(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 100 091**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **83107334.1**

(22) Date of filing: **26.07.83**

(51) Int. Cl.³: **H 01 J 61/36**

(30) Priority: **26.07.82 US 401762**

(43) Date of publication of application: **08.02.84 Bulletin 84/6**

(84) Designated Contracting States: **DE FR GB NL**

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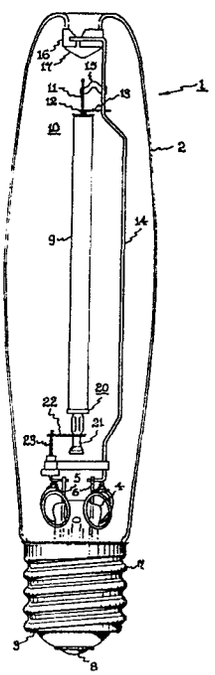
(54) Ceramic seal for high pressure sodium vapor lamps.

(57) Improved ceramic seals for both ends of a tubular light transmitting ceramic envelope used in sodium vapor lamps are disclosed to provide a more reliable hermetic seal. One end closure comprises a ceramic plug inserted into one end of the light transmitting envelope and being hermetically sealed to the inner wall of said envelope with ceramic sealing frit, said ceramic plug having a central opening through which extends one thermionic electrode inlead which is hermetically sealed at said opening with ceramic sealing frit, and having a transverse metal cross piece joined to said inlead. The remaining end closure comprises a ceramic disc having a larger diameter than the inner diameter of said light transmitting envelope which is hermetically sealed with ceramic sealing frit to the end of said light transmitting envelope as well as to the surface of a ceramic plug inserted into the end of said light transmitting envelope, with both said ceramic disc and ceramic plug having central openings through which extends an inlead and exhaust tube member for the remaining thermionic electrode and which is hermetically sealed at the central opening of said ceramic plug with ceramic sealing frit.



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CERAMIC SEAL FOR HIGH PRESSURE SODIUM VAPOR LAMPS

BACKGROUND OF THE INVENTION

Various type ceramic seals are already known to close each end of the tubular light-transmitting ceramic envelope used for sodium vapor lamps such as described in United States patents 4,034,252 and 4,065,691, both assigned to the assignee of the present invention. In said earlier issued patent, the end of said arc tube is closed with a ceramic plug that is inserted into the arc tube end and which has a central aperture to permit passage of an electrode inlead therethrough, with all of said members being hermetically sealed together by sealing frit. The sealing frit is said to be comprised primarily of aluminum oxide and calcium oxide which is heated to provide a molten glass during the sealing operation. A metal cross piece is attached directly to said inlead immediately next to the ceramic plug which extends transversely across the end of the arc tube and physically supports the thermionic electrode joined thereto. The hermetic seal is formed with a liquid slurry of suspended frit particles that is drawn by capillary action with assistance of the cross piece into the free space existing between joined components. In the subsequently issued aforementioned patent, the end closure is provided by a ceramic plug inserted into the end of the arc tube which again permits passage of an electrode inlead wire

therethrough, and with a hermetic seal being effected between all of the joined members. A significant difference does exist, however, with respect to the manner in which a hermetic seal is achieved in this end closure between two spaced apart sealing regions. Two preformed rings or washers of the ceramic frit material are employed further requiring that close tolerance dimensions be maintained between all of the components being joined together.

Difficulties can still be experienced with these end closures in the ability to produce reliable hermetic seals between the metal and ceramic lamp components being joined. For example, sealing the ceramic plug to the ceramic arc tube has proven difficult with success generally requiring careful control of both plug and tube dimensions along with precise attention being given to the amount of sealing frit used. Too little sealing frit produces incomplete filling of the surfaces being joined and with leakage occurring at such locations. Too much frit produces large sealing fillets that can cause cracking of the ceramic tubing material due to any slight mismatch in thermal expansion between the sealing frit and the ceramic tubing. Accordingly, it would be desirable to still further reduce the number of sealing frit rings or washers now being used without decreasing the reliability of seal formation. It would be further desirable to reduce difficulties now being experienced in maintaining close physical dimensions for the ceramic plug members used in these closure structures. It would be still further desirable to improve the overall end closure for this type lamp without undue modification or additional cost in either the lamp manufacture or subsequent lamp operation.

SUMMARY OF THE INVENTION

Novel means for arc tube end closures have now

been discovered which modifies one of the previously described end closure structures. More particularly, the end closure disclosed in the aforementioned 4,065,691 patent is modified for use at one end of the arc tube in combination with the unmodified end structure disclosed in the aforementioned 4,034,252 patent being used at the opposite end of said arc tube. Basically, the modified end closure replaces the single ceramic plug member with a composite assembly of a ceramic disc and ceramic plug that are bonded together with a single frit washer. The substituted ceramic disc has a larger diameter than the inner diameter of the arc tube for butt-sealing engagement with the end of said arc tube and the single frit washer provides sufficient bonding material to hermetically seal all joints in the assembled end closure. Both said ceramic disc and ceramic plug have central openings through which extend an inlead and exhaust tube member for one thermionic electrode which is hermetically sealed at the central opening of said ceramic plug with material provided by the frit washer.

The improved high pressure sodium vapor lamp of the present invention thereby includes a tubular light-transmitting ceramic envelope with a pair of thermionic electrodes being sealed at its ends by ceramic closures, wherein the improvement comprises one ceramic plug being inserted into one end of said light-transmitting envelope and being hermetically sealed to the inner wall of said light-transmitting envelope with ceramic sealing frit, said ceramic plug having a central opening through which extends an inlead for one thermionic electrode which is hermetically sealed at said opening with ceramic sealing frit, and having a transverse metal cross piece joined to said inlead at the exterior surface of said ceramic plug while the remaining ceramic closure comprises a ceramic disc having a larger diameter than the

inner diameter of said light-transmitting envelope which is hermetically sealed with ceramic sealing frit to the end of said light-transmitting envelope and the surface of a ceramic plug inserted into the end of said light-transmitting envelope, both said ceramic disc and ceramic plug having central openings through which extend an inner lead and exhaust tube member for the remaining thermionic electrode which is hermetically sealed at the central opening of said ceramic plug with ceramic sealing frit. In a preferred lamp embodiment, both thermionic electrodes comprise refractory metal wire coils wound around a tungsten shank with the metal cross piece extending transversely beyond the inner wall of said light-transmitting envelope so as to physically support one thermionic electrode joined thereto.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a high pressure sodium vapor lamp employing the presently improved ceramic closure structure;

FIG. 2 is an enlarged detailed view of one end closure employed in the FIG. 1 lamp embodiment; and

FIG. 3 is an enlarged detailed view of the remaining end closure employed in said FIG. 1 lamp embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, a representative high pressure sodium vapor lamp 1 corresponding to a 400-watt size with a given lamp voltage drop of about 100 volts is illustrated which comprises a vitreous outer envelope 2 having a standard mogul screw base 3 attached to one end and comprising a reentrant stem press seal 4 through which extend, in conventional fashion, a pair of relatively heavy lead-in conductors 5 and 6 whose outer ends are connected to the screw shell 7 and eyelet 8 of the base. The inner envelope or arc tube 9 centrally located within

said outer envelope comprises a length of light-transmitting ceramic tubing, preferably polycrystalline alumina ceramic which is translucent or which can be single crystal alumina which is clear and transparent. The upper end of the arc tube is sealed by a closure structure 10 in accordance with the aforementioned 4,034,252 patent through which extends the niobium inlead wire 11 hermetically sealed. The inlead supports the upper electrode which may be generally similar to the lower electrode and with both of said electrodes being more specifically illustrated in the following FIG. 2-3 embodiments. The external portion of inlead 11 passes through a loop 12 in transverse support wire 13 attached to a side rod 14. This arrangement allows for a thermal expansion of the arc tube during lamp operation when the lower end seal is rigidly fixed in place, and a resilient metal ribbon 15 assures continued good electrical connection. Side rod 14 is welded to lead-in conductor 6 and has its upper end braced by spring clamp 16 which engages inverted nipple 17 in the dome end of the outer vitreous envelope. The lower end closure 20 for said lamp and modified in accordance with the present invention has a central aperture through which extend a thin-walled niobium tube 21 serving as an exhaust tube and as an inlead. Said tube extends but a short distance through the end closure and is hermetically sealed therethrough by sealing frit as will be further explained in the description given for FIG. 3 dealing with said end closure embodiment. The closed arc tube is supported in the outer envelope by connector 22 which is welded across from tubular inlead 21 to a support rod 23 joined to lead-in conductor 5.

Upper ceramic closure 10 for the above illustrated lamp embodiment is depicted in greater detail as shown in FIG. 2. Specifically, said ceramic closure 10

comprises a ceramic plug 24 which is entirely inserted into one end of the arc tube and having a metal cross piece 26, which can be a short wire length, joined to inlead 11 at the exterior surface 28 of said ceramic plug. Said cross piece is bent or arched slightly about its midpoint in a horizontal plane transverse to said inlead in order to have its ends engage the edges of the arc tube diameter and help physically support the thermionic electrode joined thereto. A hermetic seal 29 is formed in the annular recess between the assembled ceramic plug and inner wall of the arc tube as hereinafter further explained. A second hermetic seal 30 is formed at the central opening 32 in ceramic plug 24 and which extends to a ridge of sealing frit 34 on the surface of said plug reaching up to the cross piece 26. All hermetic sealing in the illustrated closure embodiment can be provided with a measured quantity of sealing glass frit being placed on the ceramic plug, suitably as a slurry and the closure assembly then being heated to the melting temperature of the glass frit. The molten frit is drawn by capillary action into the annular free space between the arc tube and ceramic plug as well as into the free space formed between the central opening in said plug with the electrode inlead. Said inlead 11 is joined to a tungsten shank 36 of a conventional thermionic electrode 38 having one or more refractory metal coils wound around which is further described in the aforementioned 4,034,252 patent.

The principal feature of the present invention resides in the modification of ceramic closure 20 which is depicted in greater detail for the lower electrode structure and electrode support assembly therefor as shown in FIG. 3. Specifically, said improved ceramic enclosure 20 comprises assembly of a ceramic disc 40 having a larger diameter than the inner diameter of said arc tube 9 which is hermetically sealed with ceramic sealing frit at one

end of said arc tube as well as the outermost surface 42 of a ceramic plug 44 which has been inserted into the end of said arc tube. The butt-sealed interface between said ceramic disc 40 and ceramic plug 44 is formed with a ring or washer 46 of ceramic frit material which further provides a hermetic seal 48 to associated electrode structure 50. Said conventional electrode 50 is shown to include part of a metal exhaust tube and inlead member 21 that is inserted through a central opening 52 in both ceramic disc and ceramic plug for hermetic sealing after assembly of said component parts. As can be noted, hermetic sealing 48 between the electrode and ceramic components is generally limited to sealing engagement with the plug member only.

It will be apparent from the foregoing description that improved seal means for high pressure sodium vapor type lamps has been disclosed which is generally useful. It will be further apparent to those skilled in the lamp art, however, that said improved closure means can replace conventional end closures in this type lamp although remaining features in the lamp other than above specifically disclosed are employed. For example, lamp designs utilizing additional gettering and starting aids can use the present ceramic closure means. Accordingly, it is intended to limit the present invention only by the scope of the following claims.

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CLAIMS

1. An improved high pressure sodium vapor lamp having a tubular light-transmitting ceramic envelope with a pair of thermionic electrodes being sealed into its ends by ceramic closures, the improvement wherein one ceramic closure comprises a ceramic plug inserted into one end of said light-transmitting envelope and being hermetically sealed to the inner wall of said light-transmitting envelope with ceramic sealing frit, said ceramic plug having a central opening through which extends an inlead for a thermionic electrode which is hermetically sealed at said opening with ceramic sealing frit, and having a transverse metal crosspiece joined to said inlead at the exterior surface of said ceramic plug while the remaining ceramic closure comprises a ceramic disc having a larger diameter than the inner diameter of said light-transmitting envelope which is hermetically sealed with ceramic sealing frit to the end of said light-transmitting envelope and the surface of a ceramic plug inserted into the end of said light-transmitting envelope, both said ceramic disc and ceramic plug having central openings through which extend an inlead and exhaust tube member for the remaining thermionic electrode which is hermetically sealed at the central opening of said ceramic plug with ceramic sealing frit.

2. An improved lamp as in claim 1 wherein the thermionic electrodes comprise refractory metal wire coils wound around a tungsten shank.

3. An improved lamp as in claim 1 wherein the metal crosspiece extends transversely beyond the inner wall of said light-transmitting envelope so as to physically support the thermionic electrode joined thereto.

4. An improved high pressure sodium vapor lamp comprising:

(a) a light-transmitting alumina ceramic tube having a thermionic electrode sealed into each end by a ceramic closure and a charge of sodium-mercury amalgam in excess of the quantity vaporized along with xenon gas to facilitate starting; and

(b) an evacuated outer light-transmitting vitreous envelope surrounding said arc tube having a stem press seal at one end through which extends a pair of inleads electrically connected to said thermionic electrodes;

(c) one of said ceramic closures comprising a ceramic plug inserted into one end of said arc tube and being hermetically sealed to the inner wall of said arc tube with ceramic sealing frit, said ceramic plug having a central opening through which extends an inlead for a thermionic electrode which is sealed at said opening with ceramic sealing frit, and having a transverse metal crosspiece joined to said inlead at the exterior surface of said ceramic plug;

(d) the remaining ceramic closure comprising a ceramic disc having a larger diameter than the inner diameter of said arc tube which is hermetically sealed with ceramic sealing frit to the end of said arc tube and the surface of a ceramic plug inserted into the opposite end of said arc tube, both said ceramic disc and ceramic plug having central openings through which extend an inlead and exhaust tube member for the remaining thermionic electrode which is hermetically sealed at the central opening of the ceramic plug with ceramic sealing frit.

5. An improved lamp as in claim 4 wherein the thermionic electrodes both comprise refractory metal wire coils wound around a tungsten shank.

6. An improved lamp as in claim 4 wherein the metal crosspiece extends transversely beyond the inner wall of said arc tube so as to physically support the thermionic electrode joined thereto.

Fig. 1

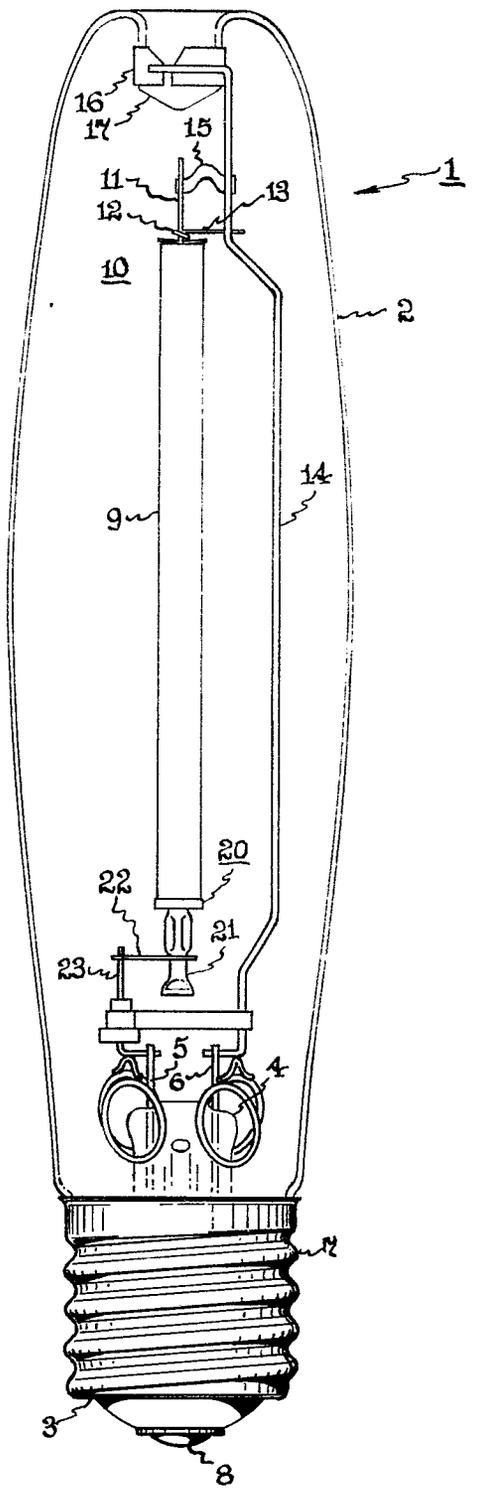

Fig. 2

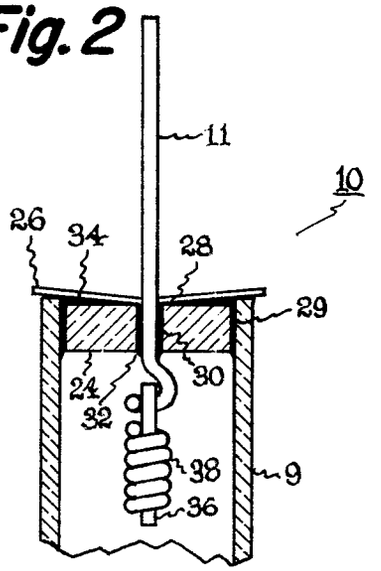

Fig. 3