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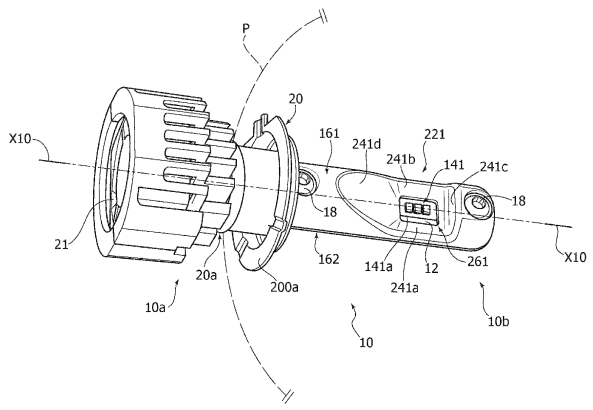
(54) LAMP AND CORRESPONDING METHOD

(57) An automotive lamp (10), which may be used e.g. as a retrofit lamp, comprises a lamp body (12, 161, 162) having opposed concave lateral recesses (221, 222) and LED light sources (141, 142) at the bottom surfaces (141a, 142a) of the lateral recesses (221, 222). Therefore, light radiation is both emitted directly and partly reflected by the peripheral surfaces (241a-d, 242a-d) of the recesses (221, 222). The aforesaid peripheral surfaces comprise a first longitudinal face (241a, 242a) which is smaller than a second longitudinal face (241b, 242b) opposed thereto. A LED linear array (141, 142) is placed between said longitudinal faces closer to the second face (241b, 242b) than to the first face (241a, 242a). The peripheral surfaces also comprise a first (241c, 242c) and a second (241d, 242d) transversal faces, with the first transversal face (241c, 242c) towards the front end being smaller than the surface area of the second transversal face (241d, 242d).

FIG. 2



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Description

Technical Field

[0001] The description refers to lamps.

[0002] One or more embodiments may be applied to lamps employing solid-state light generators, e.g. LED light generators.

[0003] One or more embodiments may advantageously be employed in the automotive sector, e.g. as automotive retrofit lamps for vehicles.

Technological Background

[0004] In sectors of use such as e.g. the automotive sector, LED light sources may exhibit various advantages in comparison with conventional lamps or bulbs.

[0005] For example, LED sources are brighter, they are quicker on power up and may be easily PMW modulated in order to regulate the intensity of the emitted light.

[0006] Another advantage is the possibility of operating LED chips in series, in parallel or in mixed topologies, with a rather long-time durable life.

[0007] As a consequence, there is an increasing tendency to develop and design LED lamps which may be used in the place of conventional lamps, for instance of halogen lamps, while complying with law requirements. It is reasonable to expect that in the near future automotive lamps, such as e.g. the lamps currently known as H-type lamps, will be nearly completely replaced by LED lamps.

[0008] It is desirable for such LED groups or clusters to meet the technical specifications applicable to the filament of an incandescent bulb, the possibility being offered of achieving a radiation beam which complies with specifications such as ECE R112 Regulation.

[0009] To this end, in the lamp bodies (which may act as heatsinks) it is possible to provide openings adapted to transmit light having a radiation pattern which closely emulates the near-field distribution of conventional lamps.

[0010] The lamp housing may comprise metal or plastic (polymeric) material, which facilitates manufacturing by moulding processes, the possibility being given e.g. to shape the lamp housing in such a way as to control the distribution of the LED-emitted light according to a Lambertian distribution.

[0011] As regards the possible features of the light sources, phosphor-converted LED sources have an emission spectrum in the range of visible light, with a narrow peak around 440 nm in the blue region and a rather wide bell curve from 500 nm to 700 nm, with a peak at 550 nm.

[0012] These issues have already been widely tackled both as regards the existing solutions on the market and as regards literature, including patent literature.

[0013] For example, in the solution described in US 2010/213809 A1, the light emission is provided by one or more semiconductor sources, arranged in a lamp closed by a cap, the emitted luminous flux being controllable by acting on the distance and the position of the LEDs with respect to the reference plane of the cap.

[0014] Document CN 205606398 U describes a LED lamp including two bodies, which define a symmetric light output.

[0015] Document WO 2018/162341 A1 describes a solution comprising a LED array, a reflector and an electrical interface adapted to control the front lighting of a motor vehicle.

[0016] Further documents, such as CN 207438161 U (corresponding to Italian Patent Application 102016000065138, CN 206802932 U, CN 205372347 U or CN 104949034 U, describe the possibility of arranging light sources between symmetric faces of the lamp body. Similar solutions are described in documents such as CN 205606224 U, CN 206419852 U, CN 206386847 U, CN 206430069 U or CN 206846618 U.

[0017] In order to complete the overview, documents such as e.g. EP 3 647 649 A1, Italian Patent Application 102019000010188 ("Lampada", filed on 26th June 2019 - Designated Inventor Gregianin) or Italian Patent Application 102019000022209 ("Lampada e procedimento corrispondente", filed on 26th November 2019 - Designated Inventors Gregianin, Selci and Bizzotto), neither of which is publicly accessible on the filing date of the present Application, exemplify lamps of the type considered herein.

[0018] Such lamps may include a housing with two complementary pieces (e.g. two half shells) having heat dissipation properties, which sandwich therebetween a Printed Circuit Board (PCB) carrying groups or clusters of several LEDs (e.g. three to five LEDs) placed on opposed surfaces of the board, in such a way as to emit light in opposite directions. Such pieces are adapted to protect the underlying electronics while achieving a good mechanical stability.

Object and Summary

[0019] In such a general scenario, one or more embodiments tackle issues which may arise with respect to specifi-

cations such as contained in (previously mentioned) ECE R112 Regulation.

[0020] For example, one or more embodiments aim at facilitating achieving a desired light distribution intensity in the so-called Zone III (Z III) of ECE R112 Regulation, e.g. as regards the points denoted as P1 + P2 + P3, P4 + P5 + P6, P7 and P8.

[0021] Indeed, a flux intensity in this zone above cut-off is desired such as to facilitate good visibility between 25 m and 50 m on the road: such aspects may be relevant, for example, in the implementation of lamps for H7 low beam lights, for instance for retrofit applications.

[0022] In this regard, it is to be borne in mind that conventional filament lamps, in order to reach this goal, may take advantage from the cylindrical distribution of the light around the lamp, so that they comply with the minimum candela requirements in such points.

[0023] One or more embodiments may specifically tackle the problems deriving from light going above the cut-off in order to achieve an illumination of the points in Zone III without originating glaring phenomena around point HV (0,0).

[0024] The meaning of the previously mentioned terms and acronyms is deemed to be known by the experts in the field, who are acquainted with specifications such as ECE R112 Regulation, already repeatedly mentioned in the foregoing.

[0025] For immediate reference, Figure 1 shows a synthesis of ECE R112 Regulation, where such specifications are stated.

[0026] In Figure 1, on the X axis and on the Y axis there are marked the angles (in degrees) referred to an H-V (Horizontal and Vertical) plane centered on point HV (0,0), each division corresponding to 1°.

[0027] As can be seen, Zone I (Z 1) and Zone IV (Z IV) are below cut-off (X-axis, i.e. 0 on the Y-axis), while Zone III (Z III) is above cut-off.

[0028] The values of the points and the boundaries of the zones depicted in Figure 1 may be summarized as follows:

P1+P2+P3 = (-8.0°, 4.0°) ; (0°,4°) ; (8.0°, 4.0°);
P4+P5+P6 = (-4.0°, 2.0°) ; (0°,2°) ; (4.0°, 2.0°);
P7 = (-8.0°, 0.0°);
P8 = (-4.0°, 0.0°);
HV (0,0) = (0°, 0°);
50L = (-3.4°, -0.9°);
B 50L = (-3.4°, 0.6°);
Z I = (-9.0° -4.0°); (9.0°, -1.7°);
Z III = (0.0°,0.0°) ; (-4.0°,0.0°) ; (-8.0°,1.0°) ; (-8.0°,4.0°) ; (0.0°,4.0°)
; (8.0°,4.0°) ; (8.0°,2.0°);
(6.0°,1.5°); (1.5'1.5') ; (0.0°,0.0°).
Z IV = (-5.2°, 5.2°); (-1.7°, -0.9°).

[0029] One or more embodiments aim at contributing to improvements in the direction explained in the foregoing.

[0030] According to one or more embodiments, said object may be achieved thanks to a lamp having the features set forth in the claims that follow.

[0031] One or more embodiments may refer to a corresponding method.

[0032] The claims are an integral part of the technical teachings provided herein with reference to embodiments.

[0033] One or more embodiments may facilitate achieving compliance with specifications such as ECE R112 Regulation by having the luminous distribution of the LEDs work in two different fashions: as direct light, if it is required for safety reasons, and as indirect/reflected light, for the points above cut-off, which are adapted e.g. to illuminate road panels.

[0034] One or more embodiments facilitate achieving such result thanks to the lamp structure, optionally combined with the materials employed to the purpose.

[0035] In order to reach this goal, one or more embodiments may make use of coatings having different optical properties, e.g. having diffusivity/specularity characteristics in the vicinity of the light source, and on the other hand a dark (black) colour in other areas.

[0036] Beside contributing to the compliance with specifications, one or more embodiments may achieve a significant increase of luminous intensity in zones Z-III, Z-IV and Z-1 by employing LEDs currently available on the market (e.g. such as LUXEON Z-ES) while at the same time adopting current galvanic deposition and moulding processes on the materials.

[0037] One or more embodiments may adopt, in order to achieve performance emulating a conventional filament lamp, linear arrays of e.g. three LEDs, the possibility being offered of increasing the luminous intensity above cut-off without originating glaring, e.g. when a lamp as exemplified herein is mounted as a retrofit lamp in the place of a conventional incandescent lamp.

[0038] One or more embodiments may exhibit further advantages as regards a frontal observation by an external

observer. For example, lamps according to embodiments may be used together with reflectors (for example in the case of low-beam lamps) having a complex shape, including so-called "pillows" which are shaped in such a way as to distribute light, and which are metallized so as to achieve a photometric structure which complies with international specifications. An external observer looking at the reflector will therefore see mirroring pillows with a focal point in the region which, in a halogen lamp, is the filament region and which, in the case of a lamp according to embodiments, e.g. for retrofit applications, is the region hosting (linear) LED arrays. By acting on the colour and on the finish of the housing and of the windows where the LEDs are located, it is possible to change the aspect of the reflector when viewed from the outside. This may be an advantage, because it allows the lamp to have e.g. a colour similar to the colour of the reflector, as can be the case with low-beam lights mounted in the body of a motor vehicle.

Brief Description of the Figures

[0039] One or more embodiments will now be described, by way of non-limiting example only, with reference to the annexed figures, wherein:

Figure 1, which illustrates ECE R112 Regulation, has already been described in the foregoing,
Figure 2 is a perspective view of a lamp according to embodiments,
Figure 3 is an exploded perspective view of a lamp as exemplified in Figure 2,
Figure 4 is a view of a lamp as exemplified in Figures 2 and 3, viewed in lateral elevation from a viewpoint approximately opposite the viewpoint in Figure 2,
Figure 5 is a section view along line V-V of Figure 4,
Figure 6 is a section view along line VI-VI of Figure 4, and
Figure 7 is a diagram showing a light intensity distribution which may be obtained according to one or more embodiments.

[0040] It will be appreciated that, for simplicity and clarity of illustration, the various figures may not be drawn to a same scale.

Detailed Description of Exemplary Embodiments

[0041] In the following description, various specific details are given to provide a thorough understanding of various exemplary embodiments according to the specification. The embodiments may be implemented without one or several specific details, or with other methods, components, materials, etc. In other instances, well-known structures, materials or operations are not shown or described in detail in order to avoid obscuring the various aspects of the embodiments.

[0042] Reference throughout this specification to "an embodiment" or "one embodiment" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment. Thus, the possible appearances of the phrases "in an embodiment" or "in one embodiment" in various places throughout the present specification are not necessarily all referring to one and the same embodiment. Furthermore, particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments.

[0043] The headings provided herein are given for convenience only, and therefore do not interpret the extent of protection or scope of the embodiments.

[0044] In the figures, reference number 10 denotes as a whole a lamp which may be employed e.g. for retrofit purposes, or optionally for the first equipment of a light (e.g. a low-beam light) of a vehicle such as e.g. a car, not visible in the figures.

[0045] In one or more embodiments, an automotive lamp 10 as exemplified herein is adapted to be mounted onto a support body P, the profile whereof is schematically shown in Figure 2 only. If it is employed in a light of a (motor) vehicle, body P may have the features of a reflector.

[0046] In one or more embodiments as exemplified herein, lamp 10 may comprise a body or housing of a generally elongated shape, extending in the direction of a longitudinal axis X10 and having a back or proximal base end 10a (which is adapted to be mounted, e.g. inserted, into the support body P) and a front (or distal) end 10b (wherefrom, in use, light radiation is emitted).

[0047] As exemplified in Figure 2, lamp 10 may be mounted on the vehicle, i.e. on the support body P (e.g. a reflector) so that axis X10 is oriented in a substantially horizontal direction, with the light radiation being emitted from the front end 10b and in the same way being directed in a substantially horizontal direction, radially, i.e. sidewise of axis X10.

[0048] In one or more embodiments (see e.g. the exploded perspective view in Figure 3), the lamp body 10 may comprise a plate-like member 12 (substantially corresponding to a Printed Circuit Board, PCB), having opposed faces hosting two linear arrays of solid-state light sources 141, 142 comprising e.g. three LEDs.

[0049] In a mounting condition as exemplified in Figure 2, the plate-like member 12 may be oriented in a substantially vertical direction, with the LED arrays 141, 142 projecting their light radiation in a substantially horizontal direction,

starting from the opposite faces of the plate-like member 12, radially, i.e. sidewise of axis X10.

[0050] As exemplified herein, the LED arrays 141, 142 extend in the longitudinal direction of lamp 10, i.e. in the direction of axis X10. Each LED array has therefore two array ends, which again may be respectively defined as back and front ends, similarly to what has been stated for the ends 10a and 10b of lamp 10.

[0051] As already mentioned in the foregoing, in one or more embodiments the LEDs of the array may be of the type LUXEON Z-ES. Such LEDs are available, for example, with dimensions of 2.04 mm in length, 1.64 mm in width and 0.49 mm in height or thickness, and may be arranged in such a way as to obtain gaps of 0.2 mm, separating the LEDs at the ends of the array from the central LED.

[0052] It has moreover been observed that the presence, in such a linear array, of three LEDs is advantageous, but not strictly mandatory for the implementation of the embodiments.

[0053] In one or more embodiments, said light generators (e.g. the LEDs of the type described in the foregoing) may be placed onto the plate-like member 12 with the interposition of a material 141a, 142a which is provided at least locally in plate-like member 12, and which has colour and/or finish characteristics (or, generally, optical properties) which are adapted to enhance the performance of lamp 10, as will be discussed in the following.

[0054] A so-called solder mask may be exemplary of such a material 141a, 142a.

[0055] As can be seen in Figure 3, in one or more embodiments the plate-like member 12 may be placed between two complementary, e.g. shell-shaped, pieces 161, 162, made of a (metal or plastic) moulded material.

[0056] For example, plate-like member 12 may be sandwiched between complementary pieces 161 and 162, in a unit which may be assembled with screws 18 passing through respective holes provided in the pieces 161, 162 and in the plate-like member 12, which is sandwiched therebetween.

[0057] In one or more embodiments, the back end 10a of the lamp body (comprising elements 12, 161 and 162) may have a generally sculptured structure (e.g. a finned surface) having heat-dissipating properties.

[0058] In one or more embodiments, the two complementary pieces 161, 162 may comprise a material (e.g. a metal material or a plastic material) having heat conductive properties: this facilitates transmission of heat generated by the LED sources 141, 142 towards the back end 10a, thereby facilitating the dissipation of the heat generated by sources 141, 142 in operation.

[0059] In one or more embodiments as exemplified herein, the back end 10a of body 10 may be shaped as a sort of box or cage, which is adapted to host electric/electronic circuits (of a type known in itself) therein; such circuits are adapted to feed the light sources 141, 142 through electrically conductive lines, which are not visible in the figures and which may be implemented e.g. as printed circuit tracks on plate-like member 12.

[0060] In one or more embodiments, lamp body 10 may have, associated therewith, fixation features such as an annular mounting member 20, optionally associated with a sealing member 20a.

[0061] The mounting solution depicted herein is however only one of a plurality of possible solutions for mounting lamp 10 onto such support body as e.g. a reflector P of an automotive lamp, e.g. via connection mechanisms such as quarter-turn connection mechanisms.

[0062] For example, the US Patent Application published as US2010/0213809 (Roehl) discloses an H7 lamp for automotive use which is formed on a conventional lamp cap, with a reference ring comprising a ring provided with lugs on three sides, which in turn define a reference plane.

[0063] As will be further described in the following, the ring member 20 illustrated herein generally exemplifies a member used for mounting the lamp on a vehicle, said member including, at the rear part of lamp body, at least one reference formation (such as a ring-shaped flange 200a) adapted to define a reference plane (denoted as RP in Figure 4) transversal to longitudinal axis X10.

[0064] A fixation member as exemplified herein may also correspond to the solutions described in documents such as the European application or the Italian patent applications, which have already been referred to in the foregoing.

[0065] In one or more embodiments as exemplified herein, the lamp body 10 (including, in the presently described examples, which are therefore merely exemplary, the complementary pieces 161, 162) may include, in an intermediate position between ends 10a and 10b and preferably nearer the front end 10b, two tray-shaped recesses 221, 222.

[0066] In the presently considered examples, said recesses have at least approximately a funnel shape, having bottom openings 261, 262 (which are more clearly visible in the exploded perspective view of Figure 3).

[0067] In the assembled lamp body, recesses 221, 222 originate two mutually opposed cavities, each cavity having (at the opening 261, 261 of recess 221, 222) a respective planar bottom surface (with said planar bottom surfaces being substantially defined by the portions 141a, 142a of plate-like member 12 whereon there are mounted the light sources 141, 142, and by the regions of the plate-like member 12 surrounding such portions); said planar bottom surface is surrounded by respective peripheral surfaces.

[0068] In one or more embodiments as exemplified herein, the peripheral surface of each recess/cavity 221, 222 includes four planar faces, respectively denoted as 241a, 241b, 241c, 241d (which surround surface 141a) and 242a, 242b, 242c and 242d (which surround surface 142a).

[0069] From the observation of the figures, it will be appreciated that:

between neighbouring faces included in faces 241a-d and 242a-d, and
between said faces and the bottom surfaces of the recesses, defined by portions 141a, 142a of plate-like member 12 and by the regions of plate-like member 12 surrounding such portions,
there may be provided, also for evident manufacturing needs (the moulding of pieces 161, 162, for example), connecting surfaces having a generally limited extension: as such, said connection surfaces will not be further discussed in the following.

[0070] The light radiation of sources 141 and 142 is projected from the lamp body 10 (in a generally radial direction with respect to axis X10 - and horizontally, considering the possible mounting condition on a support/reflector P as exemplified in Figure 2), while being adapted to pass through respective light-permeable portions (the openings or windows 261, 261 in the presently shown examples) provided at the bottom of the recesses/cavities 221, 222.

[0071] In this arrangement, the light radiation is projected:

partly directly outwardly of lamp 10, being adapted to be reflected on the surface of reflector P (see Figure 2);
partly towards faces 241a-d and 242a-d, and therefore exiting the lamp 10 indirectly, i.e. after being reflected on faces 241a-d and 242a-d, and then being adapted to be reflected on the surface of reflector P after a reflection on the surface of the recesses/cavities 221, 222.

[0072] In one or more embodiments (and referring again, for simplicity but without limitation purposes, to the specifications of ECE R112 Regulation - see Figure 1) it is possible to notice that the light radiation directly emitted by sources 141, 142 (i.e. the light radiation which is not reflected on faces 241a-d, 242a-d) is mainly responsible for the direct lighting in point 50L and generally in the zones Z III, Z IV and Z I (see Figure 1 for reference).

[0073] This zones are destined to implement "light in the foreground" and therefore, in the application to an automotive lamp, to illuminate the road.

[0074] On the other hand, the radiation reflected on faces 241a-d and 242a-d is a sort of indirect lighting, which is adapted to satisfy the low candela requirements of the points above cut-off.

[0075] As will be discussed in the following, the optical properties of said faces may influence the amount of reflected, transmitted and absorbed light.

[0076] For example, by way of exemplary hypothesis:

if faces 241a-d and 242a-d were totally absorbing, the lighting in points P1 + P2 + P3, P4 + P5 + P6, P7 and P8 would be insufficient,
if faces 241a-d and 242a-d were perfectly reflecting mirroring surfaces, the maximum value would be exceeded e.g. at point B50L.

[0077] For this reason, one or more embodiments may envisage acting on the reflectivity properties both of faces 241a-d and 242a-d and of surfaces 141a, 142a (solder mask, for example) which host the LED light generators of arrays 141, 142.

[0078] For example, it has been found that it is advantageous if the total reflectivity of surfaces 141a, 142a is lower than the total reflectivity of faces 214a-d and 242a-d, e.g. with the respective values amounting to 32% and 66%.

[0079] In both cases, it has moreover been found that it is advantageous if the level of diffused reflectivity is (significantly) higher than the level of specular reflectivity; this may be achieved e.g. by implementing, in the cavities defined by recesses 221, 222:

for surfaces 141a, 142a, values approximately amounting to 28% (diffused reflectivity) and 4% (specular reflectivity),
for faces 241a-d and 242a-d, values approximately amounting to 58% (diffused reflectivity) and 8% (specular reflectivity).

[0080] The addition of the term "approximately" to said values (which are by no means mandatory) takes into account the intrinsic tolerances deriving both from the implementation and from the measurement of said reflectivity properties.

[0081] The achievement of such characteristics may involve an intervention on the optical properties, e.g. by acting:

on faces 241a-d and 242a-d in order to define the radiation pattern of the lamp
on the regions of plate-like member 12 which define the bottom walls of recesses 221, 222, in order to define the components of ghost and stray light.

[0082] In one or more embodiments, for example, the plate-like member 12 may be coated, at least on parts 141a, 142a, with a black material, while faces 241a-d and 242a-d are white, so as to obtain a distribution of diffused light and

a low amount of stray light.

[0083] For example, in one or more embodiments, if the solder mask provided on the plate-like member 12 (which hosts the light sources 141, 142) is black, it is possible to reduce the phenomenon of light recycling and of glaring at point HV (0,0), with the faces 241a-d and 242a-d exhibiting, as mentioned in the foregoing, a behaviour of mainly diffused reflectivity.

[0084] An aspect which may be potentially significant is the choice, for sources 141, 142, of top-emitting LED generators. Indeed, it has been found that the use of LEDs with lateral emission may cause, at least in some embodiments, an undesirable increase of glaring around point HV (0,0).

[0085] As previously stated, regulating the reflectivity level may involve achieving a synthesis of diffused reflectivity and specular reflectivity, given that a high, nearly mirroring reflectivity may be useful to protect the lamp material from degradation phenomena due e.g. to the blue component of the light radiation, while also supporting a good thermal insulation.

[0086] As regards the technologies adapted to be employed to modify the characteristics of surfaces such as the surfaces of faces 241a-d, 242a-d, it is possible to adopt thin film deposition technologies, which are known for various applications. For example, vacuum deposition techniques may be advantageous in order to obtain a high quality coating in a clean environment.

[0087] However, such a solution involves the possible use of masks for a selective deposition of the film in different areas. This may be critical in the presence of complex geometries and surface discontinuities.

[0088] For this reason, in order to produce the surfaces of faces 241a-d, 242a-d, it may be useful to adopt galvanic deposition, which facilitates the deposition of metal coatings by immersion in a solution where a reduction-oxidation reaction takes place.

[0089] In a lamp as exemplified herein, such a solution may offer the advantage of facilitating the deposition of coating in different areas of the geometry, without the need to employ masks.

[0090] Upon closer examination of the geometry of possible embodiments as exemplified herein, it will be noticed that the side surface of the cavities defined by recesses 221, 222 consists almost completely of faces 241a-d and 242a-d, which practically extend from the contour or edge of the openings or windows 261, 262 (light-permeable regions) to the external contour of recesses 221, 222.

[0091] It will moreover be observed that, in each recess/cavity 221, 222, the faces 241a-d and 242a-d may be considered as comprising:

a (first) pair of longitudinal planar faces, i.e. faces 241a-b and faces 242a-b, extending on opposed sides with respect to a linear LED array 141, or respectively 142, arranged therebetween,
a (second) pair of transversal planar faces, i.e. faces 241c-d and faces 242c-d, which are spaced along the longitudinal direction of lamp 10 (i.e. along axis X10) and face opposed ends of said linear LED array 141 or, respectively, 142.

[0092] Moreover, in one or more embodiments as exemplified herein, the pair of longitudinal planar faces (i.e. pair 241a-b or pair 242a-b) comprises a first longitudinal face 241a or 242a and a second longitudinal face 241b or 242b.

[0093] By observing figures such as e.g. Figure 4 or Figure 6, it is possible to notice that, in one or more embodiments, the linear LED array 141 or 142 extending between said faces is placed closer to the second longitudinal face, 241b or 242b, than to the first longitudinal face, 241a or 242a.

[0094] In other words, considering the distances which separate the LED array (141 or 142, depending on the side or face of the plate-like member or substrate 12 taken into consideration) from the "internal" edges - the edges facing towards LEDs 141 or 142 - of the first longitudinal face, 241a or 242a, and of the second longitudinal face, 241b or 242b, it may be seen that the distance between the array 141 or 142 and the second longitudinal face, 241b or 242b, is shorter than the distance between the array 141 or 142 and the first longitudinal face, 231a or 242a.

[0095] In one or more embodiments, said result may be achieved (once again, and again by way of example only, see Figure 4 or Figure 6) by arranging the LED array 141, 142 centered or substantially centered (with the longitudinal midline thereof) with the (optical) axis X10, and by forming the first longitudinal faces 241a or 242a and the second longitudinal faces 241b or 242b in a laterally offset position with respect to axis X10 (or, more precisely, with respect to a diametrical plane of the lamp body that passes through axis X10 and is transversal to the plate-like member or substrate 12), i.e., for example, with the light permeable regions 261, 262 (see Figure 3) which are laterally offset with respect to said axis/plane.

[0096] In one or more embodiments, the first longitudinal face 241a or 242a may have a surface area which is smaller than the surface area of the second longitudinal face 241a or 241b.

[0097] For example, as can be seen in figures such as Figure 4 or the cross-section in Figure 6, in one or more embodiments the first longitudinal face 241a or 242a may be narrower than the second longitudinal face 241b or 242b, albeit having substantially the same length in the direction of axis X10.

[0098] Such solutions as exemplified herein may be advantageous, for example, if the lamp 10 is used as an automotive

low-beam light, because they enable orienting the light beam emitted by the lamp in such a way that, once it has been reflected on the associated reflector (see for instance P in Figure 2), the beam may be directed downwards, as it is required in a low-beam lamp.

[0099] This applies e.g. in the case of a mounting condition as exemplified in Figure 2 or in Figure 4 (with member 12 approximately vertical), wherein it is assumed that the (smaller) faces 241a and 242a are placed below and the (larger) faces 241b and 242b are placed above, with the faces denoted as "b" operating in a similar way as the faces denoted as "a".

[0100] In one or more embodiments as exemplified herein, the pair of transversal planar faces (i.e. pair 241c-d or pair 242c-d) comprises a first transversal face, 241c or 242c, towards the front end 10b of the lamp body, and a second transversal face, 241d or 242d, towards the rear base end 10a of the lamp body.

[0101] For example, as may be seen in the figures, in one or more embodiments the first transversal face, 241c or 242c, has a surface area which is (much) smaller than the surface area of the second transversal face 241d or 242d.

[0102] In one or more embodiments, the second transversal face, 241d or 242d, of the pair of transversal planar faces 241c-d, 242c-d is fingernail-shaped.

[0103] In one or more embodiments, this characteristic may be due to the fact that the side cavities defined by recesses 221, 222 extend between a first and a second circular cross-sectional plane of the lamp body (said planes being respectively denoted as T1 and T2 in Figure 4), with the first transversal face 241c or 242c adjacent the first cross-sectional plane T1 and the second transversal face 241d or 242d adjacent the second cross-sectional plane T2, with the lamp body being formed by the complementary pieces 161, 162 and by member 12 sandwiched therebetween, which is radially wider at the second cross-sectional plane T2 than at the first cross-sectional plane T1.

[0104] In one or more embodiments as exemplified herein, the planar bottom faces of the lateral recesses 221, 222 (which are defined, as previously stated, by the portions 141a, 142a of plate-like member 12 which accommodate light sources 141, 142, and by the regions of the plate-like member 12 which surround such portions) are parallel to a diametrical plane of the lamp body (the plane denoted as D10 in Figures 5 and 6, which will be vertically oriented in the mounting condition exemplified in Figure 2) which extends along the longitudinal direction of axis X10 passing through the narrowed portion of the lamp body, which is arranged between the lateral cavities of the body itself, defined by the recesses 221, 222.

[0105] The diametrical plane D10 therefore substantially coincides, in the presently considered examples, with the lying plane of plate-like member 12.

[0106] In one or more embodiments as exemplified herein, the lateral recesses 221, 222 are mirror-symmetrical with respect to said diametrical plane D10. It is recalled that "mirror symmetry" is the property of geometrical figures in which corresponding points are aligned on opposed sides at the same distance from a plane which is known as symmetry plane.

[0107] As can be appreciated in the section view of Figure 6, in one or more embodiments as exemplified herein, in the lateral cavities of the lamp body defined by recesses 221, 222, the first longitudinal planar face, 241a or 242a, and the second longitudinal planar face, 241b, 242b, lie on planes which form, with respect to said diametrical plane D10, externally of the recess, angles α having the same value, approximately amounting to 10°.

[0108] As can be appreciated in the section view of Figure 5, in one or more embodiments as exemplified herein, in the lateral cavities of the lamp body which are defined by recesses 221, 222:

the first transversal planar face, 241c or 242c, lies in a plane which forms, with respect to said diametrical plane D10, externally of the recess, a first angle having a first value β,
the second transversal planar face, 241d or 242d, lies in a plane which forms, with respect to said diametrical plane D10, once again externally of the recess, a second angle having a second value γ.

[0109] In one or more embodiments as exemplified herein, the second value γ is different from, optionally smaller than, the first value β.

[0110] In one or more embodiments as exemplified herein, said first value β and said second value γ respectively amount approximately to 85° and approximately to 21,5°.

[0111] As regards possible quantitative parameters (which are optional and not mandatory) it has been found advantageous for the LED arrays, having a length A in the direction of axis X10 (see Figure 4), to be located at a distance B from the reference plane RP defined by the mounting member 20, with the plane RP which may be seen as placed in the bottom plane of reflector P in which lamp 10 may be mounted (see e.g. Figure 1), with distance B (measured at the end of the array which faces towards plane RP) which is several times longer, e.g. approximately 5 times longer, than length A.

[0112] For example, with a value A which (in the presence of a 3-LED array having the previously quoted dimensions) approximately amounts to 5.18 mm, distance B may approximately amount to 25 mm.

[0113] Once again it is recalled that, as used herein, the term "approximately" takes into account the tolerances in manufacturing and measuring such dimensions.

[0114] Thanks to characteristics such as, for example, the fact that the LED array 141, 142 between said faces is

closer to the longitudinal face 241b, 242b than to the first longitudinal face 241a, 242a, or the different surface area of the longitudinal faces 241a, 242a with respect to the longitudinal faces 241b, 242b, one or more embodiments aim at facilitating achieving a desired value of the light distribution intensity in the so-called Zone III (Z III) according to the ECE R112 Regulation, e.g. as regards the points P1 + P2 + P3, P4 + P5 + P6, P7 and P8 (see Figure 1).

[0115] As stated in the foregoing, the flux intensity in this area above cut-off should be desirably adapted to achieve a good visibility at 25 m to 50 m on the road: such aspects may be significant, for example, in the implementation of low-beam lamps of the type H7, e.g. in retrofit applications, where it is desired to emulate the behaviour of conventional filament lamps, which implement a cylindrical distribution of the light around the lamp.

[0116] One or more embodiments may specifically tackle the problems connected with light passing above cut-off, in order to achieve the illumination of the points in Zone III without originating glaring around point HV (0,0), thus facilitating achieving compliance with specifications such as ECE R112 Regulation, by having the LED light distribution operate in two different modes: as direct light, where this is required for safety reasons, and as indirect/reflected light, for the points above cut-off, which are adapted to illuminate e.g. road panels.

[0117] One or more embodiments may employ coatings having different optical properties, e.g. having characteristics of diffusivity/specularity in the vicinity of the light source, while having a dark colour (black) in other areas. Beside contributing to comply with specifications, one or more embodiments enable achieving a significant increase of light intensity in the zones Z III, Z IV and Z1 by employing LEDs which are currently available on the market (e.g. LEDs of the type LUXEON Z-ES), while for the rest resorting to current galvanic deposition and material moulding processes.

[0118] One or more embodiments may adopt, in order to achieve performance emulating a conventional filament lamp, linear arrays of e.g. three LEDs, the possibility being given to increase the light intensity above cut-off without originating glaring, e.g. when a lamp as exemplified herein is mounted as a retrofit lamp to replace a conventional incandescent lamp, with further advantages as regards frontal observation by an external observer.

[0119] Figure 7 is a diagram representing a light intensity distribution which may be obtained with a lamp 10 according to one or more embodiments, which may be used in a mounting condition on a vehicle (reflector P) as exemplified in Figure 2 with reference to a low beam lamp.

[0120] In the diagram of Figure 7, the scales on the X-axis and on the Y-axis indicate angles (in degrees) representative of the projection direction of the light beam.

[0121] The diagram of Figure 7 shows isocandela lines with respective values in candelas (cd) corresponding to 25000, 10000, 5000, 2500, 1000 and 400 cd.

[0122] In the diagram of Figure 7, the region R1 encircled by dash-dotted lines refers to points below HV (0,0) and the region R2 encircled by dotted lines refers to light directed upwards.

[0123] It may be observed that the light projected from sources 141, 142 directly (i.e. without reflection on faces 241a-d, 242a-d), which illuminates zones Z III, Z IV and Z I (see the diagram in Figure 1) is essentially responsible for illumination in the region R1, while the "indirect" light which is reflected on faces 241a-d, 242a-d is essentially responsible for illumination in region R2, above cut-off.

[0124] An automotive lamp (e.g. 10) for a vehicle (see for instance the support/reflector P in Figure 2) as exemplified herein may therefore comprise:

a lamp body (e.g. 12, 161, 162) extending in a longitudinal direction (e.g. X10) between a rear base end (e.g. 10a) and a front end (e.g. 10b), the lamp body having opposed concave lateral recesses (e.g. 221, 222) therein, the recesses having respective planar bottom surfaces (e.g. 141a, 142a) separated by a narrowed body portion (e.g. 12) therebetween, as well as respective light-reflective peripheral surfaces (e.g. 241a-d, 242a-d) surrounding said planar bottom surfaces,

solid-state light sources (e.g. 141, 142) arranged at said planar bottom surfaces of the lateral recesses, wherein the light sources comprise linear arrays of light generators extending in said longitudinal direction between opposed array ends, the light sources being activatable to project light radiation away from said planar bottom surfaces, with the light radiation from the light sources partly reflected by said peripheral surfaces of said recesses,

wherein:

the peripheral surfaces of said lateral recesses comprise a pair of longitudinal planar faces extending sidewise of a linear array of light generators located therebetween and a pair of transversal planar faces, spaced along said longitudinal direction and facing opposed ends of said linear array of light generators,

said pair of longitudinal planar faces comprises a first longitudinal face (e.g. 241a, 242a) and a second longitudinal face (e.g. 241b, 242b), wherein the linear array of light generators extending therebetween is arranged closer to the second longitudinal face than to the first longitudinal face,

said pair of transversal planar faces comprises a first transversal face (e.g. 241c, 242c) towards the front end of the lamp body, and a second transversal face (e.g. 241d, 242d) towards the rear end of the lamp body, wherein the first transversal face has a surface area smaller than the surface area of the second transversal face.

[0125] In a lamp as exemplified herein, the first longitudinal face may have a surface area smaller than the surface area of the second longitudinal face.

[0126] In a lamp as exemplified herein, said second transversal face in said pair of transversal planar faces may have arcuate boundaries, that is, may be fingernail-shaped.

[0127] In a lamp as exemplified herein, said lateral recesses may extend between a first (e.g. T1) and a second (e.g. T2) circular cross-sectional planes of the lamp body, with said first transversal face adjacent the first cross-sectional plane and the second transversal face adjacent the second cross-sectional plane.

[0128] In a lamp as exemplified herein, the lamp body may be radially larger at the second cross-sectional plane than at the first cross-sectional plane.

[0129] In a lamp as exemplified herein, the planar bottom surfaces of the lateral recesses may be parallel to a diametrical plane (e.g. D10) of the lamp body extending along said longitudinal direction through said narrowed body portion.

[0130] In a lamp as exemplified herein, said lateral recesses may be mirror-symmetrical with respect to said diametrical plane.

[0131] In a lamp as exemplified herein, the first longitudinal planar face (e.g. 241a, 242a) and the second longitudinal planar face (e.g. 241b, 242b) in said pair of longitudinal planar faces may lie in planes forming to said diametrical plane, externally of the recess, first and second angles (e.g. α) of approximately 10 degrees.

[0132] That is, the first longitudinal planar face and the second longitudinal planar face in said pair of longitudinal planar faces may lie in planes inclined with respect to said diametrical plane at first and second angles of approximately 10 degrees, measured externally of the recess.

[0133] In a lamp as exemplified herein, in said pair of transversal planar faces:

the first transversal planar face (e.g. 241c-242c) may lie in a plane forming to said diametrical plane, externally of the recess, a first angle of a first value (e.g. β),
said second transversal planar face (e.g. 241d-242d) may lie in a plane forming to said diametrical plane, externally of the recess, a second angle of a second value (e.g. γ),
wherein the second value is smaller than the first value.

[0134] That is, in said pair of transversal planar faces:

the first transversal planar face may lie in a plane inclined with respect to said diametrical plane at a first angle of a first value, measured externally of the recess,
said second transversal planar face may lie in a plane inclined with respect to said diametrical plane at a second angle of a second value, measured externally of the recess,
wherein the second value is smaller than the first value.

[0135] In a lamp as exemplified herein, said first value and said second value may be amount approximately to 21,5° and approximately to 85°, respectively.

[0136] In a lamp as exemplified herein:

the lamp body may comprise complementary pieces (e.g. 161, 162) and a plate-like member (e.g. 12) sandwiched therebetween,
the solid-state light sources may be mounted on the plate-like member,
the complementary pieces may include concave cavities (e.g. 221, 222) at the solid-state electrically powered light sources, wherein the plate-like member and the cavities of the complementary pieces provide said respective planar bottom surfaces and said respective peripheral surfaces of said lateral recesses in the lamp body.

[0137] In a lamp as exemplified herein, said respective peripheral surfaces and said respective planar bottom surfaces may exhibit both diffused and specular light reflectivity.

[0138] In a lamp as exemplified herein, said respective peripheral surfaces and said respective planar bottom surfaces may exhibit diffused light reflectivity values higher than specular light reflectivity values.

[0139] In a lamp as exemplified herein, said respective peripheral surfaces may exhibit a total light reflectivity higher than the total light reflectivity of said respective planar bottom surfaces.

[0140] A lamp as exemplified herein may comprise a sculptured heat-dissipative structure at said back end of the lamp body.

[0141] In a lamp as exemplified herein, said solid-state light radiation sources may comprise LED light sources, optionally top-emitting light sources.

[0142] In a lamp as exemplified herein:

said lamp body may have a longitudinal (optical) axis extending in said longitudinal direction,
said light sources may comprise linear arrays of light generators extending in said longitudinal direction at said longitudinal axis (that is with the longitudinal midline thereof centered or substantially centered with the axis X10),
said longitudinal planar faces may extend sidewise of said linear array of light generators in a laterally offset position with respect to said longitudinal axis.

[0143] A method of using a lamp as exemplified herein may comprise mounting (e.g. with member 20) the lamp on a vehicle (e.g. on a support/reflector P) with said respective planar bottom surfaces arranged vertically and said respective light-reflective peripheral surfaces surrounding said planar bottom surfaces having said second longitudinal face placed higher than said first longitudinal face (see for instance Figure 2).

[0144] Without prejudice to the basic principles, the implementation details and the embodiments may vary, even appreciably, from what has been described herein by way of non-limiting example only, without departing from the extent of protection.

[0145] The extent of protection is determined by the annexed claims.

LIST OF REFERENCE SIGNS

Lamp	10
Rear end	10a
Front end	10b
Longitudinal axis	X10
Diametrical plane	D10
Plate-like member	12
Light sources (LEDs)	141, 142
Bottom surfaces	141a, 141b
Complementary pieces	161, 162
Screws	18
Mounting member	20
Sealing formation	20a
Flange of mounting member	200a
Electrical/electronic circuits	21
Recesses/cavities	221, 222
Openings at bottom of recesses/cavities	261, 262
Faces of recesses/cavities	241a-d, 242a-d
Support member/reflector	P
Angles of faces	α, β, γ
Cross-sectional planes	T1, T2
Reference plane	RP
Length of LED array	A
Distance between LED and reference plane	B
Regions below/above cut-off	R1, R2

Claims

1. An automotive solid-state lamp (10) for a vehicle (P), comprising:

a lamp body (12, 161, 162) extending in a longitudinal direction (X10) between a rear base end (10a) and a front end (10b), the lamp body having opposed concave lateral recesses (221, 222) therein, the recesses having respective planar bottom surfaces (141a, 142a) separated by a narrowed body portion (12) therebetween as well as respective light-reflective peripheral surfaces (241a-d, 242a-d) surrounding said planar bottom surfaces (141a, 142a),
solid-state light sources (141, 142) arranged at said planar bottom surfaces (141a, 142a) of the lateral recesses (221, 222), wherein the light sources (141, 142) comprise linear arrays of light generators extending in said longitudinal direction (X10) between opposed array ends, the light sources (141, 142) activatable to project light radiation away from said planar bottom surfaces (141a, 142a) with light radiation from the light sources (141,

142) partly reflected by said peripheral surfaces (241a-d, 242a-d) of said recesses (221, 222), wherein:

the peripheral surfaces of said lateral recesses (221, 222) comprise a pair of longitudinal planar faces (241a-b, 242a-b) extending sidewise of a linear array of light generators (141, 142) therebetween and a pair of transversal planar faces (241c-d, 242c-d) spaced along said longitudinal direction (X10) facing opposed ends of said linear array of light generators (141, 142),
said pair of longitudinal planar faces (241a-b, 242a-b) comprises a first longitudinal face (241a, 242a) and a second longitudinal face (241b, 242b) wherein the linear array of light generators (141, 142) extending therebetween is arranged closer to the second longitudinal face (241b, 242b) than to the first longitudinal face (241a, 242a),
said pair of transversal planar faces (241c-d, 242c-d) comprise a first transversal face (241c, 242c) towards the front end (10b) of the lamp body (12, 161, 162) and a second transversal face (241d, 242d) towards the rear end (10a) of the lamp body (12, 161, 162), wherein the first transversal face (241c, 242c) has a surface area smaller than the surface area of the second transversal face (241d, 242d), the first longitudinal face (241a, 242a) has a surface area smaller than the surface area of the second longitudinal face (241b, 242b).

2. The lamp (10) of claim 1, wherein said second transversal face (241d, 242d) in said pair of transversal planar faces (241c-d, 242c-d) has arcuate boundaries.

3. The lamp (10) of any of the previous claims, wherein said lateral recesses (221, 222) extend between first (T1) and second (T2) circular cross-sectional planes of the lamp body (12, 161, 162) with the first transversal face (241c, 242c) adjacent the first cross-sectional plane (T1) and the second transversal face (241d, 242d) adjacent the second cross-sectional plane (T2) .

4. The lamp (10) of claim 3, wherein the lamp body (12, 161, 162) is radially larger at the second cross-sectional plane (T2) than at the first cross-sectional plane (T1).

5. The lamp (10) of any of the previous claims, wherein said planar bottom surfaces (141a, 142a) of the lateral recesses (221, 222) are parallel to a diametrical plane (D10) of the lamp body (12, 161, 162) extending along said longitudinal direction (X10) through said narrowed body portion (12).

6. The lamp (10) of claim 5, wherein said lateral recesses (221, 222) are mirror-symmetrical with respect to said diametrical plane (D10).

7. The lamp (10) of claim 5 or claim 6, wherein the first longitudinal planar face (241a, 242a) and the second longitudinal planar face (241b, 242b) in said pair of longitudinal planar faces (241a-b, 242a-b) lie in planes inclined with respect to said diametrical plane (D10) at first and second angles (α) of approximately 10 degrees, measured externally of the recess (221, 222).

8. The lamp (10) of any of claims 5 to 7, wherein in said pair of transversal planar faces (241c-d, 242c-d) :

the first transversal planar face (241c-242c) lies in a plane inclined with respect to said diametrical plane (D10) at a first angle of a first value (β), measured externally of the recess (221, 222),
said second transversal planar face (241d-242d) lies in a plane inclined with respect to said diametrical plane (D10) at a second angle of a second value (γ), measured externally of the recess (221, 222),
wherein the second value (γ) is smaller than the first value (β).

9. The lamp (10) of claim 8, wherein said first value (β) and said second value (γ) are approximately 85 degrees and approximately 21.5 degrees, respectively.

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

the lamp body (12, 161, 162) comprises complementary pieces (161, 162) and a plate-like member (12) sandwiched therebetween,
the solid-state light sources (141, 142) are mounted on the plate-like member (12),
the complementary pieces (161, 162) include concave cavities (221, 222) at the solid-state light sources (141,

142), wherein the plate-like member (12) and the cavities (221, 222) the complementary pieces (161, 162) provide said respective planar bottom surfaces and said respective peripheral surfaces of said lateral recesses in the lamp body (12, 161, 162).

11. The lamp (10) of any of the previous claims, wherein said respective peripheral surfaces (241a-d, 242a-d) and said respective planar bottom surfaces (141a, 142a) exhibit both diffused and specular light reflectivity.

12. The lamp (10) of claim 11, wherein said respective peripheral surfaces (241a-d, 242a-d) and said respective planar bottom surfaces (141a, 142a) exhibit diffused light reflectivity values higher than specular light reflectivity values.

13. The lamp (10) of claim 11 or claim 12, wherein said respective peripheral surfaces (241a-d, 242a-d) exhibit a total light reflectivity higher than the total light reflectivity of said respective planar bottom surfaces (141a, 142a).

14. The lamp (10) of any of the previous claims, comprising a sculptured heat-dissipative structure at said back end (10a) of the lamp body (12, 161, 162).

15. The lamp (10) of any of the previous claims, wherein said solid-state light sources comprise LED light sources (141, 142).

16. The lamp (10) of claim 16, wherein said solid-state light sources comprise top-emitting LED light sources (141, 142).

17. The lamp (10) of any of the previous claims, wherein:

said lamp body (12, 161, 162) has a longitudinal axis (X10) extending in said longitudinal direction,
said light sources (141, 142) comprise linear arrays of light generators extending in said longitudinal direction at said longitudinal axis (X10),
said longitudinal planar faces (241a-b, 242a-b) extend sidewise of said linear array of light generators (141, 142) in a laterally offset position with respect to said longitudinal axis (X10).

18. A method of using the lamp (10) of any of the previous claims, the method comprising mounting (20) the lamp (10) on a vehicle (P) with said respective planar bottom surfaces (141a, 142a) arranged vertically and said respective light-reflective peripheral surfaces (241a-d, 242a-d) surrounding said planar bottom surfaces (141a, 142a) having said second longitudinal face (241b, 242b) placed higher than said first longitudinal face (241a, 242a).

FIG. 1 PRIOR ART

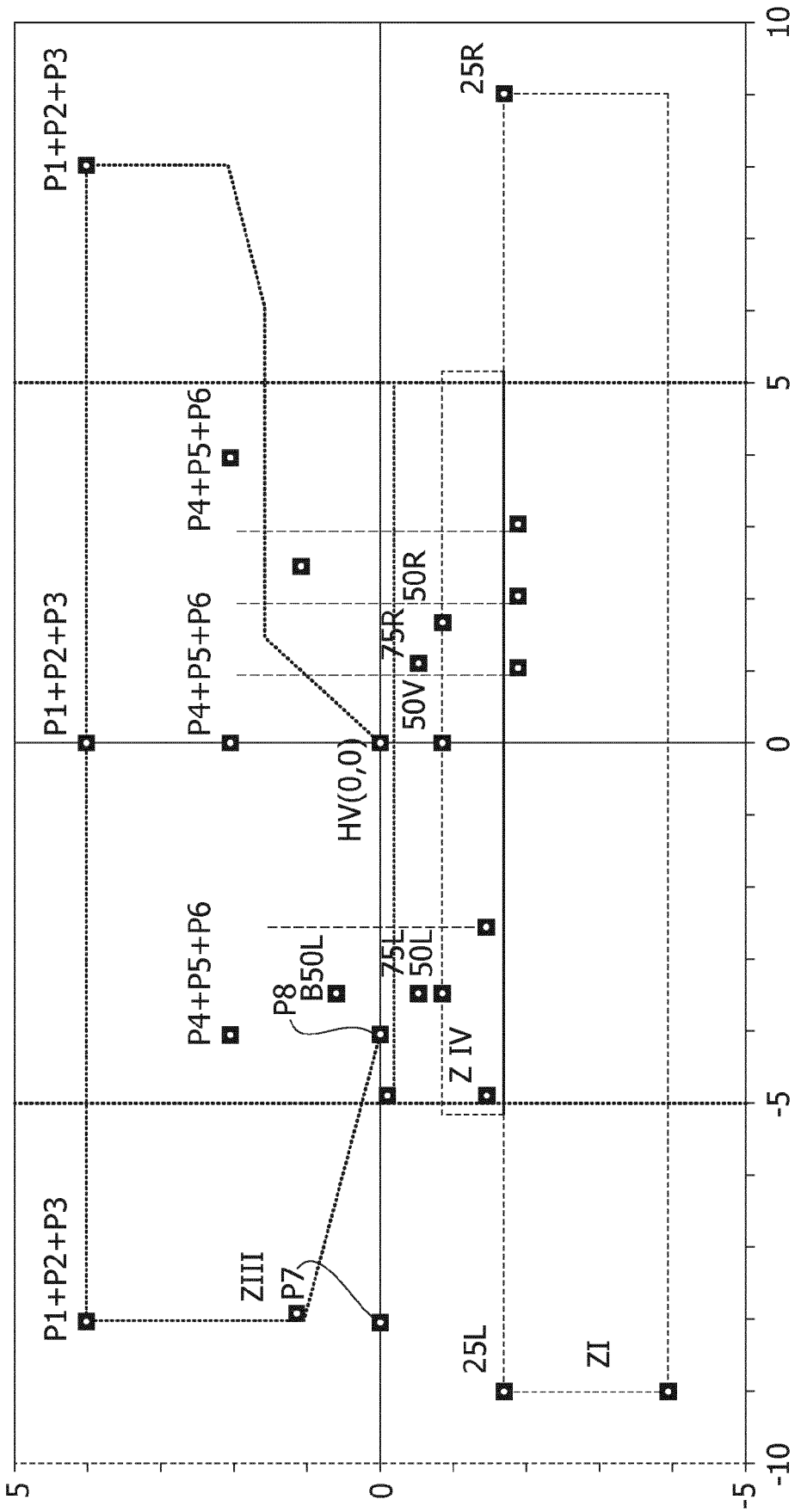
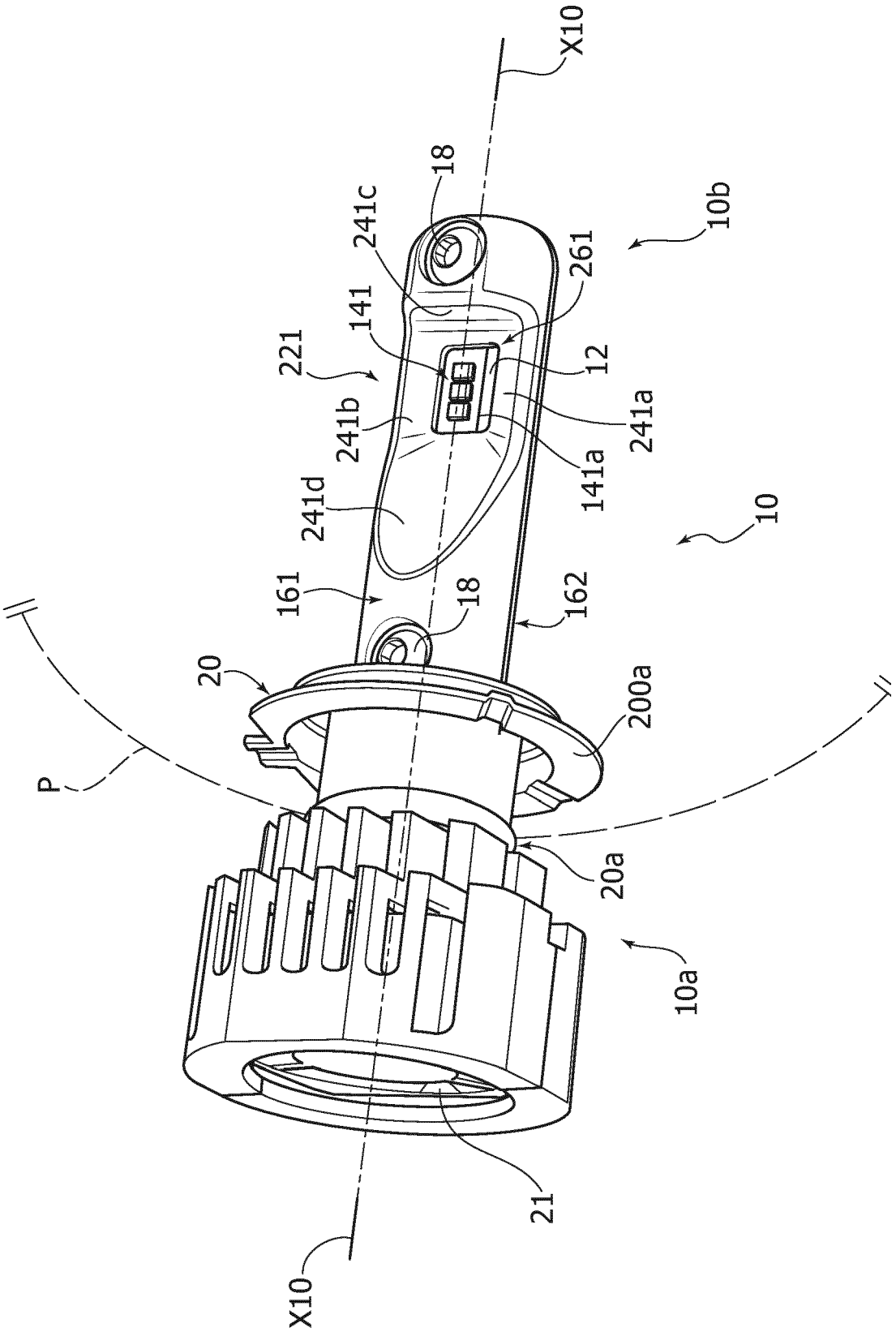


FIG. 2


X10
18
241c
261
10b
141
221
12
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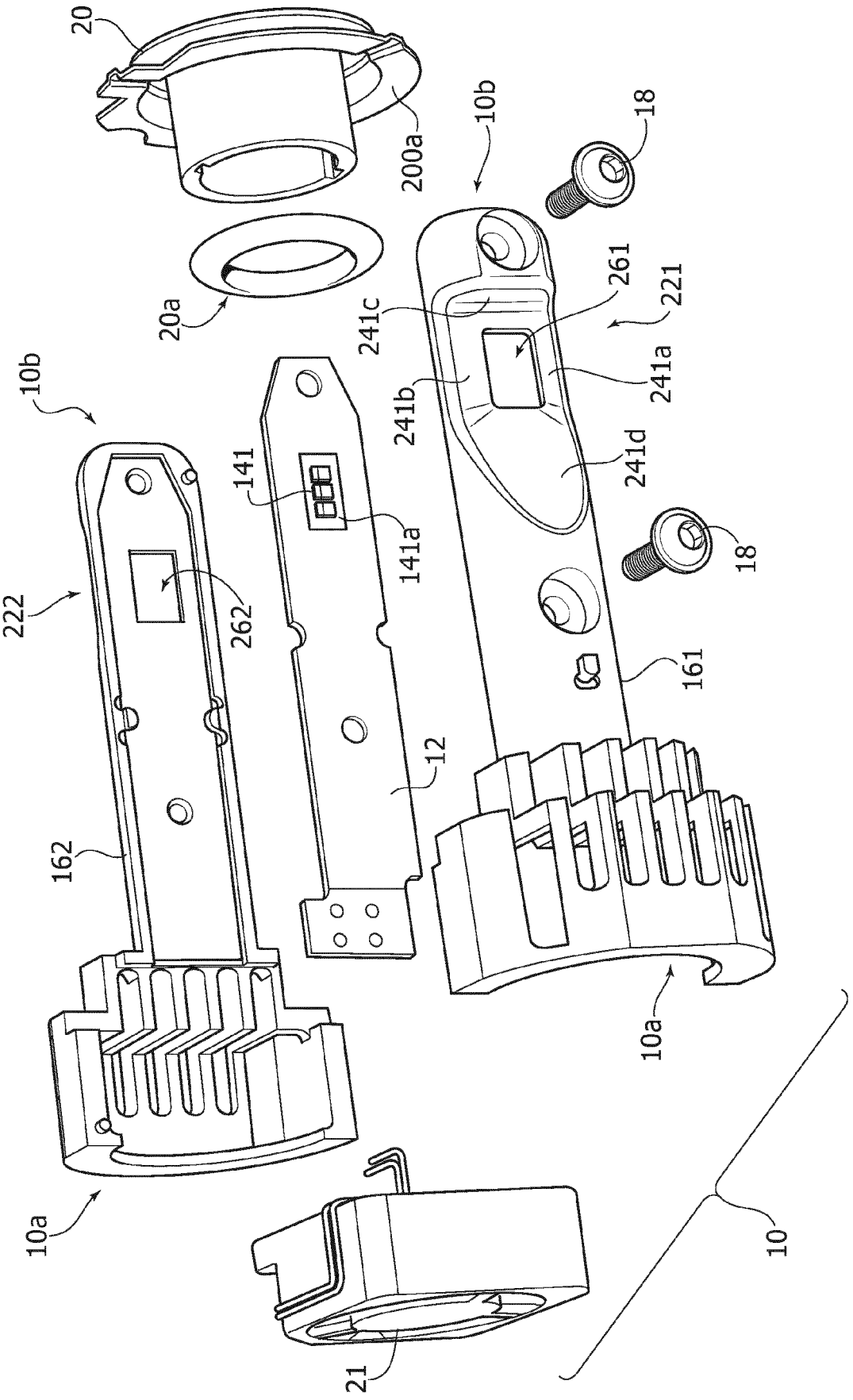
161
18
162
20
200a
P
20a
10a
21
X10

FIG. 3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161
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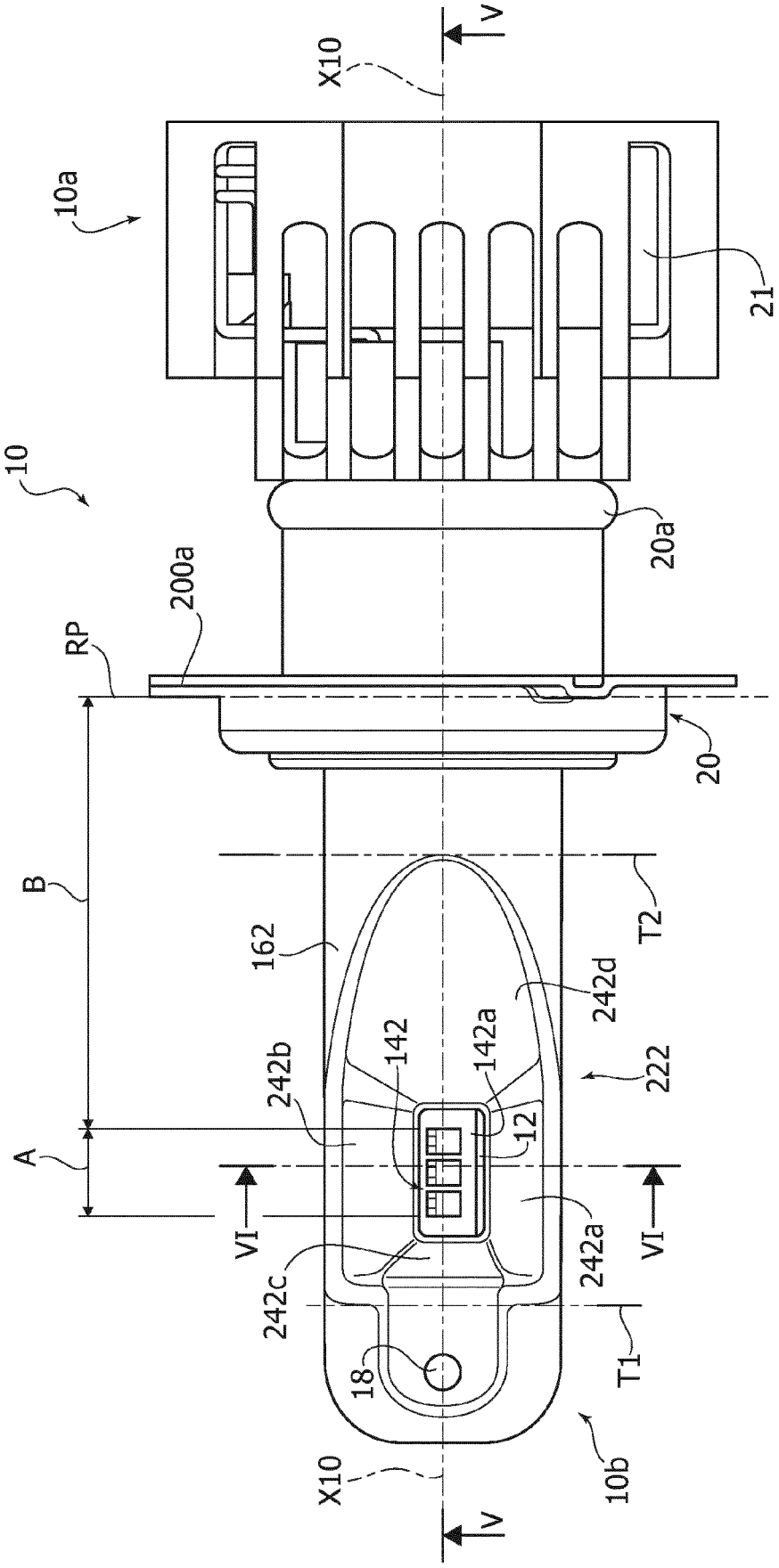
162
10a
10a
10
21

FIG. 4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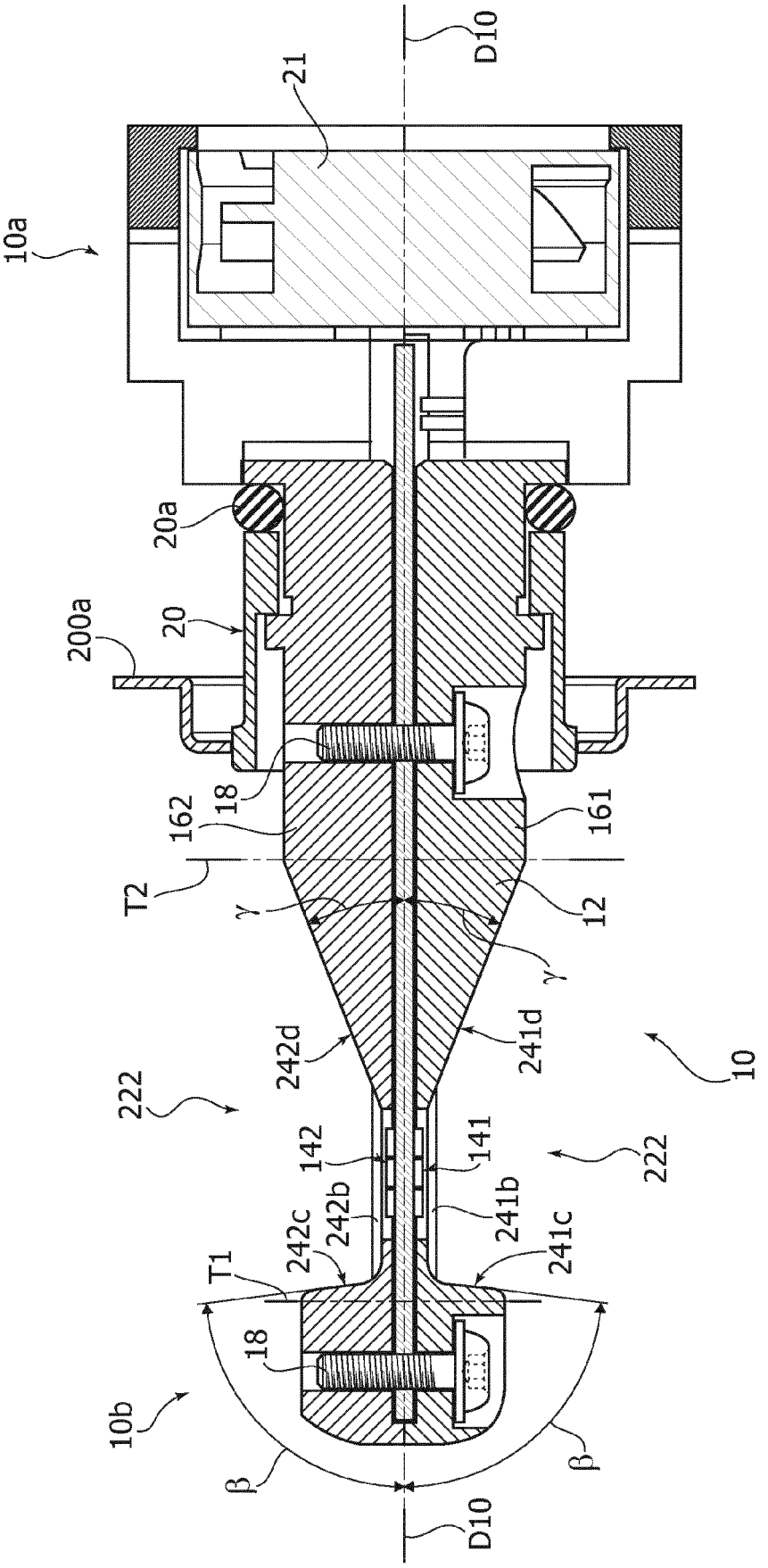
X10
10a
21
10
20a
200a
RP
20
B
T2
162
242d
142
142a
242b
222
12
A
VI
VI
242a
242c
T1
18
X10
V
10b

FIG. 5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161
T2
γ
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γ
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241d
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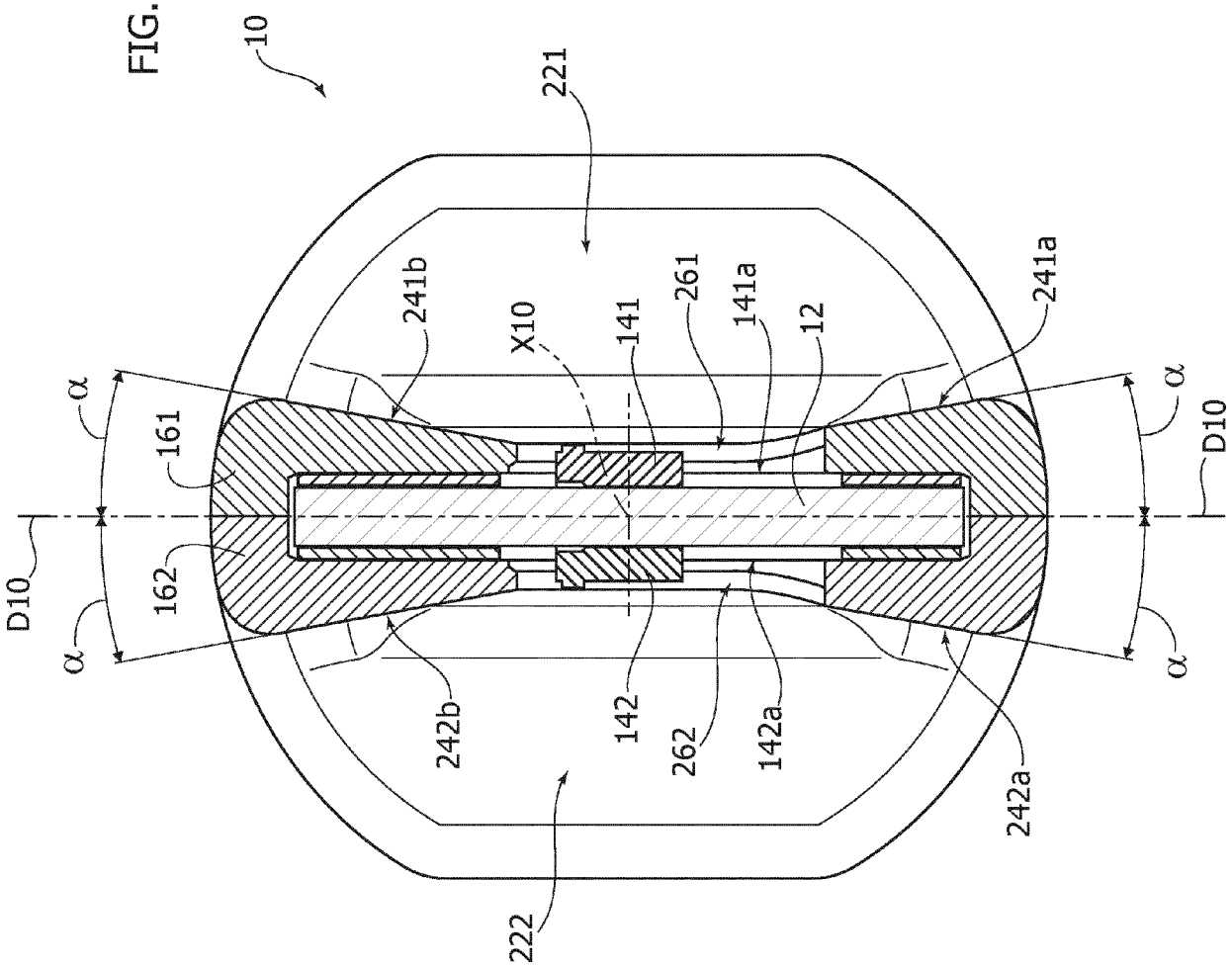
242c
242b
241b
241c
T1
18
10b
β
β
D10

FIG. 6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221
241b
X10
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α
161
D10
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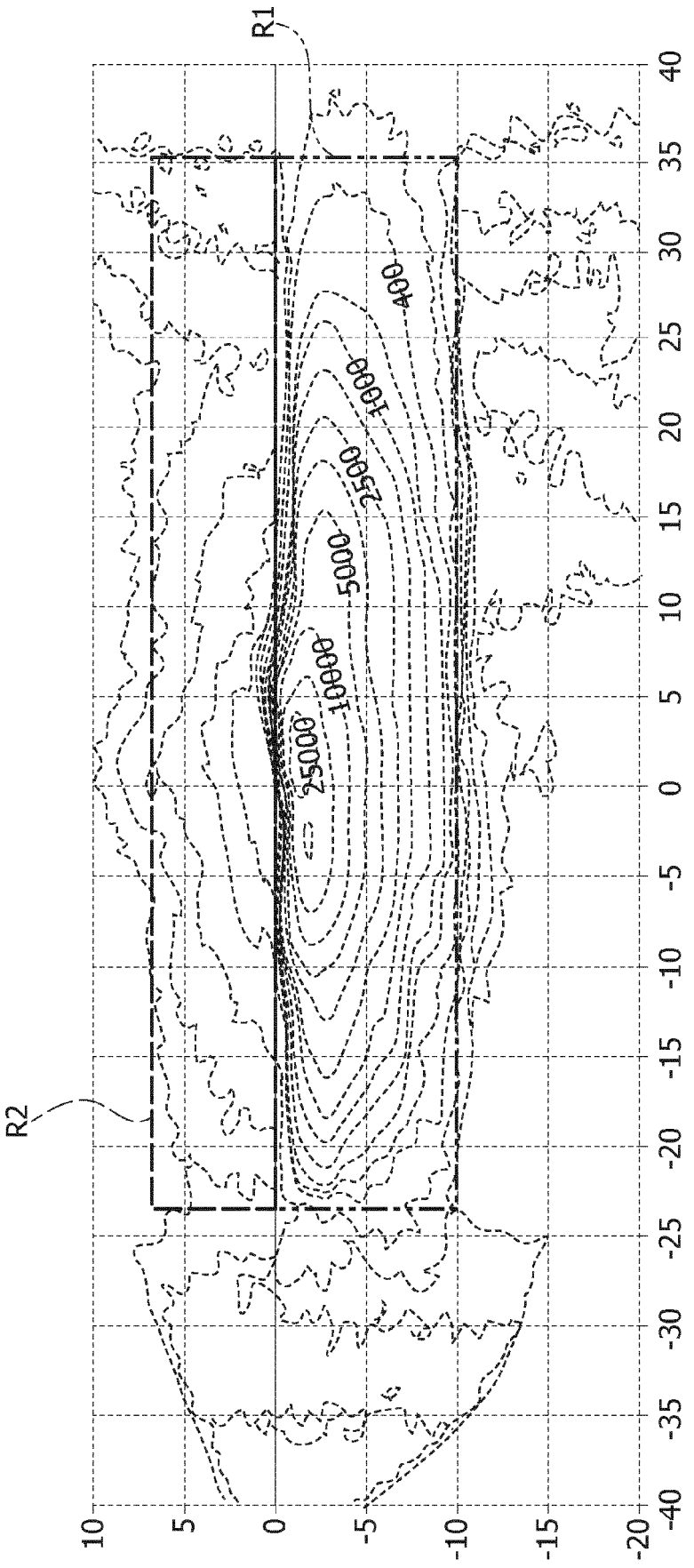
242a
222

FIG. 7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EUROPEAN SEARCH REPORT

Application Number
EP 20 20 9701

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	JP 3 197657 U (NOT KNOWN) 28 May 2015 (2015-05-28) * paragraph [0022] * * figures 1-4 *	1-18	INV. F21K9/23 F21K9/68 F21S41/148 F21V7/04
A,D	CN 207 438 161 U (OSRAM GMBH) 1 June 2018 (2018-06-01) * figures 1-3 *	1-18	ADD. F21Y103/10 F21Y107/90
A	CN 204 387 895 U (GUANGZHOU RAYTON LIGHTING TECHNOLOGY CO LTD) 10 June 2015 (2015-06-10) * figure 1 *	1	F21Y115/10
A	JP 2018 190488 A (IPF LTD) 29 November 2018 (2018-11-29) * paragraph [0020] * * figure 1 *	1	

TECHNICAL FIELDS SEARCHED (IPC)

F21K
F21S
F21V
F21Y

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	19 January 2021	Allen, Katie

CATEGORY OF CITED DOCUMENTS

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19-01-2021

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