

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
11 December 2003 (11.12.2003)

PCT

(10) International Publication Number
WO 03/103011 A1

(51) International Patent Classification⁷: **H01J 61/72**,
61/35, 61/36, 61/26

(21) International Application Number: PCT/IB03/02249

(22) International Filing Date: 21 May 2003 (21.05.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
02077216.6 4 June 2002 (04.06.2002) EP

(71) Applicant (for all designated States except US): **KONINKLIJKE PHILIPS ELECTRONICS N.V.** [NL/NL];
Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **VAN DEN BRAKEL, Ronald, A.** [NL/NL]; c/o Prof. Holstlaan

6, NL-5656 AA Eindhoven (NL). **SNIJKERS-HENDRICKX, Ingrid, J. M.** [BE/BE]; c/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). **VAN DEN BOGERT, Willem, J.** [NL/NL]; c/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

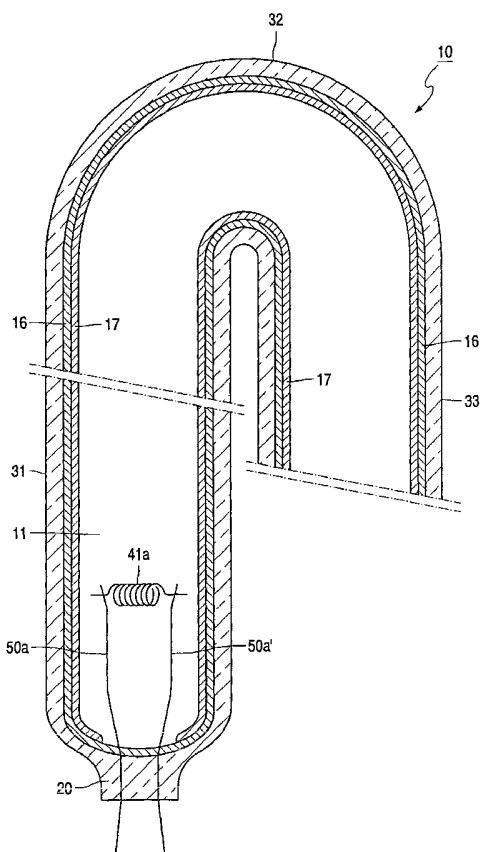
(74) Agent: **VAN WERMESKERKEN, Stephanie, C.**; Internationaal Octrooibureau B.V., Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),

[Continued on next page]

(54) Title: LOW-PRESSURE MERCURY VAPOR DISCHARGE LAMP AND COMPACT FLUORESCENT LAMP



(57) Abstract: A low-pressure mercury vapor discharge lamp has a light-transmitting discharge vessel (10), enclosing, in a gastight manner, a discharge space (11) provided with a filling of mercury and a rare gas. The discharge vessel (10) comprises means (41a) for maintaining a discharge in the discharge space (11). At least a part of an inner wall of the discharge vessel (10) is provided with a protective translucent layer (16). According to the invention, the discharge vessel (10) is provided with a pinched seal (20). In addition, the translucent layer (16) comprises a borate and/or a phosphate of an alkaline earth metal and/or of scandium, yttrium or a further rare earth metal. Preferably, the glass composition is made from a sodium-rich glass including the following constituents: 70-75 wt.% SiO₂, 15-18 wt.% Na₂O, 0.25-2 wt.% K₂O. The discharge lamp according to the invention has a comparatively high maintenance.

WO 03/103011 A1



European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

Published:

— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Low-pressure mercury vapor discharge lamp and compact fluorescent lamp

The invention relates to a low-pressure mercury vapor discharge lamp comprising a light-transmitting discharge vessel,

the discharge vessel enclosing, in a gastight manner, a discharge space provided with a filling of mercury and a rare gas,

5 the discharge vessel comprising means for maintaining a discharge in the discharge space,

while at least a part of an inner wall of the discharge vessel is provided with a translucent layer.

The invention also relates to a compact fluorescent lamp.

10 In mercury vapor discharge lamps, mercury constitutes the primary component for the (efficient) generation of ultraviolet (UV) light. A luminescent layer comprising a luminescent material (for example, a fluorescent powder) may be present on an inner wall of the discharge vessel to convert UV to other wavelengths, for example, to UV-B and UV-A for tanning purposes (sun panel lamps) or to visible radiation for general illumination
15 purposes. Such discharge lamps are therefore also referred to as fluorescent lamps. The discharge vessel of low-pressure mercury vapor discharge lamps is usually tubular and circular in section and comprises both elongated and compact embodiments. Generally, the tubular discharge vessel of so-called compact fluorescent lamps comprises a collection of relatively short straight parts having a relatively small diameter, which straight parts are
20 connected together by means of bridge parts or arc-shaped parts. Compact fluorescent lamps are usually provided with an (integrated) lamp cap.

In the description and claims of the current invention, the designation “nominal operation” is used to refer to operating conditions where the mercury-vapor pressure is such that the radiation output of the lamp is at least 80% of that during optimum
25 operation, i.e. under operating conditions where the mercury-vapor pressure is optimal. In addition, in the description and claims, the “initial radiation output” is defined as the radiation output of the discharge lamp 1 second after switching on the discharge lamp, and the “run-up time” is defined as the time needed by the discharge lamp to reach a radiation output of 80% of that during optimum operation.

It is known that measures are taken in low-pressure mercury vapor discharge lamps to inhibit blackening of parts of the inner wall of the discharge vessel, which parts are in contact with a discharge which, during operation of the discharge lamp. Such blackening, which is brought about by interaction between mercury and the material from which the inner wall of the discharge vessel is made, is undesirable and does not only lead to a reduction of the maintenance but also to an unaesthetic appearance of the lamp, particularly because the blackening occurs irregularly, for example, in the form of dark stains or dots.

A low-pressure mercury vapor discharge lamp of the type described in the opening paragraph is known from US-A 4,544,997. In the known discharge lamp, an oxide selected from the group formed by yttrium, scandium, lanthanum, gadolinium, ytterbium and lutetium is used as the translucent layer. The oxide is provided as a thin layer on the inner wall of the discharge vessel. The known translucent layers are colorless, hardly absorb UV radiation or visible light and satisfy the requirements with respect to light and radiation transmissivity. The use of the known translucent layers causes blackening and discoloring of the inner wall of the discharge vessel of the low-pressure mercury vapor discharge lamp to be reduced.

A drawback of the use of the known low-pressure mercury vapor discharge lamp is that the maintenance still is relatively poor due to said blackening. As a result, in addition, a relatively large amount of mercury is necessary for the known lamp in order to realize a sufficiently long service life. In the case of injudicious processing after the end of the service life, this is detrimental to the environment.

It is an object of the invention to eliminate the above disadvantage wholly or partly. According to the invention, a low-pressure mercury vapor discharge lamp according to the invention is characterized in that the discharge vessel is provided with a pinched seal, and in that the translucent layer comprises a borate and/or a phosphate of an alkaline earth metal and/or of scandium, yttrium or a further rare earth metal. A discharge vessel of a low-pressure mercury vapor discharge lamp according to the invention having a pinched seal and comprising a transparent layer including said borate and/or phosphate appears to be very well resistant to the action of the mercury-rare gas atmosphere which, in operation, prevails in the discharge vessel of the low-pressure mercury vapor discharge lamp. As a result, blackening

due to interaction between mercury and the glass from which the discharge vessel is manufactured is reduced, resulting in an improvement of the maintenance. During the service life of the discharge lamp, a smaller quantity of mercury is withdrawn from the discharge, so that, in addition, a reduction of the mercury consumption of the discharge lamp is obtained and in the manufacture of the low-pressure mercury vapor discharge lamp a smaller mercury dose will suffice.

Wall blackening caused by withdrawing mercury from the discharge occurs in straight parts as well as in arc-shaped parts of low-pressure mercury vapor discharge lamps and in the sealing areas of the discharge vessel. In the known discharge lamp, the means for maintaining a discharge in the discharge space are electrodes. The electrodes are supported by an (indented) end portion (also called "stem") of the discharge vessel. Current supply conductors issue from each electrode through the end portions of the discharge vessel to the exterior. In order to obtain a proper seal when mounting the end portions, it is necessary in the known discharge vessel to clean the discharge vessel in the vicinity of the end portions from coatings present on the inside of the discharge vessel. The phosphor coating is normally removed from the sealing areas (end portion(s)) as well as protective coatings made of alumina particles. As a consequence, said parts of the discharge vessel in the vicinity of the end portions are sensitive to an attack by the mercury atmosphere in the discharge lamp, during operation, and substantial wall blackening occurs in the discharge vessel in the vicinity of the end portions. By applying a protective translucent layer according to the invention in combination with a pinched seal in accordance with the invention causes blackening to be substantially reduced in the parts of the discharge vessel in the vicinity of the end portions. In principle, the entire inner wall surface of the discharge vessel is coated with the protective translucent layer thereby preventing wall blackening of the discharge vessel. Advantage of the use of the translucent layer according to the invention is that the materials can also be applied at the part of the wall of the discharge vessel where, during manufacturing of the low-pressure mercury vapor discharge lamp pinched seal is formed.

A preferred embodiment of the low-pressure mercury vapor discharge lamp according to the invention is characterized in that, the pinched seal comprises material from the translucent layer. Because it is no longer necessary to clean the discharge vessel in the vicinity of the pinched seal (apart from removing the luminescent material), material from the translucent layer can be found in the pinched seal.

Another preferred embodiment of the low-pressure mercury vapor discharge lamp according to the invention is characterized in that, the means for maintaining a

discharge comprises an electrode pair arranged in the discharge space and that current supply conductors issue from the electrode pair through the pinched seal of the discharge vessel to the exterior. In this embodiment the pinched seal also functions as feed through for the current supply conductors.

5 A preferred embodiment of the low-pressure mercury vapor discharge lamp according to the invention is characterized in that, the translucent layer comprises an alkaline earth borate, and in that the thickness of the translucent layer is in the range from 0.1–50 μm . By employing a translucent layer of alkaline earth borate and with a thickness in the range given above appears to be very well resistant to the action of the mercury-rare gas
10 atmosphere which, in operation, prevails in the discharge vessel of the low-pressure mercury vapor discharge lamp. The inventors have had the insight that by using a suspension of “nano-particles” of alkaline earth borates, in particular calcium, strontium and/or barium borate, a translucent layer can be made with a thickness which can be significantly larger than that of the translucent layer made out of a solution of the salts in the known discharge
15 lamp. With “nano-particles” in the description of the present invention it is meant that particles with a particle size in the range from 0.1–1 μm . The softening point of the calcium, strontium and/or barium borate particulate material is low enough that the particles melt together during the bending glass shaping. In addition, a dense translucent layer is obtained that, because of its large thickness, has not completely reacted with the underlying wall of the
20 discharge vessel in the bents and in the seal. In experiments it was found that a translucent layer made from nano-particles of calcium, strontium and/or barium borate showed a relatively high point of zero charge and a relatively low mercury consumption. An additional advantage of producing the translucent layer from nano-particles of alkaline earth borates is that the size of the particles of alkaline earth borates is comparable to the wavelength of the
25 UV light. This makes it possible to employ the translucent layer also as a reflector for UV light (the size of the particles is in the range from approximately 0.3 μm to approximately 0.6 μm). Preferably, the translucent layer comprises SrB_4O_7 . Preferably, nano-particles of SrB_4O_7 with a particle size in the range from approximately 0.1 to approximately 1 μm are used to manufacture the translucent layer according to the invention.

30 Preferably, the thickness of the translucent layer is in the range from 10–20 μm . Upon making the translucent layer thinner than approximately 10 μm could, in particular during bending glass shaping of discharge vessels under factory conditions, give rise to a possible complete reaction of the particulate calcium, strontium and/or barium borate with

the wall. The risk is higher in a production environment where the conditions can not always be met as precisely as in laboratory experiments. It is observed that in the straight parts of the discharge vessel of compact fluorescent lamps, the particles in the translucent layer do not reach a high enough temperature to melt leading to diffuse scattering of light in the translucent layer. In the arc-shaped parts of the discharge vessel of compact fluorescent lamps, the particles in the translucent layer reach a high enough temperature to melt leading to a transparent layer.

A preferred embodiment of the low-pressure mercury vapor discharge lamp according to the invention is characterized in that the discharge vessel is made from a glass comprising silicon dioxide and sodium oxide, with the glass composition comprising the following essential constituents, given in percentages by weight (wt.%): 60-80 wt.% SiO_2 and 10-20 wt.% Na_2O . The application of a sealed pinch and a translucent layer according to the invention in combination with the sodium-rich glass in accordance with the invention causes blackening to be substantially reduced in the vicinity of the pinch of the discharge vessel. The invention is in particular embodied in a combination of a discharge vessel with a pinched pin seal, a coating comprising the borate and/or phosphate as described above and sodium-rich glass.

Sodium-rich glasses are comparatively inexpensive. In the known discharge lamp use is made of a so-called mixed alkali glass having a comparatively small SiO_2 content (approximately 67% as compared to approximately 72% for the sodium-rich glass) and comprising, inter alia, approximately 8 wt.% Na_2O and 5 wt.% K_2O . The cost price of said glass is comparatively high. A comparison between the composition of the known glass and the sodium-rich glass shows that the alkali content is different. The sodium-rich glass has a comparatively low potassium content, while the known glass is a so-called mixed alkali glass having an approximately equal molar ratio of Na_2O and K_2O . An advantage resides in that the mobility of the alkali ions in the sodium-rich glass is comparatively high with respect to the mobility in the mixed alkali glass. The run-up time for low-pressure mercury vapor discharge lamps made from sodium-rich glass is approximately the same as for discharge vessels made from the known mixed alkali glass.

The translucent layer in the low-pressure mercury-vapor discharge lamp in accordance with the invention further satisfies the requirements with respect to light and radiation transmissivity and can be easily provided as a very thin, closed and homogeneous translucent layer on an inner wall of a discharge vessel of a low-pressure mercury vapor discharge lamp. This is effected, for example, by rinsing the discharge vessel with a solution

of a mixture of suitable metal-organic compounds (for example, acetonates or acetates, for example, scandium acetate, yttrium acetate, lanthanum acetate or gadolinium acetate mixed with calcium acetate, strontium acetate or barium acetate) and boric acid or phosphoric acid diluted in water, while the desired translucent layer is obtained after drying and sintering.

5 A preferred embodiment of the low-pressure mercury vapor discharge lamp according to the invention is characterized in that a side of the translucent layer facing the discharge space is provided with a layer of a luminescent material. An advantage of the use of a translucent layer according to the invention in low-pressure mercury vapor discharge lamps is that the luminescent layer comprising a luminescent material (for example, a
10 fluorescent powder) adheres significantly better to such a translucent layer than to a translucent layer of the known low-pressure mercury vapor discharge lamp. Said improved adhesion is obtained particularly in the arc-shaped parts of low-pressure mercury-vapor discharge lamps.

 The measure according to the invention is notably suitable for compact
15 fluorescent lamps having arc-shaped lamp parts, wherein the discharge vessel is additionally surrounded by a light-transmitting envelope. The temperature of the discharge vessel of such "covered" compact fluorescent lamps is comparatively high because the heat dissipation to the environment is reduced by the presence of the outer envelope. This unfavorable temperature balance adversely affects the maintenance of the known discharge lamp due to
20 an increased level of blackening. In experiments it has surprisingly been found that the maintenance of a compact fluorescent lamp provided with a low-pressure mercury vapor discharge lamp according to the invention, the discharge vessel of which is surrounded by an envelope, has 90% maintenance after 12,000 burning hours, while the maintenance of an identical compact fluorescent lamp provided with the known low-pressure mercury vapor
25 discharge lamp, the discharge vessel of which is surrounded by an envelope, is less than 80% after 12,000 burning hours and fluctuates (depending on the amount of Hg consumption consumed). The depletion of mercury out of the amalgam can be so high that the amalgam does no longer give the optimum mercury pressure. In addition, the light output drops significantly.

30 The glass composition preferably includes the following constituents:
70-75 wt.% SiO₂, 15-18 wt.% Na₂O, and 0.25-2 wt.% K₂O. The composition of such a sodium-rich glass is similar to that of ordinary window glass and it is comparatively cheap with respect to the glass used in the known discharge lamp. The cost price of the raw materials for the sodium-rich glass as used in the discharge lamp in accordance with the

invention is only approximately 50% of the cost price of the raw materials for the mixed alkali glass as used in the known discharge lamp. Moreover, the conductance of said sodium-rich glass is comparatively low; at 250°C the conductance is approximately $\log \rho = 6.3$ while the corresponding value of the mixed alkali glass is approximately $\log \rho = 8.9$.

5 In a preferred embodiment of the low-pressure mercury vapor discharge lamp according to the invention, the translucent layer comprises a borate and/or a phosphate of calcium, strontium and/or barium. Such a translucent layer has a relatively high coefficient of transmission for visible light. Moreover, low-pressure mercury vapor discharge lamps with a translucent layer comprising calcium borate, strontium borate or barium borate or calcium
10 phosphate, strontium phosphate or barium phosphate have a good maintenance.

 In a particularly preferred embodiment of the low-pressure mercury vapor discharge lamp according to the invention, the translucent layer comprises an yttrium-strontium-borate composition. Such a translucent layer has a relatively high coefficient of transmission for ultraviolet radiation and visible light. It has further been found that a
15 translucent layer comprising yttrium borate and strontium borate is only slightly hygroscopic and adheres well to the inner wall of the discharge vessel. Moreover, the layer can be provided in a relatively simple manner (for example, with yttrium acetate and strontium acetate mixed with boric acid), which has a cost-saving effect, notably useful in a mass manufacturing process for low-pressure mercury vapor discharge lamps.

20 These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

 In the drawings:

25 Figure 1A is a cross-sectional view of an embodiment of a compact fluorescent lamp comprising a low-pressure mercury vapor discharge lamp according to the invention,
and

 Figure 1B is a cross-sectional view of a detail of the low-pressure mercury
30 vapor discharge lamp as shown in Figure 1A.

 The Figures are purely diagrammatic and not drawn to scale. Particularly for clarity, some dimensions are exaggerated strongly. Similar components in the Figures are denoted by the same reference numerals as much as possible.

Figure 1A shows a compact fluorescent lamp comprising a low-pressure mercury vapor discharge lamp. The low-pressure mercury-vapor discharge lamp is provided with a radiation-transmitting discharge vessel 10 enclosing a discharge space 11 having a volume of approximately 10 cm^3 . The discharge vessel 10 is a glass tube which is at least substantially circular in cross-section and the (effective) internal diameter of which is approximately 10 mm. The discharge vessel 10 is closed in a gastight manner by a pinched seal 20 according to the invention (see Figure 1B). The pinched seal 20 is made by press sealing. The tube is bent in the form of a so-called hook and, in this embodiment, it has a number of straight parts, two of which, referenced 31, 33, are shown in Figure 1A. The discharge vessel further comprises a number of arc-shaped parts, two of which, referenced 32, 34, are shown in Figure 1A. An inner wall 12 of the discharge vessel 10 is provided with a translucent layer 16 and with a luminescent layer 17. In an alternative embodiment, the luminescent layer has been omitted. The use of a pinched seal 20 and the application of the bendable translucent layer 16 according to the invention enables the entire surface area of the inner wall 12 of the discharge vessel 10 to be coated with the protective translucent layer 16. The inventive combination of the pinched seal 20 and the application of the bendable translucent layer 16 according to the invention allows the use of sodium-rich glass as material for the discharge vessel. Particularly preferred is a glass of the following composition: 70-74 wt.% SiO_2 , 16-18 wt.% Na_2O , 0.5-1.3 wt.% K_2O , 4-6 wt.% CaO , 2.5-3.5 wt.% MgO , 1-2 wt.% Al_2O_3 , 0-0.6 wt.% Sb_2O_3 , 0-0.15 wt.% Fe_2O_3 and 0-0.05 wt.% MnO . Excellent run-up characteristics are obtained for low-pressure mercury vapor discharge lamps made from sodium-rich glass.

The discharge vessel 10 is supported by a housing 70 which also supports a lamp cap 71 provided with electrical and mechanical contacts 73a, 73b, which are known per se. The discharge vessel 10 of the low-pressure mercury-vapor discharge lamp is surrounded by a light-transmitting envelope 60 which is attached to the lamp housing 70. The light-transmitting envelope 60 generally has a matt appearance.

Figure 1B very diagrammatically shows a cross-sectional view of a detail of the low-pressure mercury-vapor discharge lamp shown in Figure 1A. The discharge space 11 in the discharge vessel 10 does not only comprise mercury but also a rare gas, argon in this example. Means for maintaining a discharge are constituted by an electrode pair 41a (only one electrode is shown in Figure 1B) which is arranged in the discharge space 11. In an alternative embodiment the low-pressure mercury vapor discharge lamp is a so-called

electrode-less discharge lamp. The electrode 41a in Figure 1B is a winding of tungsten coated with an electron-emissive material, here a mixture of barium oxide, calcium oxide and strontium oxide. Current supply conductors 50a, 50a' issue from the electrode pair 41a through the pinched seal 20 end portions of the discharge vessel 10 to the exterior. The electrode 41a is supported by the pinched seal 20 which seal closes the discharge vessel 10 in a gastight manner. The current supply conductors 50a, 50a' are connected to an (electronic) power supply which is accommodated in the housing 70 and electrically connected to the electrical contacts 73b at the lamp cap 71 (see Figure 1A).

In an embodiment of the low-pressure mercury vapor discharge lamp, various concentrations of an $\text{Sr}(\text{Ac})_2$ (strontium acetate) solution and H_3BO_3 (boric acid) are added to solutions comprising various concentrations of $\text{Y}(\text{Ac})_3$ (yttrium acetate) to manufacture the translucent layer 16 according to the invention. In an alternative embodiment, a $\text{Ba}(\text{Ac})_2$ (barium acetate) solution is added instead of an $\text{Sr}(\text{Ac})_2$ solution. Three recipes were tested, as shown in Table I.

Table I Three recipes for a translucent layer.

Recipe	wt.% $\text{Y}(\text{Ac})_3$	mol $\text{Sr}(\text{Ac})_2$	mol H_3BO_3
R_1	0.11	0.036	0.147
R_2	0.15	0.06	0.24
R_3	0.15	0.048	0.191

Before coating, the discharge vessels were bent in the known hook shape having straight parts and arcuate parts. In an alternative embodiment, the bending took place after coating the discharge vessel. After rinsing and drying, the discharge vessels were provided with a coating by passing an excess of the afore-mentioned solutions through the discharge vessels. After said coating operation, the discharge vessels were first dried in air at a temperature of approximately 60°C for 15 minutes and subsequently sintered at approximately 550°C for 2 minutes. In an alternative embodiment, the translucent coating is fixed in a shorter period of time at a higher temperature.

In a preferred embodiment of the low-pressure mercury vapor discharge lamp, so-called nano-particles of SrB_4O_7 with a particle size in the range from approximately 0.1 to approximately $1\ \mu\text{m}$ are used to manufacture the translucent layer 16 according to the invention. Stoichiometric quantities of SrCO_3 and H_3BO_3 are mixed and melted in a Pt-

crucible in air. After cooling down, the glass is crushed and milled with butyl acetate during two hours followed by 48 hours rolling with ZrO_2 spheres. The resulting amorphous particles of SrB_4O_7 have an average particle size of $0.6\text{ }\mu\text{m}$. After proving the discharge vessels with such a coating, the discharge vessels were first dried in air at a temperature of approximately 5 60°C for 15 minutes. In an alternative embodiment, the transparent coating is fixed in a shorter period of time at a higher temperature. The thickness of the translucent layer 16 ranges from approximately $1\text{ }\mu\text{m}$ to approximately $50\text{ }\mu\text{m}$, preferably from approximately $10\text{ }\mu\text{m}$ to approximately $20\text{ }\mu\text{m}$. In an alternative embodiment, nano-particles of BaB_4O_7 or CaB_4O_7 are employed.

10 Subsequently, the discharge vessels were provided with a luminescent coating comprising three known phosphors, namely a green-luminescent material with terbium-activated cerium magnesium aluminate, a blue-luminescent material with bivalent europium-activated barium magnesium aluminate, and a red-luminescent material with trivalent europium-activated yttrium oxide. A number of said discharge vessels were subsequently 15 assembled to low-pressure mercury vapor discharge lamps in the customary manner. A number of these discharge lamps were subsequently provided with a translucent envelope on the basis of one of the three recipes mentioned hereinabove (see the example shown in Figure 1A). Experiments were carried out on discharge vessels of two lengths, namely 230 mm (11W fluorescent lamp) and 405 mm (20W fluorescent lamp). The current intensity 20 of the lamp during operation was 200 mA in all cases.

Subsequently, the maintenance after 1,000 hours has been measured of low-pressure mercury-vapor discharge lamps comprising a discharge vessel in accordance with the invention and provided with the R3 composition of the translucent layer in accordance with the invention. For comparison, the maintenance of discharge vessels with the standard 25 seal and a transparent layer of known yttrium oxide is given. The results of these measurements are shown in Table II.

Table II Maintenance data (1000 hours) of low-pressure mercury-vapor discharge lamps comprising a discharge vessel with a pinched seal and made from sodium-rich glass and provided with the R3 composition of the translucent layer in accordance with the invention. For comparison, the maintenance of discharge vessels with the standard seal and a transparent layer of known yttrium oxide is given.

	Known glass	Sodium-rich glass
	No pinched seal	With pinched seal
	Known Y ₂ O ₃ translucent layer	Translucent layer from R3 composition
No pinched seal	95 (4)	66 (18)
With pinched seal	95 (4)	95 (6)

Table II shows that after 1,000 hours the maintenance of discharge lamps comprising the discharge vessel with a pinched seal and made from sodium-rich glass and provided with the translucent layer according to the invention is relatively high. Up to 12,000 hours there is no significant difference in maintenance with the known glass and without a pinched seal between the three compositions of the translucent layer in accordance with the invention.

In Table III the amount of bound mercury (in μg) in the discharge vessel after 1000 hours life time of low-pressure mercury-vapor discharge lamps comprising a discharge vessel with a pinched seal and made from sodium-rich glass and provided with the R3 composition of the translucent layer (see Table I). For comparison, the data for discharge vessels with the standard seal are given.

Table III Bound mercury (Hg) in the discharge vessel after 1000 hours life time of low-pressure mercury-vapor discharge lamps comprising a discharge vessel with a pinched seal and made from sodium-rich glass and provided with the R3 composition of the translucent layer in accordance with the invention. For comparison, the data for discharge vessels with the standard seal is given.

Known glass	Sodium-rich glass	Sodium-rich glass
No pinched seal	No pinched seal	With pinched seal
Known Y ₂ O ₃ translucent layer	Translucent layer from R3 composition	Translucent layer from R3 composition
110 µg Hg	922 µg Hg	100 µg Hg

The relatively high Hg consumption of the discharge vessel made of sodium rich glass and without a sealed pinch is mainly located in the seal area.

It will be evident that within the scope of the invention many variations are possible to those skilled in the art.

The scope of protection of the invention is not limited to the examples given herein. The invention is embodied in each novel characteristic and each combination of characteristics. Reference numerals in the claims do not limit the scope of protection of the claims. The word “comprising” does not exclude the presence of elements other than those mentioned in the claims. The use of the word “a” or “an” in front of an element does not exclude the presence of a plurality of such elements.

CLAIMS:

1. A low-pressure mercury vapor discharge lamp comprising a light-transmitting discharge vessel,
the discharge vessel enclosing, in a gastight manner, a discharge space provided with a filling of mercury and a rare gas,
5 the discharge vessel comprising means for maintaining a discharge in the discharge space,
while at least a part of an inner wall of the discharge vessel is provided with a translucent layer,
characterized
10 in that the translucent layer comprises a borate and/or a phosphate of an alkaline earth metal and/or of scandium, yttrium or a further rare earth metal, and
in that the discharge vessel is provided with a pinched seal.
2. A low-pressure mercury vapor discharge lamp as claimed in claim 1,
15 characterized in that the pinched seal comprises material from the translucent layer.
3. A low-pressure mercury vapor discharge lamp as claimed in claim 1,
characterized in that the means for maintaining a discharge comprises an electrode pair arranged in the discharge space and that current supply conductors issue from the electrode
20 pair through the pinched seal of the discharge vessel to the exterior.
4. A low-pressure mercury vapor discharge lamp as claimed in claim 1 or 2,
characterized in that the translucent layer comprises an alkaline earth borate, and in that the
thickness of the translucent layer is in the range from 0.1–50 μm .
25
5. A low-pressure mercury vapor discharge lamp as claimed in claim 4,
characterized in that the translucent layer comprises SrB_4O_7 .

6. A low-pressure mercury vapor discharge lamp as claimed in claim 4, characterized in that the thickness of the translucent layer is in the range from 10–20 μm .

7. A low-pressure mercury vapor discharge lamp as claimed in claim 1 or 2, characterized in that the discharge vessel is made from a glass comprising silicon dioxide and sodium oxide, with the glass composition comprising the following essential constituents, given in percentages by weight (wt.%) :

60-80 wt.% SiO_2 ,

10-20 wt.% Na_2O .

10

8. A low-pressure mercury vapor discharge lamp as claimed in claim 8, characterized in that the glass composition includes the following constituents:

70-75 wt.% SiO_2 ,

15-18 wt.% Na_2O ,

15

0.25-2 wt.% K_2O .

9. A low-pressure mercury vapor discharge lamp as claimed in claim 1 or 2, characterized in that a side of the translucent layer facing the discharge space is provided with a layer of a luminescent material.

20

10. A compact fluorescent lamp comprising a low-pressure mercury-vapor discharge lamp as claimed in claim 1 or 2, characterized in that a lamp housing is attached to the discharge vessel of the low-pressure mercury-vapor discharge lamp, which lamp housing is provided with a lamp cap.

25

11. A compact fluorescent lamp as claimed in claim 10, characterized in that the discharge vessel of the low-pressure mercury-vapor discharge lamp is surrounded by a light-transmitting envelope which is attached to the lamp housing.

2/2

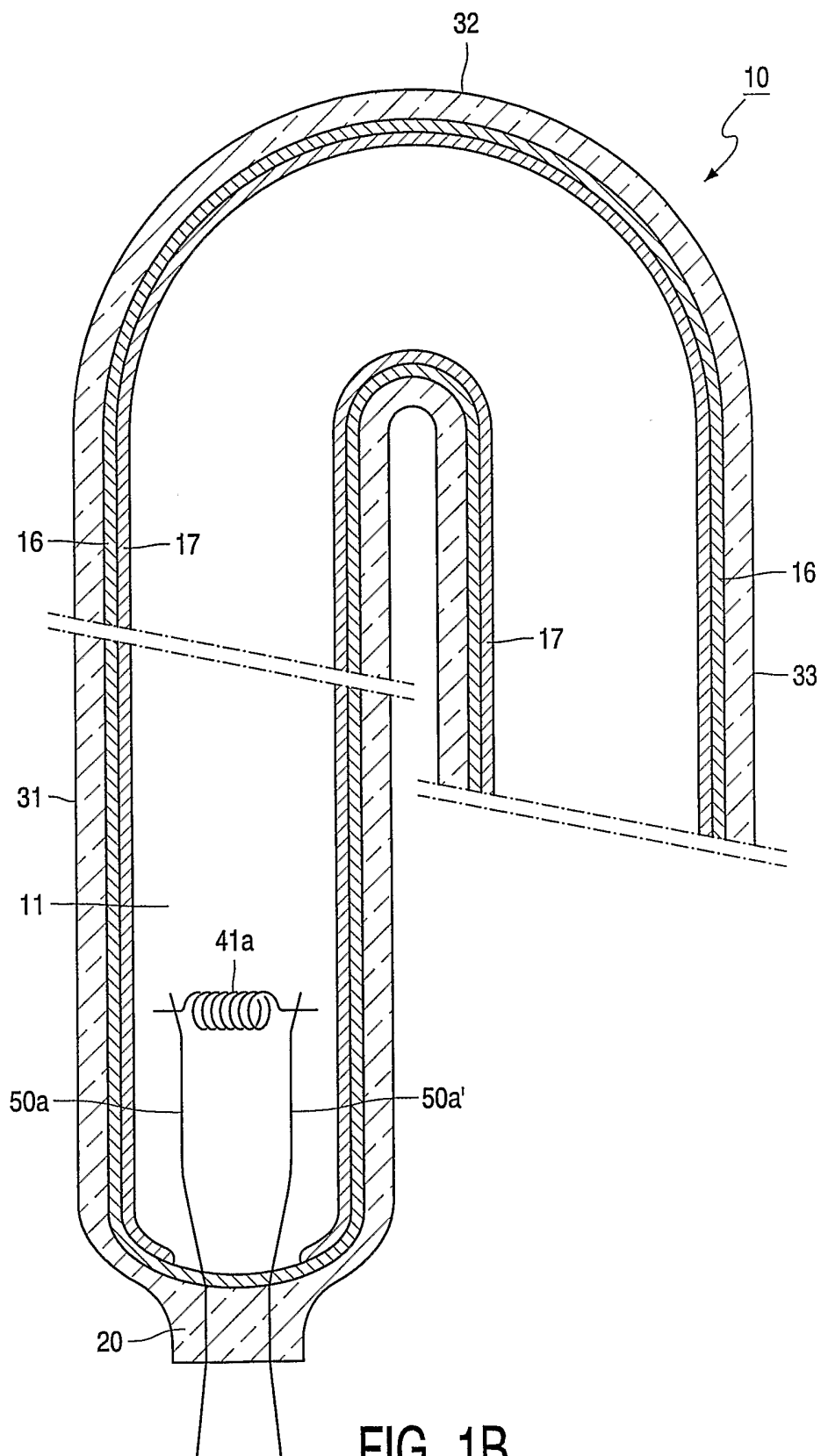


FIG. 1B

INTERNATIONAL SEARCH REPORT

Intel ^lonal Application No
PCT/IB 03/02249

A. CLASSIFICATION OF SUBJECT MATTER IPC 7 H01J61/72 H01J61/35 H01J61/36 H01J61/26		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC 7 H01J		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, WPI Data, PAJ		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 176 627 A (TOSHIBA LIGHTING & TECHNOLOGY) 30 January 2002 (2002-01-30)	1,3,6-11
Y	paragraph '0267! - paragraph '0275!; figure 16 paragraph '0088! - paragraph '0101!	4,5
Y	WO 01 56350 A (KONINKL PHILIPS ELECTRONICS NV) 9 August 2001 (2001-08-09)	4,5
A	abstract page 6, line 22 -page 7, line 22; figures 1A,1B	7,8
X	DE 898 622 C (ULRICH W DOERING MUENCHEN) 3 December 1953 (1953-12-03) page 2, line 18 -page 3, line 68; figure 1	1,3,4,9,10
	--- -/-	
☒ Further documents are listed in the continuation of box C. ☒ Patent family members are listed in annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier 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 when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
Date of the actual completion of the international search 23 September 2003		Date of mailing of the international search report 29/09/2003
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016		Authorized officer Lang, T

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/IB 03/02249

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 061 757 A (PATRA PATENT TREUHAND) 6 October 1982 (1982-10-06) abstract; figures 3,4 -----	1

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB 03/02249

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1176627 A	30-01-2002	JP 2002075275 A	15-03-2002
		JP 2002203514 A	19-07-2002
		EP 1176627 A2	30-01-2002
		JP 2002110093 A	12-04-2002
		US 2002057059 A1	16-05-2002
		JP 2003016999 A	17-01-2003
WO 0156350 A	09-08-2001	CN 1363113 T	07-08-2002
		WO 0156350 A2	09-08-2001
		EP 1188175 A2	20-03-2002
		JP 2003521804 T	15-07-2003
		US 2001026122 A1	04-10-2001
DE 898622 C	03-12-1953	NONE	
EP 0061757 A	06-10-1982	DE 3112821 A1	14-10-1982
		DE 3204249 A1	25-08-1983
		DE 3271115 D1	19-06-1986
		EP 0061757 A2	06-10-1982
		JP 57174845 A	27-10-1982
		US 4469983 A	04-09-1984
		JP 58137954 A	16-08-1983