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DISCHARGE LAMP ELECTRODE

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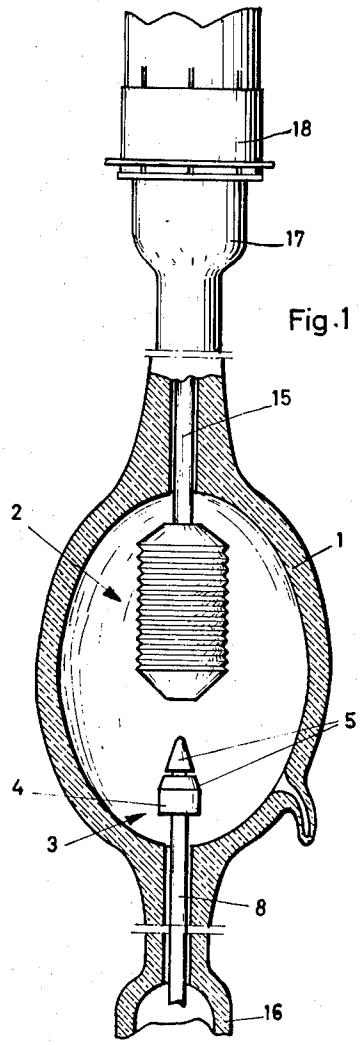


Fig.1

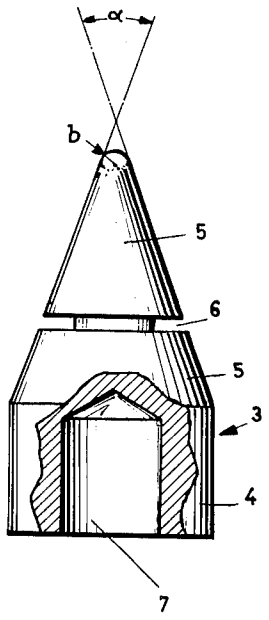


Fig.2

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DISCHARGE LAMP ELECTRODE

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5 Claims. (Cl. 313—37)

This invention relates to electric lamps and, more particularly, to an improved cathode for a high-pressure discharge lamp containing a rare gas atmosphere.

As is well known, the electrodes for such high-pressure discharge lamps generally comprise a body of suitable refractory metal such as tungsten that is attached to a metal support rod in any desired manner such as by pressing, shrinking or welding. The rod is sealed through the lamp envelope and thus also serves as a lead-in conductor.

Electrodes of this type have heretofore been made from a sintered tungsten body having a recess at one end in which a swaged or tightly compacted (as by melting) tungsten plug or insert was anchored, preferably by means of a shrink fit. This tightly compacted insert had a cone-shaped portion which projected beyond the sintered body and served as the arc-supporting tip of the electrode.

The prior art electrodes were made in this piecemeal fashion because it was heretofore very difficult to produce swaged or melted tungsten bodies of the required size and shape and, subsequently, to provide a bore or the like therein for attaching them to the support rod. In addition to being difficult to make, it has been found that sintered tungsten electrodes (even though previously thoroughly degassed in a vacuum) may, under certain unfavorable conditions, liberate absorbed gaseous impurities during operation that rapidly destroy the electrodes. Merely making the cathodes of such lamps in their usual configuration from a single piece of swaged tungsten was not satisfactory since they did not heat up quickly enough, did not operate at a sufficiently high temperature, and resulted in irregular sparking at the cathode tip.

It is, accordingly, an object of the present invention to provide a cathode for a high-pressure gaseous discharge lamp which can be fabricated from a single piece of tightly compacted refractory metal and will overcome the aforementioned disadvantages of the prior art electrodes.

The foregoing objective and other advantages are achieved in accordance with this invention by making the cathode from swaged tungsten and providing it with a specially shaped tip that has a circumferential indentation therein which reduces the transfer of heat away from the arc-supporting tip and thus increases the operating temperature of the tip segment. The cathode tip is also tapered at a predetermined angle and has a rounded point with a predetermined radius of curvature such that the point operates below its melting point and has a stabilizing effect on the discharge.

A better understanding of the invention will be obtained by referring to the accompanying drawing, wherein:

FIGURE 1 is an elevational view mainly in section, of a 2500 watt high-pressure discharge lamp which incorporates the improved cathode of the present invention; and

FIG. 2 is an enlarged elevational view, partly in section, of the cathode shown in FIG. 1.

While the improved cathode of the present invention may be used with advantage in various types of electric discharge devices, it is especially adapted for use in high-pressure gaseous discharge lamps and has accordingly been so illustrated and will be so described.

With specific reference to the drawing, in FIG. 1 there is shown a 2500 watt high-pressure discharge lamp for D.C. operation comprising an envelope 1 that is preferably fabricated from quartz and contains an anode 2 and the improved cathode 3 of the present invention. The cathode is fabricated from a single piece of tightly compacted refractory metal such as swaged tungsten that contains up to about 6% thorium oxide and preferably about 3%. The anode 2 is also fabricated from a single piece of swaged tungsten and is preferably provided with a plurality of circumferential grooves that are adapted to cool the body portion of the anode. An anode of this type is disclosed in copending application Serial No. 236,354 of Richard Arndt, entitled "Discharge Lamp Electrode and Method of Manufacture," filed November 8, 1962, and assigned to the assignee of the present invention. Of course, other types of anodes can also be used.

The activated cathode 3 is held in position within the envelope 1 and connected to a suitable power supply by a tungsten rod 8 that is hermetically sealed through an outwardly extending stem 16. The anode 2 is similarly supported by an attached rod 15 that is hermetically sealed through an oppositely extending stem 17. Suitable bases 18 (shown for the anode only) are attached to the aforesaid stems to facilitate holding the lamp and connecting its terminals with the starting and operating circuits.

As shown more particularly in FIG. 2, the cathode 3 comprises a cylindrical body portion 4 that is terminated at one end by a cone-shaped tip portion 5 and is provided at its opposite end with a hole 7 for anchoring the support rod 8. The cone-shaped tip portion is transversely divided into a pointed arc-supporting segment and a tapered root segment by a circumferential indentation such as an annular slot 6 that is of sufficient depth and width to reduce the heat transferred by conduction from the segregated point segment to the body of the cathode. The annular slot preferably extends inwardly at about a right angle to the axis of the cathode. The heat generated by the discharge in the segregated pointed segment of the tip is thus largely retained. This segment accordingly heats up at a much faster rate and operates at a considerably higher temperature than it would if the tip were merely tapered.

As a specific example, in the case of the 2500 watt lamp shown in the drawing, the cathode had an overall length of about 15 mm., the annular slot was approximately 0.5 mm. wide, was spaced from the pointed end of the cathode an axial distance of about 6.5 millimeters, and was of such depth that the cylindrical stem or bridge portion connecting the pointed and root segments had a diameter of about 3 millimeters.

In addition to the aforementioned partial separation of the pointed and root segments of the cone-shaped tip portion 5, the taper of the latter is made such that lines tangent to its sides and lying in an axial plane of section define an angle α that is no greater than about 50° and is preferably from about 30 to 40°. In the particular embodiment here illustrated, this angle was approximately 40°. This "acute-angle" tapering of the cone-shaped tip portion 5 coupled with the partial physical separation of the pointed arc-supporting segment enables the latter to reach a higher operating temperature thereby improving the thermal emission of the cathode. In the particular 2500 watt lamp here described, the resulting correlation of the size of the pointed segment and the wattage rating of the lamp was such that the pointed

segment operated at a temperature of at least 2000° C. throughout its length. Thus, the cathode operated at this minimum temperature over a distance of slightly less than half its length, as measured from its arc-supporting tip.

As is indicated in FIG. 2, the point of the cathode 3 is rounded and has a predetermined radius of curvature "*b*." This dimension is greater than about 0.2 millimeter and, in the particular lamp shown here, the radius of curvature of the ball point was about 0.6 millimeter. Rounding off the cathode tip in this manner prevents it from melting and causes a plasma sheath or dome to form which stabilizes the arc and reduces sparking at the tip.

It will be appreciated from the foregoing that the objective of the invention has been achieved insofar as a cathode has been provided that heats up at a faster rate and thus has a longer useful life, and which has a tip portion that operates at a higher temperature and has a stabilizing effect on the arc.

While one embodiment has been illustrated and described, it will be appreciated that various changes in both the configuration and organization of parts may be made without departing from the spirit and scope of this invention.

I claim as my invention:

1. A cathode for a high-pressure gaseous discharge lamp comprising,

a swaged tungsten member that contains a predetermined amount of thorium oxide and has a body portion and a cone-shaped tip portion, and

a metal support rod attached to said body portion,

said cone-shaped tip portion having a circumferential slot therein that transversely divides said tip portion into a pointed arc-supporting segment and a tapered root segment and increases the operating temperature of the pointed arc-supporting segment by reducing the heat lost by conduction to the body portion, the point of said arc-supporting segment being of round configuration and having a predetermined radius of curvature.

2. A cathode as set forth in claim **1** wherein; the width dimension of said slot is substantially uniform, and the sides of the cone-shaped tip portion was tapered at an angle no greater than about 50°.

3. A cathode as set forth in claim **2** wherein,

said tungsten member contains up to about 6% thorium oxide, and

the size of the pointed arc-supporting segment of said cone-shaped tip portion relative to the wattage rating of the lamp is such that said segment has an operating temperature of at least 2000° C.

4. A cathode for a high-pressure gaseous discharge lamp comprising,

a swaged tungsten member that contains about 3% thorium oxide and has a cylindrical body portion and a cone-shaped tip portion, and

a tungsten support rod attached to the end of said body portion opposite said tip portion,

said cone-shaped tip portion having a narrow circumferential slot therein that extends inwardly at substantially a right angle to the axis of said cathode and divides said tip portion into two segments,

the sides of said cone-shaped tip portion being tapered at an angle of between about 30° and 40°, and said tip portion having a rounded point with a predetermined radius of curvature.

5. A cathode as set forth in claim **4** wherein,

the sides of said cone-shaped tip portion are tapered at an angle of about 40°,

the point of said tip portion has a radius of curvature greater than about 0.2 mm., and

the size of said cathode is so correlated with respect to the rating of the lamp that the pointed arc-supporting segment of said tip portion has an operating temperature of at least 2000° C.

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