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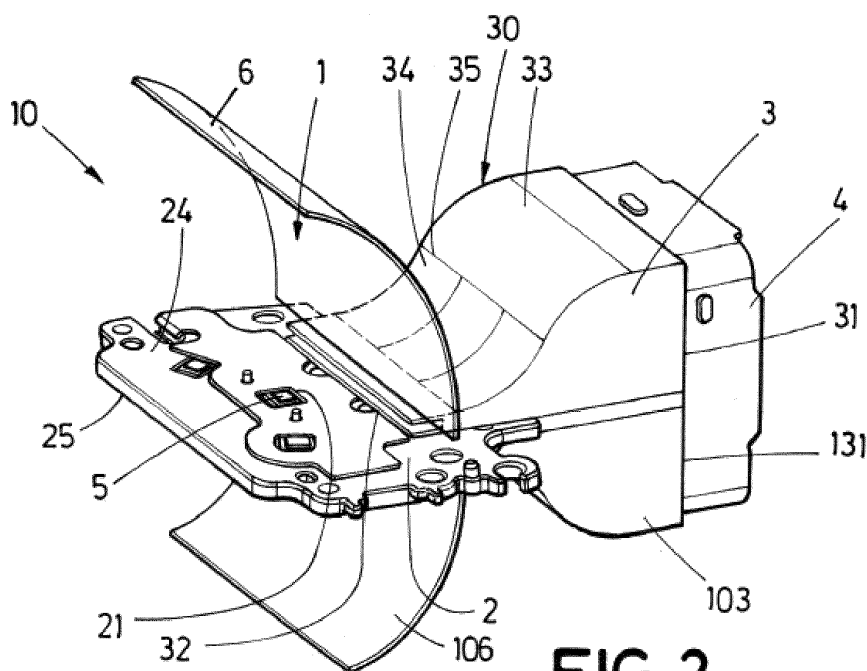
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(54) COOLING DEVICE

(57) This invention provides a cooling device (1) for cooling a light source comprised in an automotive lighting device. The cooling device (1) comprises a heat sink (2) and a flow guide (3). The heat sink (2) has a source point (21) intended to receive a light source, the source point (21) being in thermal contact with the rest of the heat sink (2), the heat sink (2) further comprising a heater (22) where heat from the heat sink (2) is communicated from the source point to ambient air, thus generating heated

ambient air. The flow guide (3) comprises an input (31) and an output (32), in such a way that heated ambient air is intended to flow from the input (31) to the output (32), the input (31) being in fluid contact with the heated ambient air and the output (32) being in fluid contact with the source point (21) so that when the heated ambient air flows from the input (31) to the output (32), further heat may be evacuated from the source point (21).

**FIG. 2****EP 3 385 605 A1**

Description

TECHNICAL FIELD

[0001] This invention is related to the field of heat dissipation in automotive lighting devices.

STATE OF THE ART

[0002] Light sources generate a big amount of heat which needs to be dissipated, so that the operation of said light sources is not jeopardized. This issue is even more important when light sources are light emitting diodes (LEDs), since temperature has a big impact on the operational properties of said light sources.

[0003] Heat sinks with heaters are known to solve this problem. A heat sink is located in thermal contact with the light source, and this heat sink is provided with heaters, which dissipate the heat coming from the heat sink, so that air surrounding the heater is heated and then wasted.

DESCRIPTION OF THE INVENTION

[0004] The invention provides a solution for reusing the wasted air in order to optimise heat dissipation by means of a cooling device according to claim 1 and an automotive lighting device according to claim 10. Preferred embodiments of the invention are defined in dependent claims.

[0005] In an inventive aspect, the invention provides a cooling device for cooling a light source comprised in an automotive lighting device, the cooling device comprising

a heat sink having a source point intended to receive a light source, the heat sink further comprising a heater in contact by thermal conduction with the source point in such a way that the heater generates heated ambient air when heat is transmitted from the source point to the heater;

a flow guide comprising an input, an output and a fluid passageway between the input and the output, the input being in fluid contact with the heater and the output being in fluid contact with the source point so that, when the heated ambient air is generated by the heater, the heated ambient air is allowed to flow from the input to the output thereby evacuating heat, by thermal convection, from the source point.

[0006] Advantageously, such a cooling device uses ambient air which has been heated by the heater, and is otherwise wasted, in order to reduce the temperature of the light source.

[0007] In some particular embodiments, the cooling device further comprises a fan element arranged to force airflow from the input to the output.

[0008] This fan element contributes to create the air flow between the input and the output, and is able to

regulate the intensity of such an air flow.

[0009] In some particular embodiments, the output has a smaller surface than the input.

[0010] This arrangement makes the air speed increase from the input to the output, provided air flow does not present major fluid irregularities, which is the case in the majority of the applications of this cooling device.

[0011] In some particular embodiments, the passageway comprises

a first section from the input to an intermediate zone having a first cross-section which decreases with an increasing decrease rate; and

a second section from the intermediate zone to the output having a second cross-section which decreases with a decreasing decrease rate.

[0012] Cross section is reduced from the input to the output to contribute to the increase of air speed. It has been found that a first section with an increasing decrease rate and a second section with a decreasing decrease rate is optimal for this purpose. The decrease rate is the derivative of the size of the cross section S with respect to the y coordinate, which is the direction from the input to the output

$$\text{decrease rate} = \frac{\partial S}{\partial y}$$

[0013] In some particular embodiments, the first section and the second section are two separate portions attachable to one another.

[0014] Advantageously, these embodiments are able to adapt better to different heat sinks, since one of the portions may be the same for all different heat sinks and the other portion be adaptive to different heat sink designs.

[0015] In some particular embodiments, the heater comprises fins.

[0016] Fins improve heat dissipation, so they are useful for transferring heat from the heat sink to ambient air. However, ambient air is not heated in a way that prevents it from being used for further cooling.

[0017] In some embodiments, the flow guide is attached or fitted into the heat sink.

[0018] The flow guide may be attached to the heat sink, either by external elements, such as screws, rivets or an adhesive, or just by press fitting or snap fitting. This way of arranging the flow guide provide stability to the cooling device.

[0019] In some particular embodiments, the heat sink comprises a further source point intended to receive a light source, the heater being in thermal contact with the further source point and the cooling device comprises a further flow guide, the further flow guide comprising a further input, a further output and a further fluid passageway between the further input and the further output, the

further input being in fluid contact with the heater and the further output being in fluid contact with the further source point so that, when the heated ambient air is generated by the heater, the heated ambient air is allowed to flow from the further input to the further output thereby evacuating heat, by thermal convection, from the further source point. In more particular embodiments, the heat sink has two faces opposite to one another, and each source point is comprised in one of these faces.

[0020] This embodiment is used in arrangements where two or more light sources are located on opposite faces of the heat sink. In this case, a second flow guide is installed in an analogue way as the first one, with its own input and output. In some embodiments, both inputs are fed by the same ambient air and in other embodiments, although both inputs are in fluid contact, they are not in direct connection.

[0021] In a further inventive aspect, the invention provides an automotive lighting device comprising

a cooling device according to the previous inventive aspect; and

a light source arranged in the source point of the cooling device, in thermal contact with the heat sink.

[0022] In some particular embodiments, the automotive lighting device further comprises a reflector, in such a way that the cooling device is partly located between the reflector and the light source.

[0023] This automotive lighting device presents a better thermal behaviour, but without increasing substantially its size, since the flow guide just serves as a guide for ambient air, but without taking much more additional volume in the lighting device.

[0024] In some particular embodiments, the light source is a semiconductor light source, such as a light emitting diode (LED).

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] 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 cooling device in a lighting device according to the state of the art.

Figure 2 shows a cooling device according to the invention, installed in a lighting device comprising a light source.

Figure 3 shows a different perspective of the cooling device of figure 2.

Figure 4 shows a longitudinal cut section of a cooling device according to the invention.

Figure 5 shows an automotive lighting device comprising a cooling device according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0026] Figure 1 shows a cooling device 1' of an automotive lighting device according to the state of the art. This lighting device comprises a light source 5' and a heat sink 2' in thermal contact with the light source, the heat sink dissipating heat from the light source.

[0027] This heat sink exchanges heat with ambient air by means of a heater 22', which is placed in one end of the heat sink 2'. By means of this heater 22', the heat received from the light source 5' is evacuated and increases the temperature of surrounding air.

[0028] Figures 2 and 3 show a cooling device 1 according to the invention, installed in a lighting device 10 comprising two semiconductor light sources 5, 105, such as LEDs or laser diodes.

[0029] This lighting device 10 further comprises reflectors 6, 106, in such a way that the cooling device 1 is partly located between a reflector 6, 106 and the corresponding light source 5, 105.

[0030] This cooling device 1 comprises

a heat sink 2 with a source point 21 intended to receive a light source 5, the heat sink 2 further comprising a heater (not shown in these figures) in contact by thermal conduction with the source point 21 in such a way that the heater generates heated ambient air when heat is transmitted from the source point to the heater;

a flow guide 3 comprising an input 31, an output 32 and a fluid passageway 30 between the input 31 and the output 32, the input 31 being in fluid contact with the heater (although this is not seen in this figure) and the output 32 being in fluid contact with the source point 21; and

a fan element 4 arranged to force airflow from the input 31 to the output 32.

[0031] The cooling device 1 also comprises a further flow guide 103, but it will be described below, since it is symmetric to the flow guide 3.

[0032] When the heated ambient air is generated by the heater, the heated ambient air is allowed to flow from the input 31 to the output 32 thereby evacuating heat, by thermal convection, from the source point 21.

[0033] The output 32 has a smaller surface than the input 31. In fact, the passageway 30 comprises two separate portions 33, 34, in such a way that the cross section of the passageway 30 decreases in a different way in each of these portions 33, 34

in the first portion 33, from the input 31 to an inter-

mediate zone 35, the size of the cross section decreases with an increasing decrease rate; and in the second portion 34, from the intermediate 35 zone to the output 32, the size of the cross section decreases with a decreasing decrease rate.

[0034] In different embodiments, instead of having two different portions, the passageway just comprises a single portion with two different sections.

[0035] In this figure, the heat sink 2 comprises two faces 24, 25, opposite to one another.

[0036] Figure 2 shows the automotive lighting device 10 from the first face 24, and figure 3 shows the same lighting device 10 from the opposite face 25.

[0037] In this figure 3, a further source point 121 is seen in this opposite face 25, intended to receive a further light source 105. Thus, the further light source 105 has a corresponding further flow guide 103. In the embodiment illustrated by these figures 2 and 3, the flow guides 3, 103 are substantially identical, but are placed in a symmetrical way with respect to the heat sink 2.

[0038] The further flow guide 103 comprises a further input 131 where heated ambient air enters a further output 132 where this heated ambient air exits to dissipate heat from the further lighting source 105.

[0039] The heater is in thermal contact with the further source point 121. The further flow guide 103 comprises a further input 131, a further output 132 and a further fluid passageway 130 between the further input 131 and the further output 132, the further input 131 being in fluid contact with the heater (not shown in this figure) and the further output 132 being in fluid contact with the further source point 121 so that, when the heated ambient air is generated by the heater, the heated ambient air is allowed to flow from the further input 131 to the further output 132 thereby evacuating heat, by thermal convection, from the further source point 121.

[0040] The passageway 130 comprises two separate portions 133, 134, in such a way that the cross section of the passageway 130 decreases in a different way in each of these portions 133, 134

in the first portion 133, from the input 131 to an intermediate zone 135, the size of the cross section decreases with an increasing decrease rate; and in the second portion 134, from the intermediate 135 zone to the output 132, the size of the cross section decreases with a decreasing decrease rate.

[0041] The flow guides 3, 103 are attached or fitted into the heat sink 2. In this embodiment, the flow guides 3, 103 are attached to the heat sink 2 by external elements, such as screws or rivets. An adhesive may also be used for this purpose. Another way of attaching these elements is just by press fitting or snap fitting. This makes easier to exchange different cooling devices between different types of heat sinks 2.

[0042] Figure 4 shows a longitudinal cut section of this

cooling device 1. In this cut section, it is observed how the heat comes from the light sources 5, 105, it is then transmitted by conduction by the heat sink 2 to the heater 22, which has fins for better heat dissipation. Once the ambient air surrounding the heater 22 has been heated, the fan element 4 reintroduce this ambient air into the passageways 30, 130 to reduce the temperature of the light sources 5, 105. The reason is that, although the ambient air has been heated by the heater, its temperature is still much lower than the temperature of the light sources 5, 105. As a consequence, this heated ambient air has still thermal properties to dissipate heat from the light sources 5, 105 by convection.

[0043] Figure 5 shows an automotive lighting device 10 comprising

a cooling device 1 according to the invention; and a light source 5 arranged at the source point of the cooling device 1 in thermal contact with the heat sink 2.

[0044] This automotive lighting device 10 benefits from the cooling device 1, so that the light source 5 comprised in it is cooled both by conduction, by means of the heat sink, and by convection, by means of the heated air flowing across the passageway of the flow guide.

[0045] In this particular case, the light source 5 is a semiconductor light source, and in particular a LED source.

Claims

1. Cooling device (1) for cooling an automotive lighting device light source, the cooling device (1) comprising

a heat sink (2) having a source point (21) intended to receive a light source, the heat sink (2) further comprising a heater (22) in contact by thermal conduction with the source point (21) in such a way that the heater generates heated ambient air when heat is transmitted from the source point to the heater (22);

a flow guide (3) comprising an input (31), an output (32) and a fluid passageway (30) between the input (31) and the output (32), the input (31) being in fluid contact with the heater (22) and the output (32) being in fluid contact with the source point (21) so that, when the heated ambient air is generated by the heater (31), the heated ambient air is allowed to flow from the input (31) to the output (32) thereby evacuating heat, by thermal convection, from the source point (21).

2. Cooling device (1) according to claim 1, further comprising a fan element (4) arranged to force the heated ambient air to flow from the input (31) to the output

(32).

3. Cooling device (1) according to any of the preceding claims, wherein the output (32) has a smaller surface than the input (31). 5
4. Cooling device (1) according to any of the preceding claims, wherein the passageway (30) comprises:
 - a first section (33) from the input (31) to an intermediate zone (35) having a first cross-section which decreases with an increasing decrease rate; and 10
 - a second section (34) from the intermediate zone (35) to the output (32) having a second cross-section which decreases with a decreasing decrease rate. 15
5. Cooling device (1) according to claim 4, wherein the first section (33) and the second section (34) are two separate portions attachable to one another. 20
6. Cooling device (1) according to any of the preceding claims, wherein the heater (22) comprises fins. 25
7. Cooling device (1) according to any of the preceding claims, wherein the flow guide (3) is attached to or fitted into the heat sink (2).
8. Cooling device (1) according to any of the preceding claims, wherein the heat sink (2) comprises a further source point (121) intended to receive a light source, the heater being in thermal contact with the further source point (121) and the cooling device comprises a further flow guide (103), the further flow guide (103) comprising a further input (131), a further output (132) and a further fluid passageway (130) between the further input (131) and the further output (132), the further input (131) being in fluid contact with the heater (22) and the further output (132) being in fluid contact with the further source point (121) so that, when the heated ambient air is generated by the heater (31), the heated ambient air is allowed to flow from the further input (131) to the further output (32) thereby evacuating heat, by thermal convection, from the further source point (121). 30 35 40 45
9. Cooling device (1) according to claim 8, wherein the heat sink (2) has two faces (24, 25) opposite to one another, and each source point (21, 121) is comprised in one of these faces. 50
10. Automotive lighting device (10) comprising
 - a cooling device (1) according to any of the preceding claims; and 55
 - a light source (5) arranged at the source point (21) of the cooling device (1) in thermal contact

with the heat sink (2).

11. Automotive lighting device (10) according to claim 10, further comprising a reflector (6), in such a way that the cooling device (1) is partly located between the reflector (6) and the light source (5).
12. Automotive lighting device (10) according to any of claims 10 or 11, wherein the light source (5) is a semiconductor light source, and in particular a LED source.

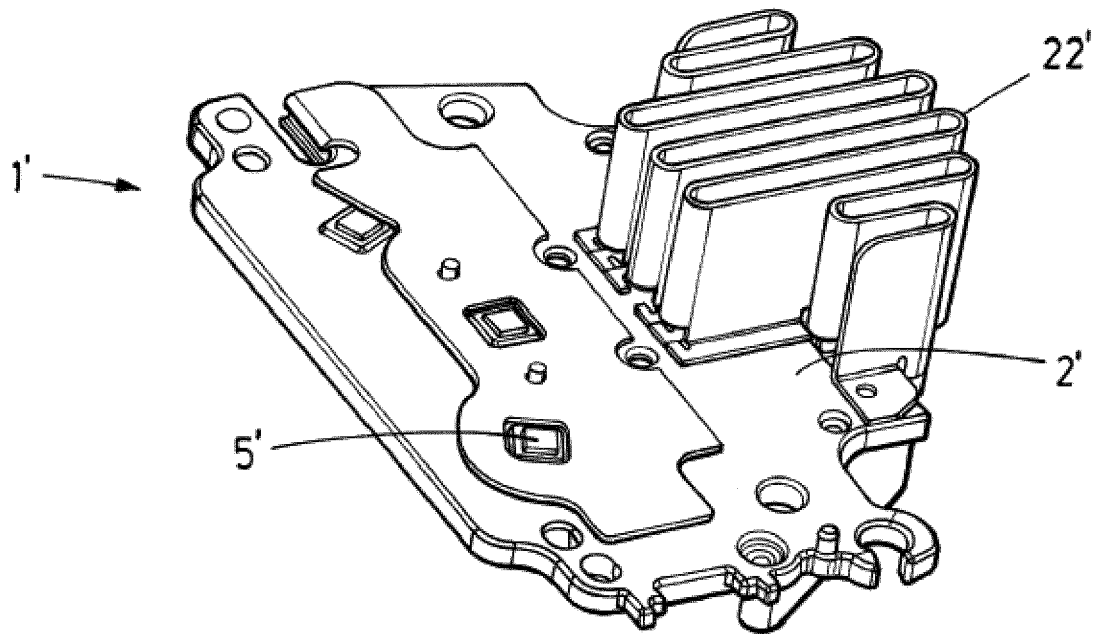


FIG.1

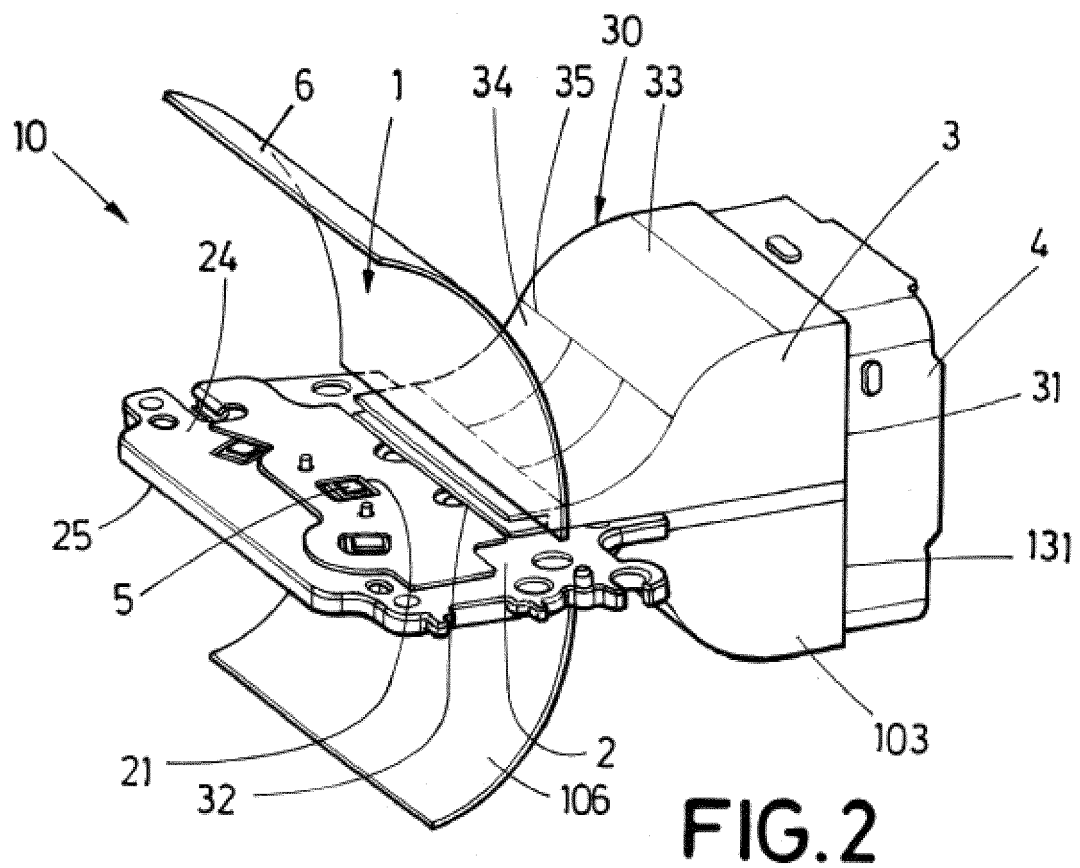


FIG.2

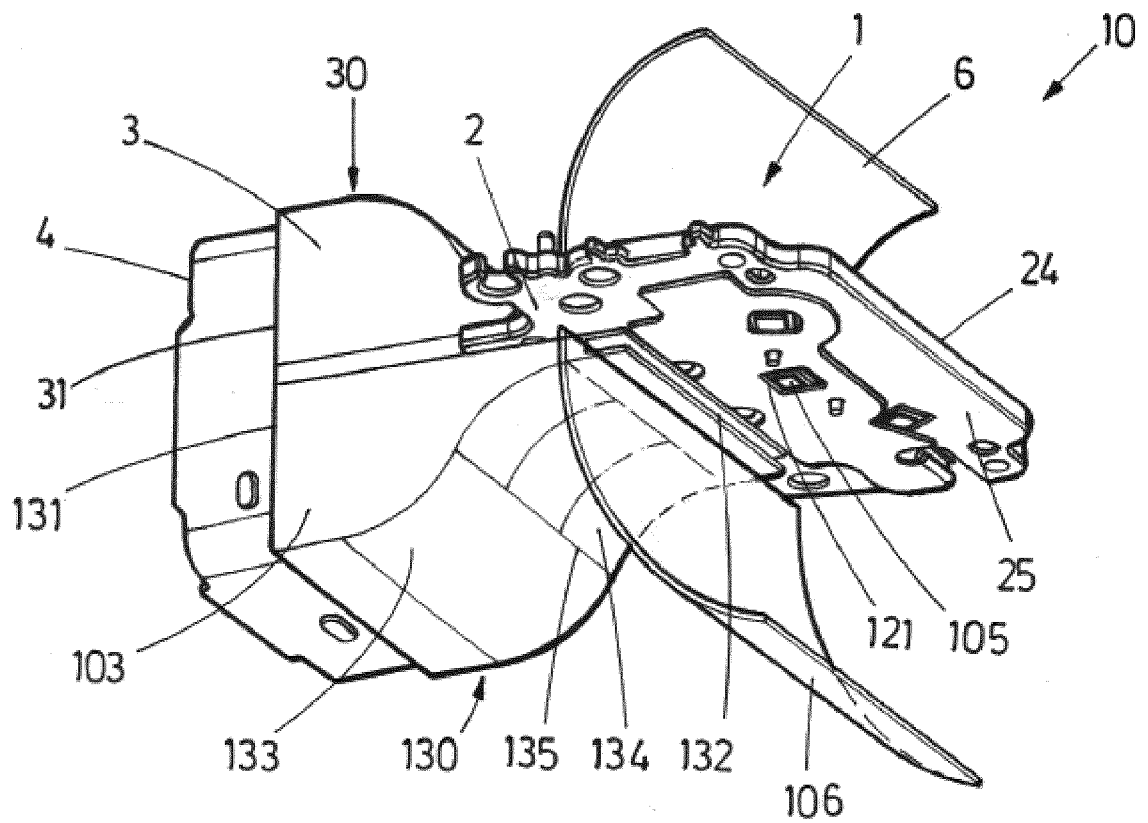


FIG.3

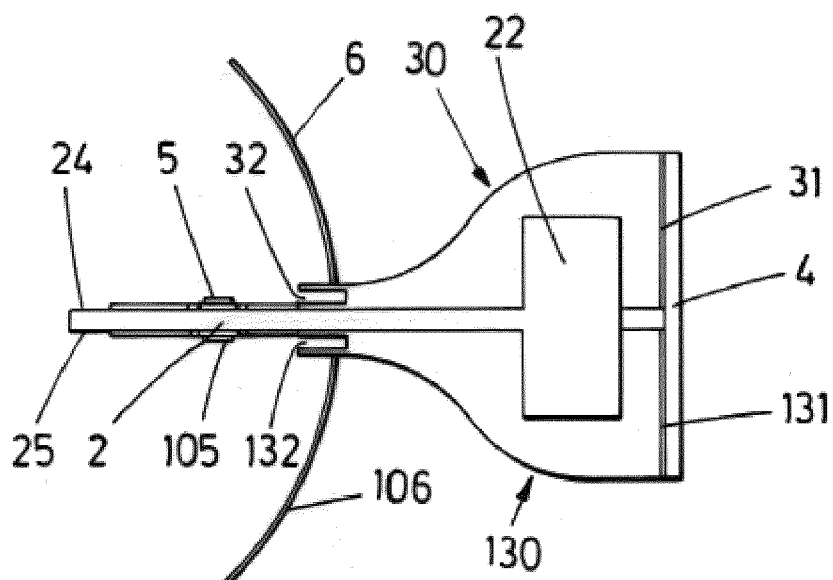


FIG.4

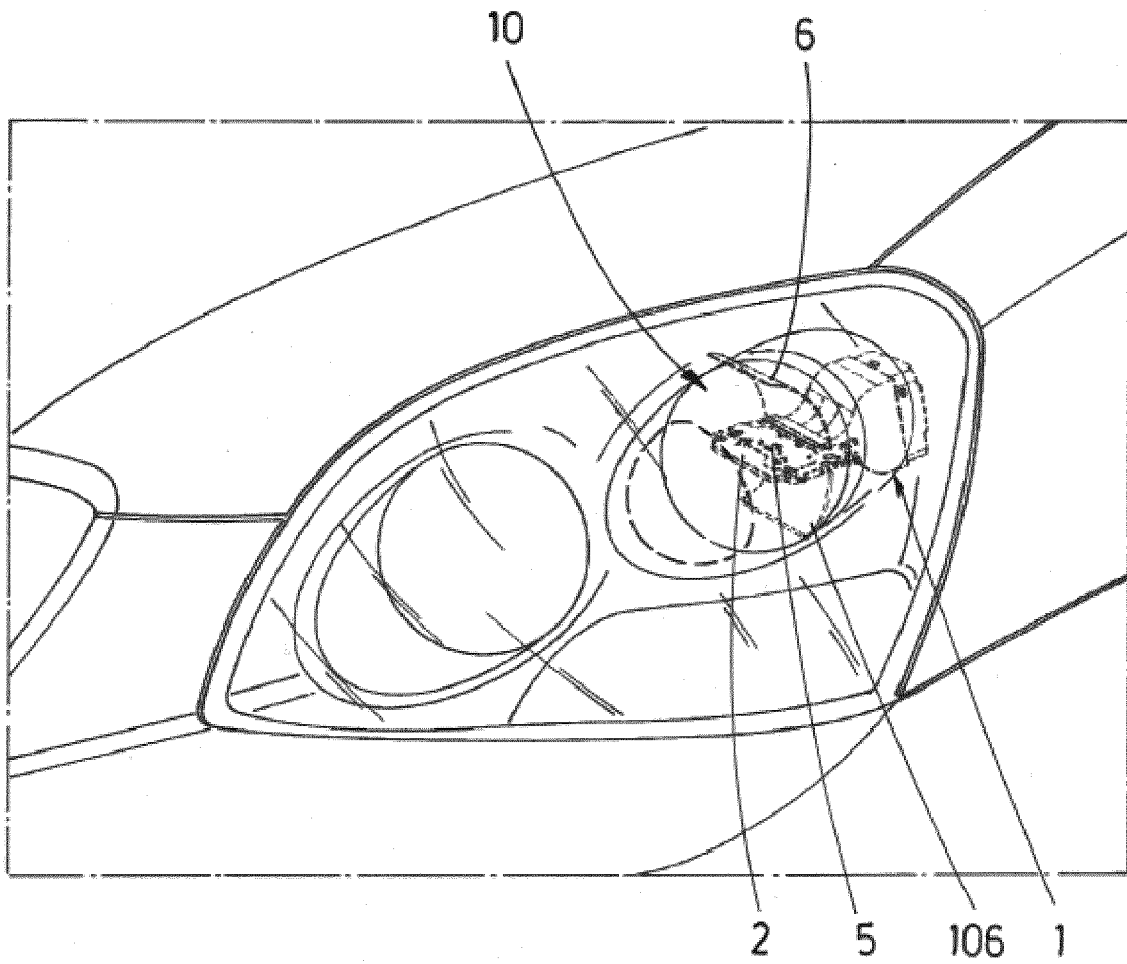


FIG.5



EUROPEAN SEARCH REPORT

 Application Number
 EP 17 38 2186

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 12 September 2017	Examiner Schulz, Andreas
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			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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