United States Patent

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[54] **EVAPORATION FILAMENT ASSEMBLY**
1 Claim, 1 Drawing Fig.

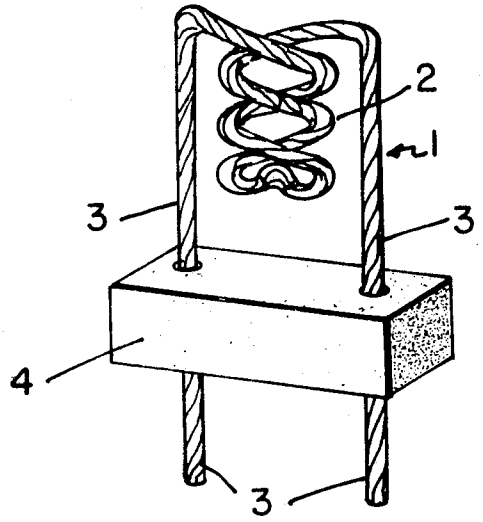
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[56] **References Cited**
UNITED STATES PATENTS

1,437,481	12/1922	Armstrong	219/523
1,804,885	5/1931	McCartney	219/546 X
2,710,270	6/1955	Cox	118/49 X
3,152,246	10/1964	Van Deuren et al.	118/49 X

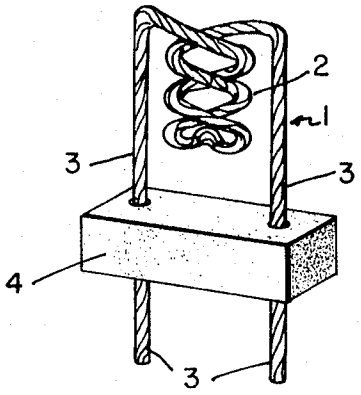
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ABSTRACT: An evaporation filament for the vapor deposition of metallic films consists of a stabilized tungsten coil having parallel legs. A ceramic support is attached to the legs and prevents distortion of the coil during operation thereof.



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EVAPORATION FILAMENT ASSEMBLY

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the field of tungsten coils used for the vapor deposition of metals.

2. Description of the Prior Art

Coiled tungsten filaments have been extensively used for the purpose of evaporating metals and depositing a thin film thereof on a substrate. A small slug of the metal to be deposited is placed in a coiled segment of the filament and the filament is mounted on two rigid binding posts in an evaporation chamber. A vacuum is then drawn on the chamber and the filament is resistively heated to evaporate the metal slug. The metal vapors radiate in a straight line and deposit on a substrate within the evaporation chamber.

When such filaments are used for the deposition of aluminum as, for example, on the face of a television picture tube, their useful life is quite short. Usually only about six to eight evaporations are obtainable from one filament before it fails. The causes of filament failure generally are excessive distortion of the coiled segment and erosion of the tungsten by the molten aluminum.

Distortion of the filament usually results from stresses induced in the legs when the filament is clamped in the binding posts. When the filament is heated during operation, the stresses are relieved by distortion of the coiled turns of the filament. Eventually the distortion can become so severe that an aluminum slug cannot be contained within the coiled segment of the filament.

Such filaments are usually made of tungsten wire strand, that is, three strands of wire intertwisted together so that they may be coiled as a single length of wire. After the filament has been coiled, it is usually fired in a reducing atmosphere at about 1,500 to 1,700° C. to stress relieve the filament and to burn off any impurities. Such a firing does not change the fibrous structure of the tungsten and the filament retains a certain degree of flexibility. This flexibility is sufficient to permit the filament legs to be bent, if necessary, at the time they are inserted in, and clamped to, the binding posts of an evaporation chamber.

SUMMARY OF THE INVENTION

An evaporation filament, in accordance with this invention, comprises a tungsten coil having substantially parallel legs protruding from a reverse helix coiled body. The turns of wire that comprise the body are spaced apart from each other to prevent electrical shorting therebetween. At the apex of the helix, the crossover wire is diametrically positioned to permit the coil body to contain a metal slug inserted therein, without providing an opening large enough for the slug to fall through. The legs of the filament are bent at their juncture with the coil body so that they protrude back in the same direction as the coil body, substantially parallel thereto. Thus when the filament is mounted in an evaporation chamber, the coil body serves as a container for a metal slug and the crossover wire serves as a bottom for the container.

Disposed intermediate the coil body and the ends of the legs is a ceramic support which is rigidly fixed to both legs. A sufficient length of each leg protrudes beyond the ceramic support to permit mounting of the filament.

The ceramic support must be electrically insulative to prevent shorting out of the filament. It must also be sufficiently rigid to fix the legs and prevent relative displacement therebetween throughout the operating temperature range of the assembly. If desired, the ceramic support may be demountably attached to the filament legs, but the connections therebetween must be sufficiently rigid to prevent the translation of any stresses that may occur in the filament legs during clamping to the coil body.

In order to reduce the rate at which the tungsten wire is eroded by the molten metal being evaporated, as mentioned above in "Description of the Prior Art," the tungsten filament of the instant invention is stabilized. That is to say, the filament is heated at a sufficiently high temperature, generally above 2,200° C., prior to attachment of the ceramic support, in order to convert the fibrous microstructure of the tungsten into a brittle crystalline structure consisting of long, interlocking grains. The fibrous microstructure is necessary, because of the flexibility it imparts to the wire, to permit the wire to be coiled into a desired filament shape. After the filament has been formed and is not subject to further extensive cold working, it is stabilized to convert its microstructure to the desire erosion-resistant but brittle crystalline state.

Prior to stabilizing, the filament legs are bent to accurately align them with the coil body and to space them a predetermined distance apart. This space corresponds to the leg spacing provided in the ceramic support and to the leg spacing of the binding posts in an evaporation chamber. After stabilizing, a ceramic support is attached and fixed to the legs of the filament, as mentioned above.

When the filament-ceramic assembly is mounted in an evaporation chamber, the ceramic support serves as a convenient handle for holding the assembly while the filament legs are clamped to binding posts. Any strains that are induced in the filament legs by reason of the clamping terminate at the ceramic support, thereby preventing distortion of the coiled body therefrom as the filament is repeatedly cycled during successive evaporation operations.

Filament assemblies made according to this invention have lasted two to three times as long as the prior art evaporating filaments.

BRIEF DESCRIPTION OF THE DRAWING

The single drawing is a perspective view of an evaporation filament assembly in accordance with this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in the drawing, filament **1** consisted of tungsten stranded wire formed into coil body **2** and substantially parallel legs **3**. In one example, the wire consisted of three intertwisted strands of 30 mil wire each having a length of 201 mm. The three strands had a current-carrying capacity equivalent to a 52 mil wire but were easier to form than a single 52 mil wire. Coil body **2** was wound at 5 turns per inch and and a body length of 0.60 inch and a diameter of 0.35 inch. Legs **3** were formed by bending them down parallel to the body axis. The legs were 1½inches long from the bend and were spaced 0.50 inch apart.

The formed coil was then stabilized in vacuo at 2,450° C. for 1 minute. After removal from the stabilizing furnace, ceramic support **4** was attached to filament legs **3**. Ceramic support **4** consisted of a rectangular block of steatite having a length of 0.70 inch, a width of 0.20 inch and a height of 0.20 inch. There were two 67 mil holes, 0.50 inch apart, through the block. Surrounding the holes was a depression about three thirty-seconds inch deep.

Filament **1** was attached to ceramic support **4** by inserting legs **3** through the holes in the block, the legs being substantially perpendicular to the block. About one-half inch of each leg protruded below the block to provide for subsequent electrical connection to binding posts. The depression in the block was packed with a ceramic cement consisting of aluminum oxide paste for the purpose of securely fixing filament **1** to ceramic support **4**. The cement was allowed to dry and the assembly was then heated at 1,300° C. for 30 minutes to harden the cement and to outgas the ceramic.

In operation, the filament assembly was mounted in an evaporation chamber by clamping the filament legs to electrical binding posts spaced 0.50 inch apart. A small cylindrical slug of aluminum was placed within coil body **2** and the chamber was evacuated. Electrical power was then supplied to the filament until it reached a temperature of about 1,600° to 1,700° C., at which time the aluminum melted, clung to the wire because of surface tension and was almost immediately

vaporized. AFter 20 such evaporation cycles, the filament had not distorted nor eroded excessively, but its use was discontinued because of an excessive buildup of aluminum on the legs of the filament.

I claim:

1. An evaporation filament assembly comprising a stabilized tungsten coil having substantially parallel legs protruding therefrom and a ceramic support rigidly attached to said legs, said coil being wound from stranded wire and being a reverse helix coil having a diametrically positioned crossover wire at the apex thereof, said crossover wire serving as the bottom of the container defined by the coil, the legs of the filament joining the coil being bent at their juncture and protruding back substantially parallel to the coil body.