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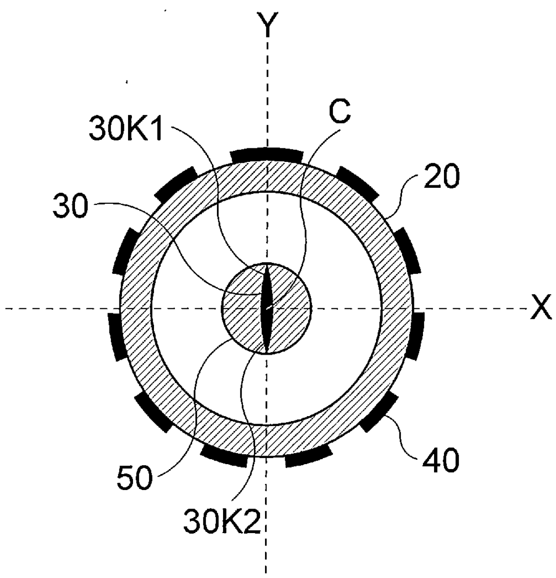
(54) DISCHARGE LAMP

(57) A discharge lamp is equipped with a discharge tube; at least one band-shaped electrode that is provided in the discharge tube; and at least one dielectric that covers the electrode, then, the thickness of at least one of the edge portions of the band-shaped electrode along longitudinal direction is thinner than the thickness of the electrode center portion.

FIG. 2



EP 2 608 245 A1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to an excimer lamp that radiates light by either dielectric barrier discharge or capacitively coupled high-frequency discharge, and an electrode-less discharge lamp such as an outer-electrode type fluorescent lamp; and it especially relates to a structure of electrodes for a discharge lamp.

BACKGROUND OF THE INVENTION

[0002] In a dual-cylinder tubular-type excimer lamp, a light-emitting part is formed by long, cylindrical coaxial tubes that extend along the axial direction, a high-pressure gas sealed in a bulb, and a pair of electrodes arranged on an inner surface of an interior tube and an outer surface of an exterior tube along the axial direction, so as to be opposite one another. Then, a discharge for emitting light occurs by applying a high-frequency voltage of several kilovolts between the electrodes.
[0003] Also, in a single-cylinder tubular-type excimer lamp such as an outer-electrode type fluorescent lamp, a band-shaped electrode that is covered with a dielectric is arranged in a discharge tube along the axial direction, and discharge for emitting light occurs between the band-shaped electrode and an outer electrode that is arranged on an outer surface of the discharge tube.
[0004] For example, in Patent Document 1, an excimer lamp that emits light by applying a high-frequency voltage is disclosed. Also, in Patent Document 2, a discharge lamp in which a band-shaped electrode is arranged in a discharge tube and an outer electrode is arranged on an outer surface of the discharge tube is described.

Patent Document 1: JP1996375242A
Patent Document 2: JP1999283579A

SUMMARY OF THE INVENTION

THE PROBLEM TO BE SOLVED

[0005] In the case of the above conventional discharge lamp, the shape of electrodes in the discharge tube is a circular cylinder or thin plate, and the cross section of which is circular or rectangular. These shapes require a significantly high voltage to cause discharge between an electrode covered with the dielectric and an electrode arranged outside of the discharge tube, so that the illumination of the lamp is delayed.
[0006] When a large voltage is supplied to the lamp, the electrode covered with the dielectric is easily peeled off the dielectric by the difference in thermal expansion between the dielectric and the electrode, and there is a possibility that oxidation of the electrode will occur since the peeled electrode is exposed to a discharge space.

MEANS FOR SOLVING PROBLEM

[0007] A discharge lamp according to the present invention is equipped with a discharge tube; at least one band-shaped electrode that is provided in the discharge tube; and at least one dielectric that covers the electrode. A discharge gas is sealed in the discharge tube. A band-shaped electrode such as a foil electrode is embedded in the dielectric so as not to be exposed to a discharge space. A gas sealed in the discharge space may be optionally selected, for example, a noble gas, a halogen gas such as chlorine, or a mixture gas composed of a halogen gas and a noble gas may be sealed.
[0008] In the present invention, the thickness of at least one of the edge portions of the band-shaped electrode along longitudinal direction is thinner than the thickness of the electrode center portion. Thus, electric filed occurs in the thin edge portion intensively and intensity of electric field becomes large. Consequently, discharge occurs between the electrodes by a relatively low voltage.
[0009] A plurality of electrodes may be covered with one dielectric or different dielectrics respectively. Preferably, the thicknesses of both edge portions of the band-shaped electrode are thinner than the thickness of the electrode center portion to improve the starting of illumination at the edge portions of the electrode.
[0010] As for the shape of the electrode, various shapes that are sharp toward the tip may be applied, and a knife-edge shape may be preferably applied as a shape that is smoothly sharp toward the tip. Thus, the voltage level for starting discharge can be more restrained since the edge cross-section becomes a line-shape along the axis direction, and it lacks probability that a clearance between the electrode and the dielectric does occur and peel does occur.
[0011] As for the arrangement of electrodes, one electrode may be arranged on the outside of the discharge tube, or all of electrodes may be arranged in the discharge tube. For example, a plurality of band-shaped electrodes having the

same polarities is arranged inside the discharge tube, and an outer electrode having different polarity is arranged on the outside of the discharge tube. In this case, considering that emitting light from the entire of this discharge tube uniformly, the plurality of band-shaped electrodes may be arranged so as to be parallel to one another with respect to the width direction. Alternatively, the plurality of band-shaped electrodes may be arranged symmetrically with respect to the tube axis of the discharge tube.

[0012] On the other hand, a plurality of band-shaped electrodes having different polarities may be arranged inside the discharge tube. In this case, considering that emitting light from the entire of the discharge tube uniformly, the plurality of band-shaped electrodes may be preferably arranged symmetrically with respect to the tube axis of the discharge tube. Also, to emit light from the total of the discharge tube, the plurality of band-shaped electrodes may be arranged along the same direction, i.e., may be arranged so as to be parallel to one another with respect to the width direction.

[0013] In the case of construction in which an electrode is arranged on the outside of the discharge tube, the band-shaped electrode may be coaxially arranged in the discharge tube such that the width direction of the electrode coincides with the dial direction of the discharge tube in order to improve intensity of electric filed at the electrode edge portion. Thus, the extension direction of the electrode edge portion has a maximum intensity of electric field so that a voltage for starting illumination can be restrained.

[0014] Electrode material may be metal or alloy having high conductivity. The thickness of the electrode may be decided on the basis of current capacity or thermal expansion coefficients, for example, the thickness of the electrode is set to a range between 20-50 μm. Also, the width of the band-shaped electrode may be decided on the basis of current capacity, for example, the electrode width is set to a range between 1.2-10 mm.

[0015] The wall thickness of the discharge tube may be preferably set to a thickness that prevent degradation of the discharge tube due to excimer light, and a thickness less than a thickness that increases a voltage for starting discharge or a voltage for maintaining illumination. For example, the wall thickness of the discharge tube is set to a range between 0.8-1.5 mm. The inner diameter of the discharge lamp may be preferably set such that shortage of illumination due to a short discharge distance does not occur and instability of discharge due to a long discharge distance does not occur, for example, the inner diameter of the discharge tube is set to a range between 8-20 mm.

[0016] The dielectric may be, for example, a pillar dielectric having a circular cross-section. The dielectric may be preferably composed of an insulation material having thermal expansion coefficients similar to the thermal expansion coefficients of the electrode at the temperature during the use of the lamp. Also, in order to maintain insulation property and prevent an increase of a voltage for starting illumination, the thickness of the dielectric may be set to a range between 0.1-2 mm.

[0017] a distance between one electrode and another electrode having a different polarity may be determined on the basis of a type of a discharge gas and/or an applied voltage, to prevent shortage of illuminate due to a short discharge interval and instability of discharge due to a long discharge distance, for example, a discharge distance may be set to a range between 3-10 mm.

[0018] When the thickness of the band-shaped electrode is designated as "w" and the inner diameter of the discharge tube is designated as "d", the ratio may be set such that the formula "$1.6 \leq d/w \leq 13.4$" is satisfied. When the "d/w" is smaller than 1 . 6, an occupied area of an foil electrode to the discharge tube becomes large, a discharge distance becomes short, and emitted light is shielded by the band-shaped electrode, which resulting in shortage of illumination. When the "d/w" is larger than 13.4, the width of the band-shaped electrode is short so that overheat occurs due to an overcurrent, and a discharge distance is long so that discharge becomes unstable.

EFFECT OF THE INVENTION

[0019] In the present invention, a discharge lamp that improves starting illumination and maintains illumination for long interval is provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

- Fig. 1 is a schematic plan view of a discharge lamp according to the first embodiment;
- Fig. 2 is a cross-sectional view along the line II shown in Fig. 1;
- Fig. 3 is an enlarged cross-sectional view of the electrode edges shown in Fig. 2;
- Fig. 4 illustrates a manufacturing process of the discharge lamp;
- Fig. 5 is a cross-sectional view of a discharge lamp according to the second embodiment;
- Fig. 6 is; a schematic cross-sectional view of a discharge lamp according to the third embodiment, and
- Fig. 7 is a schematic cross-sectional view of a discharge lamp according to the fourth embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021] Hereinafter, the preferred embodiments of the present invention are described with reference to the attached drawings.

[0022] Fig. 1 is a schematic plan view of a discharge lamp according to the first embodiment. Fig. 2 is a cross-sectional view along the line II shown in Fig. 1.

[0023] A discharge lamp 10 is an excimer lamp equipped with a discharge tube 20 that has a circular cross section and is composed of a dielectric material such as quartz glass. A noble gas or mixing gas is enclosed in the discharge tube 20 as a discharge gas. The pressure of the discharge gas, for example, is set to 5-150 kPa.

[0024] In the discharge tube 20, one piece of band-shaped foil electrode 30 that extends along the tube axis C of the discharge tube 20 is provided. The foil electrode is covered with a pillar dielectric 50 that has a generally circular cross section, and is embedded in the dielectric 50 so as not to be exposed to a discharge space.

[0025] The foil electrode 30 is coaxially arranged in the dielectric 50 such that the center portion along the width direction coincides with the center position of the dielectric 50. Also, the dielectric 50 is coaxially arranged with the discharge tube 20. Therefore, the foil electrode 30 is coaxial to the discharge tube 20, and is symmetrical with respect to the tube axis C.

[0026] As described later, the edge portions 30K1, 30K2, which are opposite end portions of the foil electrode 30 along the tube axis C, are formed in the shape of a knife blade or knife edge. Therefore, the thickness of the foil electrode 30 thins down from the center portion to the edge in the width direction, and the form of the electrode cross section is tapered and pointed. In Fig. 2, the width of the foil electrode 30 is designated as the Y-direction, and the thickness perpendicular to the Y-direction is designated as the X-direction.

[0027] An outer electrode 40 provided on the outer surface of the discharge tube 20 is formed by arranging a plurality of electrode wires in mesh, and the plurality of electrode wires are spirally aligned along the tube axis C at given intervals. An electric power supply wire 70, which is connected to the edge of the foil electrode 30, connects with a power supply (not shown) that is arranged outside of the lamp, and electric power is supplied to the lamp 10 via the wire 70.

[0028] The polarities of the foil electrode 30 and the outer electrode 40 are an anode and a cathode, respectively. When a voltage of several kilovolts is supplied to the discharge lamp 10, a dielectric barrier discharge occurs between the foil electrode 30 and the outer electrode 40 so that excimer light having a specific spectrum (e.g., 172nm) is emitted.

[0029] The length of the discharge tube 20 along the tube axis is set to a range between 100mm to 250mm. On the other hand, the wall thickness of the discharge lamp 20 is set to a range between 0.8mm to 1.5mm in order to prevent degradation of the discharge lamp 20 due to illumination of excimer light, and to restrain the rising voltage when a discharge commences . Also, an inner diameter of the discharge lamp 20 is set between 8mm to 20mm to prevent an unstable discharge that could result from a long discharge distance and a shortage of illumination due to a short discharge distance.

[0030] The thickness of the foil electrode 30 is set to 20-50μm in view of the current capacity, ease of manufacturing, and prevention of peel due to thermal expansion. Also, the width of the foil electrode is set to 1.2-10mm in view of the current capacity, ease of manufacturing, and further prevention of a shield of discharge light due to an enlargement of the electrode size. With regard to the electrode material, molybdenum or an alloy including molybdenum, etc., is used.

[0031] The dielectric 50 is composed of a dielectric material (such as SiO_2) with a thermal expansion coefficient that is as close as possible to the thermal expansion coefficient of the electrode 30. The thickness of the dielectric 50 is set to 0.1-2mm in view of the limitations needed to maintain its electrical non-conductance property and prevent a rise in the voltage when a discharge commences.

[0032] The discharge distance, i.e., an interval between the dielectric 50 and the inner diameter of the discharge tube 20 is set to 3-10mm to prevent any shortage of illumination and provide for a stable discharge. Also, when the electrode width is designated as "w" and the inner diameter of the discharge tube is designated as "d", the electrode width and the inner diameter is determined so as to meet the following formula:

$$1.6 \leq d/w \leq 13.4 \qquad (1)$$

[0033] Fig. 3 is an enlarged cross-sectional view of the electrode edges shown in Fig. 2. Note that the size of the electrode, dielectric and discharge tube are different from Fig. 1 and the relationship of the relative position is also different from Fig. 1.

[0034] As described above, the edge portions 30K1, 30K2 of the foil electrode 30 is shaped like the blade of a knife, i.e., knife-edge shaped. The foil electrode 30 becomes sharper from the center portion toward an end portion along the width direction, and the thickness of the end portion in the width direction is thinner than the thickness T of the center portion; therefore, the tip 30T1 of the edge portion is pointed. The edge portion 30K2 herein not shown also has a shape similar to the edge portion 30K1.

[0035] This electrode shape causes the electric field to concentrate at the tip 30T1. Namely, the maximum intensity of an electric field is in an area (see broken line E) adjacent to the tip 30T1, and the area E1 is narrow because of the sharpness of the tip 30T1. This is because the cross-sectional rectangular shape of a conventional lamp, which does not have a sharpened edge, produces an electric field across the whole plane of the edge, namely, the cross-sectional rectangular shape produces a large electric potential gradient, whereas the tip 30T1 according to the present embodiment is substantially a line along the tube axis so that the electric field can be concentrated at the tip.

[0036] Also, the foil electrode 30 is coaxially arranged with respect to the dielectric 50 and the discharge tube 20, and its width direction is along the radial direction of the discharge tube 20. Thereby, the distance (discharge distance) from the edge portion 30K1 to the inner surface of the discharge tube 20 is equal to the distance from the edge portion 30K2 to the inter surface of the discharge tube 20. Thus, light is uniformly emitted from the entire discharge tube 20.

[0037] Fig. 4 illustrates a manufacturing process of the discharge lamp.

[0038] Firstly, a foil electrode 70 is connected to an electric power supply wire 80 by resistance welding or the like, and is then inserted into a glass tube 60 coated with a dielectric material. After the electrode 60 is inserted, the tube 70 is subjected to a vacuum process, after which the dielectric coating material 60 is subjected to a heat treatment to weld the dielectric coating material 60 to the foil electrode 70 (Process (1)).

[0039] Next, a flange-shaped or abacus-shaped sealing portion 85 is formed at a position along the glass tube 60 that corresponds to the position of an electrode edge (Process 2) . Then, a discharge tube 90 composed of quartz glass or the like is formed with an exhaust outlet and insertion inlet (Process (3)), the electrode 70 is inserted into the discharge tube 90, and the insertion inlet of the discharge tube 90 is welded to the abacus-shaped sealing portion 85 (Process (4)).

[0040] Furthermore, a vacuum drawing or vacuum purge is performed on the discharge tube 90 via the exhaust outlet while heating the discharge tube 90 to remove all impurities. Then, the exhaust outlet is sealed after enclosing a discharge gas and an outer electrode 95 is arranged on the outer surface of the discharge tube 90 (Process 5).

[0041] In this way, in the present embodiment the foil electrode 30 that is coated with the dielectric 50 in the discharge tube 20 is arranged along the tube axis C. Also, the outer electrode 40 having a different polarity is provided on the outer surface of the discharge tube 20. Furthermore, the edge portions 30K1, 30K2 are knife-edge shaped.

[0042] Since the electrode edge portions are sharpened, the intensity of an electric field at the edge portions is relatively high, so that discharge can occur at a low voltage when illumination begins. The electrode edge portions function as a trigger at the start of illumination, and the level of illumination is maintained during a long lighting of the lamp.

[0043] Also, since the electrode edge portions are smoothly sharpened, there is no space for clearance between the electrode and the dielectric, therefore the electrode is not exposed to a discharge space if there is a difference in thermal expansion during lighting, and thereby oxidation is prevented.

[0044] Next, a discharge lamp according to the second embodiment is explained with reference to Fig. 5. In the second embodiment, two foil electrodes having different polarities are arranged in a discharge tube.

[0045] Fig. 5 is a cross-sectional view of a discharge lamp according to the second embodiment.

[0046] The discharge lamp 100 is equipped with two foil electrodes 130A and 130B in a discharge tube 20, and the foil electrodes 130A and 130B are covered with pillar dielectrics 150A an 150B, respectively. The foil electrodes 130A and 130B have different polarities, respectively, herein the foil electrode 130A is anode and the foil electrode 130B is cathode.

[0047] Also, the foil electrodes 130A and 130B are arranged in a symmetrical position with respect to the tube axis C, and the width directions of the electrodes 130A and 130B are both parallel to the Y direction. Both of the edge portions of the foil electrodes 130A and 130B are shaped like a knife edge, similarly to the first embodiment. This arrangement allows light to be emitted symmetrically from the discharge tube 20 so that light is radiated from the entire discharge lamp 20.

[0048] Fig. 6 is a schematic cross-sectional view of a discharge lamp according to the third embodiment. In the third embodiment, multiple foil electrodes are arranged in a discharge tube.

[0049] In a discharge lamp 200, nine dielectrics 220A to 220C, in which foil electrodes are embedded, are two-dimensionally arranged in a discharge tube 210 along the X and Y directions. The width direction of each foil electrode faces to the Y direction. On the outer surface of the discharge tube 210, an outer electrode 250 having a different polarity is arranged. This symmetrical electrode arrangement allows light to be emitted from the discharge tube uniformly.

[0050] In Fig. 7, a discharge lamp according to the fourth embodiment is explained. A discharge lamp 300 is equipped with three dielectrics 320, in which foil electrodes are embedded, and the dielectrics 320 are aligned in the discharge tube 310. On opposing sides of the discharge tube 300 having a rectangular cross section, outer electrodes 350 that have different polarities are arranged, respectively. This electrode arrangement allows light to be emitted from the bottom side of the discharge lamp.

[0051] The dielectric may have a cross-sectional shape other than the circular cross-section, for example, a foil electrode may be covered with a dielectric such that the foil electrode is coaxially arranged to the dielectric. The edge portions of the foil electrode may have an optional shape other than the knife-edge, for example, the shape may be such that the thickness of the edge portions of the band-shaped electrode along longitudinal direction is thinner than the thickness of the electrode center portion to cause electric field at the edge portions intensively. Also, only one edge portion may be sharpened. Furthermore, in order to cause electric field at a specific position intensively, the shape of the electrode may be a saw blade having uneven width and the center position of the dielectric may be shifted from the center position of the foil electrode. Also, the foil electrode may be spirally shaped by twisting the foil electrode along the axis direction of the discharge tube, thus a stress along the thickness direction that peels the foil electrode from the dielectric can be distributed.

[0052] As the discharge method, the capacitive-coupled (electrostatic capacity) high-frequency discharge method, which uses a relatively low-voltage and is used for a lamp used for scanning, may be applied instead of the above-mentioned dielectric barrier discharge method. In the dielectric barrier discharge type excimer lamp, discharges occur uniformly and stably even though a discharge distance of a discharge space may be long, so that an excellent illumination distribution can be realized along the lamp axis. On the other hand, in the case of the capacitive-coupled high-frequency discharge lamp, a high-voltage can be applied to electrodes by providing an LC resonance circuit at the final portion of an electric supply source.

PRACTICAL EXAMPLE

[0053] Hereinafter, an example discharge lamp corresponding to the first embodiment is explained. The length of the discharge lamp along the tube axis is 300 mm, the wall thickness is 1 mm, the inner diameter is 12.8 mm, the thickness of the dielectric having a circular cross section is 1 mm with respect to a direction parallel to the width direction of a foil electrode, and is 1.5 mm with respect to a direction parallel to the thickness direction of the foil electrode, the discharge distance is approximately 5 mm, the thickness of the foil electrode is 20 μm and the width is 1.5 mm. When the inner diameter of the discharge tube is designated as "d", the width of the foil electrode is designated as "w", the ratio d/w is 8.5.

[0054] An experimental illumination was performed with Xe gas enclosed in the discharge tube as a discharge gas, an applied voltage of 6.5kV, and gas pressure of 47 kPa. After spectrum light of 172nm was emitted continuously for 2500 hours, 90 percent of initial illumination was maintained.

[0055] Note that, the disclosure of Japanese Patent Application No. 2010-179652, filed on August 10, 2010, including the specification, drawings, and claims, is further incorporated herein by reference in its entirety.

[0056] As for the present invention, various changes, replacements, and alternation may be applied without departing from the spirit and scope of the present invention. Furthermore, it is not intended that the present invention is limited to a specific process, apparatus, manufacturing, composition, means, method and step described in the embodiments. It should be understood that the above-disclosed contents derives a function the same as the function described in the embodiments, or derives an apparatus, means, and method the same as the action and effect described in the embodiments.

Claims

1. A discharge lamp comprising:

a discharge tube, a discharge gas being sealed in said discharge tube;
at least one band-shaped electrode that is provided in said discharge tube; and
at least one dielectric that covers said electrode,
wherein the thickness of at least one of the edge portions of said band-shaped electrode along longitudinal direction is thinner than the thickness of the electrode center portion.

2. The discharge lamp of Claim 1, wherein the edge portion of said band-shaped electrode is knife-edge shaped.

3. The discharge lamp of Claim 1, wherein said band-shaped electrode is coaxially arranged in said discharge tube.

4. The discharge lamp of Claim 1 or 2, wherein the thicknesses of both edge portions of said band-shaped electrode are thinner than the thickness of the electrode center portion.

5. The discharge lamp of Claim 1, wherein a plurality of band-shaped electrodes having different polarities is arranged inside said discharge tube.

6. The discharge lamp of Claim 1, wherein a plurality of band-shaped electrodes having the same polarities is arranged

inside said discharge tube,
wherein an outer electrode having different polarity is arranged on the outside of said discharge tube.

7. The discharge lamp of Claim 5 or 6, wherein said plurality of band-shaped electrodes is arranged symmetrically with respect to the tube axis of said discharge tube.

8. The discharge lamp of Claim 5 or 6, wherein said plurality of band-shaped electrodes are arranged so as to be parallel to one another with respect to the width direction.

9. The discharge lamp of Claim 1 or 2, wherein said plurality of electrodes are covered with different dielectrics, respectively.

10. The discharge lamp of Claim 1, wherein the thickness of said band-shaped electrode is set to a range between 20-50 μm, and the width of said band-shaped electrode is set to a range between 1.2-10 mm.

11. The discharge lamp of Claim 1, wherein the wall thickness of said discharge tube is set to a range between 0.8-1.5 mm, the inner diameter of said discharge tube is set to a range between 8-20 mm, the thickness of said dielectric is set to a range between 0.1-2 mm, and a discharge distance is set to a range between 3-10 mm.

12. The discharge lamp of Claim 10 or 11, wherein the following formula is satisfied when the thickness of said band-shaped electrode is designated as "w" and the inner diameter of said discharge tube is designated as "d": $1.6 \leq d/w \leq 13.4$.

FIG. 1

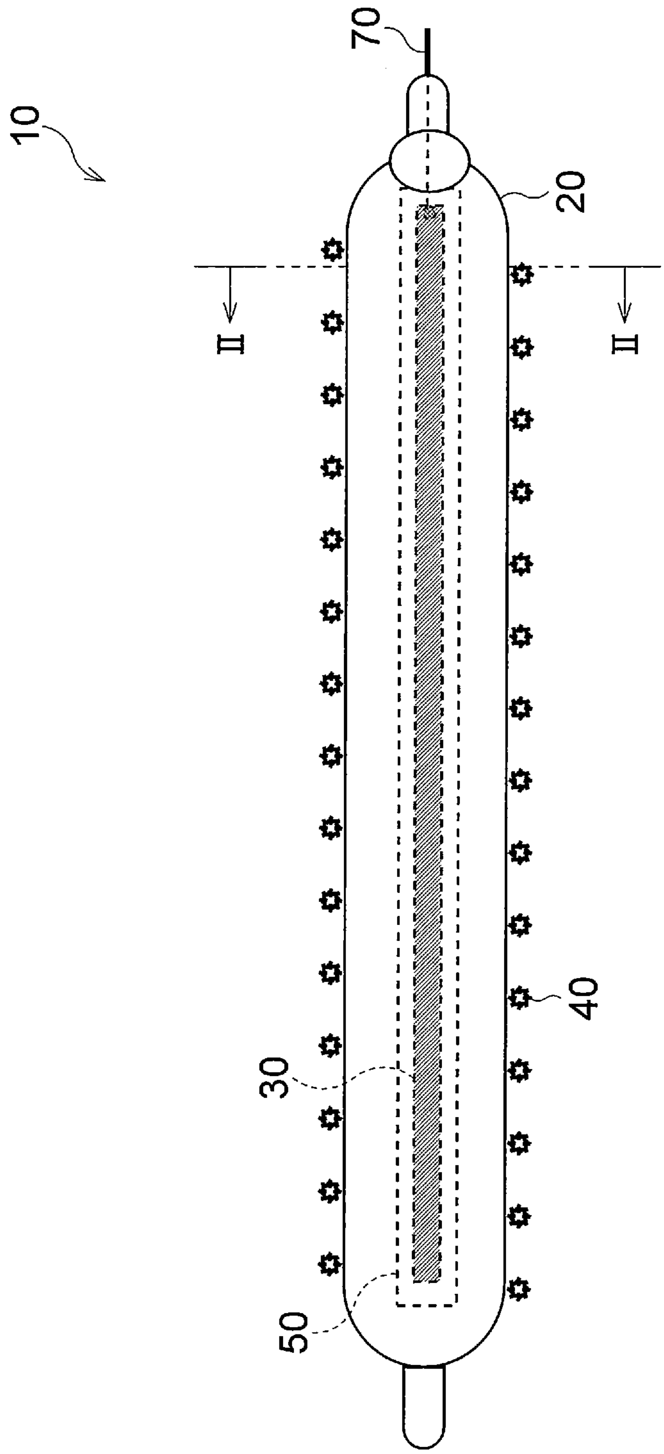


FIG. 2

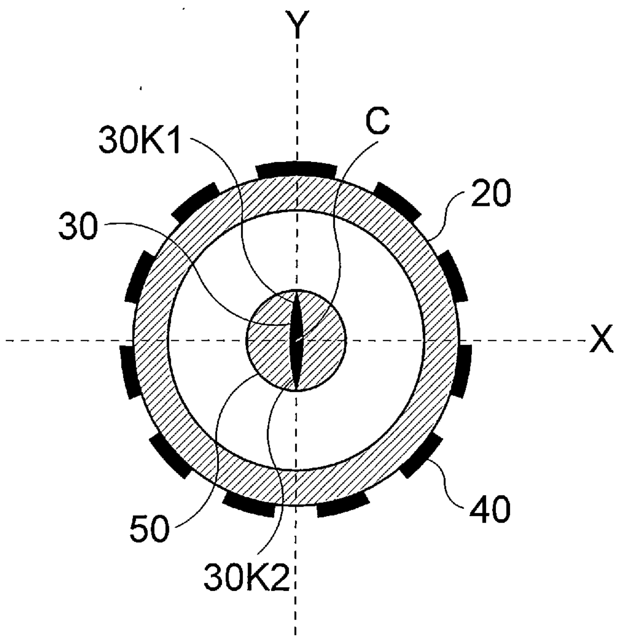


FIG. 3

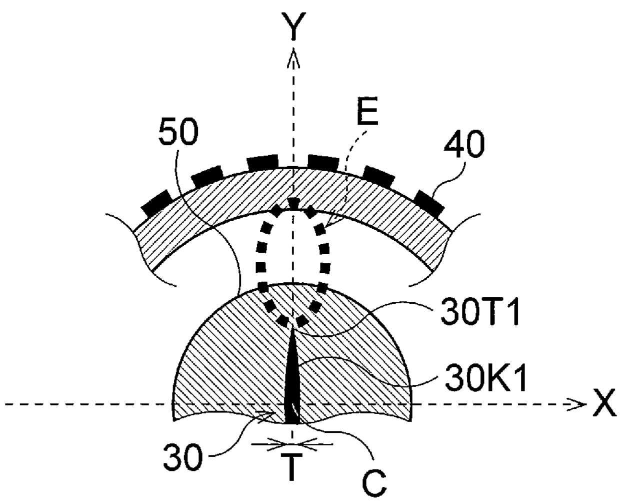


FIG. 4

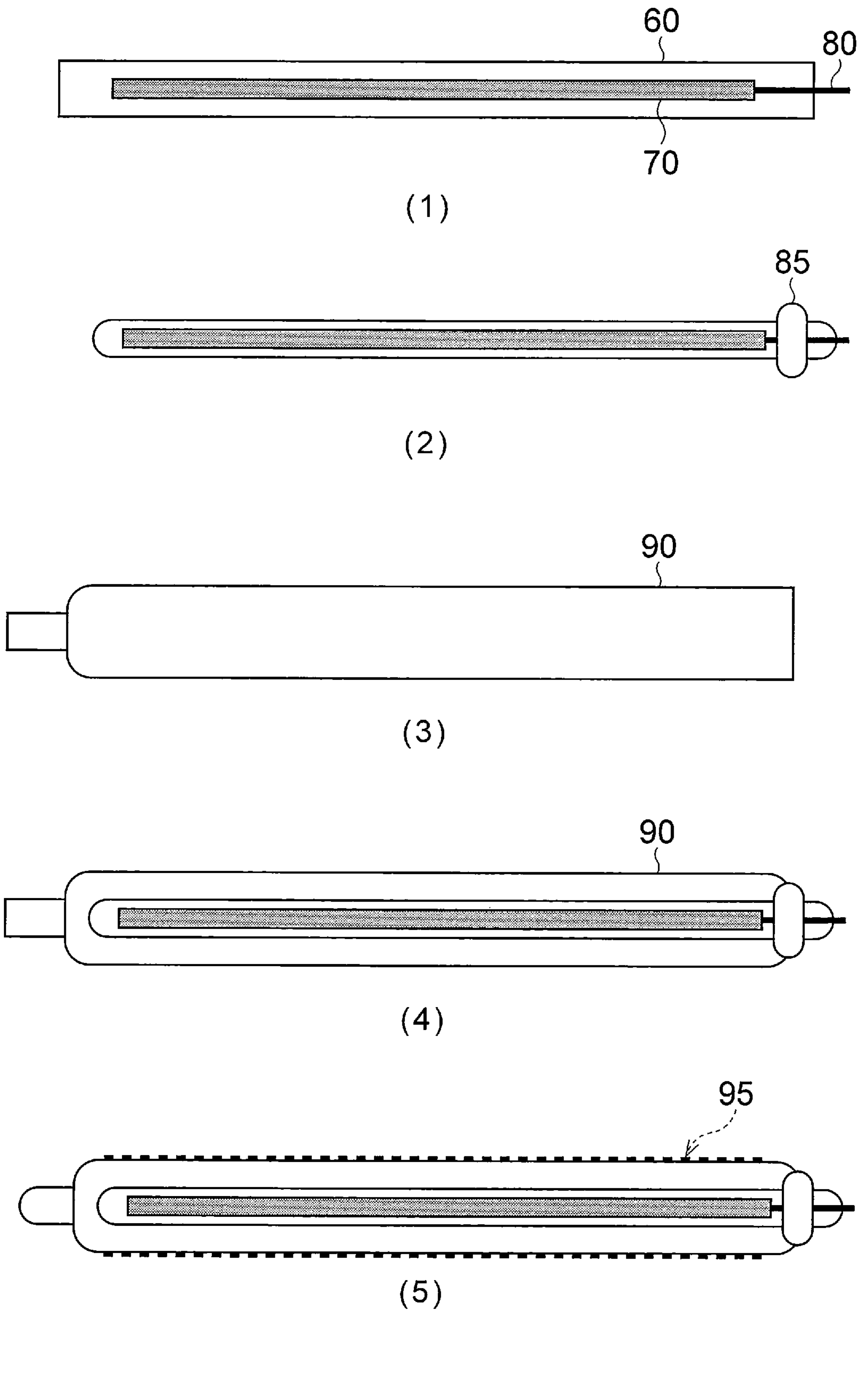


FIG. 5

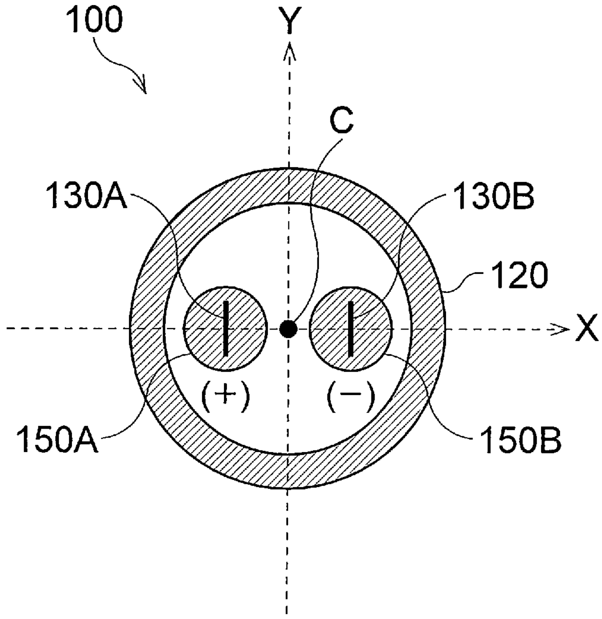


FIG. 6

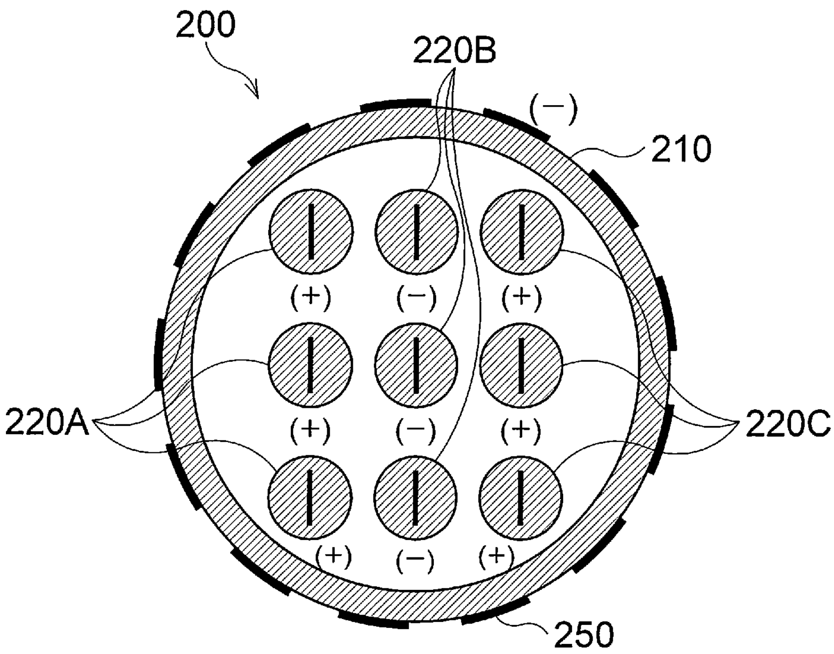
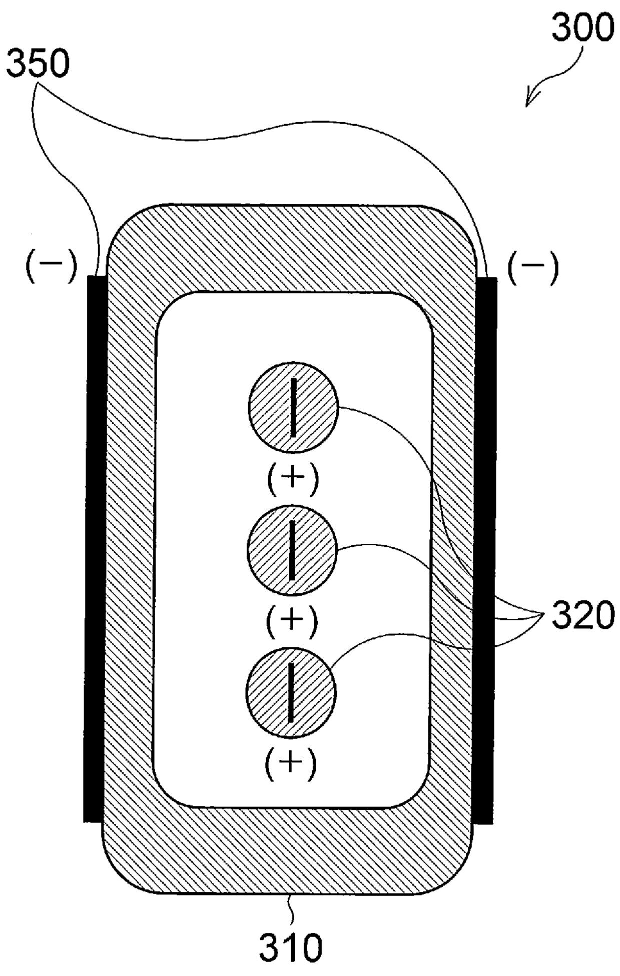


FIG. 7



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/067931

A. CLASSIFICATION OF SUBJECT MATTER
H01J65/00(2006.01)i

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)
H01J65/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2011
Kokai Jitsuyo Shinan Koho	1971-2011	Toroku Jitsuyo Shinan Koho	1994-2011

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 11-283579 A (Toshiba Lighting & Technology Corp.), 15 October 1999 (15.10.1999), entire text; all drawings (Family: none)	1-12
A	JP 2004-152605 A (Harison Toshiba Lighting Corp.), 27 May 2004 (27.05.2004), paragraphs [0014] to [0015], [0023]; fig. 2 (Family: none)	1-12
A	JP 2001-6623 A (Wataru SASAKI), 12 January 2001 (12.01.2001), paragraph [0011]; fig. 2 (Family: none)	5,7-9

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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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
24 August, 2011 (24.08.11)	06 September, 2011 (06.09.11)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/067931

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2004-14238 A (Fuji Photo Film Co., Ltd.), 15 January 2004 (15.01.2004), paragraph [0036]; fig. 6 (Family: none)	6-9

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 1996375242 A **[0004]**
- JP 1999283579 A **[0004]**
- JP 2010179652 A **[0055]**