(19) Europäisches Patentamt / European Patent Office / Office européen des brevets

(11) EP 2 919 257 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
16.09.2015 Bulletin 2015/38

(21) Application number: **13852720.5**

(22) Date of filing: **09.08.2013**

(51) Int Cl.:
H01J 61/36 *(2006.01)* ***H01J 9/28*** *(2006.01)*

(86) International application number:
PCT/JP2013/071730

(87) International publication number:
WO 2014/073253 (15.05.2014 Gazette 2014/20)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **07.11.2012 JP 2012245504**

(71) Applicant: **Toshiba Lighting & Technology Corporation**
Yokosuka-shi, Kanagawa 237-8510 (JP)

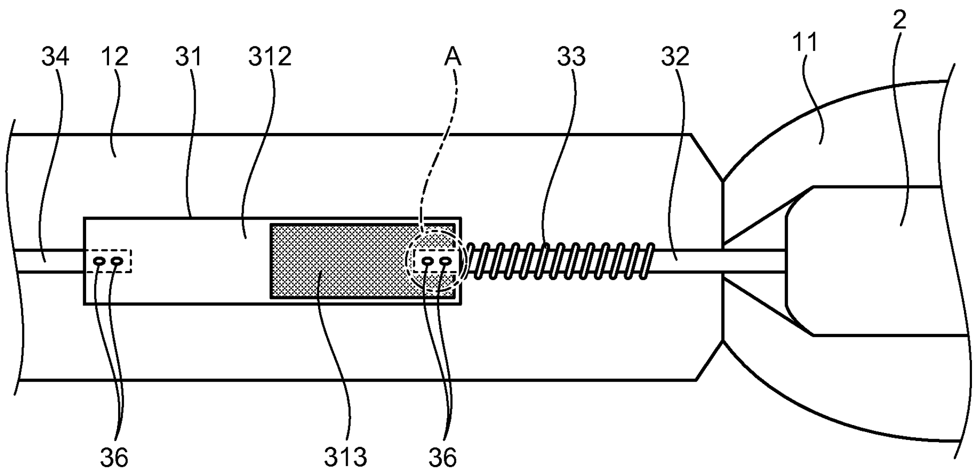
(72) Inventors:
- **YAMADA, Jun**
  Yokosuka-shi, Kanagawa 237-8510 (JP)
- **SHIRAKAWA, Osamu**
  Yokosuka-shi, Kanagawa 237-8510 (JP)

(74) Representative: **Willquist, Sofia Ellinor**
Awapatent AB
Junkersgatan 1
582 35 Linköping (SE)

(54) DISCHARGE LAMP AND METHOD FOR MANUFACTURING SAME

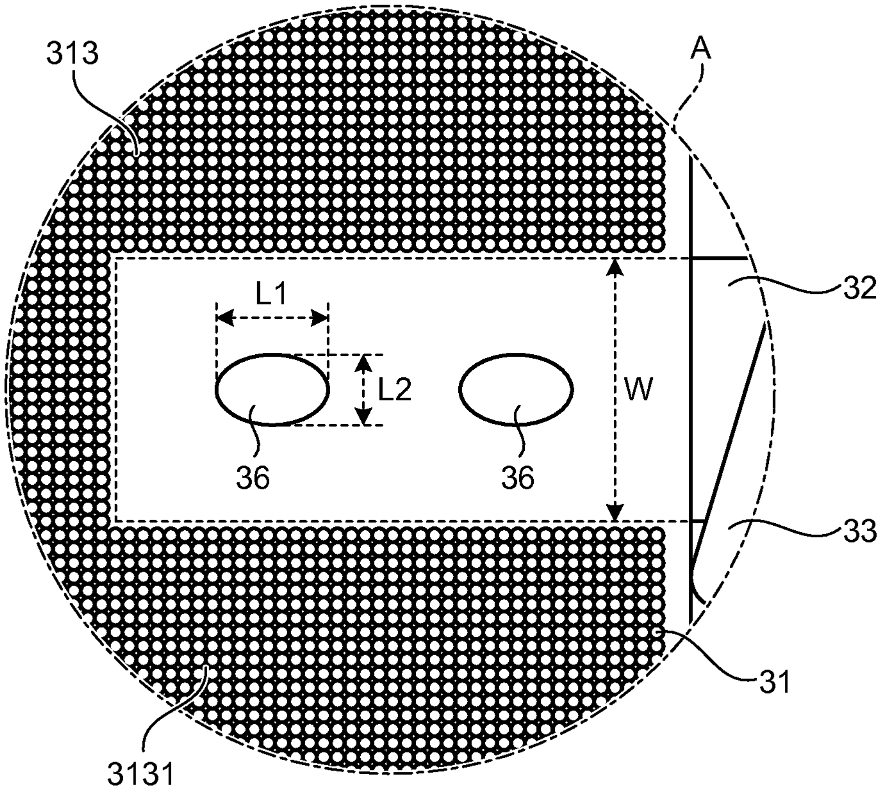
(57) According to one embodiment, there is provided a discharge lamp including a metal foil 31 including a first surface and a second surface located on the front and the back and an electrode 32 connected to the metal foil 31. A welding mark 36 is formed such that the first surface and at least a part of the electrode 32 overlap each other. The welding mark 36 has an elliptical shape long in the axial direction of the electrode 32 when viewed from a second surface side 312. A ratio L1/L2 of a first length L1 in the axial direction and a second length L2 in a direction orthogonal to the axial direction is in a relation of 1.08≤L1/L2≤1.56. Consequently, a discharge lamp excellent in joining strength and a manufacturing method for the discharge lamp are provided.

FIG.3



EP 2 919 257 A1

FIG.4



Description

Field

[0001] Embodiments of the present invention relate to a discharge lamp and a manufacturing method for the discharge lamp.

Background

[0002] A discharge lamp is a lamp comprised of an electrode mount sealed by a seal section of an arc tube including the arc tube and the seal section. The electrode mount is configured by a metal foil and an electrode. The metal foil and the electrode can be welded by laser irradiation. In the electrode mount in which the metal foil and the electrode are joined by the laser welding, a deficiency of disjoining of the metal foil and the electrode occurs, and thus improvement in joining strength is demanded.

Citation List

Patent Literature

[0003]

Patent Literature 1: JP-A-2012-84454
Patent Literature 2: Japanese Patent No. 4972172
Patent Literature 3: Japanese Patent No. 4494224
Patent Literature 4: JP-A-2005-349477
Patent Literature 5: JP-A-2004-363014

Summary

Technical Problem

[0004] An object of the present invention is to provide a discharge lamp excellent in joining strength and a manufacturing method for the discharge lamp.

Solution to Problem

[0005] A discharge lamp according to one embodiment including a light-emitting section, a seal section, and an electrode mount. The light-emitting section includes a discharge space in which metal halide is encapsulated. The seal section is formed at an end portion of the light-emitting section. The electrode mount includes a metal foil including first and second surfaces located on the front and the back and an electrode connected to the metal foil. A welding mark is formed such that the first surface and at least a part of the electrode overlap each other. The welding mark has an elliptical shape long in the axial direction of the electrode when viewed from the second surface side, and a ratio L1/L2 of a first length L1 in the axial direction and a second length L2 in a direction orthogonal to the axial direction is in a relation of $1.08 \leq L1/L2 \leq 1.56$.

Advantageous Effect of Invention

[0006] According to the present invention, it is possible to provide a discharge lamp excellent in joining strength and a manufacturing method for the discharge lamp.

Brief Description of Drawings

[0007]

FIG. 1 is a diagram showing a discharge lamp in a first embodiment.
FIG. 2 is a sectional view showing the discharge lamp in the first embodiment.
FIG. 3 is a diagram showing a state in which a metal foil of the discharge lamp is viewed from a second surface side in the first embodiment.
FIG. 4 is an enlarged view showing a range A shown in FIG. 3.
FIG. 5 is sectional view showing an electrode mount in the first embodiment.
FIG. 6 is a diagram showing a relation between a disjoining occurrence ratio and L1/L2 of the discharge lamp in the first embodiment.
FIG. 7 is a diagram showing a manufacturing method for the electrode mount in the first embodiment.
FIG. 8 is explanatory diagram showing laser irradiation of the electrode mount in the first embodiment.
FIG. 9 is diagram showing another example of the electrode mount.
FIG. 10 is diagram showing another example of the electrode mount.

Description of Embodiments

[0008] A discharge lamp according to an embodiment explained below includes a light-emitting section 11, seal sections 12, and electrode mounts 3. The light-emitting section 11 includes a discharge space 111 in which metal halide is encapsulated. The seal sections 12 are formed at end portions of the light-emitting section 11. The electrode mounts 3 include metal foils 31 including first surfaces 311 and second surfaces 312 located in the front and the back and electrodes 32 connected to the metal foils 31. Welding marks 36 are formed such that at least parts of the first surfaces 311 and the electrodes 32 overlap each other. The welding marks 36 have an elliptical shape long in the axial direction of the electrodes 32 when viewed from the second surfaces 312 side. A ratio L1/L2 of a first length L1 in the axial direction and a second length L2 in a direction orthogonal to the axial direction is in a relation of $1.08 \leq L1/L2 \leq 1.56$.

[0009] In the discharge lamp according to the embodiment explained below, a ratio L2/W of the second length L2 and a diameter W of the electrodes 32 is in a relation of $0.3 \leq L2/W \leq 0.9$.

[0010] In the discharge lamp according to the embodiment explained below, the diameter W of the electrodes

32 is 0.2 mm to 0.4 mm.

[0011] In the discharge lamp according to the embodiment explained below, the welding marks 36 are formed to extend from the metal foils 31 side to the insides of the electrodes 32. The center lines of the welding marks 36 incline with respect to the perpendicular direction of the second surfaces 312.

[0012] In a manufacturing method for the discharge lamp according to the embodiment explained below, the metal foils 31 and the electrodes 32 are arranged such that at least parts of the first surfaces 311 and the electrodes 32 overlap each other. A laser is irradiated on overlapping portions of the first surfaces 311 and the electrodes 32 from the second surfaces 312 side along an optical axis inclining with respect to the perpendicular direction of the metal foils 31 to weld the metal foils 31 and the electrodes 32 to form the welding marks 36 in which the ratio L1/L2 of the first length L1 in the axial direction of the electrodes 32 and the second length L2 in the direction orthogonal to the axial direction is in a relation of $1.08 \leq L1/L2 \leq 1.56$.

First Embodiment

[0013] A first embodiment is explained with reference to FIGS. 1 and 2. FIG. 1 is a diagram showing a discharge lamp in the first embodiment. FIG. 2 is a sectional view showing the discharge lamp in the first embodiment. FIG. 3 is a diagram showing a state in which the metal foil of the discharge lamp in the first embodiment is viewed from the second surface side.

[0014] The discharge lamp in this embodiment is a metal halide lamp used in a head lamp for an automobile headlight. The discharge lamp includes an inner tube 1 as an airtight container. The inner tube 1 has an elongated shape. The light-emitting section 11 having a substantially elliptical shape is formed around the center of the inner tube 1. Tabular seal sections 12 formed by pinch seal are formed at both the ends of the light-emitting section 11. Cylinder sections 14 are continuously formed at both the ends of the seal sections 12 by an intercalate section 13. The inner tube 1 is desirably formed of a material having heat resistance and translucency such as quartz glass. The seal sections 12 may be formed by shrink seal to be formed in a columnar shape.

[0015] On the inside of the light-emitting section 11, the discharge space 111 having a substantially columnar shape in the center and having a taper shape toward both the ends is formed. Metal halide 2 and a rare gas are encapsulated in the discharge space 111. The metal halide 2 is formed of sodium iodide, scandium iodide, zinc iodide, and indium bromide. Note that the metal halide 2 is not limited to this combination. For example, halide of tin and cesium may be added.

[0016] As the rare gas, xenon is used. The pressure of the rare gas is 12 atm to 18 atm and desirably 13 atm to 16 atm. Note that, as the rare gas, a mixed gas obtained by combining xenon and neon, argon, krypton, or the like can also be used.

[0017] The lamp in this embodiment is a mercury-free discharge lamp. The "mercury-free" means that the lamp does not substantially include mercury.

[0018] The electrode mounts 3 are respectively sealed by the seal sections 12 formed on both the sides of the light-emitting section 11. The electrode mounts 3 are configured by the metal foils 31, the electrodes 32, coils 33, and lead wires 34.

[0019] The metal foil 31 is a thin plate-like member made of, for example, molybdenum. The metal foil 31 includes the flat first surface 311 and the flat second surface 312 on the front and the back. Both the ends in the latitudinal direction of the flat surfaces are formed in a knife edge shape gradually reduced in thickness. In this embodiment, rough surfaces 313 are formed on half surfaces (excluding overlapping portions of the ends and the electrodes 32) of the first surface 311 and the second surface 312 on a side to which the electrodes 32 are connected. FIG. 4 is an enlarged view showing a range A shown in FIG. 3. As shown in FIG. 4, the rough surface 313 is formed from a plurality of circular recesses 3131. The recesses 3131 are, for example, non-penetrating semicircular hollows having a diameter of 18 μ and depth of 3 μm. The recesses 3131 can be formed by irradiating a YAG laser.

[0020] The electrodes 32 are bar-like members made of so-called thoriated tungsten obtained by, for example, doping thorium oxide in tungsten. One ends of the electrodes 32 are connected to end portions on the light-emitting section 11 side of the metal foils 31. The other ends of the electrodes 32 project into the discharge space 111, and the distal end portions of the other ends of the electrodes 32 are opposed to each other while keeping a predetermined distance. The diameter W is 0.2 mm to 0.4 mm. If the diameter W is smaller than 0.2 mm, the temperature of the electrodes 32 during lighting rises and scattering (spattering) of an electrode substance to the discharge space 111 increases. Therefore, a luminous flux maintenance factor during lighting decreases and a life characteristic is deteriorated. If the diameter W exceeds 0.4 mm, distortion (stress) of sealing portions of the inner tube 1 and the electrodes 32 increases. Therefore, it is likely that a crack occurs in the inner tube 1 during discharge lamp manufacturing or during lighting to cause non-lighting. In this embodiment, the diameter W is, for example, 0.38 mm. Note that, in the case of a use in an automobile headlight, the electrodes 32 are preferably positioned in a range in which the distance between the distal ends of the electrodes 32 is 3.7 mm to 4.4 mm when observed through an outer tube 5.

[0021] The coils 33 are metal wires made of, for example, doped tungsten. The coils 33 are wound in a spiral shape around the axes of shaft sections of the electrodes 32 sealed by the seal sections 12.

[0022] The lead wires 34 are metal wires made of, for example, molybdenum. One end of the lead wires 34 is connected to the end portions of the metal foils 31 on the opposite side of the electrode connection side from the light-emitting section 11. The other end is extended substantially in parallel to a tube axis to the outside of the inner tube 1. One end of an L-shaped support wire 35 made of, for example, nickel is connected to, by laser welding, the lead wire 34 extended to the front end side of the lamp, that is, a far side from a socket 6. In the support wire 35, a sleeve 4 made of, for example, ceramic is attached to a part extending in parallel to the inner tube 1.

[0023] On the outer side of the inner tube 1 configured as explained above, the cylindrical outer tube 5 is provided substantially concentrically with the inner tube 1 to cover the light-emitting section 11. Connection of the inner and outer tubes is performed by welding the ends of the outer tube 5 near the cylinder section 14 of the inner tube 1. Gas is encapsulated in a closed space 51 formed between the inner tube 1 and the outer tube 5. As the gas, dielectric barrier dischargeable gas, for example, one kind of gas selected from neon, argon, xenon, and nitrogen or mixed gas thereof can be used. The pressure of the gas is desirably 0.3 atm or less, in particular, 0.1 atm or less. Note that the outer tube 5 is desirably formed of a material having a coefficient of thermal expansion close to the coefficient of thermal expansion of the inner tube 1 and having ultraviolet blocking properties. For example, quartz glass added with oxide of titanium, cerium, aluminum, or the like can be used.

[0024] The socket 6 is connected to one end of the inner tube 1 to which the outer tube 5 is connected. The connection is performed by attaching a metal band 71 to the outer circumferential surface of the outer tube 5 and gripping the metal band 71 with four metal tongue pieces 72 formed to be projected from the socket 6. A bottom terminal 81 is formed in the bottom of the socket 6 and a side terminal 82 is formed on a side of the socket 6. The lead wire 34 and the support wire 35 are respectively connected to the bottom terminal 81 and the side terminal 82.

[0025] The discharge lamp (a foil seal lamp) configured as explained above is connected to a lighting circuit (not shown in the figure) to set the bottom terminal 81 on a high voltage side and set the side terminal 82 on a low voltage side. In this embodiment, the discharge lamp is lit at lamp power of 75 W during a start and 35 W during stable lighting.

[0026] The connection of the metal foil 31 and the electrode 32 is explained. In this embodiment, the metal foil 31 and the electrode 32 are welded in two places in a state in which the first surface 311 and at least a part of the electrode 32 are arranged to be overlapped each other. FIG. 5 is sectional view showing the electrode mount in the first embodiment. As shown in FIG. 5, in an overlapping portion by the welding, the welding marks 36 extending from the metal foil 31 side to the inside of the electrode 32 and recesses 37 are respectively formed in welded parts. The welding marks 36 are formed in a substantially elliptical cone shape. When viewed from the second surface 312 side, as shown in FIG. 4, the welding marks 36 are formed in an elliptical shape long in the axial direction of the electrode 32. As the elliptical shape, the first length L1 in the axial direction only has to be larger than the second length L2 in the direction orthogonal to the axial direction and a contour line only has to be formed of a curved line. The elliptical shape includes a substantially elliptical shape. In the welding marks 36, the ratio L1/L2 of the first length L1 and the second length L2 is in a relation of Expression (1) below.

$$1.08 \leq L1/L2 \leq 1.56 \qquad (1)$$

[0027] FIG. 6 is a diagram showing a relation between a disjoining occurrence ratio and L1/L2 of the discharge lamp in the first embodiment. As shown in FIG. 6, the disjoining occurrence ratio (%) greatly changes if the ratio L1/L2 of the welding marks 36 is between 1.00 and 1.08. If the ratio L1/L2 of the welding marks 36 is 1.00 or less (the shape of the welding marks 36 viewed from the second surface 312 side is a circular shape or an elliptical shape long in the direction orthogonal to the axial direction of the electrode 32), compared with if the ratio L1/L2 is 1.08, the disjoining occurrence ratio suddenly increases (in the figure, about nine times). Therefore, by setting the ratio L1/L2 of the welding marks 36 to 1.08 or more, it is possible to markedly suppress disjoining compared with if the ratio L1/L2 is smaller than 1.00. Similarly, the disjoining occurrence ratio (%) greatly changes if the ratio L1/L2 of the welding marks 36 is between 1.56 and 1.64. If the ratio L1/L2 of the welding marks 36 is 1.64 or more (the shape of the welding marks 36 when viewed from the second surface 312 side is an elliptical shape considerably longer in the axial direction than in the direction orthogonal to the axial direction of the electrode 32), compared with if the ratio L1/L2 is 1.56 (the first length L1 is about 1.5 times as large as the second length L2), the disjoining occurrence ratio suddenly increases (in the figure, about six times). Therefore, by setting the ratio L1/L2 of the welding marks 36 to 1.56 or less, it is possible to markedly suppress disjoining compared with if the ratio L1/L2 is 1.64 or more. In this embodiment, the ratio L1/L2 is 1.32 (the first length L1=330μm and the second length L2=250μm). The ratio L1/L2 is more preferably 1.16 to 1.48.

[0028] In the welding marks 36, a ratio L2/W of the second length L2 and the diameter W of the electrode 32 is in a relation of Expression (2) below. If the ratio L2/W is smaller than 0.3, welding strength decreases and a defective rate of disjoining or the like increases. If the ratio L2/W exceeds 0.9, the electrode 32 and the metal foil 31 are welded in a state in which a gap occurs between the electrode 32 and the metal foil 31. Therefore, only the metal foil 31 is melted by heating during the welding and a defect such as perforation occurs. In this embodiment, the ratio L2/W is, for example, 0.66.

$$0.3 \leq L2/W \leq 0.9 \quad (2)$$

[0029] The shape in cross sections of the welding marks 36 along the latitudinal direction of the metal foil 31 is, as shown in FIG. 5(a), a substantially triangular shape, center lines B1-B1' and B2-B2' (lines passing near a vertex of the welding mark 36 located on the most inner side of the electrode 32 and dividing the area of the welding mark 36 substantially into two) of which are respectively substantially parallel (including parallel) to the perpendicular direction of the second surface 312. The shape in cross sections of the welding marks 36 along the longitudinal direction of the metal foil 31 is, as shown in FIG. 5(b), a substantially triangular shape, the center lines B1-B1' and B2-B2' of which are substantially parallel to the perpendicular direction of the second surface 312. That is, in this embodiment, inclination angles $\alpha 1$ and $\alpha 2$ of the center lines are, for example, 0°. Note that the metal foil 31 and the lead wire 34 have the same structure.

[0030] A welding method for the metal foil 31 and the electrode 32 is explained. FIG. 7 is a diagram showing a manufacturing method for the electrode mount in the first embodiment. FIG. 8 is explanatory diagram showing laser irradiation on the electrode mount in the first embodiment. First, as shown in FIG. 7, the electrode 32 and the lead wire 34 are arranged on a jig 91 to be fit in a groove 911. Subsequently, the metal foil 31 is arranged such that the first surface 311 overlaps a part of the electrode 32 and a part of the lead wire 34. Thereafter, pressing members 92 are arranged at four corners of the second surface 312 to fix the metal foil 31. As shown in FIG. 8, a laser is irradiated on an overlapping portion of the metal foil 31 and the electrode 32 from the second surface 312 side by a laser irradiating unit 93 of a YAG laser irradiating apparatus. The laser irradiating unit 93 irradiates the laser with optical axes D1-D1' and D2-D2' in welding parts (positions where the welding marks 36 are formed) set substantially parallel to the perpendicular direction of the second surface 312 when viewed from the longitudinal direction of the metal foil 31 as shown in FIG. 8(a) and set substantially parallel to the perpendicular direction of the second surface 312 when viewed from the latitudinal direction of the metal foil 31 as shown in FIG. 8(b). In this embodiment, optical axis inclination angles $\beta 1$ and $\beta 2$ of the optical axes are, for example, 0°. This laser irradiation process is performed a plurality of times, in this embodiment, twice with a position of the laser irradiation changed. The two welding marks 36 are formed in the overlapping portion of the metal foil 31 and the electrode 32. The laser irradiating unit 93 can change an irradiation range of the laser to not only a circular shape but also an elliptical shape. The laser irradiating unit 93 irradiates the laser to the overlapping portion of the metal foil 31 and the electrode 32 from the second surface 312 side in an irradiation range in which the ratio L1/L2 of the welding marks 36 is in the relation of Expression 1 above.

[0031] The center lines B1-B1' and B2-B2' of the welding marks 36 may incline with respect to the perpendicular direction of the second surface 312. FIG. 9 is diagram showing another example of the electrode mount. For example, the shape in the cross sections of the welding marks 36 along the latitudinal direction of the metal foil 31 is, as shown in FIG. 9(a), a substantially triangular shape, the center lines B1-B1' and B2-B2' of which are respectively substantially perpendicular to the second surface 312. The shape in the cross sections of the welding marks 36 along the longitudinal direction of the metal foil 31 is, as shown in FIG. 9(b), a substantially triangular shape, the center lines B1-B1' and B2-B2' of which respectively inclined with respect to the perpendicular direction of the second surface 312. It is possible to improve joining strength compared with if the center lines B1-B1' and B2-B2' of the welding marks 36 are substantially parallel to the perpendicular direction of the second surface 312. The inclination angles $\alpha 1$ and $\alpha 2$ of the center lines are, for example, 35°. Note that, in order to further improve the joining strength, the inclination angles $\alpha 1$ and $\alpha 2$ are suitably 10° to 50°. The vertexes of the recesses 37 deviate in a direction opposite to a direction in which the welding marks 36 incline. If the welding marks 36 are formed with the center lines B1-B1' and B2-B2' inclining with respect to the perpendicular direction of the second surface 312, the laser is irradiated to be substantially orthogonal to the second surface 312 when viewed from the longitudinal direction of the metal foil 31 and incline with respect to the perpendicular direction of the second surface 312 when viewed from the latitudinal direction of the metal foil 31. The optical axis inclination angles $\beta 1$ and $\beta 2$ of the optical axes are, for example, 35°. Note that, in order to further improve the joining strength, the optical axis inclination angles $\beta 1$ and $\beta 2$ are suitably 10° to 50°. Note that, if the irradiation range of the laser by the laser irradiating unit 93 is circular, the ratio L1/L2 of the welding marks 36 changes according to inclination degrees of the optical axes D1-D1' and D2-D2' in the welding parts with respect to the perpendicular direction of the second surface 312. Therefore, the optical axes D1-D1' and D2-D2' in the processing parts are determined such that the ratio L1/L2 is in the relation of Expression 1 above.

[0032] In this way, by obliquely irradiating the laser on the overlapping portion of the metal foil 31 and the electrode 32, the shape of the welding marks 36 viewed from the second surface 312 side is the elliptical shape. Therefore, the size of the welding marks 36 increases compared with circular welding marks formed if the laser is perpendicularly irradiated on the second surface 312 (the conventional method). If the size increases, a contact area of the electrode 32 and the welding mark 36 increases. Therefore, it is possible to increase the joining strength of the metal foil 31 and the electrode 32.

[0033] Note that, if it is desired to increase the joining strength of the metal foil 31 and the electrode 32 with the conventional method, in general, a method of increasing the power of the laser is used. In the case of this method, damage to the electrode increases to cause crystal coarsening and fragility of the electrode. It is likely that an electrode break due to excessively large height h of the welding marks 36 inside the electrode 32 occurs. There is also a method of increasing an irradiation diameter of the laser. However, since a usable irradiation diameter of the laser depends on the diameter of the electrode, the irradiation diameter of the laser cannot be increased in some case. On the other hand, with the method in this embodiment, it is possible to increase the joining strength of the metal foil 31 and the electrode 32 while suppressing the occurrence of the problems explained above without increasing the power of the laser.

[0034] In the first embodiment, the laser is irradiated on the overlapping portion of the metal foil 31 and the electrode 32 from the second surface 312 side in the state in which the laser is inclined with respect to the perpendicular direction of the second surface 312 to weld the metal foil 31 and the electrode 32. Consequently, it is possible to form, in the overlapping portion, the welding marks 36, the shape of which when viewed from the second surface 312 side is the elliptical shape and the center lines B1-B1' and B2-B2' of which incline with respect to the perpendicular direction of the second surface 312. Therefore, it is possible to increase the joining strength of the metal foil 31 and the electrode 32 without increasing the power of the laser.

[0035] The present invention is not limited to the embodiment. Various modifications are possible.

[0036] For example, the material of the metal foil 31 is not limited to molybdenum. The effect of the present invention can also be obtained if the metal foil 31 is formed of rhenium molybdenum, tungsten, rhenium tungsten, and the like. The material is not particularly limited. A thin film or a layer may be formed on the surface of the material.

[0037] The shape of the electrode 32 may be a stepped shape, the diameter of the distal end of which is larger than the diameter of the proximal end, a shape, the distal end of which is a spherical shape having size of the diameter, and a shape, one electrode diameter and the other electrode diameter of which are different. The electrode material may be, for example, pure tungsten, doped tungsten obtained by doping a very small amount of aluminum, silicon, or potassium in tungsten, or rhenium tungsten obtained by doping rhenium in tungsten.

[0038] FIG. 10 is diagram showing another example of the electrode mount. The shape in the cross sections of the welding marks 36 along the latitudinal direction of the metal foil 31 may be, as shown in FIG. 10(a), a shape, the center lines B1-B1' and B2-B2' of which respectively incline with respect to the perpendicular direction of the second surface 312. As shown in FIG. 10(b), the shape in a cross section of a welding mark 361 along the longitudinal direction of the metal foil 31 may be a shape, the center line B1-B1' of which inclines to the light-emitting section 11 side with respect to the perpendicular direction of the second surface 312. The shape in a cross section of a welding mark 362 along the longitudinal direction of the metal foil 31 may be a shape, the center line B2-B2' of which inclines to the lead wire 34 side with respect to the perpendicular direction of the second surface 312. In these shapes, since the welding marks 361 and 362 hold the electrode 32, it is possible to further suppress the disjoining.

[0039] The shape in the cross sections of the welding marks 36 along the latitudinal direction of the metal foil 31 may be a shape, the center lines B1-B1' and B2-B2' of which respectively incline to cross across the perpendicular direction of the second surface 312. In the shape in the cross sections of the welding marks 36 along the longitudinal direction of the metal foil 31, the inclination angles $\alpha 1$ and $\alpha 2$ may be different.

[0040] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

Reference Signs List

[0041]

1	inner tube
11	light-emitting section
12	seal section
3	electrode mount
31	metal foil
32	electrode
36	welding mark

Claims

1. A discharge lamp comprising:

a light-emitting section including a discharge space in which metal halide is encapsulated;
a seal section formed at an end portion of the light-emitting section; and
an electrode mount including a metal foil including first and second surfaces located on a front

and a back and an electrode connected to the metal foil, wherein
a welding mark is formed such that the first surface and at least a part of the electrode overlap each other,
the welding mark has an elliptical shape long in an axial direction of the electrode when viewed from the second surface side, and
a ratio L1/L2 of a first length L1 in the axial direction and a second length L2 in a direction orthogonal to the axial direction is in a relation of Expression (1) below.

$$1.08 \leq L1/L2 \leq 1.56 \qquad (1)$$

2. The lamp according to claim 1, wherein
a ratio L2/W between the second length L2 and a diameter W of the electrode is in a relation of Expression (2) below.

$$0.3 \leq L2/W \leq 0.9 \qquad (2)$$

3. The lamp according to claim 1, wherein a diameter W of the electrode is 0.2 mm to 0.4 mm.

4. The lamp according to claim 1, wherein the welding mark is formed to extend from the metal foil side to an inside of the electrode and a center line of the welding mark inclines with respect to a perpendicular direction of the second surface.

5. A manufacturing method for a discharge lamp including:

a light-emitting section including a discharge space in which metal halide is encapsulated;
a seal section formed at an end portion of the light-emitting section; and
an electrode mount including a metal foil including first and second surfaces located on a front and a back and an electrode connected to the metal foil,
the manufacturing method comprising arranging the metal foil and the electrode such that the first surface and at least a part of the electrode overlap each other and thereafter irradiating a laser on an overlapping portion of the first surface and the electrode from the second surface side along an optical axis inclined with respect to a perpendicular direction of the metal foil and welding the metal foil and the electrode to form a welding mark, a ratio L1/L2 of a first length L1 in an axial direction of the electrode and a second length L2 in a direction orthogonal to the axial direction of which is in a relation of Expression (3) below.

$$1.08 \leq L1/L2 \leq 1.56 \qquad (3)$$

FIG.1

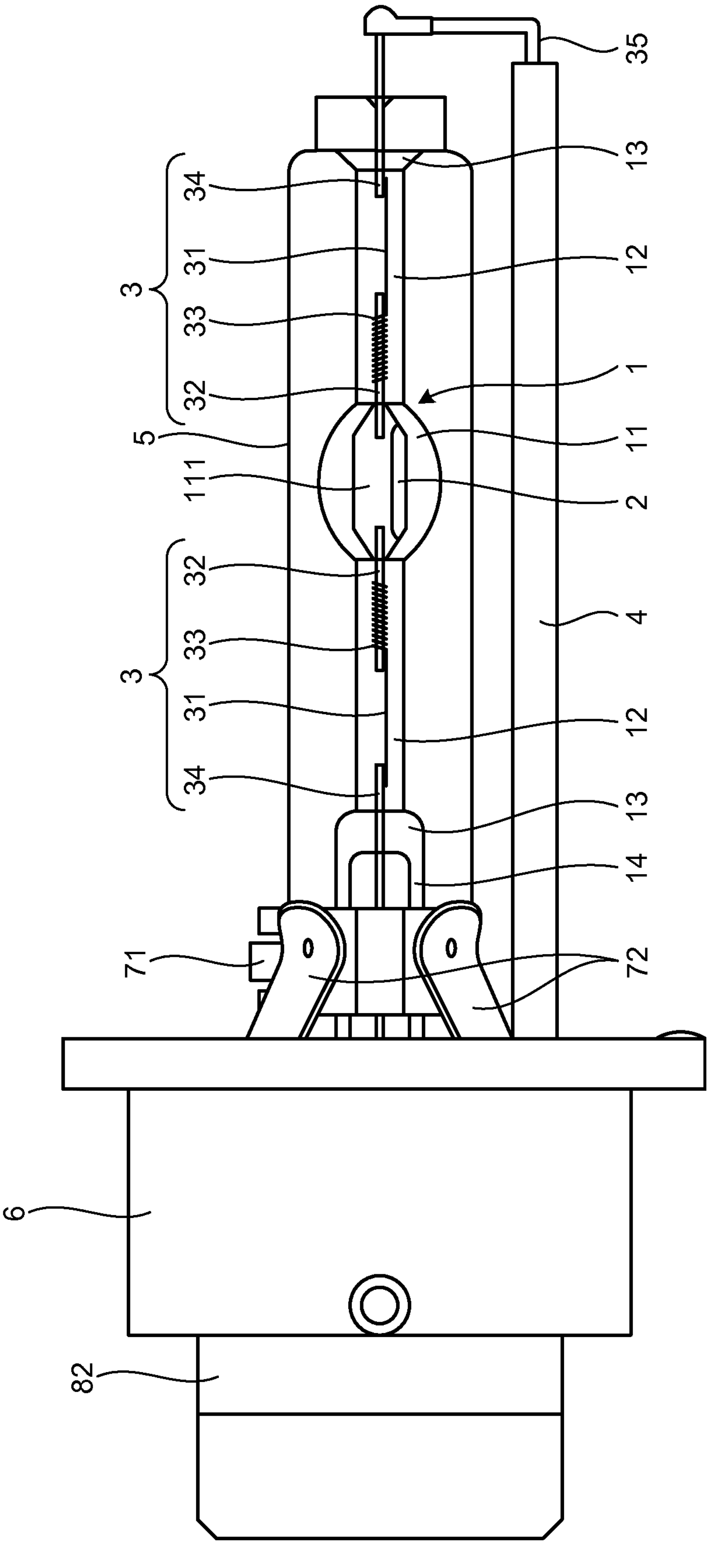


FIG.2

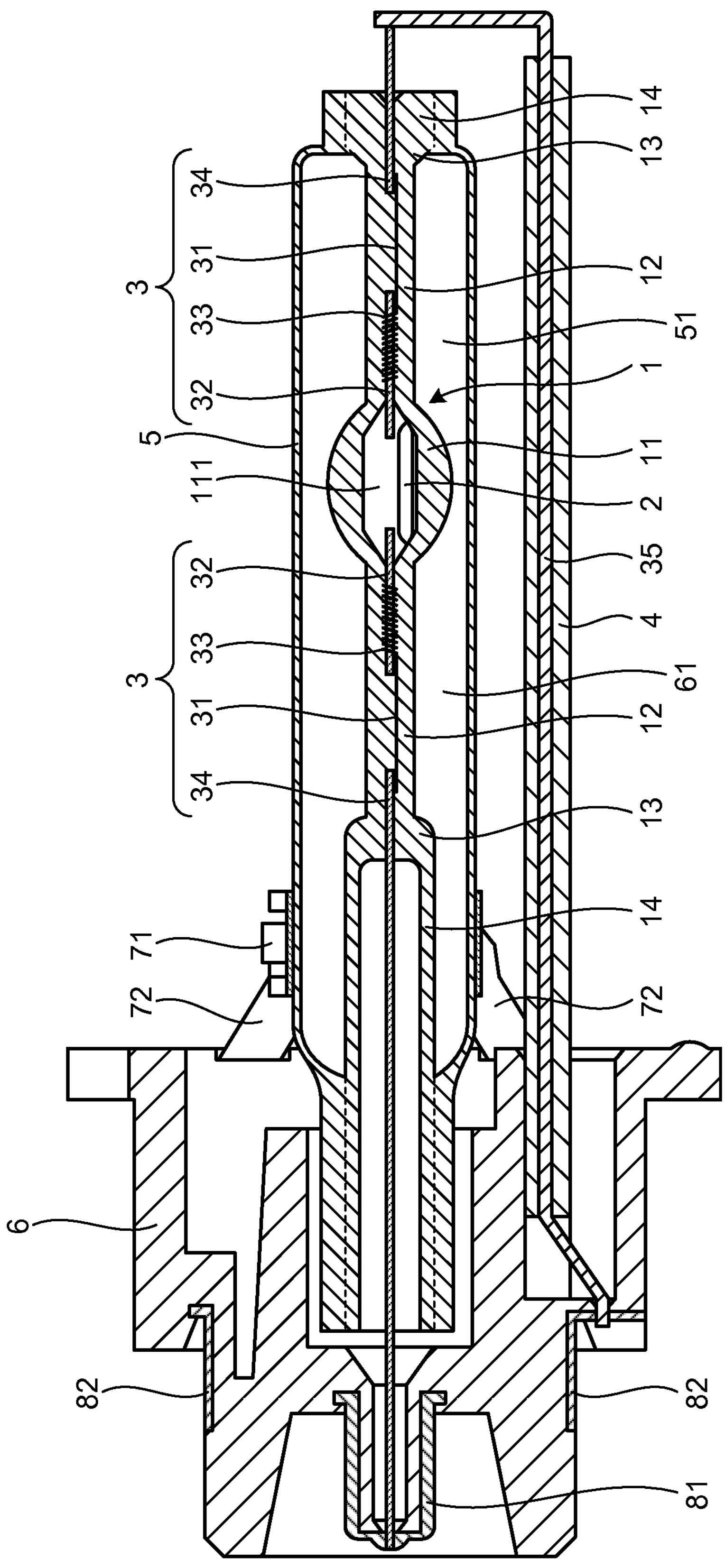


FIG.3

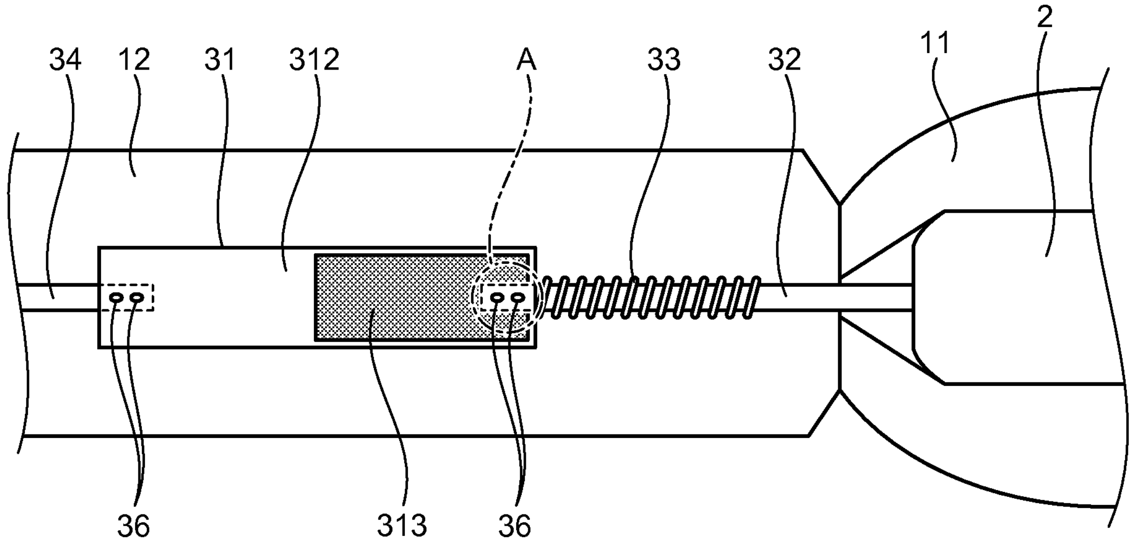


FIG.4

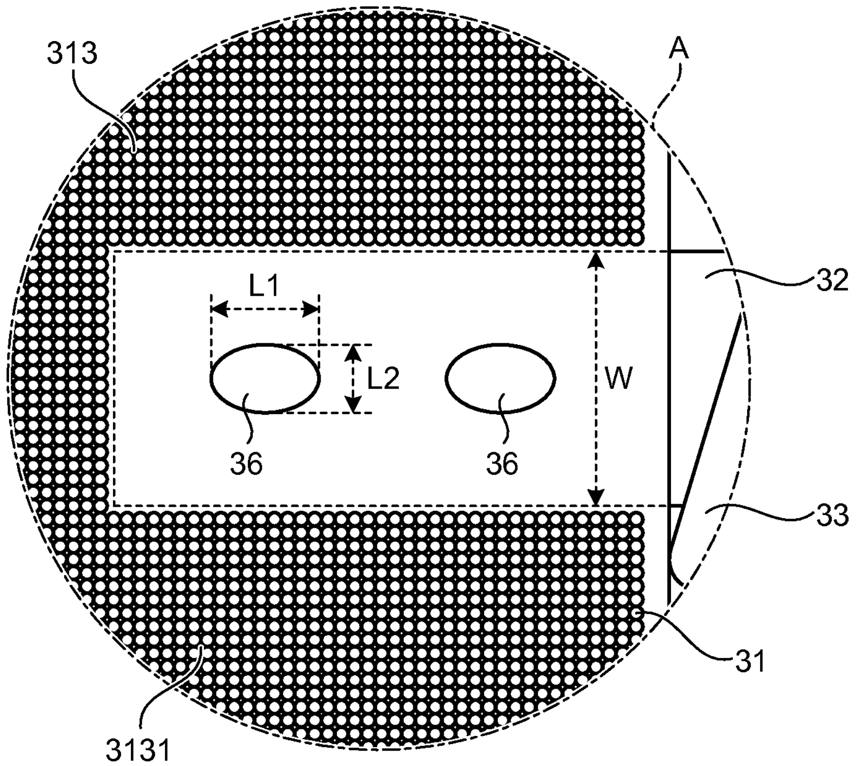


FIG.5

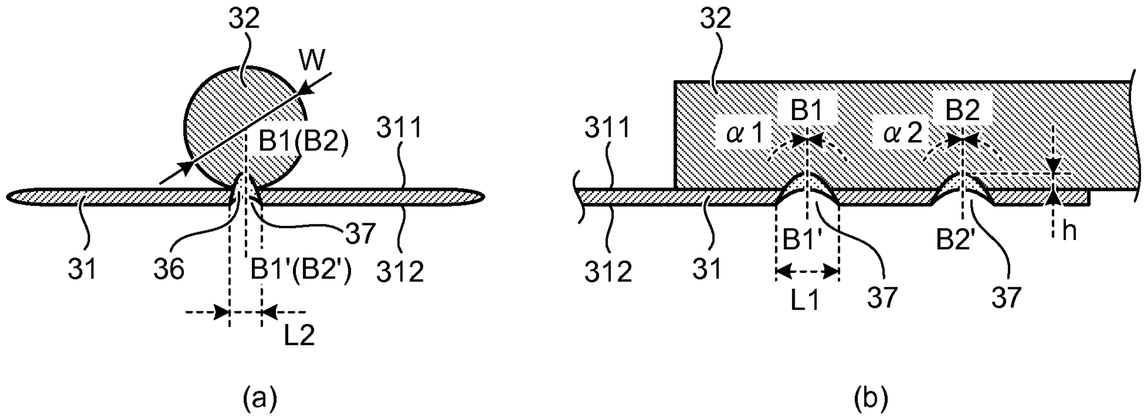

32
W
B1(B2)
311
31
36
B1'(B2')
37
312
L2
(a)
32
311
α1
B1
α2
B2
312
31
B1'
L1
37
B2'
37
h
(b)

FIG.6

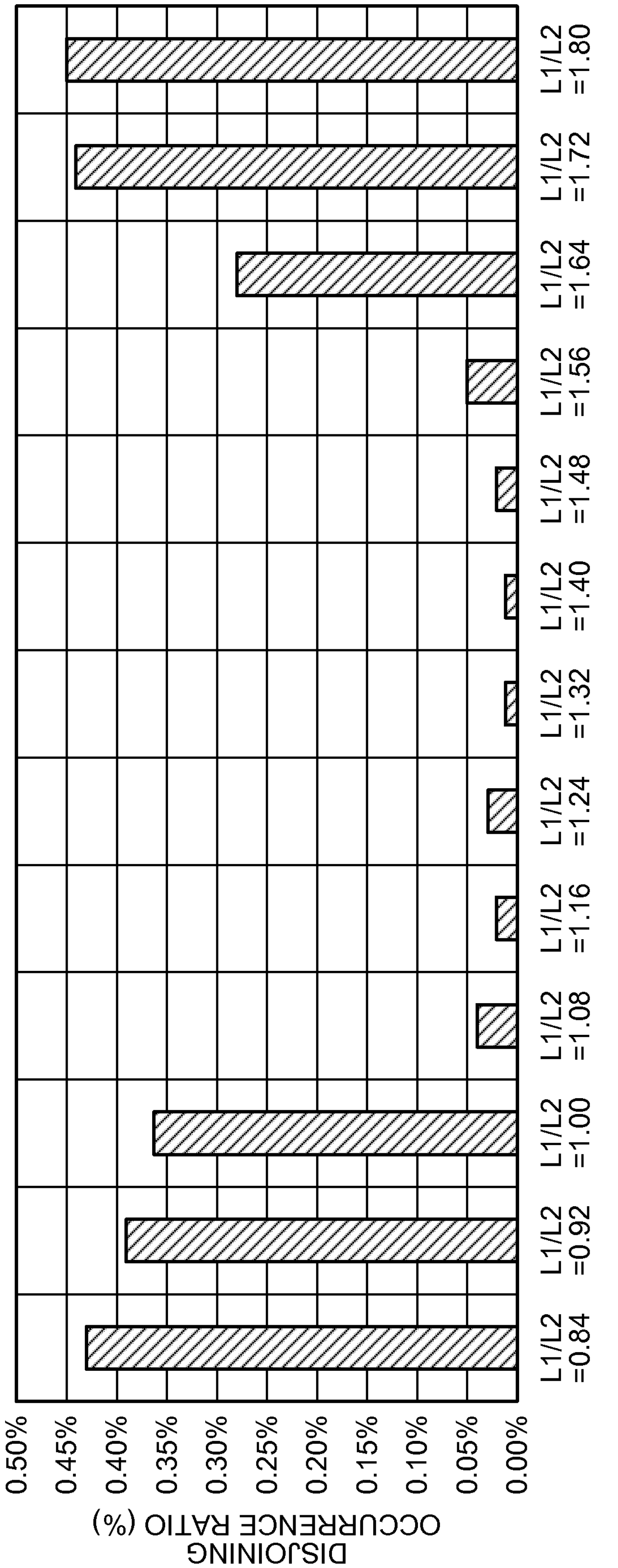

DISJOINING OCCURRENCE RATIO (%)
0.50%
0.45%
0.40%
0.35%
0.30%
0.25%
0.20%
0.15%
0.10%
0.05%
0.00%
L1/L2 =0.84
L1/L2 =0.92
L1/L2 =1.00
L1/L2 =1.08
L1/L2 =1.16
L1/L2 =1.24
L1/L2 =1.32
L1/L2 =1.40
L1/L2 =1.48
L1/L2 =1.56
L1/L2 =1.64
L1/L2 =1.72
L1/L2 =1.80

FIG.7

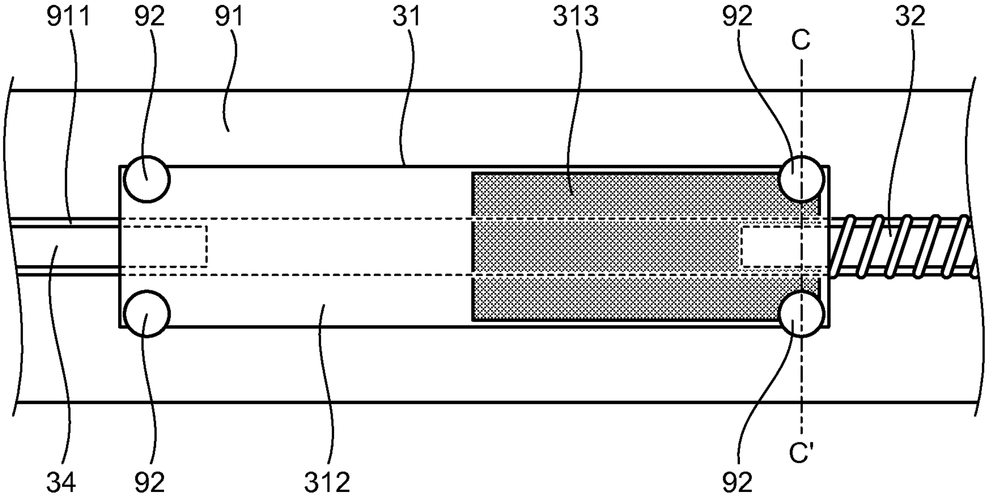

911
92
91
31
313
92
C
32
34
92
312
92
C'

FIG.8

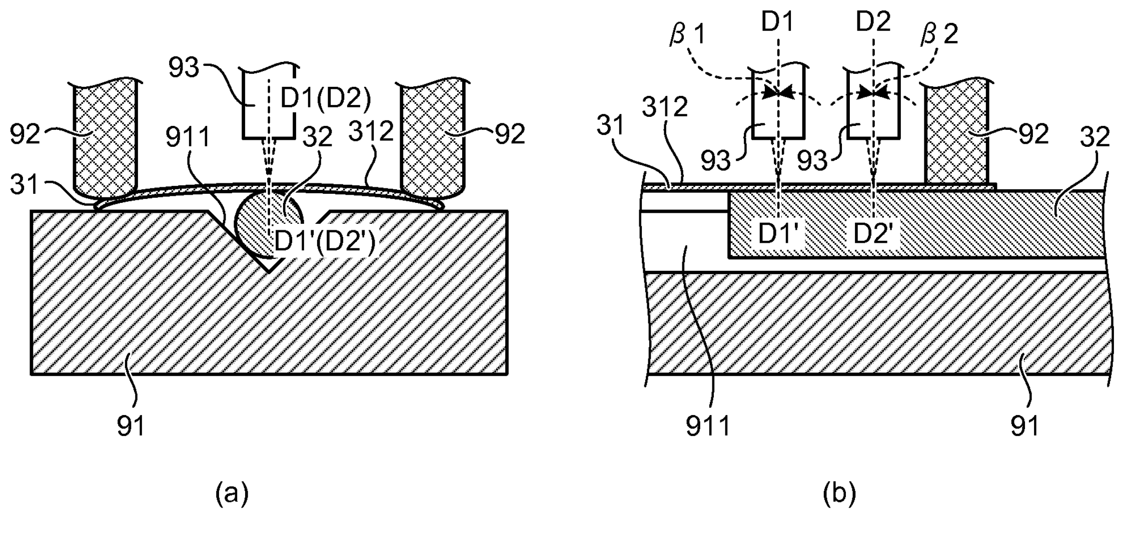
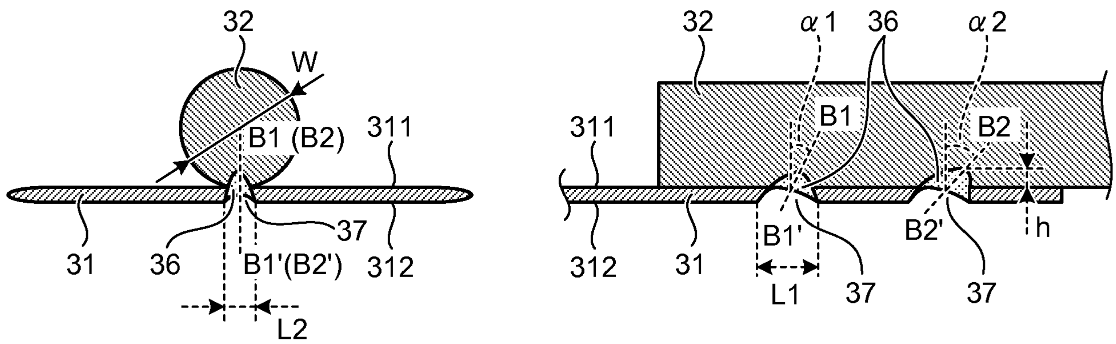
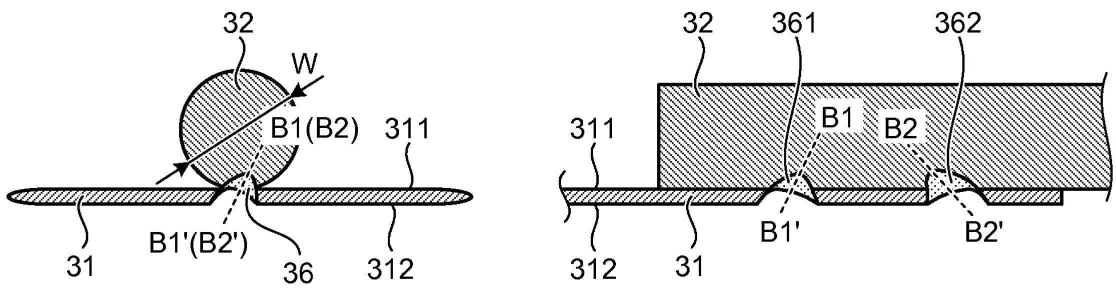

93
D1(D2)
92
911
32
312
92
31
D1'(D2')
91
(a)
β1
D1
D2
β2
31
312
93
93
92
32
D1'
D2'
911
91
(b)

FIG.9



(a) (b)

FIG.10



(a) (b)

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2013/071730

A. CLASSIFICATION OF SUBJECT MATTER
H01J61/36(2006.01)i, *H01J9/28*(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)
H01J61/36, H01J9/28, B23K26/00

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	1996-2013
Kokai Jitsuyo Shinan Koho	1971-2013	Toroku Jitsuyo Shinan Koho	1994-2013

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.
Y	WO 2009/075121 A1 (Harison Toshiba Lighting Corp.), 18 June 2009 (18.06.2009), paragraphs [0010] to [0035]; fig. 1 to 4 & JP 4972172 B & US 2010/0270921 A1 & EP 2221851 A1	1-5
Y	JP 6-190575 A (Mitsui Petrochemical Industries, Ltd.), 12 July 1994 (12.07.1994), claims 1 to 3; paragraphs [0027], [0039]; fig. 1 & US 5624585 A & EP 594210 A1 & DE 69316148 C & CA 2108761 A1	1-5

☒ 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
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"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
"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
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 August, 2013 (21.08.13)	03 September, 2013 (03.09.13)

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/JP2013/071730

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 2006-196267 A (Harison Toshiba Lighting Corp.), 27 July 2006 (27.07.2006), entire text; all drawings (Family: none)	1-5
A	WO 2008/129745 A1 (Harison Toshiba Lighting Corp.), 30 October 2008 (30.10.2008), entire text; all drawings & JP 4681668 B & US 2010/0109528 A1 & EP 2141731 A1 & AT 517429 T	1-5

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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2012084454 A **[0003]**
- JP 4972172 B **[0003]**
- JP 4494224 B **[0003]**
- JP 2005349477 A **[0003]**
- JP 2004363014 A **[0003]**