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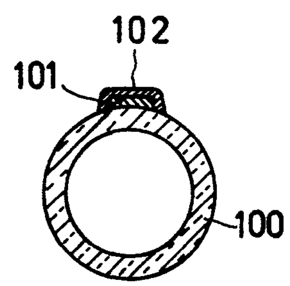
(54) Electrical high-pressure metal vapour discharge lamp.

(57) The invention relates to an electrical high-pressure metal vapour discharge lamp provided with a discharge tube (1) containing sodium and mercury as well as xenon. In the operating condition of the lamp the xenon pressure in the discharge tube is approximately 1600 torr.

In accordance with the invention the discharge tube (1) is provided with a narrow external strip-shaped coating (20) extending along substantially the entire length of the discharge tube. This strip-shaped coating consists of 80% Molybdenum, 10% Al_2O_3 and 10% CaO by volume. The strip-shaped coating acts as the starting electrode of the discharge tube.



EP 0 002 848 A1

"Electrical high-pressure metal vapour discharge lamp".

The invention relates to an electrical high-pressure metal vapour discharge lamp comprising an elongate discharge tube provided near each of its two ends with a respective internal main electrode, the wall of the discharge tube consisting substantially wholly of aluminium oxide, a strip-shaped coating being present over at least a portion of the outer surface of the wall of the discharge tube, this coating containing a first electrically conductive elementary material as well as a second material counteracting evaporation of the first material, and in which at least part of the first material is in direct contact with the aluminium oxide, the strip-shaped coating being fastened over substantially its whole length to the discharge tube and forming in use, part of a starting auxiliary device for starting a discharge between the main electrodes.

A prior art electrical high-pressure metal vapour discharge lamp of the type defined above is, for example, disclosed in Dutch Patent Application no. 7304860. A drawback of that known high-pressure metal vapour discharge lamp is that, for promoting the starting of a discharge between the main electrodes, the strip-shaped wall coating is connected to an internal auxiliary electrode of the discharge tube. This requires an additional electric feed-through through the wall of the discharge tube.

It is an object of the invention to provide a lamp of the type defined in the preamble in which the strip-shaped wall coating, provided on the outer side of the discharge tube wall, is the auxiliary electrode of the discharge tube, but that this auxiliary electrode does not substantially intercept visible light generated in the discharge tube.

An electrical high-pressure metal vapour discharge lamp according to the invention comprising an elongate discharge tube provided near each of its two ends with a respective internal main electrode, the wall of the discharge tube consisting substantially wholly of aluminium oxide, a strip-shaped coating being present over at least a portion of the outer surface of the discharge tube wall, this coating containing a first electrically conductive elementary material as well as a second material counteracting evaporation of the first material of that coating and in which at least part of the first material is in direct contact with the aluminium oxide, the strip-shaped coating being fastened over substantially its whole length to the discharge tube and forming in use, part of a starting auxiliary device for starting a discharge between the main electrodes, is characterized in that the strip-shaped coating extends along substantially the whole path between the main electrodes, and in that this strip-shaped coating has a width smaller than 0.5 mm over at least 90% of its length.

An advantage of this lamp is that the strip-shaped coating is here an external auxiliary electrode. The narrow width, over the greater portion of the length, of this auxiliary electrode implies that the auxiliary electrode intercepts the light generated in the discharge tube to a very small extent only.

The strip-shaped coating may have a width exceeding 0.5 mm for a short length, for example where there is a connecting terminal for electrically connecting the strip-shaped coating to the circuit of the lamp.

The strip-shaped coating of an electrical high-pressure metal vapour discharge lamp according to the invention consists, for example, of a solid metal conductor, the second material being in the form of a protective coating protecting the solid conductor.

In an embodiment of an electrical high-pressure metal vapour discharge lamp according to the invention the first material of the strip-shaped coating consists for 16 to 90% by volume of an element from the group molybdenum, tungsten, tantalum, niobium and carbon, and the second material of the strip-shaped coating consists of one or more oxides which, at a temperature of 1500 Kelvin, have vapour pressures below 10^{-6} torr.

An advantage of this embodiment is that more of the first material can be included in the strip-shaped coating than would be possible in the case of a solid strip on the discharge tube. In addition, it is a good electrically-conducting material. The following should be noted by way of explanation. With the narrow width of not more than 0.5 mm of the strip-shaped coating, a sufficiently low ohmic resistance thereof per running centimetre of length can - in the case of a solid metal - only be realised with a fairly thick layer of that metal. However, a very thick layer results in a poor adhesion of that metal to the discharge tube wall which mainly consists of aluminium oxide. This is caused by differences in the coefficients of expansion. By also including in the strip-shaped coating oxides which have a low vapour pressure at 1500 Kelvin, a sufficiently low ohmic resistance of the strip-shaped coating - which also remains low because the evaporation during life of the lamp is relatively low - can be combined with a proper adhesion to the discharge tube wall.

In an improvement of a lamp according to the above-mentioned embodiment, the first material of the strip-shaped coating is molybdenum or carbon, this first material being uniformly distributed in the second material of the strip-shaped coating. An advantage of this improvement is that a low degree of evaporation can be combined with a high electrical conductivity of the strip-shaped coating.

In a further improvement of that lamp the strip-shaped coating consists, by volume, of approximately 80% Molybdenum + 10% Al_2O_3 + 10% CaO. With such a strip-shaped coating it is possible to obtain, next to the above-mentioned advantages of a low evaporation and a high electrical conductivity, a very good adhesion to the discharge tube wall.

In a further embodiment of a high-pressure metal vapour discharge lamp according to the invention, the first material of the strip-shaped coating is molybdenum and the second material is tungsten, the tungsten being applied as a top coating over the molybdenum. An advantage of this embodiment is that the strip-shaped coating can be applied in a simple manner to the discharge tube. This is done by, for example, vacuum deposition or by means of a sputtering technique, for example by magnetron sputtering.

The discharge lamp is, for example, a high-pressure sodium vapour discharge lamp the discharge tube of which also contains a starting gas, for example xenon, at a filling pressure of less than 20 torr.

In an embodiment of an electrical high-pressure metal vapour discharge lamp according to the invention, which is implemented as a high-pressure sodium vapour discharge lamp, the discharge tube contains sodium and xenon, the filling pressure of the sodium exceeding 50 torr, the circumference of a transverse cross-section through the discharge tube being between 10 and 40 mm. An advantage of this embodiment is that it may furnish a lamp which combines a high luminous efficacy with a relatively low starting voltage, and wherein the interception of light by the strip-shaped coating is very small only.

A high-pressure discharge lamp according to the invention may comprise a discharge tube, the strip-shaped coating of which is not electrically connected to the lamp circuit. In that case the strip-shaped coating has a floating potential in use, preferably, however, in a high-pressure metal vapour discharge lamp according to the invention, the strip-shaped coating is electrically connected to one of the main electrodes of the discharge tube. An advantage of this is that during the starting procedure of the lamp the difference in potential between the strip-shaped coating - which then operates as an auxiliary electrode - and the main electrode of the discharge tube not connected thereto can be substantially equal to the mains voltage. As a rule this promotes the creation of ions and electrons in the discharge tube which facilitates the creation of a discharge between the main electrodes of the discharge tube. All this implies that the minimum voltage between the main electrodes for starting a discharge between these electrodes is then relatively low.

Some embodiments of lamps according to the invention will now be further explained with reference to a drawing in which:

Figure 1 shows an elevational view, partly in cross-section, of a high-pressure sodium vapour discharge lamp according to the invention;

Figure 2 shows a cross-section - not to scale - through a variant of a discharge tube for the lamp of Figure 1.

In Figure 1 reference numeral 1 denotes a discharge tube whose wall consists mainly of densely sintered aluminium oxide. This tube is located in an outer bulb 2. Reference numeral 3 denotes a base of the lamp. The discharge tube 1 comprises two internal main electrodes 4 and 5, respectively, located near the ends of this discharge tube. Via a feed-through 6 the main electrode 4 is connected to a metal conductor 7 connected to a pole wire 8 which is curved around the discharge tube 1. This form of the pole wire 8 has the advantage that annoying shadows are avoided.

Pole wire 8 is electrically connected to a contact of the base 3 of the lamp. An extended portion 9 of the pole wire 8 serves, together with a support 10, for supporting and centring the discharge tube 1 in the outer bulb 2. Via a tubular feed-through 11 the main electrode 5 is mechanically fastened to a metal conductor 12. The electrical connection is effected via a metal conductor 13. The other end of the conductor 12 is connected to a further contact in the base 3 of the lamp.

In addition, the discharge tube is provided with a strip-shaped external auxiliary electrode 20 in the form of a local ciating on the outer surface of the discharge tube 1. The auxiliary electrode 20 extends over substantially the whole distance between the main electrodes 4 and 5. The auxiliary electrode is approximately 0.2 mm wide, its composition by volume is: a mixture of 80% Molybdenum, 10% Al_2O_3 and 10% CaO. The two mentioned oxides Al_2O_3 and CaO have, at a temperature of 1500 Kelvin, a vapour pressure below 10^{-6} Torr. Near the main electrode 5 the discharge tube 1 comprises a conducting nickel sleeve 21 which also extends over the auxiliary electrode 20 and is in electrical contact therewith. A strip 22, also of nickel, connects the sleeve 21 to an electrode of a capacitor 23, disposed in the space between the discharge tube 1 and the outer bulb 2. The other electrode of capacitor 23 is constituted by a portion of the metal conductor 13 which provides the electrical connection between the main electrode 5 and the conductor 12.

The discharge tube 1 contains both sodium and mercury as well as xenon. The xenon pressure at 300 Kelvin is approximately 200 torr. The space between the discharge tube 1 and the outer bulb 2 is evacuated.

The described lamp is, for example ignited by means of a starter (not shown) provided with a thyristor, for example as disclosed in Dutch Patent Application no. 6904456.

In the operating condition of the lamp shown in Figure 1 the lamp is connected through an inductive stabilisation impedance of approximately 0.3 Henry to an a.c. mains supply of approximately 220 Volts, 50 Hertz. Further details of the described lamp are included in the following table. The temperature of the coldest spot in the discharge tube 1 is - in the operating condition of the lamp according to the invention- approximately 1000 Kelvin. A sodium vapour pressure in the discharge tube 1 of approximately 130 torr corresponds therewith. The average temperature within the discharge tube 1 in the operating condition of the lamp is approximately 2400 Kelvin. The average temperature of the wall of the discharge tube is approximately 1500 Kelvin. At this temperature of 1500 Kelvin the vapour pressure of the oxides of the strip-shaped auxiliary electrode is - as already mentioned above - small. So there is only a low degree of evaporation of said oxides.

	Lamp according to the invention
Power (in watts)	150
Operating voltage (in volts)	100
Inside diameter of the discharge tube (in mm)	4.5
Circumference of cross-section (in mm) of the discharge tube approx.	20
Main electrode spacing (in mm)	63
Weight of the amalgam (in mgram)	10
Weight ratio mercury/sodium	2.7
Xenon pressure cold (in torr)	200
Xenon pressure during operation (in torr)	1600
Luminous efficacy (lumens/watt	115
R_a	19

The voltage required between the main electrodes 4 and 5 for starting the discharge is in the present case approximately 2 kVolts.

Without the strip 20 the voltage required between the main electrodes 4 and 5 - for igniting the discharge - would be much greater, namely: approximately 6 kVolts.

The strip-shaped coating 20 of Figure 1 is approximately 35 microns thick. Its ohmic resistance per running centimetre is approximately 0.1 kOhm.

The strip-shaped coating 20 is applied to the wall of the discharge tube by means of a pen. For this purpose this pen is first dipped into a suspension of 80% molybdenum powder with 10% aluminium oxide and 10% calcium oxide in butyl acetate. After the coating has been applied a firing operation is performed at 1600 Kelvin for 30 minutes in a reducing atmosphere. This results in a proper adhesion to the wall of the discharge tube 1 over the full length of the strip-shaped coating 20.

In a case where the first material of the strip-shaped coating is carbon, that strip-shaped coating can, for example, also be applied to the discharge tube by means of a pen.

Also other processes of realizing the strip-shaped coating on the wall of the discharge tube are conceivable.

Figure 2 shows a perpendicular cross-section 100 of a second discharge tube, enlarged three times relative to that of the discharge tube 1 of Figure 1. Also tube 100 consists mainly of aluminium oxide. A strip-shaped molybdenum coating 101 is provided on tube 100. A tungsten top coating 102 is applied over coating 101. The full width of the strip is approximately 0.2 mm. To indicate the various layers, the strip is not drawn to scale in Figure 2.

An advantage of the described strip-shaped coatings in a lamp according to the invention

-as opposed to starting wires - is that the strip-shaped coatings are always very close to the main electrode path without requiring an additional measure such as subjecting it to a tensile load - as is the case with starting wires.

Claims

1. An electrical high-pressure metal vapour discharge lamp comprising an elongate discharge tube provided near each of its two ends with a respective internal main electrode, the wall of the discharge tube consisting substantially wholly of aluminium oxide, a strip-shaped coating being present over at least a portion of the outer surface of the wall of the discharge tube, this coating containing a first electrically conductive elementary material as well as a second material counteracting evaporation of the first material and in which at least part of the first material is in direct contact with the aluminium oxide, the strip-shaped coating being fastened over substantially its whole length to the discharge tube and forming, in use, part of a starting auxiliary device for starting a discharge between the main electrodes, characterized in that the strip-shaped coating extends along substantially the whole path between the main electrodes, and in that this strip-shaped coating has a width smaller than 0.5 mm over at least 90% of its length.

2. An electrical high-pressure metal vapour discharge lamp as claimed in Claim 1, characterized in that the first material of the strip-shaped coating consists for 16 to 90% by volume of an element from

the group molybdenum, tungsten, tantalum, niobium and carbon, and the second material of that strip-shaped coating consists of one or more oxides which, at a temperature of 1500 Kelvin, have vapour pressures below 10^{-6} torr.

3. An electrical high-pressure metal vapour discharge lamp as claimed in Claim 2, characterized in that the first material is molybdenum or carbon, this first material being uniformly distributed in the second material of the strip-shaped coating.

4. An electrical high-pressure metal vapour discharge lamp as claimed in Claim 3, characterized in that the strip-shaped coating consists of substantially 80% Molybdenum + 10% Al_2O_3 + 10% CaO by volume.

5. An electrical high-pressure metal vapour discharge lamp as claimed in Claim 1, characterized in that the first material is molybdenum and the second material is tungsten, the tungsten being applied as a top coating over the molybdenum.

6. An electrical high-pressure metal vapour discharge lamp as claimed in any of Claims 1, 2, 3, 4 or 5, the lamp being a high-pressure sodium vapour discharge lamp, the discharge tube containing sodium and xenon, the filling pressure of the sodium exceeding 50 torr, characterized in that the circumference of a transverse cross-section through the discharge tube is between 10 mm and 40 mm.

7. An electrical high-pressure metal vapour discharge lamp as claimed in any of Claims, 1, 2, 3, 4, 5 or 6, characterized in that the strip-shaped coating is electrically connected to one of the main electrodes of the discharge tube.

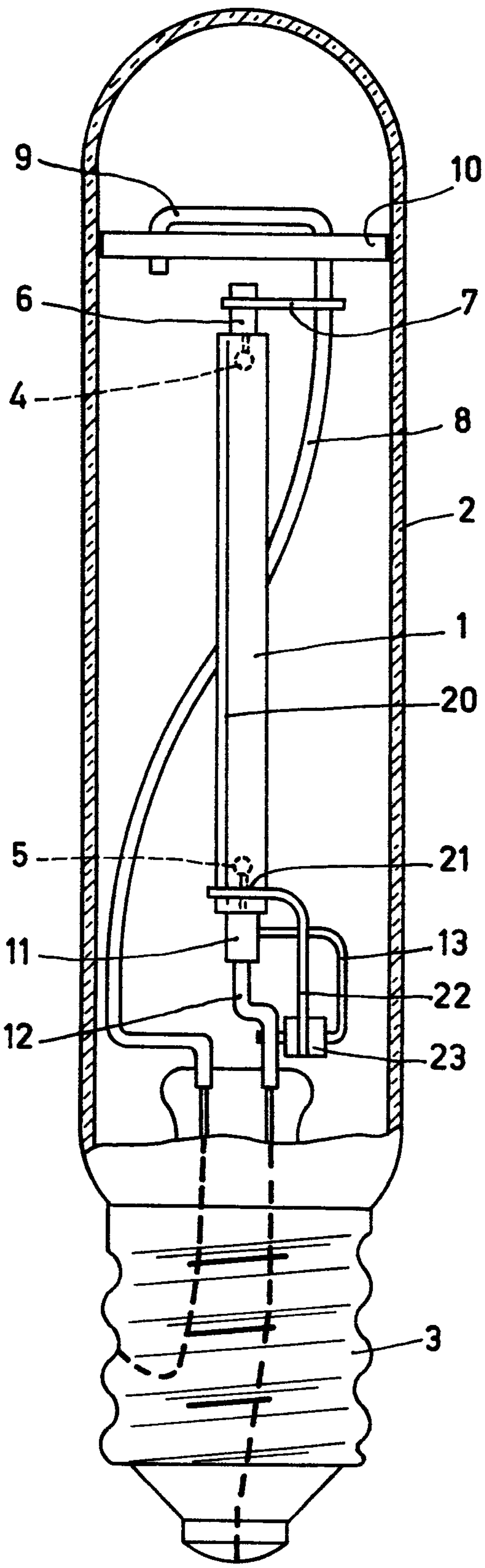


FIG.1

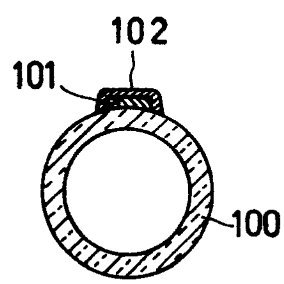


FIG.2

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EUROPEAN SEARCH REPORT

Application number
EP 78 20 0339

Category	DOCUMENTS CONSIDERED TO BE RELEVANT Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.²)
	US - A - 2 542 345 (E. MILES) * Whole *	1,6,7	H 01 J 61/54
	DE - A - 1 764 866 (PATENT-TREUHAND-GESELLSCHAFT FUR ELEKTRISCHE GLUHLAMPEN) * Page 2, lines 25-30; page 4, whole; claims 1 and 4; figures *	1	
	US - A - 4 047 064 (COSCO et al.) * Whole *	1	
P	US - A - 4 065 370 (NOBLE et al.) * Abstract; column 3, lines 25-30; column 4, lines 1-8; figures 1,3 *	1,7	

TECHNICAL FIELDS SEARCHED (Int.Cl.²)

H 01 J 61/54
61/56
61/82
61/84
61/35
17/30

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	23-03-1979	MENAGER