

[54] **HIGH INTENSITY LAMP CONTAINING THERMAL SHORTING FUSE**
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[52] U.S. Cl.**315/75, 313/25, 313/184**
[51] Int. Cl.**H01j 17/36**
[58] Field of Search.....**315/73, 74, 75, 119; 313/25, 184**

[56] **References Cited**
UNITED STATES PATENTS
466,400 1/1892 Edison et al.....315/75

2,950,417 8/1960 Breeding et al.315/75
3,222,556 12/1965 Gustin.....313/25
Primary Examiner—Palmer C. Demeo
Attorney—Ernest W. Legree and Henry P. Truesdell

[57] **ABSTRACT**
A high intensity lamp comprising an arc tube containing metal vapor such as sodium and mercury mounted within an evacuated outer jacket. A self-shorting arcing fuse is provided to forestall a destructive power arc should there occur a leak of air into the jacket or should the arc tube fail resulting in a low pressure of gas in the jacket. The fuse comprises a thermally deformable bimetal strip located to define the closest spatial approach between opposite current conductors within the jacket. A spot of brazing metal on the bimetal assists in welding the parts together at closure.

6 Claims, 3 Drawing Figures

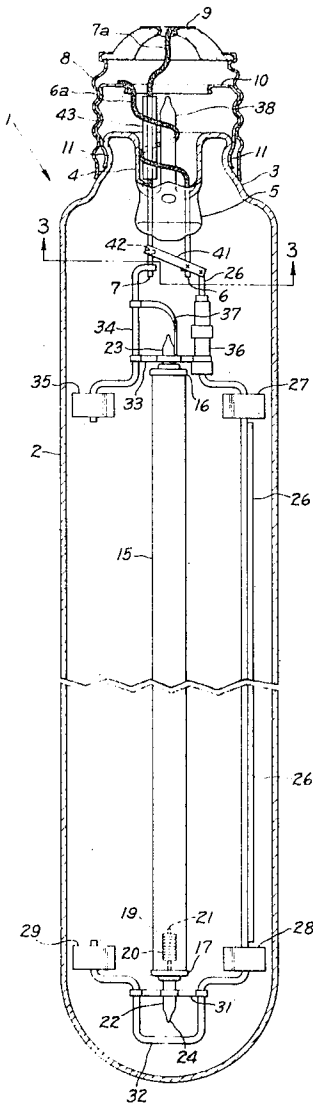


Fig. 1.

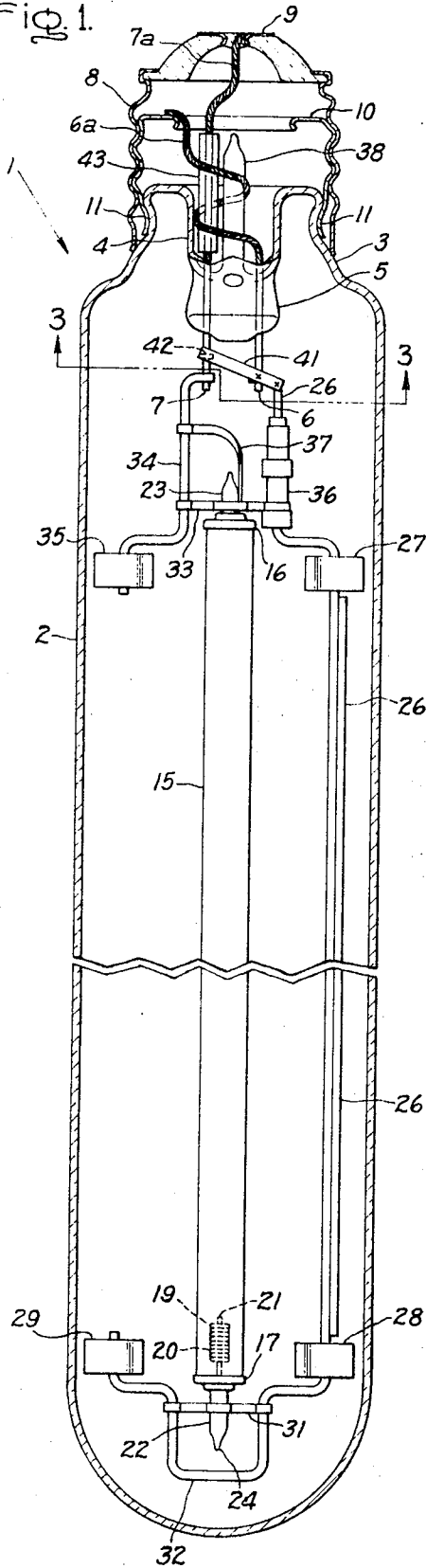


Fig. 2.

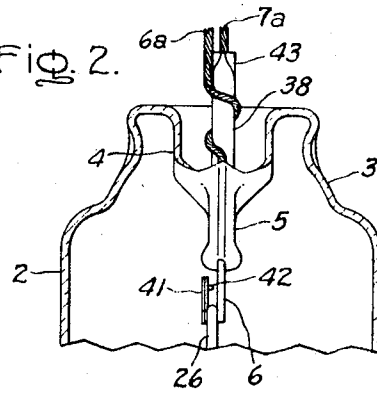
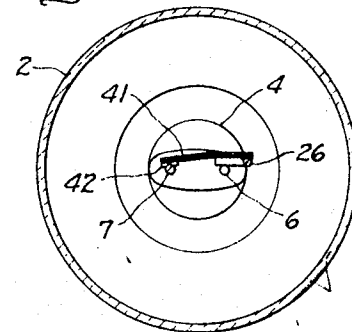


Fig. 3.



HIGH INTENSITY LAMP CONTAINING THERMAL SHORTING FUSE

BACKGROUND OF THE INVENTION

The invention relates to high intensity vapor arc lamps comprising an inner envelope mounted within a vacuum outer envelope and is particularly useful with high intensity 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 such as a high density polycrystalline alumina tube contains a filling comprising an amalgam of sodium and mercury and a rare gas to facilitate starting. Each end of the alumina tube is sealed by a refractory closure member, suitably a niobium end cap which serves as an electrical inlead and supports an electrode internally. The ceramic arc tube is supported within an outer vitreous envelope or jacket having at one end a screw base providing terminals to which the end caps of the arc tube 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 and the use of xenon as a starting gas. Also the metal end cap used for the arc tube closures does not lend itself conveniently to the incorporation 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. The pulsing circuit is disabled by the reduction in voltage at the lamp terminals from the open circuit value to the lamp running value, and the pulse is discontinued until the next time the lamp is started. When the lamp fails, the ballast continues to supply high voltage pulses until power is disconnected or the lamp is replaced. The lamp socket and the fixture wiring must have insulation capable of withstanding the high voltage pulses from the ballast over extended periods of time.

A serious problem encountered with high pressure sodium vapor lamps, particularly in the larger sizes such as lamps of 700 watts and 1,000 watts rating or higher, is the possibility of a destructive failure resulting from uncontrolled arcing and the attendant hazards. 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, two situations are described which may cause a destructive power arc to occur in the outer jacket notwithstanding the vacuum therein. The first situation is that wherein the vacuum outer jacket develops a slow air leak, for instance as a result of mishandling or heat shock. As the internal pressure rises from a high vacuum condition to 10–20 torr, the breakdown voltage across the stem leads within the jacket will drop to a few hundred volts. The ballast open circuit voltage (480 volts in a 1,000 watt lamp) 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 situation is that wherein the arc tube suddenly fails as when an end cap seal develops a leak. The release of sodium and mercury vapor and the arc

tube starting gas into the jacket may cause an arc to start between the metal parts about the stem. Even though the sodium and mercury vapor rapidly condense on the relatively cool jacket walls and their residual pressure in the much larger volume of the outer jacket would not support an arc, 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.

In said copending application of Collins et al., a self-shorting arcing fuse is provided within the jacket to extinguish any arc occurring and safely end the life of the lamp. The fuse structure 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 or short circuit the gap. In one fusing arrangement, a metallic loop portion of one conductor encircles a portion of the opposite conductor in close proximity, the loop is of nickel that will soften and flow without excessive oxidation, so that upon fusing together with the opposite conductor, a direct short is formed which extinguishes the arc.

SUMMARY OF THE INVENTION

While the self-shorting arcing fuse of said copending Collins et al. application will operate reliably to extinguish the arc and safely end the life of the lamp, it tends to be slow acting and requires several fabricated parts which must be carefully assembled. A simpler self-shorting arcing fuse which will close more rapidly and in a reliable and positive fashion to provide a low resistance short circuit is desirable.

In accordance with my invention, I provide an improved self-shorting arcing fuse which comprises a thermally deformable bimetal strip defining part of the arc gap. The arc gap is located at the closest spatial approach between opposite current conductors within the jacket. When a discharge starts, the bimetal is heated and starts to close even while the discharge is still in the glow stage and without waiting for the arc stage. Before the gap is completely closed, an arc discharge will occur which heats up the proximate metal surfaces. When the gap is closed, the hot metal fuses and the contacting parts remain attached. The permanent closing of the bimetal may be assisted by providing a spot of nickel coating in the area of contact which will serve to weld the parts together at the instant of closure.

DESCRIPTION OF DRAWINGS

In the drawings:

FIG. 1 is a front view of a high pressure sodium vapor lamp comprising a bimetal shorting fuse embodying the invention.

FIG. 2 is a fragmentary view of the neck end of the lamp turned 90° relative to the view of FIG. 1 and showing the fuse.

FIG. 3 is a sectional view through the lamp taken at plane 3–3 looking towards the base end in the direction indicated by the arrows, and showing the fuse arced over and welded closed.

DETAILED DESCRIPTION

Referring to the drawing and more particularly to FIG. 1, there is shown a high pressure sodium vapor lamp 1 comprising an outer tubular vitreous envelope or jacket 2. A central portion of the lamp has been cut

out to shorten the figure and facilitate illustration. The jacket is made of a high temperature glass such as borosilicate glass and is relatively thick-walled in order to withstand atmospheric pressure. The neck 3 of the jacket is closed by a re-entrant stem 4 terminated in a press 5 through which extend heavy inleads or current conductors 6, 7 which are connected respectively to the threaded shell 8 and insulated center contact 9 of a conventional screw base. The base is mechanically retained on the neck of the jacket by screwing shell 8 over threaded retaining ring 10 which has inwardly turned notches 11 which engage corresponding dimples in the glass of the neck.

The inner envelope or arc tube 15 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 attack the attack of sodium vapor at high temperatures. The tube is closed by thimble-like niobium metal end caps 16, 17 having skirt portions which fit around the ends of the tube. The end caps are 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.

Thermionic electrodes are mounted in the ends of the arc tube and supported from the end caps. Lower electrode 19 is shown in the drawing and comprises a tungsten wire coil or helix 20 wound around a tungsten shank or core 21 fastened in the end of a niobium tube 22 welded through the end cap. The electrodes are activated by metal oxides retained in the interstices between turns of the coil, a preferred material being dibarium calcium tungstate Ba_2CaW_6 , as described and claimed in copending application Ser. No. 97,907 filed Dec. 14, 1970 by William E. Smyser et al., entitled "Discharge Lamp Thermionic Cathode Containing Emission Material," and assigned to the same assignee as this invention. Lower niobium tube 22 has an opening into the ceramic arc tube which serves as an exhaust port during manufacture. The ionizable filling consisting of an inert gas, preferably xenon at a cold filling pressure of about 20 torr, and a sodium-mercury amalgam is introduced through exhaust tube 22 which is then hermetically pinched off by a cold weld indicated at 24. Upper niobium tube 23 has no opening into the arc tube and may be used to contain a small quantity of yttrium metal serving as a getter. In operation of the lamp, lower tube 22 is the coolest portion of the arc tube and serves as a reservoir for excess sodium-mercury amalgam. 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 longer exhaust tube 22 is located at the base end so that it is again lowermost in operation.

The arc tube is supported within the jacket by a mount comprising a side rod 26 made of two wires spot-welded together for greater stiffness, welded to inlead 6 close by the press and extending the length of the envelope. Leaf spring members 27 at the stem end and 28, 29 at the dome end bear against the tubular jacket to maintain rod 26 in place. Alumina ceramic has a substantial coefficient of expansion and the range of temperature traversed by the arc tube exceeds 1,000°C. To allow for expansion, only the lower exhaust tube 22 is completely restrained, being welded between straps 31 bridged across laterally extending

portion 32 of the side rod. The upper tube 23 extends freely through an encircling opening formed between straps 33 extending from side rod 26 to short support rod 34 which is welded to inlead 7 and braced by leaf spring 35. Ceramic sleeve 36 electrically insulates straps 33 from side rod 26. The electrical connection to end cap 16 of the arc tube is provided by flexible strap 37 welded thereto. The space within outer jacket 2 is evacuated to a high vacuum in order to reduce heat loss from the arc tube. Air is pumped out through exhaust tube 38 prior to tip-off and a suitable getter such as barium may then be flashed within the jacket to assure a high vacuum.

In accordance with my invention I provide a self-shortening arcing fuse within the jacket and close by the stem where the inleads 6, 7 emerge into the jacket or interenvelope space. As shown in FIGS. 1 and 2, a short length of bimetal strip 41 is fastened to inlead 6 close below press 5 in such fashion that it extends towards inlead 7. I prefer to attach the strip to side rod 26 by means of spot welds as indicated, rather than directly to inlead 6. This permits mounting the strip flat over the right angle bend in the side rod and at the same time its free end is spaced away from inlead 7 by the thickness of side rod 26. The resulting gap of about 0.1 inch at room temperature defines the closest spatial approach between opposite current conductors within the jacket for this example wherein bimetal strip 41 may be 0.010 inch thick, 0.125 inch wide and 0.75 inch long. The high expansion side of the bimetal strip may consist of an alloy of 25% Ni, 8.5% Cr and the balance Fe; the low expansion side, of an alloy of 50% Ni and the balance Fe; the two sides are equal in thickness.

In operation of the lamp, heat radiated by the arc tube and conducted by side rod 26 heats up bimetal strip 41 and causes it to bend and reduce the arc gap, but this initial deflection is insufficient to close the gap. However should an air leak occur or should a defective arc tube seal release metal vapor into the outer envelope, a glow, and ultimately an arc, develops in the gap and the bimetal is strongly heated. The bimetal flexes sharply and forcefully closes the gap whereupon its free end fuses or welds to inlead 7 and the lamp is permanently short circuited, as shown in FIG. 3. To assist in welding the fuse closed, a small piece or tab of brazing metal may be attached to the bimetal strip. As illustrated, a short piece of nickel wire 42 is welded at the end of bimetal strip 41 to lie transverse to inlead 7 as shown. Nickel piece 42 is softened by the arc and serves as brazing material to form a fillet which securely attaches strip 41 to inlead 7 in the event of closure, assuring that the fuse members will not break apart upon cooling. Other suitable brazing materials which may be used for tab 42 are copper, nickel-copper alloys, nickel-iron-chrome alloys, and stainless steel alloys.

A second self-shortening arcing fuse may be provided in the base of the lamp in order to extinguish any arc which might form therein. This outer arcing fuse may be similar to that described and claimed in U.S. Pat. No. 2,950,417 — Breeding et al., Series Electric Lamp, Aug. 1960, and is located within the stem tube of the jacket and enclosed within base shell 8 so that it is in outside air. Inleads 6, 7 have solid wire inner portions of nickel within the outer jacket, tungsten portions where they pass through the press 5, and external portions 6a, 7a of flexible stranded nickel-plated copper wire wrapped around a solid nickel core wire. Lead

wire portion 7a is passed through a slender thin-walled glass sleeve 43 extending through stem tube 4 alongside jacket exhaust tube 38 and its end is welded to end contact 9. Lead wire portion 6a is wrapped one or more turns around glass sleeve 43 and exhaust tube 38 together, and its end is welded to retaining ring 10 which is engaged by shell 8 of the base.

Should an arc develop in the base of the lamp, it will seek the closest approach of stranded lead-in wire portions 6a, 7a to each other. Glass sleeve 43 is made of high lead content glass which becomes relatively conductive when heated. Upon being touched by the arc, sleeve 43 will melt and permit a conductive juncture to be formed between wires 6a, 7a which will short circuit the arc.

The bimetal fuse construction described has been tested and found reliable but modifications thereof may of course be utilized and its location or orientation within the outer jacket may be changed for convenience.

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

1. A vacuum jacketed high intensity vapor arc lamp comprising:
 an evacuated vitreous outer envelope having a pair of inleads sealed therein;
 an inner elongated envelope containing ionizable vapor and having electrodes sealed into its ends; said inner envelope requiring a starting voltage high enough to start an arc discharge in said outer envelope should the vacuum therein be destroyed;
 means supporting said inner envelope within said outer envelope and including conductors connecting said electrodes to said inleads;
 and a short-circuiting arcing fuse in said outer envelope comprising a bimetal conductor connected to one inlead and defining a gap at its closest spatial approach to an opposite current conductor connected to the other inlead so that any arc forming in said outer envelope will occur at said gap; said

bimetal conductor being disposed to flex and close said gap upon being heated by a discharge.

2. A lamp as in claim 1 wherein a small piece of brazing metal is provided at the free end of said bimetal conductor for fusing to said opposite conductor upon engagement thereof at occurrence of arcing.

3. A lamp as in claim 1, wherein said inleads are a pair of stiff wires sealed into said outer envelope through

a press;

said bimetal conductor is attached to one of said inleads close to said press;

and the free end of said bimetal conductor is spaced close to said other inlead at the operating temperature of said lamp to define said gap and flexes to engage said other inlead when heated by an arc occurring in said gap.

4. A lamp as in claim 1 wherein said inleads are stiff wires sealed into said outer envelope through a press; said bimetal conductor is attached to one of said inleads close to the press;

the free end of said bimetal conductor is spaced close to said other inlead at the operating temperature of said lamp to define said gap, and flexes to engage said other inlead when heated by a discharge occurring about said gap;

and a small piece of brazing metal is provided at the free end of said bimetal conductor for fusing to said other inlead upon engagement thereof by said bimetal at occurrence of arcing in said gap.

5. A lamp as in claim 4 wherein said brazing metal is selected from the group consisting of nickel, copper, nickel-copper alloys, nickel-iron-chrome alloys and stainless steel alloys.

6. A lamp as in claim 4 wherein said brazing metal is a short length of nickel wire welded on said bimetal conductor and lying thereon in an orientation to engage said other inlead transversely.

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