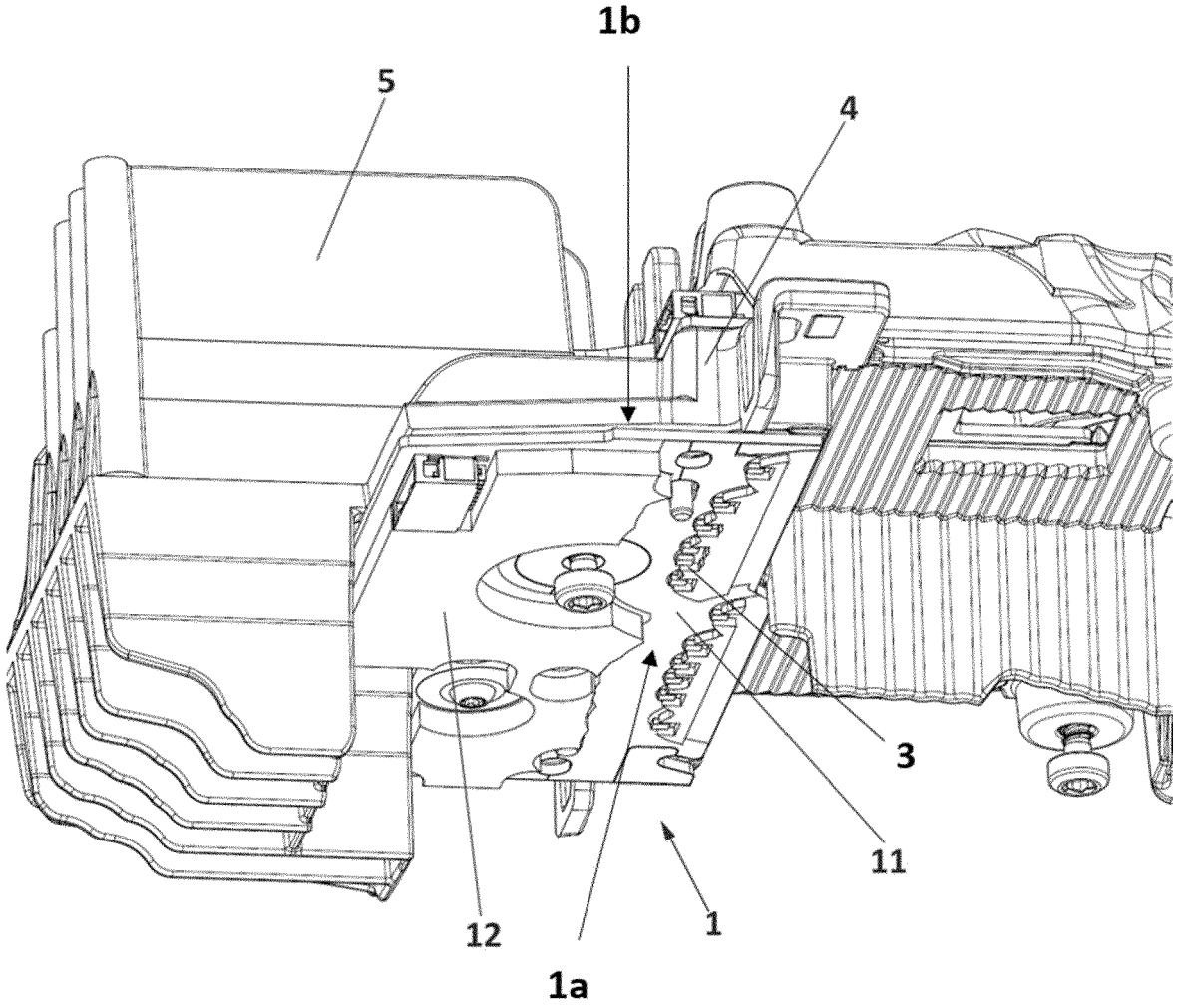

Fig. 1

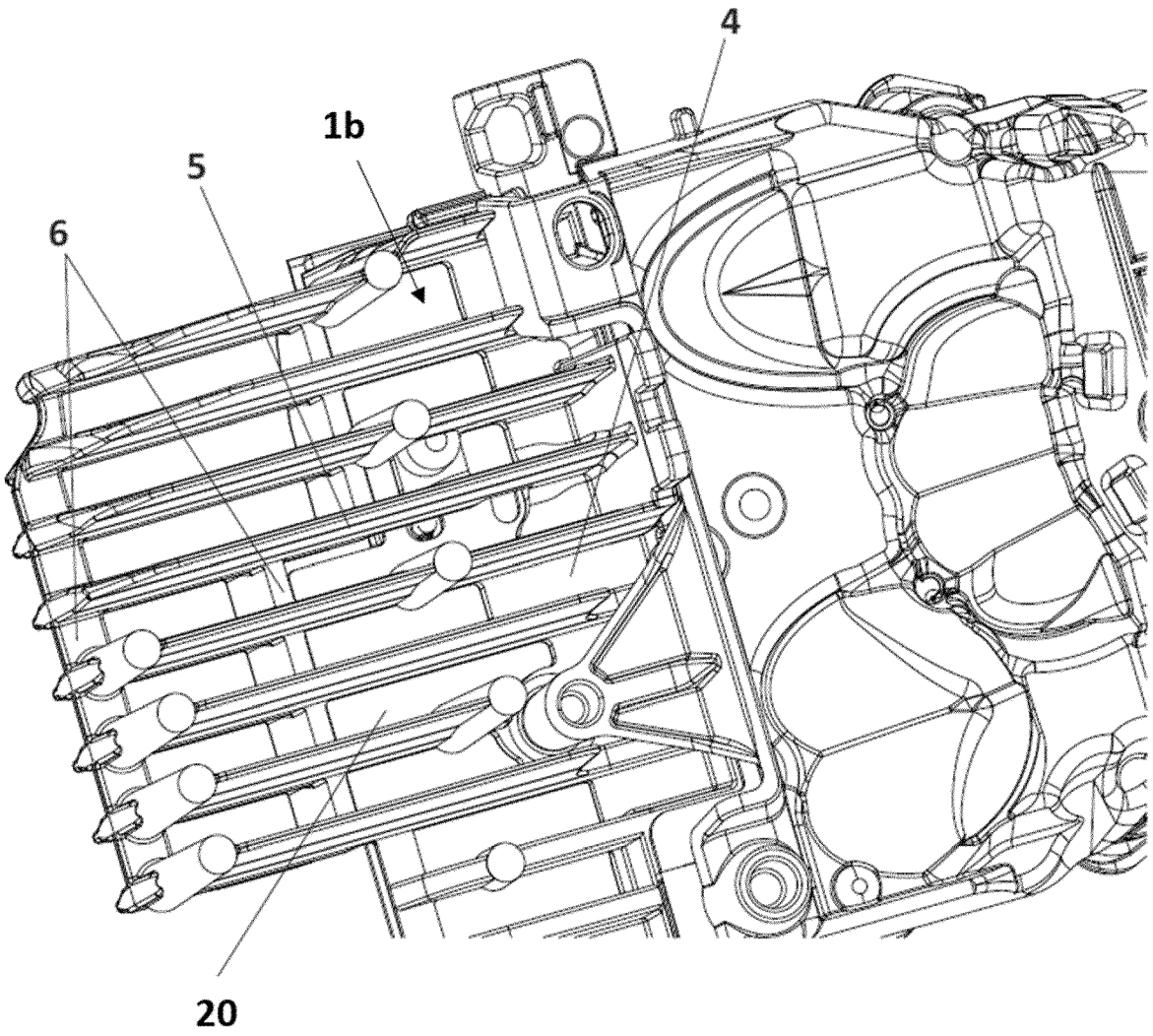

Fig. 2

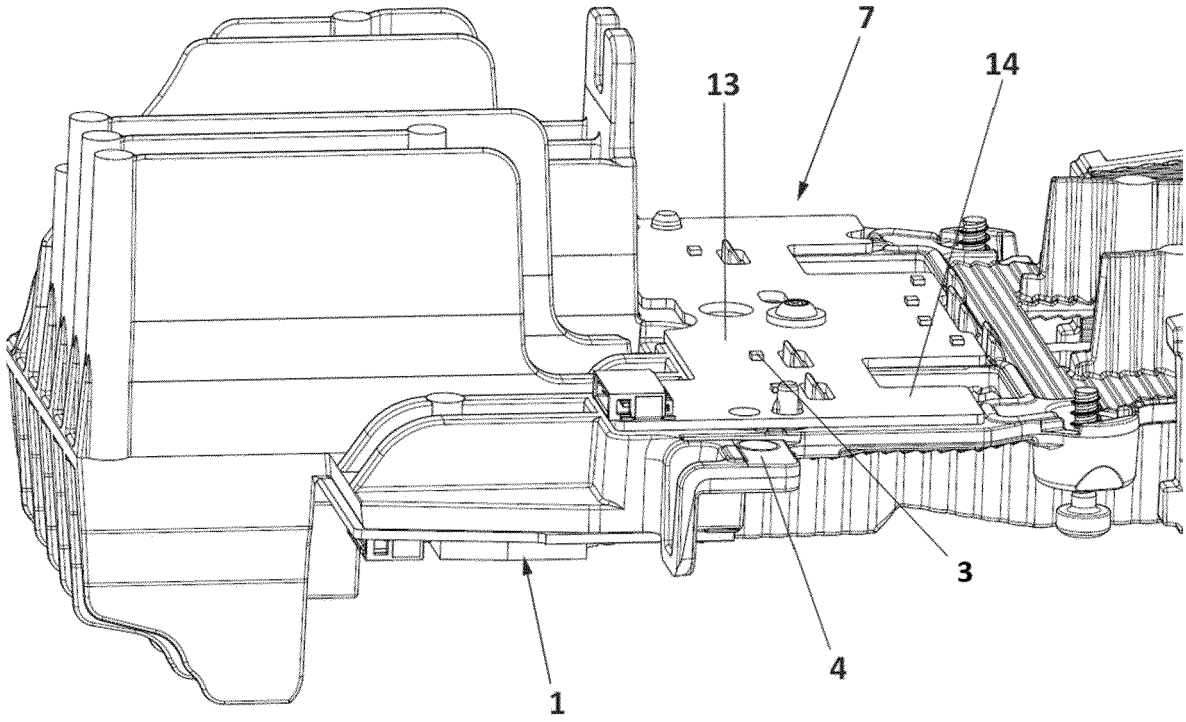

Fig. 3

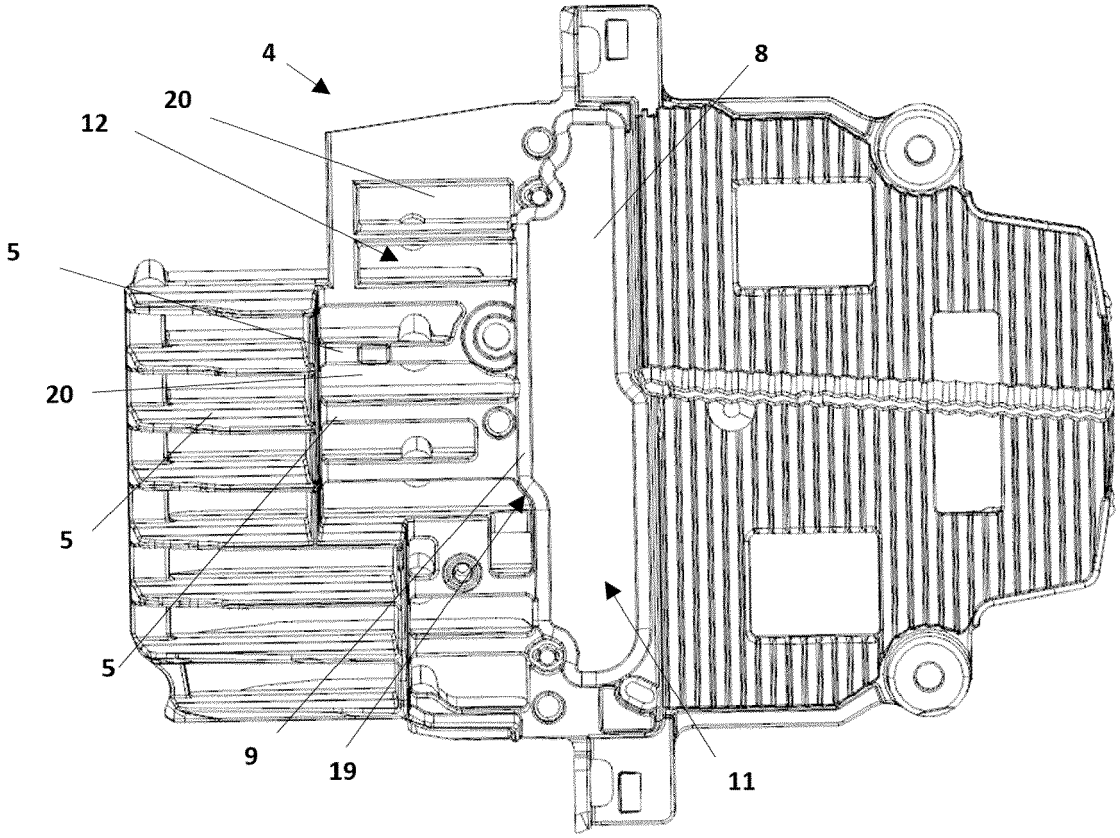

Fig. 4

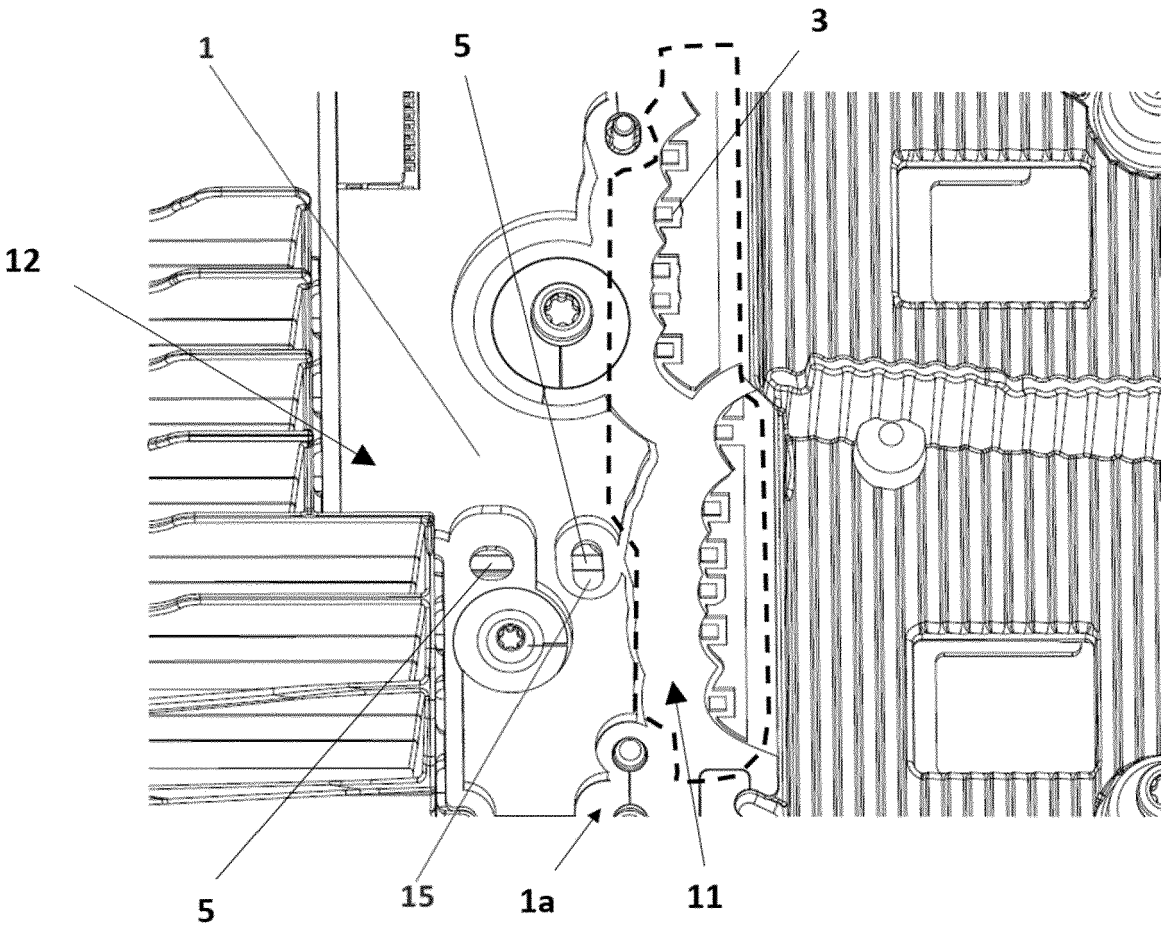

Fig. 5

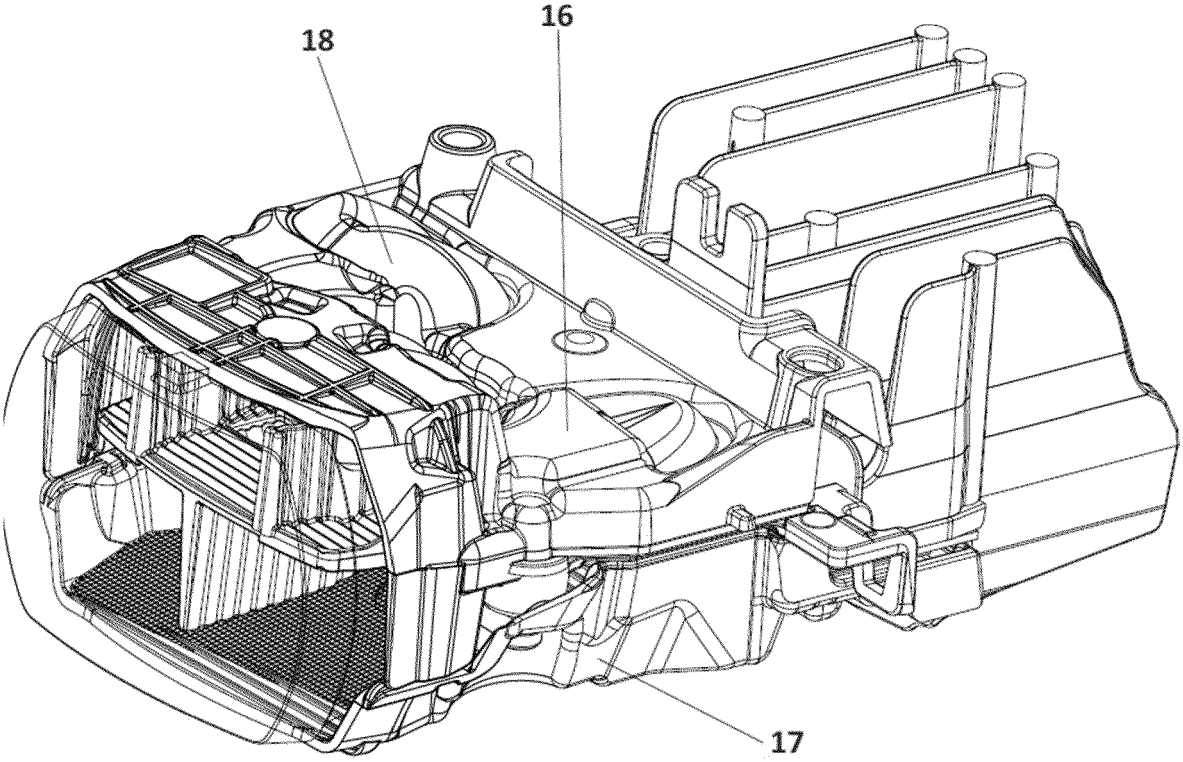

Fig. 6

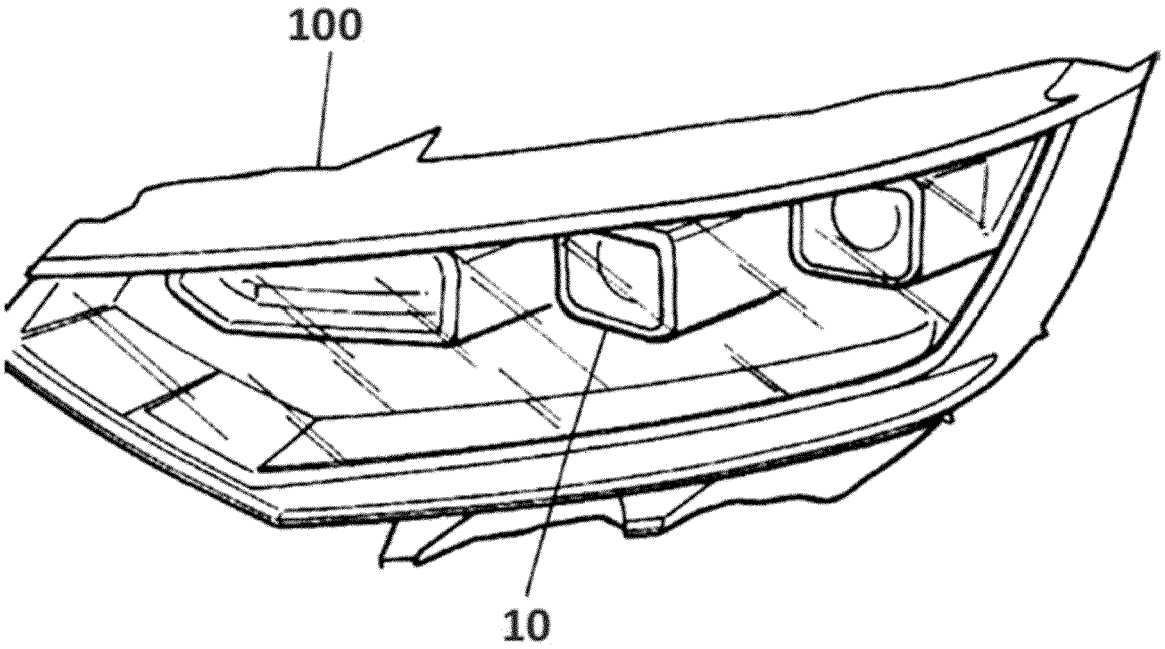

Fig. 7

Europäisches Patentamt
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Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 23 15 0219

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	EP 3 593 033 B1 (HELLA GMBH & CO KGAA [DE]) 6 July 2022 (2022-07-06) * figures 1,3,6 *	1-5, 7-10, 13-15	INV. F21S41/151 F21S41/148 F21S41/19 F21S45/47
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