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(54) **LED BULB LIGHT WITH HIGH LUMINOUS EFFICACY**

(57) Disclosed is an LED bulb light with high luminous efficacy, comprising a plurality of LED filaments (1), a stem (3), an LED driver (7), a standard interface (9) and a lampshade (10). The plurality of LED filaments and the stem are sealed by the lampshade, and the lampshade is filled with a heat dissipation material (11). Both ends of each LED filament are spot-welded to two stem electrodes (4) on the stem via two filament electrodes (2) of the LED filament, and the plurality of LED filaments are distributed around the stem inside the bulb light. The lower part of the stem is connected to an exhaust pipe (5). A lower end electrode of the stem is connected to the LED driver via an electrical connection wire (6), the LED driver is connected to the standard interface via a lead, and the standard interface is in communication with an external AC or DC power supply. Using a material with high heat dissipation performance and a stem material with high thermal conductivity, the LED filament with high luminous efficacy can have high luminous efficacy in operation at a lower temperature.

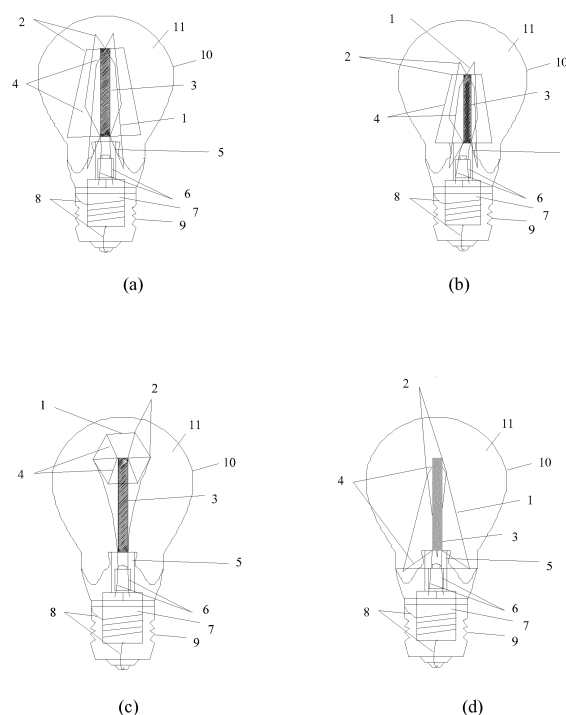


Fig. 1

Description

FIELD

- 5 **[0001]** The present application relates to an LED lamp, and particularly to a high lumen efficiency LED lamp which is directly assembled from filaments.

BACKGROUND

- 10 **[0002]** Semiconductor light-emitting diode (LED) lighting is considered as one of the most promising areas in the twenty-first Century. With the issue of laws and decrees for forbidding incandescent lamps in various countries, LED has been used in the lighting field more and more widely. An LED filament packaged on a transparent substrate is favored by terminal customers due to its high lumen efficiency and appearance similar to a traditional tungsten filament lamp. The filament uses a P-N junction of an LED chip to emit light at an angle of 4Jl, and when the filament is packaged on a frame or a ceramic, the blue light emitting downwards is lost by a half when it is reflected back through the P-N junction, and eventually results in loss of 25% of the blue light. When the filament is packaged on the transparent substrate, the lost blue light may be utilized, and the lumen efficiency of the LED light source may be improved. However, currently the filament using the transparent substrate basically has no heat dissipation capability, and the assembled lamp has an excessively high temperature which makes the feature of high lumen efficiency less prominent, especially for a lamp with high luminous flux made of this filament, therefore, an urgent issue to be addressed is to improve the heat dissipation capability of the filament lamp.

SUMMARY

- 25 **[0003]** An object of the present application is to provide a LED lamp with high lumen efficiency, to overcome the deficiencies in the conventional technology.
- 30 **[0004]** The object of the present application is achieved through the following technical solutions. An LED lamp with high lumen efficiency includes a plurality of LED filaments, a center column, an LED driver, a standard interface, and a housing; wherein the plurality of LED filaments and the center column are sealed by the housing, and a heat dissipating material is filled in the housing. Two ends of each of the LED filaments are connected to two center column electrodes of the center column via two filament electrodes of the LED filament by spot welding, and the plurality of LED filaments are arranged surrounding the center column in the lamp. A lower portion of the center column is connected to a gas discharge tube; and each of the center column electrodes of the center column is connected to the LED driver via an electrical connecting wire, the LED driver is connected to the standard interface via a lead, and the standard interface is electrically connected to an external AC or DC power supply.
- 35 **[0005]** The plurality of LED filaments are arranged surrounding the center column in the lamp in the following ways, the LED filaments are arranged linearly surrounding the center column in a shape of a cone; the LED filaments are arranged linearly surrounding the center column in a cross shape; the LED filaments are arranged surrounding the center column in a shape of a regular polygon; and the LED filaments are arranged surrounding the center column in a shape of M.
- 40 **[0006]** The LED filament includes filament electrodes, a transparent substrate, a plurality of LED chips, a bonding wire, and fluorescent glue, the plurality of LED chips are fixed on the transparent substrate having the filament electrode at two ends, and the LED chips are connected by the bonding wires, and the filament electrodes are connected to respective LED chips by the bonding wires, and the LED chips, the bonding wire and the transparent substrate are enclosed by the fluorescent glue.
- 45 **[0007]** The LED filament includes filament electrodes, a transparent substrate, a plurality of LED chips, a circuit and fluorescent glue, the plurality of LED chips are fixed on the transparent substrate having the circuit, and the circuit on the transparent substrate is connected to the filament electrodes at two ends of the transparent substrate via the LED chips, and the LED chips and the transparent substrate are enclosed by the fluorescent glue.
- 50 **[0008]** The LED filament includes filament electrodes, a conductive substrate, a plurality of LED chips, and a bonding wire, the plurality of LED chips are fixed on the conductive substrate having micropores, the conductive substrate has one end functioning as one filament electrode and another end connected to another filament electrode by a bonding material, the LED chips are connected by the bonding wires, and the filament electrodes are connected to respective LED chips by the bonding wires, and the LED chips, the bonding wires, the micropores, the bonding material and the conductive substrate are enclosed by the fluorescent glue.
- 55 **[0009]** The center column includes one or more of an insulating layer, a first interlayer, a second interlayer, a first plating layer, a third interlayer and a second plating layer; the material of the insulating layer is glass or transparent ceramics; the material of the first interlayer is metal including silver, aluminum or titanium; the material of the second interlayer is paraffin or metal salt; the material of the plating layer is silver, aluminum, titanium or platinum; the material

of the third interlayer is copper or copper alloy; the material of the second plating layer is one or more of aluminum oxide, silicon dioxide, and titanium dioxide

[0010] The material of the center column electrode is gold, silver, copper, iron, aluminum, gold alloy, silver alloy, copper alloy, iron alloy, or aluminum alloy.

[0011] The heat dissipating material is gas or liquid; and in the case that the heat dissipating material is gas, its composition is basic gas or is a mixture of the basic gas with auxiliary gas, and a ratio of the mass of the basic gas to the mass of the auxiliary gas is 80-100:0-20, the basic gas is formed by mixing one or more of hydrogen, nitrogen and helium in any proportion, and the auxiliary gas is formed by mixing one or more of neon, argon, krypton and xenon in any proportion; and in the case that the heat dissipating material is liquid, its composition is a mixture formed by mixing one or more of water, ethanol, glycerol, silicone oil in any proportion

[0012] The housing is a transparent glass housing, a frosted glass housing or a glass housing with an external portion being coated with transparent silica gel.

[0013] The standard interface is E12, E14, E26, E27 or E39.

[0014] The material of the transparent substrate is transparent glass, neoceramic glass, transparent ceramics, yttrium aluminum garnet, aluminum oxide (sapphire), aluminum oxynitride, yttrium oxide ceramics, magnesium fluoride ceramics, calcium fluoride ceramics or transparent heat-resistant PC/PS/PMMA. The material of the conductive substrate is copper, silver, aluminum, iron, copper alloy, silver alloy, aluminum alloy, or iron alloy.

[0015] The LED chip is one or more of a UV chip, a blue light chip, and a green light chip.

[0016] The material of the bonding wire is gold, silver, copper, iron, aluminum, gold alloy, silver alloy, copper alloy, iron alloy, or aluminum alloy.

[0017] The fluorescent glue is formed by mixing LED encapsulating glue and fluorescent powder, the LED encapsulating glue is silica gel, epoxy resin, Hybrid material or PMMA; and the fluorescent powder is formed by one or more of green fluorescent powder, yellow fluorescent powder, and red fluorescent powder, and a mass ratio of the encapsulating glue, the green fluorescent powder, the yellow fluorescent powder, and the red fluorescent powder is 100: (0-30): (5-50): (0-10).

[0018] The advantageous effect of the present application is that, by using the material with high heat dissipation performance and the center column with high heat conductivity, the LED filament with high lumen efficiency may operate in a low temperature to realize the high lumen efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Figures 1(a) to 1(d) are schematic views showing the structure of various embodiments of a lamp according to the present application;

Figures 2(a) to 2(e) are schematic views showing the structure of various embodiments of a center column of the lamp according to the present application; and

Figures 3(a) to 3(e) are sectional views of various embodiments of an LED filament of the lamp according to the present application.

Reference numerals in the Figures:

1	LED filament,	2	filament electrode,
3	center column,	4	center column electrode,
5	gas discharge tube,	6	electrical connecting wire,
7	LED driver,	8	lead,
9	standard interface,	10	housing,
11	heat dissipating material;		
3-1	insulating layer,	3-2	first interlayer,
3-3	second interlayer,	3-4	first plating layer,
3-5	third interlayer,	3-6	second plating layer;
12	transparent substrate,	17	conductive substrate,
13	LED chip;	14	bonding wire,
15	fluorescent glue,	16	circuit,
18	micropore, and	19	bonding material.

DETAILED DESCRIPTION

[0020] The present application is further described in detail hereinafter with reference to the figures.

[0021] As shown in Figure 1, an LED lamp with a high lumen efficiency according to the present application includes multiple LED filaments 1, a center column 3, an LED driver 7, a standard interface 9, and a housing 10. The multiple LED filaments 1 and the center column 3 are sealed by the housing 10, and a heat dissipating material 11 is filled in the housing 10. Two ends of each LED filament 1 are connected to two center column electrodes 4 of the center column 3 via two filament electrodes 2 of the LED filament 1 by spot welding, and the multiple LED filaments 1 are provided in the lamp and arranged in various shapes surrounding the center column 3. A lower portion of the center column 3 is connected to a gas discharge tube 5. The center column electrode 4 of the center column 3 is connected to the LED driver 7 via an electrical connecting wire 6, the LED driver 7 is connected to the standard interface 9 via a lead 8, and the standard interface 9 is electrically connected to an external AC or DC power supply.

[0022] Figure 1(a) shows a first embodiment of the lamp, wherein the LED filaments 1 are arranged linearly in the shape of a cone.

[0023] Figure 1(b) shows a second embodiment of the lamp, wherein the LED filaments 1 are arranged linearly in a cross shape.

[0024] Figure 1(c) shows a third embodiment of the lamp, wherein the LED filaments 1 are arranged in the shape of a regular polygon.

[0025] Figure 1(d) shows a fourth embodiment of the lamp, wherein the LED filaments 1 are arranged in the shape of M.

[0026] Reference is made to Figure 2.

[0027] Figure 2(a) shows a first embodiment of the center column 3, in which the center column 3 includes an insulating layer 3-1 enclosing a first interlayer 3-2 (made of a metal with high reflectivity, such as silver, aluminum, or titanium).

[0028] Figure 2(b) shows a second embodiment of the center column 3, in which the center column 3 includes an insulating layer 3-1 enclosing a first interlayer 3-2 (made of a metal with high reflectivity, such as silver, aluminum, or titanium) and a second interlayer 3-3 (made of a thermal phase change material, such as paraffin or metal salt) contained inside the first interlayer 3-2.

[0029] Figure 2(c) shows a third embodiment of the center column 3, in which the center column 3 includes an insulating layer 3-1 enclosing a third interlayer 3-5 (made of copper or copper alloy) and a first plating layer 3-4 (made of a reflective material, such as silver, aluminum, or titanium, or platinum) plated on the surface of the third interlayer 3-5.

[0030] Figure 2(d) shows a fourth embodiment of the center column 3, in which the center column 3 includes an insulating layer 3-1 enclosing a third interlayer 3-5 (made of copper or copper alloy), a second interlayer 3-3 (made of a thermal phase change material, such as paraffin or metal salt) contained inside the third interlayer 3-5, and a first plating layer 3-4 (made of a reflective material, such as silver, aluminum, or titanium, or platinum) plated on the surface of the third interlayer 3-5.

[0031] Figure 2(e) shows a fifth embodiment of the center column 3, in which the center column 3 includes a third interlayer 3-5 (made of copper or copper alloy) and a second plating layer 3-6 (made of a reflective material, such as aluminum oxide, silicon dioxide, or titanium dioxide) plated on the surface of the third interlayer 3-5.

[0032] Reference is made to Figure 3.

[0033] Figure 3(a) shows a first embodiment of the LED filament 1. The LED filament 1 includes filament electrodes 2, a transparent substrate 12, multiple LED chips 13, bonding wires 14, and fluorescent glue 15. The LED chips 13 (mainly for horizontal chips) are fixed on the transparent substrate 12 (made from materials such as transparent glass, transparent ceramics, yttrium aluminum garnet, sapphire or transparent heat-resistant PC/PS/PMMA) by a die bond material (such as silicone, epoxy resin, hybrid or PMMA, PU), and two ends of the transparent substrate 12 are provided with the filament electrode 2. The multiple LED chips 13 are connected by the bonding wires, and the electrodes 2 are connected to the respective chips 13 by the bonding wires, and then the LED chips 13, the bonding wires 14 and the substrate 12 are enclosed by the fluorescent glue 15 to form a 360 degree lightning LED filament 1.

[0034] Figure 3(b) shows a second embodiment of the LED filament 1. The LED filament 1 includes filament electrodes 2, a transparent substrate 12, multiple LED chips 13, a circuit 16, and fluorescent glue 15. The LED chips 13 (mainly for flip chips) are fixed on the transparent substrate 12 (made of materials, such as transparent glass, transparent ceramics, yttrium aluminum garnet, sapphire or transparent heat-resistant PC/PS/PMMA) by a die bond material (such as gold, gold tin alloy or solder paste), and the transparent substrate 12 has the circuit 16. The circuit 16 on the substrate 12 is connected to the filament electrodes 2 at two ends of the substrate via the LED chips 13, and then the LED chips 13 and the substrate 12 are enclosed by the fluorescent glue 15 to form a 360 degree lightning LED filament 1.

[0035] Figures 3(c) to 3(e) show a third embodiment of the LED filament 1, Figure 3(c) is a perspective view of the LED filament 1, Figure 3(d) is a view showing a semi-finished LED filament 1, and Figure 3(e) is a view showing the appearance of a finished LED filament 1.

[0036] The LED filament 1 includes a filament electrode 2, a conductive substrate 17, multiple LED chips 13, and bonding wires 14. Multiple LED chips 13 are fixed on the conductive substrate 17 (made of materials, such as copper,

silver, iron, copper alloy, silver alloy, or iron alloy) by a die bond material (such as silica gel, epoxy resin, Hybrid, PMMA, or PU), and the conductive substrate 17 has micropores 18 (micro cavities formed by air and having a size of 10nm to 100um). The conductive substrate 17 has one end functioning as a filament electrode 2, and another end connected to another filament electrode 2 by a bonding material 19 (made of a polymer material such as PPA, PCT, EMC, SMC, or LCP). The LED chips 13 are connected by the bonding wires 4, and the filament electrodes 2 are connected to the respective LED chips 13 by the bonding wires 4, and then the LED chips 13, the bonding wires 14, the micropores 18, the bonding material 19 and the conductive substrate 17 are enclosed by the fluorescent glue 15 by molding, with only the filament electrodes 2 not being enclosed, as shown in Figure 3(e).

[0037] The present application is not limited to the above embodiments, and any modifications and variations which are made within the spirit of the present application and the scope defined by the claims, should all be deemed to fall into the scope of the present application.

Claims

1. An LED lamp with high lumen efficiency, comprising a plurality of LED filaments (1), a center column (3), an LED driver (7), a standard interface (9), and a housing (10); wherein the plurality of LED filaments (1) and the center column (3) are sealed by the housing (10), and a heat dissipating material (11) is filled in the housing (10); two ends of each of the LED filaments (1) are connected to two center column electrodes (4) of the center column (3) via two filament electrodes (2) of the LED filament (1) by spot welding, and the plurality of LED filaments (1) are arranged surrounding the center column (3) in the lamp; a lower portion of the center column (3) is connected to a gas discharge tube (5); and each of the center column electrodes (4) of the center column (3) is connected to the LED driver (7) via an electrical connecting wire (6), the LED driver (7) is connected to the standard interface (9) via a lead (8), and the standard interface (9) is electrically connected to an external AC or DC power supply.
2. The LED lamp with high lumen efficiency according to claim 1, wherein the plurality of LED filaments (1) are arranged surrounding the center column (3) in the lamp in the following ways, the LED filaments (1) are arranged linearly surrounding the center column (3) in a shape of a cone; the LED filaments (1) are arranged linearly surrounding the center column (3) in a cross shape; the LED filaments (1) are arranged surrounding the center column (3) in a shape of a regular polygon; and the LED filaments (1) are arranged surrounding the center column (3) in a shape of M.
3. The LED lamp with high lumen efficiency according to claim 1, wherein the LED filament (1) comprises filament electrodes (2), a transparent substrate (12), a plurality of LED chips (13), a bonding wire (14), and fluorescent glue (15), the plurality of LED chips (13) are fixed on the transparent substrate (12) having the filament electrode (2) at two ends, and the LED chips (13) are connected by the bonding wires (14), and the filament electrodes (2) are connected to respective LED chips (13) by the bonding wires (14), and the LED chips (13), the bonding wire (14) and the transparent substrate (12) are enclosed by the fluorescent glue (15).
4. The LED lamp with high lumen efficiency according to claim 1, wherein the LED filament (1) comprises filament electrodes (2), a transparent substrate (12), a plurality of LED chips (13), a circuit (16), and fluorescent glue (15), the plurality of LED chips (13) are fixed on the transparent substrate (12) having the circuit (16), and the circuit (16) on the transparent substrate (12) is connected to the filament electrodes (2) at two ends of the transparent substrate (12) via the LED chips (13), and the LED chips (13) and the transparent substrate (12) are enclosed by the fluorescent glue (15).
5. The LED lamp with high lumen efficiency according to claim 1, wherein the LED filament (1) comprises filament electrodes (2), a conductive substrate (17), a plurality of LED chips (13), and a bonding wire (14), the plurality of LED chips (13) are fixed on the conductive substrate (17) having micropores (18), the conductive substrate (17) has one end functioning as one filament electrode (2) and another end connected to another filament electrode (2) by a bonding material (19), the LED chips (13) are connected by the bonding wires (14), and the filament electrodes (2) are connected to respective LED chips (13) by the bonding wires (14), and the LED chips (13), the bonding wires (14), the micropores (18), the bonding material (19) and the conductive substrate (17) are enclosed by the fluorescent glue (15).
6. The LED lamp with high lumen efficiency according to claim 1, wherein the center column (3) comprises one or more of an insulating layer (3-1), a first interlayer (3-2), a second interlayer (3-3), a first plating layer (3-4), a third interlayer (3-5) and a second plating layer (3-6); the material of the insulating layer (3-1) is glass or transparent ceramics; the material of the first interlayer (3-2) is metal comprising silver, aluminum or titanium; the material of

the second interlayer (3-3) is paraffin or metal salt; the material of the plating layer (3-4) is silver, aluminum, titanium or platinum; the material of the third interlayer (3-5) is copper or copper alloy; the material of the second plating layer (3-6) is one or more of aluminum oxide, silicon dioxide, and titanium dioxide; the material of the center column electrode (4) is gold, silver, copper, iron, aluminum, gold alloy, silver alloy, copper alloy, iron alloy, or aluminum alloy; and the standard interface (9) is E12, E14, E26, E27 or E39.

7. The LED lamp with high lumen efficiency according to claim 1, wherein the heat dissipating material (11) is gas or liquid; and in the case that the heat dissipating material is gas, its composition is basic gas or is a mixture of the basic gas with auxiliary gas, and a ratio of the mass of the basic gas to the mass of the auxiliary gas is 80-100:0-20, the basic gas is formed by mixing one or more of hydrogen, nitrogen and helium in any proportion, and the auxiliary gas is formed by mixing one or more of neon, argon, krypton and xenon in any proportion; and in the case that the heat dissipating material is liquid, its composition is a mixture formed by mixing one or more of water, ethanol, glycerol, silicone oil in any proportion; and the housing (10) is a transparent glass housing, a frosted glass housing or a glass housing with an external portion being coated with transparent silica gel.

8. The LED lamp with high lumen efficiency according to claim 3 or claim 4, wherein the material of the transparent substrate (12) is transparent glass, neoceramic glass, transparent ceramics, yttrium aluminum garnet, aluminum oxide (sapphire), aluminum oxynitride, yttrium oxide ceramics, magnesium fluoride ceramics, calcium fluoride ceramics or transparent heat-resistant PC/PS/PMMA.

9. The LED lamp with high lumen efficiency according to claim 5, wherein the material of the conductive substrate (17) is copper, silver, aluminum, iron, copper alloy, silver alloy, aluminum alloy, or iron alloy.

10. The LED lamp with high lumen efficiency according to any one of claims 3 to 5, wherein the LED chip (13) is one or more of a UV chip, a blue light chip, and a green light chip; the material of the bonding wire (14) is gold, silver, copper, iron, aluminum, gold alloy, silver alloy, copper alloy, iron alloy, or aluminum alloy; the fluorescent glue (15) is formed by mixing LED encapsulating glue and fluorescent powder, the LED encapsulating glue is silica gel, epoxy resin, Hybrid material or PMMA; and the fluorescent powder is formed by one or more of green fluorescent powder, yellow fluorescent powder, and red fluorescent powder, and a mass ratio of the encapsulating glue, the green fluorescent powder, the yellow fluorescent powder, and the red fluorescent powder is 100: (0-30): (5-50): (0-10).

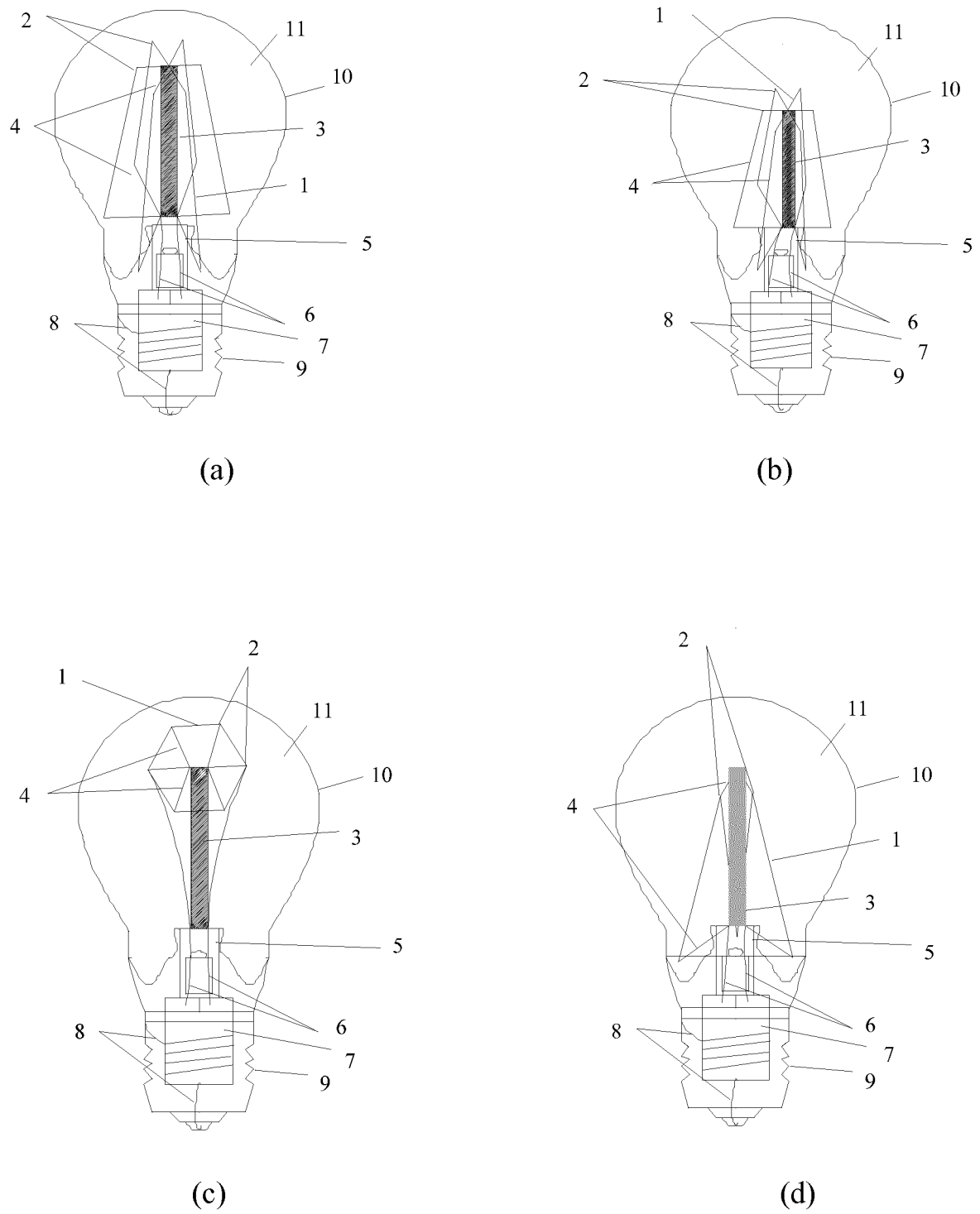


Fig. 1

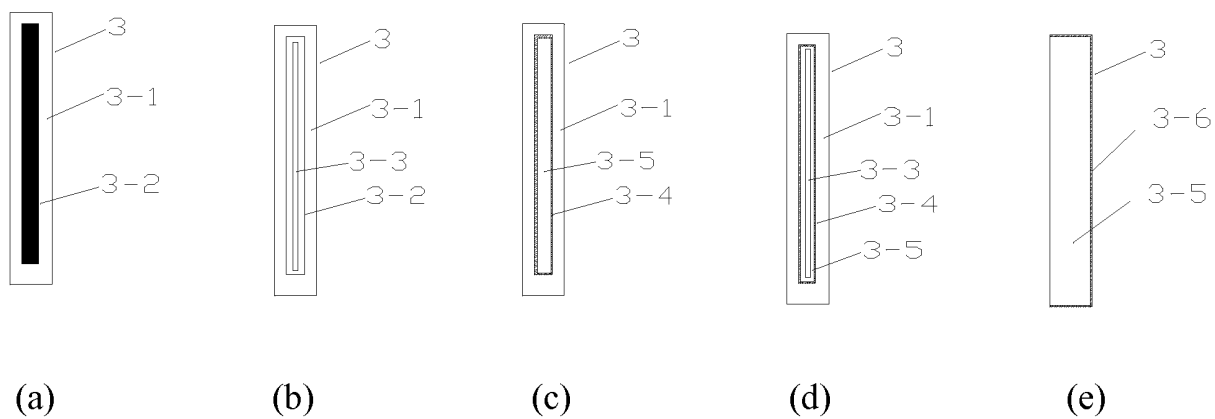


Fig. 2

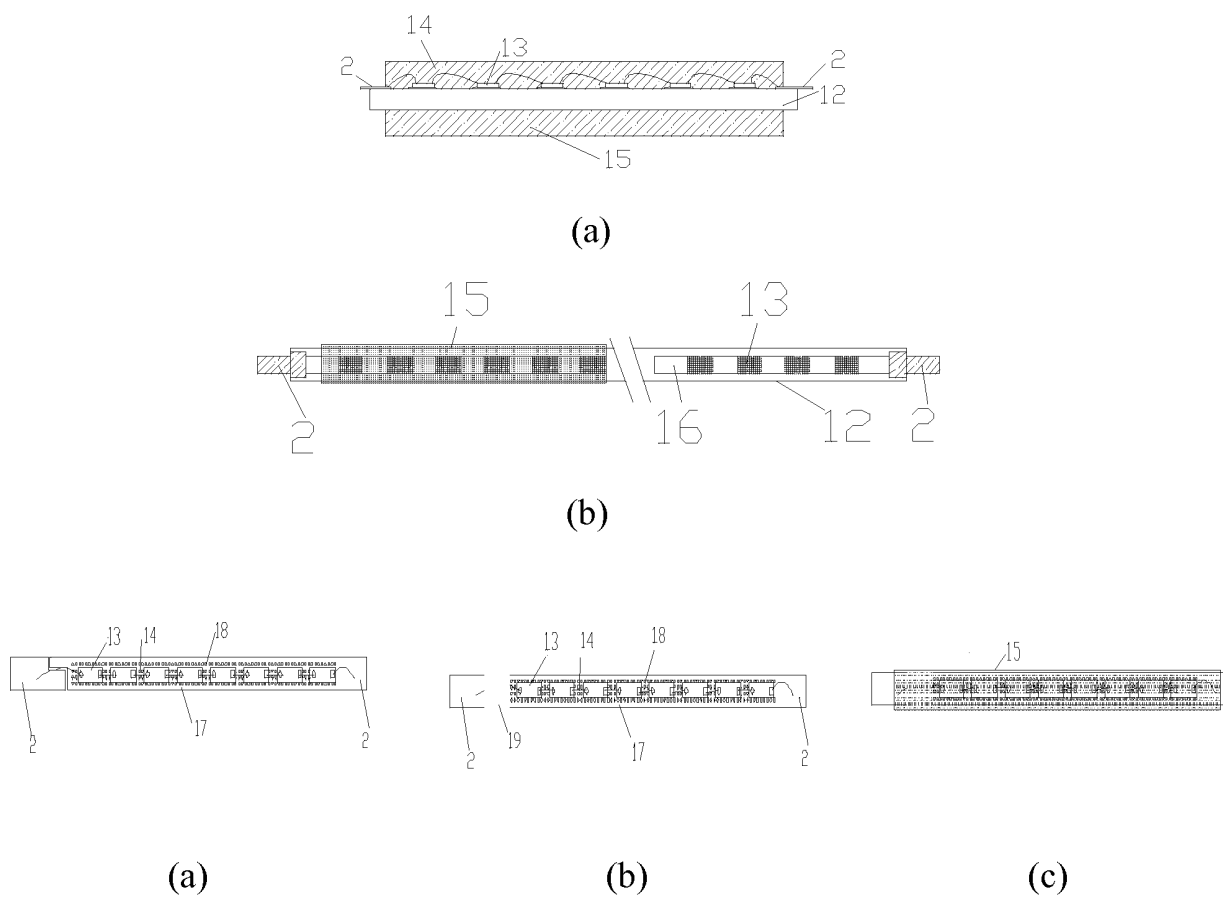


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/076700

A. CLASSIFICATION OF SUBJECT MATTER

F21S 2/00 (2006.01) i; F21V 29/00 (2015.01) i; F21V 19/00 (2006.01) i; F21Y 101/02 (2006.01) n
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)

F21

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)
CNABS, CPRS, EPOQUE: diode, bulb, filament, pillar, electrode, SICHUAN BONS; GE, Shichao; WANG, Kai; led?, core+, stem+, filament+, wire?

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	CN 201944638 U (GE, Shichao), 24 August 2011 (24.08.2011), description, pages 2-3, and figures 1-7	1-10
A	CN 203553214 U (BONS OPTOELECTRONICS TECHNOLOGY CO., LTD.), 16 April 2014 (16.04.2014), the whole document	1-10

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 02 January 2015 (02.01.2015)	Date of mailing of the international search report 10 February 2015 (10.02.2015)
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INTERNATIONAL SEARCH REPORT
 Information on patent family members

International application No.

PCT/CN2014/076700

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
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