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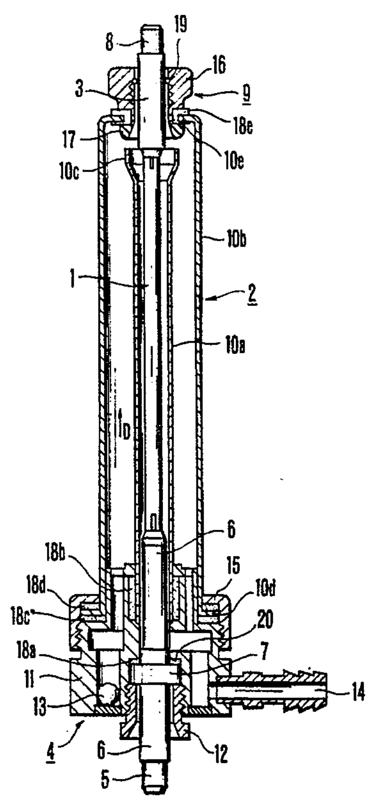
(54) Light source unit for using exposure.

(57) A light source unit for using exposure in a photomechanical process porving with a light emitting tube (1) insulating against cooling liquid and having a light transmissive jacket tube (2) fixed surrounding the light emitting tube (1) and may pass through light of wavelength desirable for exposure of the objects to be irradiated by absorbing light component of undesirable wavelength which the energy of absorbed light is removed by cooling liquid passed through therein. The unit also has a circuit for preventing a danger of electric shock by interrupting electric current of the electric source owing to the action of leak current detector by the action of current leaked from the terminals and others of said light emitting tube.

FIG.1



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Light Source Unit for using exposure

Field of the Invention

The present invention relates to light source unit for using exposure in a photomechanical process and the like, and more particularly to such type of light source unit which executes the suitable exposure to the object to be irradiated at the time of exposure and which secures safety against an electrical shock.

Prior Art

In the case of a conventional exposure device for using in a photomechanical process, it has been usual to provide an optical filter between the discharge lamp and the object to be irradiated, so as to obtain the desired ultraviolet light from the light source. The conventional light source unit with liquid cooling jacket is only used for preventing an increase in the temperature of the unit and working environment.

However, above known units have had the disadvantages that the irradiation objects have been properly exposed or they were not exposed at all in some other time, since the light suitable for the exposure does not always irradiate the objects since a part of light necessary to the exposure is absorbed.

Further, since the discharge lamp is applied with high voltage, it has been strongly desired to prevent a danger of occurrance of an electrical shock accident, but to set up countermeasures against them is troublesome and the problems have been hardly solved.

Summary of the Invention

In order to solve the above-mentioned problems, the present invention provides a light source unit having a unique structure. That is, according to the invention, the emitting tube are provided electric insulators sealed on the surface surrounding the terminals connected to the electrode of the light emitting tube and projected in the both sides of the tube with the exception of both ends of terminals, and the light transmissive jacket tube attached to the light emitting tube by using the metal fittings attached on the electric insulators so as to keep the above-mentioned insulated condition of the light emitting tube so that the cooling liquid introduced into the jacket tube from the supply port is circulated through the jacket tube and discharged outside as it remove the light absorbed through the jacket tube in the form of energy.

Further, the light-transmissive jacket tube is made of a material which allows the tube to serve as an optical filter capable of absorbing light components of wavelengths unnecessary for the light sensitive agent as an object to be irradiated and the jacket tube is made to have a single or composite structure so as to accurately absorbe and remove the light components unnecessary to the exposure. Moreover, if necessary, the cooling liquid itself is made to have the function of absorbing such light components. In addition, the neutral point of the secondary winding of a step-up transformer connected to the terminals of the electrode of the emitting tube is grounded through leak current detector so that the current (of the electric source) through the primary winding of the step-up transformer is interrupted by the action of the current flowing through the leak current detector.

The jacket tube of the light source unit is of a composite structure serving as a plurality of kinds of replaceable filters, it is possible to obtain light within a wavelength zone suitable for the photosensitive agent by removing light having wavelength unnecessary for the exposure. Especially, a cantilever light source unit as one embodiment of the present invention, in which the light emitting tube is provided with a double-structure light-transmissive jacket tube and cooling liquid supply and discharge ports are provided at one side of the unit, is advantageous in that the unit can be manufactured with ease since the structures of the required holding metal fittings are simple. Further, the light source unit for the exposure of the present invention is provided with the leak current detector on a line between the neutral point of the secondary winding of a step-up transformer and earth, in usually, electric current is not flow through the line, the (electric source) current through the primary side of the step-up transformer (electric soruce) interrupt when the leak-current flowed through the line. Therefore, there is no fear of the operator getting an electric shock even when he touches on the terminals and a line connected with the terminals, thereby securing safety.

Brief Description of the Drawings

Fig. 1 is a vertical sectional view of an essential portion of one embodiment of a light source unit according to the present invention; Fig. 2 is an example of a circuit diagram for the light source unit of Fig. 1; Fig. 3 is a view illustrating how a photomechanical process to which the present invention is applied is performed; Fig. 4 is a graph showing a main ultraviolet light spectra and given for illustrating the present invention; Fig. 5 is a vertical sectional view of an essential portion of a composite tube type cantilever light source unit according to the present invention with the view being given for illustrating how the unit operates; Fig. 6 is a vertical sectional view of a jacket tube employed in a single-structure tube type light source unit as another embodiment of the present invention; and Fig. 7 is a vertical sectional view of one end of a jacket tube of a single-tube type light source unit supported at both ends thereof.

Embodiments

Preferred embodiments of the present invention will now be described with reference to the accompanying drawings.

In Fig. 1 which is a sectional view of an essential part of an extra-high pressure mercury lamp serving as a light source unit as one embodiment of the present invention, a light-emitting section of the unit is represented by a transparent cylindrical light-emitting tube 1 whose both ends are closely fixed with first and second sylindrical insulating sections3 and 6, respectively, which are made of a highly insulating steatite material and whose diameters are somewhat larger than that of the light emitting tube 1 so that the ends are insulated from a cooling liquid and at the same time, the fixing portion of wall of the light-emitting tube and an electrode of the tube is kept insulated from the cooling liquid.

The lower end of the light-emitting tube 1 is inserted into substantially the center of a holding metal 11 and a flangelike stepped portion 7 of the second insulating section 6 is thrusted against a fixing stepped portion 20 of the holding metal 11 with a clamping screw 12 through a packing 18a.

Outside the light-emitting tube 1 there is concentrically arranged a transparent first jacket tube 10a whose inner diameter is larger that the outer diameter of the insulating section 3 or 6 of the tube 1 and whose upper end is open, and the lower end of the first jacket tube 10a is inserted into, and fixed to, the holding metal 11 with the screw 12 through a packing 18b so as to surround the second insulating section 6.

Further, outside the first jacket tube 10a there is arranged a transparent and cylindrical second jacket tube 10b forming a jacket section 2. The tube 10b has an upper end 10e of a reduced diameter and a lower end 10d of an increased diameter.

At a position above the light emitting tube 10a, the periphery of the upper end 10e of the second jacket tube 10b is fitted into an external annular groove of a packing 18e applied around a receiving member 17 fitted about the insulating section 3, and tightly fixed by a clamp member 16 having an O-ring packing 19 provided therein. The lower end of the jacket tube 10b is attached with a packing 18c which is applied to an upper annular flat portion of the abovementioned holding metal 11 and a fixing metal 15 is screw-fitted about the holding metal 11 through a packing 18d.

With the above structure, the liquid in the jacket tube 10b is prevented from leaking outside.

The holding metal 11 has a liquid supply port 13 which establishes between the first jacket tube 10a and the second jacket tube 10b a liquid passage leading thereto. Further, there is also provided another liquid passage between the second insulating section 6 and the first jacket tube 10a and a liquid discharge port 14 for discharging the liquid flowing through the passage. Consequently, the cooling liquid entering from the supply port 13 of the holding metal 11 effectively cools the light-emitting tube 1 as it flows between the first and second jacket tubes and then between the first jacket tube and the light-emitting tube and is discharged outside.

Fig. 2 is a diagram showing a power source circuit of the light source unit of the present invention. As shown, a high voltage is applied across terminals 5 and 8 of the light-emitting tube 1 from an AC power source 24 through a step-up transformer 25. On the secondary side of the transformer 25 there is provided a center tap 26 which is grounded through an leak-current detecting coil 27 having a normally open contact 28 which closes when an leak-current (for example, below 30 milli ampere) is detected. The contact 28 is connected in series with a solenoid 29 with the other ends of the contact and solenoid connected to the AC power source 24, respectively. Further, the primary side of the transformer 25 is provided with a normally closed switch 30 which is also connected to the AC power source. When an electric current leaked from the terminals and others is detected by the leak-current detecting coil 27, the normally open contact 28 closes and current of the electric source flows through the solenoid 29, thus, the normally closed switch 30 is opened owing to the action of the solenoid 29 and current of the electric source is cut off, thereby securing safety of the operator against an electrical shock.

Next, a manner in which the embodiment of the above structure operates when it is applied to a photomechanical process will be described. As shown in Fig. 3, a photosensitive layer 42 is bonded to a substrate 40 by means of a bond 41 thereby forming a photosensitive plate 43 as an object to be irradiated and then an image-forming film 44 is placed over the photosensitive plate 43. With this arrangement, the photomechanical process is performed in a vacuum such that when ultraviolet light C of a certain wavelength is appleid on the image-forming film 44, the light is interrupted at a positive section 44a of the film but passes through a negative section 44b of the film. As a result, a portion 42a of the photosensitive layer 42 formed on the substrate 40 corresponding to the negative section 44b is sensitized and a photomechanically processes form plate is obtained.

In this case, it is necessary to predetermine the wavelength of ultraviolet light to the irradiated on, and absorbed by, a photosensitive agent since the differs depending on the kind of the photosensitive agent. For example, where different kinds of photosensitive agents which absorb light components of different wavelengths such as λ_1 = 200 - 300nm, λ_2 = 200 - 400nm and λ_3 = 300 -400nm are selectively used as shown in Fig. 4, it is necessary to determine the optimum wavelength of ultraviolet light. Accordingly, when the main spectrum of the ultraviolet light from the light-emitting tube 1 is λ_1' = 253.7nm, a quartz glass filter having an optical filtering effect of λ_1'' = 200nm - 4mμ is used and when it is λ_2' = 360nm, a soda glass and a lead glass filter having an optical filtering effect of λ_2'' = 310nm - 2mμ are used. Further, when it is λ_3' = 414nm, a soda glass filter having an optical filtering effect of λ_3'' = 300nm -4mμ is us used. A combination of different glass filters may also be sued.

Accordingly, the kind of the light-emitting tube 1 is selected in advance according to the kind of the photosensitive agent used and the filtering effect is determined by selecting the first and second jacket tubes 10a and 10b. Then, as designated by the arrow D of Fig.5, the cooling liquid is circulated between the light-emitting tube 1 and the second jacket tube 10b and then between the tube 1 and the first jacket tube 10a so that the ultraviolet light C of the predetermined wavelength is made to reach a predetermined position outside the light-emitting tube 1. The lighting of the light-emitting tube 1 is effected by a high voltage generating from the step-up transformer 25 leading to the AC power source 24. In the event the secondary side of the transformer 25 becomes unbalanced to generate an current through the center tap 26, the current detecting coil 27 detects is so that the normally open contact 28 is closed and the normally closed switch 30 is opened thus interrupting the current through the primary side of the transformer 25 resulting in stopping the supply of power. Consequently, leakage of current from each terminal of the electrode and the danger of occurrence of an electrical shock can be prevented.

The cooling liquid from the cooling liquid supply port 13 enters the space between the first jacket tube 10a and the second jacket tube 10b to flow upward, then enters the space between the first jacket tube 10a and the light-emitting tube 1 to flow down along the tube 1 as it cools the heated tube 1 and is discharged from the cooling liquid discharge port 14. It is also possible to use a cooling liquid of the kind that is in itself capable of absorbing the heat energy of unnecesary components of light.

That is, as shown in Fig. 5, energy of the light unnecessary for exposure is removed by a part P1 of the cooling liquid between the light-emitting tube 1 and the first jacket tube 10a, then absorbed by the jacket tube 10a and removed by a part P2 of the cooling liquid between the first and second jacket tubes 10a and 10b.

Thus the energy of unnecessary light from the light-emitting tube 1 is absorbed and removed by the cooling liquid because the unnecessary rays of the light are interrupted by the optical filtering effects of the jacket tubes 10a and 10b and only ultraviolet rays necessary for exposure in a predetermined wavelength zone are irradiated outside as shown by the arrow C of Fig. 5. The irradiated ultraviolet light reaches the image-forming film 44 and the photosensitive plate 43. By the way, the jacket tubes 10a and 10b may be replaced with those which are capable of displaying desired optical filterig effects for removing unnecessary rays so as to obtain desired ultraviolet light.

Further, the jacket tube may be formed of a plurality of cylindrical elements having different optical filtering effects, respectively, and the cooling liquid may be circulated among the cylindrical elements themselves and between the elements and the light-emitting tube 1.

Although the above-described embodiment uses two jacket tubes 10a and 10b, a single jacket tube 31 may answer the purpose, too. (See Figs. 6 and 7). In that case, the cooling liquid is suppleid from one end of the tube and discharged from the other end and the light-emitting tube is supported at both ends thereof. The light emitting tube serving as a discharge lamp is arranged at the center of the jacket tube so that the energy of unnecessary rays from the light-emitting tube is removed by a part L1 of the cooling liquid and the heat of the wall of the tube 31 is absorbed and cooled by a part L2 of the cooling liquid. As shown in Fig. 6, in the case of the jacket tube whose both ends are funnel-shaped, the flow velocity of the cooling liquid becomes high at the narrow neck portion thereby increasing the cooling efficiency.

Fig. 7 is vertical sectional view of one end of a single layer jacket tube, wherein reference numeral 31 designates a light-emitting tube, reference numeral 33 designates an insulating section, reference numeral 35 designates terminals connecting to an electrode within the light-emitting tube and reference numeral 51 designates a stop member for the light emitting tube 31 with respect to a support member 50. The top end of the single-layer jacket tube 52 is sealed to the support member 50 by means of a fixing screw 54 through a packing 53. Further, the top end of the stop member 51 for the light-emitting tube 31 projecting from the support member is fixed to a top end 50a of the support member 50 by means of a receiving member 55 and a washer 56 and with the use of a fixing screw 57. Further, there is provided a cooling liquid supply port 59 between the jacket tube 52 and the stop member 51 for the light emitting tube 31 so as to establish communication with a cavity formed within the support member 50. Reference numeral 60 designates a ring packing provided between the top end 50a of the support member 50 and the receiving member 55 and reference numeral 61 designates a ring packing applied between the receiving member 55 and the washer 56. Further, in the case of the light-emitting tube which is supported at both ends thereof, the insulating section 33 at each end of the light-emitting tube 31 is made of a highly electric insulating material. Moreover, the ring packing 61 and the washer 56 are fastened to the insulating section 33 with the fixing screw 57 thereby preventing leakage of the cooling liquid with the terminals 35 at both ends of the light-emitting tube 31 being insulated from the cooling liquid. In this structure, the terminal 35 projects outside the jacket tube 52.

It should be noted that the present invention is applicable not only to the photomechanical process but also to various other optical devices.

As described above, the present invention has various advantages. That is, since the jacket tube of the invention has an optical filtering effect, light components of undesirable wavelengths can be absorbed and it is possible to obtain an exposure desirable for the objects to be irradiated by using light suitable for light sensitive agent and energy of light components of undesirable wavelength is removed, thereby overheating of the objects can be prevented. The present invention also provides an advantage of preventing a danger which may arise by the high voltage supplied to the light source.

Moreover, as the jacket tube serves as an optical filter and cooling liquid path, the structure of the light source unit can be simplified and miniaturized.

Claims

(1) A light source unit for using exposure providing with a light-emitting tube insulating against cooling liquid and having terminals projecting from both ends of said tube provided high electric insulating portions on the surface of the terminals with exception of the both ends of the terminals connected to the power supplying electrodes of the light emitting tube comprising, metal fittings fixed on the both high electric insulating portions sealing against cooling liquid and a light transmissive jacket tube surrounding the light emitting tube and fixed to the both metal fittings, said jacket tube being provided with a liquid supply port and a liquid discharge port so that a cooling liquid is forcibly circulated therein through said parts and made of a material having the function which pass through only light of wavelength suitable for exposure of an object to be irradiate and a circuit having a function which cut off the current of the electric source by action of leak of electric current for the light emitting tube.

(2) A light source unit for using exposure according to Claim 1, wherein said light-transmissive jacket tube is of a double-layer structure with respect to said light-emitting tube with one end of said jacket tube being supported in a cantilever fashion and said cooling liquid is supplied into and discharged from said jacket tube so as to circulate therethrough.

(3) A light source unit for using exposure according to Claim 1, wherein said light-transmissive jacket tube is of a single-layer structure surrounding said light-emitting tube, said light emitting tube is supported at both ends thereof and said cooling liquid is allowed to pass through said light-transmissive jacket tube only in one direction.

(4) A light source unit for using exposure according to Claim 2, wherein said double-layer light-transmissive jacket tube is made of a variety of materials capable of filtering transmitting light components in a different wavelength zone so as to allow a required light component to be irradiated.

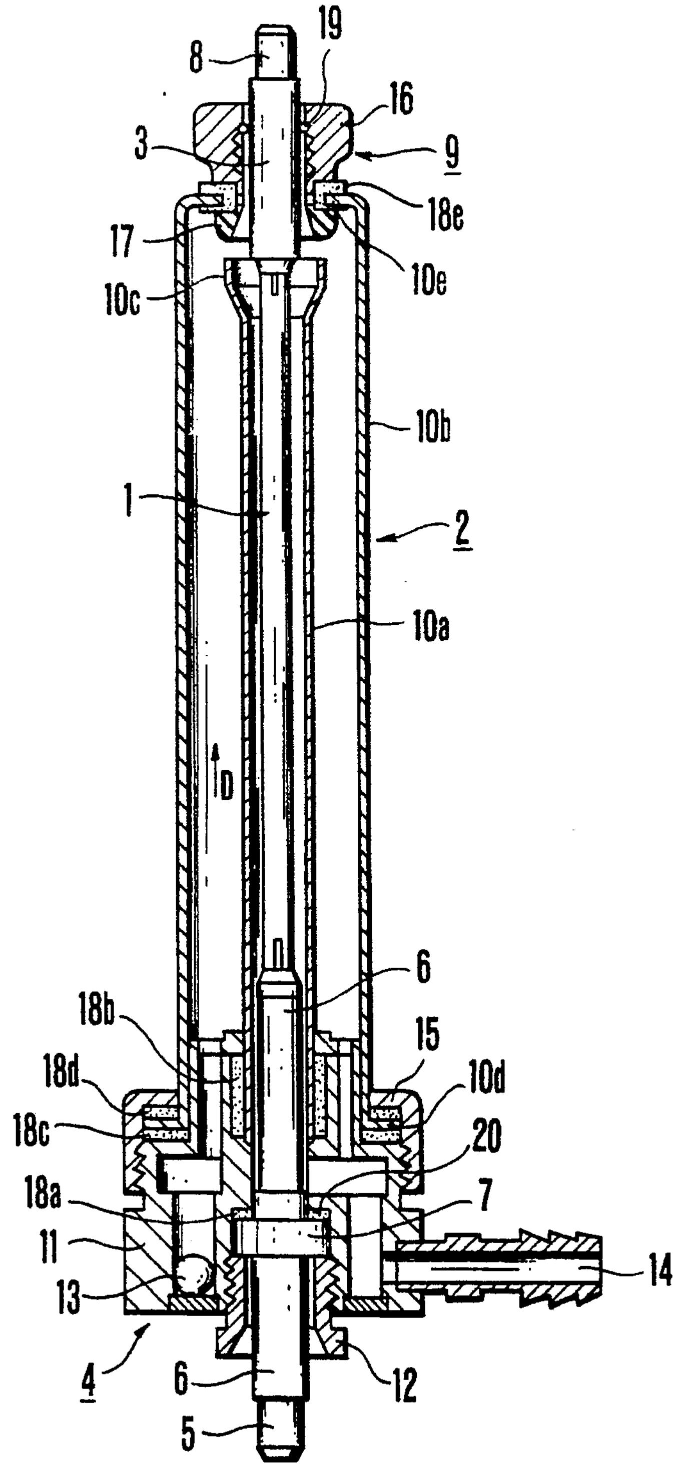
(5) A light source unit for using exposure according to Claim 2, wherein said double-layer light-transmissive jacket tube functions so that undesired light components in a different wavelength zone are removed by said cooling liquid when it is brought into contact with, and immersed in, said cooling liquid.

(6) A light source unit for using exposure according to Claim 2, wherein said double layer light-transmissive jacket tube comprises a plurality of cylindrical layers made of materials capable of displaying different optical filtering effects, respectively.

(7) A light source unit for using exposure according to Claim 1, wherein said light source unit has an electrical circuit including said power supply electrode, a step-up transformer connected to said

both terminals of said electrode and an leak-current detector such that the neutral point of a secondary winding of said transformer is grounded through the leak-current detector so that when an leak-current is detected by said leak-current detector, current flowing through a primary winding of said transformer is interrupted.

FIG.1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19
16
3
9
18e
17
10e
10c
10b
1
2
10a
D
6
18b
15
18d
10d
18c
20
18a
7
11
14
13
4
6
12
5

FIG.2

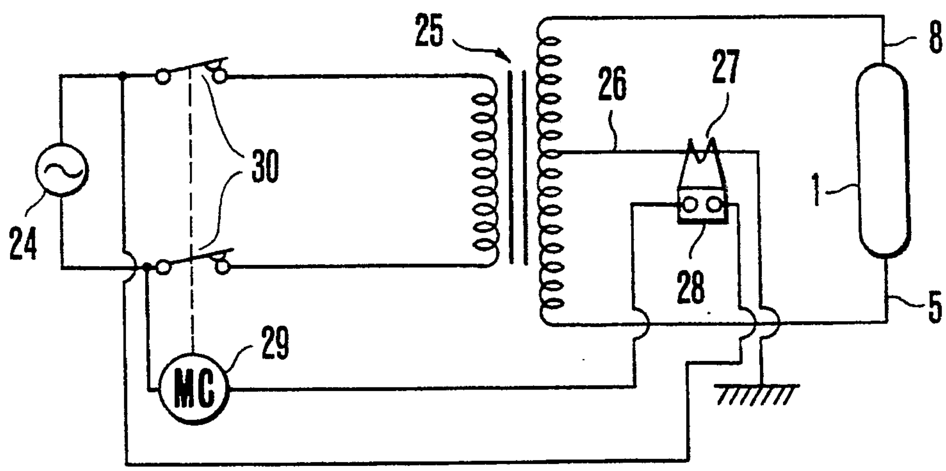


FIG.3

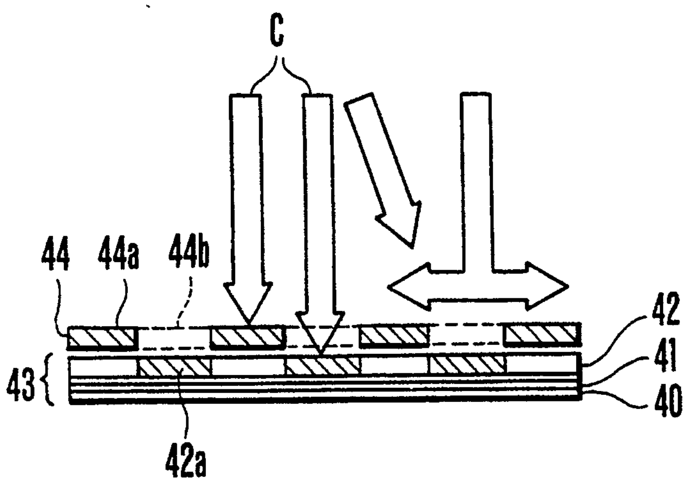
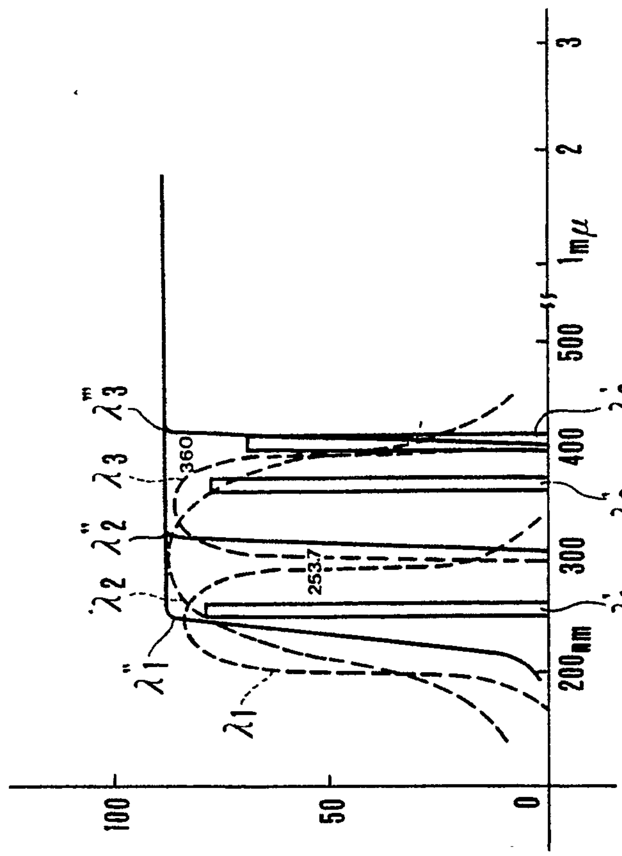


FIG.4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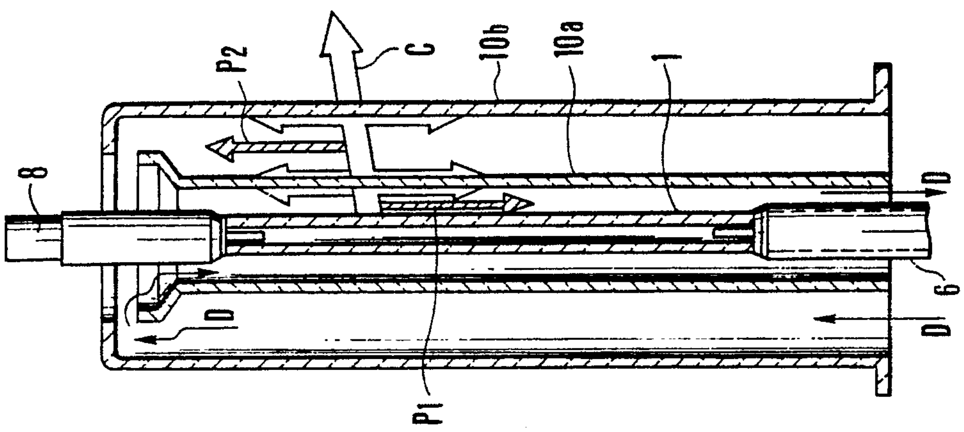
50
0
200nm
300
400
500
1mμ
2
3
253.7
360
λ1
λ1'
λ1''
λ2
λ2'
λ2''
λ3
λ3'
λ3'''

FIG.5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P2
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10b
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D
D
D
6
P1

FIG.6

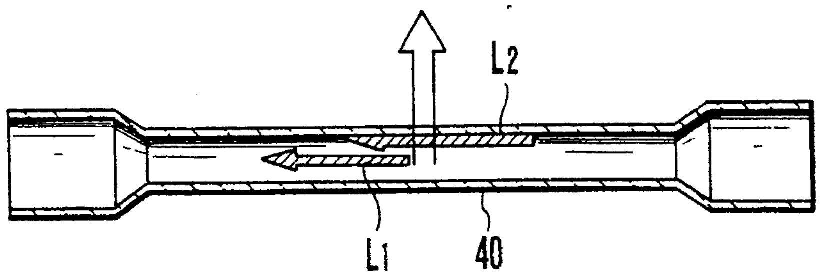

FIG.7