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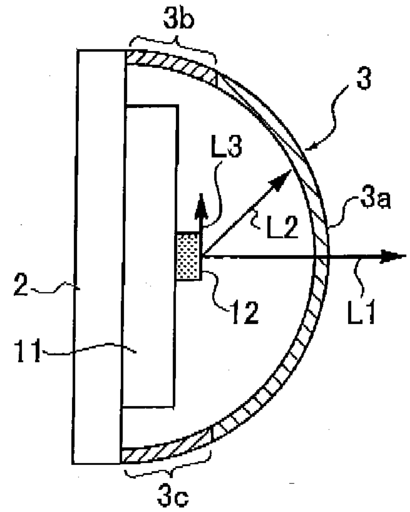
(54) Straight-tube LED lamp, and lighting device

(57) A straight-tube LED lamp (100) includes: an elongated-shaped casing (2) which has two edges along a longitudinal direction, a translucent cover member (3) which is attached to the casing so as to cover the edges of the casing throughout in the longitudinal direction; and a plurality of semiconductor light-emitting devices (12a, 12b) which are arranged in the cover member along the longitudinal direction as a light source; wherein the cover member has a portion (3a) corresponding to a portion where luminance of the light source is high, and a portion (3b, 3c) corresponding to a portion where luminance of the light source is low, and the portion corresponding to the portion where the luminance of the light source is high is higher in diffusivity than the portion corresponding to the portion where the luminance of the light source is low.

FIG.1



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Description

[0001] The present invention relates to a straight-tube LED. lamp using a semiconductor light-emitting device such as an LED, or the like as a light source, and a lighting device including the straight-tube LED lamp.

[0002] Recently, a straight-tube LED lamp using an LED (Light-Emitting Diode) as a light source has been commercialized.

[0003] Light-emitting efficiency of an LED for lighting has been improving since its practical realization.

[0004] Due to the developments in LED manufacturing technology, not only transition from an incandescent light bulb to a straight-tube LED lamp but also transition from a fluorescent lamp (fluorescent tube) to a straight-tube LED lamp have been proposed and implemented.

[0005] Compared to the fluorescent tube, the straight-tube LED lamp has more advantages such as a longer life, lower power consumption, a lower impact on the environment by non-use of mercury, and so on.

[0006] As general commercial fluorescent lamps (fluorescent tubes), there are a ring-shaped circular-tube fluorescent lamp, and an elongated-shaped straight-tube fluorescent lamp.

[0007] The circular-tube fluorescent lamp is mainly used in households, and the straight-tube fluorescent lamp is widely used for the purposes of factory use, office use, general household use, and so on.

[0008] The straight-tube LED lamp, which has been replacing the straight-tube fluorescent lamp, has a transparent cover and a metal frame, and includes a built-in LED unit having an LED substrate on which a plurality of LEDs are mounted in the longitudinal direction in the transparent cover and the metal frame.

[0009] However, because an LED has a characteristic of high directivity, it is disadvantageous in that lighting using an LED as a light source is extremely bright, and discomfort glare (discomfort caused by glare) increases easily.

[0010] As an index which evaluates discomfort glare, there is the UGR (Unified Glare Rating) provided by JIS (Japanese Industrial Standards).

[0011] In order to reduce a value of the UGR, a method of reducing a luminance value of a light source, and reduction of an apparent area of a light source as seen from an observer's side are effective.

[0012] Since the LED has high directivity in a direction of luminous intensity distribution as described above, reducing a luminance value in a front direction from a light source (a luminance value by on-axis luminous intensity) is effective in reduction of the discomfort glare.

[0013] For example, a method of increasing a spatial distance between the cover and the LED in the front direction is known.

[0014] As an example of such a method, in Japanese Patent No. 4334013, a structure in which a shape of a cover is an oval shape based on data of directivity of an LED, and a distance between the cover and the LED in the front direction where luminance is high is increased is disclosed.

[0015] A method of increasing diffusivity of an entire cover is also known.

[0016] Control of the diffusivity is performed by adjusting a contained amount of a diffusion material which is added to a synthetic resin such as an acrylic resin, a polycarbonate resin, or the like used as a cover material.

[0017] However, as the structure described in Japanese Patent No. 4334013, in the method of increasing the spatial distance between the cover and the LED, the cover has to be in the oval shape, which is not applicable to a lamp having a cover in which a cross-section is in a circular arc shape of a concentric-circular shape.

[0018] That is, a poor external appearance is unavoidable using a straight-tube lamp in place of a fluorescent lamp.

[0019] Additionally, in the method of increasing diffusivity, transmittance is decreased entirely, and it is not possible to reduce luminance without impairing total luminous flux.

[0020] That is, in the method of increasing diffusivity, the loss of light quantity is unavoidable.

[0021] A main object of the present invention is to provide a straight-tube LED lamp which reduces luminance in the front direction without impairing transmittance, prevents discomfort glare and poor external appearance, and contributes to improvement in usability.

[0022] In order to achieve the above object, an embodiment of the present invention provides a straight-tube LED lamp comprising: an elongated-shaped casing which has two edges along a longitudinal direction; a translucent cover member which is attached to the casing so as to cover the edges of the casing throughout in the longitudinal direction; and a plurality of semiconductor light-emitting devices which are arranged in the cover member along the longitudinal direction as a light source; wherein the cover member has a portion corresponding to a portion where luminance of the light source is high, and a portion corresponding to a portion where luminance of the light source is low, and the portion corresponding to the portion where the luminance of the light source is high is higher in diffusivity than the portion corresponding to the portion where the luminance of the light source is low.

FIG. 1 is a cross-sectional diagram of a main part illustrating a structure of a cover of a straight-tube LED lamp according to an embodiment of the present invention.

FIG. 2 is a perspective diagram of the cover.

FIG. 3 is a diagram illustrating that the cover has a concentric-circular shape.

FIG. 4 is an exploded perspective diagram of a lighting device according to the embodiment of the present invention.

FIG. 5 is a perspective diagram illustrating a state where the cover of the straight-tube LED lamp is removed.

FIG. 6 is a perspective diagram illustrating a state where a part of a casing of the straight-tube LED lamp is cut, and bases are removed.

[0023] Each of FIGs. 7A and 7B is a diagram illustrating a structure of the straight-tube LED lamp. FIG. 7A is an exploded perspective diagram of one end with a partial cutout. FIG. 7B is an exploded perspective diagram of the other end with a partial cutout.

[0024] Each of FIGS. 8A and 8B is a diagram illustrating a mounting structure of an LED substrate. FIG. 8A is an exploded perspective diagram of one end. FIG. 8B is an exploded perspective diagram of the other end.

FIG. 9 is a diagram of a straight-tube LED lamp as seen from a direction of an arrow A in FIG. 5.

FIG. 10 is an enlarged perspective diagram of a dotted-circle part B in FIG. 6.

FIG. 11 is a cross-sectional diagram of a main part illustrating a fixing structure of a power source substrate with respect to the casing by a clamp.

FIG. 12 is a diagram of a modified example equivalent to FIG. 9.

[0025] Hereinafter, an embodiment of the present invention will be explained with reference to the drawings.

[0026] Firstly, based on FIGs. 4 to 9, a specific structure of a straight-tube LED lamp and a lighting device according to the embodiment of the present invention will be explained.

[0027] FIG. 4 is an exploded perspective diagram illustrating an exterior of a lighting device 200. The lighting device 200 includes a straight-tube LED lamp 100 which has terminals 4a-4d, and a light fixture (luminaire) 150 which has sockets 151a, 151b with holes and to which the straight-tube LED lamp 100 is attached.

[0028] The light fixture 150 is the same as that to light a fluorescent lamp, and the terminals 4a-4d of the straight-tube LED lamp 100 coincide with positions of the holes and are inserted into the holes of the sockets 151a, 151b.

[0029] Thus, commercial electrical current flows from the terminals 4a-4d to later-described LEDs in the straight-tube LED lamp 100, and the straight-tube LED lamp 100 is lit.

[0030] The straight-tube LED lamp 100 is mainly constituted of an elongated-shaped casing 2, a cover 3 as a translucent cover member, and bases 1a, 1b as cap members which are electrically connectable to the light fixture 150.

[0031] As a material of the cover 3, it is possible to use a resin such as an acrylic resin, a polycarbonate resin, or the like, or a glass material.

[0032] The casing 2 is formed such that a cross-section has approximately the same semi-tubular shape (tubular shape) throughout a longitudinal direction (an axial direction).

[0033] The casing 2 has two edges along the longitudinal direction.

[0034] In order to improve a function of heat radiation of the heat generated inside, an outer surface of the casing 2 has roughness (see FIG. 9), and thus a surface area of the outer surface of the casing 2 is enlarged.

[0035] The casing 2 is formed of a metal material having a large thermal conductivity. Because of its tubular shape, it is possible to inexpensively make a casing 2 having a uniform cross-sectional shape by processing methods such as extrusion molding, pultrusion molding, and the like.

[0036] As the metal material, an aluminum alloy or a magnesium alloy is mostly used; however, other extrusion materials, or the like also can be used.

[0037] It is possible to provide the same heat radiation function as having a rib or a heat radiation fin by roughness on an outer surface.

[0038] Here, in order to improve heat radiation performance, on the outer surface of the casing 2, roughness is provided; however, if electrical insulation between the casing 2 and a later-described drive substrate (power source substrate) and an electrical component is ensured, roughness can be provided on an inner surface.

[0039] The cover 3 has approximately the same external diameter (curvature), and is formed in a semi-tubular shape having an opening along the longitudinal direction of the casing 2.

[0040] That is, a cross-section of the cover 3 has a circular arc shape, and the size of the cover 3 is as large as to cover the edges of the casing 2 throughout in the longitudinal direction.

[0041] As illustrated in FIG. 9, the cover 3 is attached to the casing 2 such that edges 33 of the cover 3 are fitted in grooves 21 which extend in the axial direction and are provided on the outer surface of the edges of the casing 2, and thus the casing 2 and the cover 3 are integrally formed to be in a circular-tube shape.

[0042] As illustrated in FIG. 4, the bases 1a, 1b are each provided at either end in the longitudinal direction of the integrally-formed casing 2 and cover 3 so as to cover an outer surface thereof.

[0043] As illustrated in FIGs. 7A and 7B, the bases 1a, 1b are equipped with the terminals 4a-4d attachable to a light fixture (light fixture for a fluorescent lamp) 150 that enables the fluorescent lamp to light.

[0044] Electrical current is supplied to a power source substrate 7 via the terminals 4a-4d of the bases 1a, 1b, and lead wires 6a, 6b which extend from a connector 16 connected to the bases 1a, 1b.

[0045] There is no problem electrically connecting the terminals 4a-4d and the lead wires 6a, 6b by methods of direct soldering, and the like.

[0046] The bases 1a, 1b are fixed to the casing 2 by a plurality of screws 5a-5d, and therefore, the bases 1a, 1b integrally enclose the casing 2 and the cover 3 fitted in the casing 2.

[0047] The bases 1a, 1b can be fixed to the casing 2 not by screws but fixers such as swages, or the like. A shape of the bases 1a, 1b is approximately the same as that of bases which are each located at either end of an existing fluorescent lamp.

[0048] Therefore, in place of a fluorescent lamp, by attaching a straight-tube LED lamp to an existing light fixture using a fluorescent lamp, without replacement of a light fixture, it is possible to make up a light fixture of an LED lamp.

[0049] Thus, compared to a case of attaching another new light fixture, it is possible to considerably reduce the equipment and construction cost, and realize a reduction in labor for replacement and reduction in time.

[0050] As illustrated in FIG. 9, in the inside of the integrally-formed casing 2 and cover 3, the casing 2 includes a flat part 32.

[0051] On an outer side (a lower side in the drawing) of the flat part (part equivalent to a chord of a semicircle shape) 32 of the casing 2 and in the cover 3, an LED substrate 11 as a mounting substrate is fixed to be opposite to the cover 3 via a sheet 10 having adhesiveness.

[0052] A material of the sheet 10 is preferably a material having a high heat conductivity (for example, a radiator silicon rubber, and so on) to easily conduct heat generated by an LED to the casing 2, that is, to stimulate heat radiation.

[0053] In the casing 2, the power source substrate 7 is arranged on an inner side (an upper side in the drawing) of the flat part 32.

[0054] As illustrated in FIG. 5, the LED substrate 11 is a printed substrate in an elongated-rectangular shape, and includes an LED substrate 11a and an LED substrate 11b.

[0055] The sheet 10 is divided in the longitudinal direction corresponding to a divided structure of the LED substrate 11.

[0056] On the LED substrates 11a, 11b, a plurality of LEDs 12a and a plurality of LEDs 12b as an example of a semiconductor light-emitting device having an EL (Electro-Luminescence) effect are mounted at predetermined intervals in the longitudinal direction of the casing 2, respectively, and constitute an LED array.

[0057] FIG. 6 is a perspective view of the straight-tube LED lamp 100 in which the casing 2 is cut along a line C-C in FIG. 9, and the bases 1a, 1b are removed.

[0058] As illustrated in FIG. 6, the power source substrate 7 is formed in an elongated-rectaugular shape extending in the longitudinal direction of the casing 2, and on its mounting surface, a plurality of electronic components 9 for DC (Direct Current) power source conversion are mounted in the longitudinal direction at intervals.

[0059] The electrical current rectified by the electronic components 9 is supplied to the LED substrates 11a, 11b as the mounting substrates through the lead wires 13a, 13b as illustrated in FIG. 8A.

[0060] Not-illustrated lead wire, jumper wire, and the like electrically connect between the LED substrate 11a and the LED substrate 11b.

[0061] In the present embodiment, the configuration of mounting substrates (LED substrates) mounting semiconductor light-emitting devices is a series arrangement of two mounting substrates; however, the configuration may be a series arrangement of one mounting substrate, or equal to or more than three mounting substrates, or may be a parallel arrangement.

[0062] Based on FIGS. 1 to 3, a specific structure of the embodiment of the present invention will be explained. Note that in FIGs. 1 and 3, a connected structure with the casing 2 is omitted, and schematically illustrated.

[0063] As illustrated in FIGs. 1 and 2, the cover 3 is constituted of a center portion 3a which is opposite to the light source (LED array), and peripheral portions 3b, 3c which are each located on either side of the center portion 3 a.

[0064] Because of a characteristic of an LED, an amount of light emission is largest (L1) in the front direction (axial direction) opposite to the LED 12, and at a peripheral position in a circumferential direction, the amount of light emission becomes smaller (L2, L3).

[0065] In other words, the center portion 3a is a portion corresponding to a portion where luminance is high, and the peripheral portions 3b, 3c are portions corresponding to portions where luminance is low.

[0066] In the present embodiment, a light emission characteristic of the LED 12 is a Lambertian distribution, and in a case where an angle between the LED 12 and the front direction is θ, a luminous intensity distribution is proportional to $\cos\theta$.

[0067] According to an experiment performed by the inventors of the present invention, a relationship between total light beam transmittance from an LED and diffusivity is a relationship where as diffusivity increases, transmittance reduces, and as transmittance increases, diffusivity reduces.

[0068] Based on the above relationship, in the present embodiment, diffusivity of the center portion 3a is larger than those of the peripheral portions 3b, 3c.

[0069] This makes it possible to reduce a luminance value in the front direction without excessively reducing the transmittance of the entire cover 3.

[0070] Thus, it is possible to reduce glare for an observer of light from the straight-tube LED lamp 100.

[0071] Evaluation of discomfort glare in a luminous environment is performed by the following calculation formula based on a value of the UGR (Unified Glare Rating)

[0072] Details of a calculation method of the value of the UGR are defined by the CIE (Commission Internationale de l'Éclairage) document CIE 117-1995.

$$UGR = 8\log\left[\frac{0.25}{L_b}\cdot\sum\frac{L^2{}_{\omega}}{P^2}\right]$$

where

L_b: background luminance [cd/m^2],
L: luminance of a light-emitting part of each light fixture received by an observer [cd/m^2],
ω: a solid angle of a light-emitting part of each light fixture as seen from an observer [sr], and
P: a Guth position index of each light fixture.

[0073] As is clear from the above calculation formula, if it is possible to make a luminance value L smaller, it is possible to make a value of the UGR smaller, and to prevent discomfort glare.

[0074] In the present embodiment, the cover 3 is integrally molded by extrusion molding.

[0075] In particular, the cover 3 is formed by extruding the same material with different contained amounts of a diffusion material and connecting each portion.

[0076] In this case, a case where a contained amount of a diffusion material of the peripheral parts 3b, 3c is zero is included.

[0077] As a method of molding, it is not limited to the extrusion molding, and it may be pultrusion molding, or injection molding.

[0078] Additionally, the cover 3 may be integrally formed of different materials with different diffusivity.

[0079] Furthermore, the cover 3 may be formed of a foam material, and transmittance (diffusivity) may be controlled by making the foam density different.

[0080] In this case, the foam material itself is a diffusion material.

[0081] As illustrated in FIG. 3, the cover 3 according to the embodiment is formed as a circular arc shape of a concentric-circular shape.

[0082] As described above, the cover 3 and the casing 2 are integrally formed as a circular-tube shape, and therefore, it is possible to maintain a straight-tube shape.

[0083] This makes it possible to prevent a poor external appearance as a substitute lamp of a fluorescent lamp.

[0084] Other structures of the straight-tube LED lamp 100 will be explained.

[0085] As described above, the power source substrate 7 is located on the inner side of the flat part 32 of the casing 2.

[0086] In a case where there is no electronic component on a surface opposite to the mounting surface on which the electronic components 9 are mounted of the power source substrate 7, and electrical insulation is ensured by applying an insulator such as a coating material and the like to the flat part 32, both (the power source substrate 7 and the flat surface 32) can be directly in contact with each other.

[0087] In the casing 2, a concave part 30 which is capable of accommodating the power source substrate 7 is formed.

[0088] The power source substrate 7 converts an electrical current sent from a commercial power source from AC (Alternating Current) to DC (Direct Current), supplies the electrical current to the LED substrates 11a, 11b via the lead wires 13a, 13b, and lights the LEDs 12a, 12b.

[0089] As illustrated in FIG. 10, a position of a hole 24 provided at an end of the power source substrate 7 coincides with that of a hole 25 (see FIG. 11) provided in the flat part 32 of the casing 2, a clamp 15 is inserted into the coinciding holes 24 and 25, and the power source substrate 7 is fixed to the casing 2.

[0090] The clamp 15 is a locker which fixes an end in the longitudinal direction of the power source substrate 7 to the casing 2.

[0091] The clamp 15 has a head (elastically-deforming part) 15a which includes an upper head part 15b and a lower head part 15c, a stem 15d, and a base 15e.

[0092] A positional displacement in the longitudinal direction of the power source substrate 7 is thus regulated.

[0093] Although detailed illustration is not shown, another end of the power source substrate 7 is pressed by the lead wires 13a, 13b.

[0094] The hole 25 provided in the casing 2 is provided on the outside of the LED substrate 11b and at a position closer to the base 1b, in the longitudinal direction of the casing 2 (see FIG. 5).

[0095] That is, the clamp 15 is located on a side closer to the base 1b of the power source substrate 7 and is set to be on the outside of the LED substrate 11b.

[0096] By thus arranging the clamp 15 on the outside of the LED substrate 11b, an LED light flux does not become a shadow by interrupting.

[0097] In FIG. 9 and the like, in order to easily recognize the clamp 15, the clamp 15 is illustrated in a protruded manner.

[0098] In fact, as illustrated in FIG. 11, when the clamp 15 is inserted and pressed into the hole 25 of the flat part 32 from the outer side of the flat part 32, at the time of passing through the hole 24 of the power source substrate 7, the head (elastically-deforming part) 15a (upper head part 15b) of the clamp 15 spreads outward.

[0099] The power source substrate 7 is thus fixed to the casing 2 by a fingertip operation.

[0100] A heat radiation effect is improved by providing roughness to the outer surface of the casing 2, and additionally, the power source substrate 7 is set to be in close contact with the flat part 32 of the casing 2, and contact performance is increased by the clamp 15. And therefore, the heat from the power source substrate 7 is effectively radiated to the casing 2.

[0101] As illustrated in FIGs. 9 and 11, the length h1 (length from a position where the clamp 15 (upper head part 15b) makes contact with the power source substrate 7 to a position where the clamp 15 (base 15e) makes contact with the flat part 32 of the casing 2) and the length h2 (length of thickness of the flat part 32 of the casing 2 and thickness of the power source substrate 7) are made approximately equal, and therefore, it is possible to regulate a direction vertical to the power source substrate 7.

[0102] That is, it is possible to regulate movement of the power source substrate 7 in the direction of the thickness perpendicular to the longitudinal direction of the casing 2.

[0103] The concave part 30 is constituted of the flat part 32, and two ribs 31 a, 31 b as protrusions which stand out in the direction of the thickness of the power source substrate 7 from the flat part 32.

[0104] If the length L (see FIG. 6) in the longitudinal direction of the ribs 31 a, 31 b is equal to the length of the casing 2, for example, extrusion processing can be performed.

[0105] That is, it is possible to integrally mold the ribs 31a, 31b with the casing 2 at the same time, and maintain a reduction in production cost.

[0106] Since the ribs 31a, 31b are formed on the flat part 32, an interval between protrusions is formed on a flat surface.

[0107] As illustrated in FIG. 9, when the width of the power source substrate 7, and an interval between the ribs 31a, 31b are D1 and D2, respectively, the relationship between D1 and D2 is set to establish D2>D1.

[0108] That is, the width of the concave part 30 is set such that the power source substrate 7 is inserted to the concave part 30.

[0109] The height H1 of the ribs 31a, 31b is set to be approximately equal to the height of the mounting surface of the power source substrate 7.

[0110] Thus, it is difficult for the power source substrate 7 to move in a right-and-left direction in the drawing, and therefore, it is difficult for the power source substrate 7 to deviate from the concave part 30.

[0111] Therefore, the ribs 31a, 31b prevent the power source substrate 7 from a positional displacement in a width direction (right-and-left direction) perpendicular to the longitudinal direction of the casing 2.

[0112] Accordingly, it is possible to inhibit disconnection (a sudden extinction of an LED lamp) of a lead wire caused by repetition of displacement in the width direction of the power source substrate 7 because of oscillation during commercial distribution, and shakes from an earthquake, or the like.

[0113] Additionally, also in a case of setting the power source substrate 7 in the casing 2 by sliding the power source substrate 7, it is possible to use the ribs 31a, 31b as guides, and therefore, it is easily possible to perform positioning, and insert the power source substrate 7.

[0114] The casing 2 is formed in a tubular shape having a uniform cross-sectional shape by extrusion molding, and pultrusion molding, and therefore, the power source substrate 7 may be inserted into the casing 2 from either end of the casing 2.

[0115] The height H1 of the ribs 31a, 31b is set to be a minimal height which is capable of preventing the positional displacement in the width direction of the power source substrate 7, and therefore, if the ribs 31a, 31b are provided throughout in the longitudinal direction of the casing 2, the mass does not largely increase.

[0116] Therefore, for example, even when the straight-tube LED lamp 100 is mounted on a ceiling, the mass of the casing 2 is increased, and the casing 2 is deformed by gravity, and yet there is no cause for concern of falling caused by shakes from an earthquake, and the like.

[0117] Conversely, rigidity in the longitudinal direction of the casing 2 is improved by a reinforcing effect of the ribs 31a, 31b, and therefore, it is possible to obtain a secondary effect of inflexibility.

[0118] As described above, by providing the ribs 31a, 31b by extrusion molding, and the like, most of the movement of the power source substrate 7 in the right-and-left direction is regulated.

[0119] FIG. 12 illustrates a modified example of the present embodiment.

[0120] In a case where necessary dielectric strength against leak voltage is not ensured between the casing 2 and the power source substrate 7, as illustrated in FIG. 12, a sheet-like insulator 41 that ensures dielectric strength between them is provide.

[0121] An inner width of the insulator 41 is set to be equal to or somewhat larger than the width E1 of the power source substrate 7.

[0122] An outer width E2 of the insulator 41 is set to be smaller than an interval E3 between the ribs 31a, 31b, and to be a width in which the insulator 41 can be inserted.

[0123] The insulator 41 has an edge part which stands out in the direction of the thickness of the power source substrate 7 at either end in the width direction.

[0124] The height H2 of the ribs 31a, 31b is set to be larger than the length of the thickness of the insulator 41 and the thickness of the power source substrate 7; however, if the height H2 is lower than the height K1 of the edge part of the insulator 41, the power source substrate 7 does not get over the ribs 31a, 31b.

[0125] In a case of fixation using the clamp 15, the fixation is performed such that a hole is made in the insulator 41, the insulator 41 is sandwiched between the flat part 32 of the casing 2 and the power source substrate 7, and the clamp 15 is inserted into the hole.

[0126] The size of the hole (not-illustrated) of the insulator 41 is set such that the hole of the insulator 41 is encircled by the hole of the power source substrate 7 (The hole of the insulator 42 is smaller than the hole of the power source substrate 7.).

[0127] Note that fixation may be performed with a screw in place of the clamp 15.

[0128] Also in a case where the insulator 41 is inserted, if the length h3 (length of the thickness of the flat part 32 of the casing 2, the thickness of the insulator 41, and the thickness of the power source substrate 7) ≈ the length h1 (length from the position where the clamp 15 (upper head part 15b) makes contact with the power source substrate 7 to the position where the clamp 15 (base 15e) makes contact with the flat part 32 of the casing 2), it is possible to regulate movement of the power source substrate 7 in the direction of the thickness.

[0129] In the present example, since electrical current flowing to the power source substrate 7 does not flow to the casing 2 because of the existence of the insulator 41, there is no cause for concern of injury caused by electrical shock, or the like, fire, and the like.

[0130] In the embodiment of the present invention, the straight-tube LED lamp 100 is attachable to the light fixture 150 that enables the fluorescent lamp to light; however, needless to add, the straight-tube LED lamp 100 can be attachable to a light fixture exclusive for an LED.

[0131] According to the embodiment of the present invention, it is possible to reduce luminance in the front direction without impairing transmittance. And therefore, it is possible to inhibit discomfort glare.

[0132] It is also possible to prevent a poor external appearance, and contribute to improvement of usability.

[0133] Although the present invention has been described in terms of exemplary embodiments, it is not limited thereto. It should be appreciated that variations may be made in the embodiments described by persons skilled in the art without departing from the scope of the present invention as defined by the following claims.

Claims

1. A straight-tube LED lamp (100) comprising:

an elongated-shaped casing (2) which has two edges along a longitudinal direction;
a translucent cover member (3) which is attached to the casing so as to cover the edges of the casing throughout in the longitudinal direction; and
a plurality of semiconductor light-emitting devices (12a, 12b) which are arranged in the cover member along the longitudinal direction as a light source;

wherein the cover member has a portion (3a) corresponding to a portion where luminance of the light source is high, and a portion (3b, 3c) corresponding to a portion where luminance of the light source is low, and the portion corresponding to the portion where the luminance of the light source is high is higher in diffusivity than the portion corresponding to the portion where the luminance of the light source is low.

2. The straight-tube LED lamp (100) according to Claim 1, wherein the portion (3b, 3c) corresponding to the portion where the luminance of the light source is low is formed of a diffusion material.

3. The straight-tube LED lamp (100) according to Claim 1 or Claim 2, wherein the cover member (3) in cross-section has a circular arc shape of a concentric-circular shape.

4. The straight-tube LED lamp (100) according to any one of Claims 1 to 3, wherein the cover member (3) is integrally molded.

5. A lighting device (200) comprising:

a straight-tube LED lamp (100) according to any one of Claims 1 to 4; and
a light fixture (150) to which the straight-tube LED lamp is attached.

Amended claims in accordance with Rule 137(2) EPC.

1. A straight-tube LED lamp (100) comprising:

an elongated-shaped casing (2) which has two edges along a longitudinal direction;
a translucent cover member (3) which is attached to the casing so as to cover the edges of the casing throughout in the longitudinal direction; and
a plurality of semiconductor light-emitting devices (12a, 12b) which are
arranged in the cover member along the longitudinal direction as a light source;
wherein the cover member has a portion (3a) corresponding to a portion where luminance of the light source is high, and a portion (3b, 3c) corresponding to a portion where luminance of the light source is low,
characterized in that a diffusivity of a material of the portion where the luminance of the light source is high is higher than a diffusivity of a material of the portion where the luminance of the light source is low, such that the portion corresponding to the portion where the luminance of the light source is high is higher in diffusivity than the portion corresponding to the portion where the luminance of the light source is low.

2. The straight-tube LED lamp (100) according to Claim 1, wherein the portion (3b, 3c) corresponding to the portion where the luminance of the light source is low is formed of a diffusion material.

3. The straight-tube LED lamp (100) according to Claim 1 or Claim 2, wherein the cover member (3) in cross-section has a circular arc shape of a concentric-circular shape.

4. The straight-tube LED lamp (100) according to any one of Claims 1 to 3, wherein the cover member (3) is integrally molded.

5. The straight-tube LED lamp (100) according to any one of claims 1 to 4, wherein the portion corresponding to the portion where the luminance of the light source is high and the portion corresponding to the portion where the luminance of the light source is low are formed of the same material with different contained amounts of a diffusion material.

6. The straight-tube LED lamp (100) according to any one of claims 1 to 4, wherein the portion corresponding to the portion where the luminance of the light source is high and the portion corresponding to the portion where the luminance of the light source is low are formed of different materials with different diffusivity.

7. The straight-tube LED lamp (100) according to any one of claims 1 to 4, wherein the portion corresponding to the portion where the luminance of the light source is high and the portion corresponding to the portion where the luminance of the light source is low are formed of a foam material, wherein a foam density of the foam material of the portion corresponding to the portion where the luminance of the light source is high is different from a foam density of the foam material of the portion corresponding to the portion where the luminance of the light source is low.

8. A lighting device (200) comprising:

a straight-tube LED lamp (100) according to any one of Claims 1 to 7;
and
a light fixture (150) to which the straight-tube LED lamp is attached.

FIG.1

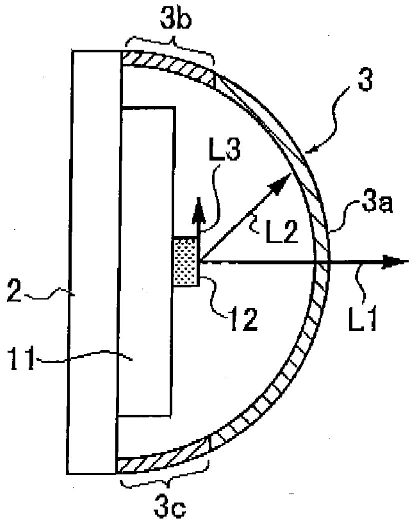


FIG.2

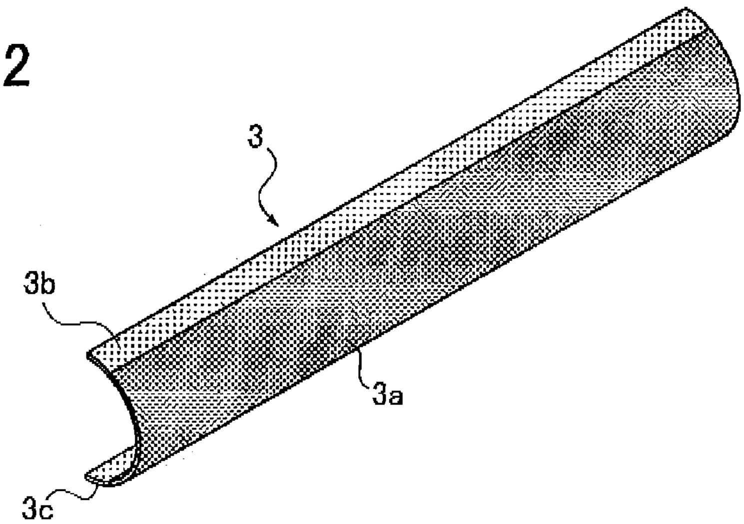


FIG.3

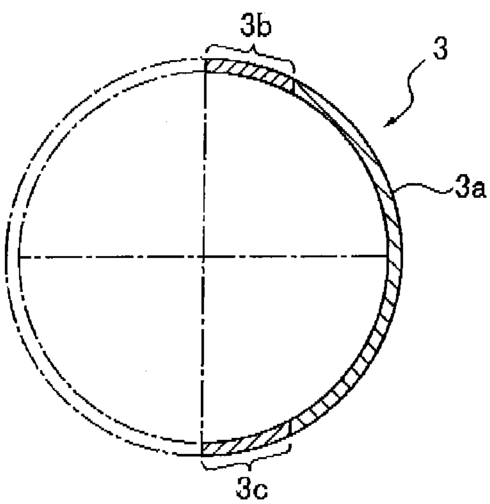


FIG.4

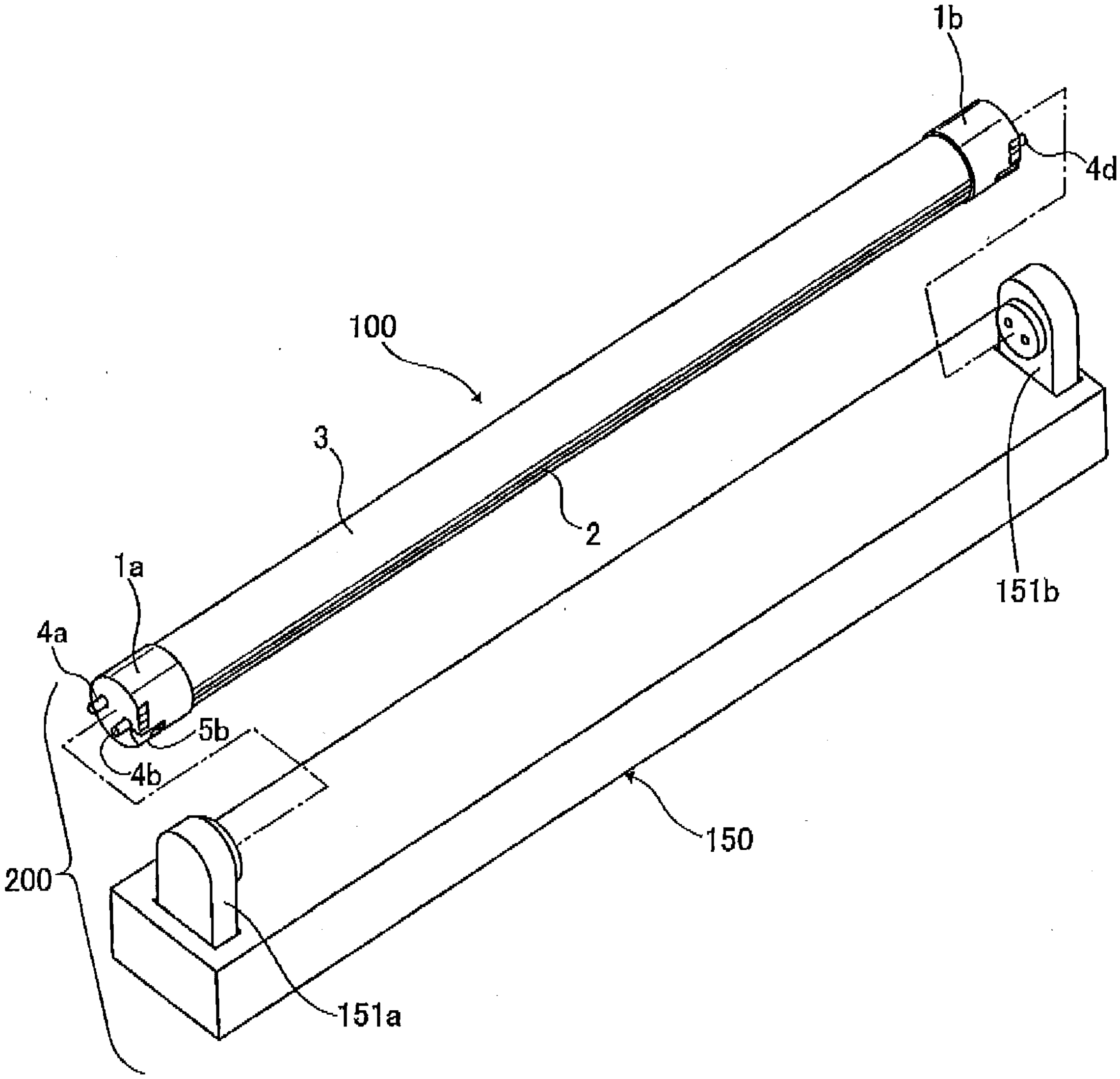


FIG.5

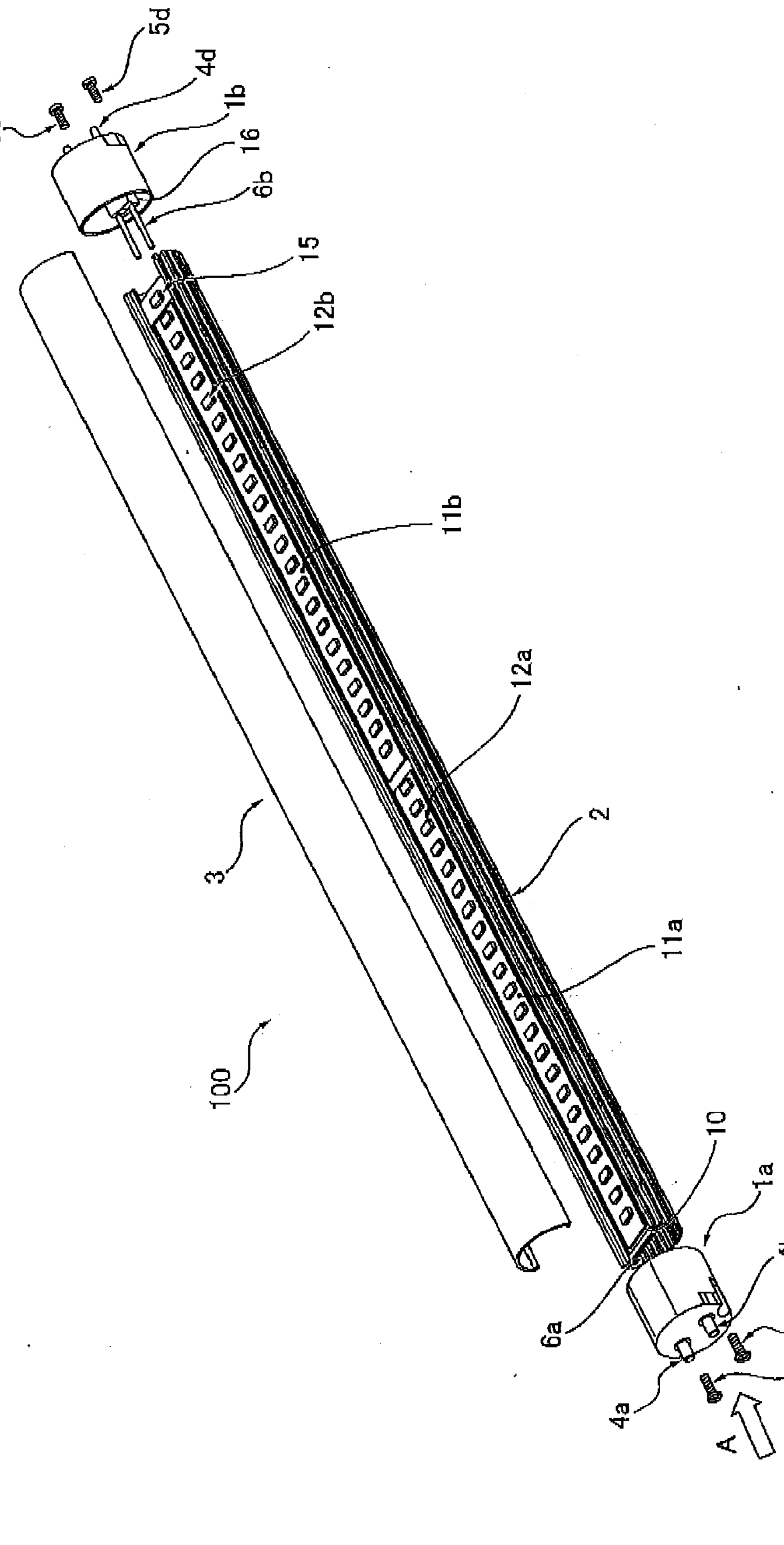


FIG.6

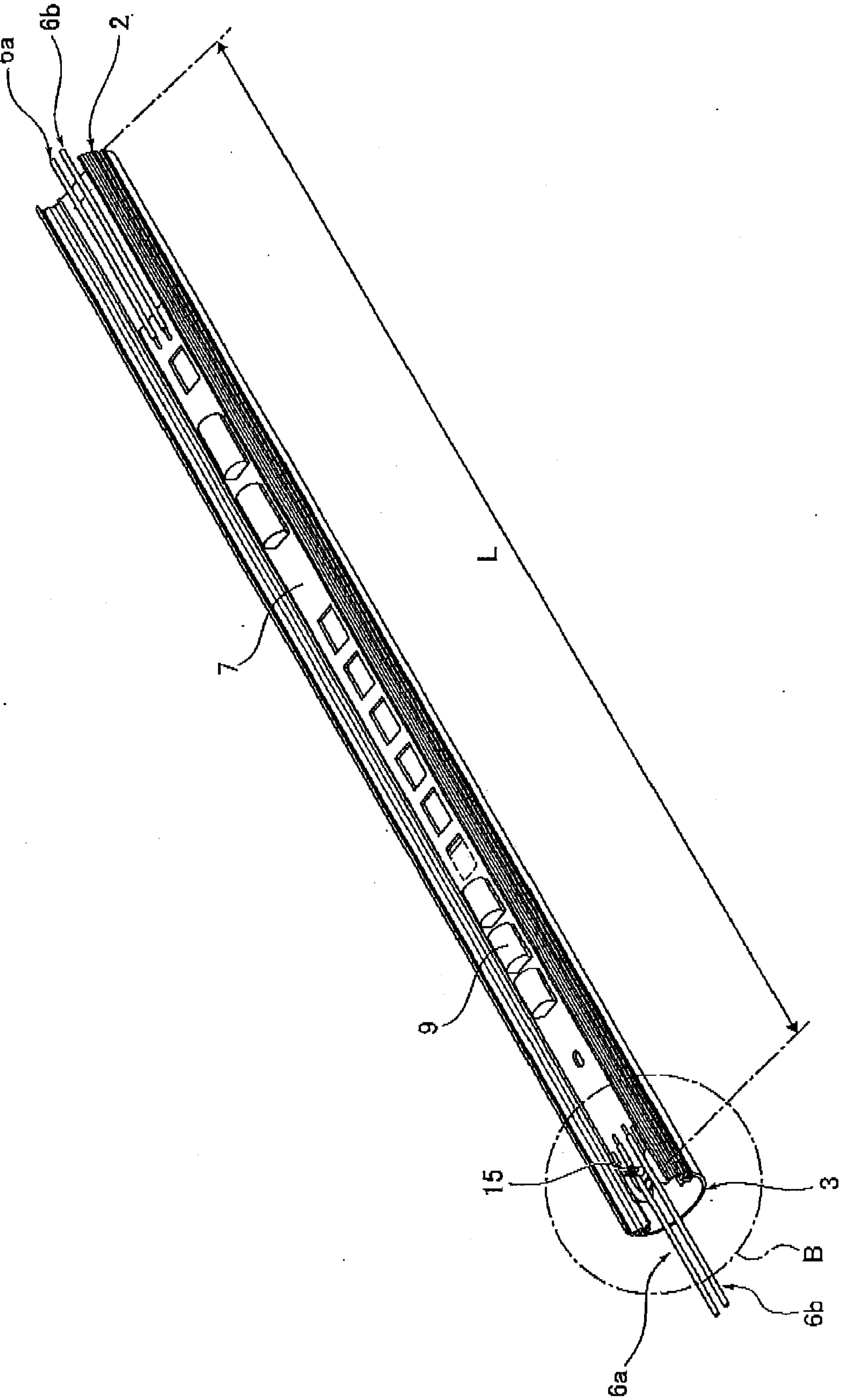


FIG.7A

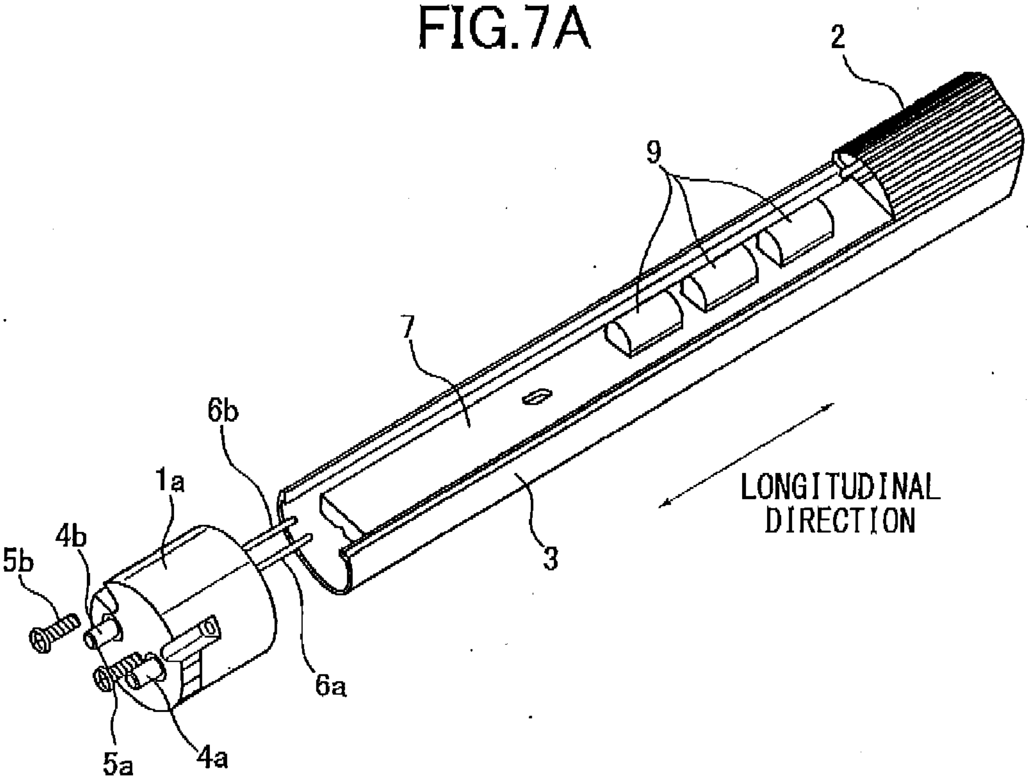

2
9
7
6b
1a
4b
5b
3
6a
5a
4a
LONGITUDINAL
DIRECTION

FIG. 7B

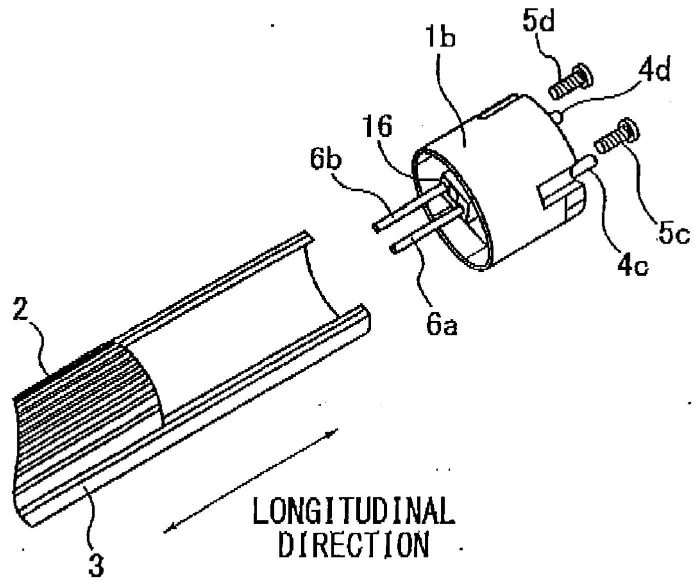

5d
1b
4d
16
6b
5c
4c
6a
2
3
LONGITUDINAL
DIRECTION

FIG.8A

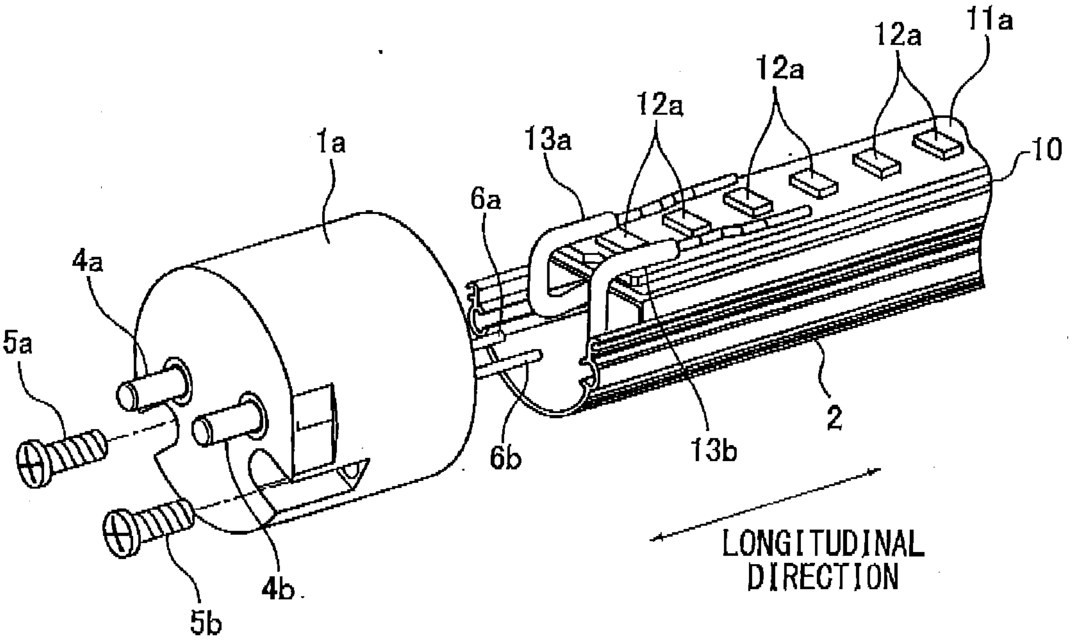

1a
4a
5a
6a
13a
12a
12a
12a
11a
10
6b
13b
2
4b
5b
LONGITUDINAL
DIRECTION

FIG. 8B

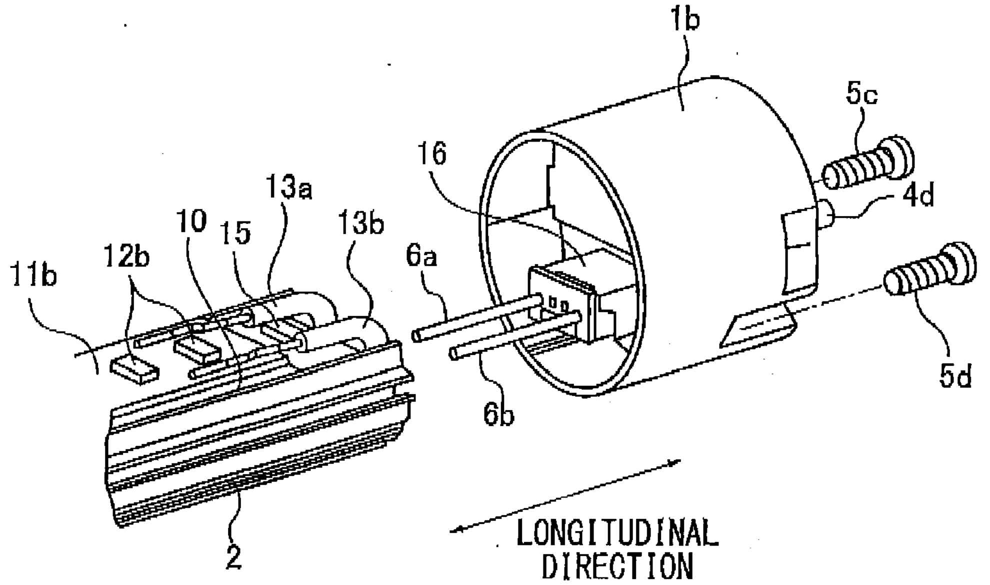

1b
5c
16
4d
13a
10
15
13b
6a
11b
12b
5d
6b
2
LONGITUDINAL
DIRECTION

FIG.9

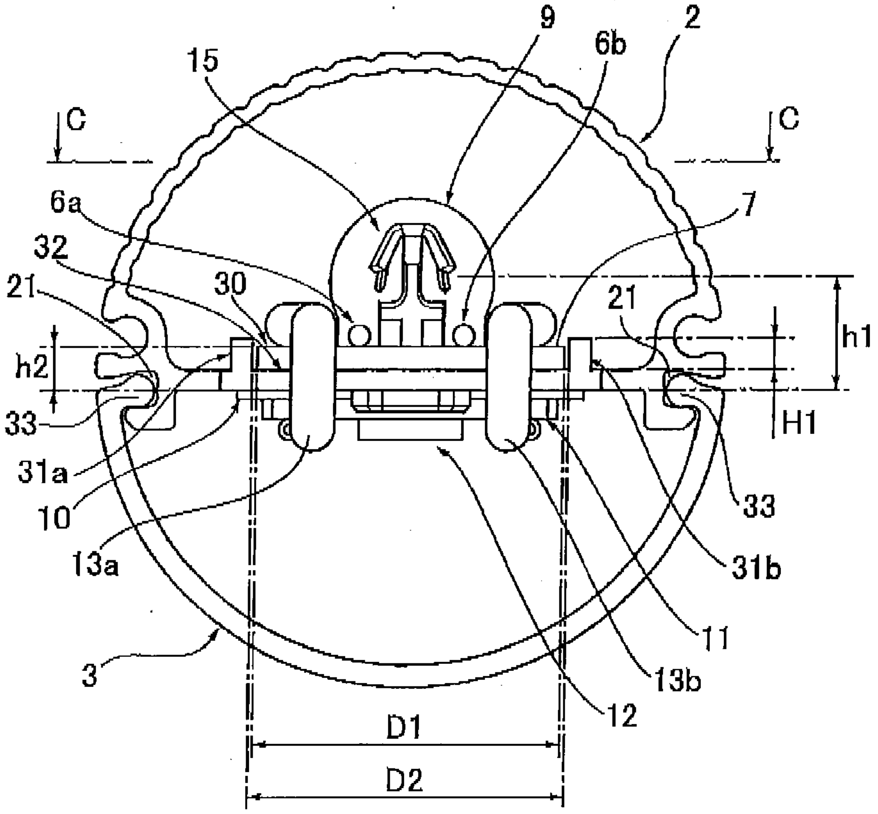

9
2
15
6b
C
C
6a
7
32
30
21
21
h1
h2
33
H1
31a
33
10
31b
13a
11
3
13b
12
D1
D2

FIG.10

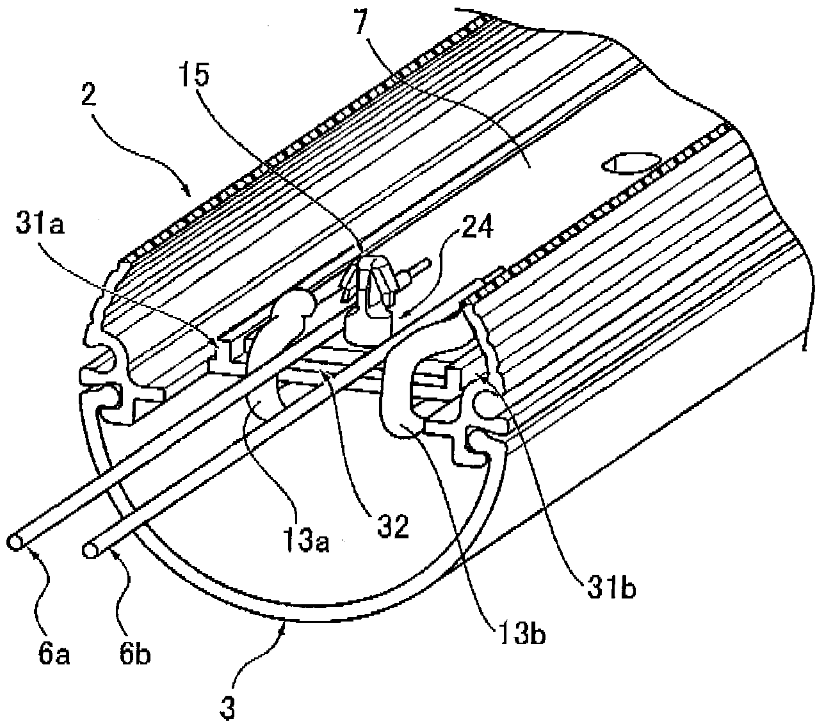


FIG.11

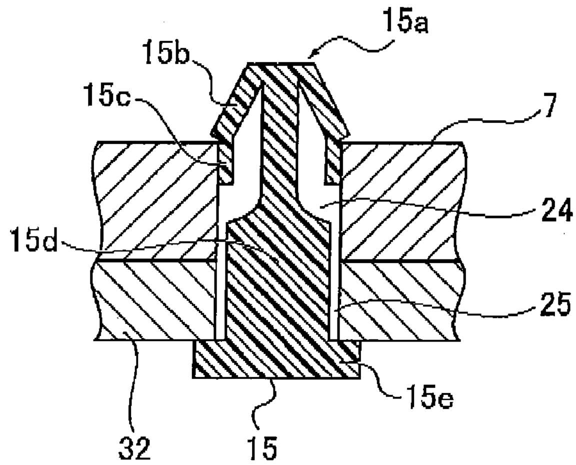
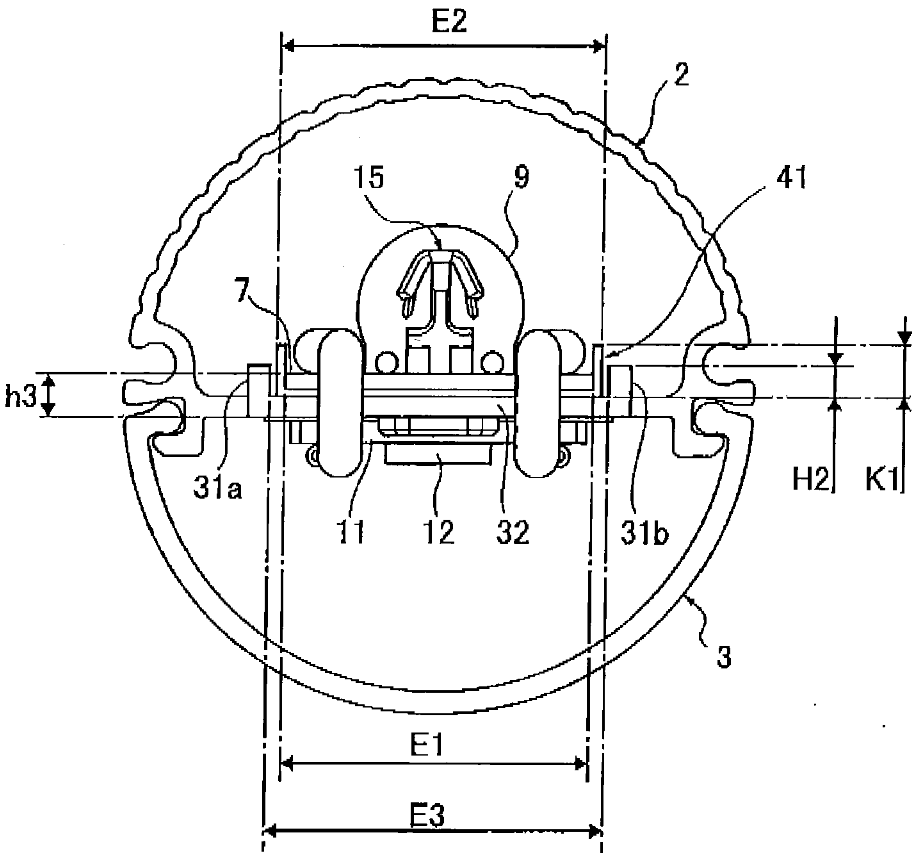


FIG.12



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EUROPEAN SEARCH REPORT

Application Number
EP 14 15 8925

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	WO 2012/043543 A1 (TOSHIBA LIGHTING & TECHNOLOGY [JP]; UEMURA KOZO [JP]; NISHIMURA KIYOSH) 5 April 2012 (2012-04-05) * figures 1, 11(a), 12(a) * -& US 2013/271971 A1 (UEMURA KOZO [JP] ET AL) 17 October 2013 (2013-10-17) * figures 1, 11(a), 12(a) * * paragraph [0074] - paragraph [0084] * -----	1-5	INV. F21K9/00 F21S4/00 ADD. F21Y101/02 F21Y103/00
X	US 2012/014116 A1 (HU WEN-SUNG [TW]) 19 January 2012 (2012-01-19) * figures 14, 15a * * paragraphs [0045], [0046] * -----	1-5	
A	US 2012/170258 A1 (VANDUINEN MICHEAL [US] ET AL) 5 July 2012 (2012-07-05) * figure 13 * * paragraph [0028] * -----	1-4	
			TECHNICAL FIELDS SEARCHED (IPC)
			F21K F21S F21V F21Y

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
The Hague	28 April 2014	Sacepe, Nicolas

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28-04-2014

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		WO 2012043543 A1	05-04-2012
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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