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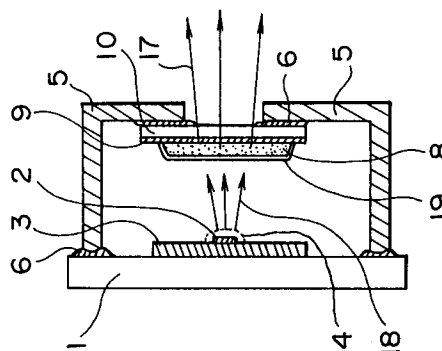
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W-8000 München 40(DE)(54) **LIGHT PROJECTING DEVICE.**

(57) A light projecting device in which cathode luminescence of a high luminance can occur even when current of a high current density is applied. In this device, an electron emission material (2), which is coated with a layer (14) capable of emitting secondary electrons, is formed on a base (1) via an insulation base (3). At the opposed position to the electron emission material (2), provided is a fluorescent material layer (8), which a secondary electron beam (18) emitted from the layer (14) strikes.

**FIG. 3****EP 0 526 663 A1**

TECHNICAL FIELD

The present invention relates to a light irradiation apparatus which uses a cathode luminescence phenomenon to emit light.

BACKGROUND ART

In a conventional light irradiation apparatus, as an electron emitter in vacuum, a filament such as a tungsten wire is simply provided on an insulated base. The filament is energized to emit thermoelectrons, which are accelerated in an electric field. The accelerated electrons are controlled by using a grid electrode suspended coilwise in a space within the light irradiation apparatus so that the electrons impinge upon a fluorescent layer coated with a powdered fluorescent member to emit light. The electrons are passed through a transparent light-transmissible plate on which the fluorescent layer is provided.

PROBLEM TO BE SOLVED BY THE INVENTION

However, the aforementioned light irradiation apparatus has technical disadvantages as follows:

(1) When a light irradiation apparatus as a high brightness light source is intended to be obtained, it is necessary to flow a high density current into an electron emitter. The service life of the electron emitter is thus extremely shortened.

(2) When an elongated light source or a light source having a large irradiation area is intended to be configured, a filament as a thermoelectron emitter need be lengthened. It is very difficult to support the filament, and the filament becomes weakened against the mechanical vibration. Moreover, an electric resistance of a filament has to be made higher and uniform in order to efficiently generate the thermoelectrons. This makes it very difficult to work and form the filament.

(3) In order to make a radiation distribution of electrons constant, it is necessary to change an installation density of a grid as a control electrode to hold it in a state suspended in space or to install a separate electrode for controlling the electrons. This makes the apparatus complicated, and assembling thereof becomes difficult.

(4) When an elongated light source or a light source having a large irradiation area is intended to be configured, a filament as an electron emitter need be lengthened, and the filament becomes weakened against the mechanical vibration so that the filament is broken to disable replacement. The service life of the apparatus is shortened.

(5) An electron emitter causes its installation means to be heated when thermoelectrons are emitted due to energization, heat generation and the like. Therefore, the installation means is thermally expanded, and a tearing-off stress is applied to the electron emitter so that the latter is locally narrowed or tends to be mechanically broken. The locally narrowed portion is excessive in current density, resulting in an uneven heat generation and a fusion.

(6) Since a simple plate-like member is used as a means for installing an electron emitter, even if the electron emitter is energized and heat-generated, it tends to be cooled by a heat conductor, failing to efficiently emit thermoelectrons.

(7) Since a grid electrode for controlling electrons is mounted to be suspended in the air, the grid electrode is unstable so that it is not only weak in mechanical vibration and shock but also difficult to be assembled.

(8) Since a control voltage of electrons and other control conditions are varied according to an installation place of a grid, the installation step of the grid is difficult when the light irradiation apparatus is assembled.

(9) An electron current impinging on a fluorescent material is influenced by the shape of a light irradiation apparatus. It is difficult to irradiate electrons against a fluorescent layer so as to provide an ideal distribution.

(10) When a fluorescent layer is formed by a means such as coating, a gap is formed between fluorescent particles which constitute a fluorescent layer. Even if an acceleration electric field is applied to the fluorescent layer, an energy loss caused by a local discharge is generated at the gap portion between the fluorescent particles, due to a low dielectric constant of the gap portion, to degrade an external luminous efficiency or to damage the fluorescent particles.

(11) When a fluorescent layer is formed, there is a gap between fluorescent particles which constitute the fluorescent layer. A light emitted within the fluorescent particles becomes internally reflected at the particle surface so that the light is hard to move into the gap portion, thus degrading the external luminous efficiency.

(12) A fluorescent material is generally high in refractive index, and light emitted from the fluorescent material repeats partial total reflection and becomes damped at an interface between a fluorescent layer or a light transmissible plate and air to degrade the external luminous efficiency.

(13) Since a heat conductivity of a fluorescent material is generally low, heat generated when electrons are accelerated by use of an electric

field to be impinged is hard to be transmitted to others. Therefore, a temperature of the fluorescent material rises during the light irradiation to lower a luminous characteristic and a reliability of a service life.

Furthermore, when the whole heat radiation is well conducted, a temperature of a thermoelectron emitter is lowered, and a thermoelectron emission amount is reduced to lower a luminous amount.

(14) Light emitted externally through a light transmissible plate is diffused at a wide angle to lower an intensity of illumination on the irradiation surface.

(15) In order to prevent a degree of vacuum from being lowered as a result of generation of evaporated gases from other materials immediately after the manufacture of apparatus or after energization for a desired period of time, a gas capturing agent is provided interiorly of the apparatus and condensed at other portions which are at a low temperature immediately after being heated and evaporated by a heater, and at the same time, residual gases are introduced to enhance a degree of vacuum in the apparatus. However, unrequited portions are to be heated for a long period of time when the gas capturing agent is heated, due to a thermal conduction of materials which constitute the apparatus, and the apparatus is often damaged.

(16) In case of performing a high brightness emission, it is necessary to increased a density of electrons to be irradiated against a fluorescent layer, giving rise to a thermal degradation of the fluorescent layer and a damage such as spattering caused by an electron current.

DISCLOSURE OF THE INVENTION

It is an object of the present invention to provide a light irradiation apparatus which is long in service life, well withstands mechanical vibrations, and is operated in a stable manner even when energization of high current density is applied.

It is a further object of the present invention to provide a light irradiation apparatus which can irradiate thermoelectrons against a fluorescent layer in a desired distribution.

It is another object of the present invention to provide a light irradiation apparatus which can efficiently take out luminous light from a fluorescent layer.

For achieving the aforesaid objects, the present invention provides a light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, and a fluorescent member on which said emitted thermoelectrons impinge to emit light, wherein said electron emitter includes a boron lanthanum compound.

The present invention further provides a light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, and a fluorescent member on which said emitted thermoelectrons impinge to emit light, wherein said electron emitter includes at least one out of tantalum compounds of tungsten, tantalum, molybdenum, tantalum chromates, ruthenium oxide and silicone oxide.

The present invention further provides a light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, and a fluorescent member on which said emitted thermoelectrons impinge to emit light, wherein said electron emitter includes a material in which an electric resistance value indicated when energized is different according to portions of the material.

The present invention further provides a light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, and a fluorescent member on which said emitted thermoelectrons impinge to emit light, wherein said electron emitter includes a plurality of electron emitting members, the apparatus comprising energizing means of the same number as that of said electron emitting members to energize said electron emitting members, said plurality of electron emitting members being successively energized by said energizing means to emit thermoelectrons.

The present invention further provides a light irradiation apparatus comprising an electron emitter which includes a material having a predetermined coefficient of thermal expansion and is heated by energization to emit thermoelectrons, and a fluorescent member on which said emitted thermoelectron impinge to emit light, the apparatus comprising an installation member which includes a material having a smaller coefficient of thermal expansion than the predetermined coefficient of the material included in said electron emitter and installs said electron emitter within said apparatus.

The present invention further provides a light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, a fluorescent member on which said emitted thermoelectrons impinge to emit light, and a control electrode applied with a predetermined voltage to control a movement of said emitted thermoelectrons, the apparatus comprising installation means which has a groove and installs said control electrode within said apparatus, said electron emitter being accommodated in said groove.

The present invention further provides a light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, a fluorescent member on which said emitted thermoelectrons impinge to emit light, and a control electrode applied with a predetermined voltage to

control a movement of said emitted thermoelectrons, wherein said control electrode has a slit through which said emitted thermoelectrons pass to converge said thermoelectrons in a direction of said fluorescent material.

The present invention further provides a light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, and a fluorescent member on which said emitted thermoelectrons impinge to emit light, the apparatus comprising a magnet which generates a magnetic field, said emitted thermoelectrons being converged in a direction of said fluorescent material by said magnetic field.

The present invention further provides a light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, and a fluorescent member on which said emitted thermoelectrons impinge to emit light, the apparatus comprising a controller secured to said fluorescent member to control a speed at which said emitted thermoelectrons impinge on said fluorescent member.

The present invention further provides a light irradiation apparatus comprising an electron emitter heated by energization to emit light, and a fluorescent member including a fluorescent material having a predetermined refractive index on which said emitted thermoelectrons impinge to emit light, wherein said fluorescent member further includes a material having a refractive index which is smaller than that of said fluorescent material but larger than 1.

The present invention further provides a light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, and a fluorescent member having a predetermined first refractive index and including a fluorescent material having a predetermined second refractive index on which said emitter thermoelectrons impinge to emit light wherein said fluorescent member further includes a material having a refractive index which is larger than said first refractive index but smaller than said second refractive index and is larger than 1.

The present invention further provides a light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, and a fluorescent member including a fluorescent material having a predetermined first heat conductivity on which said emitted thermoelectrons impinge to emit light, the apparatus comprising a first installation member including a material having a predetermined second heat conductivity and for installing said electron emitter within said apparatus and a second installation member including a material having a predetermined third heat conductivity and for installing said fluorescent member within

said apparatus, said second heat conductivity being smaller than said first heat conductivity or said third heat conductivity.

The present invention further provides a light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, a fluorescent member on which said emitted thermoelectrons impinge to emit light, and a light transmissible plate for taking out said emitted light, the apparatus comprising a condenser provided integral with said light transmissible plate to converge said emitted light in a predetermined external direction.

The present invention further provides a gas capturing method for heating a gas capturing agent to capture gases generated in a light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, and a fluorescent member on which said emitted thermoelectrons impinge to emit light, the method comprising the steps of arranging said gas capturing agent at a part farthest from said electron emitter and said fluorescent member interiorly of said light irradiation apparatus, and irradiating an excimer laser beam against said gas capturing agent from the outside of said light irradiation apparatus to heat said gas capturing agent.

The present invention further provides light irradiation apparatus comprising plural sets each consisting of an electron emitter heated by energization to emit thermoelectrons and a fluorescent member on which said emitted thermoelectrons impinge to emit light, the apparatus comprising a light mixer for mixing lights emitted from said sets of fluorescent members to emit said mixture outside said apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a principal structure of a first embodiment according to the present invention;
 FIG. 2 shows a partial sectional view for explaining the principal structure of the first embodiment according to the present invention;
 FIG. 3 shows a sectional view of a principal structural portion for explaining the operation of the first embodiment according to the present invention;
 FIG. 4 shows an electron emitter used in a second embodiment according to the present invention;
 FIG. 5 shows one modified example of the electron emitter used in the second embodiment according to the present invention;
 FIG. 6 shows one modified example of the electron emitter used in the second embodiment according to the present invention;
 FIG. 7 shows one modified example of the elec-

tron emitter used in the second embodiment according to the present invention;

FIG. 8 shows one modified example of the electron emitter used in the second embodiment according to the present invention;

FIG. 9 shows one modified example of the electron emitter used in the second embodiment according to the present invention;

FIG. 10 shows a principal structure of a third embodiment according to the present invention;

FIG. 11 shows a partial sectional view for explaining the principal structure of the third embodiment according to the present invention;

FIG. 12 shows a sectional view of a principal structural portion for explaining the operation of a fourth embodiment according to the present invention;

FIG. 13 shows a sectional view of a principal structural portion showing one modified example of the fourth embodiment according to the present invention;

FIG. 14 shows a sectional view of the principal structural portion showing one modified example of the fourth embodiment according to the present invention;

FIG. 15 shows one example of an electron emitter used in the fourth embodiment according to the present invention;

FIG. 16 shows an installed state of the electron emitter used in the fourth embodiment according to the present invention;

FIG. 17 shows a principal structure of a fifth embodiment according to the present invention;

FIG. 18 shows a partial sectional view for explaining the principal structure of the fifth embodiment according to the present invention;

FIG. 19 shows a sectional view of a principal structural portion for explaining the operation of the fifth embodiment according to the present invention;

FIG. 20 shows a view showing a principal structure of a sixth embodiment according to the present invention;

FIG. 21 shows a partial sectional view for explaining the principal structure of the sixth embodiment according to the present invention;

FIG. 22 shows a sectional view of a principal structural portion showing an installed state of a control electrode relating to the sixth embodiment according to the present invention;

FIG. 23 shows an installed state of one example of a control electrode relating to the sixth embodiment according to the present invention,

FIG. 24 shows a luminous distribution in the case where the control electrode shown in FIG. 23 is used;

FIG. 25 shows a luminous distribution in the case where the control electrode relating to the

sixth embodiment according to the present invention is used;

FIG. 26 shows a sectional view of a principal structural portion showing one example of a control electrode used in the sixth embodiment according to the present invention;

FIG. 27 shows a sectional view of a principal structural portion showing a further example of a control electrode used in the sixth embodiment according to the present invention;

FIG. 28 shows a view showing a principal structure of a seventh embodiment according to the present invention.

FIG. 29 shows a partial sectional view for explaining the principal structure of the seventh embodiment according to the present invention;

FIG. 30 shows a sectional view of a principal structural portion for explaining the operation of the seventh embodiment according to the present invention;

FIG. 31 shows the characteristic of control voltage-to-brightness in the seventh embodiment according to the present invention;

FIG. 32 shows a sectional view of a principal structural portion for explaining the operation of an eighth embodiment according to the present invention;

FIG. 33 shows a sectional view of the principal structural portion for further explaining the operation of the eighth embodiment according to the present invention;

FIG. 34 shows in an enlarged scale a positional relationship between an electron emitter and a slit hole in FIG. 33;

FIG. 35 shows a sectional view of a principal structural portion showing an installed state of a control electrode relating to the eighth embodiment according to the present invention;

FIG. 36 shows a view showing one example of a control electrode relating to the eighth embodiment according to the present invention;

FIG. 37 shows a view showing a principal structure of a ninth embodiment according to the present invention;

FIG. 38 shows a sectional view of a principal structural portion for explaining the operation of the ninth embodiment according to the present invention;

FIG. 39 shows a luminous distribution in the case where a control voltage in the ninth embodiment of the present invention is 0 (zero);

FIG. 40 shows a luminous distribution in the case where a control voltage in the ninth embodiment according to the present invention is applied;

FIG. 41 shows a sectional view of a principal structural portion for explaining the operation of a tenth embodiment according to the present

invention;

FIG. 42 shows a partial sectional view showing one example of a fluorescent layer relating to the tenth embodiment according to the present invention;

FIG. 43 shows a sectional view of a principal structural portion for explaining the operation of an eleventh embodiment according to the present invention;

FIG. 44 shows a sectional view of a principal structural portion for explaining the operation of a twelfth embodiment according to the present invention;

FIG. 45 shows a view showing a principal structure of a thirteenth embodiment according to the present invention; and

FIG. 46 shows a sectional view of a principal structural portion for explaining the operation of the thirteenth embodiment according to the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

First, a first embodiment of a light irradiation apparatus according to the present invention will be described. As shown in FIG. 1 and FIG. 2, an electron emitter 2 for emitting thermoelectrons and an insulated board 3 for installing the emitter 2 are installed on a base 1. The electron emitter 2 is connected to heater electrodes 4 and 41.

A casing 5 is sealed on the base 1 by fusion using a sealing material 6 as shown in FIG. 1. The casing 5 is formed with a window 7 for taking out light. A light transmissible plate 10 is fused and sealed on the window 7 by a material equal to the sealing material 6 as shown in FIG. 2. The light transmissible plate 10 is formed thereon with a transparent electrode 9, on which is formed a fluorescent layer 8. The fusion between the casing 5 and the base 1 is carried out under vacuum, and the interior of the casing 5 is held in vacuum so as to have a pressure less than 0.001 Pa even after fusion.

The casing 5 is formed with a hole 11 as shown in FIG. 1, in which is installed a high voltage electrode 13 so that a degree of vacuum and an insulating property therein are maintained by a sealing material 12. The high voltage electrode 13 is electrically connected to the transparent electrode 9 under vacuum interiorly of the casing 5. The electron emitter 2 is formed to have a small sectional area so that when the emitter 2 is energized and heat-generated, a temperature easily rises. It is constructed such that a secondary electron emitting layer 14 is coated on an external surface of the electron emitter 2 to enable emission of secondary electrons several times of ther-

moelectrons emitted by energization and heat generation.

The operation of the present invention will be roughly described hereinafter.

A heater source 15 is connected to the heater electrodes 4 and 41 as shown in FIG. 1, and the electron emitter 2 shown in FIG. 2 is energized with a predetermined current to emit thermoelectrons. Thereby, a large amount of secondary electrons are emitted from the secondary electron emitting layer 14. Upon arrival at a thermal equilibrium, a high voltage of 100 V to 20 kV is applied between the heater electrode 4 and the high voltage electrode 13 using a high voltage source 16 so that the high voltage 13 side is an anode. Thereby, the secondary electrons are accelerated by the electric field to impinge on the fluorescent layer 8, and a cathode luminescence emission occurs. This emission is emitted as a light 17 to be taken out.

The operation related to the present invention will be described in detail with reference to FIG. 3.

A large amount of secondary electron beams 18 emitted out of the secondary electron emitting layer 14 are accelerated in a direction of the fluorescent layer 8 in accordance with an electric field formed by a high voltage applied between the electron emitter 2 and the transparent electrode 9 and impinge on the fluorescent layer 8.

The fluorescent layer 8 is formed on the surface thereof with an antistatic electrode 19 formed of a conductive or non-conductive material as shown in FIG. 3 to be even or uneven in thickness between 0.005 μm and 2 μm , which is electrically connected to the transparent electrode 9 to prevent a charge from being stayed on the surface of the fluorescent layer 8. Thereby, it is possible to reduce a distortion of a spatial electric field caused by the staying of a charge on the surface of the fluorescent layer 8 and a local unevenness of an intensity of an electric field. Accordingly, the secondary electron beams 18 can be accelerated and impinged uniformly in a direction of the fluorescent layer 8, and uniform emission can be made. Furthermore, it is possible to prevent organic gases or the like which are present in an internal space formed by the casing 5 and the base 1 from being baked on the surface of the fluorescent layer 8.

The casing 5 is formed of a metal which has an excellent thermal conductivity and a small coefficient of gas transmission, ceramics such as alumina or glass. The sealing material 6 is formed of a glass having a low melting point or an alloy having a low melting point, the sealing material 6 being heated and fused at a temperature in the range of 130° C to 900° C to effect sealing.

The electron emitter 2 is formed of merely a boron lanthanum compound which is a high melting point and high resistance material or a com-

5 bination of said boron lanthanum compound and a 6 boron material of lanthanids family rare earth elements or a combination of said boron lanthanum compound and a heat insulating and heat resistance ceramics. These materials have their service life ten times or more of metal such as a tungsten used for an electron emitter of a normal light irradiation apparatus when the same high current density energization is carried out. Accordingly, even if the light irradiation apparatus is similarly constructed and used while emitting light with high brightness of ten times, the light irradiation apparatus according to the present invention has an extended service life and an improved reliability.

The electron emitter 2 may be formed of a 6 boron material of lanthanids family rare earth elements except erbium, thulium and lutetium.

The electron emitter 2 may be further formed of oxides such as tungsten, tantalum, molybdenum, chrome, tantalum oxide, ruthenium oxide, a tantalum compound of silicone oxide, etc. which are high melting point and high resistance materials. Further, graphite carbon, conductive diamond containing impurities and the like may be used. Carbide of titanium and silicon carbide, or other conductive ceramics which will be conductive at room temperature or high temperature may also be used.

The electron emitter 2 is formed by a thin film manufacturing method such as various vapor depositions, sputtering, printing, etc. or a combination of a thick film printing and baking. Moreover, a single or a plurality of fine small-diameter wires or foils may be used.

The electron emitter 2 may be worked into a desired dimension after being installed on the insulated board 3 or it may be installed on the insulated board 3 after being worked. This work can be easily done by cutting working, laser working, chemical or electrochemical polishing working or a combination of these or photolithography working.

An energizing current of the electron emitter 2 varies according to materials which constitute the electron emitter 2. However, energization was conducted in a range of 10^4 A to 10^9 A/cm² with respect to a section of the electron emitter 2 in a direction vertical to a passing direction of a current.

The greater the current density, the shorter the life of the electron emitter 2. However, the secondary electron beams 18 to be emitted increase, and accordingly, the intensity of the light 17 to be taken out also increases.

When the electron emitter 2 is formed so as to have a thickness of more than 0.1 μ m but less than 0.1 mm, emission of thermoelectrons suitable for the size of a light source could be efficiently carried out. More specifically, in the case where the electron emitter 2 is formed by use of a thin film

forming apparatus such as vapor deposition, sputtering, spin coating, CVD, etc., a thickness of the electron emitter is preferably more than 0.1 μ m but less than 50 μ m, and in the case where it is formed by printing using a conductive paste agent, a thickness of the electron emitter 2 is preferably more than 1 μ m but 0.1 mm or less. In the case where a thickness of the electron emitter is less than 0.01 μ m, an unevenness occurs in an electric resistance of the formed thin film electron emitter 2 due to an unevenness of the surface of the insulated board 3 on which the electron emitter 2 is installed, and a local fusion occurs as a result of energization, failing to obtain a stable emission. When the thickness exceeds 1 mm, it is necessary to excessively increase an energizing current and excessively narrow the width of the electron emitter 2, making it difficult to maintain the electron emitter 2 stably and at a high temperature and to perform fine working in the width direction of the electron emitter 2 with high precision.

A second embodiment of the light irradiation apparatus according to the present invention will be described hereinbelow. In the present embodiment, an electron emitter having a shape differentiated according to parts is provided in order to obtain a desired thermoelectron generation distribution.

In the light irradiation apparatus according to the present embodiment, constituent elements other than the electron emitter are similar to those of the first embodiment described in connection with FIG. 1, FIG. 2 and FIG. 3. Therefore a description and an illustration other than the electron emitter and the constituent elements for supporting the same will be omitted.

FIG. 4 shows a specific shape of an electron emitter 2a used in the present embodiment together with constituent elements for supporting the same. However, for better understanding, the secondary electron emitting layer 14 is omitted in FIG. 4.

FIG. 5 and FIG. 6 show a partial structural view depicting a modified example of a portion of an electron emitter relating to the present invention. In these modified examples, an electric resistance distribution is varied by varying a thickness distribution of electron emitters 2b and 2c formed of a material having a substantially even electric resistance. In FIG. 5, an upper surface of the electron emitter 2b is flat as shown, and in FIG. 6, a lower surface of the electron emitter 2c is flat. Both the constructions may be combined.

FIG. 7 shows a further modified example.

In the present example, electric resistance varying portions 201 each having an electric resistance varying portion one-sided so as to have a desired distribution are provided on opposite end portions of an electron emitter 2d. The electric

resistance varying portions 201 need not be provided on the opposite end portions. Furthermore, the portions 201 are not limited to two places but one will suffice if a desired distribution can be obtained, and alternatively, the portions 201 may be provided on many portions.

Methods for varying the electric resistance used include an adhesion of specific material, heating and beam irradiation such as electrons after adhesion, diffusion, melting and mixing of specific materials, formation of a third component, ion implantation, etc.

FIG. 8 shows another modified example.

In the present example, electron emitters 202, 203 and 204 formed of materials different in electric resistance are partly combined to provide a one-piece body.

FIG. 9 shows still another modified example.

In the present example, two electron emitters 205 and 206 are placed one over the other to provide a one-piece body so that the whole electric resistance distribution is set to a predetermined distribution. Electron emitters to be placed one over the other not necessarily have a different electric resistivity. More than two electron emitters may be used.

A third embodiment of the light irradiation apparatus according to the present invention will be described hereinbelow.

As shown in FIG. 10 and FIG. 11, an insulated board 3 on which a plurality of electron emitters 2 are installed is installed on a base 1, and the plurality of electron emitters 2 are electrically connected to a plurality of heater electrodes 4 and 41 installed corresponding thereto. The plurality of electron emitters 2 are formed to have a small sectional area of a surface vertical to a length direction so that the electron emitters are energized and heat-generated to easily increase their temperature. It is constructed so that a secondary electron emitting layer 14 is coated on an external surface of each of the electron emitters 2 to enable emission of secondary electrons several times of thermoelectrons emitted due to energization and heat generation.

while in the present embodiment, the secondary electron emitting layer 14 is provided singly continuous to the surfaces of the plurality of electron emitters 2, it is to be noted that the secondary electron emitting layers 14 may be separately provided corresponding to the plurality of electron emitters 2, respectively.

As shown in FIG. 10, a heater source 15 is connected to one set of heater electrodes 4 and 41 arranged in plural by a change-over switch 20. A one electron emitter 2 connected corresponding thereto is energized to emit thermoelectrons with a predetermined current. A cathode of a high voltage

power source 16 for applying a high voltage after arrival at thermal equilibrium is commonly connected to the plurality of heater electrodes 4.

While in the present embodiment, a thin film-like electron emitter 2 has been used, it is to be noted that a filament composed of a single or plural small diameter wires may be used as an electron emitter 2.

Other constituent elements and operation thereof in the present embodiment are similar to those of the first embodiment explained with reference to FIG. 1, FIG. 2 and FIG. 3, and a description thereof will be omitted.

A fourth embodiment of the light irradiation apparatus according to the present invention will be described hereinbelow.

In the present embodiment, there is provided an insulated board capable of minimizing a scattering of heat from an electron emitter.

As shown in FIG. 12, an insulated board 3a has a continuous difference in level in the form of a convex having an acute angle with an electron emitter 2 being an apex. This difference in level may be formed by installing the electron emitter 2 on the insulated board 3a and thereafter working it into a desired dimension, or installing it after working. This can be easily accomplished by cutting working, laser working, chemical or electrochemical polishing working or a combination of these or photolithography working.

The insulated board 3a is worked into the shape of the present embodiment whereby even if the electron emitter 2 is heat-generated, less heat transfer toward the insulated board 3a occurs, a high mechanical strength is obtained, and the electron emitter 2 is stably maintained at a high temperature. Moreover, in the shape of the present embodiment, a portion in the vicinity of the electron emitter 2 is acute-angled, and therefore, a concentration of electric field efficiently occurs so that uniform thermoelectrons and secondary electrons are emitted in a stabler manner, thus obtaining a further uniform emission.

Fig. 13 is a sectional view of essential parts showing a modified example of the present embodiment. As shown, an insulated board 3b has a square section.

In the present modified example, heat generated by the electron emitter 2 is hard to transfer as compared with the above-described embodiments, and heat generation, maintenance of high temperature and emission of secondary electrons can be efficiently carried out.

FIG. 14 is a sectional view of essential parts showing another modified example.

As insulated base 3c is partly constricted as shown so as to effectively maintain a high temperature of a portion on which an electron emitter 2 is

installed. Furthermore, coating of and holding of a secondary electron emitter 14 are facilitated. In the present modified example, an effective surface area of the secondary electron emitter 14 is so large that much more secondary electrons can be taken out.

The operation of the light irradiation apparatus in the present embodiment is similar to that of the light irradiation apparatus according to the first embodiment described in connection with FIGS. 1, 2 and 3, and a description thereof is therefore omitted.

In the above-described embodiments, when the electron emitter 2 is energized and heated, the insulated board 3 is also heated accordingly to give rise to a thermal expansion. Thereby, unnecessary stress is sometimes applied to the electron emitter 2. As materials to constitute the insulated board 3, materials which are low in heat conductivity and have a heat resistance and an electric insulating property, for example, such as quartz glass, silicon oxide such as crystal and borosilicate glass, and metal titanate ceramics such as titanium and titanate are used, so that stress can be relieved. Particularly, quartz glass is the most suitable material for the insulated board 3 because its coefficient of thermal expansion is approximately 10^{-7} $\text{m}/^{\circ}\text{C}$.

As shown in FIG. 15, when the electron emitter 2 is worked into a zigzag shape so as to cross in a plane with respect to the lengthwise of the light irradiation apparatus, a thermal stress generated between the electron emitter 2 and the insulated board 3 can be further relieved to provide a further stable emission.

Further, as shown in FIG. 16, the electron emitter 2 is not placed in close contact with the insulated board 3 but is supported at plural portions at desired intervals to thereby enable alleviation of influence of the thermal expansion from the insulated board 3.

A fifth embodiment of the light irradiation apparatus according to the present invention will be described hereinafter.

As shown in FIGS. 17 and 18, a groove 23 is formed in a base plate 1 on which control electrodes 301 and 302 for controlling electrons, an electron emitter 2 and an insulated board 3 on which the electron emitter 2 is installed are installed in the groove 23. Positions of surfaces of the control electrodes 301 and 302 and the apex of a secondary electron emitting layer 14 installed on the surface of the electron emitter 2 are changed according to the control conditions of secondary electron beams 18 to be irradiated on a fluorescent layer 6.

The control electrodes 301 and 302 are connected to an external control power source 21, as

shown in FIG. 17, so that a potential thereof can be varied and disconnected.

Protective layers 24 and 241 applied with electric insulation as necessary are installed at a portion in which a casing 5 and the base plate 1 are in contact so as to provide a vacuum seal and at a portion in which heater electrodes 4, 41 and the control electrodes 301, 302 are in contact with each other. The protective layers 24 and 241 are formed by partly or totally using a low melting point glass.

When the secondary electron beams 18 being generated and accelerated are drawn by use of the control electrodes 301 and 302 to impinge on the fluorescent layer 8 in a manner similar to that as described in connection with the first embodiment, a cathode luminescence light generated from the fluorescent layer 8 was widely enhanced in brightness.

When a width of the groove 23 is made to be larger than an open width 70 of a light take-out window 7 in the same direction as the width of the groove 23, even if an installation position of the control electrodes 301 and 302 is slightly deviated, the brightness of the surface of the fluorescent layer 8 rarely changes, and the intensity of the external take-out light 17 also rarely changes. With this, there can be obtained a light irradiation apparatus in which shapes of the control electrodes 301 and 302 are changed whereby a large tolerance of installation of these electrodes is provided and a high brightness take out light is stable.

As shown in FIG. 19, when shapes of the control electrodes 301 and 302 are formed so as to entirely cover the electron emitter 2, straying electrons 22 not impinging on the fluorescent layer 8 can be apparently reduced to obtain emission which is further stabilized and has a high brightness.

When power sources are separately connected to the control electrodes 301 and 302 are signal voltages applied each other are synchronized to control the secondary electron beams 18, the secondary electron beams 18 can be finely drawn and can be scanned in a direction indicated at 25. By making use of the aforesaid effect, a plurality of fluorescent layers 8 are installed and successively irradiated by the control electrodes 301 and 302. Then, a plurality of emissions were obtained.

A length for forming an electric field under vacuum of the control electrodes 301 and 302 is longer than that of the electron emitter 2. By doing this, an electric field to which the secondary electron emitting layer 14 is exposed can be made even, the secondary electron 18 radially emitted can be uniformly and efficiently drawn to increase an electron density, and accordingly, emission which is uniform and has a high brightness can be

obtained.

The control electrodes 301 and 302 have an angled curved surface with the groove 23 as the apex. An angle of the curved surface can be varied to thereby control emission characteristics such as an emission efficiency and an emission distribution.

The width of the groove 23 is not stuck to the foregoing but for example, the width of the groove 23 may be made to be smaller than that of the electron emitter 2 or the width of the groove 23 may be made to be smaller than a width 70 of the light take-out window 7, as shown in FIG. 19. In this case, emission which is finer and has a higher brightness can be obtained.

Furthermore, the width of the groove 23 is partly changed or the spacing between the control electrodes 301 and 302 is partly changed whereby an emission density distribution of the secondary electron beams 18 in a longitudinal direction of the electron emitter 2 can be changed.

That is, electrons and secondary electrons emitted from the electron emitter 2 and the secondary electron emitting layer 14 are radially emitted and tend to be generally uneven by being affected by the shape of the light irradiation apparatus. However, it is possible to form the groove 23 and the control electrodes 301 and 302 into a shape so as to correct such an unevenness.

In any of the aforementioned cases, the control electrodes 301 and 302 can be stably fixed and installed on the insulated board 31 and therefore can firmly withstand mechanical vibrations and shocks to not only perform controlling of the aforementioned secondary electron beams 18 but also perform assembling easily and with high accuracy because there is no assembling parts such as to be suspended in the air.

The control electrodes 301 and 302 are formed of metal, for example, such as tantalum, molybdenum and nickel which have a conductivity. Ceramics such as conductive diamond, conductive alumina or the like may be used.

A sixth embodiment of the light irradiation apparatus according to the present invention will be described hereinbelow.

In the present embodiment, a magnet is provided around a casing 5 so that electron currents emitted from an electron emitter 2 are converged by the magnet. In FIGS. 20, 21 and 22, an electromagnet 400 is provided around the casing 5.

A current is permitted to flow into the electromagnet 400 from a control power source 410, and a magnetic field generated by the electromagnet 400 is used. Similarly to the case described in connection with the first embodiment, secondary electron beam 18 being generated and accelerated are drawn to impinge on a fluorescent layer 8. As a result, a brightness of a cathode luminescent light

generated from the fluorescent layer 8 was widely enhanced.

Further, when a current which flows into the electromagnet 400 is varied, a distribution of the second electron beams 18 can be easily varied, and quantities of light and a shape of luminous portion can be varied.'

Although not shown, even if an installation position of the electromagnet 400 is mechanically displaced, the quantities of light and the luminous distribution can be varied. In this case, the electromagnet need not be installed in the casing 5 under vacuum, and since the distribution of the secondary electron beams 18 can be sufficiently varied from outside, adjustment of the luminous distribution when the light irradiation apparatus is assembled is extremely simply accomplished. Accordingly, the light irradiation apparatus constructed as above can obtain a further stabilized and high brightness emission.

Suitable number of windings of a coil of the electromagnet 400 is 20 to 400 times. When a coil former of a coil and a material for a core are varied and their diameters, a shape of a coil and distribution of arrangement are varied, desired luminous distribution and strength can be obtained.

The electromagnet 400 can be sufficiently controlled without using a core made of magnetic material. However, when a core formed of a soft magnetic material such as ferrite or a hard magnetic material is used, a luminous distribution L which is uniform in brightness and has a good linearity, as shown in FIGS. 23 and 24, can be obtained as compared with the case where the coil of FIG. 25 is not used.

Electrons or secondary electrons emitted from the electron emitter 2 or the secondary electron emitting layer 14 are radially emitted, and generally tend to be uneven by being affected by the shape of the light irradiation apparatus. In FIG. 26, a permanent magnet 420 is provided at a position so as to correct and converge an electron radiation distribution according to an unevenness thereof.

The permanent magnet 420 can be mechanically moved in directions of 430a and 430b to obtain a desired luminous distribution. Further, when a shape of the permanent magnet 420, an intensity of a magnetic field and a material for the magnet are varied, or sizes thereof, the number of installations, a distribution and angle of arrangement are varied, a desired luminous distribution and intensity can be obtained.

It is to be noted that the permanent magnet 420 is formed into a film of a small size so that the magnet 420 may be installed in the casing.

For the permanent magnet 420, almost any kind of materials can be used if they are normal ferromagnetic material.

In FIG. 27, a plurality of electromagnets 400 are provided. In the present embodiment, an arrangement of these electromagnets and an energizing current are varied whereby a luminous distribution and intensity can be varied more freely than the case of the aforementioned example.

In FIGS. 22, 26 and 27, the insulated boards 3a, 3b and 3c in the fourth embodiment described with reference to FIGS. 12, 13 and 14 are used. In the drawings of the sixth embodiment, constituent elements other than the insulated boards and the magnet and the operation thereof are similar to those described in connection with the first embodiment, and descriptions thereof are omitted.

A seventh embodiment of the light irradiation apparatus according to the present invention will be described hereinbelow. As shown in FIGS. 29 and 30, in the present embodiment, a control electrode 19a is provided. This control electrode 19a also serves as the antistatic electrode 19 shown in FIGS. 2 and 3.

The casing 5 is formed with a hole 110 in addition to a hole 11 as shown in FIG. 28, within which a signal electrode 200 is installed so as to maintain a degree of vacuum and electric insulating property interiorly thereof by a sealer 120.

The control electrode 19a is electrically connected to a signal electrode 200 in vacuum interiorly of the casing 5. The signal electrode 200 is connected to the control power source 32.

In FIG. 30, the secondary electron beams 18 are irradiated on the fluorescent layer 8, as described in the first embodiment.

As this time, an output of the control power source 32 is changed to make a polarity of the control electrode 19a cathodic which is the same polarity as that of the electron emitter 2. When the magnitude of voltage of the control electrode 19a is varied, a luminous intensity abruptly varies from the fluorescent layer 8 with a specific voltage as shown in FIG. 31.

A voltage applied to the control electrode 19a is controlled with a transparent electrode 9 as a reference. This control voltage varies according to a thickness of the fluorescent layer 8 and a voltage applied to the high voltage electrode 13. However, a luminous amount can be made to almost zero with a low voltage in the range of 4 to 100V, and can be abruptly changed more than four figures.

In a manner as described above, emission can be controlled merely by varying a potential applied to the control electrode 19a.

FIG. 30 shows the irradiation state of the secondary electron beams 18 and the luminous state, in which the high voltage electrode 13, the signal electrode 200 and so on are omitted.

For the control electrode 19a, aluminum is mainly used as a material, and the control elec-

trode 19a is formed by using a film manufacturing method such as normal vapor deposition, electron beam vapor deposition or sputtering.

Electric connection between the control electrode 19a and the signal electrode 20 is accomplished by a wire bonding procedure.

In the seventh embodiment, constituent elements other than those described above and operation thereof are similar to those described in the first embodiment, and descriptions thereof are omitted.

An eighth embodiment of the light irradiation apparatus according to the present invention will be described hereinbelow.

As shown in FIG. 32, a control electrode 440 formed with a slit hole 450 having an adequate width is installed between the electron emitter 2 and the antistatic electrode 19.

Although not shown, the control electrode 440 is connected to be electrically cathode internally or externally, and variation and disconnection of a potential can be made.

For the control electrode of the present embodiment, conductive metal, for example, such as tantalum, molybdenum, nickel, et. are used. Ceramics such as conductive diamond, conductive aluminum, etc. may also be used.

In the present embodiment, constituent elements other than the control electrode and operations thereof are similar to those described in the first embodiment, and descriptions thereof are omitted.

In the manner as described in the first embodiment, when the secondary electron beams 18 being generated and accelerated are drawn by use of the control electrode 440 to impinge on the fluorescent layer 8, a cathode luminescence light generated by the fluorescent layer is enhanced in brightness more than one figure.

Furthermore, when a width of the slit hole 450 for drawing the secondary electron beams 18 formed in the control electrode 440 is made larger than an open width 70 of the light take-out window 7 in the same direction as the first-mentioned width, even if an installation position of the control electrode 440 is slightly deviated, the brightness of the surface of the fluorescent layer 8 rarely varies, and accordingly, the intensity of the light 17 to be taken out rarely varies. From this, it is possible to obtain a light irradiation apparatus in which a shape of the control electrode 440 is varied whereby an installation tolerance of the control electrode 440 is made larger with high brightness as well as stabilized light to be taken out.

As shown in FIG. 33, when the shape of the control electrode 440 is formed to entirely cover the electron emitter 2, stray electrons 22 not impinging on the fluorescent layer 8 are apparently

reduced to obtain a further stable and high brightness emission.

As shown in FIG. 34, a width of a luminous portion can be greatly varied merely by setting a relative setting position G between the slit hole 450 and the electron emitter 2 to a desired value of -2 to +2 mm, and an orderly emission having a suitable shape, size and uniform brightness.

In FIG. 35, a length of the slit hole 450 formed in the control electrode 440 is longer than that of the electron emitter 2. With this arrangement, a group of secondary electrons radially emitted from the secondary electron emitting layer 14 can be efficiently drawn to increase an electron density. Accordingly, emission of high brightness can be obtained.

A normal line 460 is an imaginary perpendicular line vertically depicted from an end of the electron emitter 2 to the base 1, showing the positional relation of the installation of the control electrode 440.

The control electrode 440 has an angle curved surface with the slit hole 450 located at the apex. Angle of the curved surface is varied whereby luminous characteristics such as luminous efficiency, luminous distribution and the like can be controlled.

The length of the slit hole 450 may be shorter than that of the electron emitter 2, and in FIG. 32, the width thereof may be made smaller than the width 70 of the light taken-out window 7. In this case, emission having a finer high brightness can be obtained.

FIG. 36 shows a modified example of the control electrode 440.

Electrons or secondary electrons emitted from the electron emitter 2 or the secondary electron emitting layer 14 are radially emitted, and generally tend to be uneven by being affected by the shape of the light irradiation apparatus. A slit hole 450a is formed into a shape so as to correct it according to the unevenness. When the control electrode 440a formed with the slit hole 450a is used, a further uniform emission is obtained.

When a shape of the slit hole formed in the control electrode of the present embodiment is changed and a plurality thereof are provided, and a diameter and a shape of the hole and a distribution of arrangement are changed, a desired luminous distribution and a luminous intensity are obtained.

A ninth embodiment of the light irradiation apparatus according to the present invention will be described hereinbelow.

As shown in FIGS. 37 and 38, a control power source 465 as a DC power source is connected to the casing 5 so that the casing 5 be electrically cathodic, and variation and disconnection of a potential thereof can be made.

In the manner as described in the first embodiment, when the secondary electron beams 18 being generated and accelerated by the secondary electron emitting layer 14 are drawn by use of the control power source 465 to impinge on the fluorescent layer 8, stray electrons not to impinge on the fluorescent layer 8 are apparently reduced, and a cathode luminescence light generated from the fluorescent layer 8 is enhanced in brightness more than one figure.

Further, when a voltage of the control power source 465 is varied, a distribution shape of the secondary electron beams 18 being irradiated can be changed into a desired shape and can be also drawn. Because of this it is possible to obtain a stable light irradiation apparatus in which a brightness of the surface of the fluorescent layer 8 can be enhanced and an intensity distribution of the light 17 to be taken out can be made almost constant.

As shown in FIG. 39, when an output voltage of the control power source 465 is set to zero, a luminous distribution is poor and many irregularities in brightness S appear, since a potential distribution interiorly of the light irradiation apparatus is complicated. These often move as time passes, and a further unstable emission occurs. However, when an output voltage of the control power source 465 is applied to be negative, the irregularities in brightness are reduced and orderly, as shown in FIG. 40. Moreover, even if electric power applied to the light irradiation apparatus is one and the same, not only the luminous distribution is orderly and uniform but also the brightness is enhanced by 20% or more. In this case, an applied voltage varies according to the shape of the light irradiation apparatus, but in the present embodiment, the voltage is set to 50 to 500V whereby control can be made. In this case, the casing 5 is grounded, and other portions to which voltage is applied are set to be relatively positive.

Construction and operation of constituent elements other than those described above in connection with the ninth embodiment are similar to those described in the first embodiment, and descriptions thereof are omitted.

A tenth embodiment of the light irradiation apparatus according to the present invention will be described hereinbelow.

As shown in Fig. 41, a fluorescent layer 8a is formed by filling a transparent or translucent filler 480 around a particle-like fluorescent member 470. This filler 480 is formed of a selected material having a larger dielectric constant than that of the fluorescent member 470.

An external luminous efficiency of a cathode luminescence emission from the fluorescent layer 8a is enhanced 1.3 times to twice or more as

compared with the case where the filler 480 is not used.

When a dielectric constant of the filler 480 is set to be smaller than that of the fluorescent member 470, the luminous efficiency is instead reduced, and a local discharge appears between particles of a fluorescent member and at the particle surface.

Moreover, since particles of the fluorescent member 470 can be firmly bonded, a mechanical strength is further enhanced, and a fluorescent layer 8a can be obtained which can withstand mechanical strength and shock and has a reliability.

Furthermore, since no gap is present, no local discharge occurs and the luminous efficiency enhances. In addition, a local discharge breakage of the fluorescent layer 8a is not present, and a further reliable and stable emission is obtained.

A filling rate of the fluorescent member 470 in the fluorescent layer 8a is 50% or more, preferably, 65% or more but less than 99%, more preferably, 75% or more but less than 98%. The greater the filling rate, the better the luminous efficiency. The fluorescent layer 8a formed by use of the filler 480 has its surface which tends to be smooth to obtain a uniform emission.

As the fluorescent member 470 which constitutes the fluorescent layer 8a, there is used a material in which impurities to be a luminous center or luminous active material are scattered into a calcogenide compound such as a material of zinc sulfide family. A fluorescent member for high voltage application such as rare earth elements was also used.

Further, equivalent effects are obtained by applying a low voltage using a fluorescent member for low voltage emission such as a zinc oxide family.

Materials to form the filler 480 include titanate of rare earth elements; alkoxide compounds containing stannate, indium or tin, zirconium and aluminum; dielectrics such as titanate, barium titanate and metallic salt of niobate; and a metallic alkoxide compound for synthesizing ferroelectric.

The fluorescent layer 8a together with the filler 480 were formed by mixing, dissolving or dispersing these materials together with particles of the fluorescent member 470 into a solvent in which a macromolecular compound represented by a cellulose acetate family and nitrocellulose family and a semiconductive or conductive macromolecular compound are dissolved, stirring and adjusting the mixture so as to obtain an adequate viscosity, performing printing and after this drying and backing the same, and scattering organic substances.

Alternatively, the fluorescent layer 8a together

with the filler 480 may be formed by applying coating, drying and baking to the filler 480 with the metallic alkoxide compound or only the metallic alkoxide compound together with the fluorescent member 470.

Further, the fluorescent layer 8a may be formed by applying electrophoresis, plating or other electrochemical procedures to the organic compound with the metallic alkoxide compound or only the metallic alkoxide compound together with the particles of the fluorescent member 470 in the solvent or aqueous solution.

It has been found that when a refractive index of the filler 480 is set to be larger than that of the fluorescent member 470, a luminous efficiency is instead reduced, and there is an optimum range for the refractive index of the filler.

For the filler 480, a material is selected which is smaller but larger by 1 in refractive index than the fluorescent member 470. More specifically, in the case where a fluorescent material of a zinc sulfide family is used for the fluorescent member 470, an indium oxide or tin oxide and a molybdenic acid silicon compound are preferably used for the filler 480.

In this case, the filling rate of the fluorescent member 470 of the fluorescent layer 8a is 60% or more, preferably, 72% or more but less than 99%, more preferably 78% or more but less than 98%.

For the filler 480, macromolecular compounds represented by a polyimide family, a polyetherimide family, and a polyphenylene sulfide family, and semiconductive or conductive macromolecular compounds are used. Also, an alkoxide compound containing indium or tin may be used, and a metallic alkoxide compound which becomes transparent or translucent when baked may be used.

FIG. 42 shows a modified example of a fluorescent layer portion of the present embodiment. A filler 480a is formed in a film-like manner around the particles of a fluorescent member 470 to improve a filling rate of the fluorescent member 470. With this construction, a luminous efficiency can be further improved.

In the case where the aforementioned macromolecular compounds are used for the fillers 480 and 480a, the fluorescent layers 8a and 8b are formed by mixing a macromolecular compound dissolved or dispersed into a solvent or a low molecular compound previous to macromolecularization with particles of the fluorescent member 470, stirring the mixture, adjusting it to have an adequate viscosity, printing and after this, baking it.

Also in the case where the aforementioned metallic alkoxide compound is used for the fillers 480 and 480a, the fluorescent layers 8a and 8b are

formed in the procedure similar to that mentioned above. Further, the fluorescent layers 8a and 8b are formed by applying electroendosmosis and plating or other electrochemical processes to the aforementioned macromolecular compound and the metallic alkoxide compound together with the particles of the fluorescent member 470 in a solvent or aqueous solution.

When the electron emitter 2 as described in the first embodiment is energized and heated to start emission from the fluorescent layer 8, the insulated board 3 is also heated in the center near the electron emitter 2 and the temperature was risen. This temperature rise increases substantially proportional to a current flowing into the electron emitter 2 and a high voltage applied between the electron emitter 2 and the transparent electrode 9. When a thermal conductivity of the fluorescent layer 8 or the light transmission plate 10 is enhanced, heat generated in the fluorescent layer 8 tends to be transmitted to the case 5 as mentioned above so that heat is further transmitted to a mechanism (not shown) which holds the light irradiation apparatus of the present invention to radiate heat. As a result, a temperature rise of the fluorescent layer 8 is decreased, and therefore, a very stable emission without occurrence of thermal breakage or the like was obtained. Moreover, when a thermal conductivity of both the fluorescent layer 8 and light transmissible plate 10 is increased, a further stable emission was obtained. The thermal conductivity of the fluorescent layer 8 was enhanced by applying a thin film forming process or a thick film forming process such as mixing, dissolving, melting, diffusion or vapor deposition, sputtering, CVD, etc. to materials having a good thermal conductivity in the form of powder, particles, a thin film piece or a thin film layer in the fluorescent layer 8. This can be also done by a combination of these shapes, mixing and forming processes.

As materials to be mixed, materials having a high thermal conductivity (0.02 cal/cm.sec. or more, preferably, 0.05 cal/cm.sec or more, more preferably 0.1 cal/cm*sec or more), for example, such as aluminum oxide, graphite carbon, diamond, metal, indium oxide, tungsten carbide, germanium, silicon, beryllium oxide, calcium fluoride, magnesium oxide, titanium oxide, etc. are used. For the light transmissible plate 10, sapphire, magnesium oxide, titanium oxide, or transparent materials such as quartz glass on which these materials or diamond are formed in the form of a layer are used.

In the tenth embodiment, constituent elements other than those described above and operations thereof are similar to those described in the first embodiment, and descriptions thereof are omitted.

An eleventh embodiment of the light irradiation apparatus of the present invention will be described

hereinbelow.

As shown in FIG. 43, a condenser member 490 for condensing light to be taken out is installed on the light transmissible plate 10. As a fluorescent layer, the fluorescent layer 8a described in the tenth embodiment was used.

Light generated from the fluorescent layer 8a passes through the transparent electrode 9 and the light transmissible plate and enters the condenser member 490 installed on a window portion. The condenser member 490 is in the form of a convex lens as shown, and light passing therethrough is condensed while being refracted and emitted as the light 17 to be taken out.

The thus condensed light 17 to be taken out is neither concentrated in an extremely narrow range nor scattered. Therefore, when it is used for an optical read device, in the case where the light irradiation apparatus of the present invention is installed, a large installation tolerance is taken, and assembling is very easy.

An illuminance on the surface to be irradiated because of further condensation was more than about twice when the light irradiation apparatus of the present invention is installed at a normal distance.

For the condenser member 490, plastic of an acrylic family was used. However, normal glass may be used if the condition of the refractive index is fulfilled, or the condenser member 490 may be formed integral with a light transmissible plate.

When materials are selected by lowering the refractive index but to be larger than 1 in order of the fluorescent member 470, the filler 480, the transparent electrode 9, the light transmissible plate 10 and the condenser member, a combination in which the efficiency of the light taken out is best was achieved.

The light transmissible plate 10 is formed of sapphire, magnesium oxide or transparent materials such as quartz glass in which these substance are formed on the surface thereof in a layer fashion on the fluorescent layer 8a side, normal glass and the like.

Alternatively, a plurality of glasses such as crown glass or flint glass different in refractive index may be superposed, or components in glass may be continuously changed to thereby continuously change the refractive index in glass.

The aforesaid procedure for continuously changing the refractive index can be applied to not only the light transmissible plate 10 but also other constituent elements.

In any of these cases, the refractive index is taken to be large in the direction close to the fluorescent member 470.

Although not shown, when the surface of the light transmissible plate 10 on the air side is thinly

coated with magnesium fluoride, calcium fluoride, an organic silicone compound, a fluorine family macromolecular compound, etc., the light-takeout efficiency is further enhanced.

In the eleventh embodiment, constituent elements other than those described above and operations thereof are similar to those described in the first and seventh embodiments, and descriptions therefor are omitted.

A twelfth embodiment of the light irradiation apparatus according to the present invention will be described hereinbelow.

In FIG. 44, as described in the first embodiment, the fusion between the casing 5 and the base 1 is carried out under vacuum, and the interior of the casing 5 is held in vacuum so as to have a pressure less than 0.001 Pa even after fusion.

In order to obtain the vacuum in a stable manner, there is provided a gas capturing layer 500 as shown in FIG 44, so that an irradiation light 510 utilizing an excimer laser light is condensed and irradiated pulsewise from the outside and heated, is momentarily evaporated and scattered as vapor 520 in a vacuum space constituted by the casing 5 and the base 1, and is simultaneously condensed and cooled to thereby capture gases which remain in the vacuum space.

At that time, as the irradiation light 20, an Xe-Cl excimer laser light whose pulse applying time is about 5×10^{-8} seconds and wavelength is about 309 nm is used, and as the gas capturing layer material, a film whose main component is titanium is used.

Since the quartz glass is used as the material for the base 1, the irradiation light 510 merely passes through the base and is not absorbed with said wavelength. Accordingly, only the gas capturing layer 500 provided on the base 1 absorbs the irradiation light 510 and becomes evaporated. In this case, propagation of heat to the base 1 rarely occurs, and a temperature rise also rarely occurs.

Furthermore, since the irradiation light 510 makes use of an excimer laser light, it can be finely drawn so that fine adjustment of a degree of vacuum can be accurately made. This can hardly be done by heating made by a conventional heater.

Moreover, the secondary electron beams 18 are irradiated on the fluorescent layer 8 to emit light and a current amount and a luminous brightness or a luminous quantity of the secondary electron beams 18 are measured, during which times of irradiations of the laser pulse are controlled to thereby control evaporation of the gas capturing layer 500, and 5 the internal vacuum state can be set to a proper value. A carbonic acid gas laser, an argon laser and a Young laser sometimes break the casing 5. In the twelfth embodiment, constituent elements other than those described above and

operations thereof are similar to those described in the first embodiment, and descriptions therefor are omitted.

A thirteenth embodiment of the light irradiation apparatus according to the present invention will be described hereinbelow.

As shown in FIG. 45, two casings 5 for storing constituent elements according to the present invention are provided to be inclined. Constituent elements within each casing 5 and operations thereof are similar to those described in the first embodiment, and detailed description therefor is omitted.

As shown in FIG. 46, a high voltage is applied to high voltage electrodes 13-1 and 13-2 from high voltage power sources 16-1 and 16-2 corresponding to each casing 5, a light emitted from each fluorescent layer 8 passes through each light transmissible plate 10 as mentioned above. The light is mixed in a light mixer 700 within a light mixing portion 530 and is emitted as the light taken out 17 in a main direction directly or while being reflected by various parts. The light mixing portion 530 is coated with metal such as aluminum having a good light reflectance so as not to impair electric insulation characteristics of parts other than the light take-out portion with other constituent parts.

Since the two casing 5 are inclined from each other, the light emitted as described above is not confined but can be taken out to an external necessary irradiation range.

Furthermore, the casings 5 are enlarged and the fluorescent layer 8 is also widened whereby the whole luminous quantities can be increased. An angle of each casing 5 is adjusted to take out the light to an external necessary irradiation range whereby a luminous intensity of the irradiation portion can be increased.

Reflecting layers 540 and 550 are provided around the light mixer 700 to prevent a leakage, a reflecting attenuation and the like of the light, thus increasing light quantities of the light taken out 17.

Although not shown, reflecting layers are provided on the transparent electrode 9 side and on the transparent electrode 9 surface of the light transmissible plate 10 except portions through which light immediately after radiated from the fluorescent layer 8 transmits so as to prevent an occurrence of electric trouble and prevent a leakage of light.

In FIG. 45, through not depicted, a heater electrode and a heater power source are connected to the lower casing 5 of the light mixing portion 530, similar to the casing 5 depicted in an upper portion.

Various emissions can be freely obtained by adjusting quantities of light from each fluorescent layer 8 installed in each of upper and lower casing

5 or by changing a luminous wavelength of each fluorescent layer 8. The light mixer 700 is formed of plastics such as acryl. In this case, the efficiency of light taken out is further enhanced by selecting refractive indexes of materials of constituent parts installed to be smaller in order such that light emitted from the fluorescent layer 8 directly transmits and arrives at the light mixer 700 and to be smaller than 1.

The reflecting layers 540 and 550 are formed by applying vapor deposition to an aluminum film. Other materials having a good reflectance may be used.

According to the above-described embodiments, a compound which is stable even at a high temperature for an electron emitter, has a high current density and can be energized is used, and a large amount of thermoelectrons are emitted from the electron emitter.

Moreover, an electric resistance distribution of an electron emitter is varied to make constant a distribution of electrons emitted.

Furthermore, according to the present invention, the remaining electron emitters 2 without being broken are sequentially energized and used till all of a plurality of electron emitters 2 installed are broken.

Furthermore, an insulated board and an electron emitter are formed by selecting materials so that a coefficient of thermal expansion of material constituting an insulated board is smaller than that of material constituting an electron emitter. With this, a thermal stress from the insulating board to the electron emitter is reduced.

Moreover, an electrode for controlling electrons is secured to an upper and of a groove formed to relieve an influence of mechanical shocks and vibrations.

Furthermore, a slit is provided in a control electrode to change an electric field in the vicinity of secondary electron beams emitted from an electron emitter and a secondary electron emitting layer.

Moreover, a magnet is provided around the casing to converge secondary electron beams in a predetermined direction.

Furthermore, an electrode is secured to a fluorescent layer to thereby control a speed of secondary electron beams and relieve electric charges which remain on the surface of a fluorescent layer.

Moreover, a gap portion between fluorescent particles in a fluorescent layer is filled with material having dielectric constant larger than that of a fluorescent member so that most of applied electric field are applied between the fluorescent particles.

Furthermore, a gap portion between fluorescent particles in a fluorescent layer is filled with material having a refractive index which is larger than 1 to

thereby minimize a total reflection at the surface of the fluorescent layer, and a refractive index of the filler is made to be smaller than that of the fluorescent member to reduce a reflection at the interface of the filler.

Moreover, a fluorescent layer is formed of materials whose refractive indexes are different and smaller than 1. Thereby, a total reflection of light radiation from the fluorescent layer is relieved.

Moreover, an electron emitter, a fluorescent layer and an installation member for installing these within a casing are formed of materials which are different in thermal conductivities from each other. Thereby, an unnecessary heat transmission is relieved.

Furthermore, a condenser member is provided to thereby condense light taken out in a desired direction.

Moreover, an excimer laser light is irradiated on a gas capturing layer to effectively heat the gas capturing layer.

Furthermore, a light mixer is provided to thereby effectively take out the light from a plurality of fluorescent layers outside the casing.

Accordingly, according to the above-described embodiment, an electron emitter is formed of a material including a boron lanthanum compound whereby a large amount of thermoelectrons can be emitted in a stable manner. Accordingly, a large amount of electron flows can be irradiated on the fluorescent layer to obtain a cathode luminescence emission of high brightness.

Moreover, an electric resistance distribution of an electron emitter can be merely changed to obtain a desired electron irradiation distribution. Accordingly, control can be made so as to provide a suitable distribution such that a luminous distribution is made to be even. In addition, since an electrode or the like for adjusting the distribution need not be provided, there can obtain a light irradiation apparatus which is simple in assembly and inexpensive.

Furthermore, a plurality of electron emitters are provided whereby even if the electron emitters are energized and heated with a high current density, the whole light irradiation apparatus can have a long service life so that a high brightness emission can be conducted for a long period of time. In addition, replacement of an electron emitter at the time of burn-out can be quickly and efficiently carried out.

Moreover, it is possible to minimize a stress due to a difference in coefficient of thermal expansion between an electron emitter and an insulated board having said electron emitter mounted thereon and not to apply a tensile stress to the electron emitter.

Furthermore, since a control electrode can be

fixedly mounted in a stable manner, it can withstand mechanical vibrations and shocks.

Moreover, a slit is provided in a control electrode whereby an enlarged distribution and a density distribution of an electron flow irradiated on a fluorescent member can be varied.

Furthermore, a magnetic pole is installed whereby an enlargement and a density distribution of an electron flow irradiated on a fluorescent member can be easily varied from the outside.

Moreover, a control electrode can withstand mechanical vibration since it is fixedly mounted on the fluorescent layer, and when an apparatus is assembled, an adjusting step such as to control constant a distance to the fluorescent layer is not necessary. The apparatus can be simply assembled.

Furthermore, a filler having a dielectric constant in excess of a predetermined value is filled into a fluorescent layer, thereby decreasing a local discharge between the fluorescent particles and an energy loss such as a damage to the fluorescent layer resulting therefrom, as a consequence of which an external luminous efficiency is improved and brighter emission can be obtained.

Moreover, a filler having a predetermined refractive index is filled into a fluorescent layer, thereby decreasing a total reflection within the fluorescent particles to improve an external luminous efficiency and obtain brighter emission.

Furthermore, refractive indexes of structures installed between air and a fluorescent member having a refractive index larger than that of air are decreased in order of those installed on the fluorescent member side, whereby light can be taken out smoothly without occurrence of excessive total reflection. Therefore, emission which is large in light takeout efficiency and is brighter can be obtained.

Moreover, portions in the vicinity of an electron emitter which is energized and heated to emit thermoelectrons are hard to be cooled because of poor heat conductivity, and thermoelectrons can be emitted in an efficiently stable manner. Portions in the vicinity of a luminous layer have a good heat conductivity so that heat generation caused by radiant heat and impinging electrons from the electron emitter can be transmitted and scattered. Accordingly, even if light is generated for a long period of time, emission of stable light can be attained. Further, scattering of heat from an electron emitter is minimized so that the electron emitter can be efficiently energized and heated, and a temperature thereof can be maintained at a high level in an efficient and stable manner. In addition, since heat generation of a fluorescent member which emits a cathode luminescence can be suppressed, even if an electron flow of high density is

irradiated on the fluorescent member, less thermal degradation of the fluorescent member occurs, and luminous characteristics which is stable in temperature characteristic and has a high brightness can be obtained.

Furthermore, light to be taken out externally of a casing can be condensed, and an illuminance on the irradiation surface is improved.

Moreover, not only a degree of vacuum within the apparatus can be improved in a short period of time and momentarily from the outside but also propagation of heat to unnecessary portions are rarely present, and the apparatus is never broken. In addition, since light to be irradiated can be finely drawn, a degree of vacuum within the apparatus can be accurately adjusted.

Furthermore, even if a portion to be irradiated of a fluorescent layer is limited, an area of a luminous portion can be enlarged, and emitter light is not confined by the inclined arrangement but can be effectively taken out.

Claims

1. A light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, and a fluorescent member on which said emitted thermoelectrons impinge to emit light, characterized in that
said electron emitter includes a boron lanthanum compound.
2. A light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, and a fluorescent member on which said emitted thermoelectrons impinge to emit light, characterized in that
said electron emitter includes at least one of tungsten, tantalum, molybdenum, chrome, tantalum oxide, ruthenium oxide, and a tantalum compound of silicone oxide.
3. The light irradiation apparatus according to Claim 2, wherein said electron emitter has a thickness of 0.01 μm or more than 0.1 mm or less.
4. A light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, and a fluorescent member on which said emitted thermoelectrons impinge to emit light, characterized in that
said electron emitter includes a material in which an electric resistance value indicated when energized is different according to portions of the material.
5. A light irradiation apparatus comprising an

electron emitter heated by energization to emit thermoelectrons, and a fluorescent member on which said emitted thermoelectrons impinge to emit light, characterized in that

said electron emitter includes a plurality of electron emitting members and the apparatus comprises energization means of the same number as said electron emitting members to energize said electron emitting members, wherein said plurality of electron emitting members are sequentially energized by said energization means to emit thermoelectrons.

6. A light irradiation apparatus comprising an electron emitter including a material having a predetermined coefficient of thermal expansion and heated by energization to emit thermoelectrons, and a fluorescent member on which said emitted thermoelectrons impinge to emit light the apparatus characterized by comprising:
 - an installation member containing a material having a coefficient of thermal expansion smaller than the predetermined coefficient of the material included in said electron emitter and installing said electron emitter within said apparatus.
7. A light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, a fluorescent member on which said emitted thermoelectrons impinge to emit light, and a control electrode applied with a predetermined voltage to control movement of said emitted thermoelectrons, the apparatus characterized by comprising:
 - installation means having a groove and for installing said control electrode within said apparatus, and said electron emitter being accommodated in said groove.
8. A light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, a fluorescent member on which said emitted thermoelectrons impinge to emit light, and a control electrode applied with a predetermined voltage to control movement of said emitted thermoelectrons, characterized in that
 - said control electrode has a slit for permitting said emitted thermoelectrons to pass therethrough to converge said thermoelectrons in a direction of said fluorescent member.
9. A light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, and a fluorescent member on which said emitted thermoelectrons impinge to

emit light, the apparatus characterized by comprising:

- a magnet which generates a magnetic field to converge said emitted thermoelectrons in a direction of said fluorescent member by said magnetic field.

10. A light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, and a fluorescent member (8) on which said emitted thermoelectrons impinge to emit light, the apparatus characterized by comprising:
 - control means secured to said fluorescent member to control a speed at which said emitted thermoelectrons impinge on said fluorescent member.
11. A light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, and a fluorescent member including a fluorescent material having a predetermined dielectric constant at which said emitted thermoelectrons impinge to emit light, characterized in that
 - said fluorescent member further includes a material having a dielectric constant larger than that of said fluorescent material.
12. A light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, and a fluorescent member including a fluorescent material having a predetermined refractive index at which said emitted thermoelectrons impinge to emit light, characterized in that
 - said fluorescent member further includes a material having a refractive index which is smaller than that of said fluorescent material and larger than 1.
13. A light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, and a fluorescent member having a predetermined first refractive index, and including a fluorescent material having a predetermined second refractive index at which said emitted thermoelectron impinge to emit light, characterized in that
 - said fluorescent member further includes a material having a refractive index which is larger than said first refractive index, but smaller than said second refractive index and is larger than 1.
14. A light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, and a fluorescent member in-

cluding a fluorescent material having a predetermined first thermal conductivity conductivity at which said emitted thermoelectrons impinges to emit light, the apparatus characterized by comprising:

a first installation member including a material having a predetermined second thermal conductivity and for installing said electron emitter within said apparatus; and

a second installation member including a material having a predetermined third thermal conductivity and for installing said fluorescent member within said apparatus,

said second thermal conductivity being smaller than said first thermal conductivity and said third thermal conductivity.

15. A light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, a fluorescent member on which said emitted thermoelectrons impinge to emit light, and a light transmissible plate for taking out said emitted light outside, characterized by comprising:

condensation means provided integral with said light transmissible plate to converge said emitted light in an external predetermined direction.

16. The light irradiation apparatus according to Claim 15, wherein said condensation means includes a convex lens.

17. The light irradiation apparatus according to Claim 15, wherein said fluorescent member, said light transmissible plate and said condensation means include materials having a first, a second and a third refractive index, respectively, the refractive index being lowered in order of said first, second and third refractive index and being made to be smaller than 1.

18. A gas capturing method for heating a gas capturing agent to capture gases generated in a light irradiation apparatus comprising an electron emitter heated by energization to emit thermoelectrons, and a fluorescent member on which said emitted thermoelectrons impinge to emit light, the method comprising the steps of:

arranging said gas capturing agent at a part most away from said electron emitter and said fluorescent member within said light irradiation apparatus; and

irradiating an excimer laser light on said gas capturing agent from outside of said light irradiation apparatus to heat said gas capturing agent.

19. A light irradiation apparatus comprising a plurality of sets, each set comprising an electron emitter heated by energization to emit thermoelectrons and a fluorescent member on which said emitted thermoelectrons impinge to emit thermoelectrons, characterized by comprising

a light mixer in which light emitted from said sets of fluorescent members are mixed and emitted outside of said apparatus.

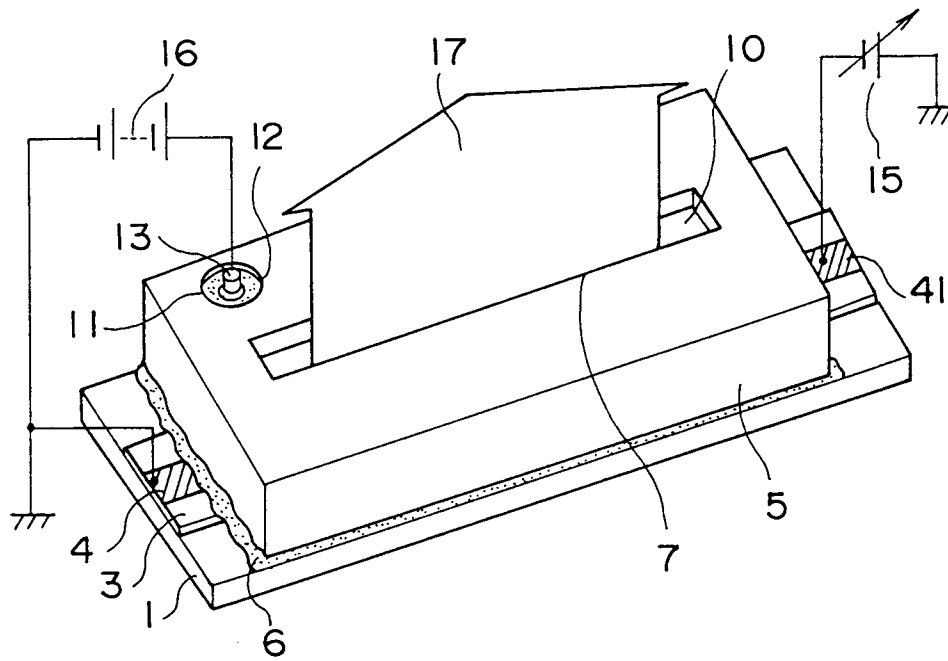


FIG. 1

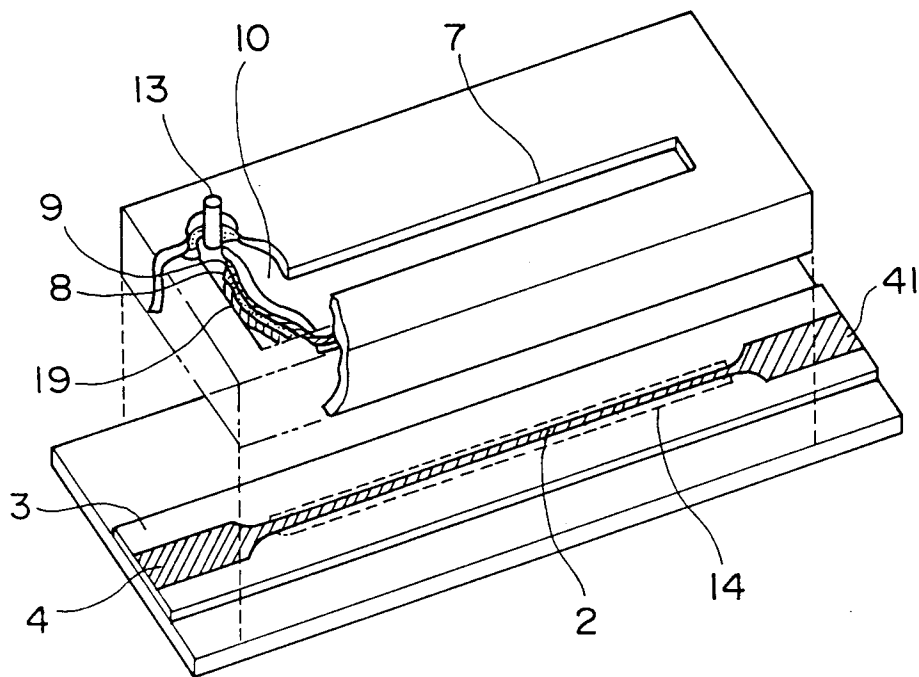


FIG. 2

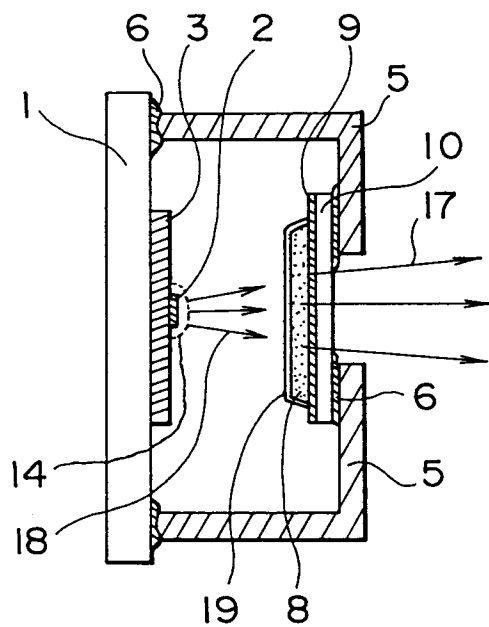


FIG. 3

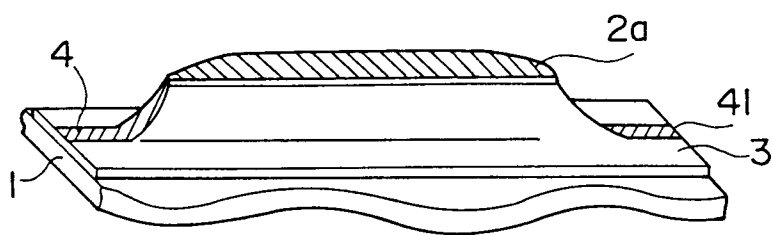


FIG. 4



FIG. 5

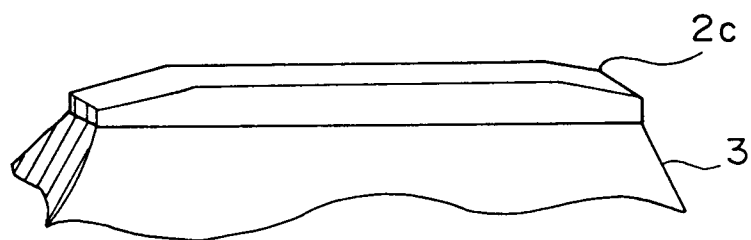


FIG. 6

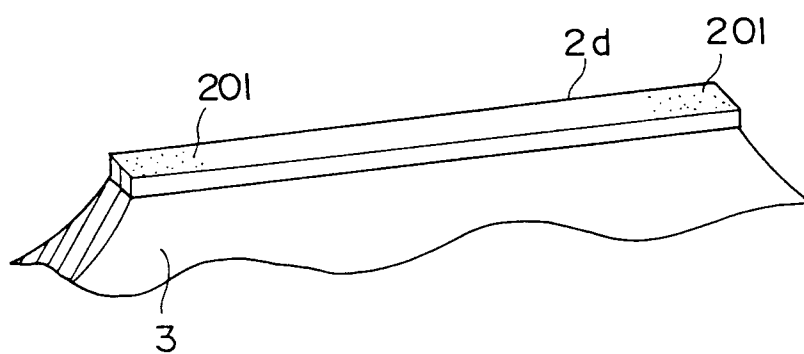


FIG. 7

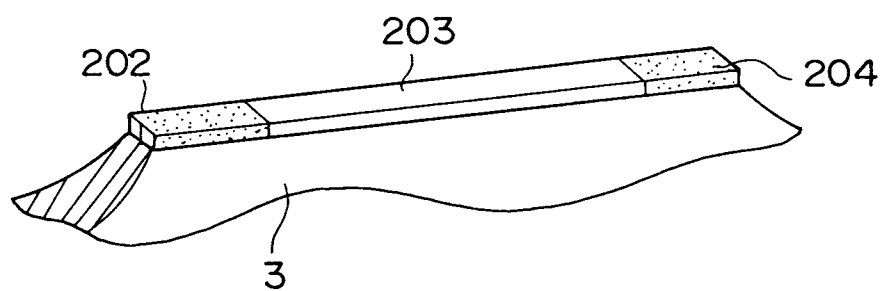


FIG. 8

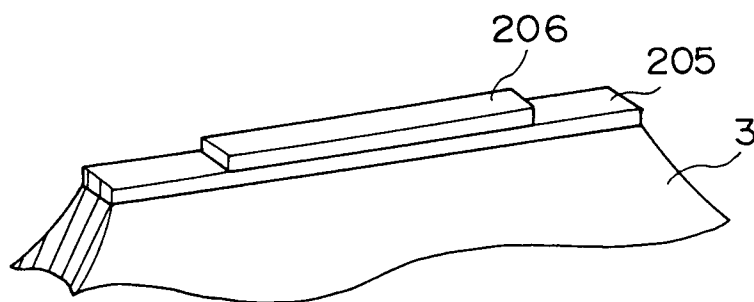


FIG. 9

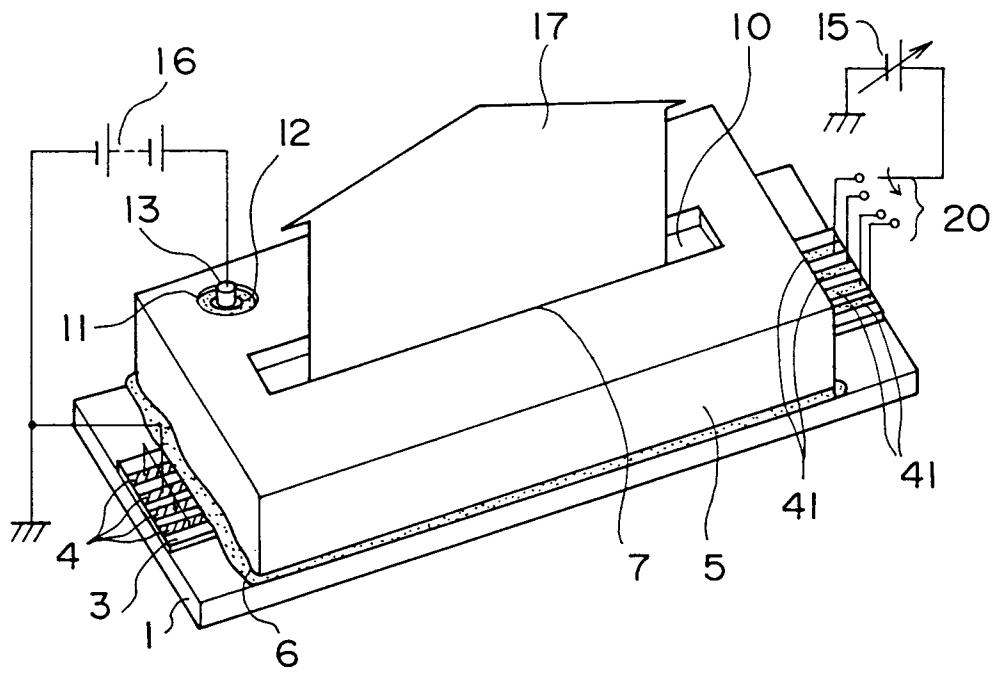


FIG. 10

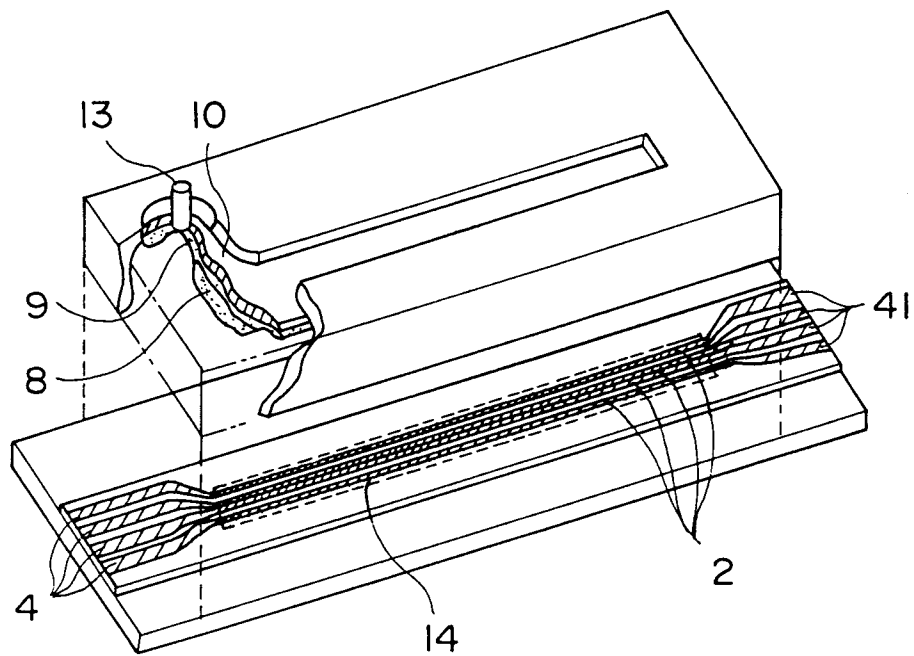


FIG. 11

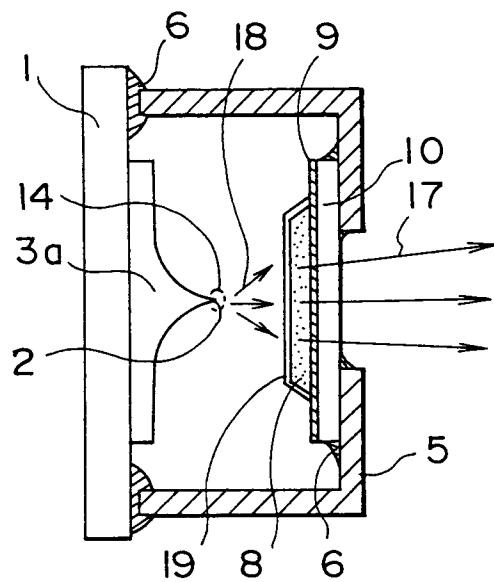


FIG. 12

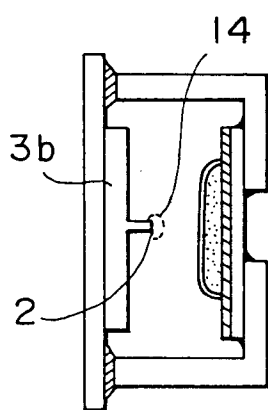


FIG. 13

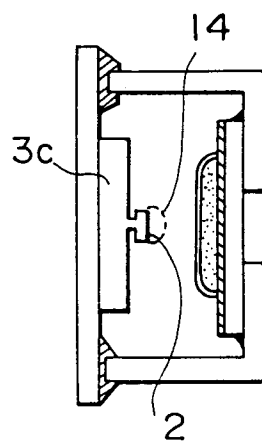


FIG. 14

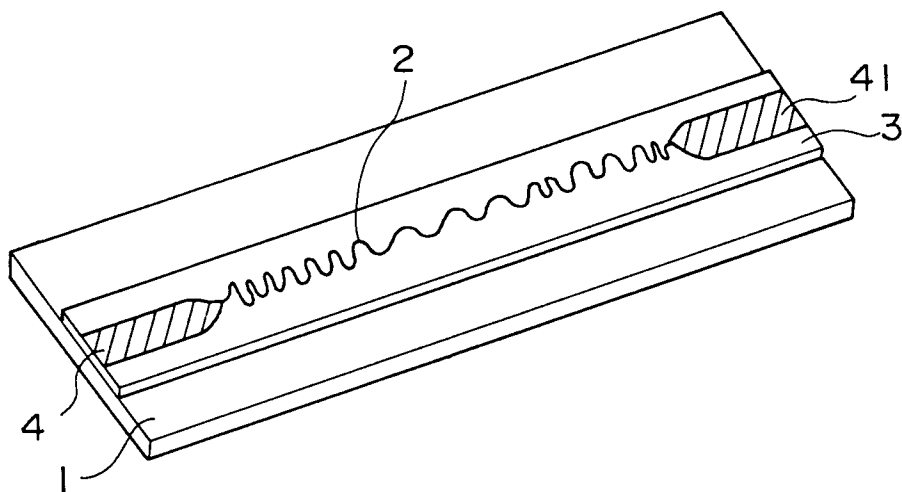


FIG. 15

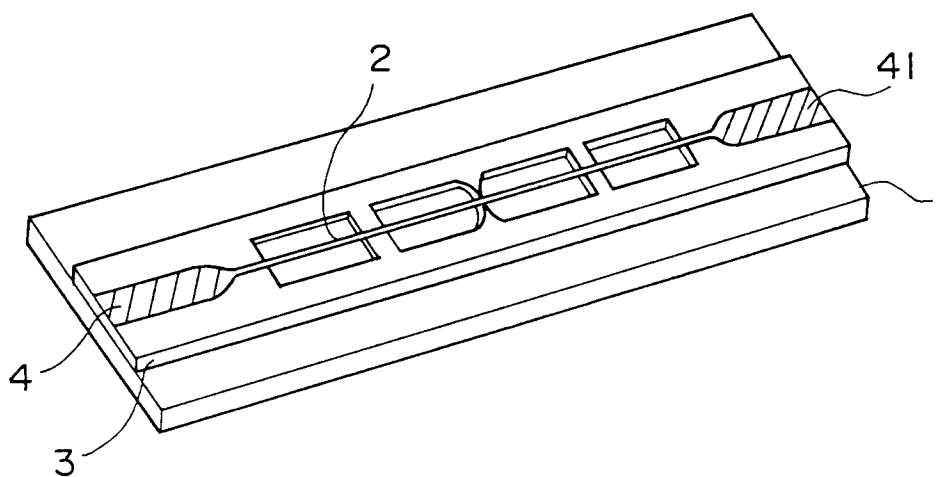


FIG. 16

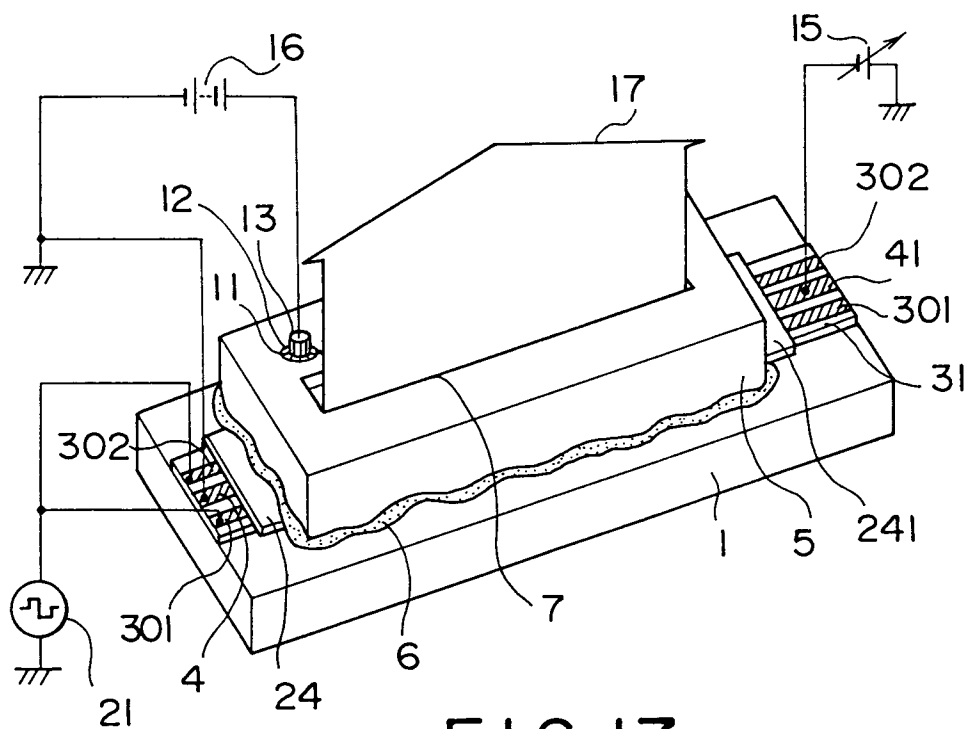


FIG. 17

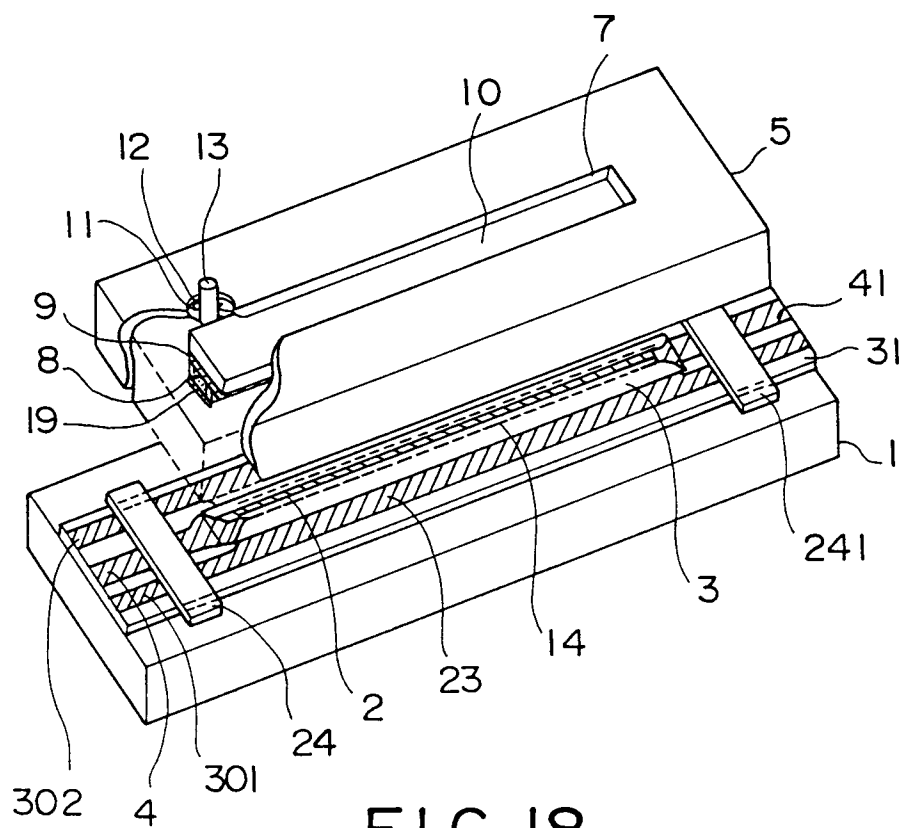


FIG. 18

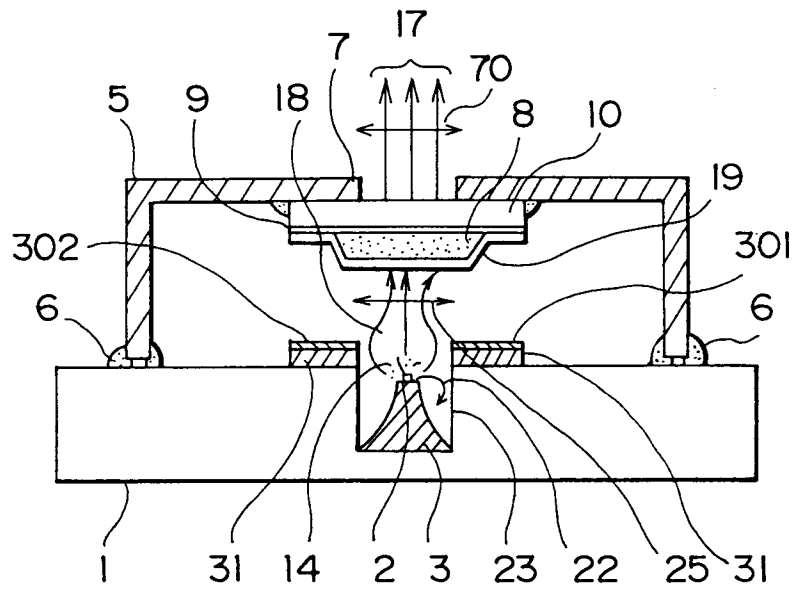


FIG. 19

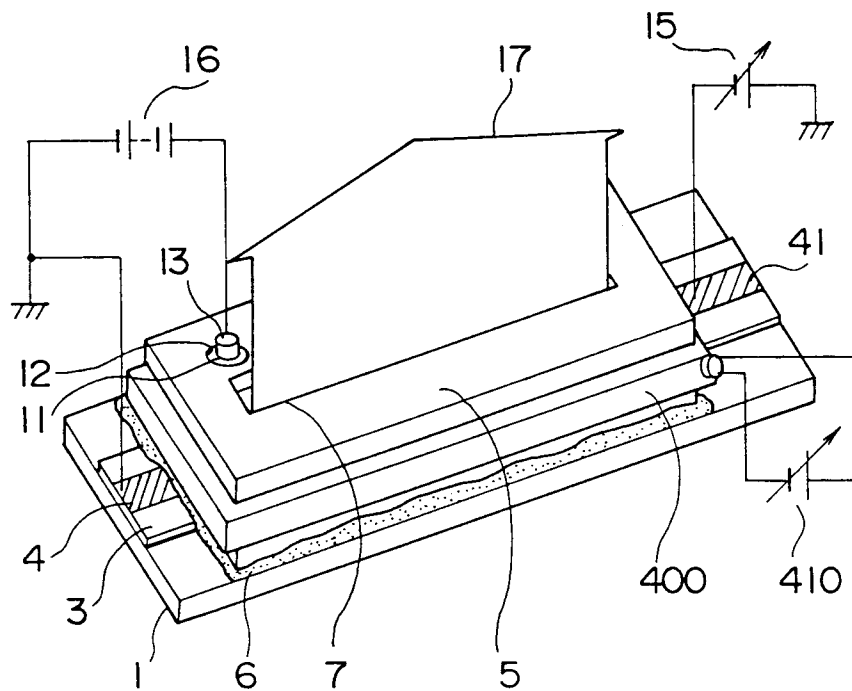


FIG. 20

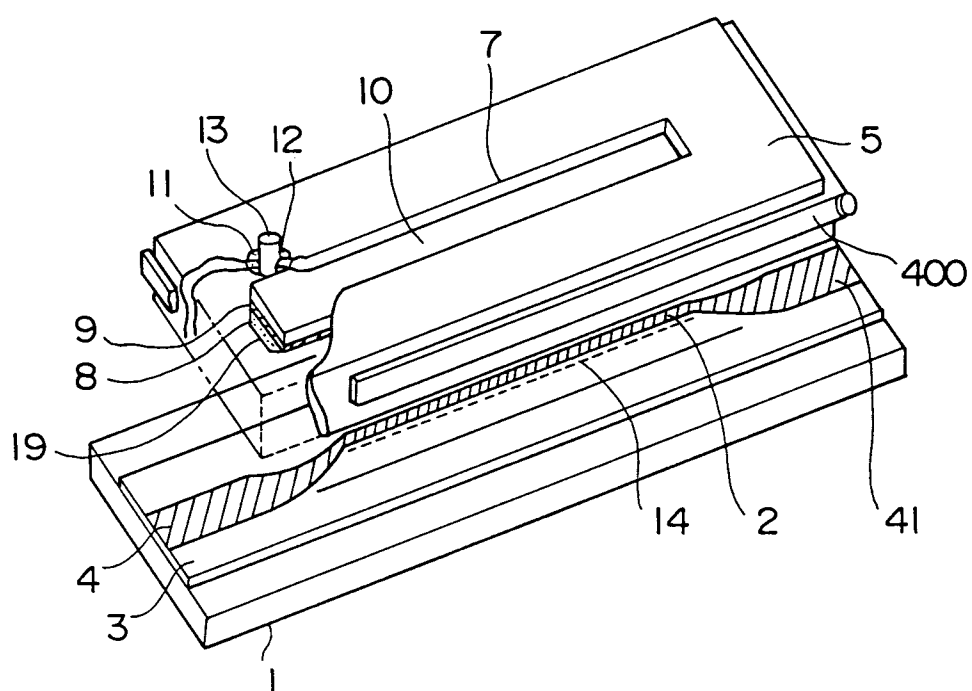


FIG. 21

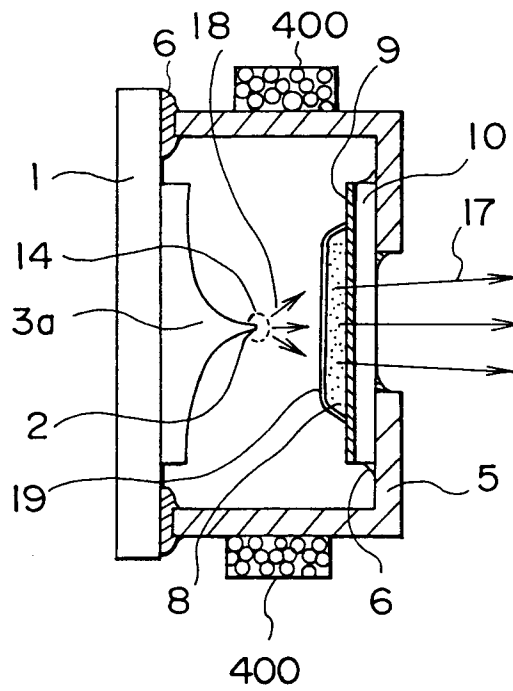


FIG. 22

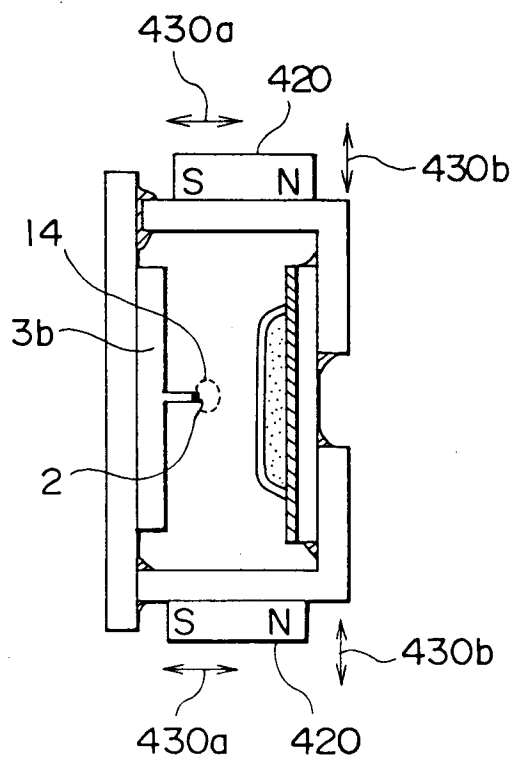


FIG. 26

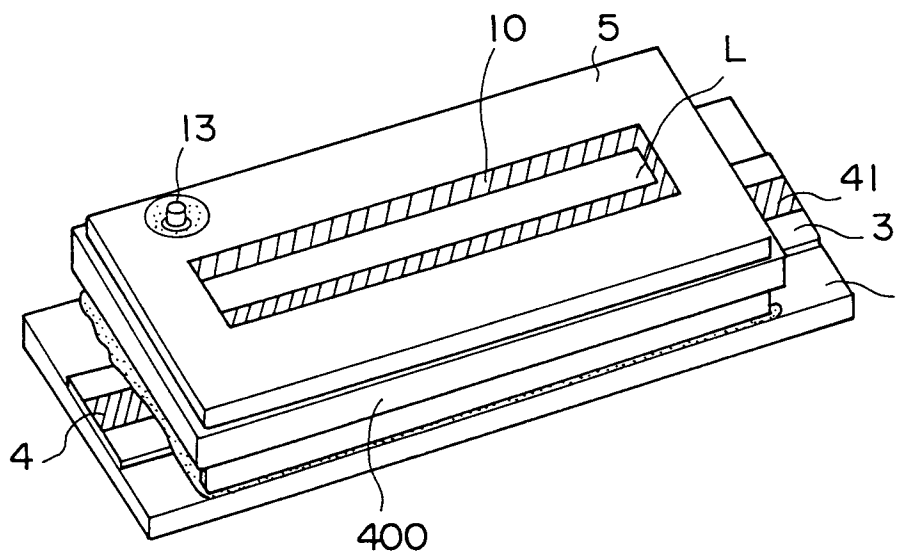


FIG. 23

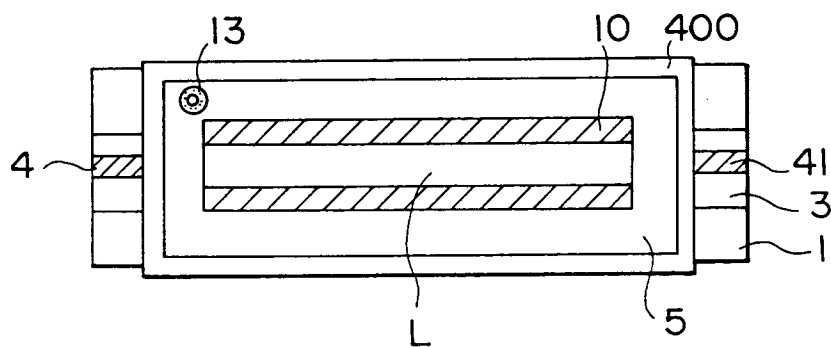


FIG. 24

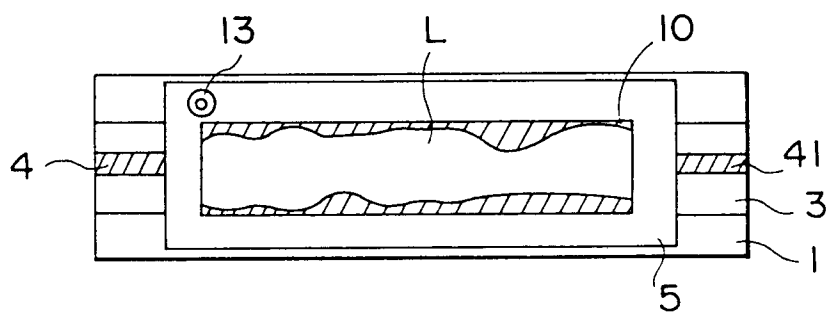


FIG. 25

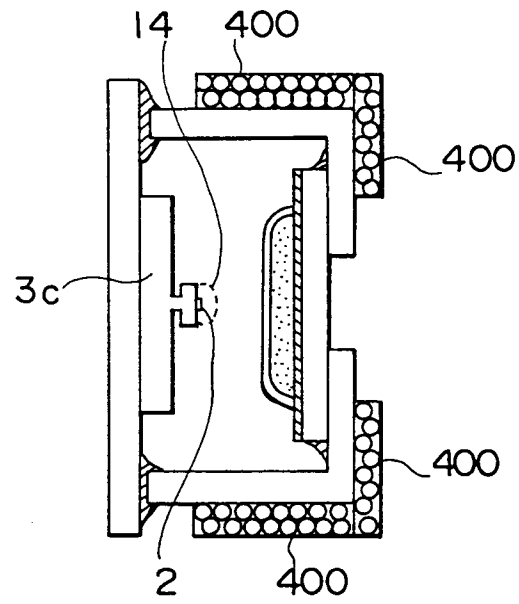


FIG. 27

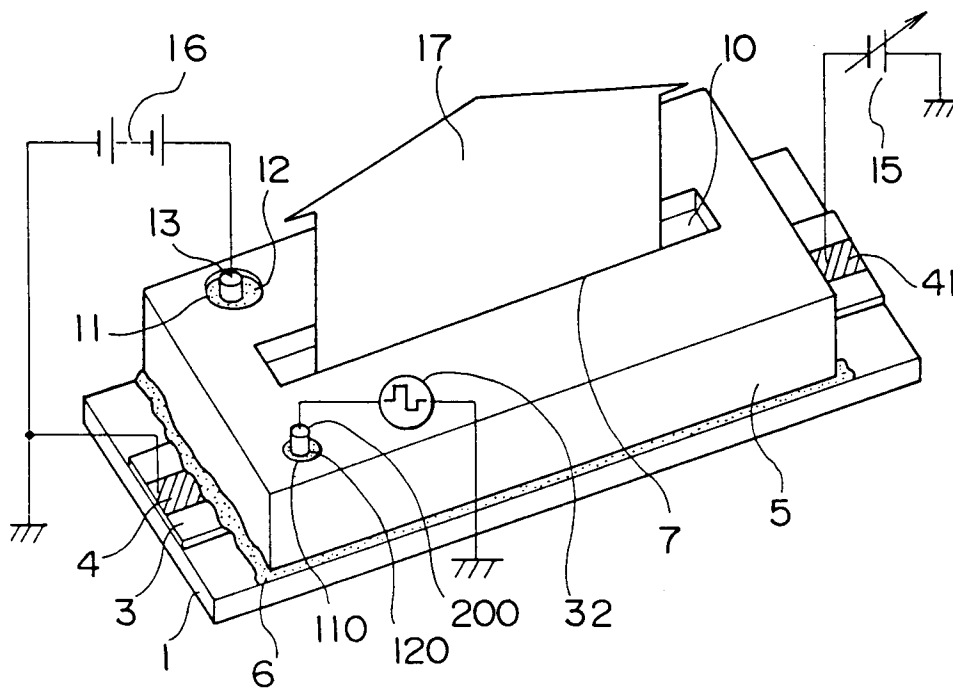


FIG. 28

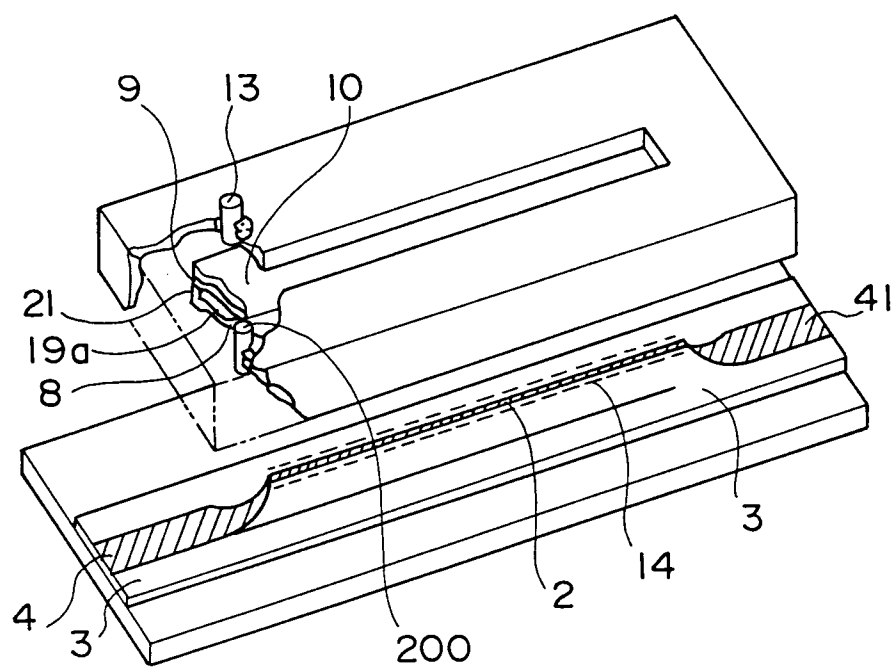


FIG. 29

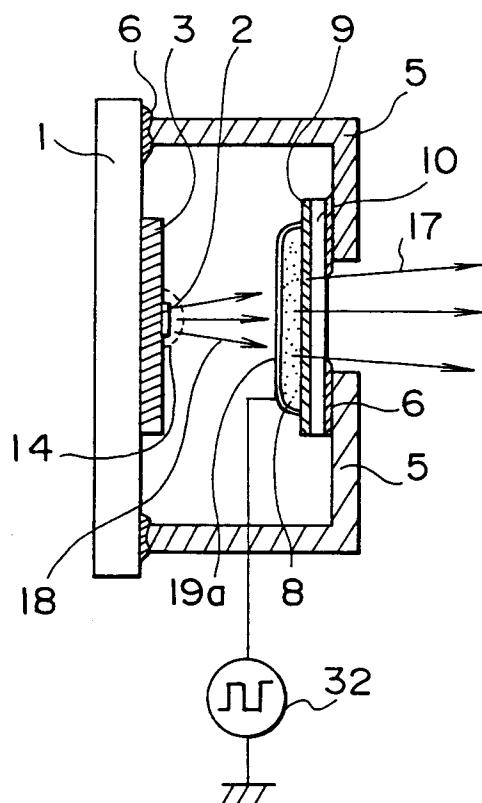


FIG. 30

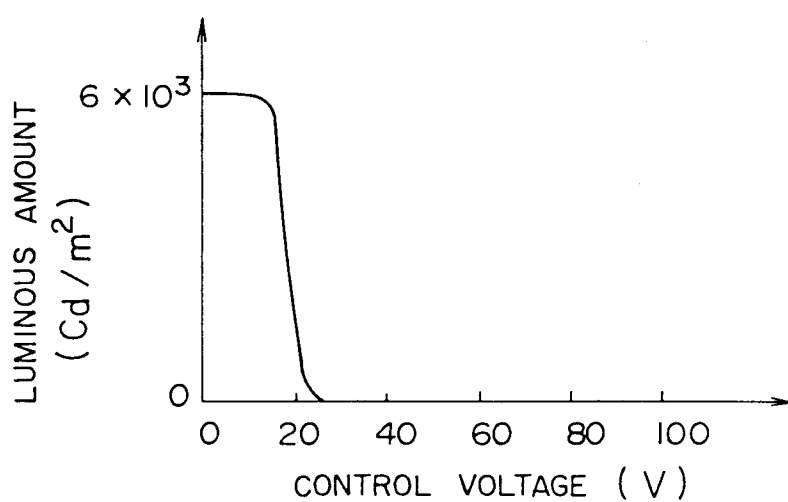


FIG. 31

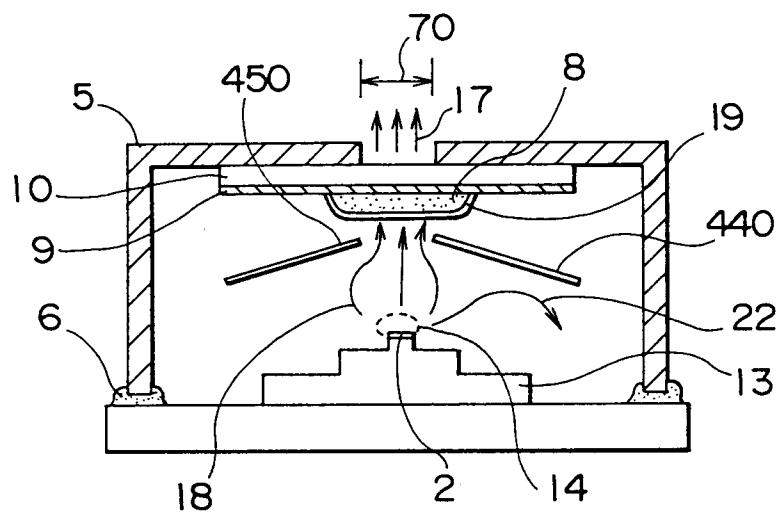


FIG. 32

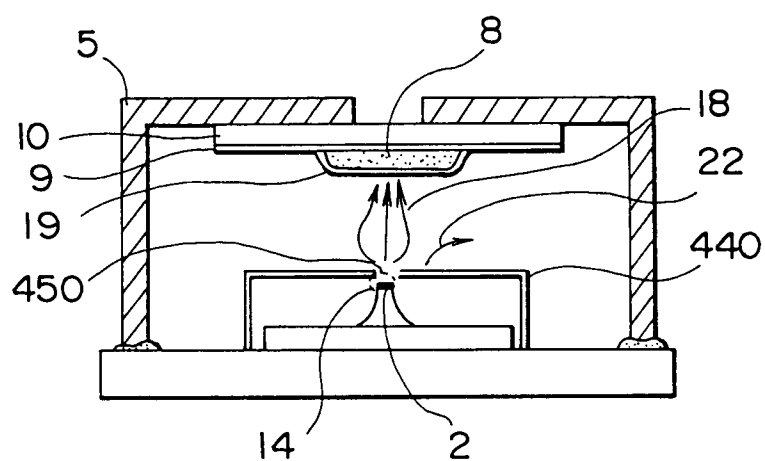


FIG. 33

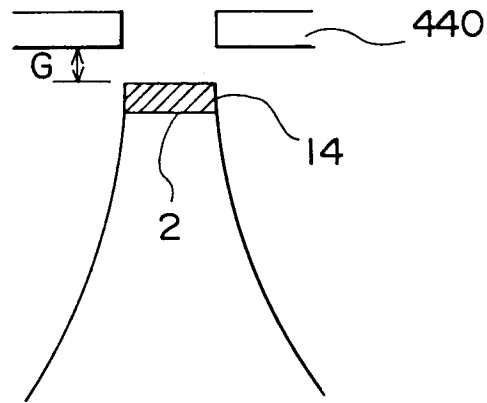


FIG. 34

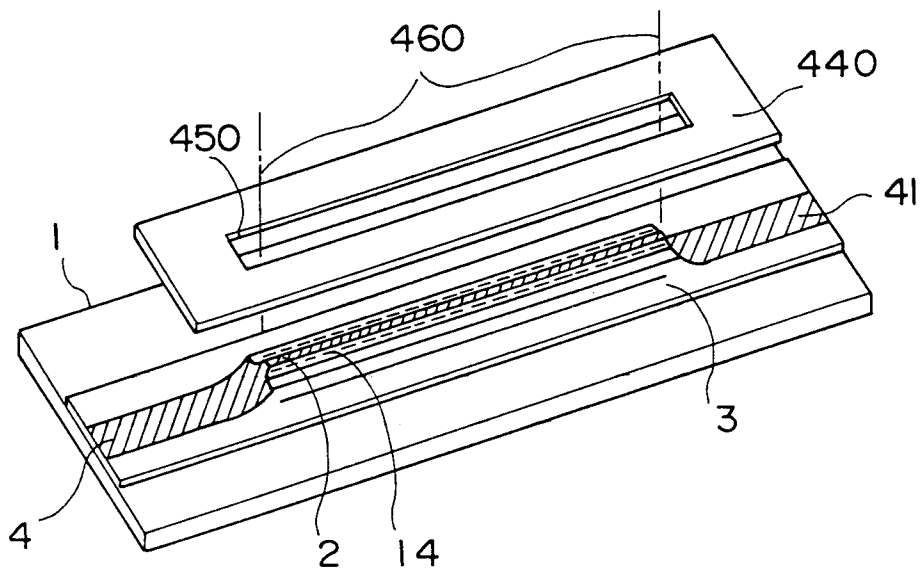


FIG. 35

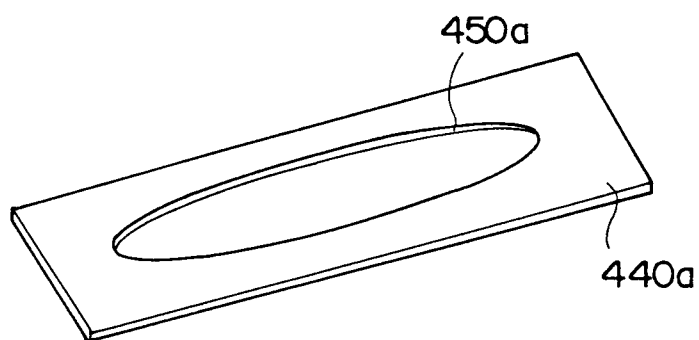


FIG. 36

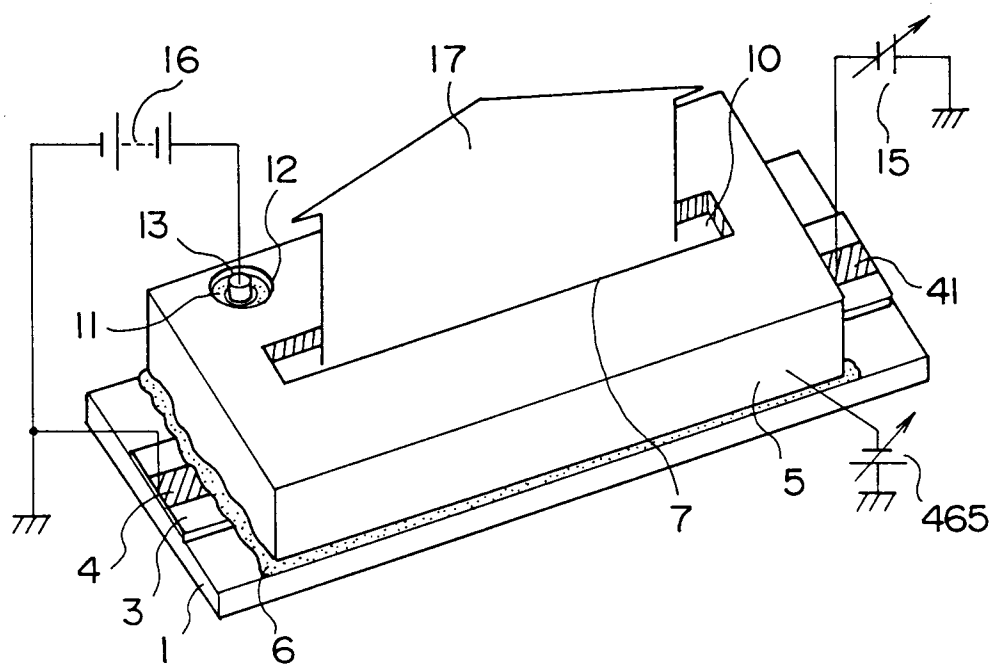


FIG. 37

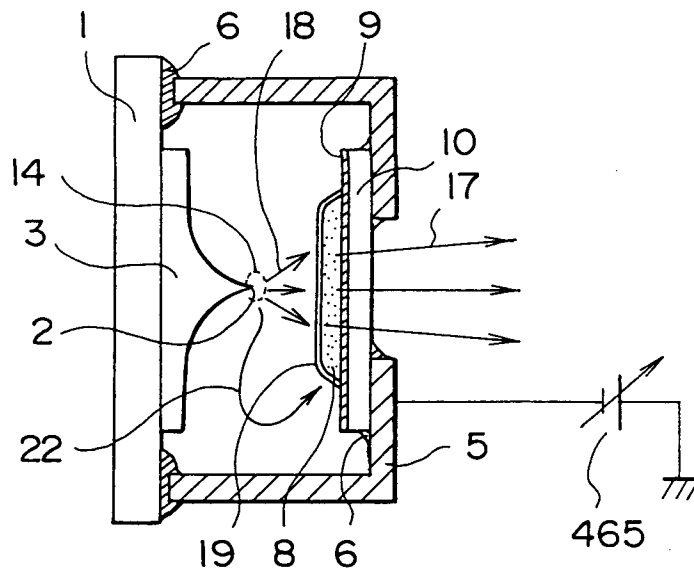


FIG. 38

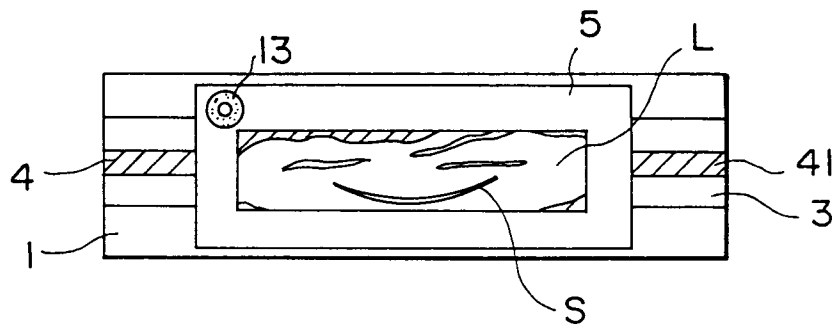


FIG. 39

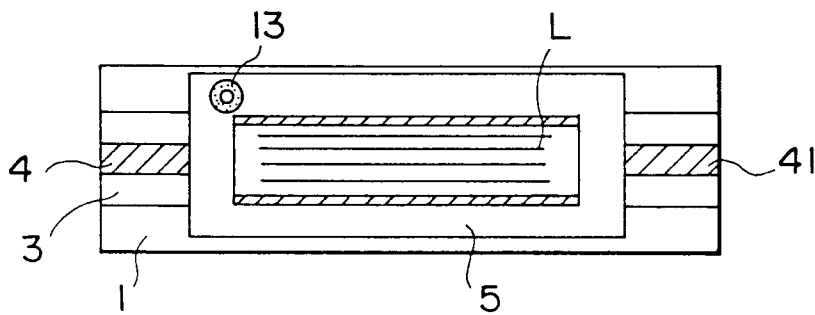


FIG. 40

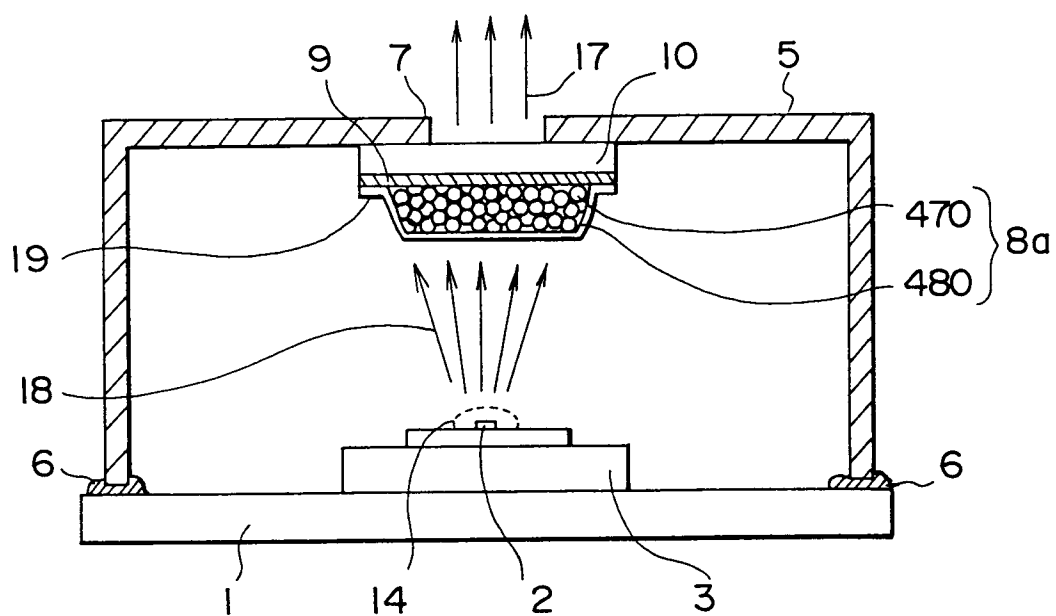


FIG. 41

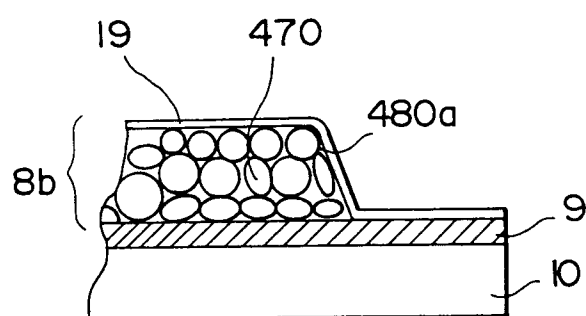


FIG. 42

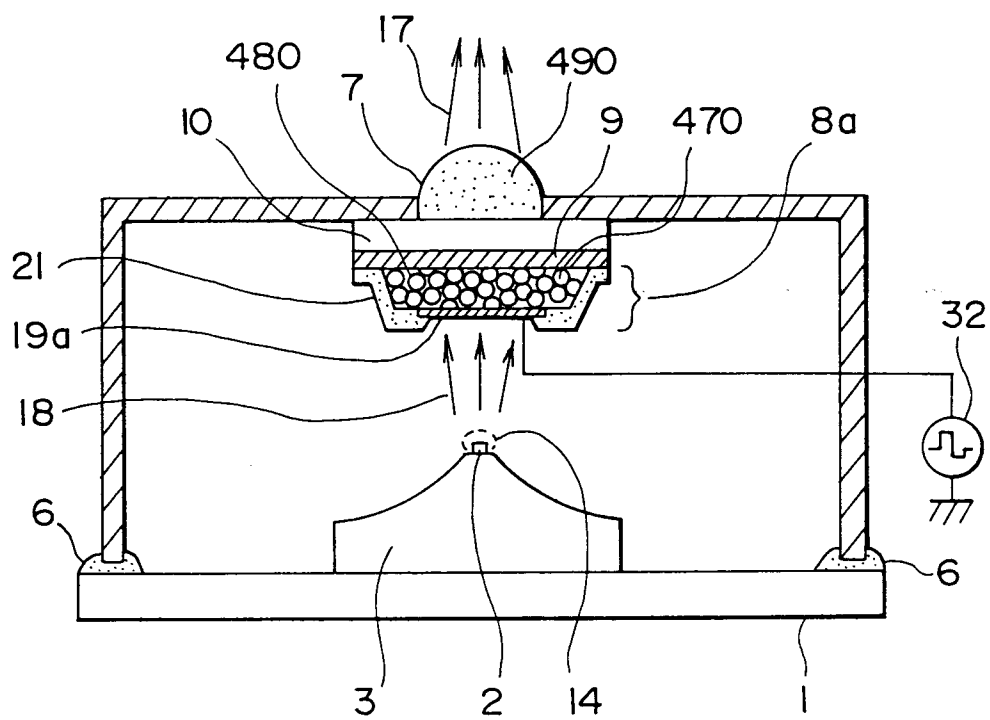


FIG. 43

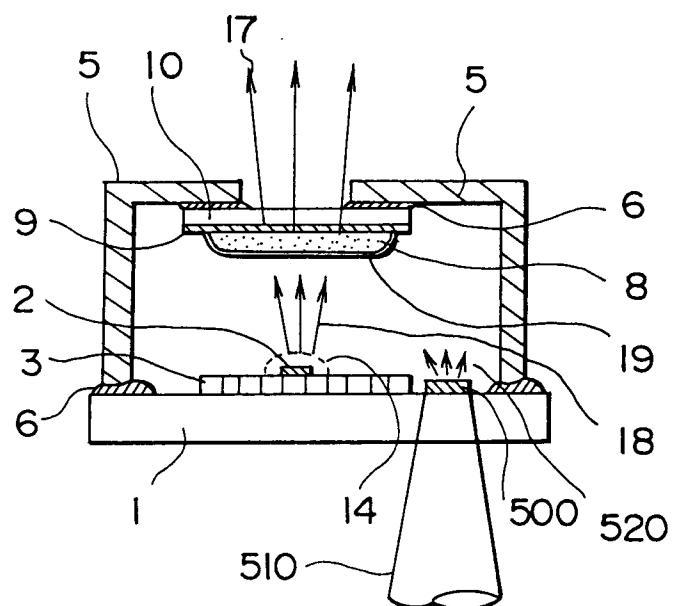


FIG. 44

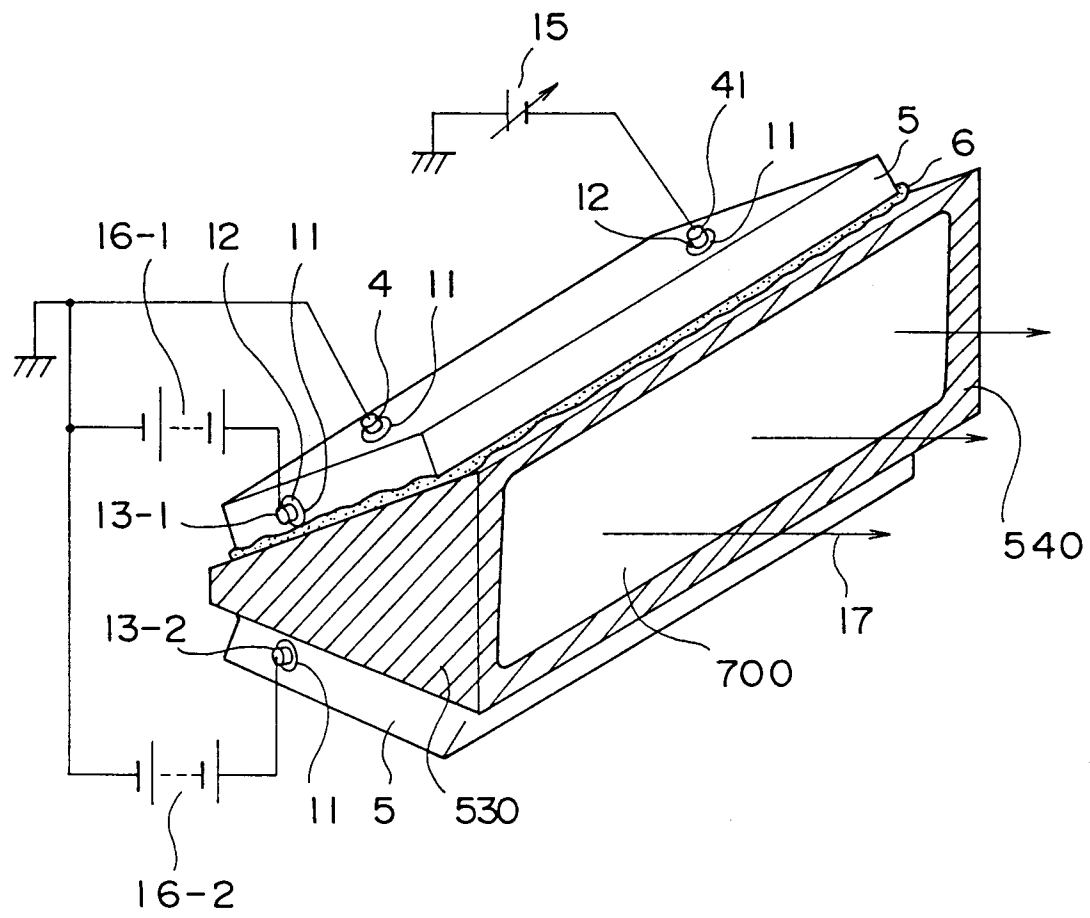


FIG. 45

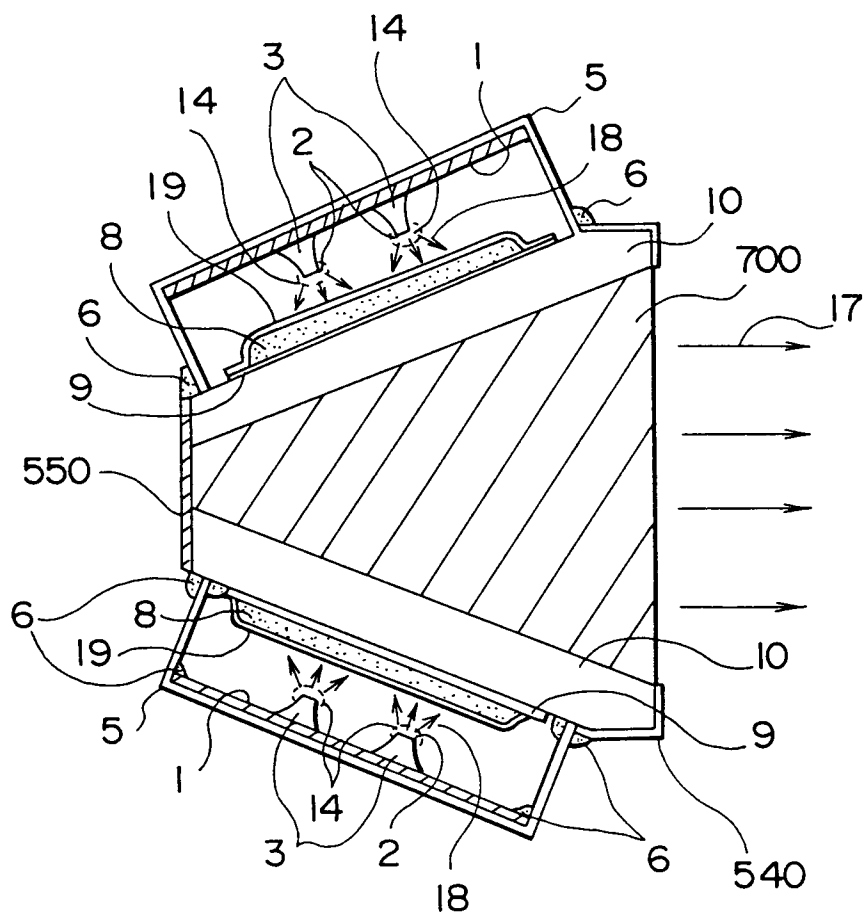


FIG. 46

INTERNATIONAL SEARCH REPORT

International Application No PCT/JP92/00214

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int. Cl ⁵ H01J63/06, 1/14		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
IPC	H01J63/00-63/06, H01J1/14-1/18	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
Jitsuyo Shinan Koho	1926 - 1992	
Kokai Jitsuyo Shinan Koho	1971 - 1992	
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
A	JP, U, 64-7754 (Ise Denshi Kogyo K.K.), January 17, 1989 (17. 01. 89), (Family: none)	1-19
A	JP, B1, 29-7060 (Hitachi, Ltd.), October 28, 1954 (28. 10. 54), (Family: none)	1
Y	JP, A, 60-100360 (English Electric Valve Co., Ltd.), June 4, 1985 (04. 06. 85), & EP, A2, 133360 & US, A, 4695765 & GB, B2, 2144575	8
Y	JP, A, 60-100361 (English Electric Valve Co., Ltd.), June 4, 1985 (04. 06. 85), & EP, A2, 133784 & US, A, 4695764 & GB, B2, 2144576	9
Y	JP, A, 2-267842 (Mitsubishi Electric Corp.), November 1, 1990 (01. 11. 90), (Family: none)	15-16
¹⁰ 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 document 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 "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		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
May 15, 1992 (15. 05. 92)	June 9, 1992 (09. 06. 92)	
International Searching Authority	Signature of Authorized Officer	
Japanese Patent Office		