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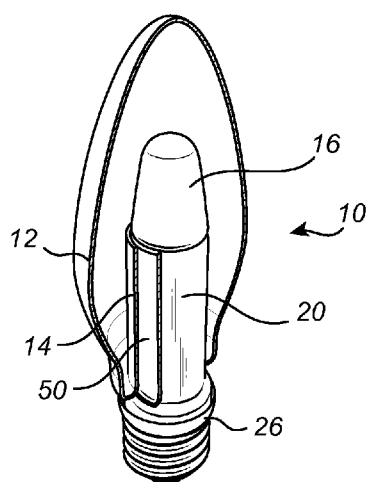


Fig. 1

(57) Abstract: A solid-state lighting lamp (10) is disclosed. The solid-state lighting lamp (10) comprises a glass tube (14), an internal member at least partly arranged inside the glass tube (14), and optical means (50) arranged on the glass tube (14), completely covering an inner surface of the glass tube (14) and adapted to at least partly cloak the internal member.



SOLID-STATE LIGHTING LAMP

FIELD OF THE INVENTION

The present invention relates to a lamp based on SSL (solid-state lighting) technology.

5 BACKGROUND OF THE INVENTION

Visual aesthetics influence consumers' buying decisions for a wide range of products, including lamps. Lamps based on SSL technology typically have components that are difficult to integrate into the overall design of the lamp in an aesthetically pleasing way. For example, the lamp disclosed in CN 103982872 A has a conspicuous insertion portion
10 which sticks into the glass bulb and which reduces the visual appeal of the lamp.

Meeting consumers' visual design preferences without compromising performance and cost is associated with many technical challenges. There is a need for further efforts aimed at addressing those challenges. In particular, there is a need to find ways to make visually unattractive lamp components less conspicuous.

15 In WO2015/177038 a solid state lighting device is disclosed with an inner envelope and an outer envelope. The solid state light sources are positioned in the inner envelope. The space in between the inner and outer envelope forms a cavity that acts as a heat pipe for transporting the heat generated by the solid state light sources from the inner envelope to the outer envelope from which it is transmitted to the ambient.

20 WO 2016/012467 discloses a solid state lighting device with light transmissive heat pipe configured to dissipate thermal energy from the light source. The heat pipe comprises a flexible conduit configured as wick.

US 2013/107523 discloses a light source device that uses a laser diode. The device is provided with an outer envelope (globe-type) and an inner tube like structure with a
25 fluorescent material for converting the laser light into visible light, therewith realizing a light source device with a light emitting inner tube.

SUMMARY OF THE INVENTION

It would be advantageous to provide an SSL lamp that represents an attractive trade-off between technical performance, costs and aesthetics. To better address this concern, and according to a first aspect, there is presented an SSL lamp which comprises a glass tube, an internal member at least partly arranged inside the glass tube, and optical means arranged
5 on the glass tube and adapted to at least partly cloak the internal member.

The optical means are adapted to alter the visibility of the internal member, for example by making it appear thinner, longer or flatter. The optical means may be adapted to render the internal member nearly invisible to an observer. The internal member will therefore not disturb, or at least to a lesser extent disturb, the visual aesthetics of the SSL
10 lamp, whereby the visual appearance of the SSL lamp is improved. Further, the fact the optical means make the internal structure less of a concern from a visual design perspective implies more freedom of choice for the manufacturer of the SSL lamp. For instance, consider the example case where the internal member is a heat spreader. It may then be possible to give the heat spreader a shape that optimizes technical performance or production costs, even
15 though that shape is not visually appealing, and/or to make the heat spreader of a material that represents the best choice from a technical or an economic perspective, even though that material is a poor choice from a visual design perspective.

The optical means may be adapted to redirect light striking the optical means so as to alter the visibility of the internal member. An efficient “cloaking effect” can be
20 achieved by optical means that operate by redirecting light. It should be noted that most of the light striking the optical means is light coming from the surroundings (and not light coming directly from the SSL lamp).

The optical means may be arranged between the internal member and the glass tube. It is possible to achieve a strong “cloaking effect” by arranging the optical means in this
25 way.

The optical means may completely cover an inner surface of the glass tube. The inner surface of the glass tube faces the internal member. The optical means may in some situations not cover the entire inner surface, for example if the internal member is smaller than the glass tube.

30 The optical means may be an optical foil. By an “optical foil” is meant a thin foil, film, sheet, or the like, which is adapted to affect light incident thereon in some way, for example by being provided with an interior structure affecting how light travels inside the foil and/or surface elements, such as micro prisms or the like, affecting light how light is reflected and/or refracted at the surface of the foil. Optical foils can provide a strong

“cloaking effect.” Further, the thinness of the optical foil facilitates its integration into existing types of SSL lamps. The manufacturing process does not become more complicated, and the other components do not need to be modified, or at least only marginally so. Further, the optical foil can be inexpensive to manufacture, so it typically represents a very small part of the total cost of the SSL lamp.

The optical means may be a prismatic foil. Prismatic foils typically operate by total internal reflection and are capable of capturing, guiding and releasing light in such a way that they seem to bend light. Prismatic foils are particularly suitable for some applications.

The optical means may be a brightness enhancement foil. Brightness enhancement foils are capable of redirecting light by reflection and refraction, and they are particularly suitable for some applications. For example, such foils can be used to render the internal member almost invisible to an observer looking at the SSL lamp from a specific direction.

The optical means may be a plastic optical foil. Plastic optical foils typically offer a high level of technical performance while being relatively inexpensive to manufacture.

The optical means may be a surface structure on the glass tube. The surface structure may be arranged or formed on the inner surface of the glass tube, i.e. on the surface of the glass tube that faces the internal member, and/or on the outer surface of the glass tube. The surface structure may be adapted to for example reflect and/or refract incident light. The surface structure may for example be a prismatic surface structure. The surface structure may for example comprise facets and/or micro prisms.

The internal member may comprise a cylindrical heat spreader and an SSL unit adapted to emit light, wherein the SSL unit is in thermal contact with the heat spreader. A heat spreader is an example a component that one typically wants to be as inconspicuous as possible, and the optical means are therefore particularly advantageous in situations where the internal member comprises a heat spreader. The optical means may be arranged so as to cover only the heat spreader, and not the SSL unit, so that light emitted by the SSL unit does not strike the optical means. However, the optical means may in some embodiments be arranged, and adapted, so as to, for example, reflect and/or diffuse the light emitted by the SSL unit. In such case, the optical means may completely or partly cover the SSL unit.

The internal member may further comprise a driver arranged at least partly inside the cylindrical heat spreader and electrically connected to the SSL unit. Arranging the

driver that powers the SSL unit inside the heat spreader helps to make the SSL lamp compact.

The cylindrical heat spreader may have a first section, arranged inside the glass tube, and a second section extending outside the glass tube. An end cap of the SSL lamp may be attached to the second section of the cylindrical heat spreader. It is possible to attach the heat spreader to the end cap by pressing it into the end cap, something which is simple from a manufacturing perspective and also means that it is not necessary to provide the SSL lamp with an interface part connecting the glass bulb to the end cap. Prior art SSL lamps typically have such an interface part, and this makes them look quite different from traditional incandescent lamps. The SSL lamp of the present invention may therefore be particularly suitable for applications where consumers prefer a lamp that resembles a traditional incandescent lamp.

The end cap may be connectable to an Edison screw socket. Such an end cap can make the SSL lamp especially suitable for retrofitting applications.

The SSL lamp may further comprise a glass bulb, the glass tube being arranged inside the glass bulb and joined with the glass bulb. Such an SSL lamp can be produced on standard GLS (general lighting service) production lines, something which is advantageous from a manufacturing perspective because such production lines are highly optimized with respect to speed and efficiency.

The glass tube may extend beyond a top of the first section of the cylindrical heat spreader as seen along a longitudinal axis of the SSL lamp in a direction away from the end cap. The glass tube may be longer than the first section of the cylindrical heat spreader as measured along a longitudinal axis of the SSL lamp. With such a glass tube it is, for example, not necessary to provide the SSL lamp with a glass bulb, and such SSL lamps can be particularly compact and robust. They are also easy to manufacture using simple machines and tools.

It is noted that the invention relates to all possible combinations of features recited in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the present invention will now be described in more detail, with reference to the appended drawings showing embodiment(s) of the invention.

Fig. 1 is a partly cross-sectional perspective view of an SSL lamp according to an embodiment of the present invention.

Fig. 2 is a partly cross-sectional side view of the SSL lamp of Fig. 1.

Fig. 3 is an exploded perspective view of the SSL lamp of Fig. 1.

Fig. 4 is a partly cross-sectional side view of an SSL lamp according to another embodiment of the present invention.

5 As illustrated in the figures, the sizes of layers and regions may be exaggerated for illustrative purposes and, thus, are provided to illustrate the general structures of embodiments of the present invention. Like reference numerals refer to like elements throughout.

10 DETAILED DESCRIPTION

The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which currently preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these
15 embodiments are provided for thoroughness and completeness, and fully convey the scope of the invention to the skilled person.

Figures 1 to 3 illustrate an SSL lamp 10 according to an embodiment of the present invention. The SSL lamp 10 in Figures 1 to 3 is an LED (light-emitting diode) candle lamp. The SSL lamp 10 may be a retrofit lamp.

20 From top to bottom as seen in Fig. 3, the SSL lamp 10 comprises a glass bulb 12 with a glass tube 14, an optical part 16, an SSL unit 18, a heat spreader 20, a driver insulator 22, a driver 24, and an end cap 26. The SSL unit 18 and the heat spreader 20 may together be referred to as an internal member of the SSL lamp 10.

The glass bulb 12 is candle-shaped ("B-shape"). The glass bulb 12 could be
25 clear or frosted. The glass bulb 12 can be made by blowing glass in a mold. The wall of the glass bulb 12 is thin and (substantially) uniform. The wall thickness of the glass bulb 12 may for example be in the range of 0.35 mm to 1.00 mm. The glass bulb 12 has a distal top (or tip) 28a and a proximal base 28b relative to the end cap 26. This means that the base 28b is closer to the end cap 26 than the top 28a.

30 The glass tube 14 may be a standard size extruded glass tube. The glass tube 14 has an open distal end 30a and a proximal end 30b relative to the end cap 26. Like above, this means that the end 30b is closer to the end cap 26 than the end 30a. The glass tube 14 is clear, transparent or at least partly transparent.

The proximal end 30b of the glass tube 14 is joined with the proximal base 28b of the glass bulb 12. The glass tube 14 and the glass bulb 12 may for example be melted together at the proximal end 30b/proximal base 28b, like in incandescent bulbs, but without any pump tube or stem wires. Hence, the glass tube 14 is freestanding, i.e. it is standing alone
5 inside the glass bulb 12 without being attached to the glass bulb 12 except at said proximal end 30b.

The heat spreader 20 is cylindrical. The heat spreader 20 can for example be deep drawn from highly thermally conductive sheet metal, such as aluminum. Alternatively the heat spreader 20 could be cold forged, for example. The heat spreader 20 comprises a first
10 section 32a and a second section 32b. The top of the first section of 32a is closed, forming a top surface 34. The second section 32b may have a larger outer diameter than the first section 32a. The first section 32a of the heat spreader 20 may substantially match the interior of the glass tube 14, and is arranged inside the glass tube 14. The top surface 34 of the first section 32a of the heat spreader 20 may be in level with the distal end 30a of the glass tube 14, as can
15 be seen in Fig. 2. To this end, the glass tube 14 and the first section 32a of the heat spreader 20 may have the same or substantially the same length. The second section 32b of the heat spreader 20, on the other hand, extends outside (or below) the glass tube 14 and glass bulb 12, as also seen in Fig 2.

The SSL unit 18 is generally adapted to emit light. The SSL unit 18 is
20 mounted on top of the first section 32a of the heat spreader 20, i.e. on the top surface 34. The SSL unit 18 can be mounted to the heat spreader 20 by use of thermally conductive (non-electrical insulative) paste, for optimal thermal performance. The SSL unit 18 may comprise one or more SSL elements 36 acting as light sources. The SSL elements 36 may for example be LEDs. The SSL unit 18 may also comprise a printed circuit board 38, such as an MCPCB
25 (metal-core printed circuit board), on which the one or more SSL elements 36 are mounted. In the illustrated embodiment, the SSL unit 18 is horizontally arranged, i.e. the PCB 38 is transversal to the longitudinal axis 40 of the SSL lamp 10. The light distribution generated by the SSL lamp 10 may be symmetric with respect to the longitudinal axis 40.

The optical part 16 is provided over the SSL unit 18. The optical part 16 in the
30 illustrated embodiment is a TIR (total internal reflection) optic. The TIR optic may be shaped like a cone with a blunt tip. The TIR optic could be injection molded. The TIR optic serves to distribute light emitted by the SSL elements 36 towards the side and also downwards, towards the end cap 26, which is beneficial for a candle lamp. The TIR optic could be replaced by a diffuser or a toroid reflector, for example.

In an alternative embodiment (not shown), the SSL unit 18 could be vertically arranged, to create a more omnidirectional distribution and not requiring an optic to bring the light downwards, although a diffuser may be beneficial to reduce glare or spottiness.

The driver 24 is generally adapted to regulate the power to the SSL unit 18.

5 The driver 24 may also contain electronics necessary for dimming, connectivity, etc. The driver 24 is provided at least partly inside the heat spreader 20. The driver insulator 22 may be provided between the heat spreader 20 and the driver 24. The driver insulator 22 may be shaped like a cylinder, with a closed top. The driver insulator 22 may for example be an inner dielectric coating on the heat spreader 20, or a separate electrical insulator. The driver
10 insulator 22 can be thermoformed. The driver 24 is electrically connected to the SSL unit 18. To this end, holes 42a, 42b may be provided in the top of the heat spreader 20 and the driver insulator 22, respectively, through which holes 42a, 42b electrical conductors between the driver 24 and SSL unit 18 may pass.

The end cap 26 is generally adapted to mechanically and electrically connect
15 the SSL lamp 10 to an external socket (not shown). The end cap 26 may have a mantel 44 and an external threading 46. The end cap can be of the type E14. The end cap 26 may for example be an aluminum end cap. The end cap 26 is attached to the circumferential outer surface 48 of the second section 32b of the heat spreader 20. The cylindrical heat spreader 20 may have a direct thermal connection to the end cap 26. This enables heat sinking through
20 the end cap 26 through conduction, rather than just heat dissipation through convection at the outer surface of the bulb 12/glass tube 14. It is also a cost efficient way to make a strong stable connection between heat spreader 20 and end cap 26 without any intermediate part(s). The second section 32b of the heat spreader 20 may for example be pressed into the mantle 44 of the end cap 26. Hence, the end cap 26 may be press fitted to the heat spreader 20. The
25 end cap 26 may about the proximal end of the joint glass bulb 12 and glass tube 14, i.e. at 28b/30b. In this way, the transition between the end cap 26 and the glass bulb 12 may be smooth.

An optical means in the form of an optical foil 50 is arranged on the glass tube 14, more precisely between the cylindrical heat spreader 20 and the glass tube 14. Differently
30 stated, the optical foil 50 is sandwiched between the glass tube 14 and the cylindrical heat spreader 20. The optical foil 50 is in contact with an inner surface of the glass tube 14 and with an outer surface of the cylindrical heat spreader 20. The optical foil 50 is cylindrical. The optical foil 50 may for example have been formed by bending a rectangular piece of optical foil cut from a large sheet and then attaching the edges together. The glass tube 14,

the optical foil 50 and the cylindrical heat spreader 20 are concentrically arranged around the longitudinal axis 40. The optical foil 50 extends from the interface between the first and second sections 32a, 32b to the top of the first section 32a, i.e. to the level of the top surface 34. The optical foil 50 thus covers substantially the entire inner surface of the glass tube 14.

5 The optical foil 50 can for example be made of PC, PMMA, PET, COP, COC, PS, PEI or silicone. The thickness of the optical foil 50 is typically in the range from about 0.1 mm to about 0.5 mm. The optical foil 50 may alternatively be referred to as an optical film. The optical foil 50 may for example be a prismatic foil or a brightness enhancement foil. There are many different types of such optical foils commercially available. For instance, 3M sells

10 brightness enhancement foils under the trade name Vikuiti.

In use, the SSL lamp 10 is fitted in an external socket, and power is supplied from the external socket via the end cap 26 and the driver 24 to the SSL unit 18, so that light is emitted. Heat generated when the SSL lamp 10 is on may be dissipated partly through conduction to the end cap 26 (max 5%), partly through radiation (less than 40%), and the rest

15 through convection by the ambient air. Further, in use, the heat spreader 20 is cloaked by the optical foil 50 as seen from outside of the SSL lamp 10 by an observer 52. The optical foil 50 redirects incident light in such a way that the visibility of the heat sink 20 for the outside observer 52 is reduced. For example, a brightness enhancement foil may be adapted to redirect light striking the foil perpendicularly so that the light goes back in the approximately

20 same direction from which it came. So a brightness enhancement film can be used as a kind of reflector that redirects light in such a way that the observer 52 cannot see, or at least almost cannot see, the heat sink 20 from the perpendicular view.

Fig. 4 discloses another SSL lamp 10' which is similar to the SSL lamp 10 described above in connection with Figs. 1 to 3, but without the glass bulb 12. The SSL lamp

25 10' comprises: a glass tube 14'; a cylindrical heat spreader 20' having a first section 32a' arranged inside the glass tube 14' and a second section 32b' extending outside the glass tube 14'; an SSL unit 18' mounted on top of the first section 32a' of the cylindrical heat spreader 20'; a driver 24' provided at least partly inside the cylindrical heat spreader and electrically connected to the SSL unit 18'; and an end cap 26' attached to the second section 32b' of the

30 cylindrical heat spreader 20'. The first section 32a' of the cylindrical heat spreader 20' is shorter than the glass tube 14' as measured along the longitudinal axis 40' of the SSL lamp 10'. The glass tube 14' extends beyond the top of the first section 32a' of the cylindrical heat spreader 20' in the direction away from the end cap 26' towards the cylindrical heat spreader 20' and along the longitudinal axis 40'. There is thus a longitudinal gap between the top of

the cylindrical heat spreader 20' and the distal end 30a' of the glass tube 14'. The heat spreader 20' is typically less than 15 mm shorter than the glass tube 14'. The distal end 30a' of the glass tube 14' is closed.

5 An optical means in the form of an optical foil 50' is arranged between the cylindrical heat spreader 20' and the glass tube 14', similarly to how the optical foil 50 in Figs. 1 to 3 is arranged. The inner side of the closed distal end 30a' of the glass tube 14' is covered by the optical foil 50', so light emitted by the SSL unit 18' strikes the optical foil 50'. The optical foil 50' may be adapted to affect the light emitted by the SSL unit 18' similarly to how the optical part 16, described above in connection with Figs. 1 to 3, affects
10 light. For example, the optical foil 50' may be adapted to diffuse the light emitted by the SSL unit 18'. In those applications where the SSL unit 18' comprises LEDs of different colors, the optical foil 50' may be adapted to mix light having different colors.

In an alternative embodiment (not shown), it may be that the optical foil 50' does not extend all the way up to the distal end 30a' of the glass tube 14'. The optical foil 50'
15 would then typically cover the entire first section 32a' of the cylindrical heat spreader 20'.

The person skilled in the art realizes that the present invention by no means is limited to the preferred embodiments described above. On the contrary, many modifications and variations are possible within the scope of the appended claims. For example, the glass bulb can have a different shape than the shape illustrated in Figs. 1 to 3, such as the shape of
20 a P45 bulb.

Additionally, variations to the disclosed embodiments can be understood and effected by the skilled person in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a
25 plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

CLAIMS:

1. A solid-state lighting lamp (10, 10'), comprising:
a glass tube (14, 14'),
an internal member at least partly arranged inside the glass tube (14, 14'), and
optical means (50, 50') arranged on the glass tube (14, 14'), completely
5 covering an inner surface of the glass tube (14, 14') and adapted to at least partly cloak the
internal member.
2. The solid-state lighting lamp (10, 10') according to claim 1, wherein the
optical means (50, 50') are adapted to redirect light striking the optical means (50, 50') so as
10 to alter the visibility of the internal member.
3. The solid-state lighting lamp (10, 10') according to any claim 1 or 2, wherein
the optical means (50, 50') are arranged between the internal member and the glass tube
(14, 14').
15
4. The solid-state lighting lamp (10, 10') according to any of the preceding
claims, wherein the optical means (50, 50') is an optical foil.
5. The solid-state lighting lamp (10, 10') according to claim 4, wherein the
20 optical means (50, 50') is a prismatic foil.
6. The solid-state lighting lamp (10, 10') according to claim 4 or 5, wherein the
optical means (50, 50') is a brightness enhancement foil.
- 25 7. The solid-state lighting lamp (10, 10') according to any of the claims 4, 5 or 6,
wherein the optical means (50, 50') is a plastic optical foil.
8. The solid-state lighting lamp according to any of the claims 1 to 3, wherein the
optical means is a surface structure on the glass tube.

9. The solid-state lighting lamp (10, 10') according to any of the preceding claims, wherein the internal member comprises:
a cylindrical heat spreader (20, 20') and
5 a solid-state lighting unit (18, 18') adapted to emit light, wherein the solid-state unit (18, 18') is in thermal contact with the heat spreader (20, 20').
10. The solid-state lighting lamp (10, 10') according to claim 9, wherein the internal member further comprises a driver (24, 24') arranged at least partly inside the
10 cylindrical heat spreader (20, 20') and electrically connected to the solid-state lighting unit (18, 18').
11. The solid-state lighting lamp (10, 10') according to claim 9 or 10, wherein the cylindrical heat spreader (20, 20') has a first section (32a, 32a') arranged inside the glass tube
15 (14, 14') and a second section (32b, 32b') extending outside the glass tube (14, 14'), and wherein an end cap (26, 26') of the solid-state lighting lamp (10, 10') is attached to the second section (32b, 32b') of the cylindrical heat spreader (20, 20').
12. The solid-state lighting lamp (10, 10') according to claim 11, wherein the end
20 cap (26, 26') is connectable to an Edison screw socket.
13. The solid-state lighting lamp (10) according to any of the preceding claims, wherein the solid-state lamp (10) further comprises a glass bulb (12), the glass tube (14) being arranged inside the glass bulb (12) and joined with the glass bulb (12).
25
14. The solid-state lighting lamp (10') according to claim 11, wherein the glass tube (14') extends beyond a top of the first section (32a') of the cylindrical heat spreader (20') as seen along a longitudinal axis (40') of the solid-state lighting lamp (10') in a direction away from the end cap (26').

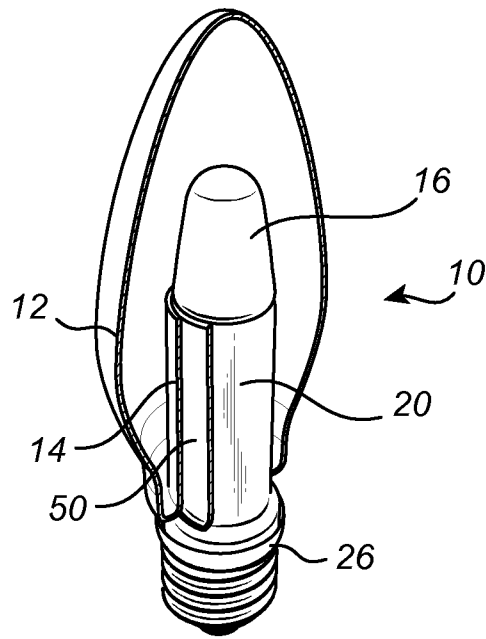


Fig. 1

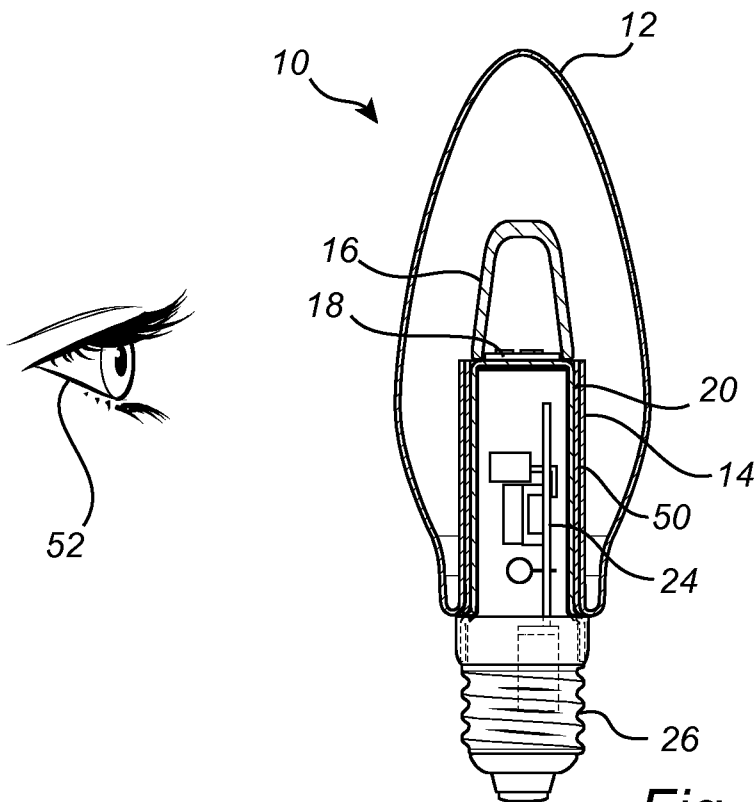


Fig. 2

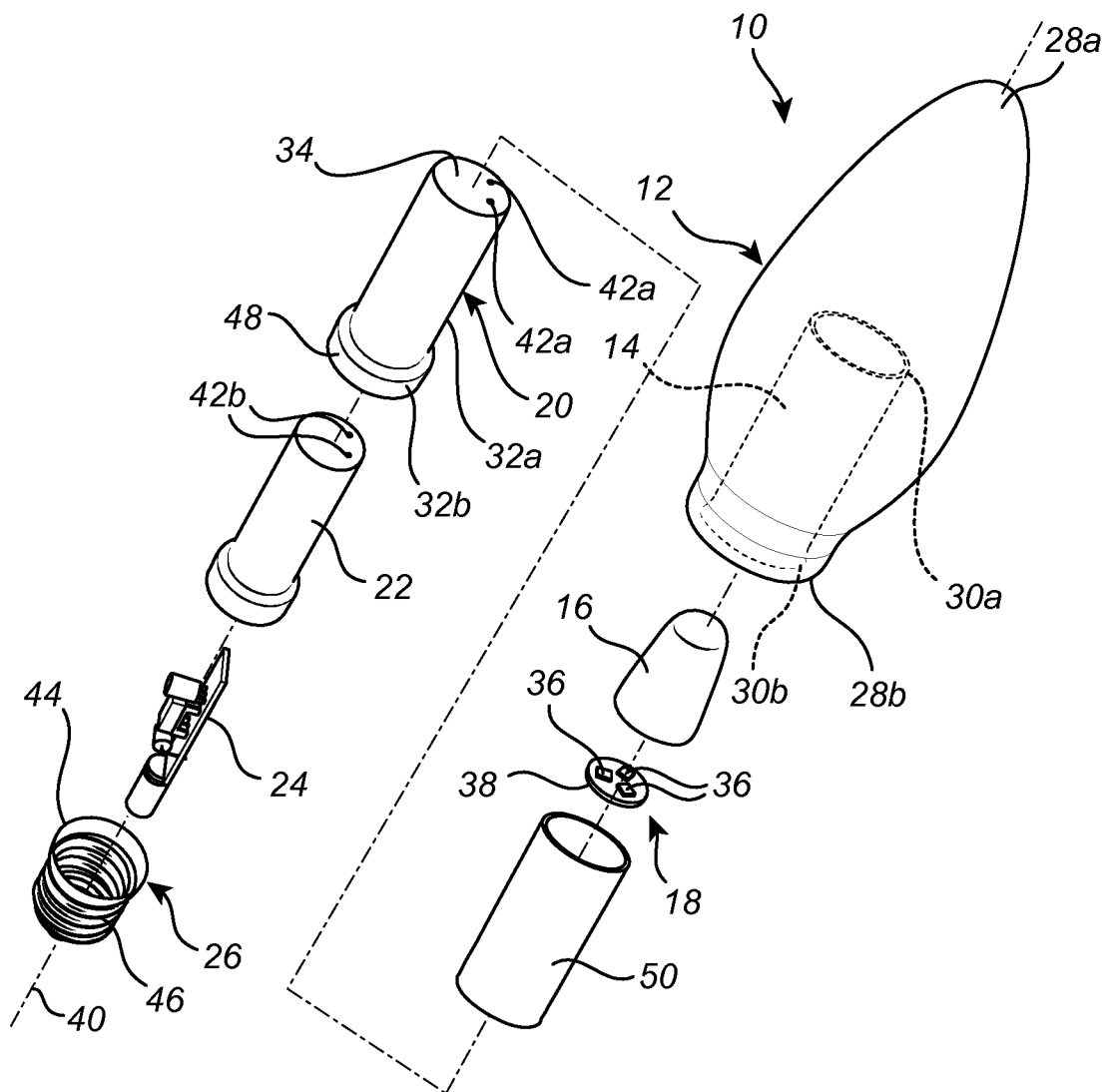


Fig. 3

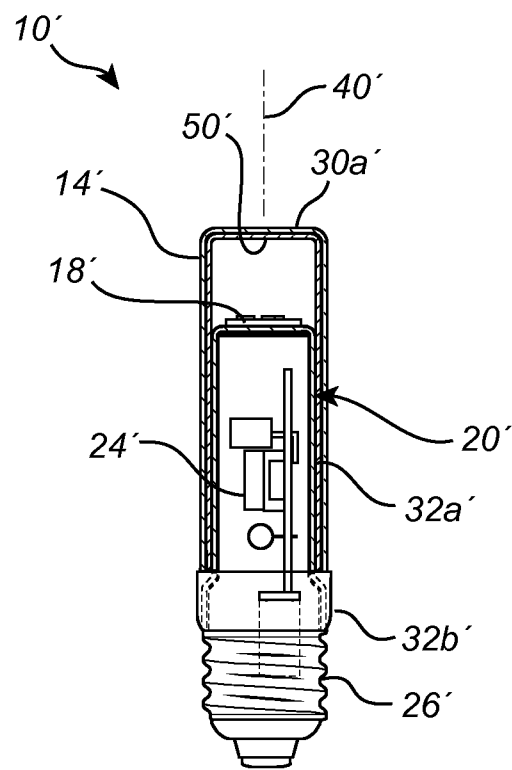


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/066446

A. CLASSIFICATION OF SUBJECT MATTER		
INV. F21K9/232	F21V3/02	F21V29/70 F21V23/00
ADD. F21K9/90	F21V3/04	F21Y101/00 F21Y115/10 F21Y113/13
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) F21V F21K F21Y		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2015/177038 A1 (KONINKL PHILIPS NV [NL]) 26 November 2015 (2015-11-26) cited in the application the whole document	1-14
A	WO 2016/012467 A1 (KONINKL PHILIPS NV [NL]) 28 January 2016 (2016-01-28) cited in the application the whole document	1-14
X	US 2013/107523 A1 (TAKEDA YUJI [JP]) 2 May 2013 (2013-05-02) cited in the application	1-7, 9-12,14
A	paragraphs [0018] - [0052]; figures 1-3	8,13
A	US 2013/099667 A1 (YE ZHI-TING [TW] ET AL) 25 April 2013 (2013-04-25) the whole document	1-14
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Menn, Patrick

INTERNATIONAL SEARCH REPORT

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