United States Patent

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[54] **METHOD OF SEALING OFF REFRACTORY METAL TUBULATION BY TUBE-IN-CIRCUIT ELECTRIC HEATING**
2 Claims, 5 Drawing Figs.

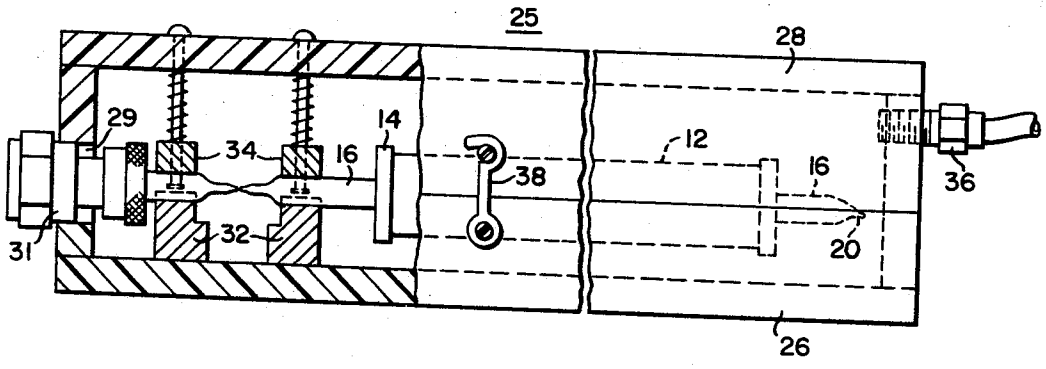
[52] **U.S. Cl.** **219/68,** 219/74
[51] **Int. Cl.** **B23k 11/22**
[50] **Field of Search** 219/68, 70, 234, 91, 117, 74

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ABSTRACT: A method of sealing off the refractory metal exhaust tubulation of a ceramic arc tube containing a rare gas at less than atmospheric pressure. The method primarily comprises, pinching or flattening a portion of the exhaust tubulation, disposing the arc tube and tubulation within an inert atmosphere at a pressure greater than that of the rare gas within the arc tube and passing a predetermined amount of electrical energy through the tubulation causing it to separate and form a vacuumtight seal at the separated edges.



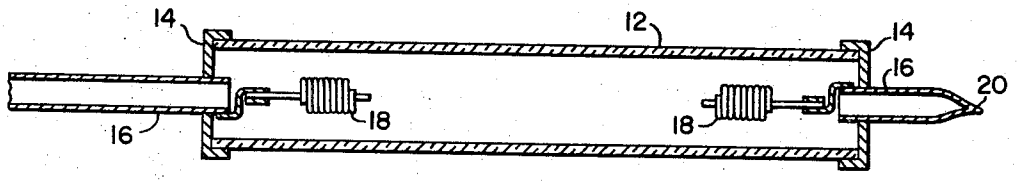


FIG. 1.

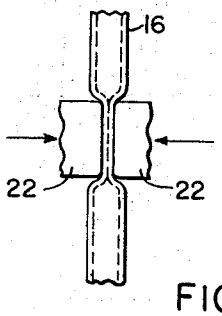


FIG. 2.

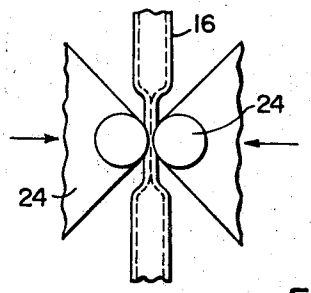


FIG. 3.

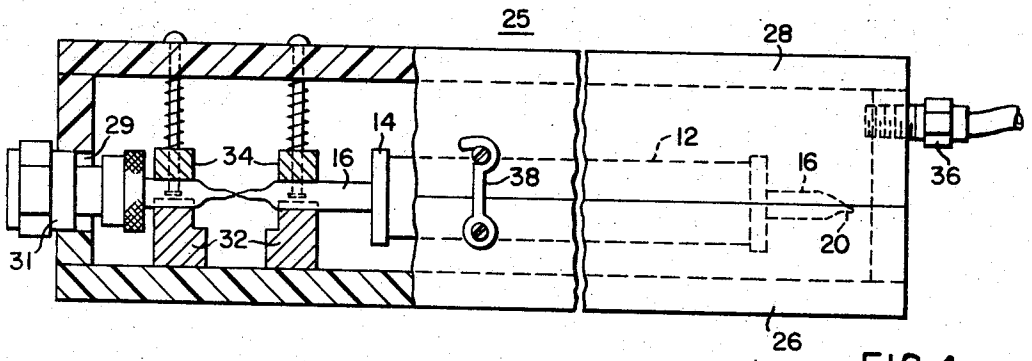


FIG. 4.

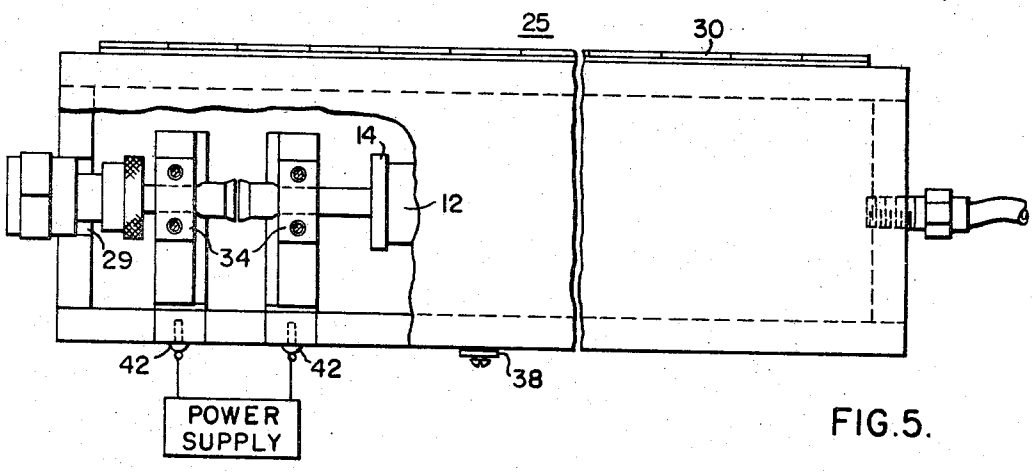


FIG. 5.

METHOD OF SEALING OFF REFRACTORY METAL TUBULATION BY TUBE-IN-CIRCUIT ELECTRIC HEATING

BACKGROUND OF THE INVENTION

The ceramic-bodied arc-discharge lamp represents a new and promising light source for the lamp industry. With the advent of this new light source, a number of material and process problems new to the lamp industry have arisen. The ceramic-bodied arc lamp generally consists of a ceramic body or envelope, tubular in cross section, closed off at each end by a refractory metal or ceramic end disc or cap. These end discs or caps generally carry the opposed discharge sustaining electrodes. After the end discs or caps are sealed to the ceramic envelope the envelope must be exhausted and filled with a discharge sustaining filling of, for example, an element or combination of elements such as mercury, argon and sodium to name only a few of the possible discharge sustaining constituents. In order to accomplish this exhausting and filling process at least one of the end caps or discs generally carries a short length of refractory metal tubulation which extends therethrough to provide necessary access to the interior of the sealed lamp body. After the envelope is exhausted and filled, the refractory metal tubulation must then be sealed off, vacuumtight and the seal must be able to maintain its integrity during extensive operation of the lamp and at the temperatures encountered, in some instances the excess of 1000° C, as well as under internal pressures of from 3 to 10 atmospheres.

Many techniques have been employed in an effort to provide a satisfactory seal in the exhaust tubulation. Some methods such as for example resistance welding or simple cold weld pinch-offs have not proven to entirely reliable under the conditions enumerated above. Others, for example, a tungsten inert gas welding process has been found to be somewhat successful but does not particularly lend itself to production methods.

SUMMARY OF THE INVENTION

This invention relates to the sealing off of refractory metal tubulation and more particularly to a method for providing a high integrity seal in the tubulation of a ceramic arc lamp.

It is an object of the present invention to provide a vacuumtight seal at the end of the exhaust tubulation of the ceramic arc lamp.

Another object of the present invention is to provide a method for producing vacuumtight seals in the refractory metal exhaust tubulation of ceramic arc lamps which will maintain their integrity when subject to both high temperatures and high pressure.

A further object of the present invention is the provision of a method for sealing off refractory metal tubing which is both simple and readily adaptable to mass production methods.

The foregoing objects are accomplished in accordance with the present invention by first pinching or flattening a portion of the exhaust tubulation, mounting the exhaust tubulation between a pair of electrical contacts and passing a predetermined amount of electrical energy through the tubulation to cause the tubulation to separated in the flattened area at approximately the midpoint between the two electrical contacts and form a vacuumtight seal at the separated edges.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing objects, and others, along with many of the attendant advantages of the present invention will become more readily apparent and better understood as the following detailed description is considered in connection with the accompanying drawing in which:

FIG. 1 is a sectional view of a ceramic-type arc tube illustrating at the right end thereof a tip off performed in accordance with the present invention;

FIG. 2 is a schematic view illustrating the first flattening step in the process of sealing off refractory metal tubulation in accordance with the present invention;

FIG. 3 is a schematic view illustrating the second flattening step of the process for sealing off refractory metal tubulation;

FIG. 4 is a side elevation view of a container and mechanism for accomplishing the final separating step; and

FIG. 5 is a top plan view of the mechanism of FIG. 4 with a portion of the top cover thereof broken away.

DESCRIPTION OF THE PREFERRED EMBODIMENT

It should be understood at the outset that the method of the present invention may be employed in any instance where it is desirable to separate and seal at least one end of a length of metal tubing. For purposes of description the sealing method of the present invention will be described with respect to the sealing off of the refractory metal exhaust and the fill tubulation of a ceramic arc tube of the type illustrated in FIG. 1.

The conventional ceramic arc tube illustrated in FIG. 1 generally includes a tubular ceramic body member **12** usually constructed of high density polycrystalline alumina. The arc tube body **12** is closed off at each end by a refractory metal end cap or disc **14**. The refractory metal exhaust and fill tubulation **16** preferably of niobium or tantalum extends through and is sealed to apertures located substantially centrally in the end closure members **14**. A pair of opposed, discharge sustaining, coiled tungsten electrodes **18** are supported on the inwardly directed ends of the refractory metal tubulation **16**. As shown at the left-hand end of the FIG. 1 discharge device the refractory metal tubulation **16** initially provides for communication with the interior of the lamp body in order that the body or envelope **12** may be exhausted and filled with the necessary discharge sustaining elements such as for example argon, mercury and sodium to name only a few of the possible constituents. Of course in a conventional lamp the exhaust and fill tubulation will generally only be employed at one end of the lamp but for purposes of illustration refractory metal tubulation has been illustrated at each end of the lamp of FIG. 1.

After the exhausting and filling of the interior of the lamp body through the exhaust tubulation **16** the exhaust tubulation must be permanently and effectively sealed off. This is accomplished by a pinch off seal as illustrated on the right-hand end of FIG. 1 at **20**. The seal at **20** must be capable of withstanding high temperatures at relatively high internal pressures and in addition must be resistant to attack from alkali metal vapors and/or other metal vapors making up the lamp discharge. The method of the present invention provides this kind of seal.

In sealing off the exhaust tubulation in accordance with the present invention it has been found preferably that the tubulation first be flattened as illustrated in FIG. 2 with a pair of flattening jaws **22**. This pressing by means of flattening jaws **22** may be accomplished using a great variety of pressures. For good secure seals with a minimum difficulty in handling it has been found that conventionally employed ⅛-inch O.D. tantalum tubing having a wall thickness of 15 mils. can be successfully flat pressed by the application of a force of 1500 p.s.i. which will just close the tubing. This pressing step should be followed by a second press employing curved jaws **24** as illustrated in FIG. 3. This second press also may be made at a setting of about 1500 p.s.i. The second squeezing by jaws **24** can also vary considerably depending on the condition of the tubing and it has been found desirable to make the second press to a desired thickness. For example, stopping at a 14 mil. jaw separation when the 15 mil. wall thickness tubing is employed provides a consistent set of power and melting conditions and hence uniform seals.

The sealing of the tubulation can be accomplished with a single flat press, for example by employing only the jaws **22** of FIG. 2 or alternatively the sealing can be accomplished without pressing at all within the concept of this invention. When electrical contact is made by means of contact blocks of a size sufficient to serve effectively as a heat sink then the

maximum heating occurs at a point midway therebetween. If the inside of the tubulation is at reduced pressure as is the case with the lamp of FIG. 1, which is normally filled with from 20 to 30 mm. of rare gas, and the external environment is a rare gas at atmospheric pressure passing sufficient current through the tubing will cause melting at the midpoint and the molten section will collapse and be pushed into the unmelted section adjacent thereto and solidify there making a very solid seal. Seals have been accomplished without pressing using ⅛-inch O.D. tantalum tubing with 15 mil. wall thickness.

Referring now to FIGS. 4 and 5 there is illustrated a fixture generally designated 25 which is suitable for accomplishing the final step in the tipping off method. The fixture 25 generally consists of a bottom portion 26 and a top portion 28 hinged together at 30 to form a closed box. At one end of the closed box 25 is an opening 29 to accommodate the valved coupling 31 which will extend into one end of the box when the lamp and exhaust tubulation are placed therein. A pair of copper electrical contact support blocks 32 are mounted in the bottom of the box 26 to serve both as part of a holding clamp and as heat sinks as well as to conduct the current to the tabulation. A pair of spring loaded copper contacts 34 are mounted to the top portion 28 of the box and serve to clamp the tubulation against the support blocks 32. At the end of the box opposite the opening 29 is an entrance conduit 36 employed to fill the box with an inert atmosphere. The top and bottom portions 28 and 26 may be secured together in a substantially airtight relationship by means of a latch member 38. A power supply 40, later to be described, is electrically connected to the copper electrical contact blocks 32 at terminals 42 on the sides of the box.

The tantalum tubulation 16 and the arc tube 12 are secured through a valved coupling 31 to the exhaust and fill mechanism not shown. The arc tube is exhausted and filled with a discharge sustaining filling and the valved coupling closed and removed from the exhaust and fill system. The tubulation appearing as illustrated on the left-hand side of the FIG. 1 embodiment is then flat pressed as illustrated in FIG. 2 with a pressure of approximately 1500 p.s.i. The tantalum tubulation is then further pressed as illustrated in FIG. 3 by the curved jaws to provide a local high resistance section.

The lamp and exhaust tubulation are then situated in the box 25 which may be constructed from "Transite," "Lucite" or some other insulating material, with the valved coupling 31 extending through the end thereof as illustrated on the left-hand side of FIGS. 4 and 5. The exhaust tubulation 16 is held between the blocks 32 and 34 with the blocks 34 being spring urged against the upper side of the tubulation. The pinch is located a substantially equal distance from each of the pairs of contact blocks. With the tubulation in the position illustrated in FIGS. 4 and 5 the box 25 is latched shut by means of the latch member 38 and the box filled with an inert atmosphere, as for example argon, through conduit 36. With an inert atmosphere within the box at a pressure in excess of that within the arc tube the power supply is activated to pass a current of about 200 amps through the exhaust tubulation. The power is supplied from a 110 volt line through a variac to a 10:1 step down transformer, the output of which is directly connected to the tantalum tubulation on either side of the flat press through terminals 42. The electrical contact with the tubulation is of course made by the copper blocks which also serve as heat sinks. The voltage, about 8 volts, is applied by closing the switch in the primary and cuts off when the pieces separate about a second later.

As indicated previously the sealing of the tubulation can be accomplished with only the single flat press thus eliminating the curved jaw press. Alternatively, the sealing can be accomplished without pressing at all. When there is no preliminary pressing the inside of the tubulation and the lamp must be filled at a pressure substantially less than the pressure of the atmosphere surrounding the exterior of the tubulation. For example with a lamp fill of 20 to 30 mm. of rare gas and an external environment of a rare gas at atmospheric pressure, passing sufficient current through the tubing will cause melting at the midpoint since the contact blocks serve effectively as heat sinks and maximum heating occurs at a midpoint therebetween. When this maximum heating at the midpoint occurs, the molten section will collapse and be pushed into the unmelted sections adjacent thereto and solidify there making a very solid seal. The difference in internal and external pressures on the tubulation causes the molten section to be pushed into the unmelted adjacent section. As indicated previously this type of seal has been accomplished using ⅛-inch O.D. tantalum tubing with a 15 mil. wall thickness.

As will be apparent from the foregoing, refractory metal tubing, whether connected to an arc tube body or not, can be effectively sealed off in accordance with the present invention by first flattening an area of the tubulation, second, providing a second press which reduces the thickness of the press to approximately the wall thickness of the tubulation and, third, by passing sufficient electric current through the tubulation to cause rapid heating at the local high resistance section established by the press to provide a vacuum tight joint at the separated ends.

The method of the present invention is particularly adapted for high speed production lines so that the tubulation can be stepped from one press to the next to a pair of electrical contacts within a chamber and rapid separation and sealing accomplished as the tubulation, and if applicable the associated arc tube, are stepped along a production mechanism.

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

I claim:

1. A method for sealing off the refractory metal exhaust tubulation of a ceramic arc tube containing a rare gas at less than atmospheric pressure comprising the steps of:

flattening a preselected portion of said tubulation;

pinching said flattened preselected portion near its midpoint to about one-half its original thickness;

confining said arc tube and tubulation within an inert atmosphere at a pressure in excess of the pressure of said rare gas within said tubulation and said arc tube;

contacting said tubulation with a pair of electrical contacts at spaced locations approximately equidistant on each side of said pinch; and

passing a predetermined electrical current between said contacts through said tubulation to thereby cause said tubulation to separate at approximately said pinch to form a seal at the separated ends.

2. The method of sealing off the refractory metal exhaust tubulation of a ceramic arc tube according to claim 1 wherein the inert atmosphere in which said tubulation is confined is argon.