

[54] **ALUMINA CERAMIC LAMP HAVING
HEAT-REFLECTING SHIELDS
SURROUNDING ITS ELECTRODES**

[75] Inventors: **Juris Sulcs**, Fairview Park; **Robert W. McKimm**, Euclid, both of Ohio

[73] Assignee: **General Electric Company**

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[51] Int. Cl. **H01j 61/52**
[58] Field of Search **313/27, 44-47, 313/219**

[56] **References Cited**

UNITED STATES PATENTS

1,878,159	9/1932	Mailey.....	313/44
1,922,244	8/1933	Hunter	313/47 X
2,315,286	3/1943	Hays, Jr. et al.....	313/47

3,333,132 7/1967 Edris et al. 313/47

Primary Examiner—Roy Lake

Attorney—Ernest W. Legree, Henry P. Truesdell, Frank L. Neuhauser, Oscar B. Waddell and Joseph B. Forman

[57] **ABSTRACT**

A high intensity sodium vapor lamp utilizing a tubular envelope of alumina ceramic closed at the ends by niobium end caps which support activated tungsten electrodes and which contains mercury and an excess of sodium not all of which is vaporized during operation. It is desirable that the excess of sodium and mercury condense in the exhaust tube or appendage and not about the interface between the end cap and the sealing glass binding it to the alumina envelope. This result is achieved by providing a heat shield of polished refractory metal about the ends of the arc tube next to the end caps.

6 Claims, 2 Drawing Figures

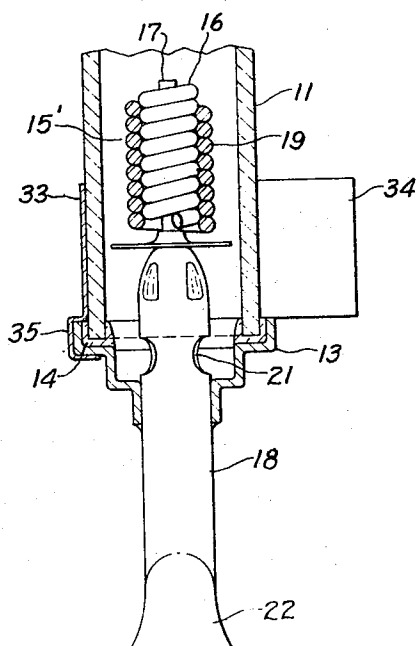


FIG. 1.

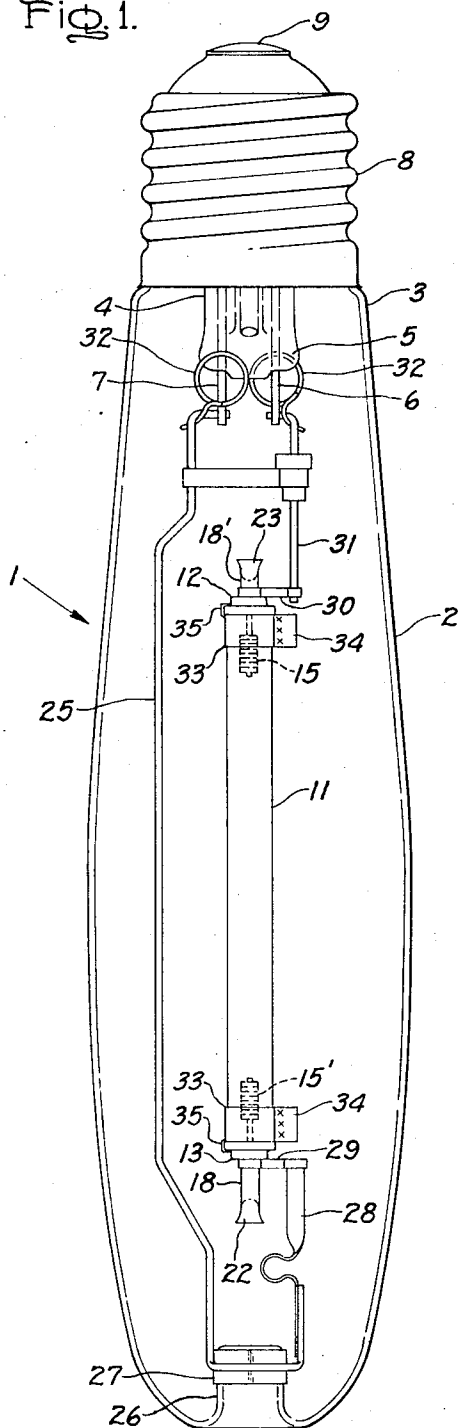
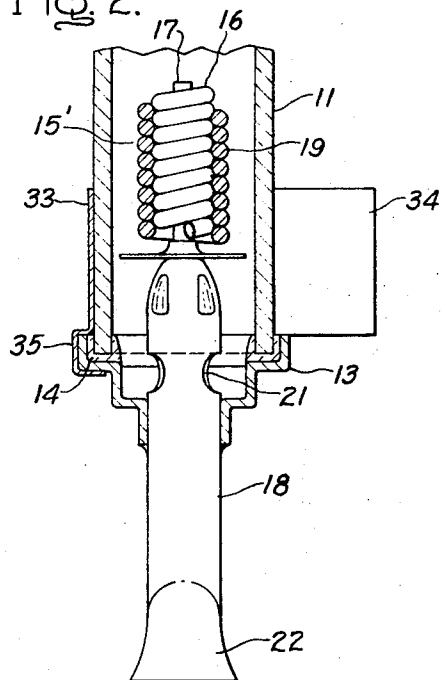


FIG. 2.



Inventor:
Juris Sulcs
by *Emmett W. Legee*
His Attorney

ALUMINA CERAMIC LAMP HAVING HEAT-REFLECTING SHIELDS SURROUNDING ITS ELECTRODES

BACKGROUND OF THE INVENTION

This invention relates to high intensity sodium vapor lamps of the kind described in U.S. Pat. No. 3,248,590 — Schmidt, entitled "High Pressure Sodium Vapor Lamp." Such lamps utilize a slender tubular envelope of a light-transmissive refractory oxide material resistant to sodium at high temperatures, suitably high-density poly-crystalline alumina. The filling comprises sodium along with a rare gas such as xenon to facilitate starting and mercury for improved efficacy, the sodium and mercury forming an amalgam. Each end of the alumina tube is sealed by a refractory metal closure member, suitably a niobium end cap having an expanded skirt portion which fits around the end of the alumina tube and is bonded thereto by a thin annular layer of glassy sealing material comprising aluminum oxide, calcium oxide, and magnesium oxide. Such a closure is described in detail in U.S. Pat. No. 3,243,635 — Loudon and Pinter, "Ceramic Lamp Construction."

Each end cap supports an electrode extending along the axis of the tube and serves as an electrical inlead. The electrode comprises a tungsten rod supported from the end cap and having a double-coil of tungsten wire wound around its inner end. The electrode is activated by a quantity of low work function material in the form of metal oxides including barium oxide retained in the interstices of the coil as a reservoir. A shield is provided to the rear of the electrode to prevent back arcing.

The ceramic arc tube is generally supported within an outer vitreous envelope or jacket provided at one end with the usual screw base to which the end caps are connected. The interenvelope space is usually evacuated in order to conserve heat.

SUMMARY OF THE INVENTION

A problem encountered with such lamps particularly in the smaller sizes less than 400 watts, as in the 250 watt size, is condensation of the excess sodium mercury amalgam about the region of the interface between niobium end cap and the sealing glass binding it to the alumina envelope instead of in the exhaust tube which extends beyond the end cap.

It is desirable to have a well-determined cold spot location and this means that the temperature of the alumina envelope next to the end cap and just ahead of it must be increased. The region in which the temperature must be increased is that extending from the junction of the end cap and tubulation up to the electrode tip.

Providing a heat shield about an alumina ceramic envelope operating at temperatures upwards of 1,000°C presents a problem entirely different from that encountered with quartz arc tubes operating at temperatures of about 700°C. Reflective metal coatings or heat reflective coatings of white metal oxides such as MgO and ZrO₂ are difficult to apply consistently and do not adhere well through the life of the lamp.

Another difficulty arises from the fact that the emissivity of translucent polycrystalline alumina or sapphire is much less than that of quartz, which is close to 1 in the spectral region of interest. According to Stefan-Boltzman Law of Radiation, $R = GeT^4$ where R = radia-

tion, T = absolute temperature, epsilon = emissivity and G = a constant. Where the emissivity of the material is close to 1, a reduction in heat loss can be achieved by applying almost any opaque coating material regardless of the emissivity of the coating. However, where the emissivity of the arc chamber is significantly less than 1, the choice of materials for the purpose of reducing the heat loss is greatly restricted because only materials having emissivity less than that of the arc chamber will cause any reduction where the coating is at substantially the same temperature as the ceramic tube itself.

In accordance with the invention, a refractory metal foil band is wrapped around the arc tube near the end cap and mechanically connected to the end cap so as to be permanently locked in place. Suitable materials for the metal foil are polished niobium, tantalum, zirconium, molybdenum or tungsten, the first being preferred to be used in combination with end caps also made of niobium.

The shield conserves heat in the electrode region resulting in increased heat flow to the seal and to the cold spot. Because heat loss from the seal and cold spot is controlled by thermal radiation, the absolute temperature and distribution of temperature in the region from the tip of the electrode to the end of the pinched tubulation can be controlled by adjusting the width of the foil. Thus the seal temperature and the cold spot temperature can be controlled by adjusting the width of the foil.

DESCRIPTION OF THE DRAWING

In the drawing:

FIG. 1 illustrates a jacketed high pressure sodium vapor lamp embodying the invention.

FIG. 2 is a section view of one end of the arc tube to a larger scale showing details of the heat shield.

DESCRIPTION OF PREFERRED EMBODIMENTS

A high intensity sodium vapor discharge lamp 1 in which the invention is embodied is illustrated in FIG. 1 and comprises an outer vitreous envelope or jacket 2 of elongated ovoid shape. The neck 3 of the jacket is closed by a re-entrant stem 4 having a press 5 through which extend relatively stiff inlead wires 6, 7 connected at their outer ends to the threaded shell 8 and center contact 9 of a conventional screw base.

The inner envelope or arc tube 11 is made of sintered high density polycrystalline alumina ceramic per U.S. Pat. No. 3,026,210 — Coble, "Transparent Alumina and Method of Preparation," or of other light-transmitting ceramic capable of withstanding the attack of sodium vapor at high temperatures. The ends of the tube are closed by thimble-like niobium metal end caps 12, 13 hermetically sealed to the alumina by means of a sealing composition comprising a major proportion of aluminum oxide and calcium oxide and a minor proportion of magnesium oxide. The sealing material is shown exaggerated in thickness at 14 in FIG. 2.

Thermionic electrodes 15, 15' are mounted in the ends of the arc tube. As best seen in FIG. 2, each electrode comprises an inner tungsten wire coil 16 which is wound over a tungsten shank 17 crimped or welded in the end of a niobium tube 18 welded through the end cap. The central turns in the inner coil 16 are spread

apart and an outer tungsten wire coil 19 is screwed over the inner coil. The electrodes are activated by metal oxides, preferably a mixture of barium oxide and thorium oxides which is retained by the coils, primarily in the interstices between the turns of the inner coil and the outer coil. Lower tube 18 is pierced through at 21 and is used as an exhaust tube during manufacture. After the gas filling and sodium mercury amalgam have been introduced into the arc tube, exhaust tube 18 is hermetically pinched off by a cold weld indicated at 22 and serves thereafter as a reservoir for condensed sodium-mercury amalgam. Upper tube 18' has no opening into the arc tube and is used to contain a small quantity of yttrium metal (not shown) fused in place which serves as a getter; the end of the tube is closed by a pinch 23. The gettering action occurs through the niobium metal. The illustrated lamp is limited to base-up operation wherein the longer exhaust tube 18, which must be the coolest portion of the arc tube for the amalgam to condense therein, is located lowermost. In the base-down version, the arc tube is reversed relative to the outer jacket.

The arc tube is supported within the outer envelope by means of a mount comprising a single side rod 25 which extends the length of the envelope from inlead 7 at the stem end to a dimple 26 at the dome end to which it is anchored by a resilient clamp 27. End cap 13 of the arc tube is connected to the frame by welded expansion strap 28 and band 29, while end cap 12 is connected to inlead 6 through band 30 and connecting rod 31. The inter-envelope space is desirably evacuated in order to conserve heat; this is done prior to sealing off the outer jacket. A getter, for instance, barium-aluminum alloy powder pressed into channeled rings 32, is flashed after sealing in order to maintain a high vacuum.

The heat shield comprises a thin metal band 33 of niobium wrapped around the end of the alumina tube and spot welded in a tab 34. Another axially extending tab 35 is bent around the end cap and locks the shield in place. The thickness of the shield is not important since it operates at substantially the same temperature as the end of the arc tube. It has been found convenient to use foil of 0.002 inch thickness because it handles readily and can be spot welded. Such a shield can be provided at one end or at both ends of the arc tube. If shields are provided at both ends of the arc tube, they may be identical or they may have different widths.

Preferably the width of the shield is such that it extends from the seal a distance no greater than the outside diameter of the arc tube.

The width of the shield controls the temperature about the seal and in the cold spot at the end of the lamp which is provided by the exhaust tube 18. Within limits, the shield may be used to raise the temperature of the cold spot in order to increase the vapor pressure and achieve both higher efficiency and higher color temperature.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A high intensity sodium vapor discharge lamp comprising a slender light-transmissive ceramic tube, closures sealing the ends of said tube, an electrode supported from the closure at each end of said tube, a filling of sodium-mercury amalgam in excess of the quantity vaporized in operation and an inert gas within said tube, at least one of said closures comprising a metal end cap into which the end of the ceramic tube is sealed and a metal exhaust tube extending through said cap, said exhaust tube supporting the electrode at its inner end and being closed at its outer end to provide a reservoir for condensed amalgam, and a heat shield next to said metal end cap comprising a band of refractory metal having an emissivity greater than said ceramic tube wrapped around its end and extending from the metal end cap into the region of the electrode supported thereby in order to raise the temperature of the ceramic tube to the rear of said electrode and prevent condensation of excess amalgam in the region between said electrode and the metal end cap.

2. A lamp as defined in claim 1 wherein the heat shield is a metal or an alloy selected from the group consisting of niobium, titanium, tantalum, zirconium, molybdenum and tungsten.

3. A lamp as defined in claim 1 wherein both of said closures comprise metal end caps and said heat shield is provided around each end of said ceramic tube.

4. A lamp as defined in claim 1 wherein said heat shield extends from said end cap a distance no greater than the outside diameter of said ceramic tube.

5. A lamp as defined in claim 1 wherein said heat shield has an axially extending tab bent around the metal end cap to lock the shield in place.

6. A lamp as defined in claim 1 wherein said ceramic tube is alumina, and said end cap, said exhaust tube and said heat shield are all made of niobium.

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Dedication

3,723,784.—*Juris Sulcs*, Fairview Park, and *Robert W. McKimm*, Euclid, Ohio.
ALUMINA CERAMIC LAMP HAVING HEAT-REFLECTING
SHIELDS SURROUNDING ITS ELECTRODES. Patent dated
Mar. 27, 1973. Dedication filed Mar. 11, 1974, by the assignee, *General
Electric Company*.

Hereby dedicates to the Public the entire term of said patent.

[*Official Gazette October 15, 1974.*]