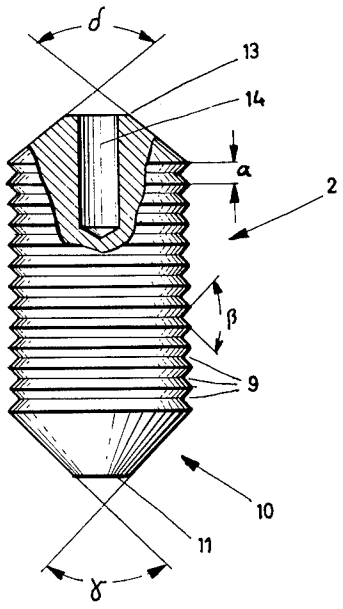
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DISCHARGE LAMP ELECTRODE WITH INTEGRAL COOLING MEANS

Filed Nov. 8, 1962

Fig.2



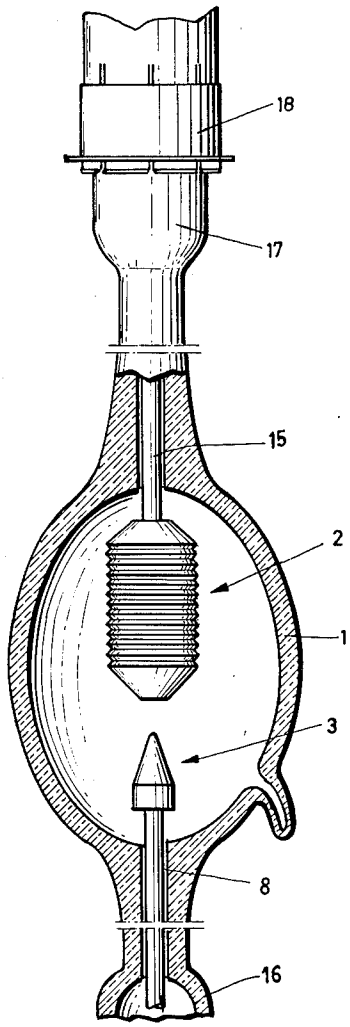


Fig.1

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DISCHARGE LAMP ELECTRODE WITH INTEGRAL COOLING MEANS

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6 Claims. (Cl. 313—217)

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

The electrodes used in high-pressure discharge lamps are customarily fabricated from tungsten and are attached to a support rod in any desired manner as by pressing, shrinking or welding the members together. The support rod is also preferably made from tungsten and serves as a lead-in conductor.

Anodes for such high-pressure discharge lamps have heretofore been made from a sintered tungsten body which was provided at one end with a recess for attaching the support rod, and at its opposite or discharge-supporting end with another recess in which a swaged or tightly compacted (as by melting) plug-like tungsten insert was anchored by means of a shrink fit. This insert had a cone-shaped portion that projected beyond the sintered body portion of the anode and served as an arc-hupporting tip. The electrode was fabricated in this piece-meal fashion because it was heretofore very difficult to produce tightly compacted or swaged tungsten bodies of the required size and shape, and then to complete their fabrication by attaching them to the support rod. In addition to being difficult and costly to make, it has also been found that under certain unfavorable conditions sintered tungsten bodies, even though previously thoroughly degassed in a vacuum, may give off absorbed gases during operation which contaminate the rare gas atmosphere of the lamp and result in the premature failure of the electrodes.

It is, accordingly, an object of the present invention to provide an anode of tightly-compacted refractory metal that is smaller and has a lower surface temperature, when operated, then the prior art electrodes.

The foregoing object and other advantages are achieved according to the present invention by making the anode from a solid piece of swaged tungsten and providing annular indentations, such as thread-like grooves, in its surface which are coated with a material that increases the heat conductivity of the body portion of the anode and thus cools it by enhancing its ability to radiate heat. The coating is preferably applied to the grooved surfaces by a sintering process.

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

FIGURE 1 is a fragmentary view, mainly in section, of a high-pressure discharge lamp embodying the present invention; and,

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

With specific reference to the drawing, in FIG. 1 there is shown a high-pressure discharge lamp comprising a quartz envelope **1** having sealed therein the improved anode **2** of the present invention and a suitable cathode **3**. The anode **2** is securely anchored in place by means of a tungsten support rod **15** that is attached to the anode and is hermetically sealed through an arm or stem **17** that is attached to and extends from the envelope. The cathode **3** is similarly held in place by a support rod **8** that is embedded in an oppositely extending stem **16**.

The anode **2** comprises a solid piece of swaged tungsten which, as shown more particularly in FIG. 2, has a cylindrical body portion and an arc-supporting tip portion **10**. The body portion is provided with indentations such as annular grooves **9**, the adjoining lateral edges whereof are disposed at a predetermined angle β with respect to each other, preferably at an angle of about 90°. These grooves serve as cooling surfaces for the anode. The depth of the cooling grooves **9** is from about one to three millimeters. In the case of a xenon high-pressure lamp designed to operate without artificial cooling and having a rating of 2500 watts, the groove depth is preferably about two millimeters.

In order to obtain the greatest possible heat conducting cross section from the front tip of the anode **2** to the peripheral surface of its cylindrical body portion, the arc-supporting tip portion **10** is flattened and conically shaped so that lines tangent to its sloping sides and disposed in an axial plane of section define a predetermined angle γ, which is preferably about 90°.

The heat conductivity of the cooling grooves **9**, and thus the ability of the grooved surfaces to radiate heat, is increased according to this invention by means of a sintered layer of suitable refractory material such as tungsten powder or tantalum carbide. Good results have been obtained by using a mixture of tantalum and graphite wherein the ratio of tantalum to graphite ranges from about 20:1 up to 40:1. Nickel powder in an amount up to about 10% and preferably less than 1% by weight, together with any desired quantity of tungsten powder, may also be added to the aforementioned mixture prior to sintering, or to the coating formed therefrom.

As a specific example, the grooved cooling surfaces of the anode **2** are coated with the heat conducting layer in the following manner. The anode is first mounted on the support rod and heated to a temperature of about 2000° to 2400° C. in a xacuum and kept at this temperature for several minutes to weld the anode and rod together and drive off surface impurities prior to the coating operation. The anode assembly is then cooled and the powder mixture is applied to its grooved surfaces in a suspension of butyl acetate with 5% cellulose binder. The coated anode is then reheated, preferably by high frequency, to a temperature of about 2000 to 2400° C. in a vacuum in the order of 10^{-4} millimeters of mercury to effect the simultaneous sintering and degassing of the coating. The anode is then cooled and withdrawn from the vacuum system thus completing its fabrication.

As shown in FIG. 2, the end of the anode **2** facing the envelope stem is also cone-shaped but is provided with more gradually sloping sides so that lines tangent to such sides and disposed in an axial section plane define an angle δ of about 100°. This end of the anode is also provided with a flat **13** and a cylindrical hole or bore **14** in which the support and conductor rod **15** (see FIG. 1) is anchored.

It has been found that making the anode from a single piece of swaged or tightly compacted tungsten body in accordance with the invention has greatly reduced the amount of gaseous impurities given off during operation. The operating temperature of the arc-supporting tip of the anode is also about 80° C. to 140° C. cooler than that of prior art type electrodes having a mass that is about 15% larger. The use of a tantalum carbide layer on the grooved cooling surfaces of the anode has, in addition, produced a gettering effect which further improves the useful life of the lamp.

It will be appreciated from the foregoing that the objects of the invention have been achieved insofar as an improved anode construction has been provided which not only decreases the mass and cost of the anode but enables it to operate at a much lower temperature than

the prior art structures and thus prolong the useful life of the lamp. While one embodiment has been illustrated and described, it will be appreciated that various changes in both the configuration and mode of manufacturing the electrode may be made without departing from the spirit and scope of the invention.

I claim:

1. An anode for a high-pressure gaseous discharge lamp comprising

a swaged tungsten member having an arc-supporting tip and an elongated body portion that is provided with a plurality of circumferential thread-like grooves for cooling said anode,

a metal support rod attached to said body portion, and

means for increasing the heat-radiating ability of the grooved surfaces of said body portion comprising an exposed sintered coating of powdered material selected from the group consisting of tungsten, admixed tantalum and graphite, and mixtures thereof.

2. A gaseous-discharge lamp anode as set forth in claim 1 wherein the sintered coating contains up to about 10% by weight of powdered nickel.

3. An anode for a high-pressure gaseous discharge lamp comprising

a swaged tungsten member having an arc-supporting tip and an elongated body portion provided with a plurality of circumferential thread-like grooves for cooling said anode,

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

an exposed sintered layer of tantalum carbide on the grooved surfaces of said body portion

4. An anode for a high-pressure gaseous discharge lamp comprising

a swaged tungsten member having an arc-supporting tip and an elongated body portion provided with a plurality of circumferential thread-like grooves for cooling said anode,

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

an exposed sintered layer of admixed tantalum and graphite on the grooved surfaces of said body portion.

5. An anode for a gaseous discharge lamp as set forth in claim 4 wherein the ratio of tantalum to graphite is from about 20:1 to 40:1.

6. An anode for a high-pressure gaseous discharge lamp comprising

a swaged tungsten member having an arc-supporting tip and an elongated body portion provided with a plurality of circumferential thread-like grooves for cooling said anode,

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

an exposed sintered layer of tungsten powder on the grooved surfaces of said body portion.

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