LOW PRESSURE MERCURY VAPOUR DISCHARGE LAMP
INCLUDING AN ALLOY TYPE GETTER COATING
Filed Feb. 3, 1969

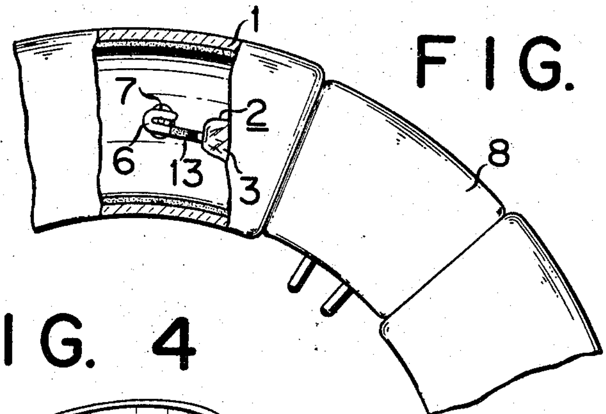


FIG. 1

FIG. 4

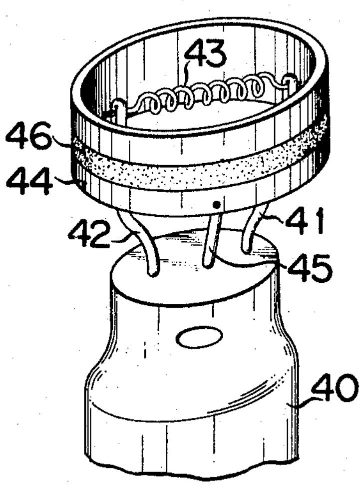


FIG. 3

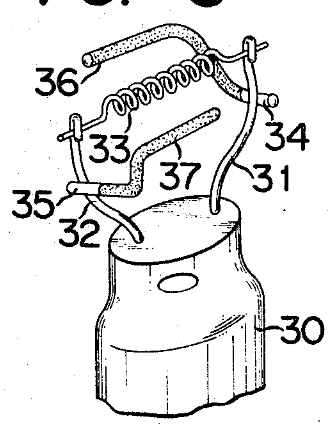
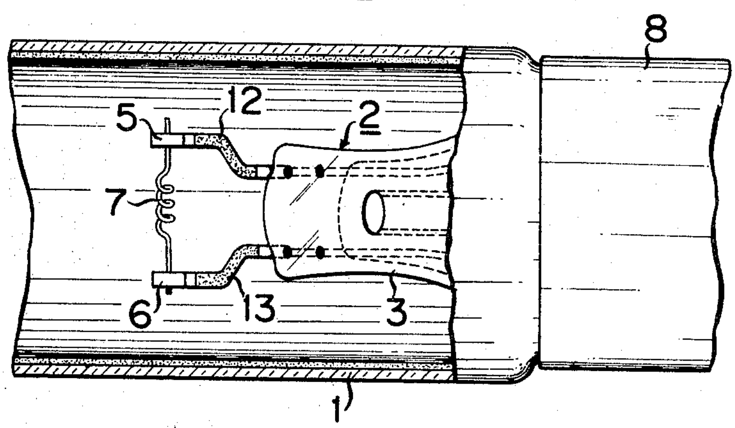


FIG. 2



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3,525,009

LOW PRESSURE MERCURY VAPOUR DISCHARGE LAMP INCLUDING AN ALLOY TYPE GETTER COATING

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Int. Cl. H01j *61/20, 61/26, 61/35*
U.S. Cl. 313—178 14 Claims

ABSTRACT OF THE DISCLOSURE

A low pressure mercury vapour discharge lamp is disposed with a getter on the electrode mounts except those portions thereof which are coated with activated electron-emitting materials, said getter including an alloy of at least one selected from a first group consisting of the metals of Groups III, IV and V and tungsten and at least one selected from a second group consisting of the metals of Group VIII, aluminum and copper, the proportion of the metal of the first group accounting for at least 5 percent by weight on the basis of the alloy, said alloy being coated in the form of powder in an amount equal to 1 to 20 times by weight that of the activated electron-emitting materials, said alloy powders having an average particle size of 1 to 50 microns, the melting point of said alloy being 1250° C. max.

This invention relates to a low pressure mercury vapour discharge lamp and more particularly to a low pressure mercury vapour discharge lamp using a getter capable of noticeably decreasing the generation of end bands and preventing the increased formation of anode spots.

Low pressure mercury vapour discharge lamps include ordinary fluorescent lamps for general lighting purposes, black light fluoresent lamps, sterilizing lamps, erythemal lamps, etc. These are discharge lamps operable by low pressure mercury vapour.

With such type of discharge lamp, there appears a blackening phenomenon at the end of the sealed envelope. The phenomenon may be classified into end bands and anode spots. The former arises from the fact that mercury oxide formed by reaction between mercury and the oxygen gas released from the electron-emitting materials during the lamp operation is deposited on the inner walls of the envelope facing the Faraday's dark space having a small potential gradient. The latter results from the deposition of sputterings of the electron-emitting materials on the inner walls of the sealed envelope facing the electrodes.

The aforementioned blackening phenomenon diminishes the visual appeal of a low-pressure mercury vapour discharge lamp and reduces the effective amounts of light beams. To eliminate such drawbacks, the inventors previously proposed a low pressure mercury vapour discharge lamp wherein a getter was employed which was formed of an alloy mainly consisting of at least one metal having a gettering action and at least one metal having good electric conductivity, thereby to decrease the

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occurrence of end bands and prevent the increased formation of anode spots. Further, the inventors studied (1) the relationship of the amounts of the getter alloy and electron-emitting materials coated versus the appearance of the blackening phenomenon, (2) the relationship of the average particle size of the alloy powders coated versus the appearance of said blackening phenomenon and (3) the relationship of the melting point of the alloy versus the appearance of said blackening phenomenon. As a result, the inventors found that proper selection of the amounts of the alloy powders to be coated, average particle size of said alloy powders and melting point of said alloy would enable the formation of end bands to be prominently reduced in a low pressure mercury vapour discharge lamp. The present invention is based on this discovery.

It is accordingly the object of the present invention to provide a low pressure mercury vapour discharge lamp wherein the use of a specified getter remarkably decreases the generation of end bands and prevents the increased formation of anode spots.

According to the present invention, there is provided a low pressure mercury vapour discharge lamp comprising a light transmissible sealed envelope, a quantity of mercury and starting rare gas sealed in said envelope, and a pair of electrode mounts sealed to both ends of said envelope, said electrode mounts each supporting a filament coated with activated electron-emitting materials, characterized by comprising a getter disposed on said mounts except those portions thereof which are coated with the activated electron-emitting materials, said getter including an alloy which is formed of at least one selected from a first group consisting of the metals of Groups III, IV and V and tungsten and at least one selected from a second group consisting of the metals of Group VIII, aluminum and copper, the proportion of the metal of the first group accounting for at least 5 percent by weight on the basis of the alloy, said alloy being coated in the form of powder in an amount equal to 1 to 20 times by weight that of the activated electron-emitting materials, said alloy powders having an average particle size of 1 to 50 microns, the melting point of said alloy being 1250° C. max.

The low pressure mercury vapour discharge lamp of the present invention enables the formation of end bands to be prominently decreased and the appearance of anode spots to be prevented from increasing over the extent which has been observed in a low pressure mercury vapour discharge lamp with no getter employed.

The invention is now described in conjunction with a preferred embodiment with reference to the accompanying drawing, in which:

FIG. 1 is a schematic top view, with part shown in section, of a low pressure mercury vapour discharge lamp or a circular fluorescent lamp according to an embodiment of the present invention;

FIG. 2 is a detailed side view, with part shown in section, of the electrode mount according to the embodiment of FIG. 1;

FIG. 3 is a perspective view of a modification of the electrode mount; and

FIG. 4 is a perspective view of a further modification of said electrode mount.

The low pressure mercury vapour discharge lamp of FIGS. 1 and 2 is a circular fluorescent lamp operable at a rated wattage of 30 watts. The lamp comprises cylindrical glass envelope **1**, the inner walls of which are coated with fluorescent materials and a pair of electrode mounts **2** (only one of them is shown) sealed to both ends of the envelope **1**. The electrode mount **2** is formed of a flared glass stem **3** sealed airtight to the envelope **1** and a pair of lead-in wires **5** and **6** penetrating the stem **3**, the inner ends of said wires constituting inner-lead wires. The inner-lead wires mechanically clamp a filament **7**, which is coated with activated electron-emitting materials such as BaO—Sro—CaO containing $MgZrO_3$. To the outside of the stem **3** is fitted a base shell **8** provided with two pairs of base pins (only one of each pair is shown in FIG. 1). The aforesaid lead-in wires **5** and **6** are connected to the pins respectively.

The suitable parts of the surfaces of the inner-lead wires are coated with getters **12** and **13**. As hereinbelow described with respect to its preferred examples, the getter is prepared from powders of an alloy which comprises at least one of a first group consisting of the metals of Group III, IV and V and tungsten and at least one of a second group consisting of the metals of Group VIII, aluminum and copper, the proportion of the metal of the first group accounting for 5 or more percent by weight on the basis of the alloy. The amount of powdered alloy coated should be equal to 1 to 20 times by weight that of the activated electron-emitting materials, namely, a cathode substance, applied on the filament **7**, the powdered getter alloy is also required to have a particle size of 1 to 50 microns. The melting point of the allow should be 1250° C. max.

The deposition of the alloy powders is carried out in the following manner. The alloy is first ground to the specified average particle size. The resultant powders are suspended in a binder solution consisting of, for example, nitrocellulose and butyl acetate. The suspension is coated on the suitable part of the inner-lead wires **5** and **6**.

FIG. 3 shows another electrode mount used in the low pressure mercury vapour discharge lamp of the present invention. The mount consists of a flared glass stem **30**, a pair of lead-in wires **31** and **32** penetrating the stem **30** to be connected to the base pins of a base shell (not shown), a filament **33** stretched across the lead-in wires **31** and **32** and having both of its ends clamped at the inner ends of said wires **31** and **32**, and wire anodes **34** and **35** attached to the wires **31** and **32** respectively, said wire anodes **34** and **35** being coated with getters **36** and **37** respectively.

A further modification of the electrode mount as shown in FIG. 4 comprises a flared stem **40**, a pair of lead-in wires **41** and **42** and a filament **43**. In this modification, there is provided a shield electrode **44** in a manner to surround the filament **43**. The shield electrode is fixed by a support pin **45** embedded in the stem **40**, and coated with a getter **46** on the surface.

The portions where the getter is to be disposed are not limited to those mentioned in the aforesaid embodiments, but the getter may be positioned on the surface of, for example, the flared stems **3**, **30** or **50**.

There will now be described the getter of the present invention. The alloy constituting said getter is prepared from at least one of a first group consisting of the metals of Groups III, IV and V and tungsten and at least one of a second group consisting of the metals of Group VIII, aluminum and copper, the proportion of the first group metal accounting for 5 or more percent on the basis of the alloy. This requirement is indispensable for the following reason. The first group metal adsorbs gases. However, if a getter used in a low pressure mercury vapour discharge lamp only consists of such metal, it adsorbs gases evolved from fluorescent materials or glass envelope during the evacuating operation involved in the manufacture of said discharge lamp and other gases released when the electron-emitting materials are thermally

decomposed. Accordingly, when the discharge lamp is finished, such getter already lacks a gas adsorbing ability. Further, said getter metal is scattered by combustion and attached to the fluorescent material, leading to the occurrence of anode spots. Even where the metal is prevented from being saturated with evolved gases, its strong reducing power causes barium to be freed from the electron-emitting materials in excess amounts, which also accelerates the appearance of anode spots.

In contrast, where, as in the present invention, the getter is alloyed from at least one metal of the first group having strong activity and at least one metal of the second group, since the second group metals are of good electrical conductivity, they will substantially suppress for the reason given below the generation of end bands and prevents the increased formation of anode spots. Namely, the presence of the second group metal enables the gettering action of the first group metal, that is, the oxygen adsorbing action in this case, to be suitably restricted, and also prevents the first group metal from being saturated with adsorbed gases during the operation of evacuating the glass envelope. The oxygen gas adsorbed to the first group metal gradually diffuses into the interior of the alloy getter coated due to the presence of the powdered second group metal, allowing the getter surface to restore its gas adsorbing ability. Accordingly, the alloy getter of the present invention is deemed effective to control the appearance of end bands, because it always displays a suitable oxygen adsorbing ability. Moreover, the pressure of the second group metal of great electrical conductivity, restricts temperature rise in the anode cycle and prevents an excess rise in the temperature of cathode spots in the cathode cycle. This is supposed to exert no harmful effect with respect to the formation of anode spots.

If the proportion of the first group metal falls below 5 percent by weight on the basis of the alloy, then the alloy getter will substantially cease its oxygen adsorbing action and became undesirably ineffective to prevent the occurrence of end bands.

For the purpose of the invention, the amount of the alloy powders coated should be equal to 1 to 20 times that of the cathode substance applied. In a low pressure mercury vapour discharge lamp, the materials which are likely to release impurities, particularly oxygen, are the electron-emitting materials coated on the cathode, sealed envelope and fluorescent materials. Among these gases, those which are supposed to evolve from the fluorescent material can be substantially removed by baking, so that the amount of alloy powders to be coated is considered eventually to be closely associated with the amount of a cathode substance to be applied. In practice, however, a fluorescent material deposited on the inner walls of the glass envelope is likely to release some amounts of gas, so that it is necessary to take this into account, in determining the quantity of alloy powders to be used. Theoretical calculation estimates the suitable amount of alloy powders to be employed at from one-tenth to 310 times (by weight) that of a cathode substance to be applied. However, experiments show that the coating of alloy powders in amounts equal to 1 to 20 times that of a cathode substance had the desired effect. If the alloy powders are coated in smaller amounts than the equivalent to that of the cathode substance applied, then the adsorbing action of the getter will become saturated in a short time with gases, mainly oxygen, gradually released during the operation of a discharge lamp, undesirably failing to display a full effect to prevent the formation of end bands during the lamp operation. Conversely where the alloy powders are coated in amounts exceeding 20 times that of the cathode substance applied, then the powders are likely to fall off the electrode mount to contaminate the envelope walls. It will be noted that the application of the getter powders in amounts equal to several times the cathode substance offers the best results.

The alloy powders used in the present invention should have an average particle size of 1 to 50 microns. If said particle size is reduced to below 1 micron, the alloy powders will remarkably lose its adsorbing ability, when exposed to impure gases during the manufacturing process, with the resultant it will not be effective to adsorb impure gases such as oxygen during the lamp operation, undesirably failing to suppress the appearance of end bands. Conversely, if the particle size exceeds 50 microns there will occur various disadvantages that it will present difficulties in coating the alloy powders on the electrode mount, making it impossible to hold the required amount of the alloy or allowing it to come off and fall into the interior of the envelope, and consequently causing also the fluorescent material to be detected from its place. If the average particle size stands at several microns it will be particularly preferable.

According to the present invention, the getter alloy is required to have melting point of 1250° C. max. Otherwise, it will be difficult to grind the alloy, and there will be posed problems with the heat resistance of a crucible used in preparing the alloy.

The getter alloy of the present invention may preferably be inter-metallic compounds, though said alloy is not restricted to the compounds. Inter-metallic compounds are adapted to prepare the getter for mass production of the low pressure vapour discharge lamps.

As such inter-metallic compounds are mentioned the following:

Series	Chemical formula	Compositions (weight percent)	Melting point
Ni-Ti	Ti_2Ni	Ni, 37.99	1,050
	TiNi	Ni, 55.06	1,240
Ni-Th	$ThNi_2$	Th, 66.42	1,150
	ThNi	Th, 79.82	1,200
	Th_7Ni_3	Th, 90.22	1,070
Ni-Zr	Zr_2Ni	Ni, 24,34	1,200
Co-Ti	$TiCo_2$	Ti, 28.89	1,250
Cu-Ti	Ti_2Cu	Cu, 39.88	1,015
	TiCu	Cu, 57.02	982
	Ti_2Cu_3	Cu, 66.55	950
	$TiCu_3$	Cu, 79.92	705
Cu-Zr	$ZrCu_3$	Zr, 32.37	1,115
	Zr_2Cu_3	Zr, 48.90	895
	ZrCu	Zr, 58.94	930
	Zr_2Cu	Zr, 74.17	1,000
Co-Ce	$CeCo_5$	Ce, 32.23	480
	$CeCo_2$	Ce, 54.31	1,070
	CeCo	Ce, 87.70	1,210
Cu-Ce	CeCu6	Ce, 26.88	940
	$CeCu_4$	Ce, 35.54	900
	$CeCu_2$	Ce, 52.44	820
	CeCu	Ce, 68.80	710
Fe-Ce	$CeFe_2$	Ce, 55.64	1,180
Ni-Ce	$CeNi_2$	Ce, 54.42	1,000
	CeNi	Ce, 70.48	670
	Ce_3Ni	Ce, 87.75	485

In addition to the above-mentioned binary compounds, such ternary inter-metallic compounds as Fe-Ni-Ti, Fe-Ni-W and Fe-Ti-W will be suitable for the getter.

As previously described, the getter is disposed on the electrode mount except those portions thereof which are coated with electron-emitting materials. The part of the electrode mount which is coated with the getter rises during the lamp operation to temperatures of from 300° C. to less than the melting point of the alloy, preferably between 400° C. or over and a level 100° C. or more lower than the melting point of the alloy. It may be generalized that temperatures of less than 300° C. cause the alloy substantially to cease its gettering action and temperatures approaching its melting point allow it to release the adsorbed gases.

There will now be given a number of examples of the getter alloy used in the present invention. The term "end band index," as used in the table below, denotes the extent to which end bands are generated, as computed by the 10-mark method. The index of 10 marks shows that there is no appearance of end bands. The index of 7 marks means that the occurrence of end bands is distinctly observed. The index of 5 or smaller marks indicates that the lamp in operation is considerably detracted in visual appeal due to the prominent formation of end bands. The getters represented by these examples were all used in a circular fluorescent lamp operable at a rated wattage of 30 watts.

Ex. No.	Compositions of alloy (weight percent), average particle size, and melting point	Amounts of getter alloy coated per lamp, mg.	Amounts of cathode material coated per lamp, mg.	Lighting time, hours	Index of end band
1	Ti, 62:Ni, 38, 30μ, 1050° C.	a, 10	10	6,000	8
		b, 20	10	6,000	10
		c, 100	10	6,000	10
2	Ti, 62:Ni, 38, 5μ, 1050° C.	20	10	6,000	10–9
3	Ti, 62:Ni, 38, 1μ, 1050° C.	20	10	6,000	9
4	Zr, 76:Ni, 24, 20μ, 1200° C.	20	10	3,000	10
5	Ti, 45:Ni, 55, 30μ, 1240° C.	20	10	6,000	10–9
6	Th, 66:Ni, 34, 30μ, 1150° C.	20	10	6,000	10–9
7	Zr, 32:Cu, 68, 30μ, 1115° C.	20	10	3,000	10
8	Ce, 56:Fe, 44, 30μ, 1180° C.	20	10	3,000	10
9	Al, 11:Zr, 89, 10μ, 1350° C.	20	10	6,000	10
10	Co, 38:Ti, 62, 10μ, 1070° C.	20	10	6,000	10–9
11	Cu, 60:Ti, 40, 10μ, 975° C.	20	10	3,000	10
12	Zr, 76:Ni, 24, 10μ, 1200° C.	20	10	3,000	10
13	Th, 66:Ni, 34 10μ, 1150° C.	20	10	6,000	9–8
14	Zr, 32:Cu, 68, 10μ, 1115° C.	20	10	3,000	10
15	Ce, 56:Fe, 44, 10μ, 1180° C.	20	10	3,000	10

Note: Examples Nos. 4, 7, 8, 11, 12, 14 and 15 had the tendencies of easy formation of anode spots. This disadvantage can be overcome by properly selecting the compositions of the electron-emitting materials.

By way of comparison there was prepared a lamp by coating 20 mg. of titanium powders having an average particle size of 10 microns and 10 mg. of cathode materials or electron-emitting materials. During the 100 hour continuous operation, the lamp presented a prominent formation of anode spots, though it indicated an end band index of 10.

For further comparison, there was prepared a lamp by coating 10 mg. of electron-emitting materials without using any alloy getter. During the initial 2000 hour operation, the lamp showed an end band index of 8 to 7 and during the subsequent 4000 hours the index fell to 5 to 4.

As apparent from these comparisons, a low pressure mercury vapour discharge lamp wherein the getter consists of alloys falling within the range specified by the present invention is prominently improved in the formation of end bands, though it is not much different from the prior art discharge lamp with respect to the occurrence of anode spots.

The aforementioned examples involve an alloy of one metal of the first group and one metal of the second group. However, it is possible to select two or more metals from either or both of the groups.

What we claim is:

1. A low pressure mercury vapour discharge lamp comprising a light transmissible sealed envelope, a quantity of mercury and starting rare gas sealed in said envelope, and a pair of electrode mounts sealed to both ends of said envelope, said electrode mounts each supporting a filament coated with activated electron-emitting materials, characterized by comprising a getter disposed on said mounts except those portions thereof which are coated with the activated electron-emitting materials, said getter including an alloy which is formed of at least one selected from a first group consisting of the metals of Groups III, IV and V and tungsten, and at least one selected from a second group consisting of the metals of Group VIII, aluminum and copper, the proportion of

the metal of the first group accounting for at least 5 percent by weight on the basis of the alloy, said alloy being coated in the form of powder in an amount equal to 1 to 20 times by weight that of the activated electron-emitting materials, said alloy powders having an average particle size of 1 to 50 microns, the melting point of said alloy being 1250° C. max.

2. A low pressure mercury vapour discharge lamp according to claim **1**, said getter being coated in amounts several times by weight the electron-emitting materials.

3. A low pressure mercury vapour discharge lamp according to claim **1**, said alloy powder being several microns in average particle size.

4. A low pressure mercury vapour discharge lamp according to claim **1**, said alloy being an inter-metallic compound.

5. A low pressure mercury vapour discharge lamp according to claim **1**, said alloy consisting of 62 percent by weight of titanium and 38 percent by weight of nickel, the average particle size being 30 microns.

6. A low pressure mercury vapour discharge lamp according to claim **1**, said alloy consisting of 62 percent by weight of titanium and 38 percent by weight of nickel, the average particle size being 5 microns.

7. A low pressure mercury vapour discharge lamp according to claim **1**, said alloy consisting of 62 percent by weight of titanium and 38 percent by weight of nickel, the average particle size being 1 micron.

8. A low pressure mercury vapour discharge lamp according to claim **1**, said alloy consisting of 45 percent by weight of titanium and 55 percent by weight of nickel, the average particle size being 30 microns.

9. A low pressure mercury vapour discharge lamp according to claim **1**, said alloy consisting of 66 percent by weight of thorium and 34 percent by weight of nickel, the average particle size being 30 microns.

10. A low pressure mercury vapour discharge lamp according to claim **1**, said alloy consisting of 11 percent by weight of aluminium and 89 percent by weight of zirconium, the average particle size being 10 microns.

11. A low pressure mercury vapour discharge lamp according to claim **1**, said alloy consisting of 38 percent by weight of cobalt and 62 percent by weight of titanium, the average particle size being 10 microns.

12. A low pressure mercury vapour discharge lamp according to claim **1**, said alloy consisting of 66 percent by weight of thorium and 34 percent by weight of nickel, the average particle size being 10 microns.

13. A low pressure mercury vapour discharge lamp according to claim **1**, said getter being disposed on a pair of anode wires which are provided on each of said mounts.

14. A low pressure mercury vapour discharge lamp according to claim **1**, said getter being disposed on a shield electrode which is provided on each of said mounts.

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