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SEALING MEANS FOR REFRACTORY CERAMIC DISCHARGE DEVICE ENVELOPES

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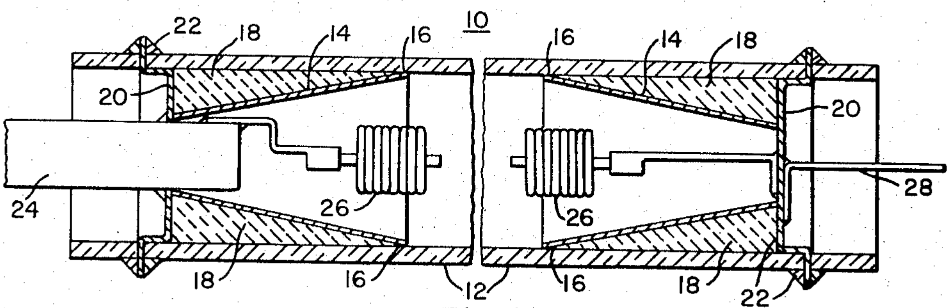


FIG. 1

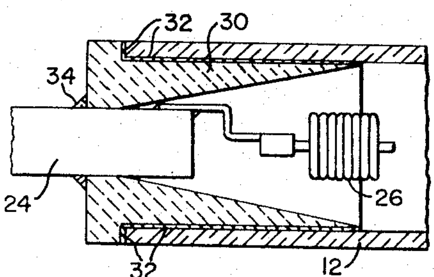


FIG. 2

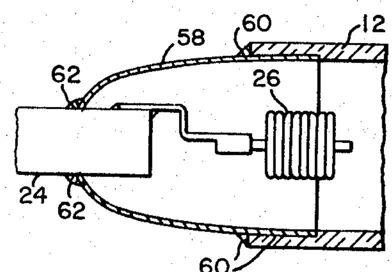


FIG. 8

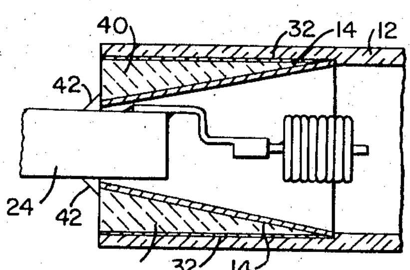


FIG. 4

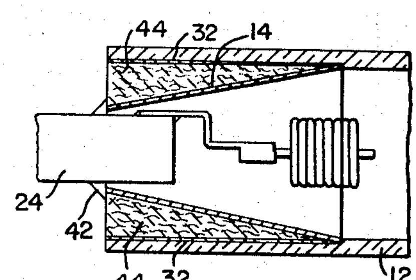


FIG. 5

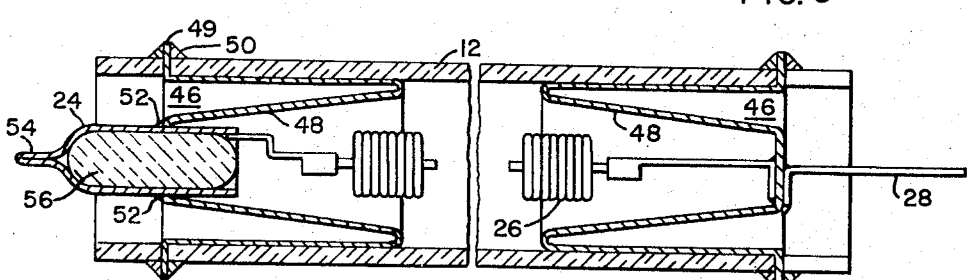


FIG. 6

FIG. 3

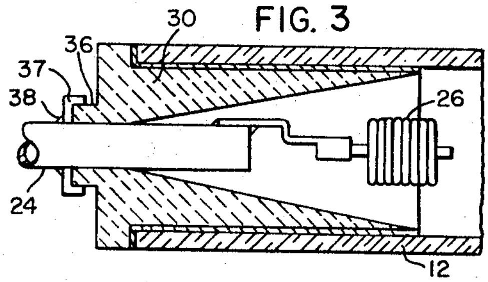
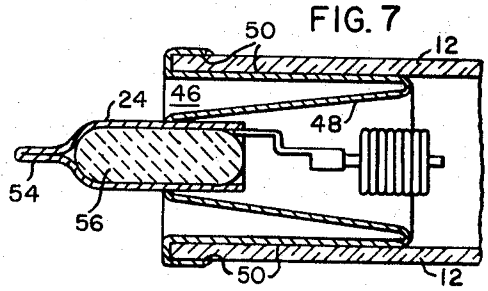


FIG. 7



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SEALING MEANS FOR REFRACTORY CERAMIC DISCHARGE DEVICE ENVELOPES

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U.S. Cl. 313—220 10 Claims

ABSTRACT OF THE DISCLOSURE

A ceramic discharge device including a polycrystalline alumina, tubular envelope hermetically sealed at each end by a refractory metal or refractory ceramic closure member. An axially extending electrode is mounted interiorly of each closure member and a lead-in conductor is electrically connected to said electrode through said closure member. The closure members sealing off the ends of the envelope have a generally frustoconically-shaped interior surface tapering from a larger diameter adjacent the arc sustaining electrode to a smaller diameter adjacent the electrode mount thereby reducing the volume of the area behind the electrodes.

Background of the invention

This invention relates to ceramic discharge devices and more particularly to the improved construction of a ceramic arc tube for high temperature discharge lamps.

The evolution of the discharge lamp from a quartz arc tube to a ceramic arc tube has been primarily dictated by the need to maintain higher temperatures within the arc tube in order to produce light sources of higher efficiency. It is generally known that by maintaining a higher temperature within the entire arc tube and more particularly maintaining the highest possible cold spot temperature within the arc tube results in increasing luminous efficiency of the light source.

In addition to maintaining the highest possible temperature within the arc tube it is also necessary to produce hermetic seals in the arc tube which will withstand the high temperatures and not break down before the maximum temperature that the arc tube itself can withstand is essentially reached. In all ceramic or for that matter quartz arc tubes it has been uniformly found that the coldest area within the arc tube is that portion behind or to the rear of the discharge sustaining electrodes. This area is also in most instances immediately adjacent the hermetic seals employed to seal off the ends of the arc tube and hence efforts to increase the temperature behind the electrodes has consequently increased the temperatures on the seal areas.

Summary of the invention

It is an object of the present invention to provide a ceramic discharge device in which the temperature in the area to the rear of the electrodes is maintained appreciably higher than that of conventional ceramic arc tubes.

Another object of the present invention is to reduce the temperature encountered by the hermetic seals employed to seal off the arc tube.

A further object of the present invention is to provide a ceramic discharge device in which the temperature of the arc can be increased through structural configuration of the device to improve the color and efficiency of the lamp.

The foregoing as well as other objects are accomplished in accordance with the present invention by pro-

viding a hermetically sealed ceramic discharge device including a tubular light transmitting ceramic envelope sealed at each end by a closure means which carries a discharge sustaining electrode secured centrally on the interior surface of each of the closure means and lead-in conductors electrically connected to each of the electrodes through said closure means and in which the closure means includes a conically shaped interior surface tapering from a larger diameter adjacent the interiorly extending end of the adjacent electrode to a smaller diameter adjacent the other end of the electrode.

Brief description of the drawings

The above recited objects and other along with many of the attendant advantages of the present invention will become more readily apparent as the detailed description is considered in connection with the accompanying drawings in which:

FIG. 1 is a sectional view of the ends of a ceramic arc tube constructed in accordance with the present invention;

FIG. 2 is a sectional view of the tubulation end of another embodiment of a ceramic discharge lamp constructed in accordance with the present invention;

FIG. 3 is a sectional view of yet another embodiment of the present invention similar to FIG. 2;

FIGS. 4 and 5 are sectional views of the tubulation ends of ceramic discharge devices illustrating still further embodiments of the present invention;

FIG. 6 is a sectional view of the ends of a ceramic discharge device illustrating a still further embodiment of the present invention; and

FIGS. 7 and 8 illustrate, in cross section, still further embodiments which the ends of the arc tube may take in accordance with the present invention.

Description of the preferred embodiments

Referring now in detail to the drawings wherein like reference characters represent like parts throughout the several views there is shown in FIG. 1 the end sections of a ceramic arc tube generally designated **10**. Conventional ceramic arc tubes generally consist of a main body member in the form of a high density polycrystalline alumina tube of ⅜ or 5⁄16 outside diameter. The main tubular body member is generally hermetically sealed with a closure member in the form of a refractory metal or refractory oxide cap or disc at each end. The cap or disc generally has mounted on its interior surface an arc sustaining electrode with a lead-in conductor in the form of a refractory metal strip or refractory metal tubulation secured to or through the external side of the end cap or disc in electrical connection with the electrode. In the conventional ceramic arc tube the internal volume of the hermetically sealed chamber is of a uniform diameter from the internal surface of one closure member to the other. In the arc tubes of the present invention the internal diameter of the portion of the enclosed volume is substantially decreased in the area of the arc tube between the electrode and its adjacent closure member.

In the embodiment of FIG. 1 refractory metal cones **14** preferably of tantalum are secured within each end of the ceramic arc tube **12** by means of a suitable sealing composition at **16**. Although several known sealing compositions may be used effectively, where reference to sealing compositions are made throughout this application it is preferable that the sealing compositions described in the copending application Ser. No. 562,016, filed June 30, 1966, by Richard B. Grekila, Shih Ming Ho, William J. Knochel and Francis C. M. Lin and owned by the present assignee, are preferable. These sealing compositions, in general comprise CaO and Al_2O_3 in nearly eutectic proportions plus selective additives oxides. The area between the refractory metal cones **14** and the walls of the tubular envelope **12** are then filled with a mixture of aluminum oxide powder and amyl acetate or alternatively a preformed ceramic plug **18**. An end cap or disc **20** is then sealed by means of the above referred to sealing compositions to the aluminum oxide fill and the polycrystalline alumina envelope as indicated at **22**. The end cap or disc **20** preferably carries at one end a refractory metal exhaust and fill tubulation **24** brazed thereto and extending therethrough on which is mounted a discharge sustaining electrode **26**. The other end of the arc tube may be sealed off identically with tubulation **24** or as illustrated on the right-hand side of FIG. 1 by a refractory metal disc preferably of niobium having welded thereto a second discharge sustaining electrode **26** on the interior surface and a refractory metal lead-in conductor **28**, preferably in the form of a tantalum strap, welded to the outer surface thereof.

As will be apparent from the FIG. 1 embodiment the sealed configuration with its conical refractory metal interior surface with a large diameter to small diameter ratio of about 2:1 substantially reduces the enclosed area behind each of the electrodes thus reducing cold spot temperatures. Additionally the surface of the tantalum cone reflects radiation back to the arc which also assists in raising the arc temperature to thereby produce better color particularly in the red and increased lamp efficiencies of from 10 to 20%. Not the least of the advantages of the present construction is the fact that the seals at **22** are substantially insulated from the high temperatures of the arc, which reduction in seal temperature contributes greatly to the life of the lamp.

In the embodiment of FIG. 2 a preformed ceramic plug **30** is sealed to the ends and along the interior surface of the arc tube **12** by means of the above described sealing compositions as for example at **32**. The same sealing compositions are employed to seal refractory metal tubulation **24** with its associated electrode **26** through a central bore in the preformed ceramic plug **30** as for example at **34**. In addition to the above described advantages this embodiment provides an extended seal area **32** to ensure a good hermetic seal at each end of the arc tube **12**. The other end of the arc tube may be sealed off similarly with refractory metal tubulation or alternatively have sealed through a substantially smaller central opening a single lead-in conductor electrode combination.

The embodiment of FIG. 3 is quite similar to that of FIG. 2 but has as an addition an extension **36** to ceramic plug **30**. A niobium end cap **37** is secured by the previously referred to sealing compositions to the end of the extension **36** in order that a titanium or zirconium braze can be employed at **38** to seal the electrode carrying exhaust and fill tubulation **24** to the plug closure member. This configuration provides for even greater insulation of the seal from the high temperature arc while providing for metal to metal sealing to the tubulation or lead-in conductor.

The embodiment of FIG. 4 combines the advantages of the FIG. 1 and FIG. 2 embodiments by eliminating the requirement for a metallic end disc or cap while still having the reflective characteristics of a refractory metal interior surface on the conical insert. In this embodiment a refractory metal, preferably tantalum, cone **14** is sealed within the end of the arc tube and a ceramic cylinder having a complementary tapered conical interior surface inserted within the end of the arc tube to fill the gap between the refractory metal cone and the interior surface of the arc tube body member **12**. Again both the refractory metal cone and the ceramic cylinder are sealed to the interior wall of the arc tube by the sealing composition at **32** and the seal is completed by the application of a titanium braze at **42** to the refractory metal tubulation **24**.

The FIG. 5 embodiment is substantially identical with the FIG. 4 embodiment except that the ceramic cylinder **40** is replaced with a packing material, preferably quartz wool, **44** which provides additional insulation between the high temperature internal arc tube area and the sealing compositions **32**.

In the embodiments of FIGS. 6 and 7 a double walled cup **46** of refractory metal, such as for example tantalum or niobium has a conical inner wall **48** the inner surface of which operates as described in the preceding embodiments. In this embodiment the radial flange **49** of the cup extends from the outer wall **47** and to the ceramic body member **12** as illustrated at **50** by the above described sealing compositions or the radial flange **49** may be turned over and the entire surface of the body member **12** which contacts the cup member **46** sealed thereto by the sealing compositions as indicated at **50** in FIG. 7. The tantalum tubulation may then be sealed to a central bore in the double walled cup member **46** by a zirconium or titanium braze as illustrated at **52**. If one of the ends is desired to be sealed without exhaust and fill tubulation the central bore in the cone shaped cup is eliminated and a discharge sustaining electrode **26** may be welded directly to the interior surface of the cone and a lead-in conductor **28** welded to the exterior surface centrally thereof.

In each of the embodiments of FIGS. 1–8, in order to further reduce the area behind the electrode at the tubulation end of the arc tube after exhaust and fill and before the tubulation is sealed off as illustrated at **54** in FIGS. 6 and 7, a refractory metal plug **56** may be inserted into the tubulation **24**.

In the embodiments of FIGS. 6 and 7 the actual seal area is again comparatively remote from the hot arc chamber and the inner wall with its internal conical surface is free to expand and contract during temperature changes incident to starting and stopping the lamp and hence additionally reduces any strains which might act upon the seal areas.

The FIG. 8 embodiment is somewhat similar to the embodiments of FIGS. 6 and 7. In this embodiment a cup shaped refractory metal member of niobium or tantalum **58** is sealed into the end of the arc tube **12** by one of the preferred sealing compositions as illustrated at **60** while a refractory metal tubulation **24** with its associated discharge sustaining electrode **26** is sealed into an aperture in the bottom of the cup shaped member by means of a zirconium or titanium braze as illustrated at **62**. In this embodiment the materials employed are substantially reduced, the expansion and contraction characteristics are retained to a limited extent and the volume of the area behind each of the discharge sustaining electrodes is slightly reduced.

Although many variations may be made in the above described specific embodiments without departing from the scope of the present invention it will be seen that the closure members for ceramic discharge devices described in the foregoing paragraphs considerably reduce the area of the arc sustaining volume behind each of the electrodes, substantially insulates the seal areas from the hot arc sustaining enclosed volume to reduce seal tempeartures and provides for the reflection of radiation directed at the ends of the arc tube back into the arc to improve the temperature of the arc and hence create better color and efficiency in the lamp. In this regard light outputs have been increased from about 100 lumens per watt to as high as 120 lumens per watt with the present end closure construction while at the same time color rendition, particularly of the reds, has been signficantly improved.

Since numerous changes may be made in the above described embodiments of the invention and other embodiments may be made without departing from the spirit thereof, it is intended that all matter contained in the foregoing description or shown in the accompanying drawings, shall be interpreted as illustrative and not in a limiting sense.

We claim:

1. A hermetically sealed ceramic discharge device comprising:
(a) a hollow light transmitting ceramic envelope;
(b) closure means hermetically sealing off each end of said ceramic envelope;
(c) electrode means including a discharge sustaining electrode secured centrally on an interior surface of each of said closure means and extending substantially axially of said envelope; and
(d) a lead-in conductor electrically connected to each of said electrode means through said closure means, said closure means having a conically shaped interior surface tapering from a larger diameter adjacent electrode means to a smaller diameter adjacent the other end of said electrode means.

2. A hermetically sealed ceramic discharge device according to claim 1 wherein said closure means is a ceramic plug.

3. A hermetically sealed ceramic discharge device according to claim 1 wherein the conically shaped interior surface of said closure member is a refractory metal.

4. A hermetically sealed ceramic discharge device according to claim 2 wherein the conically shaped interior surface of said ceramic plug is a refractory metal.

5. A hermetically sealed ceramic discharge device according to claim 4 wherein said refractory metal on the interior surface of said ceramic plug is tantalum.

6. A hermetically sealed ceramic discharge device according to claim 1 wherein said closure means comprises a double walled refractory metal cup with one of said walls sealed to said envelope and the other of said walls forming said conically shaped interior surface.

7. A ceramic discharge device comprising:
(a) a tubular light transmitting ceramic envelope;
(b) closure means sealing off each end of said ceramic envelope, said closure means having a cone shaped interior surface extending about an axis coextensive with the axis of said tubular envelope with the largest diameter of said cone shaped surface nearest the longitudinal middle of said envelope; and
(c) discharge sustaining means including an electrode and a lead-in conductor secured to each of said closure means, said electrode extending internally of said envelope with at least a portion thereof lying within said cone shaped surface, and said lead-in conductor extending externally of said sealed envelope.

8. A discharge device according to claim 7 wherein said closure means includes a cylindrical ceramic plug having an outer diameter substantially equal to the internal diameter of said envelope and an internal bore forming said cone shaped surface.

9. A discharge device according to claim 8 wherein said internal bore is covered by a thin walled refractory metal cone.

10. A ceramic discharge device according to claim 7 wherein said closure means comprises a double walled refractory metal cup with one of said walls sealed to said envelope and the other of said walls forming said cone shaped interior surface.

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U.S. Cl. X.R.

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