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HIGH PRESSURE ELECTRIC DISCHARGE DEVICE AND CATHODE

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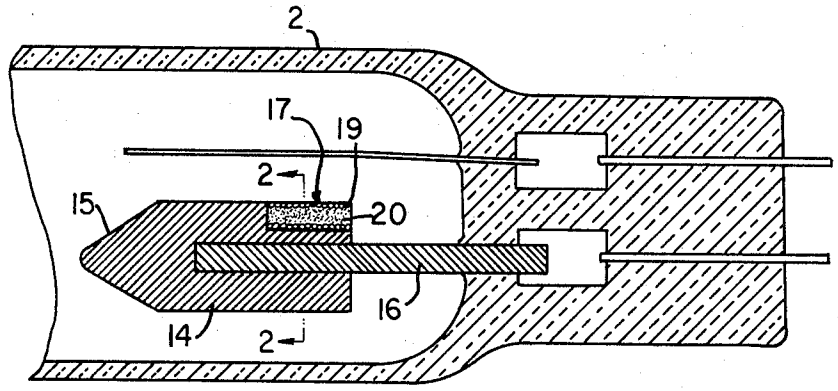


FIG.1

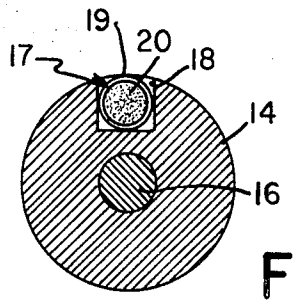


FIG.2

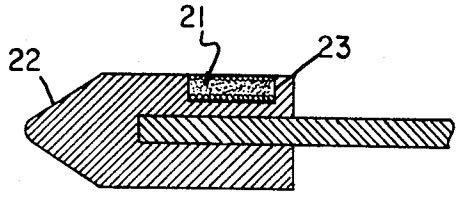


FIG.3

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HIGH PRESSURE ELECTRIC DISCHARGE DEVICE AND CATHODE

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Continuation-in-part of application Ser. No. 515,921, Dec. 23, 1965. This application May 16, 1967, Ser. No. 638,920

Int. Cl. H01j *1/14, 17/06, 17/20*

U.S. Cl. 313—184 2 Claims

ABSTRACT OF THE DISCLOSURE

A sintered cathode for a lamp comprising a bullet-shaped tungsten body in which a slot is disposed in the rearward end. Emissive material is held in the slot by a retaining spring.

This application is a continuation in part of our co-pending application, Ser. No. 515,921, filed Dec. 23, 1965, and now abandoned.

This invention relates to high pressure electric discharge devices and particularly to a new construction of a cathode for such devices which can improve the maintenance, facilitate manufacturing and reduce costs.

In the past, many designs for cathodes have been proposed to the art. The most commonly used design was made from drawn tungsten wire and included a rod upon which was mounted a tungsten wire helix. Upon this helix was screwed a second wire helix which served to retain a small quantity of emissive material. We have discovered that this cathode design is not wholly satisfactory in all cases. For example, the innermost end of the cathode operates at a much higher temperature than the opposite end and the emissive material is apt to sputter off onto the arc tube wall, thus reducing the transmission. Moreover, assembly of this type of cathode is difficult because of the close tolerances which must be maintained. One coil must be screwed upon another and unless the pitch is substantially the same in both, the proper relationships will not be attained.

According to our invention we form a cathode of sintered tungsten, as distinguished from drawn wire. The tungsten is fabricated generally in a bullet-like shape with a drawn refractory metal wire rod extending from the flat end to serve as a support for the cathode within the arc tube. Preferably, this rod is coaxially disposed upon the axis of the sintered tungsten body. A small cavity is formed in the rearward end of the cathode so that the conventionally used emissive material of barium, calcium and thorium oxides can be held therein. A retaining means, preferably a refractory metal wire spring, is forced into the cavity to prevent the emissive material from falling out. Generally, we prefer to dispose the emissive material within the bore of the spring, however it is apparent that it may be merely placed therein and the retaining means placed thereover. The use of sintered tungsten cathodes eliminates the necessity of manufacturing wire helixes for the cathodes and screwing them in place. Many steps in the fabrication of an arc tube can be eliminated through the use of such cathodes.

Accordingly, the primary objects of our invention are the reduction of sputtering of emissive material from the cathode onto the wall of the arc tube and the elimination of many steps in the fabrication of a cathode.

The many other objects, features and advantages of our invention will become manifest to those conversant with the art upon reading the following specification when

taken in conjunction with the accompanying drawings wherein the preferred embodiments are shown and described by way of illustrative examples.

Of the drawings:

FIG. 1 is an enlarged view, partially in cross section, of a sintered tungsten cathode according to our invention.

FIG. 2 is an enlarged cross-section taken along the lines 2—2 of the cathode shown in FIG. 1.

FIG. 3 is a cross-sectional view of another construction of the electrode shown in FIG. 1.

In the high pressure electric discharge device shown in FIG. 1, an arc tube **2**, generally made of quartz or Vycor, surrounds the cathode of our invention. The cathode includes a sintered tungsten body **14** having a tapered end **15** which points into the inside of the arc tube. A refractory metal rod **16**, generally formed of molybdenum or tungsten is axially disposed within the cathode at the rear end thereof. The sintered tungsten body **14** is pressure-formed around the rod **16** to insure permanence. A small cavity **18** is formed on the side and nearest to the rearward end of the cathode. The retaining means **17** fits therein. Preferably, the cavity is formed wholly within the body, that is, it has a bottom and four sides, although it can be formed with either an open front or rear end. Generally, the retaining means can be refractory metal wire spring **19** which is forced into the cavity after it is formed. A small quantity of the conventional emissive material **20** shown in FIG. 2 fills the retainer **17**.

In manufacturing the cathodes, the rod **16** and a quantity of tungsten powder, or if desired, a mixture of tungsten and thorium oxide (up to 25% by weight) is pressed together prior to the sintering. The rod is preferably made of wire rather than sintered material for reason of mechanical strength. Thin sintered forms tend to be rather brittle. The sintering operations which are used are those which are conventional in tungsten metallurgical processing.

We have discovered that in order to use the emissive material, it must be held in the cavity of the cathode with a retainer, preferably by a small refractory metal wire spring which acts like a basket. Two approaches can be used to prepare the emissive metal for use in the cathode. In the first, a mixture of thorium oxide with carbonates of barium and calcium are forced into the retainer. The retainer is then fired in a reducing atmosphere, preferably hydrogen to form the respective oxides. This unit is then slipped into the cavity. Alternatively, this activation can be done after a coil containing the carbonates is slipped into the cavity by firing both the cathode and the emissive material-containing retainer together. If the former activation procedure is desired, insertion of the retainer would take place just prior to sealing the arc tube thereby minimizing subsequent contamination of the emissive material.

Importantly, the sintered cathode described herein can contain as much as 2 to 3 times more emissive material as previously was possible with conventional cathodes. Lumen maintenance and life of a high pressure electric discharge device are direct functions of the emissivity of the cathodes throughout the life of the lamp. Lamps which fail between 1000 and 16,000 hours demonstrate that the principal cause of failure has been a lack of cathode emission caused by an exhausted supply of emissive material. The primary cause of loss of the emissive material has been sputtering from the helix onto the arc tube wall. Besides depleting the supply of emissive material, the sputtering upon the wall results in decreased transmission of the glass and subsequent reduction in lumen maintenance. Since the temperature at the rear of the cathode is much lower than that at the front of the cathode where the arc of the discharge fixes itself, we preferably place

the cavity for the retainer at a location in the rear of the cathode where the arc will not reach it in order to prevent boiling off and sputtering.

Referring now to FIG. 2 of the drawing, the refractory metal rod **16** is disposed generally upon the axis of the sintered tungsten body **14**. A cavity **18** is formed within the body **14** and in this embodiment, has a bottom and three sides. Retainer **17**, with its emissive material, is snapped into the cavity **18**.

In FIG. 3, the cavity **21** has been moved forward in the electrode **22** so that a rear end **23** is formed. In this way, the cavity **21** has a bottom and four sides and emissive material contained in the retainer **23** cannot be readily dislodged.

It is apparent that modifications and changes may be made within the spirit and scope of the instant invention. For example, although the bullet-like shape of the cathode is preferred for manufacturing ease and stability, it may be formed in a more conical-like shape and the limitation upon its shape is that it must narrow down to a relatively small point at the end so that the arc will have a point upon which to fix and not wander, which would cause lamp instability. Another modification may be redesigning the cavity into a circular or elliptical shape. The retaining means which is preferred is a helical coil although rectangular or oval shapes also have applicability and more than one cavity and retaining means can be used in a single cathode, if desired. Hence, it is our intention only to be limited by the scope of the appended claims.

As our invention, we claim:

1. A high pressure electric discharge device including a quartz arc tube with a press seal disposed at each end thereof; a pair of cathodes disposed inside said arc tube, each of said cathodes comprising: a bullet-like form consisting essentially of tungsten in which the particles of tungsten are bound together by sintering, said form having a tip and an enlarged rearward end portion; a cavity disposed on the side of said form at the rearward end thereof; emissive material and a helical coil of refractory metal wire to retain said emissive material within said cavity; means for supporting each of said cathodes disposed at the rear of said form, said supporting means being a rod of drawn refractory metal wire located substantially upon the axis of said form, said supporting means extending into said press seal and wherein a starting probe extends through one of said press seals into said arc tube adjacent to one of said cathodes, said one cathode being disposed so that said cavity is adjacent to said starting probe.

2. The device according to claim **1** wherein said cavity in said cathode is a generally rectagular slot having a bottom and four sides.

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