Feb. 16, 1965 F. ROKOSZ 3,170,081

DISCHARGE LAMP ELECTRODE

Filed June 5, 1962

FIG. 1.

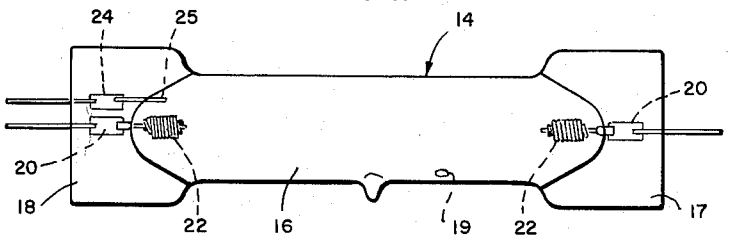


FIG. 3.

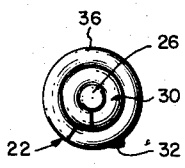


FIG. 2.

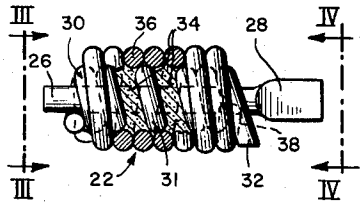


FIG. 4.

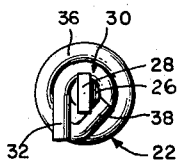


FIG. 5.

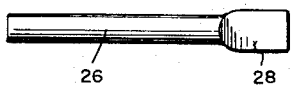


FIG. 6.

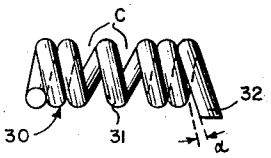


FIG. 7.

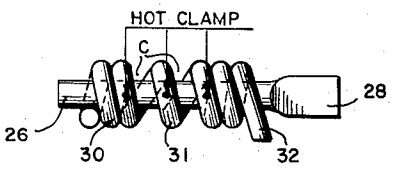


FIG. 8.

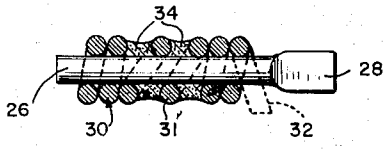


FIG. 9.

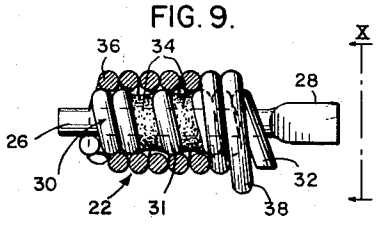


FIG. 10.

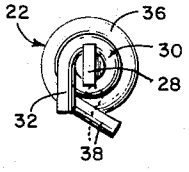
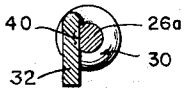


FIG. 12.



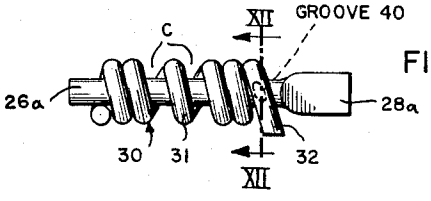


FIG. 11.

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DISCHARGE LAMP ELECTRODE

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9 Claims. (Cl. 313—213)

This invention relates to electric discharge devices and, more specifically, to an improved thermionic electrode for a mercury discharge lamp and to a method for assembling such electrodes.

Comparative tests have shown that both the life and lumen maintenance of high-pressure mercury vapor (HPMV) lamps can be increased by using so called "oxide-coated" electrodes in lieu of conventional type electrodes that contain thorium. The improvement in lamp performance obtained with such oxide-coated electrodes is due, primarily, to the fact that the reservoir of alkaline-earth metal oxides used as the electron-emissive material is completely shielded from the arc stream and ion bombardment. This is accomplished by depositing the emissive material in an open medial portion of a refractory wire coil that has closed end sections and is mounted on a supporting member such as a tungsten rod. A tightly wound outer coil of refractory metal is then placed over the inner coil and positioned so as to protect the emission material from the discharge thus minimizing sputtering and the resultant progressive blackening of the bulb walls.

The present invention is directed to the problem of manfacturing such oxide-coated electrodes and to improvements in their construction that will permit them to be assembled quickly and with a minimum amount of shrinkage.

One satisfactory method of assemblying such electrodes without distorting and changing the emission-carrying capacity of the inner coil is to rotate a slightly oversize support rod and simultaneously insert it into the inner coil while the latter is held stationary. The temporary expansion of the inner coil effected by the rotating rod facilitates the insertion of the latter and locks the inner coil in place by means of the resulting force fit. The pitch and inner diameter of the outer coil are also made such that the outer coil is adapted to be forcibly threaded over and locked with the inner coil. This construction and manner of assembly is disclosed and claimed in copending U.S. application, Serial No. 861,339 of George A. Freeman, filed December 22, 1959, entitled "Electrode Component and Process and Apparatus for Assembling Electrodes," and assigned to the assignee of the present invention.

While the aforementioned simultaneous "rotation and insertion" method of assembling the rod and inner coil is a distinct improvement over the method used previously wherein the parts were simply force-fitted together by brute force, it requires the use of special tolerance wire and the utmost care in winding the coils and making the rods in order to control the critical dimensions and obtain the proper force-fitting of the components. The resulting tight manufacturing tolerances and criticality as regards the dimensions of the coils and rod complicated their fabrication and assembly. The finished electrode thus consisted of a plurality of precision made and force-fitted parts and was, accordingly, rather expensive.

With the foregoing in mind, it is the general object of the present invention to provide an improved thermionic electrode of the aforementioned oxide-coated type that contains a protected reservoir of emission material and avoids the problems associated with the prior art methods of manufacture.

Another and more specific object is the provision of a composite oxide-coated electrode that does not require any force-fitting parts and eliminates the critical tolerances and dimensions this mode of assembly entails.

The aforesaid objects, and other advantages which will become apparent as the description proceeds, are achieved by dimensioning the coils and rod so that they fit freely one inside the other and then bending or otherwise processing only preseletced portions of the coils during the assembly operation to lock them together in the desired position on the rod. Specifically, the inner coil is attached to the loose fitting support rod by hot clamping or welding one or several of the coil turns to the rod. Alternatively, a preformed depression is provided in a preselected portion of the rod and a turn of the inner coil is bent into the depression so as to mechanically lock the members together in assembled relation. The loose fitting outer coil is held in place on the inner coil by seating it against a protruding leg provided on the inner coil and then bending a portion of the abutting end turn of the outer coil into interlocking engagement with the proximate end face of the inner coil. The components are, accordingly, very readily and securely locked together to form the desired unitary electrode structure without the tight dimensional tolerances or the costly and tedious force-fitting of the parts required heretofore.

A better understanding of the invention will be obtained from the accompanying drawing, wherein:

FIGURE 1 is a side elevational view of an arc tube for a HPMV lamp which incorporates the improved electrodes of this invention;

FIG. 2 is an enlarged side elevational view, partly in section, of one of the lamp electrodes;

FIG. 3 is an end view of the arc-supporting portion of the electrode as viewed from the reference plane III—III of FIG. 2, in the direction of the arrows;

FIG. 4 is a similar view of the opposite end of the electrode as viewed from the reference plane IV—IV of FIG. 2 in the direction of the arrows;

FIG. 5 is a side elevational view of the support rod shown in the preceding figures;

FIG. 6 is a similar view of the inner coil component;

FIG. 7 to 10 are views illustrating various phases of the assembly operation in accordance with the preferred embodiment of the invention;

FIG. 11 is a side elevational view of an alternative rod and inner coil subassambly; and

FIG. 12 is a cross-sectional view through the interlocked portion of the aforesaid subassembly taken along the reference plane XII—XII of FIG. 11, in the direction of the arrows.

While the present invention affords advantages in the fabrication of composite type electrodes for various kinds of electrical discharge devices, it is especially adapted for use in conjunction with the manufacture of thermionic electrodes for HPMV lamps and has accordingly been so illustrated and will so be described.

General

With specific reference to the form of the invention shown in the drawing, in FIG. 1 there is shown an arc tube 14 for a HPMV lamp comprising a tubular envelope 16 of quartz or the like that is closed at each end by press seals 17 and 18. A pair of oppositely disposed thermionic electrodes 22 are anchored in each of the seals and electrically connect with usual ribbon-conductor assemblies 20 that are hermetically embedded in and extend through the seals. A filling of ionizable starting gas such as argon or the like is also sealed within the envelope 16 along with a charge of mercury 19 and an auxiliary electrode 25. The latter is disposed adjacent

one of the main electrodes 22 and is electrically connected to a separate ribbon-conductor assembly 24, as illustrated.

As shown more particularly in FIGS. 2 to 4, each of the main electrodes 22 basically consists of a support rod 26 of tungsten or the like that extends through and beyond an inner coil 30 which is, in turn, enclosed by an outer coil 36. As illustrated in FIG. 5, the rod 26 is of generally cylindrical configuration and has a flattened portion 28 at one end to which the ribbon-conductor assembly is attached. The inner coil 30 has closely wound end sections and a spaced intermediate turn 31 that defines what may be termed an open or expanded medial section. This feature is clearly discernible in FIG. 6. The resultant spacing between turns forms a cavity C for holding a predetermined amount of electron emissive material, as will become apparent as the description proceeds.

Returning to FIG. 2, the outer coil 36 is tightly wound and forms a substantially closed helix that is of approximately the same length as the inner coil 30. The outer coil, accordingly, covers the aforesaid cavity C defined by the spaced turn 31 and completely shields the emission material 34 deposited in the cavity. The emission material comprises a mixture of suitable materials such as alkaline-earth metal oxides, binders, etc. that forms a hard mass when it dries.

Both the inner and outer coils are wound from a suitable refractory metal wire, such as tungsten or the like, of such diameter that the coils are rigid but deformable.

The invention

In accordance with the present invention, the rod 26, inner coil 30 and the outer coil 36 are so dimensioned as to fit freely one within the other. The inner coil 30 is provided with a transversely protruding leg 32 at one end and is preferably fastened to the rod 26 by hot clamping at least one of the coil turns to the underlying portion of the rod. The outer coil 36 is also provided with a transversely protruding leg 38 (see FIGS. 2 and 4) and is so oriented with respect to the inner coil 30 that both coil legs face and are adjacent to the flattened end portion 28 of the rod. Thus, the arc-supporting end of the electrode 22 is free from such protuberances, as shown in FIG. 3.

The outer coil 36 is held in place by bending the leg 38 inwardly toward the rod behind and into interlocking engagement with the proximate end face of the inner coil 30, as shown in FIGS. 2 and 4. Since the inner coil 30 is rigidly anchored to the rod 26, the outer coil 36 is prevented from slipping toward the flattened end of the rod by the abutting leg 32 of the inner coil. Its movement in the opposite direction is, on the other hand, prevented by the bent-in leg 38 that abuts against the end face of the inner coil. The coils are, accordingly, locked together on the rod by the coaction of protruding legs and by anchoring a preselected portion of the inner coil to the rod.

Method of assembly

The composite electrodes 22 are very conveniently assembled according to the invention by first inserting the loose fitting support rod 26 into the inner coil 30 and positioning the latter so that the protruding leg 32 is located adjacent but predetermined distance inwardly from the flattened end portion 28 of the rod, as shown in FIG. 7. As will be noted in FIGS. 2, 4, and 6 to 10, the protruding legs 32 and 38 each constitute tangential extensions of the end turn of the respective coils and protrude a considerable distance beyond the coil body.

After the inner coil 30 has been oriented in its position of use on the rod 26, at least one and preferably several of the intermediate coil turns are hot clamped to the rod, as indicated in FIG. 7. The rod-and-coil subassembly is then dipped into the emission material so that

the interstitial cavity C defined by the open turn 31 or expanded medial portion of the inner coil is filled with emission material 34, as shown in FIG. 8.

The aforesaid hot clamping operation may be readily accomplished by centering the rod-and-coil subassembly between the jaws of a suitable welder and passing sufficient current through the parts to heat the coil turns white hot. The resultant simultaneous application of heat and pressure to the intermediate coil turns permanently deforms them and hot clamps them tightly around the rod, as indicated in FIG. 7. The turns thus compressively grip the rod and lock the inner coil rigidly in place.

The inner coil 30 can also be anchored to the support rod 26 by actually welding one or several of the coil turns to the rod, especially if these parts are made from a refractory metal other than tungsten.

After the inner coil 30 has been filled with emission material 34, the loose fitting outer coil 36 is slipped over the inner coil until the end of the outer coil seats against the protruding leg 32 of the inner coil, as shown in FIG. 9. The outer coil 36 is then oriented so that its protruding leg 38 terminates at a point located approximately a quarter of a turn beyond the protruding leg 32 of the inner coil, as shown in FIG. 10. The leg 38 is then bent inwardly toward the rod 26 until it is seated behind and thus interlockingly engages the proximate end face of the inner coil 30, as shown by the dotted outline of the inturned leg 38 in FIG. 10. The legs 32 and 38 are also wedgingly seated one against the other so that the outer coil 36 is unable to rotate in either direction relative to the inner coil 30. The outer coil 36 is preferably wound and dimensioned to thread loosely over the inner coil 30 and supplement the interlocking action therebetween.

In order to provide sufficient clearance to enable the leg 38 to be bent behind the end face of the inner coil, the protruding leg 32 is canted in an axial direction at an angle α of approximately 6° to 8° (as indicated in FIG. 6) with respect to the adjacent turn of the inner coil.

Specific example

Following is a specific example of an electrode for a 400 watt HPMV lamp which further illustrates the teachings of this invention. The inner coil was wound at about 32 turns per inch (t.p.i.) from tungsten wire having a diameter of approximately 31.5 mils. Its inside diameter was about 48 mils and overall length about 7.8 millimeters. The spaced turn was wound at approximately 15 to 16 t.p.i. The rod was approximately 14 millimeters long and 47 mils in diameter. The outer coil was wound from the same size wire as the inner coil but at approximately 28 to 29 t.p.i. The overall length of the outer coil was about 8 millimeters and the leg protruded approximately 30 mils beyond the body of the coil. Its inside diameter was approximately 110 mils so as to permit the outer coil to be easily threaded by hand over the inner coil.

Alternative embodiment

As shown in FIG. 11, the inner coil 30 may also be anchored to the rod by a mechanical interlock instead of the hot clamping or welding operations described above. This can be accomplished by using a modified rod 26*a* that is provided with a depression, such as groove 40, located adjacent its flattened end portion 28*a* and then bending the overlying portion of the end turn of the inner coil 30 inwardly toward and seating it in the groove, as shown in FIGS. 11 and 12. The groove extends in the same direction relative to the rod axis as the coil turn and thus constitutes a keyway for the bent-in portion thereof. The inner coil is, accordingly, prevented from rotating in either direction around the rod 26*a*.

It will be appreciated from the foregoing that the objects of the invention have been achieved in that an oxide-coated type thermionic electrode has been provided

which is so constructed that the parts can be very quickly assembled and then locked one with another simply by deforming preselected portions of the components rather than by force-fitting the parts together. The close tolerances and critical dimensions heretofore required are, accordingly, no longer necessary resulting in a corresponding reduction in the manufacturing cost of the electrode and in the percent shrinkage experienced during fabrication.

While several embodiments have been illustrated and described in detail, it will be appreciated that various changes in the construction of the electrodes can be made without departing from the spirit and scope of this invention. For example, locking of the outer coil with the inner coil can be accomplished by bending a portion of the end turn itself inwardly against the end face of the inner coil. The protruding leg on the outer coil in this case would not be required and could, therefore, be eliminated, thus further simplifying the electrode structure.

I claim as my invention:

1. An electrode for an electric discharge lamp or the like comprising, a support rod, a loose fitting inner coil of refractory metal wire on said support rod, and a loose fitting outer coil of refractory metal wire over and enclosing said inner coil, said inner coil having a transversely protruding leg at one end and at least one turn that is anchored to said rod and thus locks said inner coil in predetermined position on said rod, and the end turn of said outer coil proximate the protruding leg of said inner coil being seated against said leg and having a deformed portion that protrudes inwardly toward said rod and interlockingly engages the proximate end face of said inner coil.

2. The electrode as set forth in claim 1 wherein the anchored turn of said inner coil is welded to said rod.

3. The electrode as set forth in claim 1 wherein the anchored turn of said inner coil comprises an end turn that is bent inwardly toward and is seated in a depression provided in said rod.

4. The electrode as set forth in claim 1 wherein the anchored turn of said inner coil is permanently deformed and compressively grips said rod.

5. An electrode for an electric discharge lamp or the like comprising, in combination, a generally cylindrical support rod, a refractory wire inner coil dimensioned to fit freely over said rod and having a transversely protruding leg at one end, and a refractory wire outer coil dimensioned to fit freely over and enclose said inner coil, said rod extending through and beyond said inner coil, a portion of said inner coil being bent into locking engagement with said rod, said outer coil being disposed over said inner coil and seated against the protruding leg thereof, a portion of the end turn of said outer coil that abuts the protruding leg of said inner coil being bent inwardly toward said rod and seated behind the end face of said inner coil and thereby locking said outer coil in place on said inner coil.

6. An electrode as set forth in claim 5 wherein, said inner coil has an open intermediate turn that defines a cavity, and said outer coil is threaded over said inner coil and covers the cavity defined thereby.

7. An electrode for a high-pressure vapor discharge lamp or the like comprising, in combination, a generally cylindrical refractory metal support rod, a refractory wire inner coil dimensioned to fit freely over said support rod and having closed end sections and an expanded medial section that defines a cavity, a refractory wire outer coil that is wound and dimensioned to thread freely over said inner coil, said inner and outer coils each having an end turn with a tangential extension that protrudes beyond said coils and comprises a transversely extending leg, said rod extending through and beyond said inner coil, at least one turn of said inner coil being clamped around said rod so that the latter is locked in predetermined relation with said inner coil, said outer coil being threaded over said inner coil and enclosing the expanded medial section thereof, the end of said outer coil with the protruding leg being seated against the protruding leg of said inner coil, and the protruding leg of said outer coil being bent toward said rod and into interlocking engagement with the proximate end face of said inner coil.

8. The electrode as set forth in claim 7 wherein, said support rod has a flat portion at one end, the cavity defined by the expanded medial section of said inner coil contains a filling of electron-emissive material, and the leg portions of said inner and outer coils are located proximate the flat end portion of said support rod.

9. The electrode as set forth in claim 7 wherein said inner and outer coils are so oriented that the leg of said outer coil terminates at a point located approximately a quarter of a turn beyond the leg of said inner coil.

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