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Hammer et al.

[11] **3,826,946**

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[54] **VAPOR DISCHARGE LAMP ELECTRODE HAVING CARBON-COATED AREAS**

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[52] **U.S. Cl.** **313/218,** 313/311, 117/212, 117/226

[51] **Int. Cl.** **H01j 61/06**

[58] **Field of Search** ..... 313/213, 218, 311; 117/212, 226; 204/290 R

[56] **References Cited**

UNITED STATES PATENTS

3,538,373 11/1970 Van der Linden et al. 313/178

3,706,895 12/1972 Martyny 313/42

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[57] **ABSTRACT**

A carbon coating is provided on the filament end regions, and also on the adjacent support wires and anodes, of an electrode structure for a low pressure mercury vapor discharge lamp, such as a fluorescent lamp. This results in improved lamp efficiency and reduced oxide ring formation at the lamp ends.

7 Claims, 2 Drawing Figures

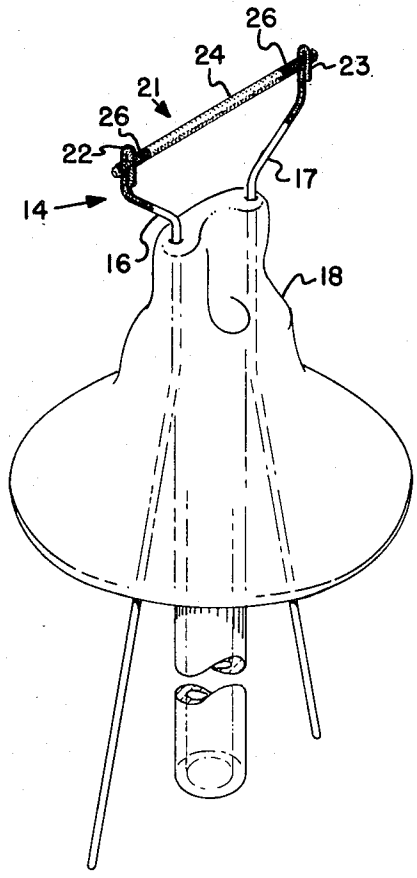


Fig. 1

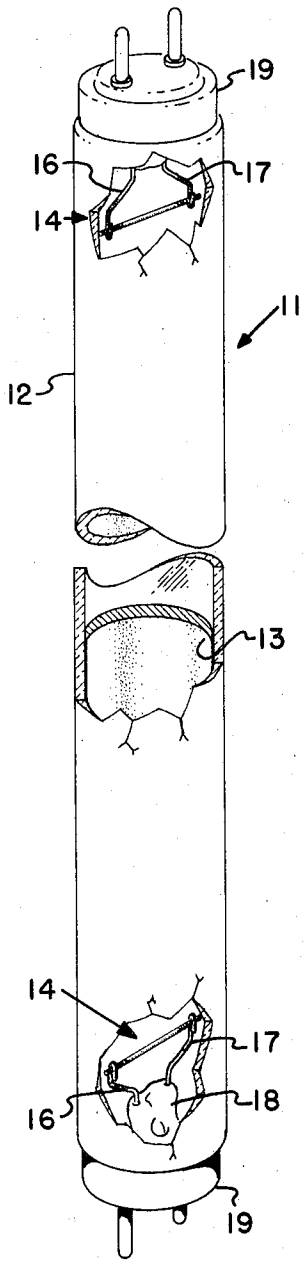
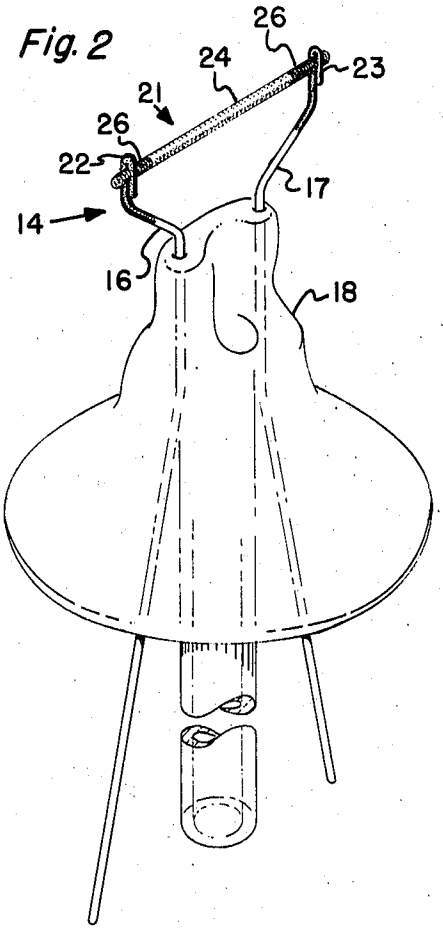


Fig. 2



VAPOR DISCHARGE LAMP ELECTRODE HAVING CARBON-COATED AREAS

BACKGROUND OF THE INVENTION

The invention is in the field of electrode structures for vapor discharge lamps such as low pressure mercury discharge fluorescent lamps and ultraviolet lamps.

A typical low pressure mercury vapor discharge lamp comprises an elongated glass bulb having an electrode structure sealed at each end of the bulb. Each electrode structure comprises an elongated helically coiled or doubly coiled filament of tungsten supported at the ends thereof by lead-in wires of nickel or other suitable metal which also provide electrical connections to the filament. A portion of the filament, between the ends thereof, is coated with an electron-emitting cathode mixture of alkaline earth oxides such as barium oxide, calcium oxide, and strontium oxide. The lamp contains a small amount of mercury to provide mercury vapor at a pressure of about 6 mm (6 torr) when the lamp is operating, and argon or other inert gas at a pressure of about 3 torr to aid in starting the discharge.

The aforesaid emission mixture of alkaline earth oxides is initially applied to the filament in the form of alkaline earth carbonates, and, before completing the lamp, the mixture is "activated" by passing current through the filament to heat the mixture to about 1,600°C to convert the carbonates into oxides. The emission mixture is not applied to the end regions of the filament near their attachment to the lead wires because these regions do not become hot enough during activation to fully convert the carbonates into oxides, and any uncoverted carbonates would have a deleterious effect in the lamp.

The electrode structure, in addition to having a cathode in the form of an electron emission mixture coated on a filament (for the purpose of emitting electrons during the alternate half-cycles of operating current when the electrode is at a negative polarity), also has an anode which may comprise the lead-in wires and the bare ends of the filament, and additional wires or metal plates if greater anode area is desired. The anode functions by receiving electrons during the alternate half-cycles of operating current when the electrode is at a positive polarity. The portion of the filament coated with emission mixture can also function as an anode, but at lower electrical efficiency due to the voltage drop through the emission mixture material.

Among the many areas in which improvement has been sought in vapor discharge lamps, such as low pressure mercury vapor fluorescent lamps, is increased electrical operating efficiency and reduction of oxide rings (sometimes called end bands) usually of a dark brown, black, or other coloration, which tend to form on the inside of the bulb (or on the inside surface of the phosphor coating in a fluorescent lamp) at locations inwardly of the electrodes near the beginning of the positive column region of the vapor discharge. It has been proposed to reduce the formation of oxide rings by providing a coating of refractory oxide insulating material (such as aluminum oxide, zirconium oxide, magnesium oxide, etc.) on metal areas of the electrode structures not covered with emission mixture. Such coatings are described, for example, in U.S. Pat. Nos. 2,769,112 to Heine and Meister; 2,966,606 to Biggs; and 3,069,580 to Waymouth for the purposes of reducing oxide ring formation and/or increasing lamp life. U.S. Pat. No. 3,706,895 to Martyny, Miller, and Olwert describes an electrode having a coating of a high temperature insulating plastic on exposed metal areas, which reduces the formation of oxide rings.

SUMMARY OF THE INVENTION

Objects of the invention are to provide improved vapor discharge lamp electrodes, and to provide such electrodes which reduce the formation of oxide rings in the lamp and which also increase the electrical operating efficiency of the lamp.

The invention comprises, briefly and in a preferred embodiment, a vapor discharge lamp electrode structure having a filament connected to lead-in wires and provided with an emission mixture coating on a center portion thereof, the filament and lead-in wires being provided with a coating of carbon over at least a portion of the exposed metal areas thereof. Preferably, the carbon is coated over end regions of the filament, up to the cathode coating of electronemitting material, and also over the adjacent regions of the lead-in wires.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a broken-away perspective view of a preferred embodiment of the invention; and

FIG. **2** is a perspective view of an electrode structure in accordance with a preferred embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. **1**, a fluorescent lamp **11** comprises an elongated glass bulb **12** having a coating of phosphor material **13** on the inside thereof, and containing an electrode structure **14** at each end thereof, supported on lead-in wires **16, 17** which extend through a mount stem **18** to the contacts of a base **19** affixed to the end of the lamp. The lamp is filled with an inert gas such as argon or a mixture of argon and other gases at a low pressure, for example about **3** torr, and a small quantity of mercury to provide a low vapor pressure of about 6 mm (6 torr) during lamp operation.

As shown in FIG. **2**, the electrode structure **14** comprises an elongated filament **21** in the form of a helically coiled or doubly coiled tungsten wire, attached near the ends thereof to the lead wires **16** and **17**, such as by clamping the end regions of the lead wires around the filament as indicated by numerals **22** and **23.** The central region of the filament **21** is provided with a coating of the usual electron emission material **24,** which may be applied in any suitable way such as by dipping or spraying a mixture of alkaline earth carbonates.

In accordance with the invention, the remaining exposed portions of the filament **21** at the end regions thereof, and the lead wire clamps **22** and **23,** are covered with a coating of carbon **26.** The carbon coating may be applied by any suitable method, such as spraying or dipping, using a suitable material such as Aquadag E which is a fine particle dispersion of graphite in a volatile liquid which, upon volatilizing, leaves a coating of carbon. After both the emission mix coating **24** (in the form of carbonates) and the carbon coating **26** have been applied to the filament **21,** the emission mix

is activated by passing current through the filament to heat the carbonates to a temperature of about 1,600°C in order to convert the carbonates into oxides. This can be done either before or after sealing the mount structure into the lamp.

The carbon coating **26** should continuously cover all of the exposed metal parts of the filament **21** and clamps **22, 23** and should extend down to at least about **3** mm below the points where the filament **21** is clamped. If desired, however, the carbon coating may cover the entire area of the lead wires **16** and **17.** The carbon coating also should cover the entire end portions of the filament which extend outwardly from the clamps **22** and **23,** and should extend inwardly from the clamps **22** and **23** to meet exactly with the ends of the emission mixture coating **24,** without any overlapping of carbon and emission mixture. In a successful embodiment, the filament **21** is coated with carbon **26** for a distance of about **3** mm inwardly from each of the clamps **22** and **23.** These carbon-coated areas function as anode areas of the electrode structure. If the ends of the lead wires **16, 17** are extended, of if additional wires or metal plates are provided in the plane of the filament or forward of the filament in the vapor discharge region, in well-known manner to provide increased anode area, they also could be coated with carbon.

Lamps made with electrodes having carbon-coated areas in accordance with the invention and as described above operate at higher electrical efficiency, and develop less oxide ring formation than do lamps without the carbon-coated areas. In a test comparison of 18 96-inch Slimline fluorescent lamps having carbon-coated electrode areas in accordance with the invention versus eighteen of the same kind of lamps without carbon-coated areas, the lamps having carbon-coated areas produced an average of 1.5 more lumens per watt at 100 hours of operating life, which is a 1.9 percent improvement in lamp efficacy. Similar tests with 48-inch Slimline lamps showed an improvement of 3.2 lumens per watt, which is a 4.1 percent gain in efficacy. In another test comparison of 96-inch Slimline lamps, 36 lamps having carbon-coated electrode areas in accordance with the invention were lighted for a total of 3,000 hours on a cycle of 3 hours lighted followed by 20 minutes unlighted and then compared for ring formation with 36 identically operated lamps of the same kind without carbon-coated areas. Four of the lamps with carboncoated areas developed visible oxide rings whereas 27 of the lamps without carbon-coated areas developed visible oxide rings many of which were more objectionable (darker) than those in the aforesaid four lamps having carbon-coated areas.

It is believed that the carbon coating of the electrode areas in accordance with the invention achieves the improved results by covering already oxidized metal parts such as the lead wires, or preventing those electrode areas from becoming oxidized as would otherwise occur when the filament is heated to the high temperature during the activation process. Additionally, the carbon-coated areas function very efficiently as anodes because of their low resistivity and good thermal conduction. By its good thermal conduction, the carbon coating conducts to its metal substrate, and to the surrounding atmosphere in the lamp, the surface heat generated on the carbon coating by electron impingement when functioning as an anode, whereby the carbon coating operates cooler and has a lower resistance to the passage of current than would an oxidized surface on the metal parts. The reduced oxide ring formation achieved by the invention is believed due to the fact that the carbon-coated areas cannot become oxidized. If these electrode areas, which function as anodes during alternate half-cycles of operating current, were oxidized, the vapor discharge current would tend to break down the oxidized surface, releasing oxygen or oxygen-containing materials into the vapor discharge. In the presence of the discharge, mercury can react with these materials forming mercury oxide which deposits on the bulb (or on the phosphor surface if the lamp were a fluorescent lamp) at the beginning of each positive column region of the discharge. This subsequently permits the deposition of mercury thereat, resulting in the formation of a dark ring which is unsightly and which also impairs the light output of the lamp.

While preferred embodiments of the invention have been shown and described, various other embodiments and modifications thereof will become apparent to persons skilled in the art and will fall within the scope of the invention as defined in the following claims.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. An electrode structure for a vapor discharge lamp comprising a pair of support wires, an elongated filament attached at spaced apart points thereof to said support wires, and an electron-emitting cathode material carried on the central portion of said filament intermediate said support wires, wherein the improvement comprises a coating of carbon carried on at least a portion of the exposed metal surfaces comprising the end regions of said filament and the regions of said support wires adjacent to said filament.

2. A structure as claimed in claim **1** in which said coating of carbon covers substantially the entirety of said exposed metal surfaces.

3. A structure as claimed in claim **2** including anode areas comprising said exposed metal surfaces, and in which said coating of carbon covers substantially the entirety of said anode areas.

4. A vapor discharge lamp comprising an elongated bulb and a pair of electrode structures sealed at the respective ends of said bulb, each of said electrode structures comprising a pair of support wires, an elongated filament attached at spaced apart points thereof to said support wires, and an electron-emitting cathode material carried on the central portion of said filament intermediate said support wires, wherein the improvement comprises a coating of carbon carried on at least a portion of the exposed metal surfaces comprising the end regions of said filaments and the regions of said support wires adjacent to the filaments on both of said electrode structures.

5. A lamp as claimed in claim **4** in which said coating of carbon covers substantially the entirety of said exposed metal surfaces on both of said electrode structures.

6. A lamp as claimed in claim **5** in which each of said electrode structures includes anode areas comprising said exposed metal surfaces, and in which said coating of carbon covers substantially the entirety of said anode areas of both electrode structures.

7. A lamp as claimed in claim **4** in which said lamp is a low pressure mercury vapor lamp.

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