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Collins

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[54] **HIGH INTENSITY LAMP CONTAINING ARC EXTINGUISHING BASE**

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[52] **U.S. Cl.** **313/318,** 313/25, 315/184
[51] **Int. Cl.** **H01j 5/46**
[58] **Field of Search** 313/25, 184, 227, 228, 313/318

[56] **References Cited**

UNITED STATES PATENTS

2,888,585	5/1959	Martt	313/25
3,248,590	4/1966	Schmidt	313/225
3,253,179	5/1966	Edwards	313/318

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[57] **ABSTRACT**

A high intensity lamp comprising an arc tube containing metal vapor such as sodium and mercury mounted within an evacuated single-ended outer jacket provided with a screw base. The use of high circuit voltage and high voltage starting pulses in conjunction with a vacuum jacket make the lamp especially susceptible to breakdown. Insulating refractory sleeves are provided about the inleads within the base which increase the breakdown voltage. However should an arc form, the ends of the inleads ball-up and withdraw into the sleeves and the arc is thereby constricted and extinguished.

10 Claims, 3 Drawing Figures

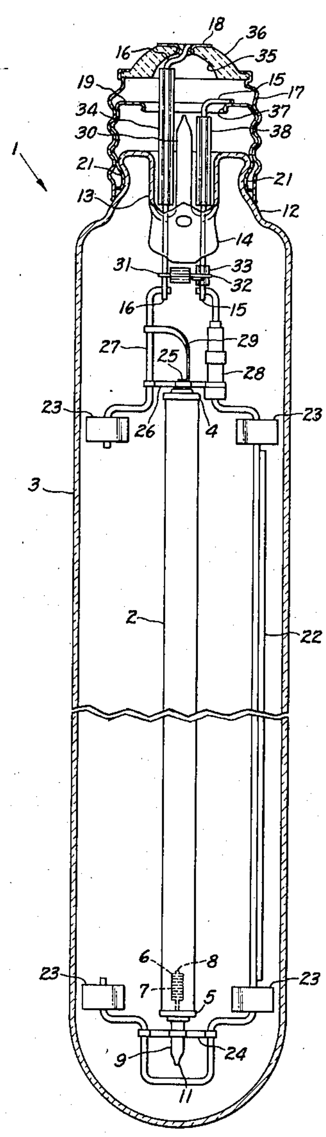

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Fig. 1.

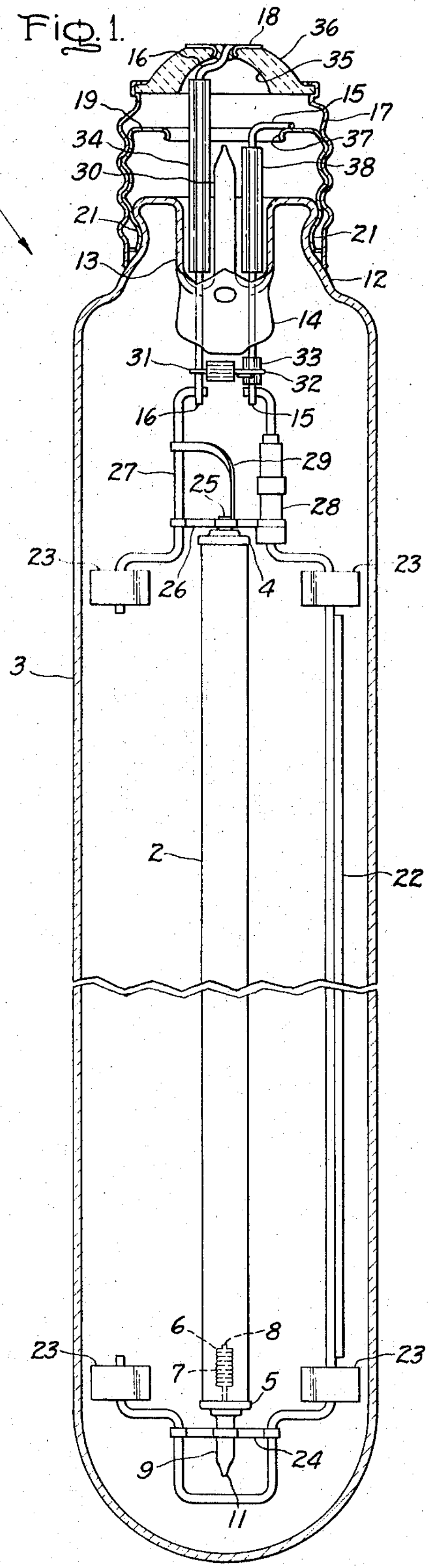


Fig. 3.

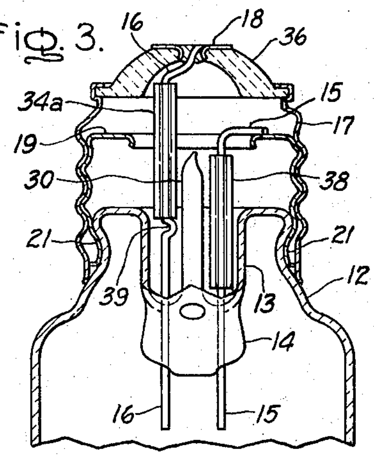
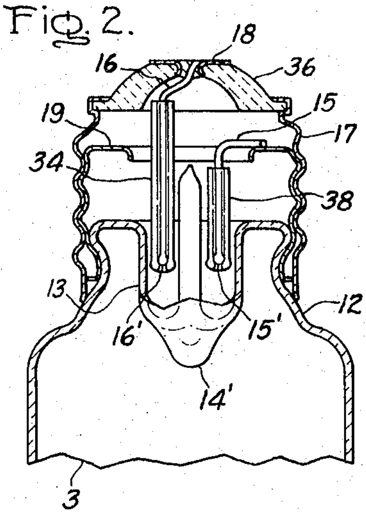


Fig. 2.



HIGH INTENSITY LAMP CONTAINING ARC EXTINGUISHING BASE

BACKGROUND OF THE INVENTION

The invention relates to high intensity vapor to high lamps comprising an inner envelope mounted within a single-ended outer envelope and requiring a starting voltage high enough to start a discharge between spaced conductors in air.

The invention is particularly useful with high pressure sodium vapor lamps of the kind described in U.S. Pat. No. 3,248,590 – Schmidt, entitled "High Pressure Sodium Vapor Lamp." In these lamps, an elongated inner envelope of ceramic material contains a filling comprising an amalgam of sodium and mercury and a rare gas to facilitate starting. The ends of the ceramic envelope or tube are sealed by refractory closure members, suitably niobium end caps which serve as electrical inleads and support electrodes internally. The tube is supported within an outer vitreous envelope or jacket having at one end a base to which the end caps are connected. The jacket is evacuated in order to conserve heat and maintain the cold spot or lowest temperature portion of the arc tube at a sufficiently high temperature.

The high pressure sodium vapor lamp has a relatively high starting voltage due in part to the small diameter of the arc tube, the use of xenon as a starting gas, and the absence of an auxiliary starting electrode. To start and operate the lamp, a ballast circuit is generally used which supplies a high voltage pulse, customarily near the peak of the open circuit waveform, until the lamp ignites. For instance, in a 1000 watt lamp, the ballast open circuit voltage is approximately 480 volts and pulses of 3000 to 5000 volts are supplied. Then voltages greatly exceed the minimum breakdown voltage of about **330** volts between closely spaced conductors in air. In particular, pulse voltage exceeding 1000 volts can easily start a discharge if the spacing between conductors is reduced or if the insulation is damaged. When the lamp starts, the pulsing circuit is disabled by the reduction in voltage at the lamp terminals from the open circuit value to the lamp running value. However should the lamp extinguish or fail, the ballast continues to supply high voltage pulses until power is shut off or the lamp is replaced.

In high pressure sodium vapor lamps, particularly in the larger sizes above 400 watts rating, the possibility of a destructive failure resulting from uncontrolled arcing within the outer envelope presented a problem. In copending application Ser. No. 230,761, filed Mar. 1, 1972 by Byron R. Collins, Juris Sulcs and Charles I. McVey, entitled "High Intensity Lamp Containing Internal Shorting Fuse" and assigned to the same assignee as the present invention, now patent **3,767,965,** two situations are described which may lead to this condition. The first occurs when the vacuum outer jacket develops a slow air leak; the ballast open circuit voltage or the high voltage pulses supplied by the ballast circuit will insure ignition of a discharge which will become a destructive power arc as the bulb airs up further. The second occurs when the arc tube fails, as when an end cap seal develops a leak; the release of sodium and mercury vapor and inert gas into the jacket may cause an arc to start between the metal parts about the stem, and the arc once started can maintain itself in the vapor of the metal parts such as iron or nickel inleads and supports to which it attaches. The solution provided is a self-shorting arcing fuse located within the jacket to extinguish any arc occurring and safely end the life of the lamp. The arcing fuse comprises metal conductors defining an arc gap at the closest spatial approach between opposite current conductors within the jacket, such that under the heat of the power arc the metal conductors will deform and bridge over the gap.

However a problem remaining with single-ended high pressure sodium vapor lamps in the larger sizes is the possibility of destructive uncontrolled arcing within the base. The shorting fuse within the outer jacket will extinguish an arc originating within the jacket. However an arc may originate within the base. For instance, if a slow leak should permit a lamp to become aired while the power is off, when subsequently power is switched on, an arc may start within the base. Faulty wiring within the base, for example failure to maintain sufficient separation between the inleads as they are directed one to the end contact and the other to the base shell, may drastically reduce the breakdown voltage. Other factors which may reduce breakdown voltage are a cracked glass base insulator, accumulated soil or excessive humidity and condensation within the base, and spatter from soldering flux. Once started the arc can totally destroy the base and socket if it is not confined and extinguished.

In the aforementioned Collins et al. application, it is proposed to place a second self-shorting arcing fuse in the base of the lamp in order to extinguish any arc which might form therein. That fuse is similar to the one described and claimed in U.S. Pat. No. 2,950,417, – Breeding et al., "Series Electric Lamp," August 1960, and requires the use of flexible stranded wire, preferably nickel-plated copper strands, for the external portions of the inleads. One of the external inleads extending through the stem tube is passed through a thin-walled glass sleeve alongside the jacket exhaust tube, and the other is wrapped one or more turns around both the glass sleeve and exhaust tube together. The glass sleeve is made of high lead content glass which becomes relatively conductive when heated. Upon being touched by any arc forming within the base, the sleeve will melt and permit a conductive juncture to be formed between the inleads which will shortcircuit the arc.

While the Breeding et al. shorting fuse is satisfactory for use in the series type mercury lamp for street lighting for which it was intended, it is not fully satisfactory for higher wattage high pressure sodium lamps. The lead glass sleeve is brittle and easily cracked in handling or as a result of wrapping the stranded inlead too tightly around it, whereupon the very high voltages used make a breakdown likely. If the stranded inlead is wrapped loosely around the lead glass sleeve, the wire loop which it forms is not physically restrained and can move, shortening the gap between inleads and again reducing the breakdown voltage. Finally, soldering of the inlead to the base eyelet is not satisfactory in high pressure sodium vapor lamps due to the high temperatures encountered and has been largely replaced by welding using a tungsten electrode in an inert gas atmosphere, commonly referred to as TIG welding. In TIG welding a brass brazing washer may be used and metal smoke as copper and zinc or their oxides from the brazing material may be deposited within the base forming a partially conductive layer. With the Breeding et al. type short-circuiting fuse in the base, the smoke from TIG welding can reduce the breakdown voltage by several thousand volts.

SUMMARY OF THE INVENTION

My invention resolves the foregoing problems by providing within the base an open circuit fusing construction which increases the breakdown voltage and which, in the event that a voltage breakdown should nevertheless occur, serves to extinguish by open circuit any arc that may form.

In a preferred embodiment, at least the inlead extending from the press through the stem tube to the eyelet or end contact of the base is passed through a refractory insulating sleeve of material which retains its shape and does not become conductive at high temperatures, even at 1000°C. Quartz or quartz-like glasses such as Vycor, and ceramics are suitable but ordinary lime glass or hard borosilicate glass will not do. Preferably both inleads are passed through refractory sleeves disposed to insure a minimum spacing between the high voltage conductors within the base. However should an arc occur within the base, the ends of the inleads or conductors melt and ball-up under the heat of the arc and withdraw into the sleeves. As the arc attempts to follow the balled ends into the sleeves, it is lengthened and constricted, and finally extinguished. It is because the high temperature arc is extinguished into an open circuit by being drawn up into the sleeves that the sleeves must be made of material which retains its shape and does not become conductive at high temperatures.

Preferably the base insulator is made of ceramic which can stand a higher temperature than glass and serve as a firewall to confine arc damage within the base.

DESCRIPTION OF DRAWING

In the drawing:

FIG. 1 is a front view of a high pressure sodium vapor lamp provided with an arc extinguishing base embodying the invention.

FIG. 2 is a fragmentary view of the neck end and base of the lamp showing the fuse after operation.

FIG. 3 is a fragmentary view of the neck end and base of the lamp showing a variant of the invention.

DETAILED DESCRIPTION

In FIG. 1 there is shown a high pressure sodium vapor lamp 1 comprising an innver ceramic arc tube 2 and an outer tubular vitreous envelope or jacket 3. A central portion of the lamp has been cut out to shorten the figure and faciliate illustration.

The inner envelope or arc tube 2 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 tube is closed by thimble-like niobium metal end caps **4, 5** 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 and barium oxide.

Thermionic electrodes are mounted in the ends of the arc tube and supported from the end caps. Lower electrode **6** is shown in the drawing and comprises a tungsten wire coil helix **7** wound around a tungsten shank or core **8** fastened in the end of a niobium tube **9** welded through the end cap. The electrodes are activated by metal oxides retained in the interstices between turns of the coil. The ionizable filling consists of an inert gas, preferably xenon at a cold filling pressure of about **20** torr, and a sodiummercury amalgam. The filling is introduced through exhaust tube **9** which is then hermetically pinched off by a cold weld indicated at **11** and serves in operation as the cold spot and reservoir for excess amalgam.

The outer envelope or jacket **3** is made of a high temperature glass such as borosilicate glass and is relatively thick-walled in order to withstand atmospheric pressure after exhaust. The neck **12** of the jacket is closed by a re-entrant stem **13** terminated in a press **14** through which extend heavy inleads or current conductors **15, 16** which are connected respectively to the threaded shell **17** and insulated end contact or eyelet **18** of a mogul screw base. The base is mechanically retained on the neck of the jacket by screwing shell **17** over threaded retaining ring **19** which has inwardly turned notches **21** engageing corresponding dimples in the glass of the neck.

The arc tube is supported within the jacket by a mount comprising a long side rod **22** welded to inlead **15** close by the press and braced by leaf spring members **23** bearing against the tubular jacket. Niobium exhaust tube **9** in the lower end cap is seized in straps **24** bridged across the laterally extending end portion of the side rod. Projecting teat **25** in the upper end cap extends through an encircling opening formed between straps **26** extending from support rod **27** to ceramic sleeve **28** on side rod **22,** and is electrically connected to inlead **16** by flexible strap **29** and rod **27.** The space within outer jacket **3** is evacuated to a high vacuum in order to reduce heat loss from the arc tube. The illustrated lamp is intended for base-up operation; in a base-down version of the same lamp, the arc tube is reversed relative to the outer jacket and niobium exhaust tube **9** is again lowermost in operation.

The self-shorting arcing fuse provided within the jacket in accordance with the aforementioned Collins et al. application comprises short wire **31** welded to inlead **16** close below the press and extending towards inlead **15** where it terminates in a loop **32** encircling a short glass sleeve **33** placed around inlead **15.** Inlead **15** and ring **32** define the closest approach between opposite current conductors within the jacket. Should an arc discharge occur, it will take place about loop **32** which will melt and fuse to inlead **15** forming a direct short circuit which extinguishes the arc. Glass sleeve **33** is made of lead glass which assures a low resistance joint when the metal parts fuse together.

In accordance with the invention, inlead **16** extending from press **14** through the stem tube to base eyelt **18** is passed through a refractory insulating sleeve **34.** The sleeve is made of material which does not soften not become conductive at high temperatures, even as high as 1000°C. Quartz or quartzlike glass such as Vycor are suitable but ordinary lime glass or hard borosilicate glass will not do. Sleeve **34** extends from the bottom or saddle of the stem tube up into cavity **35** in base insulator **36.** The minimum gap between opposite current conductors usually occurs where inlead **16** passes through the plane of aperture **37** in retaining ring **19** and sleeve **34** effectively insulates the inlead from the ring at that point. While not essential, it is desirable to place a refractory insulating sleeve **38** around inlead **15** which is welded to retaining ring **19**.

In the event of a voltage breakdown within the base, the arc may occur between inleads **15** and **16** about the points where they come out of glass press **14**. In FIG. **2**, there is shown the neck end and base of a lamp where the heat of the arc has melted the stem press **14'**. The arc has caused the wires to melt at the ends and ball up as shown at **15'**, **16'**, the wires simultaneously withdrawing into sleeves **34, 38**. This lengthens and constricts the arc causing it finally to be extinguished.

By way of example, the maximum allowable starting pulse voltage for a 1,000 watt high intensity sodium lamp identified LU1000W is 5,000 volts. A suitable safety margin is 2,000 volts which requires that the lamp be capable of withstanding 7,000 volt starting pulses. This means that a 9 millimeter air gap must be maintained throughout the base and in the mogul base illustrated, the gap between inlead **16** and the edge of aperture **37** through retaining ring **19** is from 2 to 5 millimeters. Thus sleeve **34** about inlead **16** serves to eliminate that one place of potential breakdown.

The gap across base insulator **36** in a conventional mogul base is about one centimeter. However such insulators made of glass may occasionally be cracked and this reduces the breakdown voltage of the base by several thousand volts. In addition, should the connection to the eyelet or end contact of the base be soldered, the flux used may drastically reduce the breakdown voltage across the insulator. I have found that a clean base having an uncracked insulator breaks down at about 7,000 volts (RMS 60 Hz.) while a cracked, soldered base may have a breakdown voltage as low as 2,500 volts.

Accordingly in a preferred construction base insulator **36** which supports end contact **18** is a glazed crack-free ceramic and inlead **16** is attached to the end contact by spatterfree welding, suitably by TIG welding. The ceramic insulator may also act as a fire wall to contain any arc which may occur within the base and confine the damage within the base. By reason of its resistivity and dielectric strength even at elevated temperatures, the arc is confined within the base until the melting back of the inleads into the refractory sleeves has lengthened and constricted the arc to the point where it extinguishes.

In some lamps, the presence of insulating sleeves about the lead wires within the stem may increase the chance of sleeve or exhaust tube breakage. Such breakage may result from mishandling during manufacture, for example by twisting of the base relative to the lamp envelope. FIG. 3 illustrates a variant of my invention which reduces this hazard. As shown, long sleeve **34** is replaced by a shorter sleeve **34***a* which barely extends into the stem cavity. A kink **39** formed in inlead **16** prevents the sleeve from dropping down into the cavity. Sleeve **34**a is effective in increasing the breakdown voltage between the base because it effectively insulates the eyelet inlead from retaining ring **19** at the point of closest approach where it passes through the plane of aperture **37**. Electrical performance tests have shown that one sleeve should extend into the stem cavity because otherwise an arc once started in the stem cavity may continue long enough and produce enough heat to damage the lamp socket. Sleeve **38** which has not been shortened is effective in this regard and is essential in this variant. With this construction, slight twisting of the base relative to the envelope will merely bend longer inlead **16** and do no harm.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A jacketed high intensity arc lamp comprising:

a vitreous outer envelope having a neck and a pair of inleads sealed therein at the neck end through a press;

an inner arc tube containing a discharge medium and having electrodes sealed into its ends and requiring a starting voltage high enough to start a discharge between spaced conductors in air;

means supporting said arc tube within said outer envelope and including conductors connecting said electrodes to said inleads;

a base attached to the neck of said outer envelope and comprising a metal shell, and end insulator, and an end contact centrally mounted thereon;

one of said leads extending through said shell and being connected to said end contact and the other of said inleads being connected to said shell;

and a sleeve within said base, said sleeve being of refractory insulating material which retains its shape and does not become conductive at high temperatures up to 1,000°C, said one inlead being passed through said sleeve which serves to assure a minimum breakdown voltage therefrom to said shell and facilitates arc extinguishment by drawing the arc up into the sleeve as said one inlead shortens until the arc is lengthened and constricted into extinction.

2. A lamp as in claim **1** including another sleeve of said refractory insulating material within said base, said other inlead being passed therethrough.

3. A lamp as in claim **1** wherein said sleeve is made of quartz-like material.

4. A lamp as in claim **1** including an end insulator made of ceramic material capable of serving as a firewall.

5. A jacketed high intensity arc lamp comprising:

an evacuated vitreous outer envelope having a neck end closed by a re-entrant stem terminating in a press having a pair of inleads sealed therethrough side by side and extending through said stem;

an inner elongated arc tube containing metal vapor and having electrodes sealed into its ends;

said arc tube requiring a starting voltage high enough to start a discharge between spaced conductors in air;

means supporting said arc tube within said outer envelope and including conductors connecting said electrodes to said inleads;

a base attached to the neck end of said outer envelope and comprising a metal shell, and end insulator, and an end contact centrally mounted thereon;

one of said inleads extending through said shell and being connected to said end contact and the other of said inleads being connected to said shell;

and a sleeve within said base, said sleeve being of refractory insulating material which retains its shape and does not become conductive at high temperatures up to 1,000°C, said one inlead being passed through said sleeve to assure a minimum breakdown voltage therefrom to said shell and facilitate arc extinguishment by drawing the arc up into the sleeve as said one inlead shortens until the arc is lengthened and constricted into extinction.

6. A lamp as in claim **5** wherein said sleeve extends from the end insulator of the base through the stem substantially all the way to the press.

7. A lamp as in claim **5** wherein said sleeve extends from the end insulator of the base through the stem substantially all the way to the press and including within said base another sleeve of said refractory insulating material through which said other inlead is passed.

8. A lamp as in claim **5** including an end insulator made of ceramic material capable of serving as a firewall.

9. A lamp as in claim **5** wherein said sleeve extends from the end insulator of the base into the stem opening only, and including means for restraining said sleeve in such position, and including within said base another sleeve of said refractory insulating material through which said other inlead is passed and extending all the way into the stem.

10. A lamp as in claim **9** wherein said sleeve is restrained in such position by a kink in said one lead wire passing through it.

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