

(19)



(11)

EP 4 563 878 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:

04.06.2025 Bulletin 2025/23

(21) Application number: **23213513.7**

(22) Date of filing: **30.11.2023**

(51) International Patent Classification (IPC):

F21K 9/23 ^(2016.01)

F21K 9/232 ^(2016.01)

F21S 41/151 ^(2018.01)

F21S 45/47 ^(2018.01)

F21V 29/70 ^(2015.01)

F21Y 107/90 ^(2016.01)

F21Y 115/10 ^(2016.01)

(52) Cooperative Patent Classification (CPC):

F21K 9/232; F21S 41/148; F21S 41/192;

F21S 45/47; F21V 29/70; F21V 29/763;

F21Y 2107/90; F21Y 2115/10

(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 ME MK MT NL
NO PL PT RO RS SE SI SK SM TR**

Designated Extension States:

BA

Designated Validation States:

KH MA MD TN

(71) Applicant: **Lumileds LLC**

San Jose, CA 95131 (US)

(72) Inventors:

- **Giese, Frank**
San Joé, 95131 (US)
- **Mertens, Jürgen**
San Joé, 95131 (US)
- **Strzelczyk, Martin**
San Joé, 95131 (US)

(74) Representative: **Cohausz & Florack**

Patent- & Rechtsanwälte

Partnerschaftsgesellschaft mbB

Bleichstraße 14

40211 Düsseldorf (DE)

(54) **LED RETROFIT LAMP**

(57) According to the invention, a lighting device is provided, comprising: a support structure (110) comprising at least two at least partly electrically conductive heat sink parts (112) and at least one electrically isolating layer (114) separating the at least two electrically conductive heat sink parts (112),

at least one light emitting element (120) arranged on one of the at least two electrically conductive heat sink parts (112), wherein the at least one light emitting element (120) is electrically connected to electrical contact portions (114) of the at least two electrically conductive heat sink parts (112).

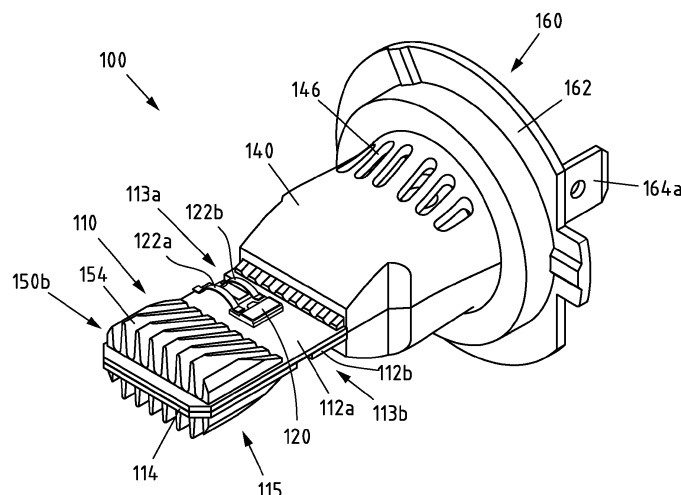


Fig.1

EP 4 563 878 A1

Description

FIELD OF THE INVENTION

[0001] The present disclosure relates to a lighting device such as e.g. a light source for an automotive headlight.

BACKGROUND OF THE INVENTION

[0002] Lighting devices such as halogen lamps have been used as light sources for automotive headlights for many years. However, recent advances in light-emitting diode, LED, technology have enabled developments of lighting devices providing replacements for halogen lamps. Such lighting devices replacing halogen lamps may be referred to as LED retrofits.

[0003] While LED retrofits often allow for efficient halogen lamp replacements, at least in certain situations, heat usually produced by operating LEDs has to be guided away from operating LEDs. To this end, heatsinks in combination with rather expensive metal core printed circuit boards may be used, i.e. components of the corresponding LED retrofits that usually are in thermal contact with corresponding LEDs and that are formed from a material with sufficiently high thermal conductivity, to guide heat away from the LEDs when operating. In addition, it is desirable to provide LED retrofits of substantially similar dimension as compared to typical halogen lamps.

SUMMARY OF THE INVENTION

[0004] In view of this, it is an object of the present invention to provide a lighting device with an improved solution for guiding heat away from operating LEDs of the lighting device. It is a further object of the present invention, to enable a lighting device with improved heat guiding capability having dimensions comparable to existing halogen lamps in a cost-effective manner.

[0005] According to a first aspect of the present invention, a lighting device is provided, comprising: a support structure comprising at least two at least partly electrically conductive heat sink parts and at least one electrically isolating layer separating the at least two electrically conductive heat sink parts, at least one light emitting element arranged on one of the at least two electrically conductive heat sink parts, wherein the at least one light emitting element is electrically connected to electrical contact portions of the at least two electrically conductive heat sink parts.

[0006] According to a second aspect of the present invention, an automotive headlight is provided, comprising a lighting device according to the first aspect.

[0007] Exemplary embodiments of the first and second aspect of the invention may have one or more of the properties described below.

[0008] In an exemplary embodiment, the lighting de-

vice is a light source for an automotive headlight, e.g. a retrofit lamp for automotive headlight applications. Thus, as explained further herein, in an exemplary embodiment, the at least one light emitting element is or comprises at least one light-emitting diode, LED. Preferably, the lighting device comprises at least two light emitting elements. In addition, in an exemplary embodiment, the lighting device is provided with suitable means to be mounted to a vehicle, e.g. a car, a motorcycle or a truck. To this end, the lighting device comprises in particular adapter means for mounting the lighting device.

[0009] In an exemplary embodiment, the support structure of the lighting device comprises at least two at least partly electrically conductive heat sink parts. It is in particular preferred that the support structure comprises exactly two heat sink parts. The heat sink parts are configured to guide the heat generated by the at least one light emitting element away from the at least one light emitting element and to additionally electrically connect the at least one light emitting element. In an exemplary embodiment, the support structure, in particular the heat sink parts may be formed, at least in part, from a heat conductive material, in particular from a metal. Use of such material may be advantageous in that heat is guided away from the at least one light emitting element in a particularly efficient manner and electrical connection of the at least one light emitting element is similarly enabled.

[0010] In an exemplary embodiment, the support structure comprising the at least two at least partly electrically conductive heat sink parts may be formed by extrusion molding. Extrusion molding is a process that allows forming the support structure in a non-complex way nevertheless allowing for sufficient production quality. At the same time, further components such as cooling elements provided on the support structure may be formed integrally in combination with the heat sink parts in a single production step. Preferably, the support structure does not additionally comprise a printed circuit board or PCB, in particular no metal PCB.

[0011] In an exemplary embodiment, the at least one electrically isolating layer is configured to electrically separate the conductive parts of one of the heat sink parts from the conductive parts of one other of the heat sink parts. This enables a support structure which may inherently provide the necessary electrical connections to connect at least one light emitting element and additionally provide beneficial cooling abilities. In particular, via the at least one electrically isolation layer shorts may be prevented reliably.

[0012] In an exemplary embodiment, the at least one light emitting element is a light emitting diode (LED), for example a light emitting diode configured for emitting light in a color temperature range of 2500-7500K, in particular of 4000-7000K, in particular of 5000-6500K. Such light emitting diodes are suitable light sources in particular for automotive applications as they enable emitting light of suitable color at advantageous brightness. Thus, in an exemplary embodiment, the at least

one light emitting element is configured to emit light at a luminous flux of 600 -1200 lumen (lm), in particular of 620 - 1100 lm.

[0013] In an exemplary embodiment, the at least one light emitting element is a top contact light emitting element. This allows for electrically contacting the at least one light emitting element from a top surface which in particular enables a beneficial electrical connection of the at least one light emitting element as well as beneficial heat dissipation properties.

[0014] As mentioned, the at least one light emitting element is arranged at least on one of the at least two heat sink parts. Thus, in an exemplary embodiment, the heat sink part comprises a mounting section or mounting surface configured to support and/or hold the at least one light emitting element. For example, the heat sink part may in an exemplary embodiment, comprise or correspond to, at least in part, an essentially flat member, e.g. with an elongated, e.g. essentially rectangular, shape, forming a mounting surface for supporting the at least one light emitting element. The lighting device may comprise more than one light emitting element and more than one heat sink part, whereby one or more light emitting elements and/or one or more, in particular two heat sink parts may be provided on opposing sides of the support structure, the opposing sides facing opposing directions. Thus, in an exemplary embodiment, the support structure comprises two sides with at least one light emitting element being arranged on either one of the two sides of the support structure, wherein the two sides of the support structure are provided by at least two heat sink parts respectively. The support structure may thus comprise two mounting surfaces on opposing sides facing opposing directions for mounting, wherein a light emitting element is provided on both sides of the two mounting surfaces.

[0015] The support structure, in particular the at least two electrically conductive heat sink parts, may provide an electrical connection to the at least one light emitting element and/or to further electrical components provided on the support structure as needed. Thus, in an exemplary embodiment, the at least two heat sink parts at least comprise one or more electrical contact portions or regions for electrically contacting the at least one light emitting element. Preferably, the isolation layer is not arranged on the electrical contact portions of the at least two heat sink parts.

[0016] In an exemplary embodiment, the at least one light emitting element is arranged, preferably directly arranged, on one of the at least two electrically conductive heat sink parts by means of an adhesive, in particular by means of an electrically non-conductive adhesive. By arranging the at least one light emitting element on one of the at least two heat sink parts via an adhesive, preferably via glue, a connection method is provided which comprises good heat dissipation properties even at high temperatures. Thus, the at least one light emitting element preferably is in direct thermal contact with the heat

sink part and/or the adhesive and heat is transferred from the at least one light emitting element to the heat sink part of the support structure in an efficient and reliable manner. For example, the used adhesives may provide sufficient reliabilities in temperature ranges above 125 °C. Hence, a lighting device may be provided which can be run at higher temperature ranges with a sufficiently high reliability. Preferably, the at least one light emitting element is directly connected to the respective conductive heat sink part via the adhesive. In particular, no solder or the like is arranged between the at least one light emitting element and the heat sink part on which the light emitting element is arranged.

[0017] In an exemplary embodiment, the at least one light emitting element is electrically connected to the electrical contact portions of the at least two electrically conductive heat sink parts via bonding means. In particular, electrical contact regions of the at least one light emitting element are respectively electrically connected to the corresponding electrical contact portions of the at least two electrically conductive heat sink parts. This allows for connecting an electrical contact region comprising a negative terminal of the at least one light emitting element with one of the at least two electrically conductive heat sink parts and an electrical contact region comprising a positive terminal of the at least one light emitting element with the other of the at least two electrically conductive heat sink parts in a favorable design manner. It is in particular preferred that the at least one light emitting element comprises the electrical contact portions with the negative terminal and the positive terminal on its top side, e.g. the side facing away from the side which is arranged on one of the at least two electrically conductive heat sink parts. Preferably, the light emitting element therefore is a top contact light emitting element. Hereby, a sufficient transfer of heat may be realized to the electrically conductive heat sink part and in parallel a constructively advantageous electrical connection of the at least one light emitting element is enabled.

[0018] In an exemplary embodiment, the bonding means preferably are formed as wire bonding means, ribbon bonding means and/or wedge bonding means. Hereby, a electrical connection of the at least one light emitting element may be ensured in a constructively advantageous manner. Preferably, at least two bonding means are supplied for each light emitting element in order to connect the negative and the positive terminal of the light emitting element to the respective heat sink parts.

[0019] In an exemplary embodiment, each of two electrical contact regions of the at least one light emitting element are electrically connected to a different one of the at least two electrically conductive heat sink parts via the bonding means. Hereby, the supporting structure, in particular the heat sink parts, may be used for electrically connecting the at least one light emitting element. This enables a connection method of the at least one light emitting element which also inherently comprises bene-

ficial cooling abilities.

[0020] In an exemplary embodiment, at least one of the electrically conductive heat sink parts comprises a cutout area for connecting the at least one light emitting element being arranged on the at least one electrically conductive heat sink part to another one of the electrically conductive heat sink parts via the bonding means. This allows for an efficient connection of the at least one light emitting element, in particular both a positive terminal and a negative terminal of the at least one light emitting element, to a first heat sink part as well as a second heat sink part via bonding means. Preferably, one bonding means is used to connect the positive terminal of the at least one light emitting element to the first heat sink part and another bonding means is used to connect the negative terminal of the at least one light emitting element to the other heat sink part, wherein such a connection is enabled by the cutoff area of the first heat sink part.

[0021] In an exemplary embodiment, the electrical contact portions of the at least two electrically conductive heat sink parts are substantially not covered by the at least one electrically isolating layer. The isolating layer may for example be removed by a laser ablation process. Hereby, a sufficient electrical connection between the at least one light emitting element and the at least two electrically conductive heat sink parts is enabled.

[0022] In an exemplary embodiment, the at least one electrically isolating layer is configured as a separate dielectric isolating layer. Hereby, an electric insulation between the at least two heat sink parts may be enabled. For example, the isolating layer may be configured as an isolating pad and/or may be provided by coating at least one of the at least two heat sink parts. Preferably, the at least one electrically isolating layer is arranged in between the at least two heat sink parts, in particular interposed between the at least two heat sink parts and thus electrically isolates the at least two heat sink parts from each other. Preferably, the dielectric isolating layer may cover substantially at least one side of the heat sink part, in particular the side of the heat sink part which faces towards the other heat sink part, except for the electrical contact portions, for reliably preventing shorts.

[0023] In an exemplary embodiment, the at least one electrically isolating layer is configured as at least one integral layer of at least one of the at least two electrically conductive heat sink parts, wherein the at least one integral layer preferably is configured as an anodized layer. Via the integral layer, an electrical isolation is enabled without adding a separate part or coating to the lighting device. Hence, the overall dimensions of the support structure may be reduced. In addition to the electrical isolation supplied by the anodized layer, the anodized layer improves corrosion resistance and wear resistance of the heat sink part. Preferably, the integral layer may be formed substantially on at least one side of the heat sink part, in particular on the side of the heat sink part which faces towards the other heat sink part, except for the electrical contact portions, for reliably

preventing shorts.

[0024] In an exemplary embodiment, the at least two partly electrically conductive heat sink parts comprise metal, aluminum and/or an aluminum alloy, preferably consist of aluminum and/or an aluminum alloy. Preferably, the at least two partly electrically conductive heat sink parts are made as extruded metal, in particular as extruded aluminum, profiles. By using a metal material, in particular an aluminum or an aluminum alloy, for the at least two heat sink parts, the heat generated by the at least one light emitting element may be thermally dissipated in a beneficial way. Further, the at least one light emitting element may be electrically connected through the at least two heat sink parts so that not printed circuit board has to be used in the vicinity of the at least one light emitting element.

[0025] In an exemplary embodiment, the at least two partly electrically conductive heat sink parts each comprise at least one cooling element, preferably a plurality of cooling fins, wherein the at least one cooling element preferably is formed integrally with the respective at least partly electrically conductive heat sink part. Thus, the at least one cooling element dissipates the heat generated by the at least one light emitting element in a beneficial way. The at least one cooling element thus enhances a cooling effect and an effect of the support structure functioning as heat sink of the lighting device. Heat generated by the at least one light emitting element in operation may thus be transferred to the support structure and thus to the at least one cooling element. In an exemplary embodiment, the at least one cooling element may be formed, at least in part, from extruded rods, in particular comprising suitable alloys of aluminum.

[0026] In an exemplary embodiment, the at least one cooling element is or comprises a cooling fin comprising a cooling surface, e.g. of essentially rectangular or triangular shape, the cooling surface being arranged essentially orthogonal to the mounting section of the at least one light emitting element. In an exemplary embodiment, the at least one first cooling element is formed by extrusion molding in a single production step with the at least one heat sink element. Preferably, the plurality of cooling fins are arranged essentially mutually parallel. Thereby, being essentially mutually parallel is to be understood such that an angle formed by the plurality of cooling elements to each other is smaller than 10° , in particular smaller than 5° , in particular smaller than 2° .

[0027] In an exemplary embodiment, the at least one cooling element comprises an edge with at least one section being inclined with respect to the heat sink part. In an exemplary embodiment, the at least one first cooling element is inclined continuously along this section, for example in a direction away from the at least one light emitting element. The edge of the at least one first cooling element may be inclined away from the at least one light emitting element to avoid an obstruction of light emitted from the at least one light emitting element. For example, an inclination with respect to the support structure may be

smaller than 50°, in particular smaller than 30°, in particular smaller than 20°.

[0028] In an exemplary embodiment, the lighting device further comprises at least another cooling element being arranged opposite to the at least one first cooling element with respect to the at least one light emitting element. In other words, in an exemplary embodiment, the lighting device further comprises at least another cooling element being spatially separated from the at least one cooling element by the at least one light emitting element.

[0029] In an exemplary embodiment, the at least two partly electrically conductive heat sink parts are substantially identical. In particular, the at least two partly electrically conductive heat sink parts are tilted with regard to each other, in particular one heat sink part is tilted along its longitudinal axis by substantially 180°. The two rear sides of the two heat sink parts are then preferably arranged on each other, wherein an isolating layer is arranged between the two heat sink parts. By providing two at least substantially identical heat sink parts, two light emitting elements may be arranged on the support structure in a beneficial way and the optics of a halogen lamp may be mimicked.

[0030] In an exemplary embodiment, the at least two partly electrically conductive heat sink parts are attached to each other via electrically non-conductive fixation means, preferably via adhesive and/or electrically non-conductive screws. Aforementioned fixation means enable a mechanical connection of the at least two heat sink parts without electrically connecting the two heat sink parts. Thus, short of the lighting device may be provided in a reliable manner.

[0031] In an exemplary embodiment, the lighting device further comprises: at least one printed circuit board, wherein the at least two electrically conductive heat sink parts are electrically connected to the at least one printed circuit board. Preferably, the at least one light emitting element is electrically connected to the at least one printed circuit board (PCB) via the heat sink parts. As a result, in an exemplary embodiment, the at least one light emitting element is electrically controlled via the PCB. By arranging the at least one light emitting element on the at least one heat sink part and not on the PCB itself, the PCB does not need to have beneficial heat dissipation properties and a cost-efficient PCB, for example a non-metal PCB, in particular a PCB which comprises FR4 material, may be used. According to an exemplary embodiment, the at least one printed circuit board preferably comprises at least one driver element, for example a signal processing unit, for the at least one light emitting element. Preferably, the at least one printed circuit board is not in direct contact with the at least one light emitting element and with the heat sink parts.

[0032] A beneficial connection between the at least one PCB and the heat sink parts may be provided by connection means, wherein the connection means may be connected to the heat sink parts and/or the PCB via

ribbon bonding, at least one clamping system, soldering and/or welding.

[0033] In an exemplary embodiment, the lighting device further comprises: a housing, wherein the support structure is at least in part arranged within at least part of the housing. The housing may be a component of the lighting device that may provide in particular protection for one or more further components of the lighting device. The support structure being arranged at least in part within at least part of the housing, in an exemplary embodiment, at least in mounted condition of the lighting device, the housing encloses at least part of the support structure. In addition or alternatively, in an exemplary embodiment, at least in mounted condition of the lighting device, the housing encloses at least part of the at least one cooling element. It is to be noted that in an exemplary embodiment, the housing and the support structure are separate components of the lighting device. In this way, advantageous flexibility is provided, in particular for attributing a main heat guiding function to the support structure, enabling a construction of the housing independently of this function, thereby enabling in particular fabrication of the housing from a different material.

[0034] While in certain embodiments, the housing may be formed of a material corresponding to the material of the support structure, e.g. from a metal, embodiments of the present disclosure attribute a main heat guiding function to the support structure, which may thus correspond to a main heat sink of the lighting device. In this way, it becomes possible to form at least part of the housing from a different material, such as a plastic material.

[0035] In an exemplary embodiment, at least part of the housing is tapered in at least one dimension towards the at least one light emitting element. In other words, in an exemplary embodiment, at least a section of the housing comprises a cross-section decreasing in size towards the at least one light emitting element. Thereby, the housing may in an exemplary embodiment comprise a tubular section having an essentially circular, an essentially elliptical, an essentially rectangular or an irregular cross-section. The housing may thus reduce the space in between the support structure and the housing and may thus act in a nozzle-like way not only guiding but also intensifying an air flow onto the support structure, in particular within an area of the support structure supporting the at least one light emitting element thus facilitating an improved cooling effect in particular in this area.

[0036] In an exemplary embodiment, at least part of the housing at least partly surrounds at least part of the at least one cooling element. In other words, at least part of the housing at least partly encloses or encapsulates at least part of the at least one cooling element. Thus, the housing confines at least part of an air flow generated by the at least one air source onto the at least one cooling element increasing the cooling effect of the air flow.

[0037] In an exemplary embodiment, the housing is at least in part formed from a material transparent for at

least part of light emitted from the at least one light emitting element, e.g. a glass material or a transparent plastic material. The housing may for example be formed at least in part as an at least partly transparent tube.

[0038] In an exemplary embodiment, the lighting device further comprises: an air source configured to generate an air flow. To this end, in an exemplary embodiment, the at least one air source may e.g. be provided adjacent to the at least one cooling element. Thus, in order to support a cooling effect of the support structure, heat may be transferred from the support structure to the cooling element, which may then transfer at least part of the heat on to the air flow. The air flow may thus remove at least part of the heat generated by the at least one light emitting element.

[0039] In an exemplary embodiment, the at least one air source configured to generate an air flow is or comprises a fan, for example an axial fan with an air flow being generated and output in a direction essentially vertical to a plane of rotation of the fan. Alternatively, such fan may be a radial fan with an air flow being generated and output in a direction essentially parallel to the plane of rotation of the fan. In an exemplary embodiment, the at least one air source may be arranged on the support structure and/or the at least one air source may be electrically connected to the electrical power supply via the support structure and/or via the at least two heat sink parts. In an exemplary embodiment, the at least one air source may be arranged on a component of the lighting device other than the support structure, e.g. in an exemplary embodiment, the at least one air source is supported by the adapter means. In an exemplary embodiment, the housing contains structures to guide the air flow to and from the fan.

[0040] In an exemplary embodiment, the at least one air source is arranged such that an air flow generated by the at least one air source has a general direction towards the at least one cooling element and/or towards the at least one light emitting element. While it is thus possible that the air flow is generated in a direction towards the at least one light emitting element, in an exemplary embodiment, the at least one air source is arranged on the support structure adjacent to the at least one cooling element, wherein a main direction of an air flow generated by the at least one air source is essentially perpendicular to a direction from the at least one cooling element (e.g. from an arrangement of one or more cooling elements) to the at least one light emitting element (e.g. to an arrangement of one or more light emitting elements).

[0041] In an exemplary embodiment, the lighting device further comprises: at least two light emitting elements, wherein at least one first of the at least two light emitting elements is arranged on at least one first mounting section, preferably first mounting surface, of at least one first of the at least two electrically conductive heat sink parts, and wherein at least one second of the at least two light emitting elements is arranged on at least one second mounting section, preferably second mounting surface, of at least one second of the at least two elec-

trically conductive heat sink parts. The first and the second mounting section are configured to support and/or hold the at least one light emitting element. For example, the support structure, in particular the respective heat sink parts, may in an exemplary embodiment, comprise or correspond to, at least in part, an essentially flat member, e.g. with an elongated, e.g. essentially rectangular, shape, forming a mounting section for supporting the at least one light emitting element. The support structure may preferably comprise two mounting surfaces on opposing sides facing opposing directions for mounting, wherein at least one light emitting element and/or at least one cooling element is provided on a respective one of the two mounting surfaces.

[0042] In an exemplary embodiment, the at least two electrically conductive heat sink parts are arranged such that the respective mounting sections are substantially opposite to each other. Hereby, at least two light emitting elements may be arranged on the lighting device and thus similar radiation characteristics to those of a halogen lamp may be achieved.

[0043] The features and example embodiments of the invention described above may equally pertain to the different aspects according to the present invention. In particular, with the disclosure of features relating to the lighting device according to the first aspect, also corresponding features relating to the automotive headlight according to the second aspect are disclosed.

[0044] It is to be understood that the presentation of embodiments of the invention in this section is merely exemplary and non-limiting.

[0045] 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 are merely intended to conceptually illustrate the structures and procedures described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0046] Examples of the invention will now be described in detail with reference to the accompanying drawings, in which:

- Fig. 1 exemplarily illustrates a lighting device according to an embodiment of the invention;
- Fig. 2 illustrates a view of the lighting device of Fig. 1 without the housing; and
- Fig. 3 illustrates a cross-sectional side view of a lighting device according to an embodiment of the invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0047] It is noted that throughout the figures, like reference numerals indicate corresponding or equal components.

[0048] Fig. 1 shows an example of a lighting device 100 according to an exemplary embodiment of the invention. The lighting device 100 is an LED retrofit which contains an adapter means 160 to connect the LED retrofit to an automotive headlight unit. The adapter means 160 comprises an adapter ring 162 and two power pins 164a and 164b for electrical connection (only pin 164a being visible in Fig. 1). The support structure 110 supports a top-contact LED 120, which is an example of a light emitting element. A further LED 120 is provided on the opposing side of the support structure 110 which is not visible in the figure. Preferably, the LEDs 120 are directly attached to the heat sink parts 112a and 112b by means of an adhesive, in particular by means of an electrically non-conductive adhesive. The two heat sink parts 112a and 112b are substantially identical and attached to each other via electrically non-conductive fixation means.

[0049] The LED 120 is electrically connected through ribbon-bonding connections 122a, 122b to electrical contact portions of the electrically conductive heat sink parts 112a and 112b of the support structure 110 for electrically connecting LEDs 120. For connecting the LEDs 120 to the electrically conductive heat sink part 112a, 112b on which the respective LED 120 is not arranged in a convenient manner, heat sink parts 112a and 112b comprises cutout areas 113a and 113b in which the ribbon-bonding connections 122b are arranged. An electrically isolating layer 114 is arranged between the two heat sink parts 112a and 112b. The electrically isolating layer may be configured as an integral layer of one of the two heat sink parts 112a and 112b or as a separate dielectric layer. The isolating layer 114 does not cover electrical contact portions of the heat sink parts 112a and 112b, e.g. the portions where the ribbon-bonding connections 122a and 122b contacts the heat sink parts 112a and 112b. Preferably, the two heat sink parts 112a and 112b consist of a metal, in particular of aluminum or an aluminum alloy.

[0050] A cooling element 150b with eight cooling fins 154 (cooling extensions) is arranged on each of the heat sink parts 112a, 112b of the support structure 110, the cooling fins being arranged such that a main plane of the cooling fins (cooling extensions) is arranged essentially parallel to a main direction of extension of the support structure 110. An air source and further cooling elements 150a are shown in Fig. 2, whereby in the shown example the air source is a fan 130 as described further herein. As shown in Fig. 1, a housing 140 is provided surrounding part of support structure 110 and the cooling elements 150a, the housing 140 being tapered towards the LED 120. The housing 140 comprises ventilation slits 146 (an arrangement of slits) to ensure sufficient air supply for the underlying radial fan 130. Both cooling elements 150a and 150b are preferably formed integrally with the heat

sink parts 112a and 112b.

[0051] Fig. 2 shows an exploded view of the lighting device 100 of Fig. 1. As can be taken from this figure, an air flow that can be generated by fans 130 exits a housing of fan 130 at its side directly adjacent to cooling element 150a to pass through cooling element 150a over LED 120 and further through cooling element 150b such that a cooling effect of the air flow on the support structure 110, which acts not only as a support for the LED 120 but also as a heat sink for the lighting device 100, is further enhanced by cooling elements 150a and 150b. As visible in Fig. 2, respective fans (air sources) 130 are provided on either side of the support structure 110 on each of the heat sink parts 112a and 112b.

[0052] As shown in Fig. 2, the cooling fins 150a have respective inclined edges (inclined section 156) being inclined away from the LED (a respective height decreases towards the LED). In the shown example, housing 140 has two mutually opposing parts respectively surrounding or enclosing at least part of the support structure 110 and the cooling fins 150a, the housing 140 being arranged to guide at least part of the air flow generated by the at least one air source (fan 130) in between the support structure 110 and the housing 140. In the tapered section 144 of housing 140, an inner surface of housing 140 follows the inclination of inclined section 156. In the shown example, the support structure 110, in particular the two heat sink parts 112a and 112b, are formed from a heat conductive material such as a metal, in particular aluminum or copper to facilitate a heat flow away from the LED 120 and to enable an electrical connection of the LED 120. At the same time, the provision of cooling elements 150a, 150b in the shown example enhances a cooling effect of an air flow generated by the at least one air source (fan 130). The advantageous cooling effect provided by support structure 110 with cooling elements 150a, 150b allows for housing 140 to be fabricated from a material that does not need to be heat conductive, e.g. a plastic material.

[0053] Figs. 3 shows a cross-sectional view of a further examples of a lighting device 100 according to exemplary embodiments of the invention. As mentioned, like reference numerals indicate the same components.

[0054] Figs. 3 may correspond to a cross-sectional view of the examples shown in Figs. 1 and 2. The cooling elements 150a, 150b comprise cooling fins (cooling extensions) 154 which are connected to the support structure 110. As in the example of Fig. 1, eight cooling fins 154 may be provided on either side of the LED 120, only one respective one of which is visible in the figure. The fan 130 (air source) is mounted next to the cooling elements 150a with an airflow 170 guided by the cooling extensions 154 towards the LED 120. After passing the cooling elements 150a and the LED 120 the air flow further passes cooling elements 150b to enable a further cooling of the support structure.

[0055] The cooling fins 154 are formed integrally with the heat sink parts 112a and 112b such that a main plane

of the cooling fins (cooling extensions) is arranged essentially perpendicular to a main direction of extension of the support structure 110 and the heat sink parts 112a and 112b.

[0056] The lighting device 100 further comprises a printed circuit board 190, wherein the printed circuit board 190 is connected via ribbon bonds 200 to both of the heat sink parts 112a and 112b. The printed circuit board 190 in particular comprises the driver elements needed for the functioning of the LEDs 120.

LIST OF REFERENCE SIGNS:

Lighting device	100
Support structure	110
Heat sink parts	112a, 112b
Cutout areas	113a, 113b
Isolating layer	114
Light emitting element	120
LED top connection	122a, 122b
Fan	130
Housing	140
Tapered section	144
Ventilation slit	146
Cooling element	150a, 150b
Cooling extension	154
Inclined section	156
Adapter means	160
Adapter ring	162
Power pins	164a, 164b
Air flow	170
Driver PCB	190
Ribbon Bonds	200

Claims

1. A lighting device (100) comprising:

a support structure (110) comprising at least two at least partly electrically conductive heat sink parts (112a, 112b) and at least one electrically isolating layer (114) electrically isolating the at least two electrically conductive heat sink parts (112),
 at least one light emitting element (120), preferably a top contact light emitting element (120), arranged on one of the at least two at least partly electrically conductive heat sink parts (112a, 112b),
 wherein the at least one light emitting element (120) is electrically connected to electrical contact portions of the at least two electrically conductive heat sink parts (112a, 112b).

2. The lighting device according to claim 1,

wherein the at least one light emitting element (120) is arranged, preferably directly arranged, on one of the at least two electrically conductive heat sink parts (112a, 112b) by means of an adhesive, in particular by means of an electrically non-conductive adhesive.

3. The lighting device according to claim 1 or 2,

wherein the at least one light emitting element (120) is electrically connected to the electrical contact portions of the at least two electrically conductive heat sink parts (112a, 112b) via bonding means (122a, 122b),
 wherein the bonding means (122a, 122b) preferably are formed as wire bonding means, ribbon bonding means and/or wedge bonding means.

4. The lighting device according to claim 3,

wherein each of two electrical contact regions of the at least one light emitting element (120) are electrically connected to a different one of the at least two electrically conductive heat sink parts (112a, 112b) via the bonding means (122a, 122b).

5. The lighting device according to claim 3 or claim 4, wherein at least one of the electrically conductive heat sink parts (112a, 112b) comprises a cutout area (113a, 113b) for connecting the at least one light emitting element (120) being arranged on the at least one electrically conductive heat sink part (112a, 112b) to another one of the electrically conductive heat sink parts (112a, 112b) via the bonding means.

6. The lighting device according to any of claims 1 to 5, wherein the electrical contact portions of the at least two electrically conductive heat sink parts (112a, 112b) are substantially not covered by the at least one electrically isolating layer (114).

7. The lighting device according to any of claims 1 to 6,

wherein the at least one electrically isolating layer (114) is configured as a separate dielectric isolating layer, and/or
 wherein the at least one electrically isolating layer (114) is configured as at least one integral layer of at least one of the at least two electrically conductive heat sink parts (112a, 112b), wherein the at least one integral layer preferably is configured as an anodized layer.

8. The lighting device according to any of claims 1 to 7,

wherein the at least two partly electrically conductive heat sink parts (112a, 112b) comprise aluminum and/or an aluminum alloy, preferably

consist of aluminum and/or an aluminum alloy,
and/or

wherein the at least two partly electrically conductive heat sink parts (112a, 112b) each comprise at least one cooling element (150a, 150b), preferably a plurality of cooling fins, wherein the at least one cooling element (150a, 150b) preferably is formed integrally with the respective at least partly electrically conductive heat sink part (112a, 112b).

9. The lighting device according to any of the claims 1 to 8,

wherein the at least two partly electrically conductive heat sink parts (112a, 112b) are substantially identical, and/or

wherein the at least two partly electrically conductive heat sink parts (112a, 112b) are attached to each other via electrically non-conductive fixation means, preferably via adhesive and/or electrically non-conductive screws.

10. The lighting device according to any of claims 1 to 9, further comprising:

at least one printed circuit board (190), wherein the at least two electrically conductive heat sink parts (112a, 112b) are electrically connected to the at least one printed circuit board (190),

wherein the at least one printed circuit board (190) preferably comprises at least one driver element for the at least one light emitting element (120), and,

wherein the at least one printed circuit board (190) preferably comprises FR4 material.

11. The lighting device according to any of claims 1 to 10, further comprising:

a housing (140), wherein the support structure (110) is at least in part arranged within at least part of the housing (140).

12. The lighting device according to any of claims 1 to 11, further comprising: an air source (130) configured to generate an air flow.

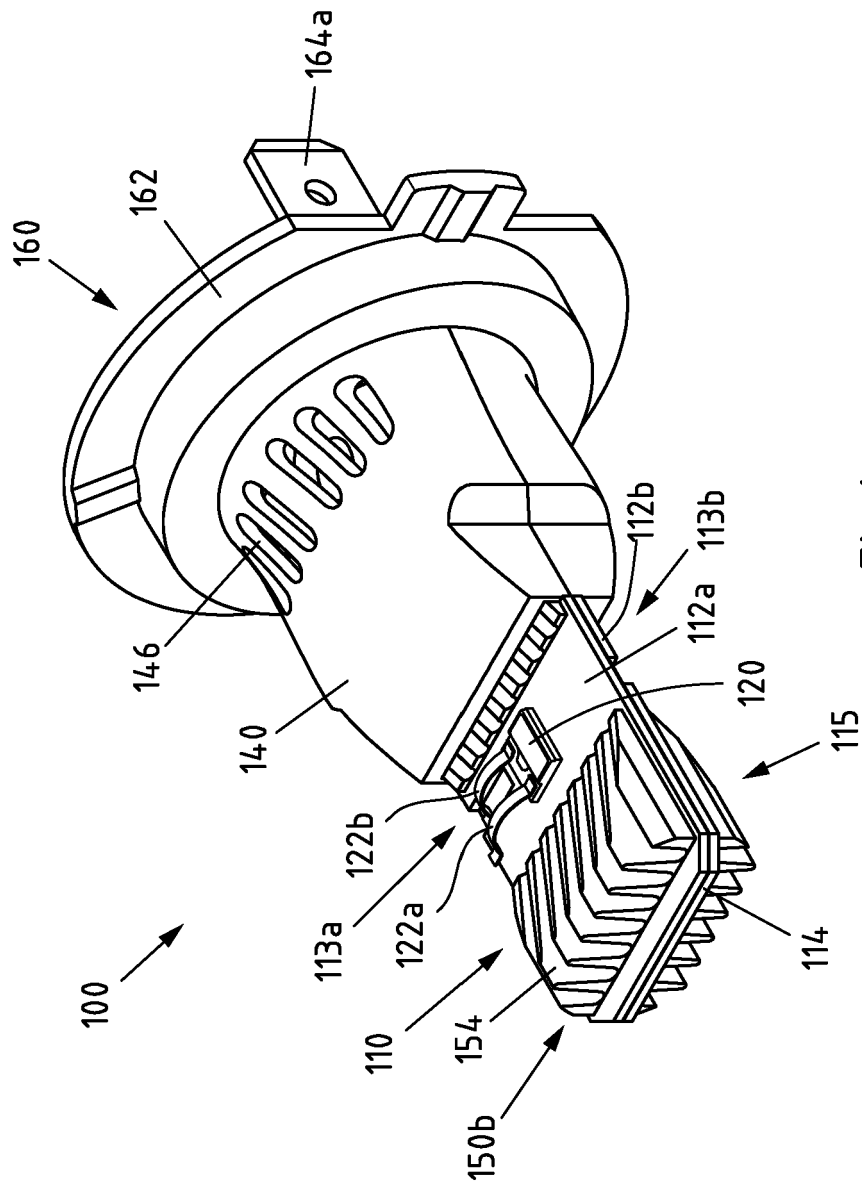
13. The lighting device according to any of claims 1 to 12, further comprising:

at least two light emitting elements (120), wherein at least one first of the at least two light emitting elements (120) is arranged on at least one first mounting section (116) of at least one first of the at least two electrically conductive heat sink parts (112a, 112b), and wherein at least one second of the at least two

light emitting elements (120) is arranged on at least one second mounting section (116) of at least one second of the at least two electrically conductive heat sink parts (112a, 112b).

14. The lighting device according to claim 13, wherein the at least two electrically conductive heat sink parts (112a, 112b) are arranged such that the respective mounting sections (116) are substantially opposite to each other.

15. Automotive headlight comprising the lighting device according to any of claims 1 to 14.



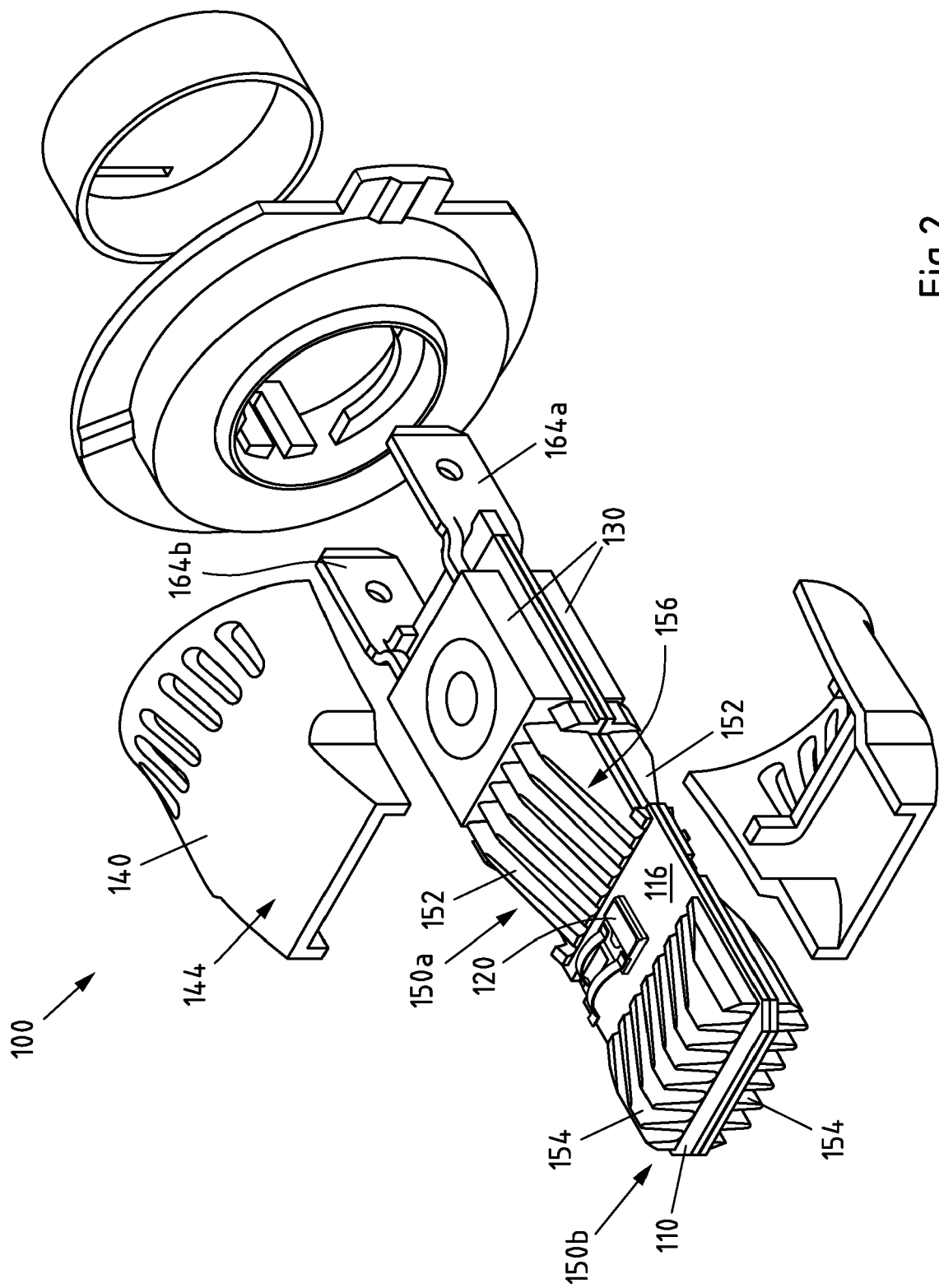
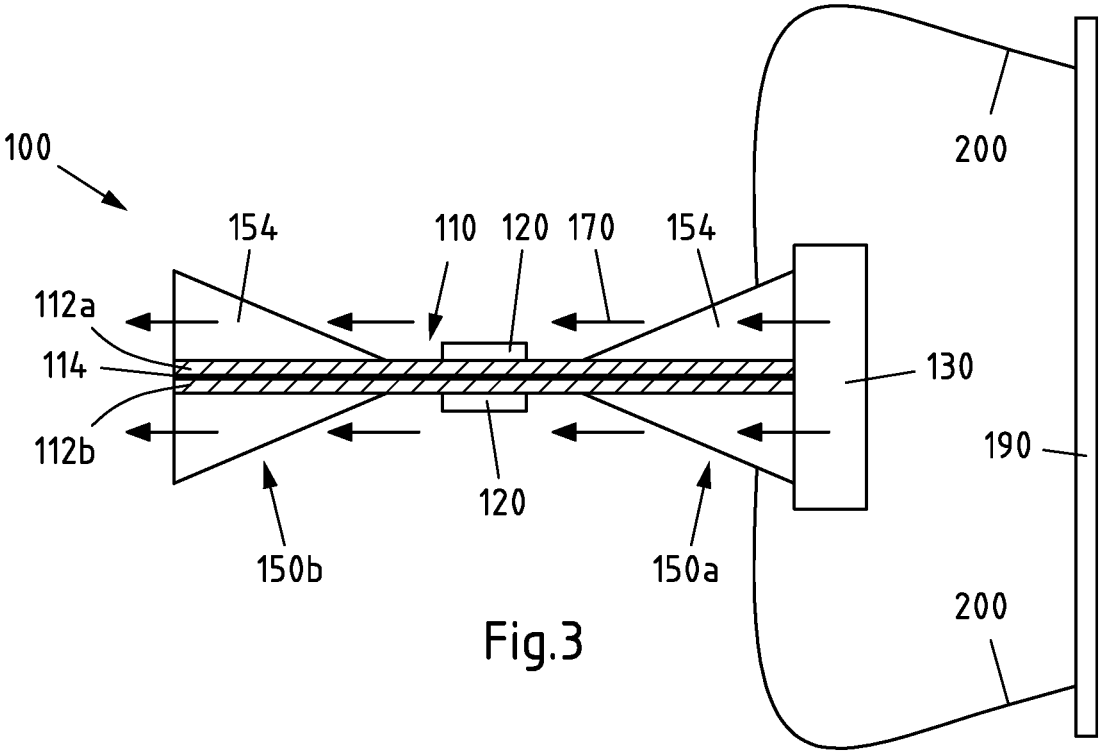


Fig.2





EUROPEAN SEARCH REPORT

Application Number

EP 23 21 3513

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 10 2011 005823 A1 (OSRAM AG [DE]) 27 September 2012 (2012-09-27) * the whole document *	1-4, 6-15	INV. F21K9/23 F21K9/232 F21S41/151 F21S45/47 F21V29/70
X	US 2022/260222 A1 (EPMEIER MATTHIAS [DE]) 18 August 2022 (2022-08-18) * paragraphs [0020] - [0048]; figures 1-4 *	1, 3-15	ADD. F21Y107/90 F21Y115/10
X	US 2014/362573 A1 (IMAI SADATO [JP] ET AL) 11 December 2014 (2014-12-11) * paragraphs [0040] - [0061]; figures 1-5 *	1-4, 6-11, 13, 14	
X	CN 207 602 619 U (MAIKELE CHUZHOU NEW MATERIAL TECH CO LTD) 10 July 2018 (2018-07-10) * paragraphs [0057] - [0066]; figures 4-5 *	1-4, 6-15	
A	EP 3 073 180 A1 (VALEO VISION [FR]) 28 September 2016 (2016-09-28) * abstract; figure 3 *	1-15	TECHNICAL FIELDS SEARCHED (IPC) F21K F21S F21V F21Y
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 7 May 2024	Examiner Thibaut, Arthur
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 23 21 3513

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.

07-05-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102011005823 A1	27-09-2012	DE 102011005823 A1	27-09-2012
		WO 2012126739 A1	27-09-2012

US 2022260222 A1	18-08-2022	CN 117157485 A	01-12-2023
		EP 4295077 A1	27-12-2023
		US 2022260222 A1	18-08-2022
		WO 2022178024 A1	25-08-2022

US 2014362573 A1	11-12-2014	CN 103814450 A	21-05-2014
		EP 2760058 A1	30-07-2014
		JP 5551322 B2	16-07-2014
		JP 5615456 B2	29-10-2014
		JP 2014187035 A	02-10-2014
		JP WO2013042662 A1	26-03-2015
		US 2014362573 A1	11-12-2014
		WO 2013042662 A1	28-03-2013

CN 207602619 U	10-07-2018	NONE	

EP 3073180 A1	28-09-2016	CN 105987290 A	05-10-2016
		CN 116379375 A	04-07-2023
		EP 3073180 A1	28-09-2016
		FR 3034171 A1	30-09-2016
		US 2016281946 A1	29-09-2016

EPO FORM P0459

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