United States Patent

Willemsen

[15] 3,649,864

[45] Mar. 14, 1972

[54] LOW-PRESSURE DISCHARGE LAMP HAVING AN ENVELOPE ENCOMPASSING THE DISCHARGE SPACE AND CONSISTING INTER ALIA OF A SUPPORT

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[30] **Foreign Application Priority Data**

Sept. 19, 1968 Germany.....G 67 53 632

[52] **U.S. Cl.**.....**313/221,** 313/201, 313/210, 313/217, 313/220

[51] **Int. Cl.**.....**H01j 17/16**

[58] **Field of Search**.....313/201, 210, 217, 220, 109, 313/109.5, 112, 221

[56] **References Cited**

UNITED STATES PATENTS

2,004,577	6/1935	Lebedenko et al.	313/109.5
2,654,042	9/1953	Clarke et al.	313/109
2,925,511	2/1960	Skellett	313/109 X
3,363,134	1/1968	Johnson	313/221 X
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FOREIGN PATENTS OR APPLICATIONS

456,184	11/1936	Great Britain	313/220

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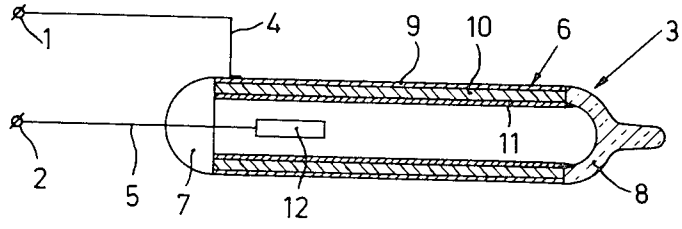
[57] **ABSTRACT**

A low-pressure glow discharge lamp having an envelope encompassing the discharge space formed from a ceramic dielectric material which is coated by layers of electrical conducting material to function as a self-ballasting capacitor for stabilizing the electric discharge in the lamp.

10 Claims, 3 Drawing Figures



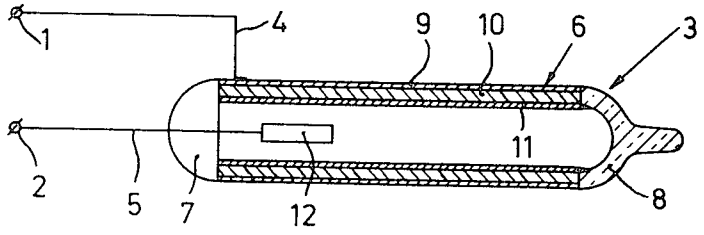


fig.1

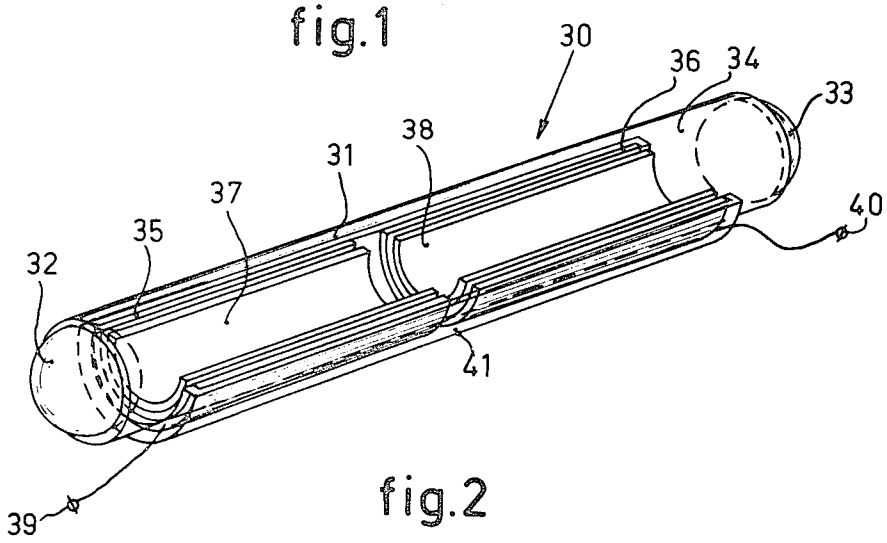


fig.2

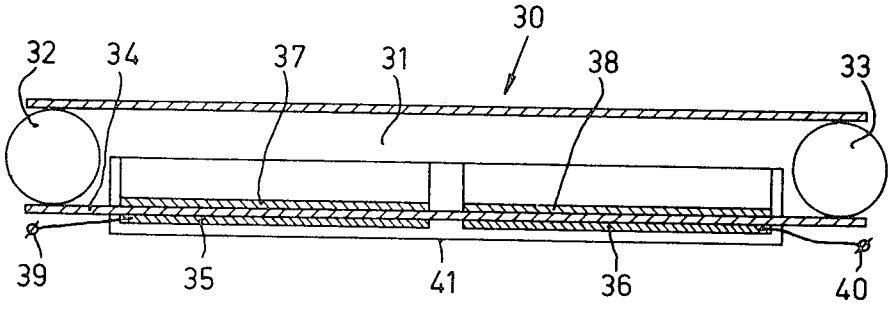


fig.3

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LOW-PRESSURE DISCHARGE LAMP HAVING AN ENVELOPE ENCOMPASSING THE DISCHARGE SPACE AND CONSISTING INTER ALIA OF A SUPPORT

The invention relates to a low-pressure discharge lamp having an envelope encompassing the discharge space and consisting inter alia of a support in which at least a portion of the envelope comprises a layer of transparent ceramic material and a transparent electrically conductive layer, the last-mentioned layer being provided on the side of the ceramic layer remote from the discharge, the transparent electrically conductive layer being a current supply conductor of the lamp.

In a known lamp of the kind described, the transparent electrically conductive layer is formed by a capacitor plate, whose ceramic layer is the dielectric, which capacitor serves to stabilize the discharge in the lamp. An advantage of this known lamp which has been described, for example, in U.S. Pat. specification No. 2,654,042 is that a separate series capacitor is not required.

A drawback of this known lamp is that the envelope encompassing the discharge space is provided with a glass support. This glass makes the envelope of the known lamp complicated. In fact, both the transparent electrically conductive layers and the ceramic layer are still present on the internal side of the envelope of the known lamp.

Although it is known from another embodiment of the above-mentioned U.S. Pat. specification to obtain a simple structure of the envelope by using the glass support as a dielectric of the ballasting capacitor, this solution has the drawback that the required capacitance of the capacitor can sometimes only be obtained when using a very thin glass support or when using a high frequency of the electrical supply voltage of the lamp. A thin glass support of course gives rise to a very vulnerable lamp and the use of a high frequency causes a complication in the supply circuit of the lamp.

It is an object of the present invention to provide a discharge lamp which has both a simple but robust structure of the envelope and has a capacitor impedance which is satisfactory for stabilizing when being fed by a normal low-frequency alternating voltage supply.

A low-pressure discharge lamp according to the invention having an envelope encompassing the discharge space and consisting inter alia of a support and in which at least a portion of this envelope comprises a layer of transparent ceramic material and a transparent electrically conductive layer, the last-mentioned layer being provided on the side of the ceramic layer remote from the discharge, and the transparent electrically conductive layer being a current supply conductor of the lamp is characterized in that the lamp is a glow discharge lamp and that in a cross section of the envelope at the area of the ceramic layer the support of the envelope is constituted by said layer.

An advantage of this lamp is that the ceramic layer performs two functions. The ceramic layer serves as a dielectric for the stabilizing capacitor, but also as a supporting portion of the envelope. The latter means that the mechanical strength of the envelope is mainly determined by the mechanical strength of the ceramic layer. Such a combination of the two functions of the ceramic layer was found to be possible in glow discharge lamps. On the one hand this has to be ascribed to the comparatively small values of the required series capacitances for glow discharge lamps, and on the other hand to the comparatively small dimensions of these lamps, and this because the use of this ceramic material makes it possible to obtain both a sufficiently high ballasting impedance of the capacitor and a still acceptable light transmission due to the small envelope section required on account of mechanical considerations.

In a lamp according to the invention the other electrode of the series capacitor is formed for example, by ionized gas in the discharge space during operation of the lamp.

In a lamp according to the invention the envelope on the side of the ceramic layer facing the discharge is preferably provided with a second transparent electrically conductive layer which is in contact with the discharge space.

An advantage thereof is that the ignition voltage of the lamp may be comparatively small, because the second transparent electrically conducive layer may now function as the lamp electrode which may have a work function which is low for electrons.

In a further advantageous embodiment of a glow discharge lamp according to the invention the lamp is oblong and is provided with a penlike electrode the longitudinal axis of which substantially coincides with the longitudinal axis of the lamp.

An advantage of this embodiment is that the glow discharge lamp in this case may have a light distribution wherein the light intensity in a flat plane at right angles to the longitudinal axis of the lamp is substantially the same in any direction.

In a further embodiment, the lamp is oblong, the envelope near one end of the lamp consisting of glass.

An advantage of this embodiment is that during the manufacturing process the ends of the lamp can easily be sealed in a vacuumtight manner. In fact, this is a simple matter when using glass.

It is feasible that only one end of the lamp is made of glass, for example, an end to which an exhaust tube was secured. It is also feasible that both ends of the lamp are provided with a glass part of the envelope. One of these parts or both parts consist, for example, of glass beads.

In a further preferred embodiment according to the invention the lamp includes an envelope having both a second transparent electrically conductive layer and a third transparent electrically conductive layer, the two coatings being in contact with the discharge space, and the electric resistance of the envelop between the third and the second transparent electrically conductive layer being highly resistive, the discharge current of the lamp flowing through the third electrically conductive layer. A highly resistive electric resistance is understood to mean a resistance in the order of that of an isolator.

An advantage of this lamp is that the light radiation in this case is substantially not influenced by the lamp electrodes.

The third electrically conductive layer may be connected, for example, to a connection wire which protrudes through the envelope of the discharge space.

A lamp according to the invention preferably has not only the said first, second and third transparent electrically conductive layers, but also a fourth transparent electrically conductive layer, which fourth layer is provided on the side of the ceramic layer remote from the discharge, all this in such a manner that the electric resistance of the envelope between the fourth electrically conductive layer and the first electrically conductive layer is highly resistive, the fourth electrically conductive layer being a current supply conductor of the lamp, the second conductive layer facing the first conductive layer and the third conducive layer facing the fourth conductive layer.

In this case connection wires through the envelope of the discharge space are superfluous. In fact, the lamp is now fed through the first and the fourth transparent electric conductor. Going from the first transparent conductor the current passes successively a first series capacitor, the discharge path and a second series capacitor. Then the current has reached the fourth transparent electric conductor.

In certain cases, for example, when the lamp is incorporated in a permanently closed housing of, for example, synthetic plastic material, a transparent electric conductor may form the exterior of the lamp.

The exterior of the envelope preferably consists of a coating of a transparent insulation material, particularly a transparent lacquer coating.

An advantage of the last-mentioned embodiment is that the lamp can safely be touched by hand.

In order that the invention may be readily carried into effect, a few embodiments thereof will now be described in detail by way of example, with reference to the accompanying diagrammatic drawing in which:

FIG. 1 is a longitudinal section of a glow discharge lamp according to the invention;

FIG. 2 is a perspective view of a second glow discharge lamp according to the invention;

FIG. 3 is a longitudinal section of the lamp of FIG. 2.

In FIG. 1, reference numerals 1 and 2 denote connection terminals, which are intended to be connected to an alternating voltage supply of 220 v., 50 Hz. An electric conductor 4 is connected between terminal 1 and a glow discharge lamp 3. An electric conductor 5 is connected between the terminal 2 and the glow discharge lamp 3. The lamp 3 comprises a light-transmitting cylindrical part 6, an endpart 7 in the form of a hemispherical bead and an endpart 8 having an arclike profile. The glow discharge lamp has a length of approximately 3 cm. The cylindrical envelope 6 consists of an external electrically conductive transparent layer 9 which is provided on the outer side of the envelope 6. In this case this layer consists of tin oxide, but it is feasible that a different material, for example, indium oxide is used for this purpose. The envelope 6 further includes a layer of a ceramic material 10. This material mainly consists of barium titanate. The interior of the envelope 6 includes a second transparent electric layer 11 which likewise consists of tin oxide. In FIG. 1 the layers 9 and 11 are shown too thickly, namely to clearly indicate their location. Actually, their thickness is at the most a few percents of that of the thickness of the ceramic layer 10. The glow discharge lamp 3 further includes a penlike electrode 12 which is provided on the longitudinal axis of the lamp. The hemispherical bead 7 and the arclike endpiece 8 consist of glass, namely a soft glass the coefficient of expansion of which is substantially equal to that of the ceramic material of the layer 10. The arclike portion 8 is the remainder of a pinched glass exhaust tube through which this lamp was exhausted and filled with neon gas during manufacture. The electric conductor 4 is connected to the electrically conductive layer 9, for example, by means of a soldered joint. The electric conductor 5 is connected between terminal 2 through the glass bead 7 to the penlike electrode 12. The lamp 3 if filled with neon gas, whose pressure was approximately 30 torr. The external diameter of the lamp was approximately 3 mm. and the internal diameter was approximately 2 mm., as already previously stated the length was approximately 3 cm. The length of the cylindrical part 6 was approximately 2½ cm.

In the lamp described the combination of the conductive layer 9, the ceramic layer 10 and the conductive layer 11 constitutes a series capacitor for the discharge which takes place in the discharge space encompassed by the envelope of the lamp. This combination of three layers also constitutes the cylindrical portion of the envelope of the said lamp. The electric current flows via the connection terminal 1 through the electric conductor 4 to the capacitor plate 9. The layer 11, which is the other plate of the capacitor, also functions as an electrode of the lamp 3. A current flows from this electrode 11 through the discharge space to the electrode 12 and thence through the electric conductor 5 to the connection terminal 2. The lamp described is intended to be used in a sealed housing (not shown) of a transparent insulating material.

The capacitance of the capacitor of FIG. 1 may approximately be determined by way of the formula:

$$C = E_r \cdot \frac{10^{-9} - 1}{18 \ln \frac{D_2}{D_1}}$$ of a cylindrical capacitor; wherein:

C = the capacitance in Farad;

E_r = the relative dielectric constant of the intermediate layer 10;

l = the length of the cylinder 6 in meter; and

D_2/D_1 = the ratio between the external diameter of the lamp and the internal diameter of the lamp.

In the relevant case the relative dielectric constant of the ceramic intermediate material was approximately 4,000. After substitution of $l = 2.5.10^{-2}$ and $D_2/D_1 = 1\frac{1}{2}$, the capacitance C of the capacitor is found to be approximately 14,000 pf. A comparatively small resistivity is added to this capacitance, which resistivity is formed by the electric resistance of the transparent electrically conductive coatings.

In the case of the glow discharge lamp described the lamp current was approximately 1 ma. A capacitance of 14,000 pf. is a satisfactory capacitance for the above-mentioned current source to which the lamp is connected.

The mechanical strength of the cylindrical envelope 6 is substantially determined by the mechanical strength of the ceramic layer 10.

In FIG. 2 the reference numeral 30 again denotes a glow discharge lamp. This glow discharge lamp has a light transmitting cylindrical portion 31 which is closed on either side with the aid of glass beads 32 and 33, respectively. The cylindrical portion 31 consists of a ceramic support 34 (see also FIG. 3) half the circumference of which is provided with two externally located transparent electric conductors (35, 36). A semicylindrical transparent electric conductor 37 is provided internally of the ceramic layer 34. The conductor 37 faces the conductor 35 (see also FIG. 3). A likewise semicylindrical electrically conductive layer 38 is provided, likewise as the layer 37, internally of the ceramic layer 34. The layer 38 faces the transparent electrically conductive layer 36. The conductor 35 is connected to a connecting terminal 39, the conductor 36 is connected to a connecting terminal 40. These connection terminals 39 and 40 are intended to be connected to an alternating voltage mains of 220 v., 50 Hz. The layers 35 and 36 of the glow discharge lamp 30 are covered by a transparent lacquer coating 41.

If desired, the lacquer coating may, however, partly consist of a reflective material. THe material of the ceramic layer 34 is the same as that of the layer of the lamp of FIG. 1. The material of the transparent conductors is the same as that of the layers 9 and 11 of the lamp of FIG. 1.

In FIG. 3 the locations of the different layers such as the ceramic layer 34 and the electrically conductive layers 35 to 38 inclusive are shown in a longitudinal section of the lamp. The coating 41 and the layers 35 to 38 inclusive are shown comparatively too thickly in FIGS. 2 and 3. This has been done for the same reason as stated in the description of the layers 9 and 11 of FIG. 1.

The lamp of FIGS. 2 and 3 also had a length of approximately 3 cm., an external diameter of 3 mm. and an internal diameter of 2 mm. The overall length of the semicylindrical conductors 37 and 38 was approximately 2½ cm. In the relevant case the lamp current was approximately one-eighth ma. In this case the stabilization of the discharge current was carried out by two capacitors, to wit the capacitor including the plates 35 and 37 and the capacitor including the plates 38 and 36. In fact, these capacitors are incorporated in the series circuit 39, 35, 37, the discharge path 38. 36, 40. The capacitance of these two capacitors combined is approximately one-eighth of that of the lamp of FIG. 1. With the above-mentioned current source and the above-mentioned lamp current intensity of the glow discharge lamp 30 this also gives a satisfactory stabilization of the glow discharge.

It is feasible that a cylindrical portion of the lamp envelope is not closed with the aid of a glass bead, but by means of a different closure, for example, a flat thin-walled final portion which is transverse to the longitudinal axis of the lamp.

What is claimed is:

1. A discharge lamp comprising an oblong envelope forming a discharge space, end parts for hermetically sealing said envelope, said envelope essentially consisting of a transparent ceramic dielectric material having a coefficient of expansion substantially equal to that of said end parts, an ionizing gas filling said discharge space, electrodes for producing a gaseous discharge within said envelope, electrically conductive transparent layers on opposite sides of said envelope in confronting relationship, the inner conduction layer functioning as one of said electrodes in said discharge space, the inner and outer conducting layers and said dielectric material forming a ballasting capacitor in series with said discharge space for stabilizing said gaseous discharge within said lamp, an electrode functioning as the second of said electrodes in said discharge space, and terminal means for providing current to said lamp.

2. A discharge lamp as claimed in claim 1 wherein said second electrode is positioned along the longitudinal axis of said lamp.

3. A discharge lamp as claimed in claim 1 wherein said transparent ceramic dielectric material essentially consists of barium titanate and said electrically conducting material essentially consists of tin oxide.

4. A discharge lamp as claimed in claim 1 further comprising a lacquer coating of a transparent insulating material for said electrically conducting material.

5. A discharge lamp as claimed in claim 4 wherein said lacquer coating partly consists of a reflective material.

6. A discharge lamp as claimed in claim 1 wherein said end parts essentially consist of glass, one of said end parts being in the form of a hemispherical bead and the other having an arclike profile.

7. A discharge lamp as claimed in claim 1 wherein said end parts are flat thin walled portions positioned transverse to the longitudinal axis of said lamp.

8. A discharge lamp as claimed in claim 1 wherein said internal electrically conductive, transparent layer has a low work function.

9. A discharge lamp comprising an oblong envelope forming a discharge space, end parts for hermetically sealing said envelope, said envelope essentially consisting of a transparent ceramic dielectric material having a coefficient of expansion substantially equal to that of said end parts, an ionizing gas filling said discharge space, at least one pair of electrically conductive transparent layers spaced apart on opposite sides of said envelope in confronting relationships, the internal conducting layer functioning as an electrode for producing a gaseous discharge, the inner and outer conducting layers and said dielectric material forming a ballasting capacitor in series with said discharge space to stabilize said gaseous discharge within said lamp, and terminal means connected to said external conducting layers for providing current to said lamp.

10. A discharge lamp as claimed in claim 9 wherein said electrically conductive transparent layers have a semicylindrical shape.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3649864 Dated May 4, 1972

Inventor(s) PETRUS JOHANNES MARIE WILLEMSEN

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 18, "vacuumtight" should read -- vacuum-tight --

Column 3, in the formula, "10^{-9} - 1" should read -- $10^{-9} \cdot 1$ --

Column 4, line 30, after "layer" insert -- 10 --

Signed and sealed this 24th day of October 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents