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

(11) EP 4 421 378 A1

(12) # EUROPEAN PATENT APPLICATION

(43) Date of publication:
28.08.2024 Bulletin 2024/35

(21) Application number: **24158522.3**

(22) Date of filing: **20.02.2024**

(51) International Patent Classification (IPC):
F21K 9/232 *(2016.01)* ***F21S 41/00*** *(2018.01)*
F21V 7/04 *(2006.01)* ***F21K 9/68*** *(2016.01)*
F21Y 109/00 *(2016.01)* *F21Y 115/10* *(2016.01)*

(52) Cooperative Patent Classification (CPC):
F21K 9/68; F21K 9/232; F21S 41/00; F21V 7/041;
F21Y 2109/00; 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:
GE KH MA MD TN

(30) Priority: **22.02.2023 IT 202300003045**

(71) Applicants:
- **OSRAM GmbH**
  80807 München (DE)
- **OSRAM S.P.A. - SOCIETA' RIUNITE OSRAM EDISON CLERICI**
  20126 Milano (IT)
  Designated Contracting States:
  IT

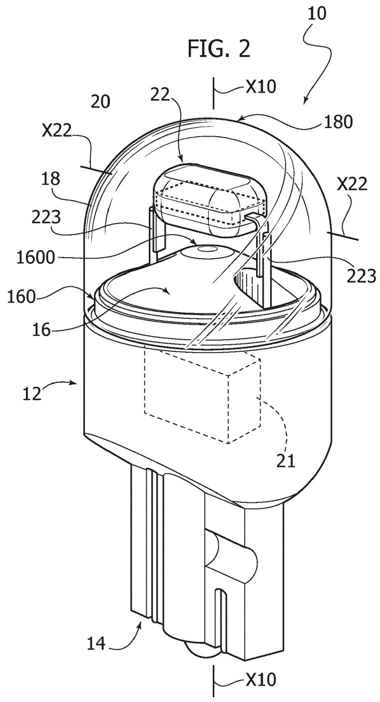
(72) Inventors:
- **MUNARIN, Marco**
  I-31038 Casale sul Sile (Treviso) (IT)
- **MOSOLO, Mattia**
  I-30020 Marcon (Venezia) (IT)
- **BIZZOTTO, Alessandro**
  31033 Castelfranco Veneto (Treviso) (IT)

(74) Representative: **Bosotti, Luciano**
Buzzi, Notaro & Antonielli d'Oulx S.p.A.
Corso Vittorio Emanuele II, 6
10123 Torino (IT)

(54) **LAMP AND RELATED METHOD OF USE**

(57) A lamp (10) that can be used, for example, as WSW retrofit lamp for motor vehicles (10) comprises a lamp body (12) extending in a first direction along a longitudinal axis (X10) between a proximal base portion (14) and a light-reflecting distal front surface (16) and extends in a direction transverse to the longitudinal axis (X10). An elongated array (22) of solid-state light sources (221), for example LED sources, is set distally with respect to the distal front surface (16) of the lamp body (12). The aforesaid elongated array (22) extends in a second direction (X22) transverse to the longitudinal axis (X10). The distal front surface (16) is a surface of revolution about the longitudinal axis (X10), for example a (frusto)conical surface. The distal front surface (16) converges from an outer edge (160) towards a vertex region (1600) adjacent to the elongated array (22) of light sources, with the longitudinal axis (X10) that intersects the aforesaid vertex region (1600).

FIG. 2



EP 4 421 378 A1

Description

Technical field

[0001] The present disclosure relates to lamps.

[0002] One or more embodiments may be applied to lamps that use solid-state light sources, for example LED sources.

[0003] One or more embodiments may find advantageous application in the automotive sector, for example as retrofit lamps for motor vehicles.

Technological background

[0004] In sectors of use such as, for example, the automotive sector, light sources such as LED sources may present various advantages over traditional lamps or lights.

[0005] For instance, LED sources are brighter, prove faster to light up and are conveniently suited to a pulse-width modulation (PWM) to adjust the intensity of the light emitted.

[0006] Another advantage is linked to the fact that LED chips can be made to work in array, in parallel or in mixed configurations, presenting a rather long service life.

[0007] There may consequently be noted a growing tendency to develop and design LED lamps that can be used instead of traditional lamps, for example instead of halogen lamps, that are able to comply with the specifications.

[0008] Rather, it is reasonable to expect that in quite short times lamps for vehicles are likely to be replaced almost completely by LED lamps.

Prior art

[0009] The prior art regarding lamps with solid-state light sources (for example, LED sources) is extremely extensive. In this regard, there may be cited documents, such as DE 20 2012 012 007 U1, US 2011/0233578 A1, US 2012/0241778 A1, US 2013/307399 A1, US 2015/0247606 A1, US 2015/0247606 A1, US 5 160 200 A, US 8 556 473 B2, JP 2017 098056 A, EP 2 933 552 A1, or again WO 2022/180474 A1, WO 2019/093713 A1, WO 2017/028787 A1 or EP 2 735 786 A1.

[0010] In such a possible context of application it is desirable to have available lamps with solid-state light sources that are improved as regards aspects such as efficiency and distribution of the luminous intensity, for example as regards:

- the possibility of providing in an adequate way retrofitting of traditional filament lamps; and/or
- compliance with the specifications of the ECE regulations (see, for example, the recent normative proposal ECE/TRANS/WP.29/2019/126) in terms of brightness, efficiency, and light diffusion.

[0011] Figure 1 is a perspective view of a lamp 10, as described in WO 2022/180474 A1, which can be used, for example, as W5W retrofit lamp for motor vehicles.

[0012] The above lamp comprises a lamp body 12 extending in a first direction along a longitudinal axis X10 between a proximal base portion 14 and a light-reflecting distal front surface 16. An elongated array 22 of solid-state light sources arranged in a distal position with respect to the front surface 16 of the lamp body 12 extends in a second direction X22 transverse to the longitudinal axis X10, having, in this second direction X22, a length greater than the width in a direction transverse to the second direction X22.

[0013] As may be seen in Figure 1, the distal front surface 16 tapers from its outer edge 160 towards the elongated array 22 of light sources and comprises two opposite surface portions 161, 162 that have a so-called eyelid conformation.

[0014] Each of these portions extends from the outer edge 160 to an elongated inner edge line 1610, 1620 that:

- is aligned with the second direction X22 and is longer than the array 22 of solid-state light sources; and
- is set at a distance from the elongated array 22 of solid-state light sources 221 towards the proximal base portion 14 of the lamp body 12.

[0015] A domed element 18 permeable to light is coupled to the lamp body 12 so as to define with respect to the surface 16 a light-generating chamber 20.

[0016] In a solution as described in WO 2022/180474 A1, the alignment of the inner edge line of the eyelid portions with the direction of extension of the array of light sources can play a certain role in meeting the relevant specifications.

[0017] Furthermore, it has been found that arrays of light sources comprising radiation generators mounted on both faces of a substrate are exposed to possible unbalancing of the emission, which can be put down to the fact that the part of array on one side of the substrate may present characteristics of emission at least in part different from the characteristics of emission of the part of array that is located on the opposite side.

[0018] More in general, it is desirable to be able to provide lamps of a, so to speak, universal type, which can be mounted on a wide range of vehicles, irrespective of particular features linked to specific vehicle models.

Object and summary

[0019] The object of one or more embodiments is to contribute to making available lamps with solid-state light sources further improved in relation to the aspects referred to above, for example as regards the possibility of providing lamps in the framework of large-scale production processes where, also for considerations of cost, it may prove problematical to ensure high levels of precision in positioning of the components and/or in determination of the characteristics of emission of the light generators.

[0020] According to one or more embodiments, the above object is achieved thanks to a lamp having the characteristics recalled in the ensuing claims.

[0021] One or more embodiments refer to a method of use of such a lamp.

[0022] The claims form an integral part of the technical teachings provided herein in relation to embodiments.

[0023] One or more embodiments preserve the advantages linked to the use as a light source of a solid-state filament, for example a LED filament, such as maintenance of the overall dimensions, without variations with respect to a traditional halogen lamp, with a containment of the number of components: for example, a heat sink and a printed-circuit board (PCB) do not need to be provided as stand-alone elements, in so far as they are already "integrated" in the LED filament.

[0024] One or more embodiments afford advantages at the level of manufacturing process, also as regards the possibility of providing lamps in the framework of production processes of an automated type, with the possibility of achieving high levels of mass production, also with a simplification of the assembly operations, thanks to the possibility of operating with levels, as regards precision in positioning of the components and/or as regards determination of the characteristics of emission of the light generators, that are not excessively binding.

Brief description of the drawings

[0025] One or more embodiments will now be described, purely by way of non-limiting example, with reference to the annexed drawings, wherein:

Figure 1, which represents the prior art, has been described previously;
Figure 2 is a perspective view of a lamp according to embodiments of the present disclosure;
Figure 3 is an exploded perspective view of a first possible embodiment of a lamp as exemplified herein;
Figure 4 is an exploded perspective view of a second possible embodiment of a lamp as exemplified herein;
Figure 5 is an exploded perspective view of a third possible embodiment of a lamp as exemplified herein;
Figure 6 is a perspective view of a lamp as exemplified herein, with some parts removed for clarity of presentation in order to highlight some possible details of construction;
Figure 7 is a view, reproduced at an enlarged scale, of the part of Figure 6 indicated by the arrow VII;
Figure 8 is a perspective view of a lamp as exemplified herein, with some parts removed for clarity of presentation in order to highlight some possible details of construction according to a possible variant of Figure 6;
Figure 9 is a view, reproduced at an enlarged scale, of the part of Figure 8 indicated by the arrow IX;
Figure 10 exemplifies possible modalities of use of a lamp according to embodiments of the present disclosure; and
Figure 11 is a diagram that illustrates characteristics of operation of a lamp according to embodiments.

[0026] It will be appreciated that, for clarity and simplicity of illustration, the various figures may not be at the same scale.

[0027] Moreover, for brevity - except where the context indicates otherwise - parts or elements that are similar are designated in the various figures by the same reference symbols, without a corresponding description being repeated for each figure.

Detailed description of examples of embodiment

[0028] In the ensuing description, various specific details are illustrated in order to enable an in-depth understanding of various examples of embodiments according to the disclosure. The embodiments may be obtained without one or more of the specific details, or with other methods, components, materials, etc. In other cases, known structures, materials, or operations are not illustrated or described in detail so that the various aspects of the embodiments will not be obscured.

[0029] Reference to "an embodiment" or "one embodiment" in the framework of the present description is intended to indicate that a particular configuration, structure, or characteristic described in relation to the embodiment is comprised in at least one embodiment. Phrases such as "in an embodiment" or "in one embodiment" that may be present in various points of the present description do not necessarily refer exactly to one and the same embodiment. Moreover, particular conformations, structures, or characteristics may be combined in any adequate way in one or more embodiments.

[0030] The references used herein are provided merely for convenience and hence do not define the sphere of protection or the scope of the embodiments.

[0031] In the figures, the reference number 10 designates as a whole a lamp that can be used, for example, for retrofitting or, possibly, also for first fitting-out of a light or lamp (for example: position light, number-plate light), not visible in the figures.

[0032] This may, for example, be a W5W solid-state retrofit lamp for motor vehicles.

[0033] Such a lamp has already been described in general terms with reference to Figure 1.

[0034] For brevity and in order not to burden the treatment, the ensuing description will present, at least in part, the differences in the embodiments, hence assuming that, unless the context indicates otherwise, the description of parts and elements provided with reference to Figure 1 also applies to corresponding parts and elements illustrated in Figure 2 and in the subsequent figures.

[0035] Consequently - except where the context indicates otherwise - parts or elements that are similar are designated in the various figures by the same reference symbols, without a corresponding description being repeated for each figure.

[0036] The lamp 10 to which Figure 2 and the subsequent figures refer exemplifies a solid-state lamp suited to being mounted on a vehicle (not visible in the figures).

[0037] The lamp 10 to which Figure 2 and the subsequent figures refer comprises a lamp body 12, for example made of moulded plastic material, which extends along a longitudinal axis X10 between:

a proximal base portion 14, having, for example, a mushroom shape, which is to be plugged into a mounting body, such as a headlamp F (represented in a purposely schematic way just in Figure 10); and
a distal front surface 16 that reflects the light (for example, in so far as the body 12 is made of a plastic material of a light colour and/or in so far as the surface 16 is treated and rendered reflecting).

[0038] In the lamp 10, to which Figure 2 and the subsequent figures refer, the body 12 hence extends in a first direction along the longitudinal axis X10 between the proximal base portion 14 with the distal front surface 16 which has an outer peripheral edge 160 and extends in a direction transverse to the longitudinal axis X10.

[0039] The lamp 10, to which Figure 2 and the subsequent figures refer, likewise comprises an elongated array 22 of solid-state light sources 221 (e.g., LED light generators) arranged in a distal position, i.e., downstream, with respect to the front surface 16 of the body 12 of the lamp 10. The elongated array 22 of sources 221 extends in a second direction X22 transverse to the longitudinal axis X10.

[0040] As exemplified herein, the outer edge 160 of the surface 16 is substantially circular, and the part of the lamp body 12 adjacent to the edge 160 is of an as a whole cylindrical shape.

[0041] Also in the case of the solution of Figure 2 and of the subsequent figures, a domed element 18 permeable to light, made, for example, of fully frosted or semi-frosted plastic, is coupled (for example, by snap action) to the lamp body 12 so as to form, around the array 22, a chamber 20 for generation of light from the reflecting surface 16.

[0042] The array 22 of solid-state light sources (for example, LED sources) of elongated shape is set at the centre the light-generation chamber 20, at a distance from the surface 16, in particular from the vertex region of the surface 16, designated by 1600.

[0043] The array of light sources 22 extends in a direction X22 transverse to the longitudinal axis X10: the array 22 is in fact of an as a whole elongated shape, in the sense that it has, in the direction X22, a length greater than the width in a direction transverse to the above direction.

[0044] The array 22 may on the other hand comprise one or more rows set side by side of solid-state generators of light radiation 221, for example LEDs coated with phosphors so as to give rise to a so-called LED filament.

[0045] The generators of light radiation 221 of the array 22 are arranged on a substrate 222 permeable to light so that the light radiation generated thereby propagates (also) through the substrate 222.

[0046] A source such as the source 22 may adopt the solution described in the document 3 828 461 A1. This application is incorporated via citation as entirely included herein.

[0047] As may be appreciated from the views of Figure 7 and Figure 9, the LEDs 221 can be mounted on the substrate 222 englobed in a light-permeable body 200 (for example made of plastic material resistant to high temperatures).

[0048] The body 200 may be made of an approximately lenticular shape and may co-operate with the part of the surface 16 closest to the LEDs 221 with the function of primary optics, possibly providing an action of beam forming of the beam of light emitted "backwards" towards the surface 16 at grazing angles, i.e., towards the body 12.

[0049] As may be appreciated from the views of Figure 7 and Figure 9, the substrate or support 222 is of a flat shape and lies in a plane transverse to the longitudinal axis X10, with the generators of light radiation 221 that may be located on the side of the support 222 facing away from the surface 16 (upwards in Figure 7) or else on the side of the support 222 facing in the direction of the surface 16 (downwards in Figure 9), i.e., (all) mounted on just one of the faces or sides of the support 222.

[0050] In other words, as may be appreciated from the views of Figure 7 and Figure 9, the sources 221 (e.g., LED sources) of the elongated array 22 are mounted on a support 222 having a first side facing in the direction of the distal front surface 16 of the lamp body 12 and a second, opposite, side, facing away from the distal front surface 16 of the lamp body.

[0051] In the example presented here, the sources 221 of the array 22 are (all) mounted on just one between the first side and the second side of the support 222.

[0052] It has been found that this solution may prove advantageous compared with a solution that envisages a flat substrate set in the plane identified by the axes X10 and X22 with generators of light radiation mounted on both faces or sides of the substrate: the latter solution is in fact exposed to possible unbalancing of the emission that may be put down to the fact that the part of array on one side of the substrate has characteristics of emission at least in part different from those of the part of array that is located on the opposite side.

[0053] In the conventional solution of Figure 1, the surface 16 comprises two opposite portions 161, 162 arranged at a distance from the source 22 and having a shape that can be defined as "eyelid" shape. More precisely, in Figure 1, each of the portions extends from the outer edge 160 (from an edge line or boundary line located at the outer edge 160) as far as an inner rectilinear edge line 1610, 1620, which is aligned with the direction X22 of extension of the source 22 (transverse to the longitudinal axis X10).

[0054] As shown in Figure 2 and in the subsequent figures, the surface 16 has, instead, a tapered profile, for example conical (or frustoconical), which can be viewed as a surface of revolution (or rotation) about the longitudinal axis X10 with the source 22 that is located so as to extend in a diametral direction X22 with respect to said (frusto)conical profile and lines 223 for electrical connection of the source 22 to the corresponding supply circuitry 21 that are such as to pass through the surface 16.

[0055] As illustrated here, the longitudinal axis X10 identifies the central axis of the surface 16 and intersects the light source 22 in a median plane of the source 22 itself. In other words, the longitudinal axis X10 traverses (at the centre) the vertex region 1600 of the surface 16 (as well as the end or apical region 180 of the covering element 18).

[0056] In summary, as illustrated in Figure 2 and in the subsequent figures, the distal front surface 16 is a surface of revolution about the longitudinal axis X10, this surface being convergent from the outer edge 160 towards the vertex region 1600 that is adjacent to the elongated array 22 of solid-state light sources (LEDs 221) arranged distally with respect to the front surface 16, with the longitudinal axis X10 that traverses the aforesaid vertex region 1600.

[0057] As illustrated herein, the longitudinal axis X10 intersects a portion of the elongated array 22 of light sources 221.

[0058] For instance, the longitudinal axis X10 may intersect the elongated array 22 of light sources 221 in a median plane of the array 22.

[0059] The surface 16 comprises, and is preferably constituted by, a conical (e.g., frustoconical) surface centred on the central axis X10.

[0060] As said in what follows, the surface 16 may on the other hand be a surface of revolution about the longitudinal axis X10 of a type at least marginally different from a conical surface.

[0061] Characteristics such as the ones recalled previously facilitate obtaining, in a lamp 10 as illustrated in Figure 2 and in the subsequent figures, efficiency and distribution of luminous intensity that can approach more closely the efficiency and distribution of luminous intensity thanks to the presence of a primary optics around the array 22 of light sources 221 (LED sources), without increasing the size of the lamp (which can remain within the ECE specifications) and/or the number of components and without any considerable impact on the production process. The primary optics may in fact form part of the body (made, for example, of plastic), in which the array 22 of light sources is mounted.

[0062] This result may, from certain points of view, be unexpected, considering that a lamp 10 as illustrated in Figure 2 and in the subsequent figures does not use an array 22 with generators of radiation mounted on both faces of the substrate so as to direct the radiation towards two half-spaces (in a way apparently more similar to the 360° distribution of a traditional filament lamp).

[0063] A lamp 10 as illustrated in Figure 2 and in the subsequent figures uses, instead, generators of light radiation 221 that are mounted on just one side or face of the substrate 222 (which is permeable to light) and may be set facing:

- away from the surface 16 (upwards in Figure 7), or else
- in the direction of the surface 16 (downwards in Figure 9).

[0064] Advantageously, the elongated array 22 of solid-state light sources 221 has a light-emitting area lying in a light-emitting plane orthogonal to the longitudinal axis X10.

[0065] The fact of using generators of light radiation 221 mounted on just one side or face of the substrate 222 (permeable to light) means that the action of distribution of the light radiation is primarily due to the conical surface 16 (which is able to reflect light, for example being made of plastic material of a light colour, and possibly rendered further reflecting with a surface treatment).

[0066] The surface 16 is impinged upon by the radiation of the generators (e.g., LED generators) 221, which propagates towards the surface 16 itself in the direction of the axis X10:

- in so far as it is projected towards the surface 16 by the generators 221 facing in the direction of the surface 16 (downwards in Figure 9), or else
- in so far as the radiation produced by the generators 221 facing away from the surface 16 (upwards in Figure 7) propagates through the support 222, which is permeable to light.

[0067] As has been said, the array 22 comprises an elongated array (which is longer than it is wide in the direction of the axis X22) of solid-state light generators 221 that are such as to define a light-emitting area (LEA) lying in a plane orthogonal to the longitudinal axis X10.

[0068] By way of example, the aforesaid light-emitting area of the array 22 may have a (maximum) width d1 of approximately 2.5 mm, measured in a direction transverse to the direction X22, and a length of approximately 4.5 mm, measured in the direction X22.

[0069] Once again by way of example, the array 22 may be a LED filament formed on (a side of) a substrate 222 of (transparent) sapphire on which the chips of the LEDs 221 are glued, if necessary with a leadframe crimped to the sapphire.

[0070] In a way in itself known, the chips of the LEDs may be connected to the leadframe with a wire-bonding configuration and/or to the spot-welded electrical-connection lines 223.

[0071] The LED filament may be obtained with, for example, three, four or six rows of LEDs (three chips for each row), preserving the elongated shape in the direction of the axis X22.

[0072] For the connection it is possible to adopt different configurations, such as:

three rows with the same polarity, hence with one LED filament without reverse-polarity function; or

four or six rows, with two/three rows with one polarity and two/three rows with opposite polarity, hence with one LED filament that allows opposite polarities, for example adopting the solution described in the document EP 3 099 141 A1: this application is incorporated via citation as entirely included herein.

[0073] A source 22 as described herein is suited to being provided in versions supplied at different voltage levels, for example, in the version supplied at 12 V or in the version supplied at 24 V.

[0074] It is possible to distribute the conversion phosphors over both sides of the support (e.g., made of sapphire) 222 to facilitate a better spatial distribution (virtually over 360°) of the light radiation emitted.

[0075] Figures 3, 4, and 5 are exploded perspective views of various possible embodiments of a lamp as exemplified herein.

[0076] Figures 3 and 4 illustrate the possibility for the lines for electrical connection 223 of the source 22 to the corresponding supply circuitry 21 to comprise (in a way in itself known) plated through-hole (PTH) resistors 2230 and/or be fitted in a body 12 made of a single piece, or else be sandwiched between two complementary parts 121 and 122 of the body 12 (connected together, for example, via ultrasonic welding), each defining a respective portion 161, 162 of the surface 16 (comprising the vertex portion 1600).

[0077] Figure 5 illustrates instead the possibility for the electrical-connection lines 223 to come under a printed-circuit board (PCB) 2231 (which may possibly house an integrated control circuit), which itself may also be sandwiched between two complementary parts 121 and 122 of the body 12, connected together, for example, via ultrasonic welding.

[0078] Whatever the specific embodiment adopted, the distal front surface 16 has openings for passage of formations 223 for electrical connection of the elongated array 22 of solid-state light sources 221.

[0079] Whatever the specific embodiment adopted, the lamp 10 is suited for application of a covering element 18 coupled to the lamp body 12 and configured for covering the elongated array 22 of light sources 221.

[0080] The covering element 18 comprises an end region 180 intersected by the longitudinal axis X10 in a distal position with respect to the elongated array 22 of light sources 221.

[0081] The covering element (dome) 18, which may be made of fully or semi-frosted material or opalescent material, is built so as to be permeable to light at least in the end region 180.

[0082] It will be noted that the various details exemplified in Figures 3 to 5 are suited to being used in various combinations: the fact that a certain detail is illustrated in one of Figures 3 to 5 together with another is hence not to be interpreted in the sense that these details must necessarily be used together.

[0083] This also applies as regards the domed element 18 permeable to light and the choice of making it, for example, of fully frosted or semi-frosted glass or plastic (at least in the apical part) or of opalescent material.

[0084] Figures 6 to 9 refer to the lamp 10 represented without the domed element 18 so as to highlight better certain possible characteristics of the surface 16 and of the source 22.

[0085] Figures 6 to 9 highlight the fact that, in a lamp 10 like the one illustrated here, the surface 16 may have:

an angle of conicity (angle between the axis X10 and the generatrices of the conical surface) that is wide (for example, approximately 60°, and hence with a rather squat conical surface 16, as may be seen in Figure 6), with the generators 221 arranged on the face (or side) of the support 222 opposite to the surface 16 (i.e., facing upwards as viewed in Figure 7); or else

an angle of conicity, once again with respect to the axis X10, that is narrower (for example, of approximately 40°-45°, and hence with a conical surface 16 that is somewhat acute, as may be seen in Figure 8), with the generators 221 arranged on the face (or side) of the support 222 facing in the direction of the surface 16 (i.e., downwards as viewed in Figure 9).

[0086] It has on the other hand been noted that these aspects (angle of conicity of the surface 16 and location of the generators 221 on the support 222 on the side opposite to or else the side facing the surface 16) are not bound to one another in a unique way for the purposes of achieving a certain configuration of emission of radiation by the lamp 10.

[0087] In other words, in some embodiments, we can choose to have:

a wide angle of conicity (with a conical surface 16 that is rather squat, as may be seen in Figure 6), with the generators 221 arranged on the face (or side) of the support 222 facing the surface 16, and/or

a narrow angle of conicity (with a conical surface 16 that is somewhat acute, as may be seen in Figure 8), with the generators 221 arranged on the face (or side) of the support 222 opposite to the surface 16.

[0088] It is consequently possible to choose the angle of conicity of the surface 16 as a function of a desired overall length of the lamp 10 in the longitudinal direction X10, for example, maintaining the same overall dimensions and leaving sufficient space for mounting the source 22 and retaining the possibility of making the body 12 of plastic by means of injection moulding, simply by opening the mould and without any further movements (via inserts).

[0089] Specifications such as the specifications of the ECE regulations in terms of brightness, efficiency, and light diffusion mainly refer to values measured in a horizontal plane.

[0090] As schematically represented in Figure 10, a lamp such as the lamp 10 disclosed herein is to be mounted (for example by plugging it via the proximal base portion 14) into a headlight body (headlamp) F.

[0091] It has been found that meeting the specifications of the ECE regulations by the above lamp is facilitated by an assemblage with the array 22 set in an upright position with respect to a horizontal plane.

[0092] In other words, a lamp 10 as described herein is suited to being used by being mounted in a mounting support (for example, a headlamp F) longitudinally extending in a horizontal or substantially horizontal direction, and with the elongated array 22 of solid-state light sources 221 set in an upright position with respect to the horizontal, hence also only approximately vertical, without requiring an exact alignment with the vertical direction (V_A in Figure 10) .

[0093] For instance, it has been found that a lamp 10 as described herein is able to meet the specifications of the ECE regulations also with the array 22 set with its longitudinal axis X22 forming with respect to the vertical direction an angle α in the region of 18°.

[0094] This finding confirms that solutions like the ones described herein facilitate production of lamps in compliance with specifications such as the ECE specifications in the framework of large-scale production processes where, also for considerations of cost, it may prove problematical to ensure high levels of precision in positioning of the components and/or in determination of the characteristics of emission of the light generators.

[0095] Figure 10 highlights the fact that - even if it may have a flat shape extending in a plane substantially aligned with the axes X10 and X22, i.e., a flat shape substantially aligned with the array of sources 22 - the proximal base portion 14 of the lamp body 12 does not require an exact angular alignment with respect to the array 22, which may also be tilted (by an angle α) with respect to the proximal base portion 14 provided for fitting the lamp 10 into the headlight body F.

[0096] Moreover, the (frusto)conical conformation exemplified herein for the reflecting surface 16, albeit advantageous, is not strictly imperative.

[0097] In some embodiments, the surface 16, albeit having a convergent profile (in a distal direction with respect to the lamp 10, i.e., in the direction of the array 22 of sources 221) from the peripheral edge 160 towards the vertex region 1600 aligned with the axis X10, i.e., traversed by the axis X10, it may have other possible geometries.

[0098] These may be other geometries of revolution that can be obtained, as in the case of a conical (for example, frustoconical) geometry, by rotation of a plane figure about the axis X10.

[0099] It is recalled that in mathematics, and in particular in geometry, a surface of revolution (or rotation) is a surface (in a Euclidean space) created by rotating a curve (generatrix) about an axis of rotation.

[0100] Cylindrical and conical surfaces are examples of surfaces of revolution generated by a straight-line generatrix (according to whether the straight line is parallel or otherwise to the axis, a cylindrical or a conical surface is obtained).

[0101] A surface such as the surface 16 illustrated in Figure 2 and in the subsequent figures may be viewed as being ideally obtained by rotating (through 180°) about the axis X10 a plane region shaped like an isosceles triangle (or isosceles trapezium, to take into account a possible flattening of the vertex region 1600), i.e., with generatrices of the surface that are rectilinear (i.e., with infinite radius of curvature).

[0102] In some embodiments, the surface 16 can assume a shape where the generatrix curve is not rectilinear but has a finite (even though large) radius of curvature with centre of curvature located either on the inside or on the outside of the surface 16, which can in this case assume an overall shape that can be defined, respectively, as "ogival" or "trumpet" shape.

[0103] Figure 11 is a polar diagram corresponding to a goniometric detection of the distribution of luminous intensity by a lamp 10 as described herein and provided with the details visible in Figures 6 and 7 (squat surface 16, i.e., with a wide angle of conicity, measured with respect to the axis X10, in the region of 60° and with the generators 221 of the source 22 mounted on the side of the support 222 facing away from the surface 16, i.e., towards the outside of the lamp 10) .

[0104] The diagram of Figure 11 refers to a source 22 oriented in an (approximately) vertical direction, i.e., set in an upright position, centred with respect to the axis X10 and with a distance between the light-generating area of the generators 221 (that is, the outer surface of the emitting body) and the plane of the vertex region 1600 of approximately 0.5 mm.

[0105] Reference, in various points of the present disclosure, to data, even of a quantitative nature, preceded by "approximately" or "(at least) approximately", highlights that solutions such as those described herein facilitate obtaining a certain effect or result even within a certain tolerance.

[0106] Solutions such as those described herein prove in fact particularly robust in the face of possible variations in positioning of the components and/or in determination of the characteristics of emission of the light generators.

[0107] This is particularly advantageous as regards the possibility of producing lamps in the framework of large-scale production processes, at contained costs. The diagram of Figure 11 refers to a measurement made with a source (LED filament) 22 manufactured by Seoul Semiconductor with registered office at 97-11, Sandan-ro 163beon-gil, Danwon-gu, Ansan-si, Gyeonggido, South Korea, which is able to supply on the axis X10 of the lamp 10 (0° point at the bottom in Figure 11) a maximum intensity of 131 cd/klm.

[0108] The diagram of Figure 11 regards a detection of data of luminous intensity carried out with a standard goniophotometer, with the measurement distance chosen in such a way that the detector is located in the far field of the light distribution.

[0109] The measurements are made in the C-planes containing the reference axis of the light source.

[0110] The C-planes detected are C_0 (dashed curve), C_{30} (solid curve) and C_{330} (dashed-and-dotted curve) for a number of polar angles γ (from -100° to +100° with steps of 25°) as defined in the specification ECE/TRANS/WP.29/2019/126.

[0111] The values of luminous intensity measured, normalized with respect to the luminous flux measured for the individual light source under test were converted into normalized values of luminous intensity of a 1000-lm light source.

[0112] The data of luminous-intensity distribution detected correspond to a luminous flux of 50 +/- 20% lm and are such as to respect the range of tolerance (ECE limit) highlighted in Figure 11, in accordance with the specification ECE/TRANS/WP.29/2019/126.

[0113] Likewise, the behaviour in terms of light-emitting area proved to be in accordance with the specification ECE/TRANS/WP.29/2019/126.

[0114] The corresponding test has the purpose of defining the requisites for the apparent light-emitting area of the LED light source and of determining whether the light-emitting area is positioned correctly with respect to the reference axis and to the reference plane in order to verify compliance with the specifications. The position of the light-emitting area is controlled by a box system with the source activated at a test voltage, observing the light projected in the direction γ = 0° (observation from above), γ = $\pm$ 45° (observation in an inclined direction) and γ = +/- 90° (observation in front/rear view) in the plane C_0 (as defined in the specification ECE/TRANS/WP.29/2019/126).

[0115] The behavior represented in the diagram of Figure 11 is altogether comparable to the efficiency of a traditional filament lamp, also thanks to the optical coupling between the light rays emitted by the LED filament (source 22) and the domed element 18, above all for the rays emitted back towards the plastic body 12, with a reduction in the Fresnel losses at the air-dome interface. In other words, the reflecting surface 16 functions as primary optics and improves optical coupling of the rays of the source 22 with the domed element 18.

[0116] The efficiency of the lamp 10 may be further improved if the front surface 16 of the body 12 receives an optical treatment aiming at improving reflectivity thereof.

[0117] Reflectivity may be improved with treatments (in themselves known to persons skilled in the sector) implemented, for example, in the mould or with additional coatings. For instance, the surface 16 may be provided with micro- optical formations.

[0118] Even in the absence of a particular optical treatment/coating, i.e., with the body 12 made of white plastic (usually polycarbonate, which facilitates production of the body 12 by means of injection moulding) the surface 16 has a reflectivity of around 50%.

[0119] Without prejudice to the underlying principles, the details of construction and the embodiments may vary, even significantly, with respect to what is illustrated herein purely by way of non-limiting example, without thereby departing from the sphere of protection, as this is specified in the annexed claims.

LIST OF REFERENCE SIGNS

[0120]

Lamp	10
Reference axis	X10
Lamp body	12
Lamp-body parts	121, 122
Base portion	14
Front surface	16
Front-surface outer edge	160
Front-surface portions	161, 162
Vertex region	1600
Covering element (dome)	18
End region of covering element	180
Light-generation chamber	20
Circuitry	21
Array of light sources	22
Light sources (LEDs)	221
Body englobing the sources	200
Longitudinal direction of array	X22
Light-source support	222
Electrical-connection lines	223
Printed-circuit board	2231
Mounting body (headlamp)	F
Vertical direction	V_A
Tilt angle	α

Claims

1. A solid-state lamp (10) for vehicles, comprising:

a lamp body (12) extending in a first direction along a longitudinal axis (X10) between a proximal base portion (14) and a light-reflecting distal front surface (16), the distal front surface (16) extending transverse to the longitudinal axis (X10) and having an outer edge (160), and

an elongated array (22) of a plurality of solid-state light sources (221) arranged distally of the distal front surface (16) of the lamp body (12), the elongated array (22) of solid-state light sources (221) extending in a second direction (X22) transverse to said longitudinal axis (X10), wherein the distal front surface (16) is a surface of revolution around the longitudinal axis (X10), wherein the distal front surface (16) converges from said outer edge (160) towards a vertex region (1600) adjacent to the elongated array (22) of solid-state light sources (221) arranged distally to the distal front surface (16) wherein the longitudinal axis (X10) intersects said vertex region (1600).

2. The lamp (10) of claim 1, wherein said longitudinal axis (X10) intersects a portion of the elongated array (22) of solid-state light sources (221) .

3. The lamp (10) of claim 1 or claim 2, wherein said longitudinal axis (X10) intersects the elongated array (22) of solid-state light sources (221) at a median plane of the array (22).

4. The lamp (10) of any of the preceding claims, wherein said distal front surface (16) comprises and, preferably consists of, a conical surface centered on said longitudinal axis (X10).

5. The lamp (10) of any of the preceding claims, wherein:

the solid-state light sources (221) of the elongated array (22) are mounted on a support member (222) having a first side facing towards the distal front surface (16) of the lamp body (12) and a second side facing away from the distal front surface (16) of the lamp body (12), and

the solid-state light sources (221) of the elongated array (22) are mounted on only one of the first side and the second side of the support member (222) .

6. The lamp (10) of any of the preceding claims, wherein the elongated array (22) of solid-state light sources (221) has a light emitting area in a light-emitting plane orthogonal to said longitudinal axis (X10),

7. The lamp (10) of claim 6, wherein the vertex region (1600) of the distal front surface (16) is located approximately 0.5 mm from the light-emitting plane of the light-emitting area of the elongated array (22) of solid-state light sources (221).

8. The lamp (10) of any of the preceding claims, wherein the distal front surface (16) has extending therethrough electrical connection formations (223) of the elongated array (22) of solid-state light sources (221) .

9. The lamp (10) of any of the preceding claims, comprising a cover member (18) coupled to the lamp body (12) and configured to cover the elongated array (22) of solid-state light sources (221), wherein the cover member (18) comprises an end region (180) intersected by said longitudinal axis (X10) distal to the elongated array (22) of solid-state light sources (221), wherein the cover member (18) is permeable to light at least in said end region (180).

10. A method of use of a lamp (10) according to any one of the preceding claims, the method comprising mounting the lamp (10) in a mounting support (F) with said longitudinal axis (X10) extending horizontally and the elongated array (22) of solid-state light sources (221) arranged in an upright position with respect to the horizontal.

FIG. 1

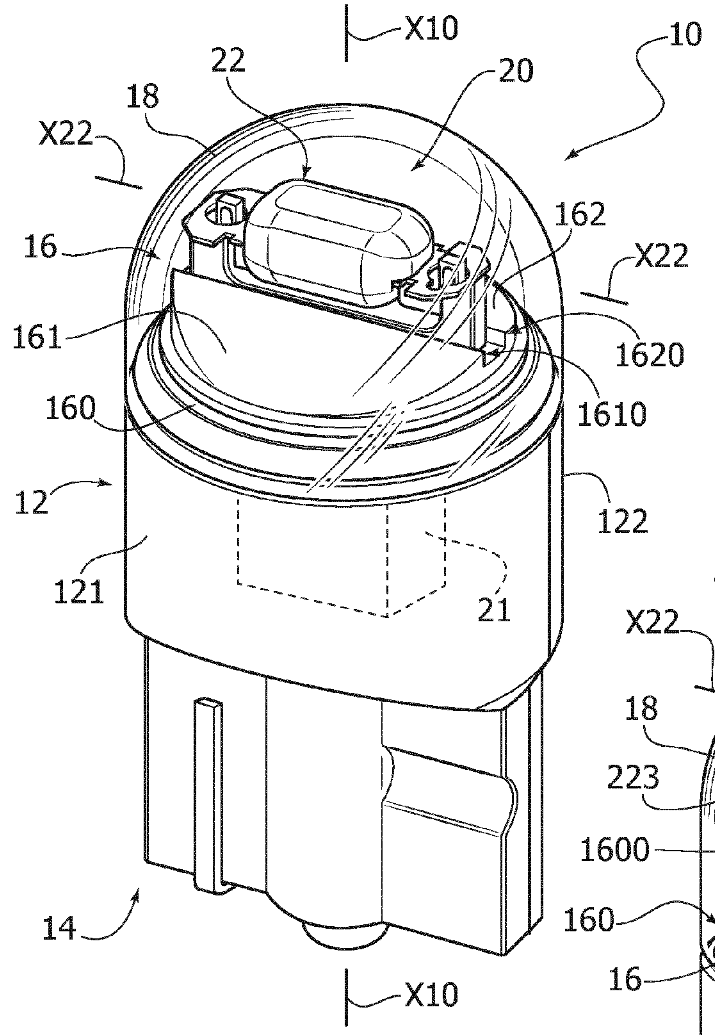

X10
10
22
20
18
X22
16
162
X22
161
1620
160
1610
12
122
121
21
14
X10

FIG. 2

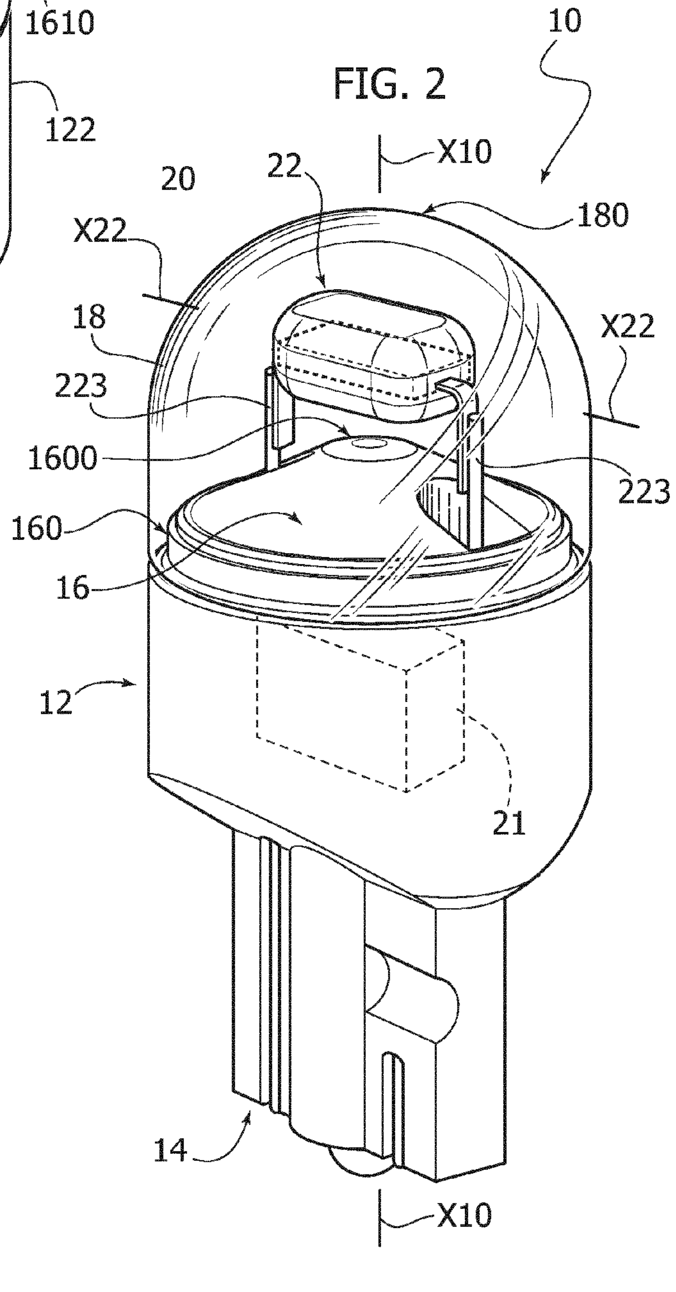

10
X10
20
22
180
X22
18
X22
223
1600
223
160
16
12
21
14
X10

FIG. 3

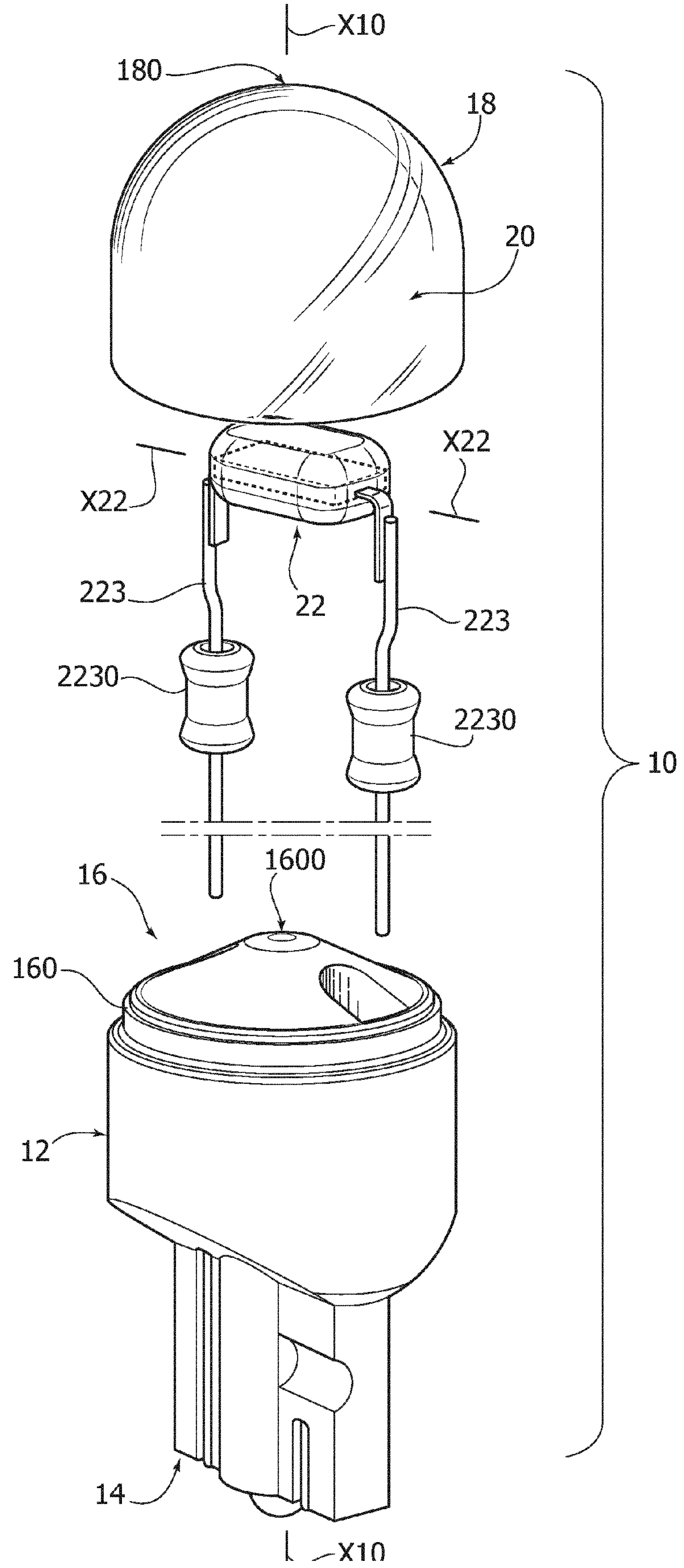
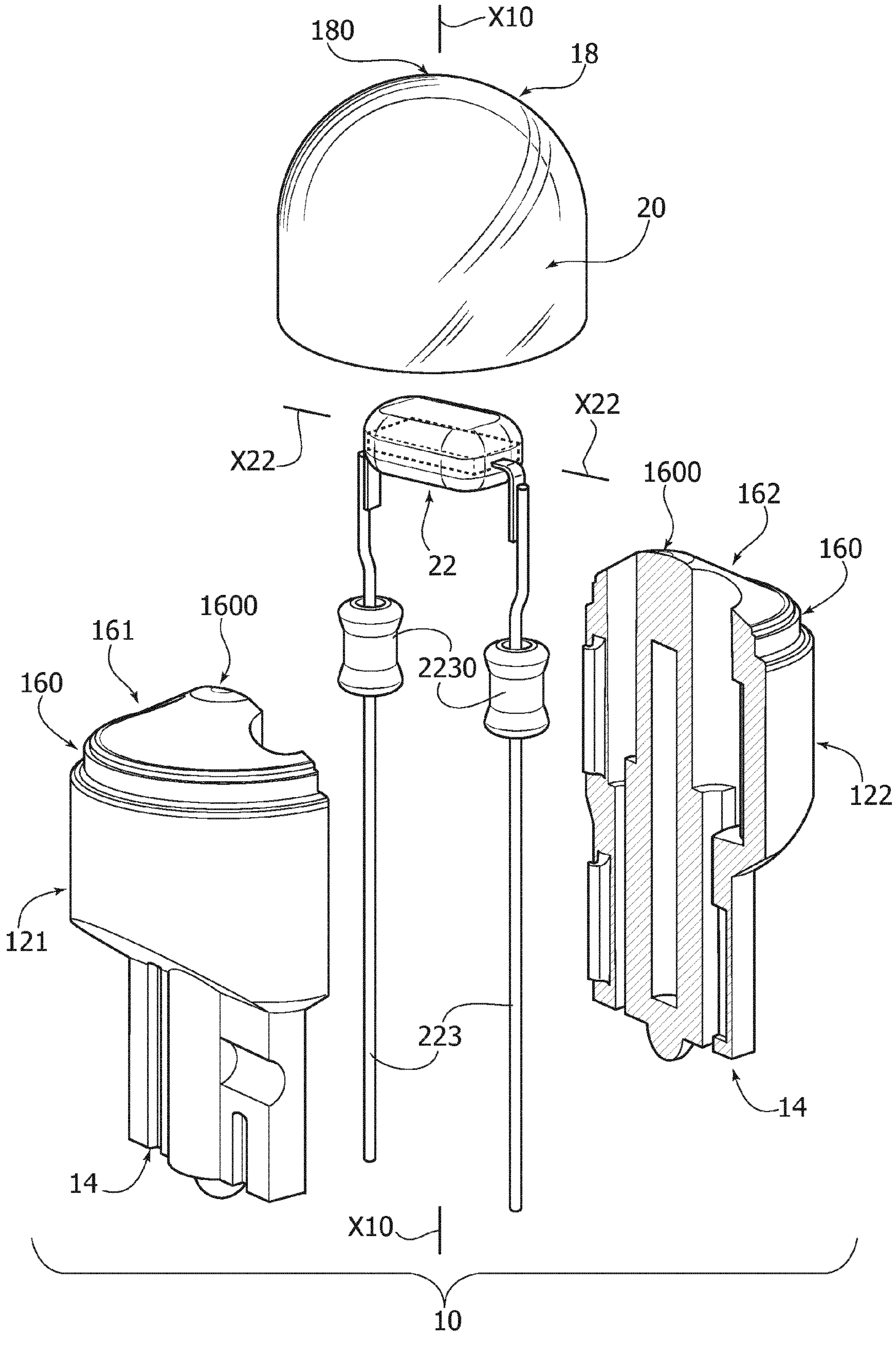
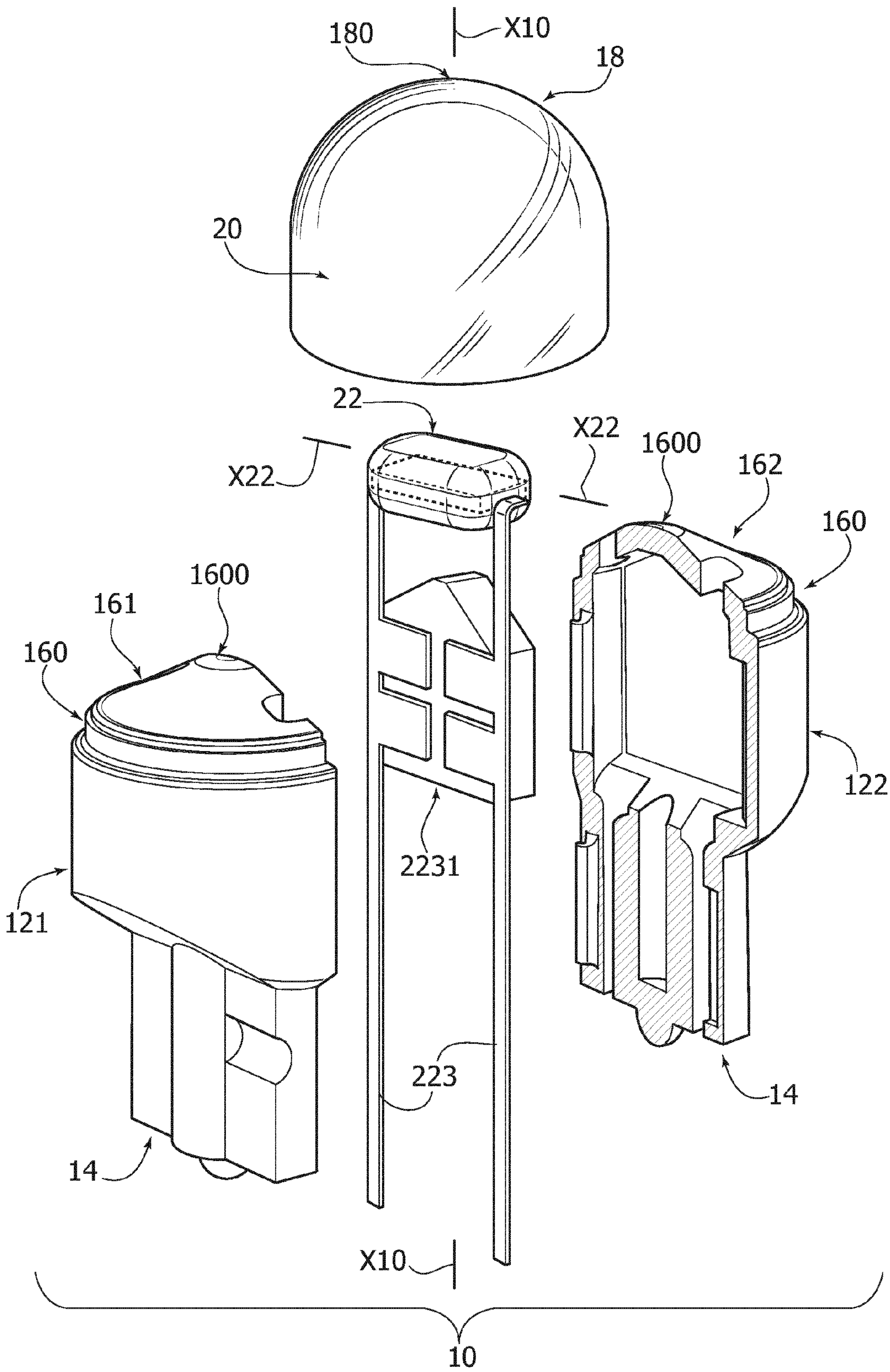

X10
180
18
20
X22
X22
223
22
223
2230
2230
10
1600
16
160
12
14
X10

FIG. 4



X10
180
18
20
X22
X22
1600
162
160
22
1600
161
160
2230
122
121
223
14
14
X10
10

FIG. 5



180
X10
18
20
22
X22
X22
1600
162
160
1600
161
160
122
2231
121
223
14
14
X10
10

FIG. 6

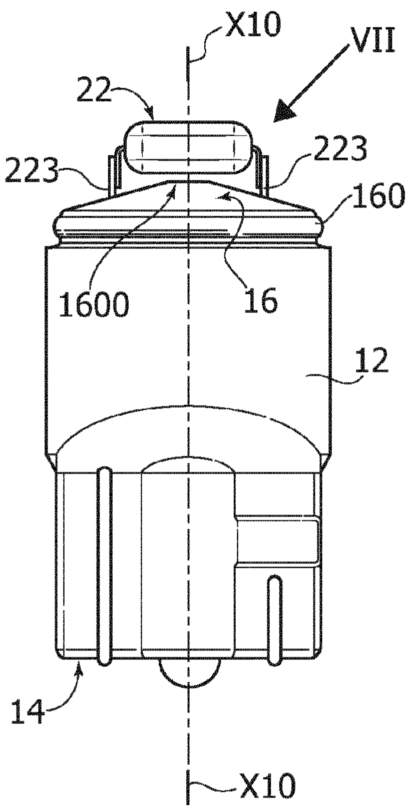


FIG. 8

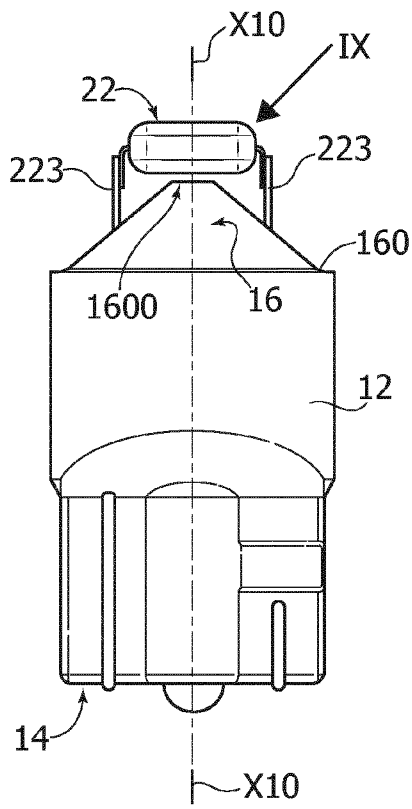


FIG. 7

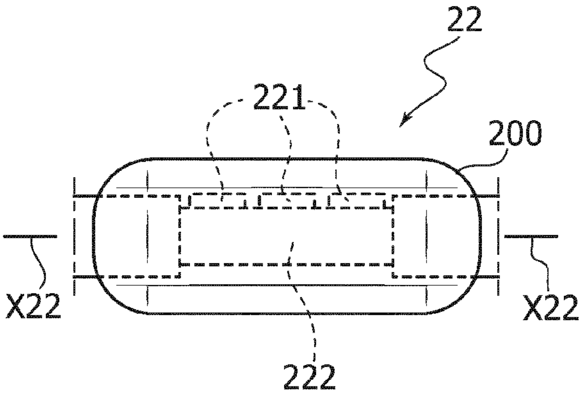


FIG. 9

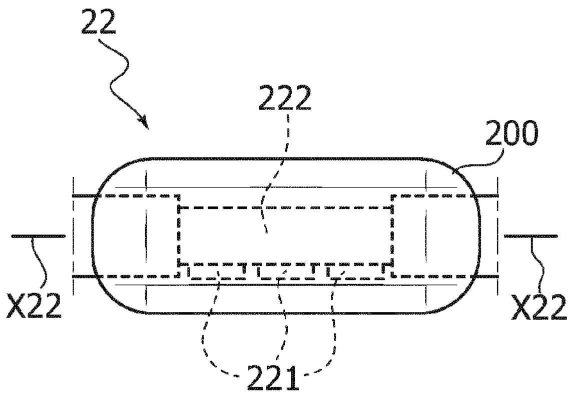
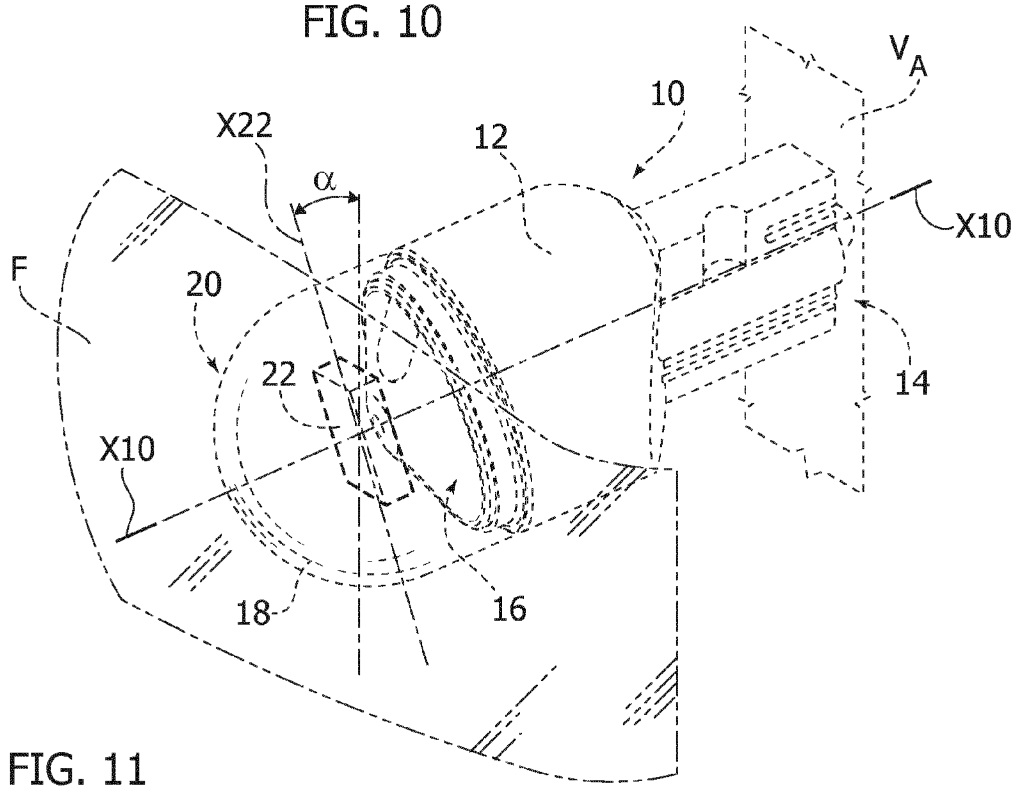
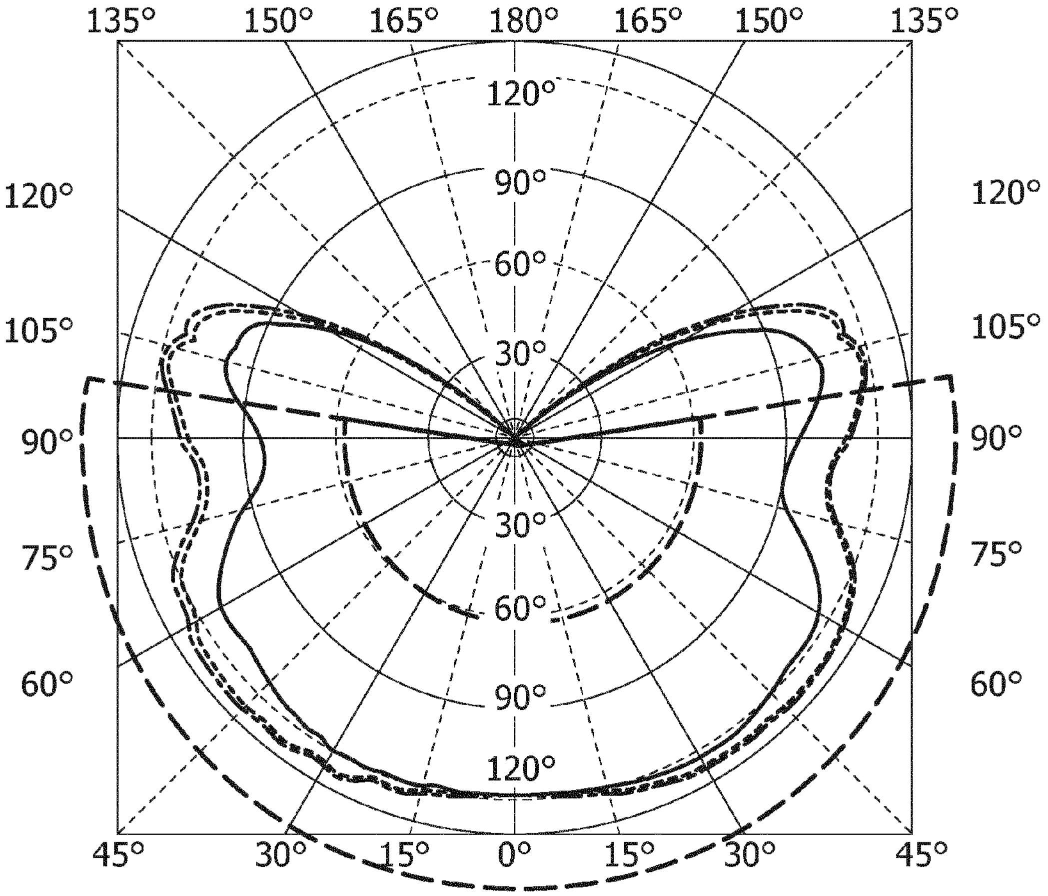


FIG. 10



VA
10
12
X22
α
X10
F
20
22
14
X10
18
16

FIG. 11



135°
150°
165°
180°
165°
150°
135°
120°
90°
60°
30°
120°
120°
105°
105°
90°
90°
30°
60°
75°
75°
90°
60°
60°
120°
45°
30°
15°
0°
15°
30°
45°

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 24 15 8522

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,D	US 2013/307399 A1 (KIM JAEHWAN [KR] ET AL) 21 November 2013 (2013-11-21) * paragraph [0015] - paragraph [0108] * * figures 1,2,3,4 *	1,4,6,7, 9,10	INV. F21K9/232 F21S41/00 F21V7/04 F21K9/68 ADD. F21Y109/00 F21Y115/10
Y	WO 2019/093713 A1 (SEOUL SEMICONDUCTOR CO LTD [KR]) 16 May 2019 (2019-05-16) * paragraph [0033] - paragraph [0144] * * figure 8c *	1-4,6, 8-10	
Y	WO 2017/028787 A1 (ZHEJIANG SUPER LIGHTING ELECTRIC APPLIANCE CO LTD [CN]) 23 February 2017 (2017-02-23) * paragraph [0104] * * figures 12a,13a *	1-4,6, 8-10	
X	EP 2 735 786 A1 (PANASONIC CORP [JP]) 28 May 2014 (2014-05-28) * paragraph [0016] - paragraph [0169] * * figures 1-4 *	1-6,8-10	TECHNICAL FIELDS SEARCHED (IPC)
X	EP 2 636 942 A1 (PANASONIC CORP [JP]) 11 September 2013 (2013-09-11) * paragraph [0100] - paragraph [0154] * * figures 27,28,29 *	1-6,8-10	F21K F21S F21Y F21V

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	7 June 2024	Blokland, Russell

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 24 15 8522

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.

07-06-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2013307399 A1	21-11-2013	KR 20130128623 A	27-11-2013
		US 2013307399 A1	21-11-2013
WO 2019093713 A1	16-05-2019	CN 110678978 A	10-01-2020
		CN 111180432 A	19-05-2020
		CN 111261765 A	09-06-2020
		CN 113054078 A	29-06-2021
		CN 113054079 A	29-06-2021
		DE 202018006444 U1	03-06-2020
		EP 3709354 A1	16-09-2020
		EP 3890455 A1	06-10-2021
		EP 4106502 A2	21-12-2022
		KR 20190053720 A	20-05-2019
		KR 20230065945 A	12-05-2023
		US 2020219857 A1	09-07-2020
		US 2021183829 A1	17-06-2021
		US 2022254761 A1	11-08-2022
		US 2023100018 A1	30-03-2023
		WO 2019093713 A1	16-05-2019
WO 2017028787 A1	23-02-2017	CN 106468405 A	01-03-2017
		CN 106838660 A	13-06-2017
		CN 106939973 A	11-07-2017
		CN 107035978 A	11-08-2017
		CN 206563190 U	17-10-2017
		CN 206669380 U	24-11-2017
		CN 207349843 U	11-05-2018
		CN 207364690 U	15-05-2018
		CN 207500848 U	15-06-2018
		CN 207500849 U	15-06-2018
		CN 207716114 U	10-08-2018
		EP 3341653 A1	04-07-2018
		GB 2543139 A	12-04-2017
		US 2017051878 A1	23-02-2017
		US 2019154206 A1	23-05-2019
		US 2020103081 A1	02-04-2020
		WO 2017028787 A1	23-02-2017
EP 2735786 A1	28-05-2014	CN 203771077 U	13-08-2014
		EP 2735786 A1	28-05-2014
		JP 5406347 B2	05-02-2014
		JP 2013048090 A	07-03-2013
		US 2014152177 A1	05-06-2014
		WO 2013014819 A1	31-01-2013
EP 2636942 A1	11-09-2013	CN 103052839 A	17-04-2013

EPO FORM P0459

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

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 24 15 8522

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.

07-06-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		EP 2636942 A1	11-09-2013
		EP 2672166 A2	11-12-2013
		EP 2672175 A2	11-12-2013
		JP 5049414 B2	17-10-2012
		JP 5143307 B2	13-02-2013
		JP 5162041 B2	13-03-2013
		JP 5162042 B2	13-03-2013
		JP 5286440 B2	11-09-2013
		JP 5306534 B2	02-10-2013
		JP 5307283 B2	02-10-2013
		JP 2012227162 A	15-11-2012
		JP 2012227163 A	15-11-2012
		JP 2012238602 A	06-12-2012
		JP 2013033768 A	14-02-2013
		JP 2013033769 A	14-02-2013
		JP 2013033770 A	14-02-2013
		JP 2013229623 A	07-11-2013
		JP WO2012060106 A1	12-05-2014
		US 2013215625 A1	22-08-2013
		US 2013235592 A1	12-09-2013
		US 2013235593 A1	12-09-2013
		WO 2012060106 A1	10-05-2012

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- DE 202012012007 U1 **[0009]**
- US 20110233578 A1 **[0009]**
- US 20120241778 A1 **[0009]**
- US 2013307399 A1 **[0009]**
- US 20150247606 A1 **[0009]**
- US 5160200 A **[0009]**
- US 8556473 B2 **[0009]**
- JP 2017098056 A **[0009]**
- EP 2933552 A1 **[0009]**
- WO 2022180474 A1 **[0009] [0011] [0016]**
- WO 2019093713 A1 **[0009]**
- WO 2017028787 A1 **[0009]**
- EP 2735786 A1 **[0009]**
- EP 3099141 A1 **[0072]**