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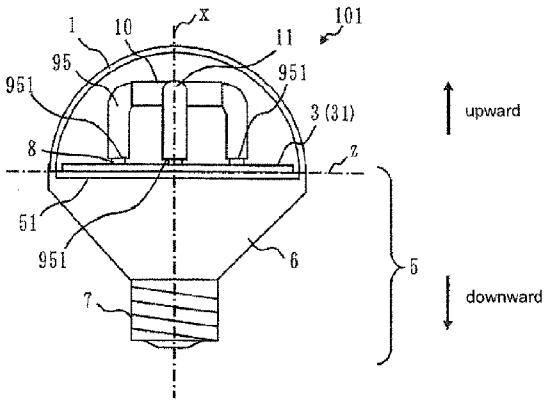
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(54) **Title**: LIGHTING DEVICE

Fig. 2



(57) **Abstract**: (Problem) To provide a lighting device with a broad light distribution in which the light from an LED light source is led near to the center of the lighting device. (Means of Resolution) Lighting device provided with LED board (3) on which LED element (8) is mounted, and lighting circuit board which powers LED element (8), having a plurality of U- shaped light guides (95) positioned above LED element (8), LED element (8) being mounted on the lower surface of the two bases of light guides (95), and the plurality of U-shaped light guides (95) characterized in crossing over each other. Light from LED elements (8) mounted on the lower surface of the base of the light guides (95) is led by light guides (95) near to the center of the lighting device, with light from LED elements (8) able to have a broad light distribution due to diffusion over a wider area including the vertical and horizontal directions of the board surface of LED element (8).

Description

Lighting device

Technical Field)

(0001)

The invention relates to a lighting device which employs a light-emitting diode.

(Technical Background)

(0002)

Various improvements have contributed to realizing an LED bulb with a broad light distribution close to that of an incandescent bulb.

(Prior Art Reference)

(Patent Literature)

(0003)

(Patent Literature 1) JP 2001-243807
(Patent Literature 2) JP 2009-4130
(Patent Literature 3) JP 2004-296245
(Patent Literature 4) JP 2008-103112
(Patent Literature 5) JP 2010-129300
(Patent Literature 6) JP 2008-077900
(Patent Literature 7) JP 2005-514752

(Summary of Invention)

(Difficulty to Be Resolved by the Invention)

(0004)

The invention has the purpose of employing a light-emitting diode element to provide a lighting device with a broad light distribution.

(Means of Resolution)

(0005)

The lighting device of the invention is characterized in being provided with a board mounted with a light source, and a lighting circuit which powers the light source, and in having a plurality of U-shaped light guides positioned above the light source, the light source being mounted on the lower surface of the two bases of the light guides, and the plurality of U-shaped light guides crossing over each other.

(0006)

The U-shaped light guides which cross over each other are characterized in intersecting at a crossover point.

(0007)

The U-shaped light guides which cross over each other are characterized in that the heights of each light guide are different, and do not intersect at a crossover point.

(0008)

The U-shaped light guides are characterized in that the horizontal section is processed to diffuse light, or has material added which diffuses light.

(0009)

The lighting device of the invention is characterized in being provided with a board mounted with a light source, and a

lighting circuit which powers the light source, and in having a spiral-shaped light guide positioned above the light source, the light source being mounted on the lower surface of the two bases of the light guide.

(0010)

The spiral-shaped light guide is characterized in that part of or the whole surface of the pipe is processed to diffuse light, or has material added which diffuses light.

(0011)

The lighting device is further characterized in being provided with a translucent globe which covers the light source.

(0012)

The light source is characterized in being a light-emitting diode.

(Effect of the Invention)

(0013)

With the invention, light from the light source mounted on the lower surface of the bases of the light guide is guided by the light guide near to the center of the lighting device, ensuring that light from the light source has a broad light distribution as it is diffused over a wider area including directions both perpendicular and horizontal to the board surface of the light source.

(Brief Description of the Drawings)

(0014)

(Fig. 1) Structural diagram of the lighting device in Embodiment 1.
(Fig. 2) Structural diagram of the lighting device in Embodiment 2.
(Fig. 3) Structural diagram of the lighting device in Embodiments 1, 2, 3.
(Fig. 4) Structural diagram of the lighting device in Embodiment 4.
(Fig. 5) Structural diagram of the lighting device in Embodiment 5.
(Fig. 6) Structural diagram of the lighting device in Embodiment 5.
(Fig. 7) Structural diagram of the lighting device in Embodiment 6.
(Fig. 8) Structural diagram of the lighting device in Embodiment 6.

(Fig. 9) Schematic diagram of the light paths of the lighting device in Embodiment 1.
(Fig. 10) Schematic diagram of the light paths of the lighting device in Embodiment 2.
(Fig. 11) Schematic diagram of the light paths of the lighting device in Embodiment 6.

(Embodiments)

(0015)

Embodiment 1

(1) First Embodiment (Fig. 1, Fig. 3 (a) (b), Fig. 9):

LED board 3 on which LED element 8 (light-emitting diode element) is mounted is provided within an enclosure comprising translucent globe 1 made of polycarbonate which covers LED light-emitting surface 31, outer surround 6, and fitting 7. The lighting circuit board (not shown) which powers the LED

is provided within outer surround 6 which forms the enclosure.

(0016)

Main plane plate 51 on the surface of the translucent globe 1 side of outer surround 6 is made of aluminum, and LED board 3 on which LED element 8 is mounted is provided on main plane plate 51. Lighting device 5 comprises items such as the lighting circuit board, outer surround 6, fitting 7, and main plane plate 51.

(0017)

Translucent globe 1 is hemispherical in shape, and provided with an overhang which extends upward (the direction in which light shines out) (see Fig. 1). Moreover, a diffusing agent which diffuses light is added to translucent globe 1. A resin to which a diffusing agent has been added is used for translucent globe 1, but may be of any type provided that translucent globe 1 allows light to pass through and that a method is employed to allow part of it to reflect and diffuse, such as frosting the resin itself, or coating the inside with titanium oxide which diffuses and reflects light.

(0018)

With the surface of LED board 3 as the z direction, the central axis of lighting device 100 is taken as the x direction.

x direction: perpendicular to the plane of LED board 3 (axis of lighting device)
z direction: horizontal to the plane of LED board 3

(0019)

LED board 3 is made of aluminum, with four LED elements 8 provided on one side (light-emitting surface 31) of LED board

3 and two U-shaped light guides 9 (Fig. 3 (a)) mounted above these with their ends facing downward in parallel and the two ends of each positioned respectively above two LED elements 8 (see Fig. 3 (a)).

(0020)

Light guide 9 is a U-shaped light pipe, with the both ends of the U-shape (bases) having end surfaces 91 which allow light to pass (see Fig. 1). As shown in Fig. 3 (a), a pair of LED elements 8a and a pair of LED elements 8b are positioned on light-emitting surface 31. Moreover light guide 9a is attached so that a pair of LED elements 8a are respectively positioned at the lower part of end surfaces 91 on both sides. Light guide 9b is attached so that so that a pair of LED elements 8b are respectively positioned at the lower part of end surfaces 91 on both sides. Light guide 9a and light guide 9b are positioned in parallel.

(0021)

Light guide 9 has the ends of the U-shape (end surfaces 91) attached to light-emitting surface 31 of LED board 3 so as to cover LED element 8. With light guide 9, light emitted by LED element 8 positioned under end surfaces 91 on both sides at the end of the U-shape is guided into the light pipe from the ends of the U-shape (end surfaces 91) and guided to the central horizontal section within the light pipe. As shown in Fig. 1, the central horizontal section of U-shaped light guide 9 is diffusion section 10 which diffuses light, and has a light diffusing agent added to it.

(0022)

Light guide 9 of the embodiment is a rod-type light pipe processed into a U-shape from a cylinder formed of transparent material such as glass for example, but it may be a

light-tunnel type of light pipe formed with a hollow interior and mirrored side surfaces.

(0023)

LED element 8 is coated around with silicon adhesive, and the ends of U-shaped light guide 9 are mounted on and fixed to the surface of LED element 8 by sticking the ends of light guide 9

(0024)

Fig. 9 is a schematic diagram of the light paths of light guide 9 in the embodiment. Light emitted from LED element 8 is led to diffusion section 10 by light guide 9, and the light by diffusion 10 diffused into paths K1, L1, M1 etc., for example.

(0025)

As it passes through translucent globe 1, light K1 emitted from diffusion unit 10 of light guide 9 is diffused by the effect of translucent globe 1 into light paths K11, K12, K13, for example. Moreover, as it passes through translucent globe 1, light L1 emitted from diffusion section 10 of light guide 9 is diffused by the diffusing effect of translucent globe 1 into light paths L11, L12, L13 etc. Light M1 emitted from diffusion unit 10 of light guide 9 is in the same way diffused into light paths M11, M12, M13 etc..

(0026)

In this way the light emitted by LED element 8 is first diffused into light paths such as K1, L1, M1 etc. by diffusion unit 10, and then diffused further by translucent globe 1. In other words, light paths K1, L1, M1 etc., are diffused into K11, K12, K13 etc., L11, L12, L13 etc., M11, M12, M13 etc. and shone out from lighting device 100.

(0027)

As described above, the light emitted from LED element 8 turns into the light paths shown by solid and broken lines in Fig. 9 due to light guide 9 and translucent globe 1, both realizing light distribution over more than 180°, and enabling greater light distribution in the z direction, for example.

(0028)

As shown in Fig. 3 (b), three U-shaped light guides 9 may be used. In Fig. 3 (b), six LED elements 8 are mounted on light-emitting surface 31 of LED board 3. In addition, in Fig. 3 (a), a pair of LED elements 8c is positioned on light-emitting surface 31. Light guide 9c is then attached such that a pair of LED elements 8c are respectively positioned at the lower part of both end surfaces 91. Light guide 9a, light guide 9b and light guide 9c are positioned in parallel. Light guide 9a, light guide 9b and light guide 9c are preferably positioned so as to be equidistant from one another.

(0029)

Lighting device 100 of the embodiment comprises a board (LED board 3) on which a light source (LED element 8) is mounted, and a lighting circuit board which powers the lighting source, and with lighting device 100 in which a plurality of U-shaped light guides 9 are positioned above the light source, the light source is characterized in being mounted on the lower surface of the two bases of light guides 9 (lower ends of the U-shape (end surfaces 91)).

(0030)

Lighting device 100 of Embodiment 1 is such that the light source mounted on the lower surface of the two bases of light guides 9 is led near the center of lighting device 100 by a

plurality of U-shaped light guides 9, enabling a broad light distribution due to diffusion over a wider area including vertical and horizontal directions of the board surface of the light source.

(0031)

Moreover, lighting device 100 of Embodiment 1 is characterized in that the plurality of U-shaped light guides 9 are positioned in parallel.

(0032)

With lighting device 100 of Embodiment 1, the extent of the light distribution is broadened due to the fact that light guides 9 are positioned in parallel, enabling a further broadening of the range of light distribution.

(0033)

Moreover, lighting device 100 of Embodiment 1 is characterized in that U-shaped light guide 9 has a light-diffusing material added in the horizontal section of the pipe (diffusion unit 10), or is processed to diffuse light.

(0034)

With lighting device 100 of Embodiment 1, the horizontal section of the pipe (diffusion unit 10) in light guide 9 is processed to diffuse light (frosting) or has material added which diffuses light, which increases the diffusion effect, and further increases the range over which light is distributed.

(0035)

Embodiment 2

(2) Second Embodiment (Fig. 2, Fig. 3 (e) (f), Fig. 10):

As shown in Fig. 2, Fig. 3 (e), lower end surfaces 951 of light guide 95 formed of two U-shapes made to intersect at crossover point 11 are positioned above four LED elements 8 positioned at the apexes of a square. Apart from this, the structure is the same as in Embodiment 1, and parts of the embodiment having the same structure as that described for Embodiment 1 are keyed identically and their description is omitted.

(0036)

As shown in Fig. 3 (e), light guide 95 in this embodiment is shaped such that two U-shapes are made to intersect in a cross shape at crossover point 11. Light guide 95 also has a cross shape connected internally. The horizontal section of the cross shaped part of light guide 95 acts as diffusion section 10.

(0037)

Light guide 95 is attached to light-emitting surface 31 of LED board 3 so that the four end sections (end surfaces 951) (see Fig. 2) respectively cover the four LED elements 8. With light guide 95, the light emitted from LED elements 8 positioned below end surfaces 951 is guided within the light pipe from end surfaces 951 and led into the horizontal central section (diffusion unit 10) of the light pipe. A diffusing agent is added to diffusion unit 10.

(0038)

Fig. 10 shows a schematic diagram of the light paths caused by light guide 95 in the embodiment. The method of diffusion shown in Fig. 10 is the same as the method described in Fig. 9 for Embodiment 1. The light from LED element 8 becomes the light paths shown in Fig. 10 due to light guide 95, enabling

a light distribution to be realized over more than 180°, and enabling greater distribution of light in the z direction.

(0039)

As shown in Fig. 3 (f), light guide 95a may also be used in which three U-shapes are made to intersect at crossover point 11. With light guide 95a shown in Fig. 3 (f), diffusion unit 10 has a form which extends more to the periphery than with light guide 95 shown in Fig. 3 (e). For this reason, improved light distribution in both the vertical and the horizontal directions of LED board 3 can be obtained in every direction from lighting device 100.

(0040)

With lighting device 101 in Embodiment 2, the plurality of U-shaped light guides 9 provided are characterized in mutually intersecting one another. Moreover, the mutually intersecting U-shaped light guides 9 are characterized in intersecting at crossover point 11. The mutually intersecting U-shaped light guides 9 intersect with one another at crossover point 11, forming a single light guide 95a.

(0041)

As light guides 9 intersect with one another in lighting device 101 of Embodiment 2, light is directed all around the lighting device, and improved light distribution in both the horizontal and vertical direction of light-emitting surface 31 of LED board 3 can be obtained from all directions of lighting device 101.

(0042)

Embodiment 3

(3) Third Embodiment (Fig. 3 (c) (d)):

With this embodiment, a method of forming a lighting device using two U-shaped light guides 9d, 9e of different heights will be described.

(0043)

As shown in Fig. 3 (c), with this embodiment U-shaped light guides 9d, 9e of different heights are made to cross over in a cross shape, so that the two light guides 9d, 9e do not intersect with each other. As shown in Fig. 3 (c), the two ends 91d of light guide 9d are positioned respectively above two LED elements 8 on a diagonal line between the four LED elements 8 positioned at the apexes of a square. Moreover, the two ends 91e of light guide 9e are positioned respectively above the other two LED elements 8. The rest of the structure is identical to that described for Embodiment 1, and its description will be omitted.

(0044)

By having U-shaped light guides 9d, 9e of different heights made to cross over in a cross shape, diffusion unit 10d of light guide 9d and diffusion unit 10e of light guide 9e are made to cross over in a cross shape. By this means diffusion units 10 (10d, 10e) have a form which extends further to the periphery.

(0045)

With the embodiment, two U-shaped light guides 9 of different heights are combined, but as the light guides are not formed into the shape of an intersecting cross, the processing and manufacture of light guides 9 are simple.

(0046)

As shown in Fig. 3 (d), three U-shaped light guides 9d, 9e, 9f of different heights may be used in such a way that the three light guides 9 (9d, 9e, 9f) do not intersect.

(0047)

With the lighting device of Embodiment 3, the U-shaped light guides 9 are characterized in that the heights of the respective light guides 9 are different, and that they do not intersect with one another at a crossover point 11.

(0048)

With the lighting device of Embodiment 3, since light guides 9 which cross over each other have heights that differ from one another, and as they do not intersect at crossover point 11, U-shaped light guide 9 does not need to have a complex shape, thus reducing processing costs.

(0049)

Embodiment 4

(4) Fourth Embodiment (Fig. 4):

The two lower end surfaces 912 of spiral-shaped light guide 96 are positioned so as to be mounted over two LED elements 8. Spiral-shaped light guide 96 comprises vertical sections 910 of the spiral (parts which rise up along the x-axis) and a swirl section 911 of the spiral (a part which winds in a spiral shape along the x-axis). Except for vertical sections 910 of the spiral, with spiral-shaped light guide 96 a light-diffusing agent is added to swirl section 911 of the spiral. Apart from this it is identical to Embodiment 1, and its description will be omitted.

(0050)

The interior of translucent globe 1 is coated with reflective/diffusing titanium oxide, forming light reflecting/diffusing film 2.

(0051)

Lighting device 102 of Embodiment 4 comprises a board (LED board 3) on which a light source (LED element 8) is mounted, and a lighting circuit board which powers the light source, and in lighting device 102 in which spiral-shaped light guide 96 is positioned over this lighting source, the lighting source is characterized in being mounted on the bottom surface of the two bases of light guide 96 (lower end surfaces 912).

(0052)

With lighting device 102 of Embodiment 4, light from the light source mounted on the bottom surface (lower end surfaces 912) of the two bases of light guide 96 is led by spiral light guide 96 near to the center of lighting device 102, enabling a broader light distribution due to diffusion over a wider area including the horizontal and vertical directions of the board surface (light-emitting surface 31).

(0053)

Moreover, lighting device 102 of Embodiment 4 is characterized in that all or part of the surface of the pipe in spiral light guide 96 is processed to diffuse light, or has light-diffusing material added.

(0054)

As with lighting device 102 of Embodiment 4, all or part of the surface of the pipe in spiral light guide 96 is processed to diffuse light (frosted) or has light-diffusing material

added, a greater diffusion effect is obtained, and light distribution can be expanded over an even greater range.

(0055)

Embodiment 5

(5) Fifth Embodiment (Fig. 5, Fig. 6):

With lighting device 103 of the embodiment, 12 LED elements 8 are positioned in a circle on light-emitting surface 31 of LED board 3 (see Fig. 6). Hemispherical-shaped hemispherical light guide 90 is mounted above the 12 LED elements 8 positioned in a circle. The inside of hemispherical light guide 90 is hollowed out, and L2 of hemispherical light guide 90 (see Fig. 6) may be of any thickness as long as it is greater than the width L1 of LED element 8 (see Fig. 6).

(0056)

A resin to which a light diffusing agent has been added is used for hemispherical light guide 90. Apart from this, the structure is identical to that of Embodiment 1. As shown in Fig. 5, Fig. 6, lower end surfaces 913 of hemispherical light guide 90 form a circular shape of width L2. Lower end surfaces 913 of hemispherical light guide 90 are attached so as to cover the 12 LED elements 8 positioned in a circle. The method of attachment for hemispherical light guide 90 is identical to the method described for Embodiment 1.

(0057)

Light emitted from the 12 LED elements 8 is guided over the entire hemispherical light guide 90 from the lower end surfaces 913 of hemispherical light guide 90. The thickness L2 (width) of lower end surfaces 913 is larger than the width L1 of LED element 8, and so the LED elements 8 are entirely covered by lower end surface 913, and the light emitted from LED

elements 8 can be guided without leakage into hemispherical light guide 90.

(0058)

With this embodiment, hemispherical light guide 90 is formed so as to cover 12 LED elements 8, but the light guide need not be a hemispherical shape. Light guide 9 may for example be in the shape of a dome, a bell, an egg-plant, a gourd, a hill, a lump, a semioval, a light bulb or the like.

(0059)

Lighting device 103 of the embodiment provided with a board (LED board 3) on which a light source (LED element 8) is mounted, and a lighting circuit board which powers the light source, and translucent globe 1 which covers the light-emitting surface 31 of the light source, is characterized in that the hemispherical light guide (hemispherical light guide 90) is positioned above the board provided on the horizontal surface of the lighting device 103 where translucent globe 1 and lighting device main body 5 join together, the light source being mounted on the circular bottom surface (lower end surface 913) of the periphery of hemispherical light guide 90.

(0060)

With lighting device 103 of the embodiment, the positioning of a hemispherical light guide (hemispherical light guide 90) with the light source mounted on the circular bottom surface of the periphery of the light guide (hemispherical light guide 90) allows the entire hemispherical light guide (hemispherical light guide 90) to emit light, enabling light to be distributed in the vertical direction and over the entire peripheral area of translucent globe 1.

(0061)

Embodiment 6

(6) Sixth Embodiment (Fig. 7, Fig. 8, Fig. 11):

With lighting device 104 in this embodiment, as shown in Fig. 7, Fig. 8 the hemispherical globe light guide 900 is mounted above 12 LED elements 8 positioned in a circle around LED board 3. Hemispherical globe light guide 900 also functions as translucent globe 1. L3 between inner surface 902 of hemispherical globe light guide 900 and outer surface 901 may be of any thickness as long as it is greater than the width L4 of LED elements 8 (see Fig. 8).

(0062)

The thickness (width) L3 of lower surface 921 (lower end surface) of globe light guide 900 is circular in form. 12 cut-away sections (12 concavities 903) are provided facing the inside of globe light guide 900 at lower end surface 921 of globe light guide 900, into which LED elements 8 fit. As the thickness (width) L3 of lower end surface 921 is greater than the width L4 of LED elements 8, LED elements 8 are completely covered by lower end surface 921, and the light emitted from LED elements 8 can be transmitted without leakage into globe light guide 900.

(0063)

Resin to which a light diffusing agent has been added is used for globe light guide 900. Apart from this the structure is identical to that of Embodiment 1.

(0064)

Light from LED elements 8 forms the light paths shown in Fig. 11 due to light guide 9, realizing light distribution over

more than 180°, and also enabling a greater distribution of light in the z direction.

(0065)

Lighting device 104 of the embodiment is characterized in that the hemispherical light guide (globe light guide 900) also functions as translucent globe 1.

(0066)

With lighting device 104 of the embodiment, as the hemispherical light guide (globe light guide 900) also functions as translucent globe 1, the structure is simple and light distribution is enabled in the vertical direction and over the entire region of the periphery of the hemispherical light guide (globe light guide 900) over a broad area.

(0067)

With lighting device 104 of the embodiment, the hemispherical light guide (globe light guide 900) is characterized in that its internal surface 902 or external surface 901 is processed so as to diffuse light, or has material added which diffuses light.

(0068)

With lighting device 104 of the embodiment, the hemispherical light guide (globe light guide 900) has its internal surface 902 or external surface 901 processed to diffuse light, or has material added which diffuses light, so the light diffusion effect is increased and it is possible to have light distributed over an even greater range.

(0069)

Embodiments 1-6 have been described above, but these may be realized by combining two or more of these embodiments. Alternatively one of these embodiments may be partially realized. Alternatively an embodiment may be also realized by combining parts of two or more of these embodiments.

(Key to Diagrams)

(0070)

1 translucent globe,
2 light reflecting/diffusing film,
3 LED board,
8 LED element,
5 main body of lighting device,
6 outer surround,
7 fitting,
9 light guide,
10 diffusion unit,
11 crossover point,
31 light-emitting surface,
51 main plane plate,
90 hemispherical light guide,
91 end surface,
95 light guide,
95a light guide,
96 light guide,
100, 101, 102, 103, 104 lighting device,
900 globe light guide,
901 external surface,
902 internal surface,
903 concavity,
910 vertical section of spiral,
911 whirl section of spiral,
912 lower end surface,
913 lower surface,
921 lower end surface,
951 end surface.

Patent claims

(Claim 1)

A lighting device characterized in being provided with a board mounted with a light source, a lighting circuit board which powers the light source, and having a plurality of U-shaped light guides positioned above the light source, the light source being mounted on the lower surface of two bases of the light guide, the plurality of U-shaped light guides crossing over each other.

(Claim 2)

The lighting device as claimed in claim 1, in which the U-shaped light guides which cross over each other are characterized in intersecting with one another at a crossover point.

(Claim 3)

The lighting device as claimed in claim 1, in which the U-shaped light guides which cross over each other are characterized in that the heights of each light guide are different, and do not intersect at a crossover point.

(Claim 4)

The lighting device as claimed in any of claims 1-3, in which the U-shaped light guides are characterized in that the horizontal section is processed to diffuse light, or has material added which diffuses light.

(Claim 5)

A lighting device characterized in being provided with a board mounted with a light source, and a lighting circuit board which powers the light source, and in having a spiral-

shaped light guide positioned above the light source, the light source being mounted on the lower surface of the two bases of the light guide.

(Claim 6)

The lighting device as claimed in claim 5, characterized in that the spiral light guide is such that part or all of the surface of the pipe is processed to diffuse light, or has material added which diffuses light.

(Claim 7)

The lighting device as claimed in any of claims 1-6, characterized in that the lighting device is further provided with a translucent globe which covers the light source.

(Claim 8)

The lighting device as claimed in any of claims 1-7, characterized in that the light source is a light-emitting diode.

Fig. 1

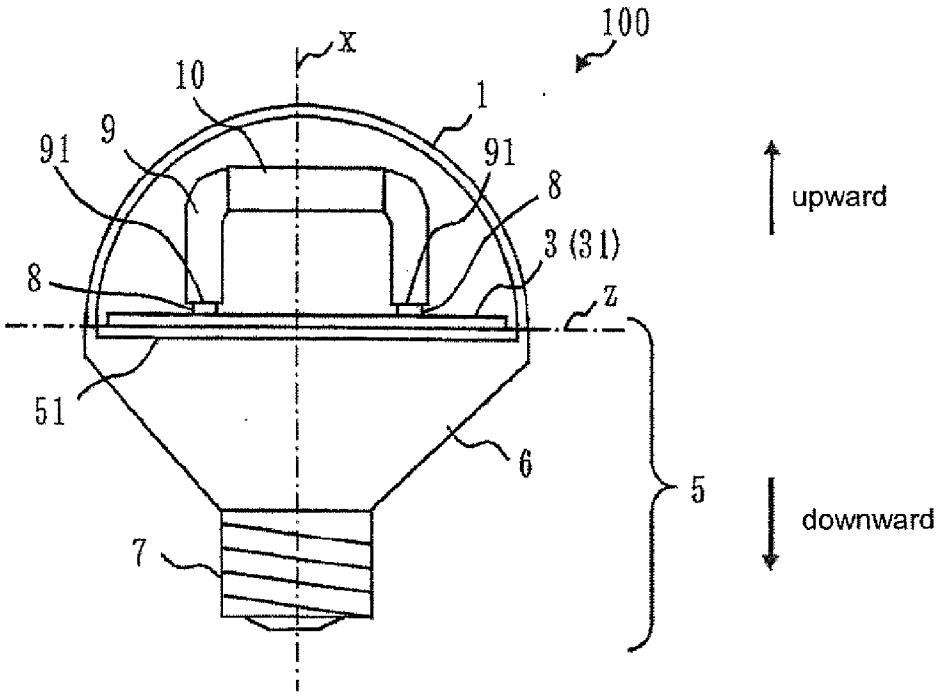

100
X
10
1
9
91
91
8
3 (31)
8
Z
51
6
5
7
upward
downward

Fig. 2

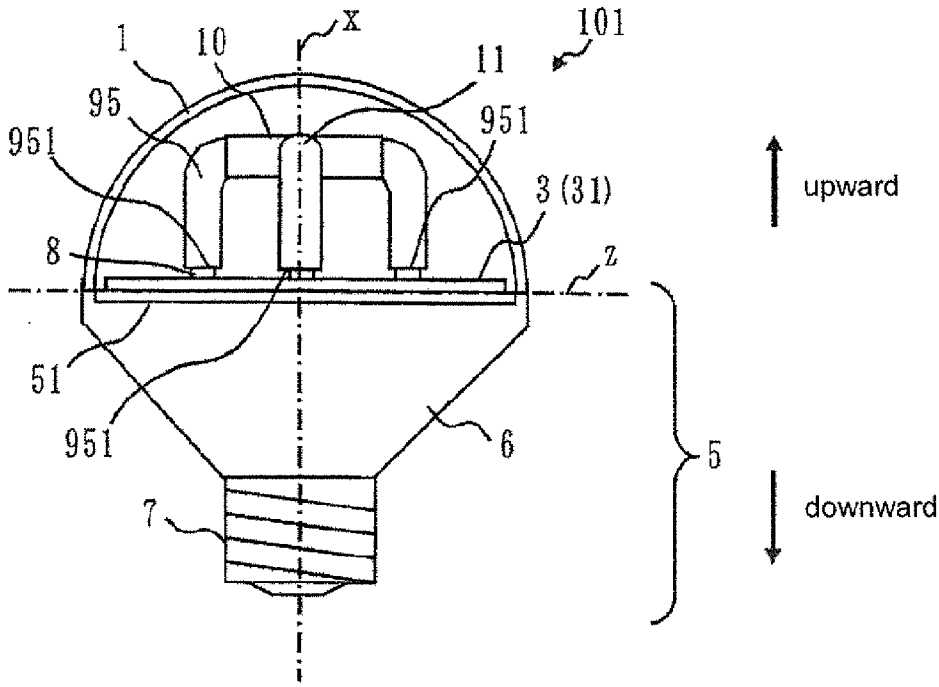

101
X
1
10
11
95
951
951
3 (31)
8
Z
51
951
6
5
7
upward
downward

Fig. 3

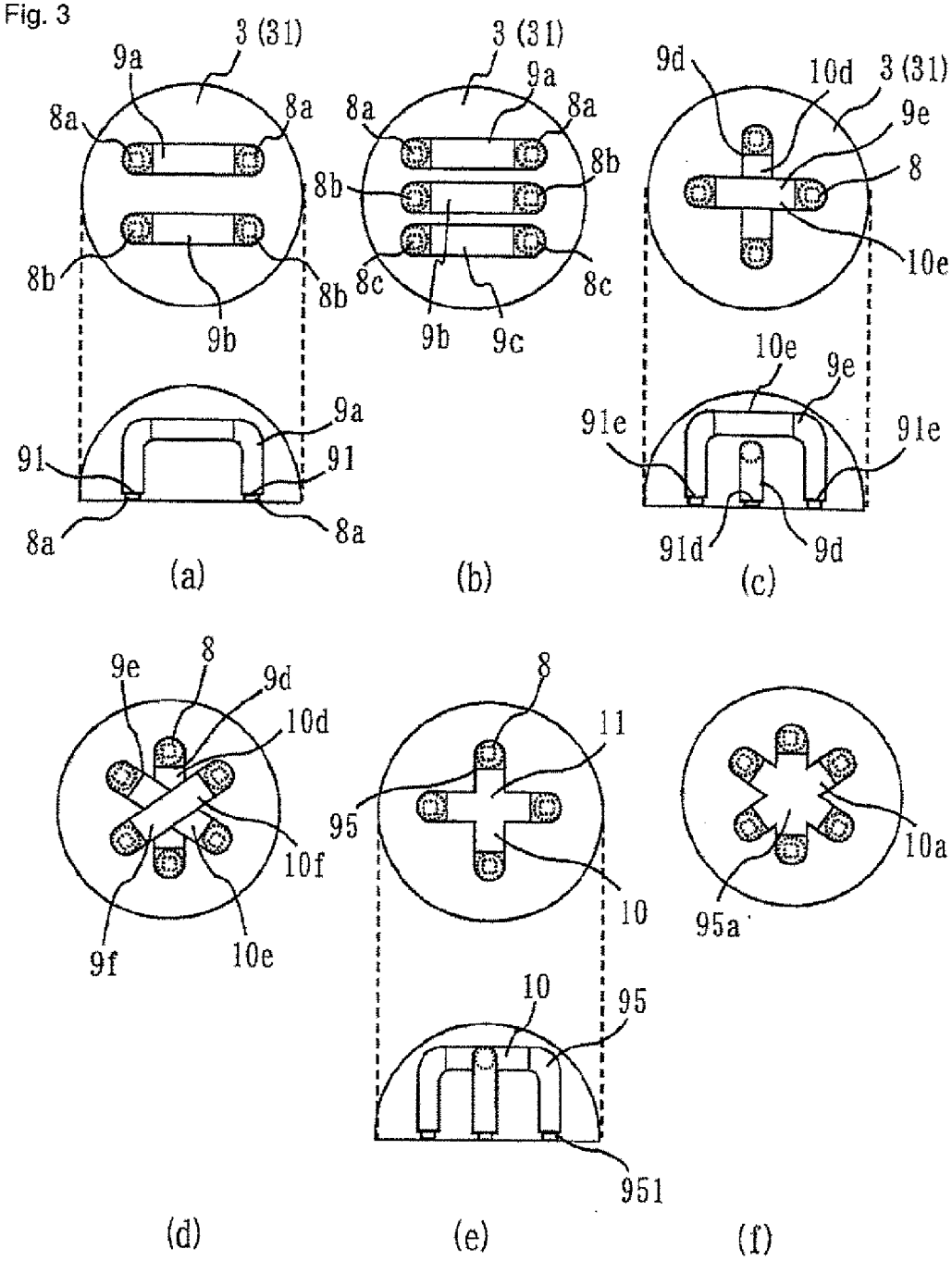

3 (31)
9a
8a
8b
9b
91
(a)
9c
8c
(b)
9d
10d
9e
8
10e
91e
91d
(c)
9f
10f
(d)
95
11
10
951
(e)
95a
10a
(f)

Fig. 4

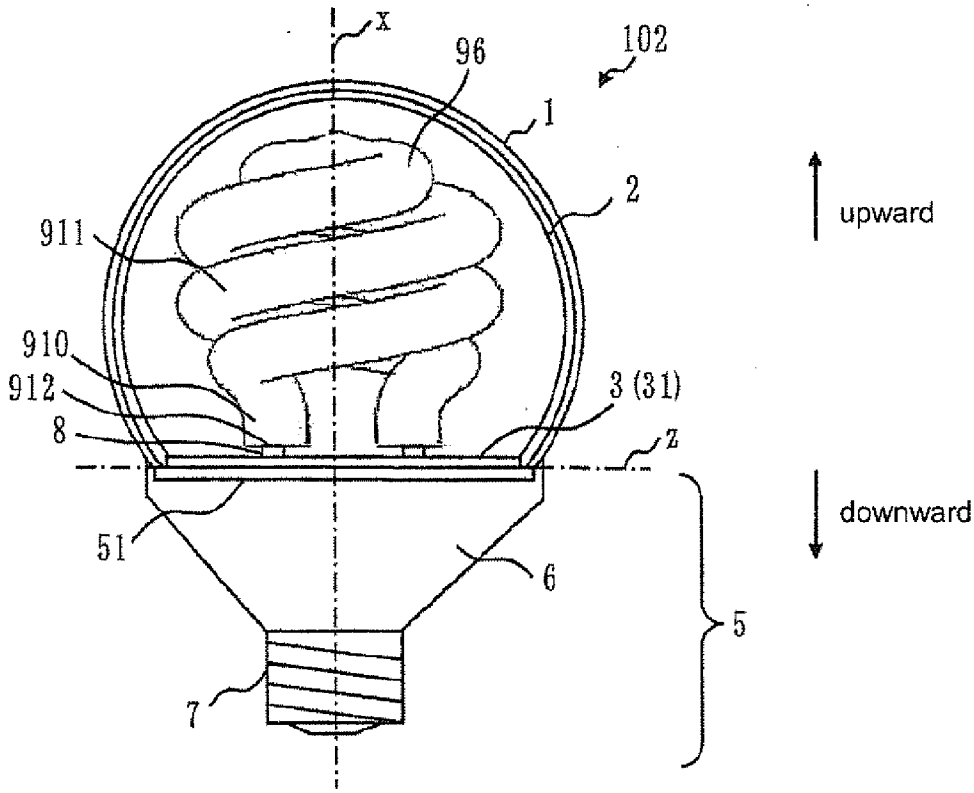

X
96
102
1
2
911
910
912
8
3 (31)
z
51
6
5
7
upward
downward

Fig. 5

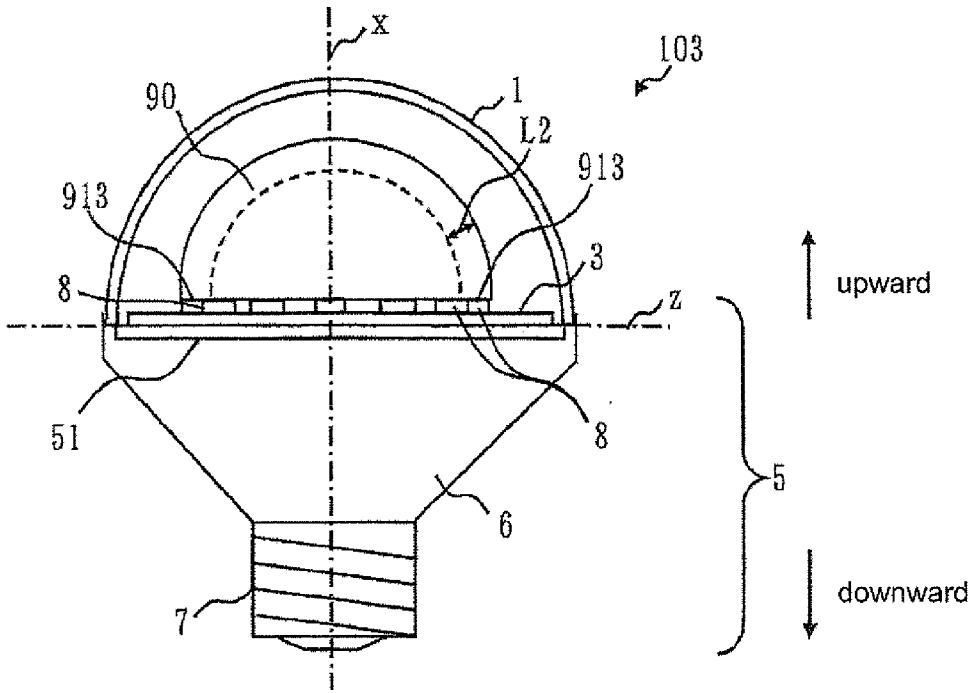

X
103
90
1
L2
913
913
3
8
z
51
8
6
5
7
upward
downward

Fig. 6

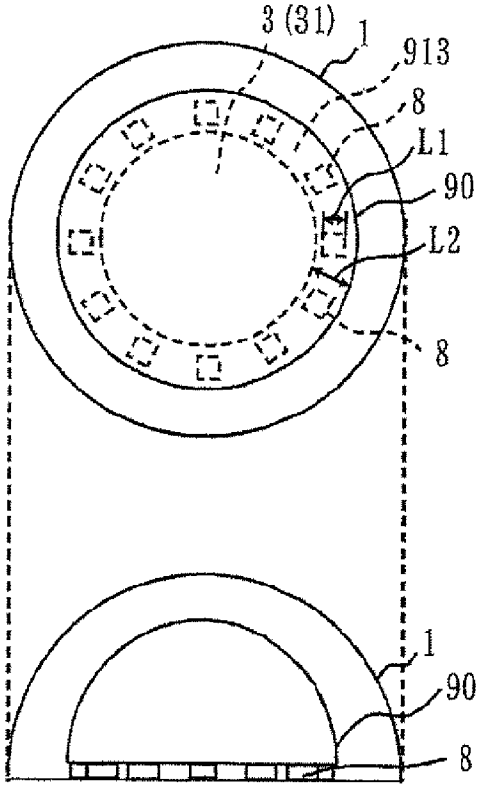

3 (31)
1
913
8
L1
90
L2
8
1
90
8

Fig. 7

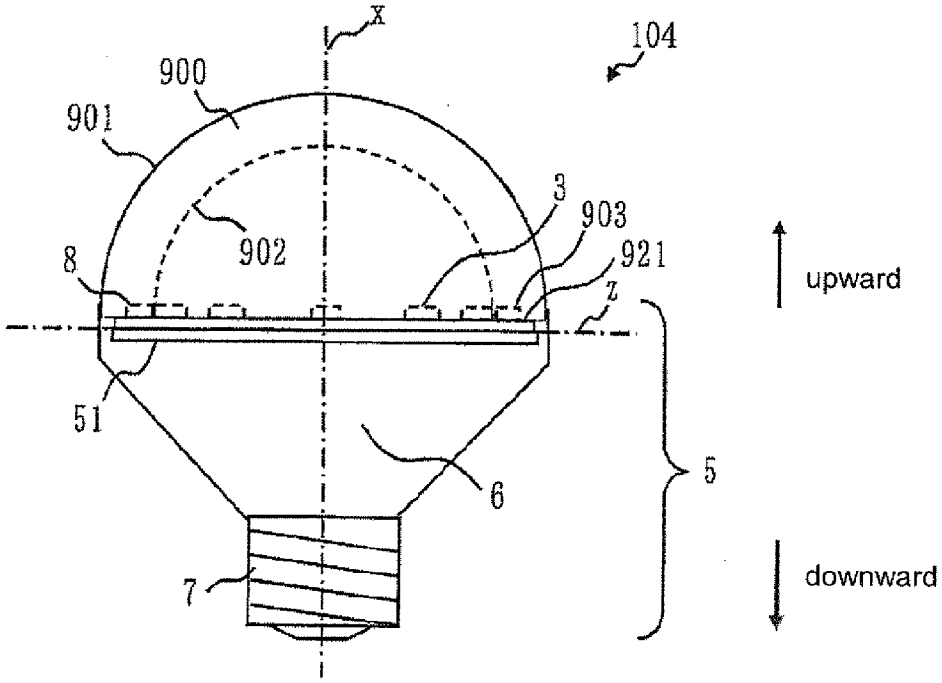

X
104
900
901
902
3
903
921
8
Z
51
6
5
7
upward
downward

Fig. 8

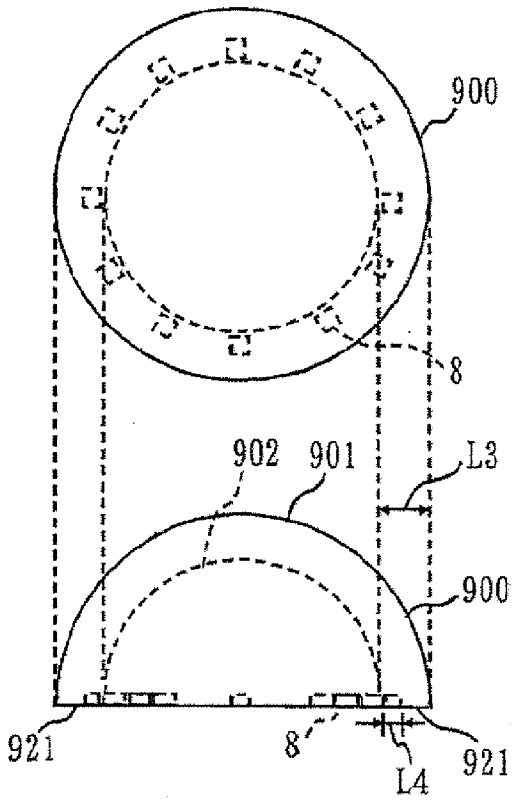

900
8
902
901
L3
900
921
8
L4
921

Fig. 9

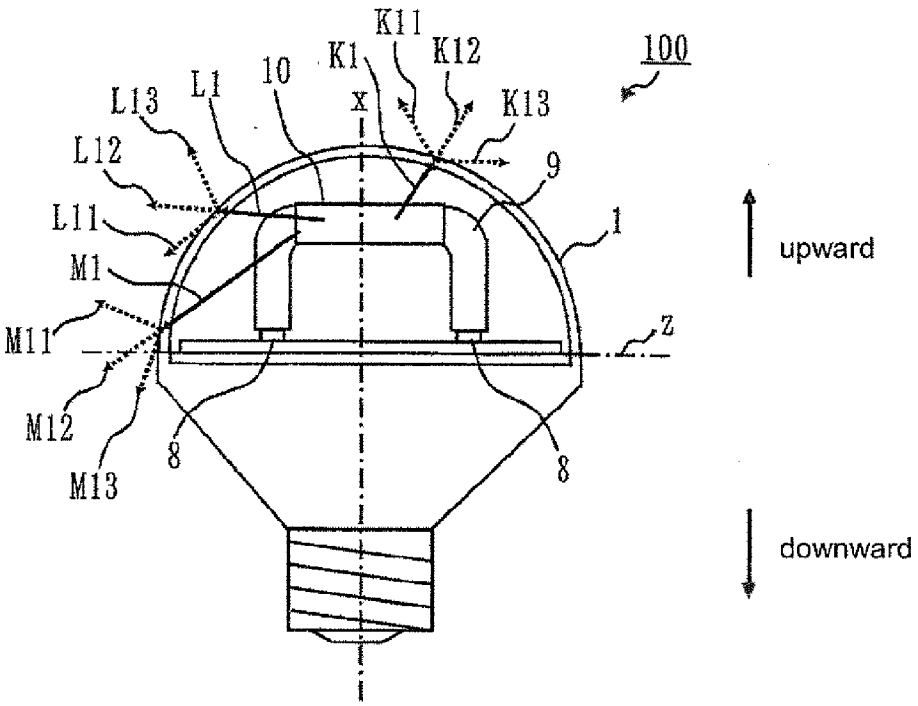

K11
K1
K12
100
10
L13
L1
x
K13
L12
9
L11
1
M1
M11
z
M12
8
8
M13
upward
downward

Fig. 10

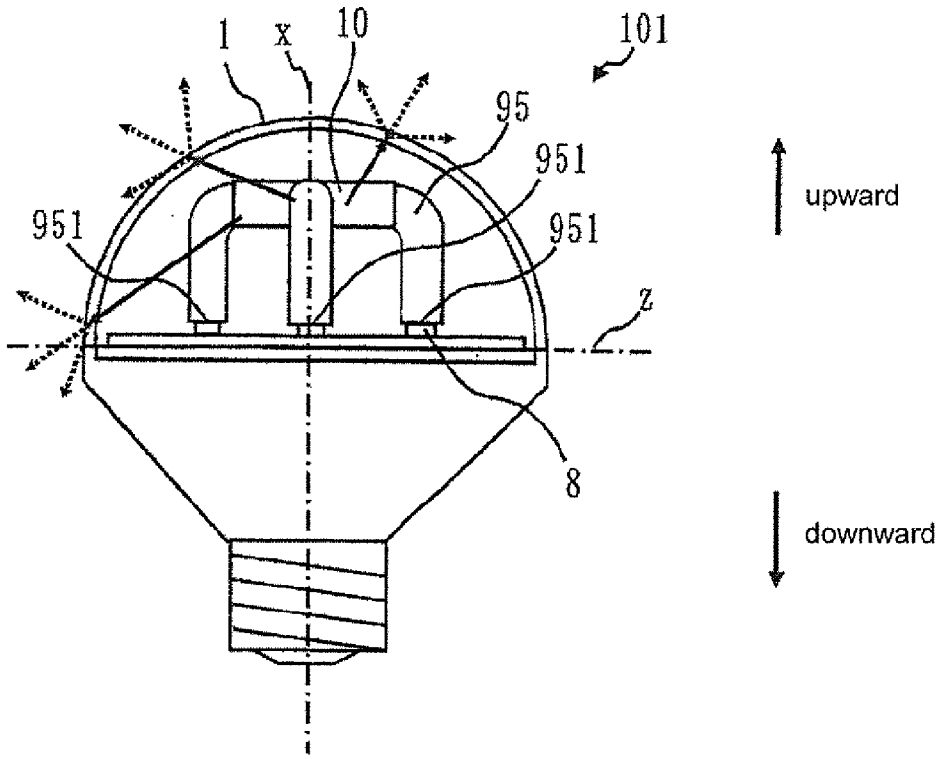
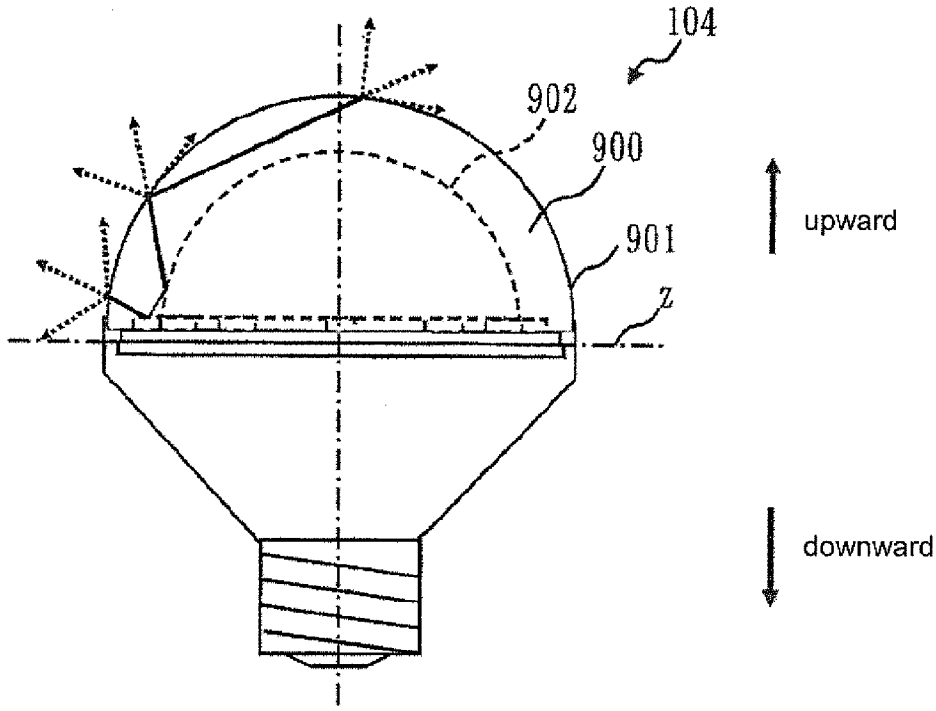

1
x
10
101
95
951
951
951
z
8
upward
downward

Fig. 11


104
902
900
901
z
upward
downward

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/063965

A. CLASSIFICATION OF SUBJECT MATTER
INV. F21K99/00
ADD.

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)
F21K G02B

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.
X	WO 2010/146746 A1 (S K G CO LTD [JP]; SAKAMOTO MITSUHIDE [JP]; NAKASHIMA HIROSHI [JP]; HA) 23 December 2010 (2010-12-23) abstract figure 9 & EP 2 444 722 A1 (S K G CO LTD [JP]) 25 April 2012 (2012-04-25) paragraph [0001] paragraph [0013] - paragraph [0020] -----	1-4,7,8
X	JP 2004 342411 A (SHARP KK) 2 December 2004 (2004-12-02) figures 2,8, 11 -----	5-8

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 October 2012	19/10/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Schulz, Andreas

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2012/063965

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		CN 102635794 A	15-08-2012
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