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Loughridge

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[54] **PRESS SEAL FOR LAMP HAVING FUSED SILICA ENVELOPE**

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[52] **U.S. Cl.** **313/318,** 313/317

[51] **Int. Cl.** **H01j 5/46,** H01j 5/50

[58] **Field of Search** 313/317, 318

[56] **References Cited**

UNITED STATES PATENTS

3,132,279	5/1964	Lewin	313/318 X
3,436,109	4/1969	Loose	313/317 X
2,517,019	8/1950	Nordberg	313/318 X

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[57] **ABSTRACT**

Lead-in wires of lamps are sealed in a vitreous silica envelope through the use of a graded seal in which two abutting segments of refractory metal wires are disposed in a tube or tubes of a cermet formed of an admixture of powder refractory metal and vitreous silica. The lead-in wires and cermet tubes are disposed in a specially formed press seal of a vitreous silica envelope.

5 Claims, 2 Drawing Figures

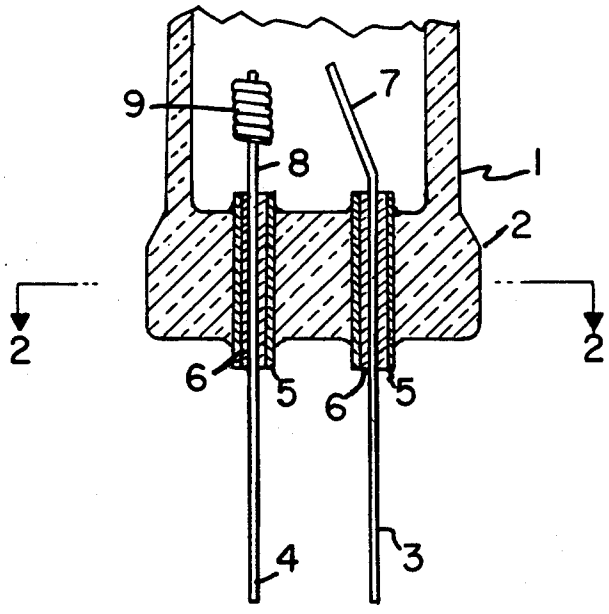
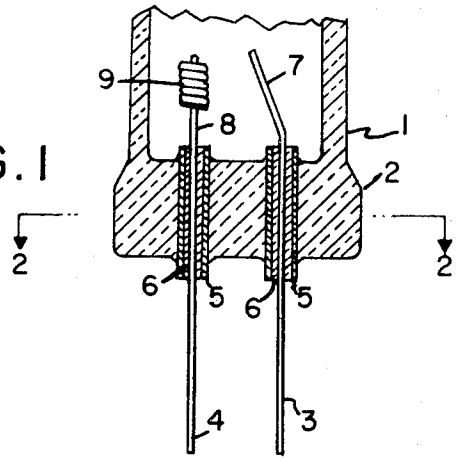


FIG. 1



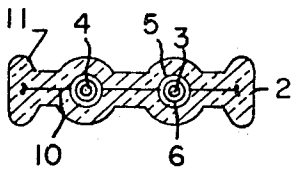


FIG. 2

PRESS SEAL FOR LAMP HAVING FUSED SILICA ENVELOPE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to electric lamps utilizing an envelope of vitreous silica, containing an electric energy translating means and which are adapted to operate at high temperatures and/or pressures.

2. Description Of The Prior Art

In making a hermetic seal between a lead-in wire or conductor and a vitreous envelope in the prior art, it has been necessary either that the conductor have the same coefficient of expansion as the glass into which it is sealed, or that very thin foil sections of metal be used to compensate for the unequal coefficients of expansion. The use of materials having similar rates of expansion is generally followed in the manufacture of incandescent and low pressure discharge lamps. Both of these types of lamps operate at relatively low temperatures. However, where the lamp operates at very high temperatures and particularly where the lamp envelope is made of vitreous quartz, fused silica or quartz-like high temperature glasses, the use of such techniques is inapplicable. The reason for the inapplicability is that the very high fusing temperature of quartz restricts the choice of metals for the lead-in wires to only a few, such as tungsten, tantalum and molybdenum. Only these metals can withstand the high temperatures. However, the coefficient of thermal expansion of either of these two metals is very much greater than that of quartz, as much as ten times greater. Accordingly, recourse has generally been to the second technique involving the use of the foil or ribbon seals.

In a quartz envelope, a hermetic seal can be formed with either tungsten, tantalum, or molybdenum or ribbons, provided that the metal is sufficiently thin. Molybdenum is generally used because of its ductility and the fact that it is readily available. Owing to the much greater coefficient of expansion of molybdenum as compared with that of quartz, stresses will be set up in the seal at different temperatures. Provided the metal is very thin and properly bonded to the quartz, such stresses may be reduced to the point where they will not produce any cracks. In other words, the metal having become bonded to the quartz at a relatively high temperature will merely go into tension when the quartz cools but will not rupture nor crack the seal.

Such molybdenum ribbon seals have generally been produced by welding thin strips of foil or ribbon to suitable lengths of wire. The molydenum foil is cut into strips a few millimeters wide and of the proper length required for the seal, and thicker molybdenum wires are welded to each end of a strip to form the current connection. The ribbon or foil is preferably etched in an electrolytic bath which cleans the surface thoroughly and roughens it slightly. The bath also dissolves away some of the metal so that feather edges which are produced assist in preventing leakage around the seal.

Lamps with this type of connection and seal are expensive to fabricate because of the several welding steps which are required. Moreover, each weld introduces the additional possibility of embrittlement of the foil and the subsequent failure of the lamp.

A different approach to the same problem is disclosed in U.S. Pat. No. 2,667,595. Therein, the lead wires are made of a highly refractory metal such as molybdenum, tungsten or tantalum and consist of a single piece of wire whereof an intermediate portion is foliated by longitudinal elongation so as to provide a gradual change in the shape of the cross section. Such a lead wire may be made, for instance, by rolling a piece of molybdenum wire longitudinally between a pair of hardened cylindrical rollers. Although seals using this technique perform satisfactorily, rolling very short lengths of refractory metal wire is rather difficult. Moreover, while uniformity in thickness of the foliated portion is important, it tends to be rather difficult to obtain on a mass production basis.

SUMMARY OF THE INVENTION

According to the present invention, two refractory metal wires are abutted against each other, end to end, so that a good electrical connection is made. Preferably, the two wires are butt-welded to insure the connection. A tube or a multiplicity of tubes of cermet which have a coefficient of expansion between that of the wire and that of the quartz are disposed around the wire. As used herein, cermet means a fusible mixture of powdered refractory metal, such as tungsten, and a high temperature silica glass, such as vitreous quartz or fused silica. The cermet tubes can be heated to fusion, sealed to the wire and then pressed into a quartz seal or alternatively, the wire, cermet tubes and quartz envelope tubing can be pressed and sealed simultaneously. Alternatively, a single refractory metal wire can be used and the cermet tube slipped over it.

In making a lamp, the above-described seal can be made as a subassembly and then sealed to vitreous quartz envelope tubes or, alternatively, the entire assembly of the envelope, the intermediate tubes of cermet and the wires can be mounted and pressed together.

We have found that it is important to prevent the vitreous quartz envelope tubing from touching the wire directly. Thus, the cermet tubes which surround the wires should be sufficiently long so as to separate the wires from the quartz envelope tubing along the entire length of the press-seal. Preferably, recesses are made in the jaws of the press-sealing equipment in the area of the wires to compensate for the additional elements which are contained therein. In this way, the quartz envelope tubing will flow around and fuse to the cermet tubes without contacting the wires.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of a portion of a lamp, particularly showing the seal area and the location of the lead-in wires.

FIG. 2 is a cross-sectional view, taken along the line 2—2 of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

According to the present invention, the lamp includes a quartz envelope 1 which has a press-seal area 2. The seal 2 is formed by heating quartz envelope tubing to its fusion point and then the walls of the tubing are collapsed inwardly and flattened down at the leads. To collapse the walls, preferably a pair of opposing jaws can be closed upon the softened quartz to seal the end of the tubing.

As shown in the drawing, the length of the seal area 2 can be much shorter than conventional seals using

molybdenum ribbons. In such conventional seals, the quartz must extend beyond both ends of the molybdenum ribbon. With the present construction, substantial savings in quartz can be realized and the possibility of failure in the seal area is reduced.

Lead-in wires 3 and 4 are made of refractory metal such as tungsten, molybdenum and tantalum, and are disposed within seal 2. In this example, these wires form a starting probe 7 and an electrode 8, respectively. The particular form of electrical translating means utilized in conjunction with the seal and lead-in wires is not important and may be, for example, a filament for an incandescent lamp.

Disposed about each lead-in wire are two concentric tubes 5 and 6 formed of cermets which have coefficients of expansion intermediate that of the quartz which forms seal 2 and the refractory metal of the wires. In some instances, for example where the lead-in wires are very thin, it may be possible to use only one cermet tube between the wire and press seal 2. In cases where wire 3 is relatively thick, say, in the order of 0.030 to 0.090 inches, more than one cermet tube of intermediate coefficients of expansion should be used.

A lead-in wire can be formed of one segment of wire which extends from the outside of press-seal 2 to the inside or it can be formed of two segments of wire. In the latter case, thpe two segments are placed in electrical conducting relationship with each other and then butt-welded. A current is passed through the two segments and they are joined together. When two segments are used, the inner portion, that is, the part which extends into envelope 1, can be tungsten while the outer portion can be molybdenum. Both of these metals readily withstand the high temperatures to which the lamp will be subjected.

It is important that the quartz which forms press seal 2 does not touch the refractory metal wire at any point. If touching does occur, the quartz may scale and crack, thereby ruining the lamp. To avoid this possibility, the cermet tubes are longer than press seal 2 and completely prevent contact.

When the seal is used in an arc tube, electrode 7 and starting probe 8 are formed of wires of tungsten. One end serves as the external terminal and the other end supports the active portion of the electrode within envelope 1. When the lead-in wires serve as electrodes (as distinguished from supports for incandescent filaments), it is conventional to mount a small sliver of thorium underneath helix 9. Envelope 1 may be filled with a starting gas such as argon and a predetermined quantity of mercury. Wires 3 and 4 may be sealed into envelope 1 by locating them inside a length of cylindrical quartz tubing. The end of the quartz envelope tubing is heated to fusion while the wires and cermet tubes are bathed in an inert gas atmosphere and thereafter the tubing is collapsed by mechanical means so as to lock the wire and cermet tubes between the two layers of press seal 2.

As shown in FIG. 2, it will be noticed that an interface 10 denotes a line of fusion between opposite sides of press seal 2. While the seal 2 is preferentially made by collapsing the quartz envelope tubing upon the wires and cermet tubes through mechanical means, there are other ways of making such seals. For instance, the seal may be made in stages, the first of which consists of a vacuum collapse of a short length of quartz tubing about each of the lead-in wires and cermet tubes 5 and 6. In the next stage this short length may be fused to a suitable length of a longer size of quartz tubing which will serve as the main body or envelope of the lamp.

As illustrates in FIG. 2, press-seal 2 is enlarged around the lead-in wires and cermet tubes. Such enlargement is provided by forming grooves in the jaws of the press-sealing equipment which will be coincident with the alignment of the lead-in wires. In this way, the softened quartz will flow around tubes 5 and 6 but will not force the softened quartz into contact with wires 3 and 4. Conventional flanges 11 are formed on the edges of press-seal 2 to dissipate heat and add ruggedness to the structure.

Important considerations in making the seal include suitable control of the wire diameter and the composition of the cermet tubes which surround the wire. As mentioned previously, the tubes must have a coefficient of expansion which is intermediate that of quartz (4×10^{-7}/°C) and the wire (tungsten 44×10^{-7}/°C) or molybdenum 50×10^{-7}/°C). When a thin wire is used, in the order of 0.012 inch diameter, it may be possible to dispose but a single cermet tube between the wire and the quartz, the cermet having a coefficient of expansion in the order of about 15 to 20×10^{-7}in./in./°C. In one such example, the cermet tube was made of a mixture of 75 percent powdered quartz and 25 percent tungsten powder having an A.S.T.M. Fisher number particle size of 0.75 ± 0.15. The mixture was heated, pressed and fused into the desired tubular shape. When thicker wires are used, for example 0.030 to 0.090 inch, two, three or even more cermet tubes should be used. The coefficient of expansion of the first tube, that is the one which immediately surrounds the wire, should be between about 30 and 36. The second tube is slipped over the first and should have a coefficient of expansion between about 15×10^{-7} to 20×10^{-7}/°C. Additional tubes having a coefficient of expansion lower than that which is immediately beneath, but greater than the coefficient of expansion of the quartz can be used, if desired. The tubes can be formed of sintered mixtures of powdered quartz and powdered refractory metal. As the quartz content is increased, the coefficient of expansion will more clearly approximate that of the quartz.

As mentioned above, several approaches may be used in the fabrication of the seals. For example, it may be desirable to slip the cermet tube or tubes over the wire and then fire them in an inert atmosphere or vacuum, to fuse the cermet and the wire together. This subassembly would then be disposed in a press-seal machine and quartz envelope tubing slipped over it. The end is then heated (while the wire is bathed in an inert or reducing gas) to soften the quartz tubing and the cermet tubes, and the jaws of the press-sealing equipment are closed to form the press-seal.

It is important to prevent the cermet tubes from collapsing during the sealing operation because such collapse could increase the strain at the interface between the various components. Grading of the seal reduces the strains to tolerable limits but if, for example, the quartz envelope tubing were to touch the wire, the differences in coefficients of expansion at that point could be sufficient to produce rupturing.

I claim:

1. A lamp comprising: a vitreous silica envelope; a vitreous silica press-seal at one end of said envelope; a refractory metal outer lead-in wire disposed outside

said envelope and extending into said press-seal; a refractory metal inner lead-in wire disposed inside said envelope and extending into said press-seal, said inner and said outer wires being in electrical conducting relationship with each other; at least one cermet tube surrouning said lead-in wires and sealed thereto, said cermet comprising a fused mixture of powdered refractory metal and vitreous silica and having a coefficient of expansion intermediate the coefficient of expansion of said lead-in wires and said vitreous silica and said tube being longer in length than said press-seal, whereby the silica of the press-seal is prevented from touching said lead-in wires said powdered refractory metal in said cermet being the same metal as that of said lead-in wires.

2. The lamp according to claim **1** wherein at least two concentric cermet tubes are disposed around said lead-in wires, the innermost tube having a coefficient of expansion closest to that of said lead-in wires and being sealed to said lead-in wires and the outermost tube being sealed to said press-seal and having a coefficient of expansion closest to that of the vitreous silica thereof.

3. The lamp according to claim **1** wherein said cermet tube is formed of a sintered admixture of powdered refractory metal and powdered quartz.

4. The lamp according to claim **1** wherein the silica has a coefficient of expansio of about 4×10^{-7} in/in/°C and the lead-in wire is tungsten having a coefficient of expansion of about 44×10^{-7} in/in/°C and the cermet tube has a coefficient of expansion greater than the silica but less than the tungsten.

5. The lamp according to claim **3** wherein said powdered refractory metal is tungsten.

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