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Kimball et al.

[11] **3,863,313**

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[54] **MANUFACTURE OF SUBMINIATURE INCANDESCENT LAMPS**

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[73] Assignee: **GTE Sylvania Incorporated,** Danvers, Mass.

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[52] **U.S. Cl.** **29/25.15,** 313/271

[51] **Int. Cl.** **H01j 9/18**

[58] **Field of Search** 29/25.14, 25.15, 25.17, 29/25.18, 25.1, 25.11, 25.13, 423; 313/315, 271

[56] **References Cited**

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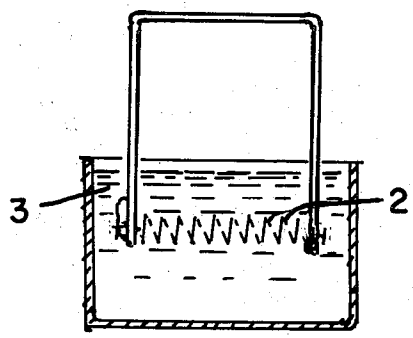
[57] **ABSTRACT**

In the manufacture of a single ended subminiature incandescent lamp, helically coiled filament wire, while still on the mandrel wire on which it has been coiled, is unreeled from a spool and a predetermined length thereof is attached to the ends of a U shaped support wire. The filament is then inserted into acid to dissolve the mandrel and is subsequently sealed within a glass envelope. Each leg of the U shaped support is then converted into a lead-in wire by severing the midportion of the support.

1 Claim, 4 Drawing Figures



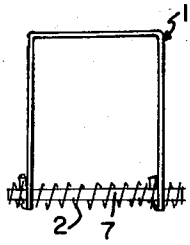


FIG. 1

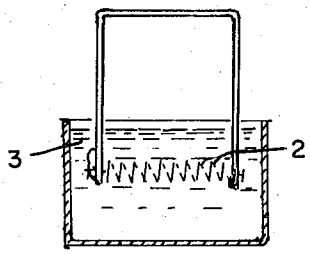


FIG. 2

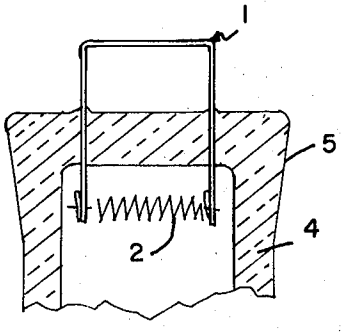


FIG. 3

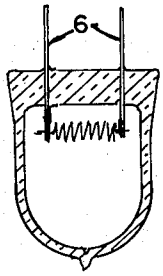


FIG. 4

MANUFACTURE OF SUBMINIATURE INCANDESCENT LAMPS

BACKGROUND OF THE INVENTION

This invention relates to single ended subminiature lamps the illumination from which results from a tungsten filament heated to incandescence by flow of electric current therethrough. It especially relates to a method of making such lamps.

Subminiature lamps generally have a filament made of such fine wire that it can only be seen and handled under magnification; thus the coil mount and assembly is done by hand with consequent high costs. The filament is generally made by helically coiling fine tungsten wire on a metal mandrel wire, several times its diameter, in a long continuous length. The coiling is heat treated to set it and is then cut into predetermined filament lengths. The mandrel is dissolved in acid either before or after the cutting step. The filament is then hand mounted on a suitable support and then sealed within a small glass envelope.

It is an object of this invention to provide a method of manufacturing that permits employment of automatic assembly machines, thereby eliminating much of the hand work involved and thereby significantly reducing the cost of such lamp.

THE INVENTION

In the drawing,

FIG. 1 is an illustration of a mandrel-containing, helically coiled lamp filament attached to the ends of a U-shaped support wire.

FIG. 2 shows the supported filament immersed in acid to dissolve the mandrel.

FIG. 3 shows the supported filament sealed in one end of a glass tubing.

FIG. 4 shows the finished lamp.

In the manufacture of a single ended subminiature incandescent lamp in accordance with this invention, fine tungsten wire **2**, generally less than 1 mil in diameter, is continuously helically coiled on a wire mandrel **7** of larger diameter. The mandrel **7** is made of a suitable metal, say, nickel, steel or molybdenum, that can be dissolved in an acid that does not readily attack tungsten. In a typical case, the mandrel **7** diameter is 3 or 4 mils.

The coiling-with-mandrel can then be heat treated, if necessary, to set the coiling **2** and is then taken up on a spool in a long continuous length. Next, the coiling **2** is mounted on suitable apparatus where it can be continuously unreeled. The coiling is drawn across the ends of a U shaped support wire **1** and a short length of coiling **2** is permanently connected to said ends, such as by welding or clamping, and cut. Said short length equals the distance between said ends and comprises the filament in the finished lamp. The fact that the mandrel **7** is still within the coiling **2** gives it sufficient bulk to permit the unreeling and connecting steps to be performed on automatic equipment. The distance between legs of the U shaped support **1** is small enough to permit it, with the filament connected therebetween, to be inserted into a tubular glass envelope **4** at the time of lamp assembly. In a typical case, the distance between legs was about one-sixteenth inch.

After the filament has been mounted on the support **1**, the filament is dipped in a suitable acid **3** to completely dissolve the mandrel **7**, at least in the case of a straight filament, that is to say, a coiled filament where the mandrel is straight. The support **1** need not be completely immersed as long as the filament is. The acid **3** may be heated to reduce the time for dissolving the mandrel **7** to a few seconds. Typically, hydrochloric acid is used to dissolve a steel mandrel, while a combination of sulphuric and nitric acids is used to dissolve a molybdenum mandrel. Preferably, the support **1** is of a metal that is resistant to the acid used.

After the filament is rinsed and dried, it is ready for sealing within a glass envelope **4**. The filament end of the support **1** is inserted in one end of a small diameter glass tubing, typically, T1 or ⅛ inch diameter, and the end of the tubing is heated to its softening point. The softened end is then squeezed on part of the legs of the support to form a hermetic press seal **5**. The support **1** is made of a wire, such as dumet, kovar or invar, that is sealable to glass.

After the support **1** has been sealed in one end of the glass tubing, the tubing is exhausted through the other end and is then heated and tipped off to form the lamp envelope **4**. The tubing at said other end may have previously been tubulated or necked down in diameter to aid in tipping off the lamp.

The support **1** is then cut to remove the middle section of the U and each leg of the support serves as a lead-in wire **6** for the filament. If desired, the support **6**, i.e., lead-in wire, may be of a material that is readily solderable, to simplify final connection of the lamp.

In an example of a 5 volt 60 milliampere T1 lamp made in accordance with this invention, the filament coiling **2** consisted of 0.6 mil tungsten wire wound on 4 mil molybdenum wire **7** at 650 TPI. The coiling was heat treated at 1,525°C and then 2 mm lengths thereof were welded across the ends of U shaped support wires **1**. Each support **1** was made of 10 mil dumet wire, nickel plated, the distance between the ends of the U being 2 mm and the length of the support being about 10 mm. The filament was then inserted into heated sulfuric-nitric acid **3** for about 5 to 10 seconds to dissolve the molybdenum mandrel **7** therein. After rinsing and drying, the filament **2**, while still on the support **1**, was inserted into one end of T1 glass tubing **4**, open at both ends. The other end of the glass tubing **4** was connected, by a vacuum tight connection, to exhaust and filling apparatus. The first end of the glass tubing **4** was heated to its softening point and then pressed onto part of the legs of the support **1** to form a hermetic press seal **5**. If necessary, the interior of the tubing could be flushed with a suitable inert gas to prevent oxidation of the filament during press sealing. The other end of the glass tubing **4** was then heated and tipped off while a vacuum was maintained in the tubing. The middle section of the support **1** was then removed by cutting, thereby forming two lead-in wires **6** for the filament.

The finished lamp had a diameter of about one-eighth inch and an overall envelope length of about 6 mm. The lighted length of the filament was about 2 mm. The length of the press seal was about 2½ mm and the length of the lead-in wires protruding outside the press was about 3 mm. The lamp was energized by suitable connection of said legs to a 5 volt power supply.

In some cases, it may be desirable to make the filament longer than the space between the ends of the U support by, for example, bending it into somewhat of a V shape. This is accomplished by physically bending

the coiling-with-mandrel at the time it is drawn across the ends of the U support and is attached thereto. Or else the legs of the U may be excessively open at the time of attaching the coiling-with-mandrel thereto; then partially closing said legs would result in a somewhat V shaped filament. In the case of a V filament, it may also be desirable not to dissolve the entire mandrel, say, if it is desired to reduce the lighted filament length. The filament then would not be entirely immersed in acid, but only to a predetermined depth, which would result in short lengths of mandrel remaining in the coiling at the point of attachment to the U support. Said short lengths would effectively short out the encircling filamentary turns thereon. Masking could also be used to prevent dissolving of said short lengths of mandrel.

I claim:

1. In the process of manufacturing a single ended subminiature incandescent lamp, the steps which sequentially comprise: helically coiling a length of fine tungsten wire on a mandrel wire having a larger diameter; heat treating the coiling; connecting a predetermined length of the coiling across the ends of a U shaped support wire, said predetermined length comprising a lamp filament; immersing said filament into acid to dissolve the mandrel therein; inserting the filament into an open ended glass tube; heating and press sealing one end of the glass tube onto a portion of the legs of the support; sealing the other end of the glass tube; and removing the middle section of the support so that each leg thereof comprises a lead-in wire for the filament.

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