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(54) **Polymer coated lamps and their production.**

(57) Disclosed is a polymer layer coating on the outer surface of the envelope of high intensity discharge lamps, halogen lamps and similar lamps whose envelope can become heated, in use, to temperatures in excess of 200°C.

A first (overcoated) layer (39) is provided for preventing glass pieces of the envelope (11) from scattering should the glass envelope (11) break.

A strengthened layer comprises a fluorocarbon polymer containing metal oxide grains dispersed therein. For strengthening the first (overcoated) layer (39), it may have an even density of metal oxide grains in the fluorocarbon polymer, by means of an electrostatic coating step.

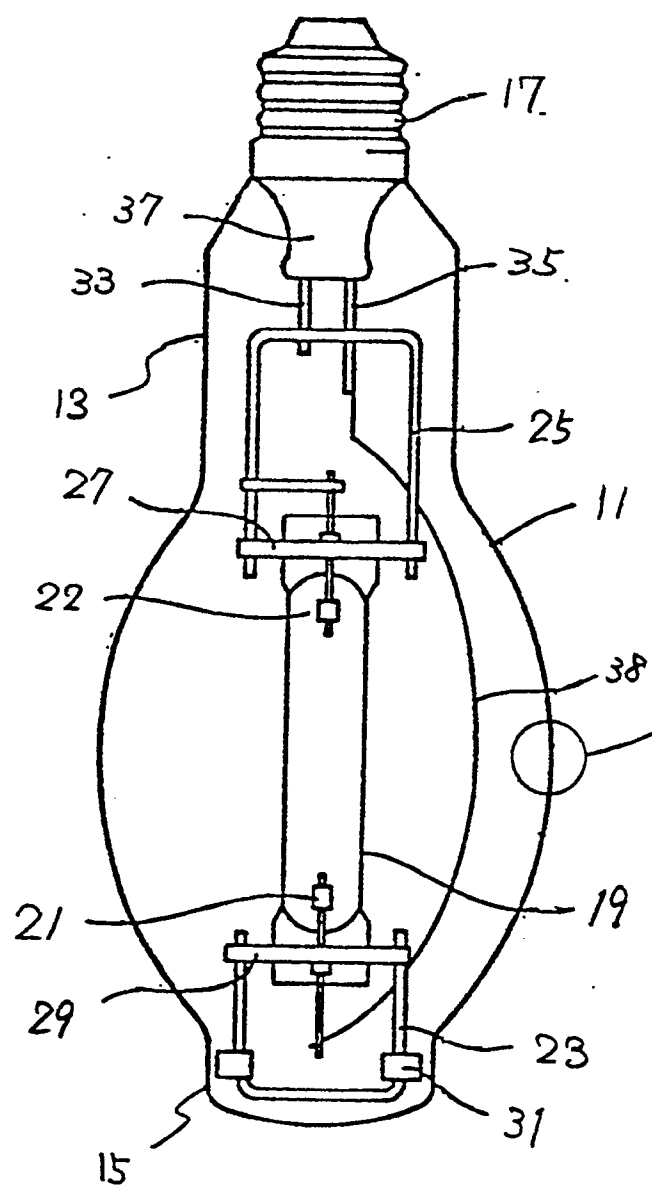


Fig. 1

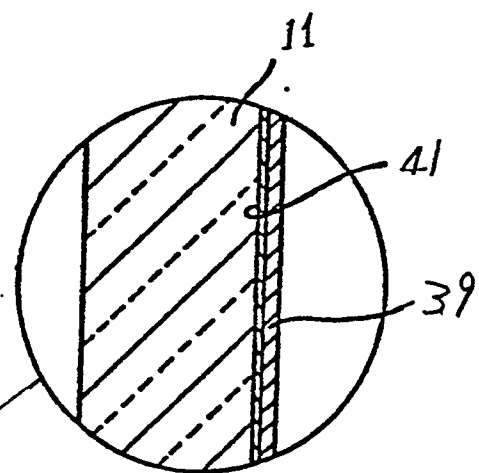


Fig. 2

The present invention relates to a lamp having a layer, which is made of fluorocarbon polymer, coated on an envelope thereof, and also relates to a method for forming the layer.

A lamp having a layer, which is made of fluorocarbon polymer, coated on a glass envelope of the lamp is known in this field. The layer is formed so as to prevent glass pieces of the glass envelope from scattering when the glass envelope of the lamp is broken. The fluorocarbon polymer is used as a material of the layer since the fluorocarbon polymer has a high melting temperature. Therefore, the layer of the fluorocarbon polymer is adapted especially to high intensity discharge lamps such as metal halide lamps whose outer envelopes have high temperature of more than 200 °C.

However, the conventional layer of the fluorocarbon polymer is not sufficient in its strength for high intensity discharge lamps. Therefore there is a demand to increase the strength of the layer of the fluorocarbon polymer on the outer glass envelope of the high intensity discharge lamp.

A strengthened layer of the fluorocarbon polymer is obtained by way of increasing the thickness of the layer of the fluorocarbon polymer. However in this case the lamp has a shortcoming in that the luminous flux of the lamp emitted from the outer glass envelope of the lamp decreases, because of light absorption by the layer of the fluorocarbon polymer.

Further lamps having an improved layer of the fluorocarbon polymer are shown in the Japanese Patent Laid Open Publications No. 60-71546 and No. 64-21855. The lamp shown in the 60-71546 publication has a layer of fluorocarbon polymer containing glass fibers. But the glass fibers are mixed into the fluorocarbon polymer for increasing the adhesive strength between the layer of the fluorocarbon polymer and the outer glass envelope of the lamp, and not for increasing the strength of the layer of the fluorocarbon polymer itself, in other words not for tensile strength. The layer of the fluorocarbon polymer of this lamp is not improved in its tensile strength.

The lamp shown in the 64-21855 publication has an under layer between the layer of the fluorocarbon polymer and the outer glass envelope of the lamp. The under layer is generally called a primer layer. The under layer shown in the 64-21855 publication contains metal oxide grains dispersed therein and is coated for the same reason as the glass fibers mixed into the fluorocarbon polymer. The layer of the fluorocarbon polymer of this lamp is not improved in its strength.

Accordingly, it is an object of the present invention to provide a strengthened layer of fluorocarbon polymer coated on the outer envelope of the lamp and to provide a method for manufacturing thereof.

In order to achieve the above mentioned object, the lamp according to the present invention com-

prises:

means for emitting light and heat;

an envelope surrounding said means and heated at more than 200 °C by said means; and

an first layer coated on the outside of said envelope, said layer comprising a fluorocarbon polymer containing metal oxide grains dispersed therein.

In the accompanying drawings:

Fig. 1 is a front view of a metal halide lamp according to a first embodiment of the present invention;

Fig. 2 is a partial sectional view of Fig. 1;

Fig. 3 is a graph for explaining a relation between tensile strength of the overcoated layer of the lamps and the weight ratio of the metal oxide grains dispersed in the overcoated layer;

Fig. 4 is a graph for explaining a relation between luminous flux of the lamps and the weight ratio of the metal oxide grains dispersed in the overcoated layer;

Fig. 5 is a graph for explaining a relation between intensity of UVB emitted from the lamps and an amount of the metal oxide grains dispersed in the overcoated layer;

Fig. 6 is a graph for explaining a relation between luminous flux of the lamps and an amount of the metal oxide grains dispersed in the overcoated layer;

Fig. 7 is a front view of a metal halide lamp according to a second embodiment of the present invention;

Fig. 8 is a partial sectional view of Fig. 7; and

Fig. 9 is a partial sectional view of a third embodiment of the present invention.

Referring to the accompanying drawings, embodiments of the present invention will be described. However, in the drawings, the same numerals are applied to the similar elements in the drawings, and therefore the detailed descriptions thereof are not repeated.

Fig. 1 is a front view of a metal halide lamp according to the first embodiment of the present invention.

The metal halide lamp has an outer envelope 11 made of hard glass. The outer envelope 11 forms a shape, so called BT-shape, swelling around a centre thereof and forms thin portions at both ends of the outer envelope 11 as compared with a portion around the centre of the outer envelope 11. One thin portion is a neck portion 13 and the other is a top portion 15. The neck portion 13 has a base 17 for attaching the lamp to lighting equipment (not shown) and for receiving electric power.

The outer envelope 11 includes an inner tube 19 therein. The inner tube 19 is made of quartz glass. A pair of electrodes 21 and 22 are provided at both ends in the inner tube 19. A rare gas as a starting gas such

as argon and a discharge gas such as may be derived from mercury, sodium halide and scandium halide are sealed in the inner tube 19.

The inner tube 19 is supported in the outer envelope 11 by a pair of supporting wires 23 and 25 and a pair of insulated holders 27 and 29. The one supporting wire 23 is fixed by elastic members 31 and 31 at the top portion 15 and the other supporting wire 25 is connected with and supported by the lead wire 33 which is mounted to a stem portion 37. The electrode 21 is connected electrically with the other lead wire 35 through a connecting wire 38. The other electrode 22 is connected electrically with the other supporting wire 25. Both of the lead wires 33 and 35 are connected electrically with the base 17. Accordingly, both of electrodes 21 and 22 are connected electrically with the base 17.

An overcoated layer 39 is coated on an outside outer glass envelope 11 shown in Fig. 2 which indicates a partial sectional view of the outer glass envelope 11 of the lamp. The overcoated layer 39 essentially consists of fluorocarbon polymer containing metal oxide grains (not shown) dispersed therein and has a thickness of about 100 μm . An undercoated layer 41 is formed between the overcoated layer 39 and the outer surface of the outer glass envelope 11.

The fluorocarbon polymer of this embodiment essentially consists of tetrafluoroethylene - perfluoroalkylvinylether copolymer (called PFA) (MP-103; available from MITSUI DUPONT FLUOROCHEMICAL CO., LTD in Japan), but other fluorocarbon polymers, for example tetrafluoroethylene -hexafluoropropylene copolymer (called FEP), tetrafluoroethylene -hexafluoropropylene-perfluoroalkylvinylether copolymer (called EPE) (available from MITSUI DUPONT FLUOROCHEMICAL CO., LTD in Japan) and so on, may be used. The metal oxide grains of this embodiment consist of zinc oxide (ZnO) (available from SUMITOMO SEMENTO CO., LTD in Japan) and titanium oxide (TiO_2) (available from SUMITOMO SEMENTO CO., LTD in Japan), but other metal oxide, for example tantalum oxide (Ta_2O_5), silicon oxide (SiO_2), aluminium oxide (Al_2O_3) and so on, may be used. The weight of metal oxide grains is 1 % by weight of fluorocarbon polymer. An average particle size of grains of zinc oxide (ZnO) and titanium oxide (TiO_2) is about 0.02 μm , and the weight of zinc oxide (ZnO) and the weight of titanium oxide (TiO_2) are the same as each other.

The undercoated layer 41 is formed by coating a mixed agent, generally called a primer, of a noionic surface active agent (458-500; available from MITSUI DUPONT FLUOROCHEMICAL CO., LTD in Japan), a certain amount of silicon oxide (SiO_2) grains and aluminium oxide (Al_2O_3) grains on the outer surface of the outer glass envelope 11 and drying the coated agent. It is necessary to eliminate fats and oils from

the outer surface of the outer glass envelope 11, for example, by washing or baking before coating the mixed agent.

After coating the undercoated layer 41, the overcoated layer 39 is formed by steps including a well known electrostatic coating method. The first step is preparing a mixed powder containing the powder of the fluorocarbon polymer, the powder of zinc oxide (ZnO) grains and the powder of titanium oxide (TiO_2) grains. The detail of each powder is described above. The next step is coating the mixed powder on the surface of the undercoated layer 41 in an area of the undercoated layer 41 by the electrostatic coating method. In this case, the undercoated layer 41 works as an electrode attracting charged particles of powder. Therefore, the overcoated layer 39 is formed only on the undercoated layer 41. The next step is heating the powder coated on the surface of the outer glass envelope 11 at a temperature of 310 $^{\circ}\text{C}$ to 400 $^{\circ}\text{C}$ in order that the powder of the fluorocarbon polymer melts and forms a continuous layer of the fluorocarbon polymer, i.e. the overcoated layer 39. As is understood from the above description, the undercoated layer 41 is coated not only in order to increase the adhesive strength of the overcoated layer 39 with respect to the outer surface of the outer glass envelope 11 but also in order to form the overcoated layer 39.

According to the above described method, the overcoated layer 39 has an even density of the metal oxide grains at any position thereof because the above described method does not use liquid, and is not wet coating. Therefore the metal oxide grains do not collect or aggregate unevenly during forming of the overcoated layer 39. In other words, the above described method does not have the disadvantage that the metal oxide grains would collect at one side of the envelope during drying of the coating liquid because of the effect of gravity. Moreover the overcoated layer 39 has an even thickness at any position thereof since the above described method does not use liquid and therefore does not have the defect that coating liquid would flow and drop toward one side of the envelope during the step for drying the coating liquid.

Fig. 3 shows measured results of tensile strength of the overcoated layer 39 of the lamps when the weight ratio of the metal oxide grains dispersed in the overcoated layer 39 is varied. In Fig. 3, a horizontal axis indicates the weight ratio of the metal oxide grains and a vertical axis indicates relative value of the tensile strength of the overcoated layer 39, and 100% means the tensile strength in case of the overcoated layer 39 without the metal oxide grains. As described above, an average particle size of the metal oxide grains is 0.02 μm and the thickness of the overcoated layer 39 is about 100 μm .

According to the measured results of Fig. 3, the tensile strength increased, accompanied by an

increase of the weight ratio of the metal oxide grains in the range of more than 0.05% of the metal oxide grains.

The reason why the tensile strength increased is thought to be that the metal oxide grains dispersed between overlapped fluorocarbon polymer molecules of the overcoated layer 39 prevent slipping between fluorocarbon polymer molecules. Moreover, the following is supposed. As the overcoated layer 39 formed by the above described method has the even density of the metal oxide grains at any position thereof and there is no position that has extremely low density of the metal oxide grains, there is no position that has an extremely weak tensile strength as compared with other positions. It is thought that the tensile strength increased because of the above described reason.

Similar results were obtained in cases of other kinds of metal oxide grains and different particle sizes.

Fig. 4 shows measured results of luminous flux of the lamps, varying the weight ratio and the average particle size of the metal oxide grains dispersed in the overcoated layer 39. In Fig. 4, a horizontal axis indicates the weight ratio of the metal oxide grains and a vertical axis indicates relative value of the luminous flux of the lamps, and 100% means the luminous flux of the lamps in case that the overcoated layer 39 does not have the metal oxide grains. The three lines (a), (b) and (c) correspond to the average particle size of 0.02 μm , 0.1 μm and 0.2 μm respectively.

According to the measured results of Fig. 4, the luminous flux decreased, accompanied by an increase of the weight ratio of the metal oxide grains. This indicates that the metal oxide grains of the overcoated layer 39 absorb the light. In this case, the decrease of the luminous flux was not so much within the range of 3 % of the weight ratio of the metal oxide grains, but it was too much beyond the range of 3 % of the weight ratio of the metal oxide grains. It is also understood that the decrease of the luminous flux was too much when the particle size was more than 0.1 μm even if the weight ratio of the metal oxide grains was small. When the weight ratio of the metal oxide grains is too much, the overcoated layer 39 may have the defects of opacity or non-transparency.

Similar results were obtained for other types of metal oxide grains.

Accordingly, the preferable range of the particle size of the metal oxide grains was determined to be not more than 0.1 μm and the preferable range of the weight ratio of the metal oxide grains was determined to be from 0.05 to 3 %.

Fig. 5 shows measured results of intensity of ultraviolet rays emitted from the lamps, varying the weight ratio (M wt%) of the metal oxide grains dispersed in the overcoated layer 39 and the thickness (t μm) of the overcoated layer 39. The metal oxide grains of the lamps comprise titanium oxide (TiO_2)

and zinc oxide (ZnO) as described above. The ultraviolet rays of wavelength 280 - 320 nm, which is called UVB, was measured. In Fig. 5, a horizontal axis indicates an amount (Mxt) of the metal oxide grains dispersed in the overcoated layer 39. The amount (Mxt) of the metal oxide grains dispersed in the overcoated layer 39 is defined as a multiple of the weight ratio (M) of the metal oxide grains and the thickness (t) of the overcoated layer 39. A vertical axis indicates relative intensity of UVB emitted from the lamps and 100 % means the intensity of UVB where the overcoated layer 39 does not contain the metal oxide grains.

As shown in Fig. 5, the intensity of UVB emitted from the lamp decreased, accompanied by an increase of the weight ratio (M) of the metal oxide grains and the thickness (t) of the overcoated layer 39. Especially, the intensity of UVB emitted from the lamp which has, as described above, 100 μm thickness of the overcoated layer 39 containing 1 % weight of the metal oxide grains of titanium oxide (TiO_2) and zinc oxide (ZnO) decreases under a hundredth as much as the intensity of UVB emitted from the lamp having the overcoated layer 39 not containing the metal oxide grains. Further, the intensity of UVB emitted from the lamp which has 5 wt% μm (=Mxt) of the amount of the metal oxide grains is a half of the intensity of UVB emitted from the lamp having the overcoated layer 39 not containing the metal oxide grains. In general, it is understood that the effect of suppressing fading is obtained by decreasing the intensity of the UVB by a half. Therefore, preferred lamps have more than 5 wt% μm (=Mxt) of the amount of the metal oxide grains in order to suppress fading. Similar results were obtained with regard to the lamps which have the overcoated layer 39 containing different particle sizes of the metal oxide grains, and were also obtained in lamps which have the overcoated layer 39 containing different types of metal oxide grains such as only titanium oxide (TiO_2), only zinc oxide (ZnO) or a mixture comprising cerise oxide (CeO).

Fig. 6 shows the relation between luminous flux of the lamp and the amount (Mxt) of the metal oxide grains. In Fig. 6, a horizontal axis indicates the amount (Mxt) of the metal oxide grains and a vertical axis indicates relative value of the luminous flux of the lamp, and 100 % means the luminous flux of the lamp whose overcoated layer 39 does not have the metal oxide grains, or 100 % means the luminous flux of the lamp which does not have the overcoated layer 39. Fig. 6 was obtained under the condition that the metal oxide grains consisted of the same amounts of titanium oxide (TiO_2) and zinc oxide (ZnO) which had an average particle size of about 0.02 μm and that the overcoated layer 39 had a thickness of about 100 μm .

As shown in Fig. 6, the intensity of the luminous flux emitted from the lamp decreased, accompanied by an increase of the weight ratio (M) of the metal

oxide grains and the thickness (t) of the overcoated layer 39. These results coincide with the measured results shown in Fig. 4. In this case, the decrease of the luminous flux was not so much within 300 (wt% $\times\mu\text{m}$) of the amount of the metal oxide grains, but it was too much beyond 300 (wt% $\times\mu\text{m}$) of the amount of the metal oxide grains. Further the overcoated layer 39 may have defects of opacity or non-transparency where the amount (Mxt) of the metal oxide grains is beyond 300 (wt% $\times\mu\text{m}$), the same as the results according to Fig. 4.

Similar results were obtained for other types of metal oxide grains and for different particle sizes of the metal oxide grains.

According to the measured results regarding to Fig. 5 and Fig. 6, the preferred amount of the metal oxide grains satisfies the following relationship:

$$5 \leq M \times t \leq 300$$

Fig. 7 and Fig.8 show a second embodiment of the present invention. In the drawings, the same numerals are applied to the similar elements to the first embodiment, and therefore detailed description thereof is not repeated.

The weight ratio (or density) of the metal oxide grains of the overcoated layer 39 of the lamp of this embodiment varies according to positions of the overcoated layer 39. This is the only difference between the lamp of this embodiment and the lamp of the first embodiment. The weight ratio of the metal oxide grains of the overcoated layer 39a is 0.75 wt% at the top side area A of the lamp including the top portion 15 of the envelope 11, and the weight ratio of the metal oxide grains of the overcoated layer 39b is 1 wt% at the base side area B of the lamp including the neck portion 13 of the envelope 11. A boundary between the top side area A and the area base side B is positioned at the thickest portion of the envelope 11. The thickness of the overcoated layer 39 is 100 μm on both sides, as in the first embodiment. The other elements of this embodiment are the same as the first embodiment.

The lamp having two kinds of overcoated layers is obtained by preparing two kinds of coating mixtures having different weight ratios of the metal oxide grains and by coating each mixture on the specific area of the envelope 11 in two steps.

It was found that the metal oxide grains dispersed in the overcoated layer 39 disturbed radiation of heat from the lamp. Considering this fact, it is preferred that the weight ratio (or density) of the metal oxide grains at the portion of the envelope 11 tending to have high temperature be lower than that at the portion of the envelope 11 tending to have low temperature. Generally, these kinds of lamps, having a single base, are frequently attached to lighting equipment for use where the base is upward, and accordingly the top side area A of the envelope 11 tends to have high temperature. Therefore, the weight ratio of the metal

oxide grains at the top area A of the envelope 11 is preferably lower than that at the base area B of the envelope 11, so as to radiate heat effectively from the lamp.

As shown in Fig. 9, instead of varying the weight ratio of the metal oxide grains according to the area of the envelope 11, it may be possible to vary the thickness of the overcoated layer 39 according to the top area A and the base area B, keeping a set value of the weight ratio of the metal oxide grains in both areas. In this case, thickness of the overcoated layer 39a at the top area A of the envelope 11 is thinner than that of the overcoated layer 39b at the base area B of the envelope 11.

The present invention may be applied not only to the metal halide lamps described above, but also to high intensity discharge lamps such as high pressure sodium lamps, high pressure mercury discharge lamps and so on. Further, the present invention may be applied to halogen lamps. In this case, a tungsten filament emits light and heats an envelope, which is usually made from quartz glass, at more than 200 °C. Therefore the present invention is also suitable for halogen lamps.

In summary, it will be seen that the present invention overcomes or otherwise mitigates the disadvantages of the prior art and provides an improved layer for preventing glass pieces from scattering should the glass envelope of the lamp be broken.

Claims

1. A lamp comprising:
 - means (19), (21), (22) for emitting light and heat;
 - an envelope (11) surrounding said means (19), (21), (22) capable of being heated to a temperature greater than 200 °C by said means (19), (21), (22); and
 - a first layer (39) coated on the outside of said envelope (11), said layer (39) comprising a fluorocarbon polymer containing metal oxide grains dispersed therein.
2. A lamp according to claim 1, wherein said metal oxide grains comprise at least one of the following: TiO_2 , ZnO_2 , SiO_2 , Ta_2O_5 , Al_2O_3 and CeO .
3. A lamp according to claim 1 or 2, wherein the average particle size of said metal oxide grains is not more than 0.1 μm .
4. A lamp according to any preceding claim, wherein the weight ratio of said metal oxide grains to fluorocarbon polymer is 0.05 % to 3%.

5. A lamp according to any preceding claim, wherein said means emits ultraviolet rays and said metal oxide grains suppress said ultraviolet rays.
6. A lamp according to claim 5, wherein said metal oxide grains comprise at least one of the following:
TiO₂, ZnO₂ and CeO.
7. A lamp according to claim 5 or 6, wherein the weight ratio (M wt%) of said metal oxide grains and the thickness (t μm) of said overcoated layer (39) satisfy the following relation:
$$5 \leq M \times t \leq 300.$$
8. A lamp according to any preceding claim, further comprising a second layer (41) formed between said envelope (11) and said first layer (39) for increasing the adhesive strength of said first layer (39) to said envelope (11).
9. A lamp according to any preceding claim, being a high intensity gas discharge lamp wherein said means (19), (21), (22) is a light emitting tube having an inner tube (19), a discharge gas contained in or capable of being generated in said inner tube (19) and a pair of electrodes (21), (22) disposed in said inner tube (19), so as to emit light and heat generated by discharge of said discharge gas.
10. A lamp according to any preceding claim, wherein said first layer has a plurality of portions of varying thickness and/or varying weight ratio portions of said metal oxide grains, such as one or more thick portions optionally (39b) of high weight ratio and one or more thin portions optionally of low weight ratio of said metal oxide grains
11. A lamp according to claim 10, further comprising a base (17), attached to a position of said envelope (11) corresponding to said thick portion (39b) of said first layer (39), so as to obtain electric power and to supply said electric power to said means (19), (21), (22).
12. A method for forming a layer comprising a fluorocarbon polymer containing metal oxide grains onto an envelope (11) of a lamp, comprising:
 - preparing a mixed powder containing said metal oxide grains and powder of said fluorocarbon polymer;
 - coating said mixed powder to said envelope (11) by electrostatic coating means; and
 - melting said powder of said fluorocarbon polymer by heating so as to form a continuous layer comprising said fluorocarbon polymer con-
13. A method for forming a layer according to claim 12, further comprising forming a primer layer (41), which is electroconductive, on said envelope (11), before coating said mixed powder.
14. A method for forming a layer according to claim 12 or 13, wherein said primer layer (41) contains metal oxide grains.
15. Use of a method for forming a layer as claimed in any one of claims 12 to 14 in the production of a lamp as claimed in any one of claims 1 to 11.

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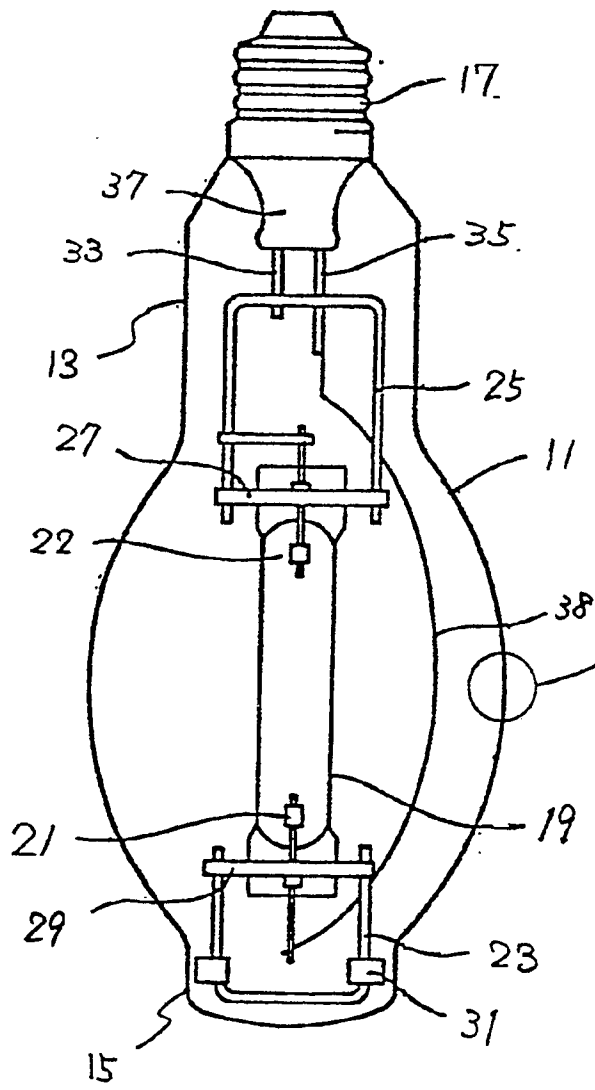


Fig. 1

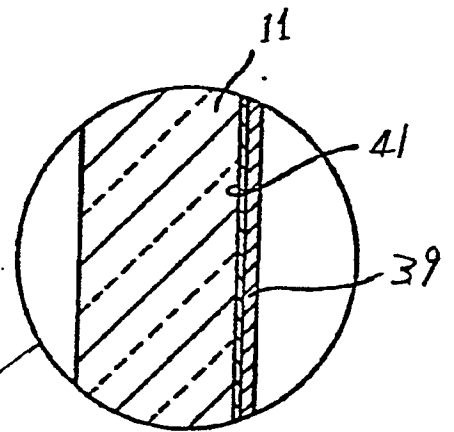


Fig. 2

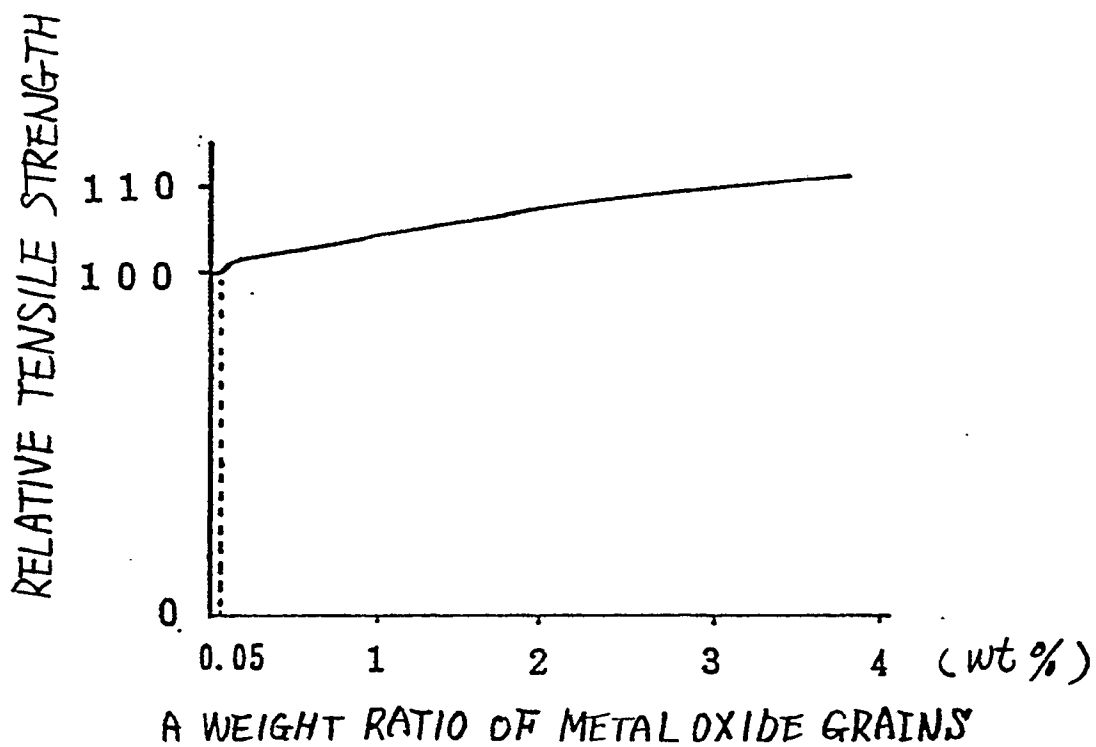


Fig. 3

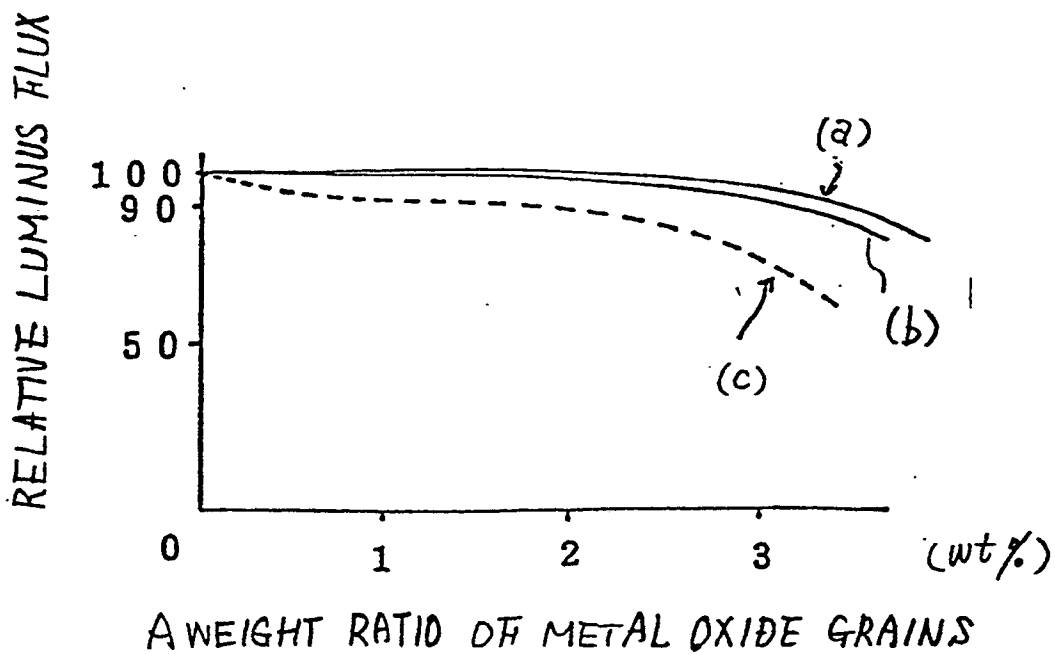


Fig. 4

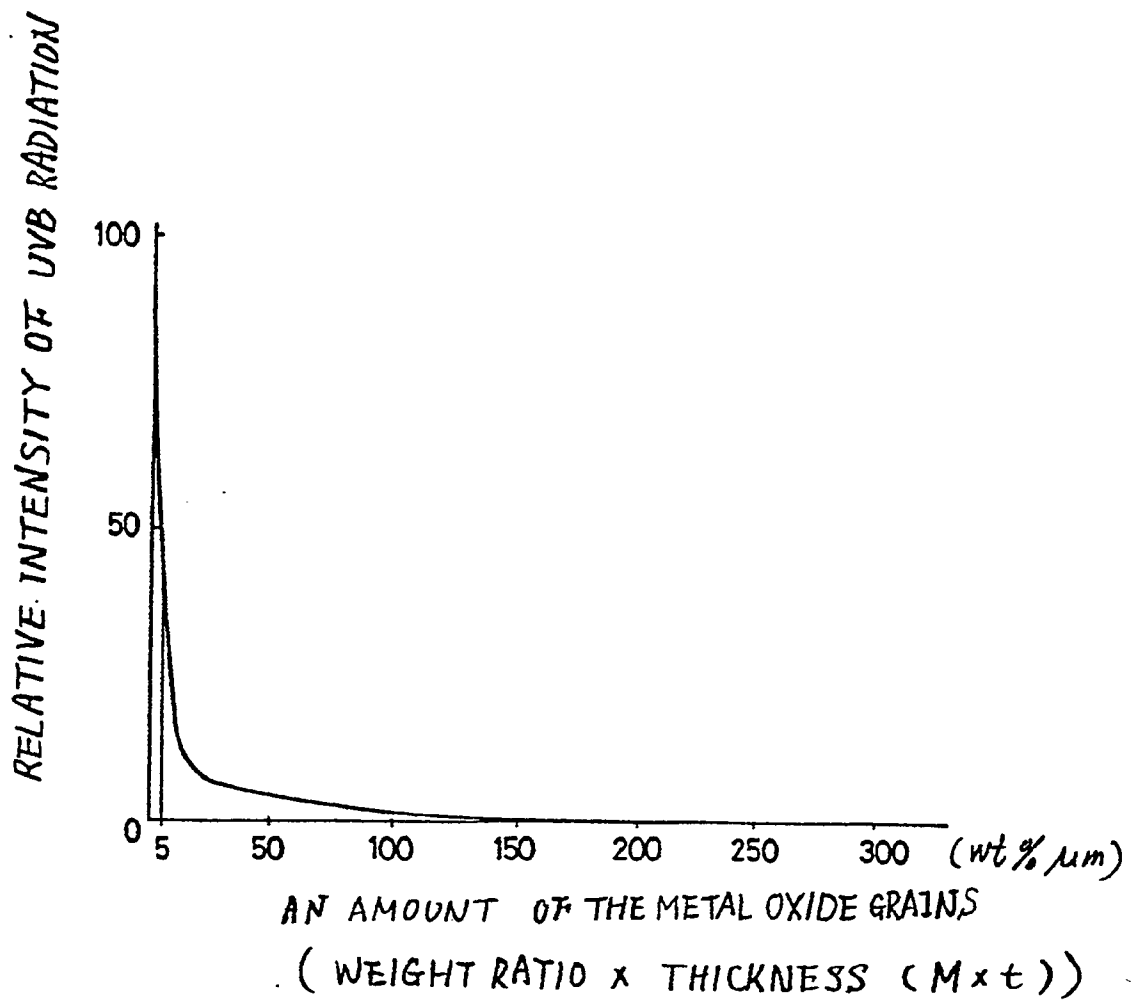


Fig 5

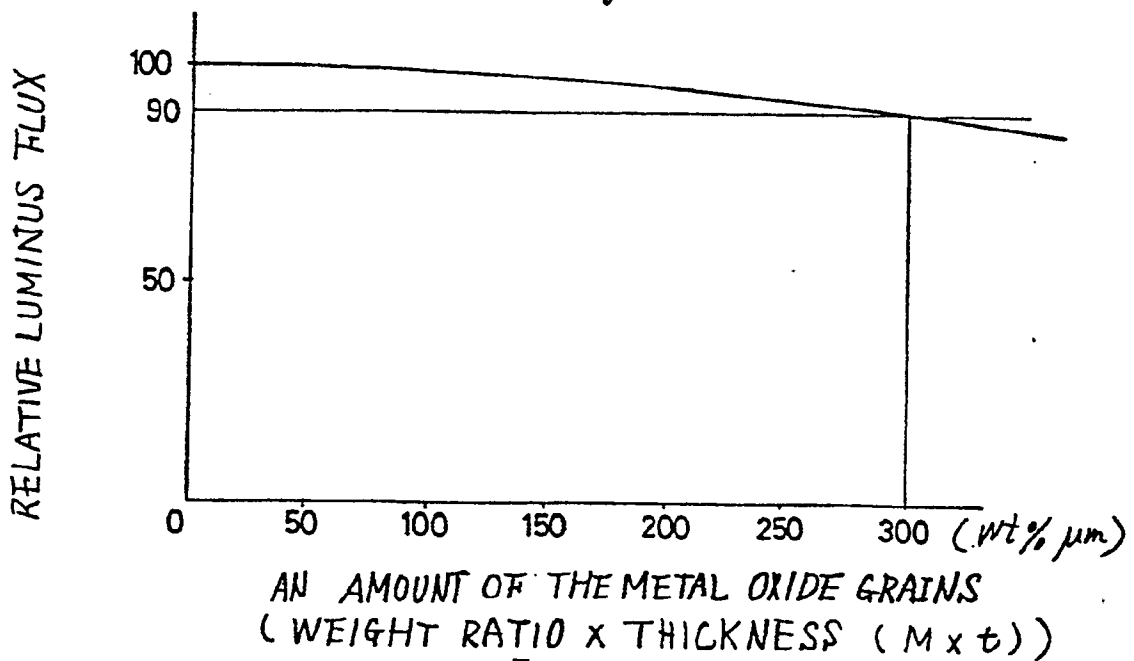
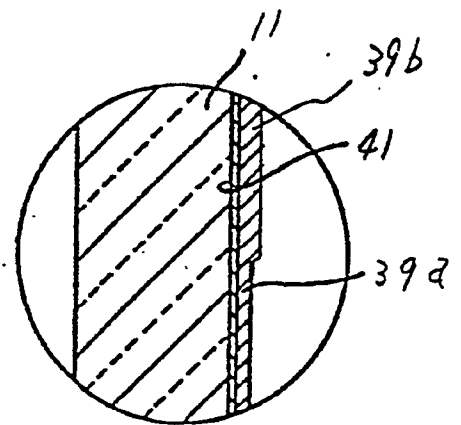
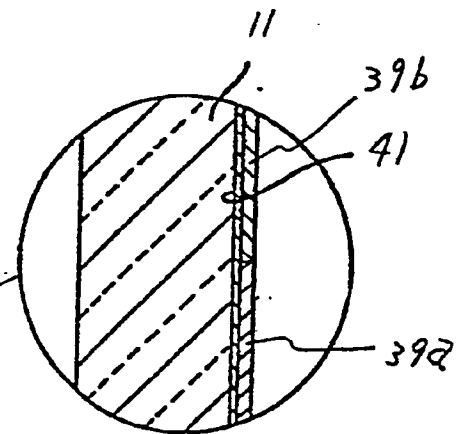
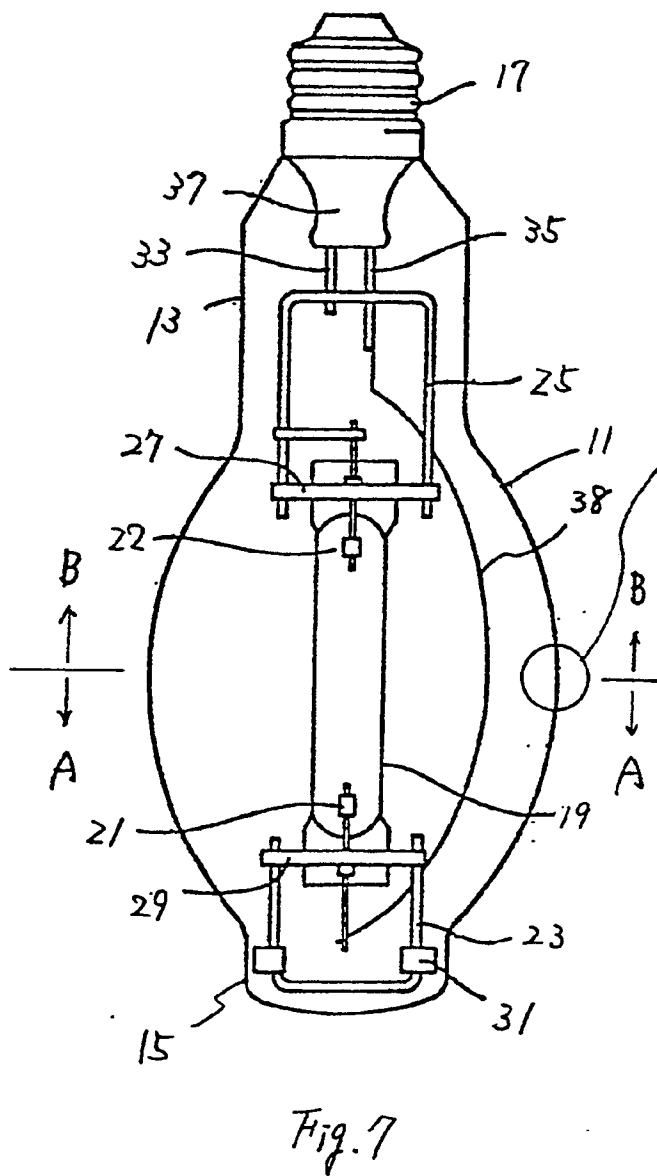


Fig. 6.





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

DOCUMENTS CONSIDERED TO BE RELEVANT			EP 91303221.5
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. CL5)
Y	EP - A2 - 0 175 333 (GTE PRODUCTS CORP.) * Fig. 1; claims 1,2,4 *	1,12,	H 01 J 61/50 H 01 J 5/08
A	--	9,11	
Y	US - A - 3 969 547 (ISAWA) * Column 1, lines 37-49; example 1; claims 1,6 *	1,12	
A	--	2,7	
A	EP - A1 - 0 181 197 (ASAHI GLASS COMPANY) * Page 8, lines 3-7; page 16, lines 1-21; claims *	1,2,5, 6	
D,A	PATENT ABSTRACTS OF JAPAN, unexamined applications, C field, vol. 9, no. 205, August 22, 1985 THE PATENT OFFICE JAPANESE GOVERNMENT page 38 C 299 * Kokai-no. 60-71 546 (IWASAKI DENKI) *	13,14	
			TECHNICAL FIELDS SEARCHED (Int. CL5)
A	EP - A1 - 0 342 721 (NORTH AMERICAN PHILIPS) * Table II, claims *	1,2	H 01 J 5/00 H 01 J 9/00 H 01 J 61/00 H 01 K 1/00 B 05 D 7/00 C 03 C 17/00
The present search report has been drawn up for all claims			
Place of search VIENNA		Date of completion of the search 03-07-1991	Examiner BRUNNER
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	

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