



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**30.05.2018 Bulletin 2018/22**

(21) Application number: **17200913.6**

(22) Date of filing: **09.11.2017**

(51) Int Cl.:  
**F21V 3/04** <sup>(2018.01)</sup> **F21S 4/22** <sup>(2016.01)</sup>  
**F21V 31/00** <sup>(2006.01)</sup> **F21V 17/10** <sup>(2006.01)</sup>  
**F21Y 103/10** <sup>(2016.01)</sup> **F21Y 115/10** <sup>(2016.01)</sup>  
**F21Y 107/90** <sup>(2016.01)</sup>

(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 MK MT NL NO PL PT RO RS SE SI SK SM TR**  
Designated Extension States:  
**BA ME**  
Designated Validation States:  
**MA MD**

(30) Priority: **25.11.2016 IT 201600119677**

(71) Applicants:  
• **OSRAM GmbH**  
**80807 München (DE)**  
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 MK MT NL NO PL PT RO RS SE SI SK SM TR**

• **OSRAM S.P.A. - SOCIETA' RIUNITE OSRAM EDISON CLERICI**  
**20126 Milano (IT)**

(72) Inventors:  
• **ZANOTTO, Alberto**  
**I-35127 Padova (IT)**  
• **DIDONE', Roberto**  
**I-36027 Rosà (Vicenza) (IT)**  
• **BALDO, Lorenzo**  
**I-31040 Giavera del Montello (Treviso) (IT)**

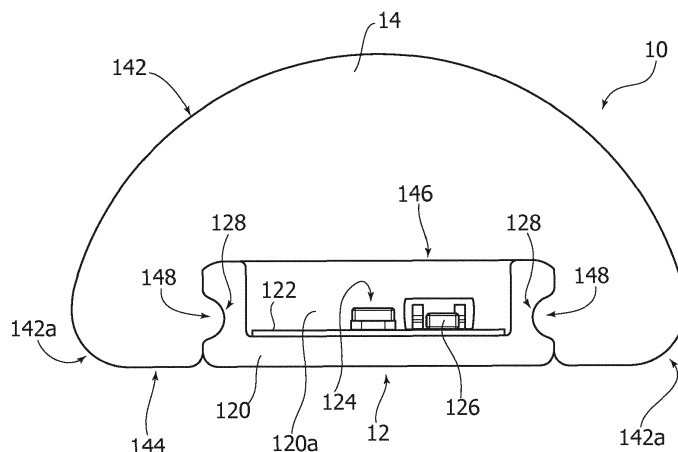
(74) Representative: **Bosotti, Luciano et al Buzzi, Notaro & Antonielli d'Oulx**  
**Corso Vittorio Emanuele II, 6**  
**10123 Torino (IT)**

(54) **A LIGHTING DEVICE AND CORRESPONDING METHOD**

(57) A lighting device (10) includes:  
- at least one elongate lighting module (12) having at least one support surface (122) with an array of electrically-powered light radiation sources (124), e.g. LED sources, thereon, and  
- an elongate cover member including light-diffusive material.

The cover member includes at least one roof-tile-shaped portion (14) having a convex outer surface (142) and a cavity (146) opposite outer surface (142). The elongate lighting module (12) is arranged within cavity (146), so that light radiation from light radiation sources (124) propagates through the light-diffusive material of cover member (14).

FIG. 2



## Description

### Technical Field

**[0001]** The present description relates to lighting devices.

**[0002]** One or more embodiments may refer to lighting devices employing electrically-powered light radiation sources, e.g. solid-state lighting sources such as LED sources.

### Technological Background

**[0003]** In the sector of lighting technology the interest is increasing for lighting devices (modules) employing solid-state light radiation sources, such as linear LED sources.

**[0004]** In such devices, it is desirable to have a light radiation emission pattern extending over wide angles, if possible all around the module.

**[0005]** Flexible linear modules, e.g. LED modules, are available both as unprotected modules and as modules protected against the penetration of external agents, e.g. having an IP protection degree.

**[0006]** Unprotected modules may be used e.g. in indoor applications, while protected modules are adapted to be used both indoors and outdoors.

**[0007]** In order to implement a protected module, different solutions may be resorted to, e.g. applying potting masses, extrusion, coextrusion and the like.

**[0008]** For example, in a protected module, the light radiation emission dots located at the light radiation sources may be made visible or not visible, even though the light radiation emitting area is only a part of the surface or external shape of the module.

**[0009]** In order to achieve a uniform and diffuse emission in all direction it is possible to use diffusive covers, e.g. tubular sheaths adapted to be fitted onto the lighting device. In this way it is possible to achieve emission patterns over angles higher than 120°.

**[0010]** This, however, may entail a reduction of the luminous flux emitted by the module, in some cases without achieving a wholly satisfactory uniformity.

**[0011]** For example, document US 6 860 007 B1 describes the use of a tubular element in order to create a structure grossly resembling a rope with a LED structure. The tubular element is not sealed on the module and is not diffusive.

**[0012]** Document US 7 210 818 B2 describes a module which may be bent in a plurality of directions, having a plastic tubular element around it, which however does not tackle with the problem of light radiation distribution and of the diffusive effect.

**[0013]** Essentially, both previously quoted documents may be seen as relating to spot lighting.

## Object and Summary

**[0014]** One or more embodiments aim at overcoming the drawbacks of the previously described solutions, e.g. as regards the possibility of implementing modules, e.g. LED modules, having an IP protection degree and emission angles adapted to achieve values from 270° to 360°.

**[0015]** According to one or more embodiments, said object may be achieved thanks to a lighting device having the features set forth in the claims that follow.

**[0016]** One or more embodiments may also concern a corresponding method.

**[0017]** The claims are an integral part of the technical teaching provided herein with reference to the embodiments.

**[0018]** One or more embodiments are applicable both to protected (e.g. LED) modules having a diffuse emission, wherein the single light radiation sources are not clearly distinguishable from the outside, and to protected modules wherein the single light radiation sources are distinguishable, the possibility being given to achieve higher power efficiency than is the case with modules having diffuse emission.

**[0019]** One or more embodiments may achieve one or more of the following advantages:

- (complete) emitting areas having values which may reach 270°-360°, i.e. offering the possibility of replacing traditional light radiation sources while keeping the flexibility of the module,
- a wide range (portfolio) of modules which may be achieved by using the same basic materials,
- possibility of changing the external shape and/or the optical properties of the device by acting only on an external profile (e.g. a silicone profile), without the need to change production processes,
- a plurality of profiled elements (e.g. two profiled elements of a material such as silicone) may be combined e.g. while keeping fixation during the production process,
- a high efficiency is obtained due to the properties of the materials (e.g. extruded silicone) which may be used to produce the device,
- high lighting uniformity, achievable thanks to diffusive particles (e.g. of TiO<sub>2</sub> or Al<sub>2</sub>O<sub>3</sub>) in the profiled element,
- possibility of using a high flux LED module as a luminaire.

### Brief Description of the Figures

**[0020]** One or more embodiments will now be described, by way of non-limiting example only, with reference to the annexed Figures, wherein:

- Figure 1 is a perspective view of a component which may be used in one or more embodiments,
- Figure 2 is a cross-sectional view of a lighting device

- employing a component as exemplified in Figure 1,
- Figure 3 is a cross-sectional view of a lighting device employing a plurality of components as exemplified in Figure 1,
- Figure 4 is a perspective view of one or more embodiments,
- Figure 5 is a section along line V-V of Figure 4,
- Figure 6 is a perspective view of embodiments,
- Figure 7 is a section view along line VII-VII of Figure 6, and
- Figure 8 is a perspective view of one or more embodiments.

**[0021]** It will be appreciated that, for simplicity and clarity of illustration, the various Figures may not be drawn to the same scale.

#### Detailed Description

**[0022]** In the following description, various specific details are given to provide a thorough understanding of various exemplary embodiments of the present specification. One or more embodiments may be practiced 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 various aspects of the embodiments. Reference throughout this specification to "one embodiment" or "an 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 one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment. Furthermore, particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments.

**[0023]** The headings provided herein are for convenience only, and therefore do not interpret the extent of protection or scope of the embodiments.

**[0024]** In the Figures, reference 10 denotes an elongate (optionally ribbon-like and/or flexible) lighting device, adapted to employ electrically-powered light radiation sources, e.g. solid-state light radiation sources such as LED sources.

**[0025]** Such a device may include, in one or more embodiments, a light emitting module 12 adapted to include e.g. a channel-shaped casing 120 containing a support 122 substantially similar to a Printed Circuit Board (PCB), optionally a Flexible Printed Circuit (FPC), whereon there are distributed electrically-powered light radiation sources 124, e.g. LED sources.

**[0026]** In one or more embodiments, support 122 may also host electrical/electronic components 126, having the functions of supplying, driving, controlling etc. the light radiation sources 124.

**[0027]** Such lighting modules are known in the art,

which makes it unnecessary to provide a more detailed description herein.

**[0028]** One or more embodiments as exemplified in the Figures 3 and following may envisage the presence of a casing 120 having an H-shaped cross section, which is adapted to be obtained by juxtaposing back-to-back (and optionally to form in one-piece) two channel-shaped casings 120 as shown in Figure 2.

**[0029]** In one or more embodiments, the use of a section profile as exemplified in Figures 3 and following leads to having two opposite surfaces for locating two supports (PCB/FPC) 122, both adapted to be "peopled" with light radiation sources 124, with optional associated circuits 126.

**[0030]** In one or more embodiments as exemplified in Figure 2, the light radiation emitted by sources 124 will be directed towards a half-space corresponding to the lying plane of support 122, i.e. by the plane of extension of the bottom wall of casing 120.

**[0031]** In one or more embodiments as exemplified in Figures 3 and following, the radiation emitted by sources 124, arranged on both opposite faces of the central or core wall of casing 120, will be directed towards both opposite half-spaces lying on both sides of said core wall, i.e., at least approximately, towards all the space surrounding device 10.

**[0032]** In this respect it will be remarked, moreover, that as far as the present case is concerned the lighting module 12, and therefore device 10 as exemplified in the Figures, may be considered in themselves as having an indefinite length, and are adapted to be cut to length according to the application and usage needs.

**[0033]** In one or more embodiments, the light radiation emitting module 12 may be coupled to (at least) one cover member 14 (shown in Figure 1) which is adapted to have a general roof-tile-like shape, having e.g.:

- a generally convex external or front surface 142, e.g. extending, at least approximately, on a cylindrical surface which constitutes the outer surface of cover member 14, and
- a substantially planar back surface 144 (e.g. transitioning to rounded ends 142a of front or outer surface 142), provided with a cavity 146 adapted to act as a receiving cavity for module 12.

**[0034]** In one or more embodiments, cover member 14 (i.e. cavity 146) and casing 120 of module 12 may have complementary engaging formations (such as ribs 148 protruding from cover member 14, adapted to engage grooves 128 provided on the inner surface of the side walls of casing 120) so as to strengthen the mounting condition of module 12 within cover member 14.

**[0035]** In one or more embodiments, on one or both sides the location of such complementary engaging formations may be inverted with respect to what exemplified herein, i.e. with ribs on module 12 and grooves in cover member 14.

**[0036]** In one or more embodiments, module 12 may be placed within cover member 14:

- either by means of a lengthwise relative sliding motion, e.g. by inserting module 12 into cover member 14 by sliding it along cavity 146,
- or by means of a snap fit mechanism, e.g. by taking advantage of the compliance (e.g. elastic property) of cover member 14, adapted to include a plastic element having elastic properties.

**[0037]** In one or more embodiments, cavity 146 (and therefore module 12 placed therein) may be contained nearly completely within the section profile of cover member 14, the bottom wall of casing 120 being practically flush with the back surface 144 of cover member 14.

**[0038]** To state it differently, in one or more embodiments (see for example Figure 2), the envelope of the cross section of module 12 is nearly completely contained in the envelope of the cross section of cover member 14.

**[0039]** In other words (for immediate reference see Figure 2), the front surface 142 of cover member 14 may be seen as having an arch-shaped cross-section profile which extends between both ends 142a, with the bottom wall of casing 120 of module 12 lying in a so-to-say "chordal" plane with respect to the extension path of the outer surface 142 of cover member 14.

**[0040]** In one or more embodiments, cover member 14 may include a light-permeable material, adapted to be defined as a translucent/semi-transparent or diffusive material.

**[0041]** In one or more embodiments, it may be a transparent (e.g. silicone) material embedding light diffusive particles (e.g.  $\text{TiO}_2$  or  $\text{Al}_2\text{O}_3$ ) dispersed therein.

**[0042]** In one or more embodiments, cover member 14 is adapted to perform both the function of closing module 12, i.e. of protecting it against the penetration of external agents, and the function of diffusing the light radiation emitted by light radiation sources 124.

**[0043]** It will be appreciated (see e.g. Figure 2) that the previously described geometry of the elements causes the light radiation sources 124 (and particularly the Light Emitting Surfaces (LESs) thereof) to be located in an at least approximately central position with respect to the arched (e.g. approximately semi-circular) path of the section profile of external surface 142 of cover member 14.

**[0044]** As regards the protective action against external agents (e.g. an IP protection degree), in one or more embodiments it is possible to use either a bare, i.e. unprotected, module 12, or a module 12 which is protected in itself, e.g. because the inner cavity of casing 120, which hosts sources 124 and optionally circuits 126, contains a filling of sealing material 120a (e.g. polyurethane, silicone material, polycarbonate, etc.).

**[0045]** In one or more embodiments a satisfactory tradeoff may be achieved between the intensity of the emitted luminous flux and the uniformity of the light radi-

ation emission, e.g. by controlling the amount of diffusive particles in the material of cover member 14 (and optionally in the sealing material 120a).

**[0046]** The increase of the amount of such diffusive particles may determine a higher uniformity, with a reduction of the luminous flux. In a complementary way, the reduction of the amount of such diffusive particles may bring about a higher luminous flux having lower uniformity.

**[0047]** One or more embodiments as exemplified in Figure 2 (employing only one module 12 having light radiation sources 124 arranged on one of the faces thereof and only one roof-tile-shaped cover member 14) lead to achieving a light radiation emission surface over about  $270^\circ$  (i.e. at least approximately over a dihedral angle of  $270^\circ$ , the edge whereof is aligned with device 10).

**[0048]** A solution as exemplified in Figure 3, which may be seen as obtained by coupling two devices as exemplified in Figure 2 back-to-back, with the back surfaces 144 of two portions 14 of cover member and the bottom walls of casings 120 of both modules 12 adjoining each other, may originate an emission surface over  $360^\circ$ , i.e. so as to practically cover all the space surrounding device 10.

**[0049]** For the connection of both complementary elements exemplified in Figure 3 it is possible to resort e.g. to glueing.

**[0050]** Figures 4 and 5 exemplify the possibility, in one or more embodiments, to "fuse" both modules 12 shown in Figure 3 together, thereby originating one single module 12 having a casing with an H-shaped cross-section profile.

**[0051]** One or more embodiments as exemplified in Figures 4 and 5 may offer the advantage of a higher compactness of the group, while preserving the separation between two portions of roof-tile-shaped cover member 14, adapted to be coupled e.g. by glueing, optionally (also) taking advantage of the fact that each such cover member 14 is coupled (e.g. via complementary formations such as ribs 148 and grooves 128) to two branches or portions of the single module 12.

**[0052]** Figures 6 and 7 exemplify the possibility, in one or more embodiments, of further integrating the components of device 10 so that both portions 14 are completely fused with each other in a single cover body having a tubular structure, with the back surfaces 14 therefore becoming "virtual" surfaces, because the portions 14 of cover members 14 are fused with each other to be one piece, while cavities 146 are in turn fused with each other, so as to form a central (axial) cavity of the tubular structure, deriving from the fusion of both portions of cover member 14 of the previous Figures.

**[0053]** In this case, the "twofold" module 12 (having an H cross-section profile) may be inserted into said tubular structure e.g. by sliding it with a relative sliding motion in the central cavity defined by the cavities 146 fused with each other.

**[0054]** The perspective view of Figure 8 exemplifies

one or more embodiments wherein module 12 may be implemented in a simplified form as a laminar support 122 (e.g. of silicone material) lodging on both faces light radiation sources 124 and optionally circuits 126 associated thereto.

**[0055]** Cross-section views such as the views in Figures 5 and 7 highlight the possibility, in one or more embodiments, of acting onto the shape of the wall of cavity 146 facing towards front surface 142 of cover member 14, passing from a substantially planar shape, as exemplified in Figure 3, to an at least slightly convex shape (e.g. with convexity facing towards front surface 142), thus bringing about an optional shaping effect on the light radiation pattern emitted from device 10.

**[0056]** It will be appreciated, moreover, that:

- in one or more embodiments, elements or features exemplified herein in any one of the annexed Figures may also be applied, alone or in mutual combination, to embodiments as exemplified in other Figures,
- in one or more embodiments, the solution exemplified in Figures 3 and following with reference to the possible presence, in the cover member, of two roof-tile-shaped portions 14 and/or of two modules 12, is adapted to be extended to the possible presence of a higher number of such elements (e.g., instead of two portions 14 each having an angular extension of 180°, in one or more embodiments there may be present e.g. three portions 14 with a respective angular extension of 120°, each having a respective module 12 inserted therein).

**[0057]** One or more embodiments may therefore envisage a lighting device (e.g. 10) including:

- at least one elongate lighting module (e.g. 12) having at least one support surface (e.g. 122) with an array of electrically-powered light radiation sources (e.g. 124) thereon, and
- an elongate cover member including light-diffusive material, the cover member including at least one roof-tile-shaped portion (e.g. 14) having a convex outer surface (e.g. 142) and a cavity (e.g. 146) opposite said outer surface, said elongate lighting module arranged within said cavity, wherein light radiation from said light radiation sources propagates through the light-diffusive material of said cover member.

**[0058]** In one or more embodiments, said light radiation sources may be located centrally (see e.g. Figure 2) of the convex outer surface of said at least one roof-tile-shaped portion.

**[0059]** In one or more embodiments, said at least one lighting module may include a sealed (e.g. with sealing mass 120a) casing for said light radiation sources.

**[0060]** One or more embodiments may include complementary coupling formations (e.g. 128, 148) between

said at least one lighting module and said cover member.

**[0061]** In one or more embodiments, said cover member may include a plurality of (e.g. two) said roof-tile-shaped portions, each said roof-tile-shaped portion including a convex outer surface and a cavity opposite said outer surface, with an elongate lighting module arranged within said cavity.

**[0062]** In one or more embodiments, said roof-tile-shaped portions of said plurality of roof-tile-shaped portions may be one-piece which each other, so that said elongate cover member includes a tubular member having said at least one lighting module extending lengthwise therein (see e.g. Figures 6 and 7).

**[0063]** One or more embodiments may include a lighting module (e.g. with H-shaped cross section: see e.g.

**[0064]** Figures 4 and following) having opposed support surfaces, each support surface with an array of electrically-powered light radiation sources thereon.

**[0065]** In one or more embodiments, said cover member and/or said at least one lighting module may include flexible material.

**[0066]** In one or more embodiments, said light-diffusive material may include light-permeable material having light-diffusive particles dispersed therein.

**[0067]** In one or more embodiments, said electrically-powered light radiation sources may include LED sources.

**[0068]** In one or more embodiments, a method of producing a lighting device (10) may include:

- providing at least one elongate lighting module having at least one support surface with an array of electrically-powered light radiation sources thereon, and
- coupling with said at least one lighting module an elongate cover member including light-diffusive material, the cover member including at least one roof-tile-shaped portion having a convex outer surface and a cavity opposite said outer surface, said elongate lighting module arranged within said cavity, wherein light radiation from said light radiation sources propagates through the light-diffusive material of said cover member.

**[0069]** Without prejudice to the basic principles, the implementation details and the embodiments may vary, even appreciably, with respect to what has been described herein by way of non-limiting example only, without departing from the extent of protection.

**[0070]** The extent of protection is defined by the annexed claims.

## Claims

1. A lighting device (10), including:

- at least one elongate lighting module (12) having at least one support surface (122) with an

- array of electrically-powered light radiation sources (124) thereon, and  
 - an elongate cover member including light-diffusive material, the cover member including at least one roof-tile-shaped portion (14) having a convex outer surface (142) and a cavity (146) opposite said outer surface (142), said elongate lighting module (12) arranged within said cavity (146), wherein light radiation from said light radiation sources (124) propagates through the light-diffusive material of said cover member (14).
2. The lighting device (10) of claim 1, wherein said light radiation sources (124) are located centrally of the convex outer surface (142) of the at least one roof-tile-shaped portion (14).
  3. The lighting device (10) of claim 1 or claim 2, wherein said at least one lighting module (12) includes a sealed (120a) casing (120) for said light radiation sources (124).
  4. The lighting device (10) of any of the previous claims, including complementary coupling formations (128, 148) between said at least one lighting module (12) and said cover member (14).
  5. The lighting device (10) of any of the previous claims, wherein said cover member includes a plurality of said roof-tile-shaped portions (14), each said roof-tile-shaped portion (14) in said plurality including a convex outer surface (142) and a cavity (146) therein opposed said outer surface (142) with an elongate lighting module (12) arranged within said cavity (146).
  6. The lighting device (10) of claim 5, wherein said roof-tile-shaped portions (14) of said plurality of roof-tile-shaped portions (14) are one-piece which each other, wherein said elongate cover member includes a tubular member having said at least one lighting module (12) extending lengthwise therein.
  7. The lighting device (10) of claim 5 or claim 6, including a lighting module (12) having opposed support surfaces (122) each support surface with an array of electrically-powered light radiation sources (124) thereon.
  8. The lighting device (10) of any of the previous claims, wherein said cover member (14) and/or said at least one lighting module (12) include flexible material.
  9. The lighting device (10) of any of the previous claims, wherein said light-diffusive material includes light-permeable material having light-diffusive particles dispersed therein.
  10. The lighting device (10) of any of the previous claims, wherein said electrically-powered light radiation sources include LED sources (124).
  11. A method of producing a lighting device (10), the method including:
    - providing at least one elongate lighting module (12) having at least one support surface (122) with an array of electrically-powered light radiation sources (124) thereon, and
    - coupling (128, 148) with said at least one lighting module (12) an elongate cover member including light-diffusive material, the cover member including at least one roof-tile-shaped portion (14) having a convex outer surface (142) and a cavity (146) opposite said outer surface (142), said elongate lighting module (12) arranged within said cavity (146), wherein light radiation from said light radiation sources (124) propagates through the light-diffusive material of said cover member (14).

FIG. 1

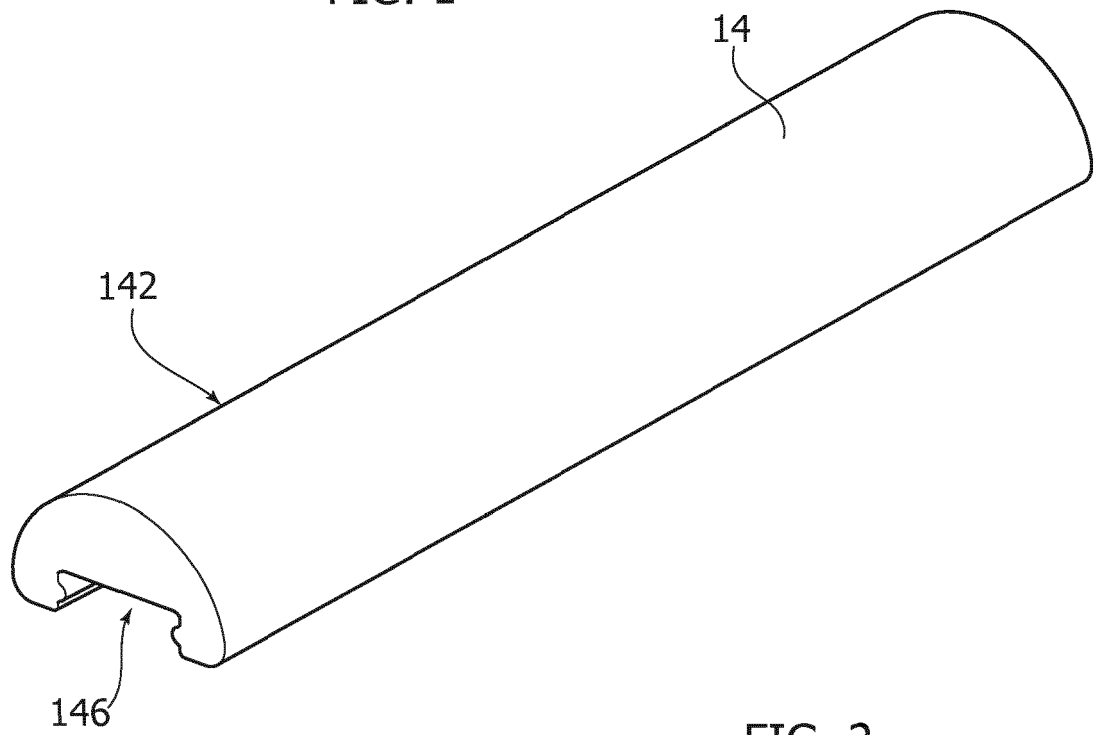
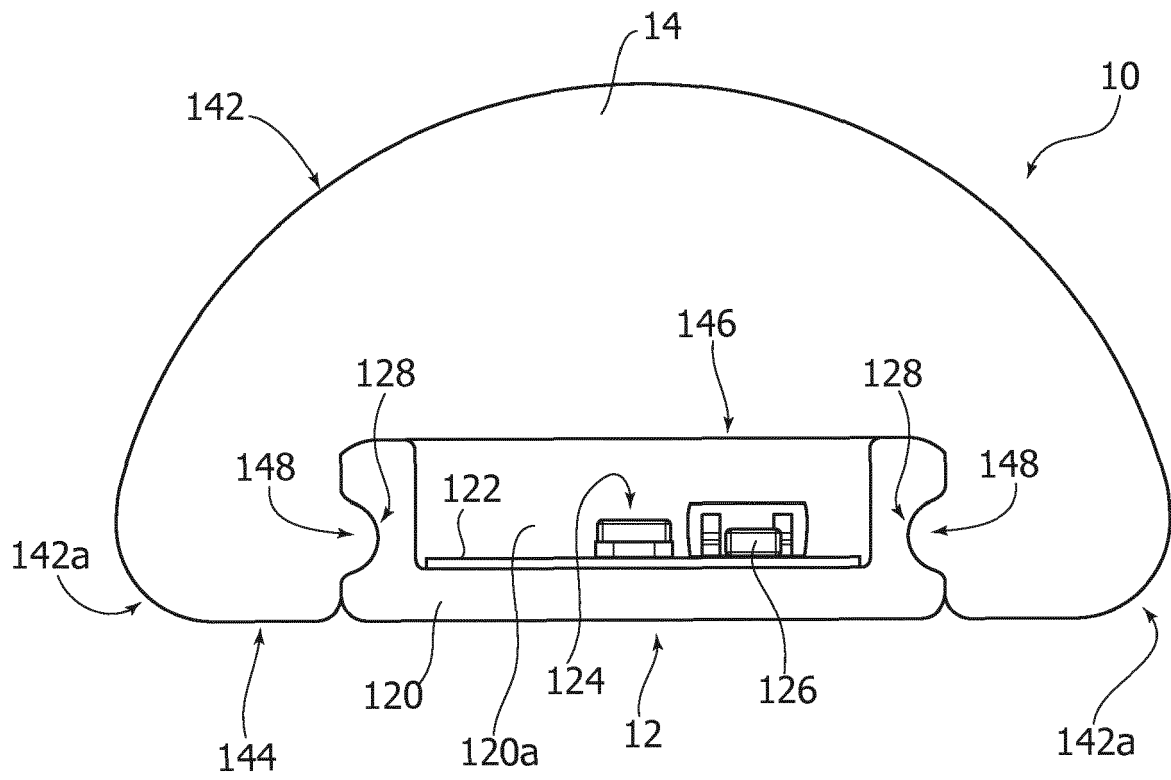
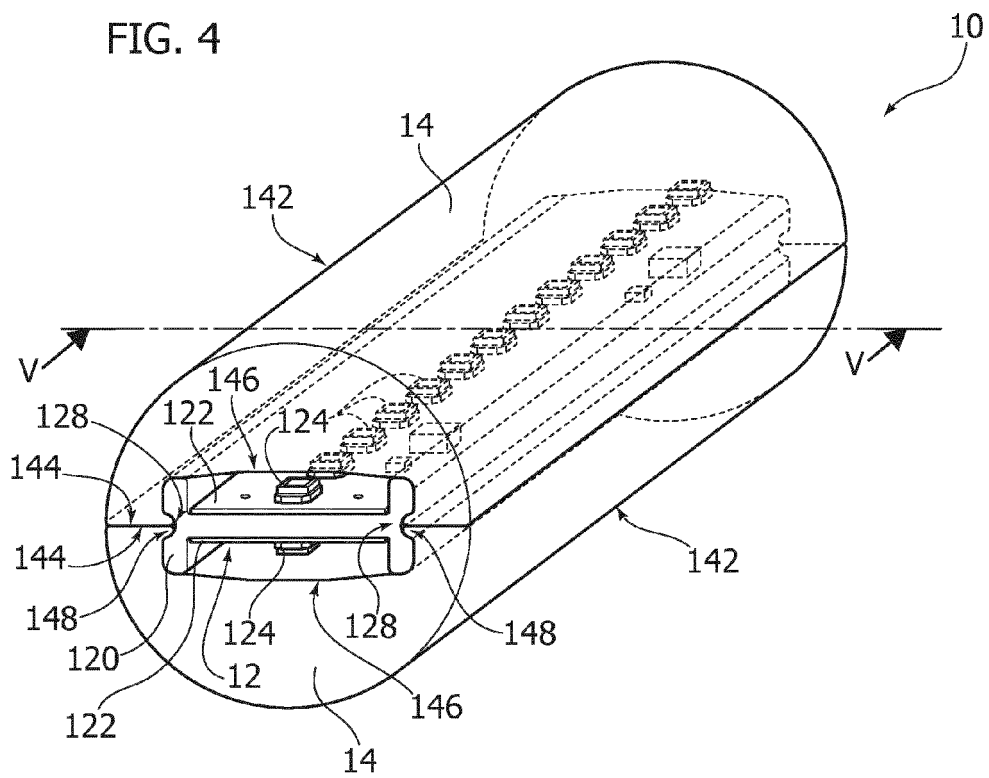
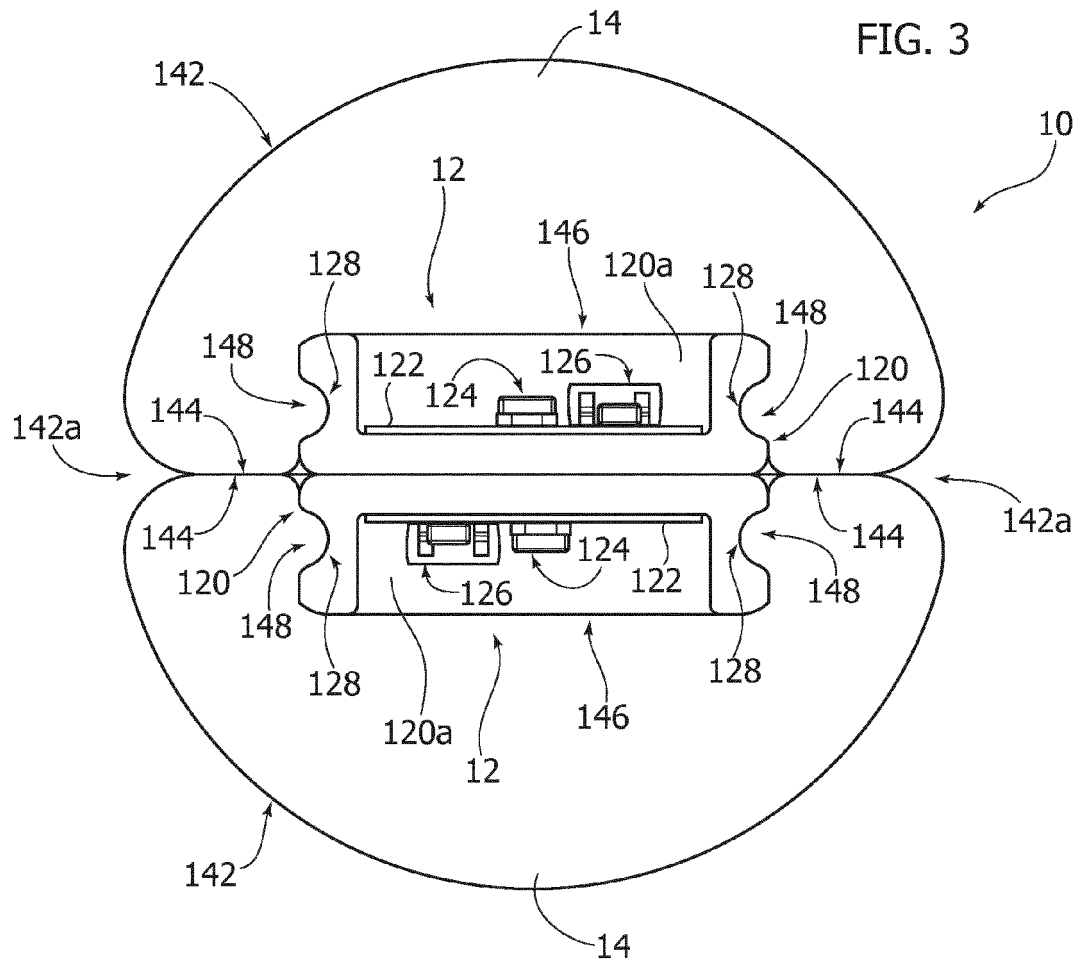
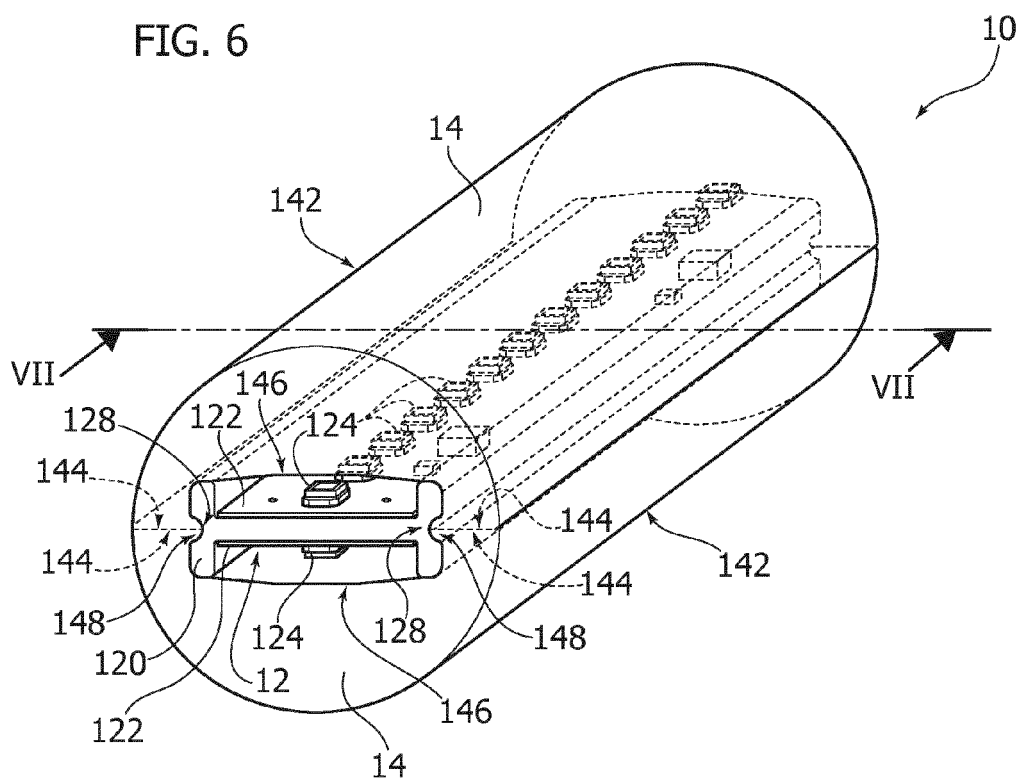
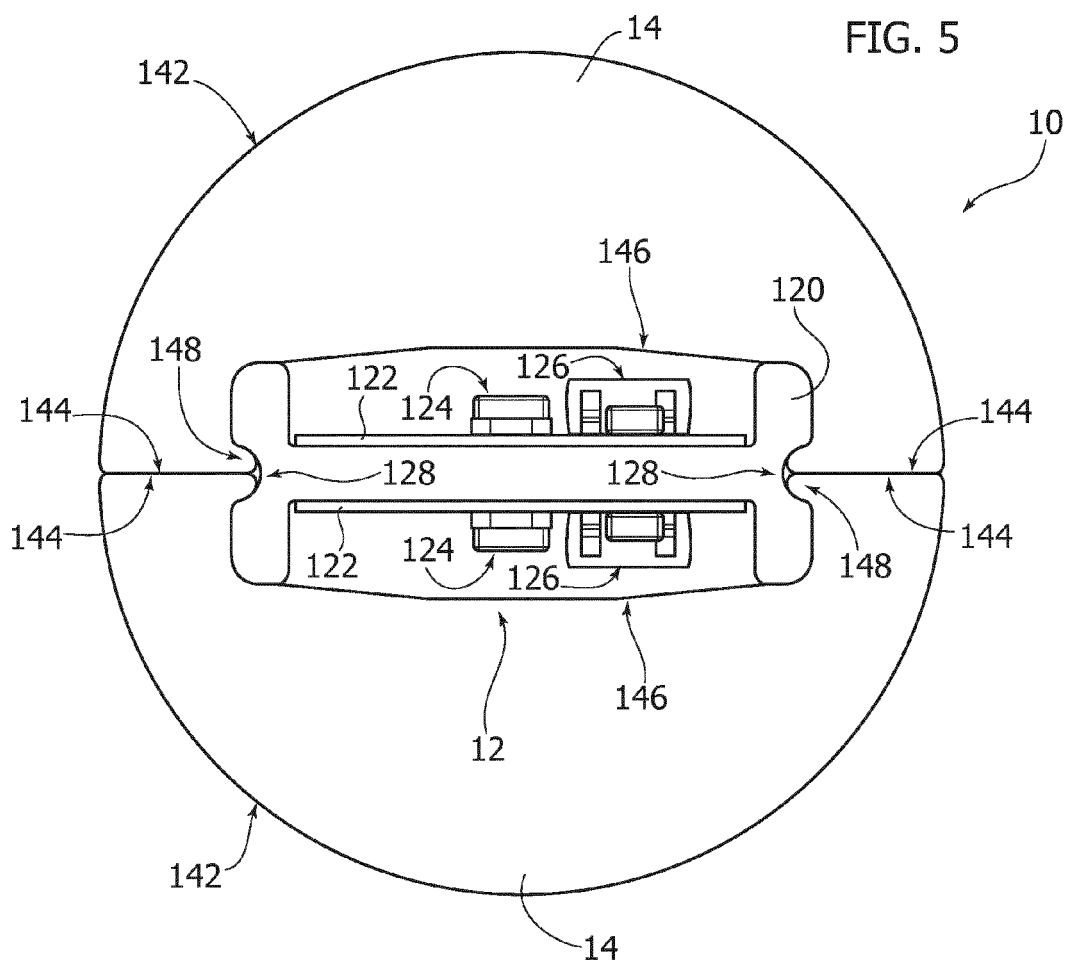


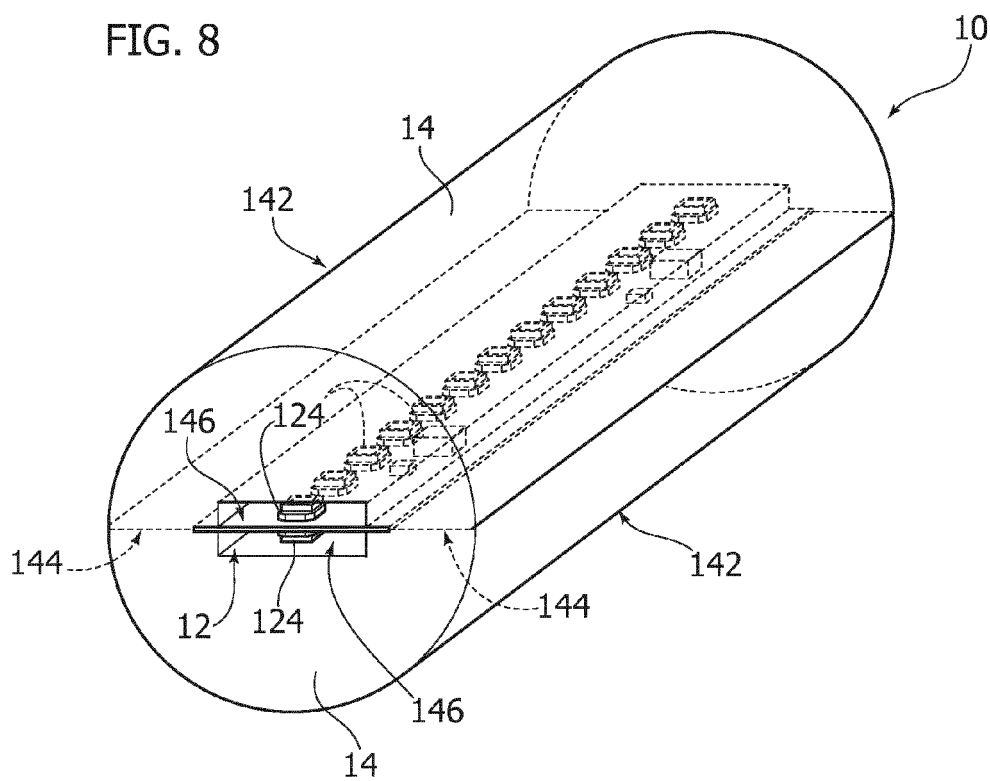
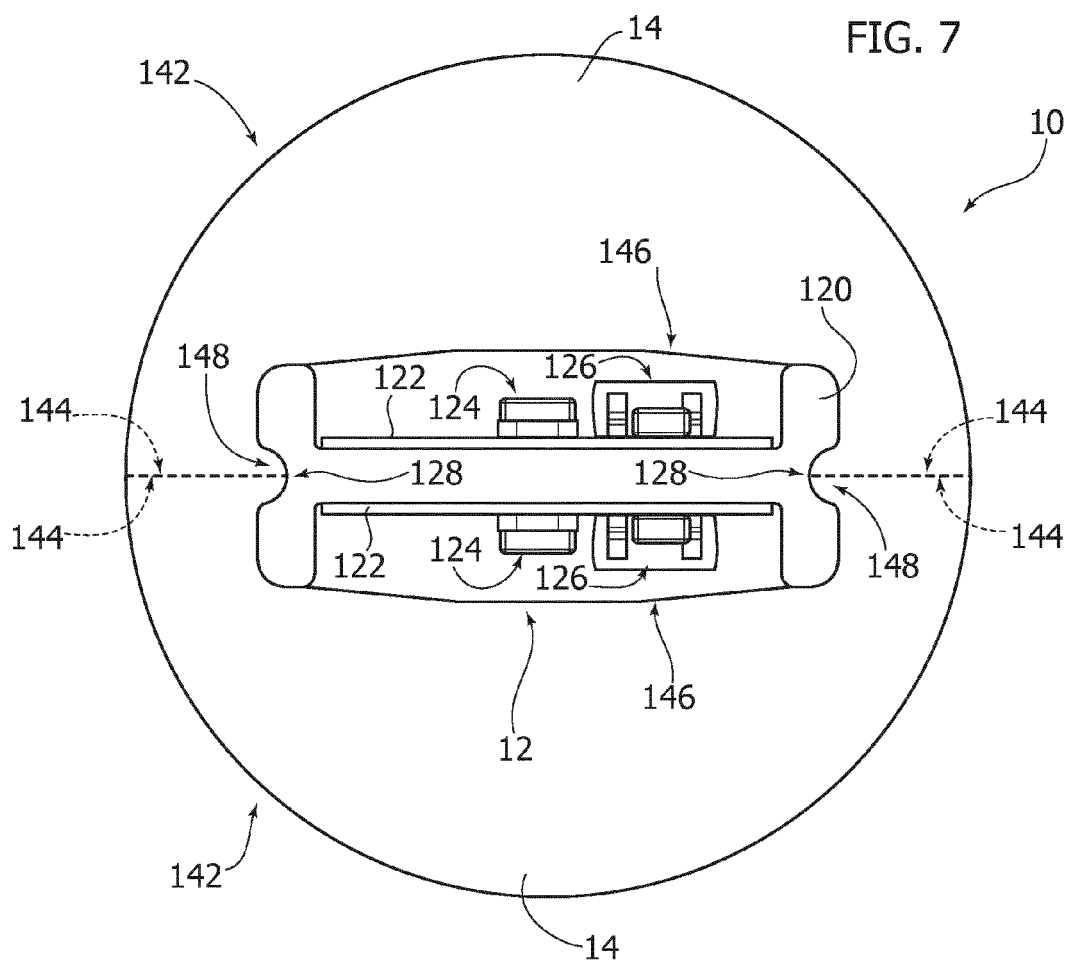
FIG. 2













## EUROPEAN SEARCH REPORT

 Application Number  
EP 17 20 0913

5

10

15

20

25

30

35

40

45

50

55

| 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | AT 10 993 U2 (SP ADVERTISING GMBH [AT])<br>15 February 2010 (2010-02-15)<br>* figure 2 *<br>* claims 1,7 *                                     | 1-5,7-11                                            | INV.<br>F21V3/04<br>F21S4/22                                             |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | US 2013/271971 A1 (UEMURA KOZO [JP] ET AL)<br>17 October 2013 (2013-10-17)<br>* paragraph [0072] *<br>* figures 14,23 *                        | 1-11                                                | ADD.<br>F21V31/00<br>F21V17/10<br>F21Y103/10<br>F21Y115/10<br>F21Y107/90 |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | CN 103 375 695 A (OSRAM GMBH)<br>30 October 2013 (2013-10-30)<br>* figures 4-6 *                                                               | 1-11                                                |                                                                          |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | CN 204 494 175 U (HANGZHOU JUNMING TECHNOLOGY CO LTD)<br>22 July 2015 (2015-07-22)<br>* figures 4,10 *                                         | 1-4,8-11                                            |                                                                          |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | US 2015/345712 A1 (PURDY STEVEN [US])<br>3 December 2015 (2015-12-03)<br>* paragraphs [0015], [0018] *<br>* figures 6,7,9 *                    | 1-11                                                | TECHNICAL FIELDS SEARCHED (IPC)                                          |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | US 2013/293098 A1 (LI YI-QUN [US] ET AL)<br>7 November 2013 (2013-11-07)<br>* paragraphs [0006], [0017], [0082], [0121] *<br>* figures 17,31 * | 1-4,8-11                                            | F21V<br>F21S<br>F21Y                                                     |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | DE 10 2012 214488 A1 (OSRAM GMBH [DE])<br>20 February 2014 (2014-02-20)<br>* paragraphs [0001], [0016], [0017], [0057] *<br>* figures 6,9 *    | 1-4,8-11                                            |                                                                          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                | -/--                                                |                                                                          |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                |                                                     |                                                                          |
| Place of search<br>The Hague                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                | Date of completion of the search<br>29 January 2018 | Examiner<br>Dinkla, Remko                                                |
| CATEGORY OF CITED DOCUMENTS<br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document<br>T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |                                                                                                                                                |                                                     |                                                                          |

EPO FORM 1503 03.82 (P04C01)



## EUROPEAN SEARCH REPORT

Application Number  
EP 17 20 0913

5

10

15

20

25

30

35

40

45

50

55

| 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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | EP 3 001 095 A1 (OSRAM GMBH [DE]; OSRAM SPA [IT]) 30 March 2016 (2016-03-30)<br>* paragraphs [0003], [0024], [0036], [0044], [0045] *<br>----- | 1,9                                                 |                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                |                                                     | TECHNICAL FIELDS SEARCHED (IPC)         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                |                                                     |                                         |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                |                                                     |                                         |
| Place of search<br>The Hague                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                | Date of completion of the search<br>29 January 2018 | Examiner<br>Dinkla, Remko               |
| CATEGORY OF CITED DOCUMENTS<br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document<br>T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : 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 17 20 0913

5

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.

29-01-2018

10

15

20

25

30

35

40

45

50

55

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|-------------------------------------------|---------------------|----------------------------|---------------------|
| AT 10993 U2                               | 15-02-2010          | NONE                       |                     |
| US 2013271971 A1                          | 17-10-2013          | CN 203463964 U             | 05-03-2014          |
|                                           |                     | US 2013271971 A1           | 17-10-2013          |
|                                           |                     | WO 2012043543 A1           | 05-04-2012          |
| CN 103375695 A                            | 30-10-2013          | NONE                       |                     |
| CN 204494175 U                            | 22-07-2015          | NONE                       |                     |
| US 2015345712 A1                          | 03-12-2015          | NONE                       |                     |
| US 2013293098 A1                          | 07-11-2013          | NONE                       |                     |
| DE 102012214488 A1                        | 20-02-2014          | DE 102012214488 A1         | 20-02-2014          |
|                                           |                     | WO 2014026888 A1           | 20-02-2014          |
| EP 3001095 A1                             | 30-03-2016          | CN 105465616 A             | 06-04-2016          |
|                                           |                     | EP 3001095 A1              | 30-03-2016          |
|                                           |                     | KR 20160037109 A           | 05-04-2016          |
|                                           |                     | US 2016091166 A1           | 31-03-2016          |

**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**

- US 6860007 B1 [0011]
- US 7210818 B2 [0012]