United States Patent [19]

Reid

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[54] **METHOD OF COATING CATHODE HEATERS**

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[52] **U.S. Cl.** ..... **117/217,** 117/231, 117/71 M, 117/106 R, 313/337, 313/345

[51] **Int. Cl.** **B44d 1/18**

[58] **Field of Search** ..... 117/106 R, 71 R, 117/71 M, 217, 231; 313/337, 340, 345

[56] **References Cited**

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3,206,329	9/1965	Hickle	117/231 X
3,504,325	3/1970	Rairden	117/106 R

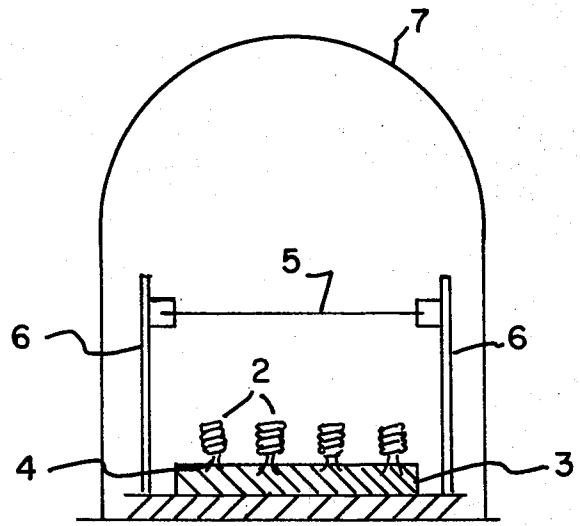
Primary Examiner—Edward G. Whitby

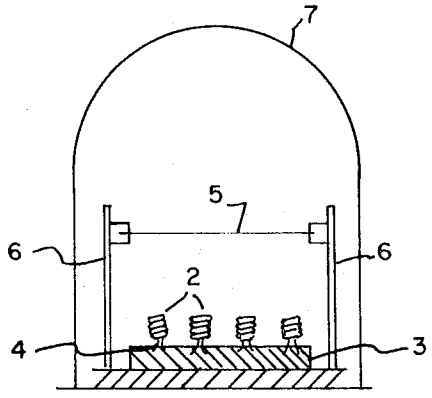
Attorney—Norman J. O'Malley et al.

[57] **ABSTRACT**

A heater for use in an indirectly heated cathode of a vacuum tube is first coated with an insulating layer of alumina. Metallic tungsten is then vacuum deposited on the alumina in order to darken the color of the coating, thereby increasing its thermal emissivity.

3 Claims, 1 Drawing Figure




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METHOD OF COATING CATHODE HEATERS

BACKGROUND OF THE INVENTION

1. Field Of The Invention

This invention relates to dark coated insulated tungsten heaters for indirectly heated cathodes such as are used in vacuum tubes.

2. Description Of The Prior Art

Heaters for indirectly heated cathodes are normally made of tungsten wire and coated with an insulating coating, usually aluminum oxide, to electrically insulate the turns of the heater wire from each other and from the cathode in which it will be disposed. The aluminum oxide coating is normally white; however, it is advantageous to have a gray or black colored coating on the heater. The higher emissivity of the dark coating results in better heat transfer to the cathode. Therefore, for the necessary cathode temperature and adequate electron emission, a dark coated heater would operate at a lower temperature than a white coated heater. The advantages resulting from this lower heater temperature are longer life, better current stability of the heater and lower heater-cathode electrical leakage.

Conventional processes for obtaining a dark coating on the heaters are by direct use of a coating suspension that incorporates insoluble metallic oxide powders, such as tungsten, which will impart a dark color to the coating, after the coated heater has been fired. Another method of obtaining a dark coated heater is to directly deposit a dark coating over a conventional white coated heater. In this process, the heater is first coated with white aluminum oxide. It may then, although not necessarily, be fired at a high enough temperature to sinter the coatng. The sintered, coated coil is then electrophoretically or dip coated in a suspension of the fine tungsten powder to incorporate the metal and produce a dark coating. Examples of heaters that have been dark coated according to prior art methods are shown in U.S. Pat. Nos. 3,450,565, 3,246,197, 3,328,201, 3,195,004, 3,029,360, 3,005,926 and in British patents 1,006,476, 976,012 and 922,440.

These patents all disclose the use of a liquid vehicle to obtain a dark coating, the vehicle being either a solution or suspension, and the process utilized being dipping, electrophoretic coating, drag coating or spraying.

A disadvantage to the use of liquid vehicles for obtaining a dark coating on a heater having an insulating coating thereon is that the dark coating can undesirably penetrate into the insulating coating and thereby, in some applications, increase leakage current between the heater and the cathode.

SUMMARY OF THE INVENTION

This invention discloses a process for dark coating an insulated heater in which there is substantially no penetration of the dark coating material into the white insulating layer of alumina. In accordance with this invention a source of tungsten metal is heated to its evaporation temperature in a vacuum and vapor deposited on the surface of the insulated heater. The tungsten source is so located relative to the heater to be coated that substantially all of the outer surfaces of the insulated heaters are coated with a very thin dark layer of tungsten.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE in the drawing shows vacuum coating apparatus that can be used for dark coating a plurality of heaters in accordance with this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in the drawing, reverse helix heater coils **2**, made of tungsten wire and having been conventionally coated with an insulating layer of white alumina (aluminum oxide), are disposed in a suitable support fixture **3** by means of the uncoated legs **4** of the heaters. Disposed above heaters **2** is a tungsten source consisting of, for example, a plurality of spaced parallel tungsten wires **5**. The heaters and tungsten source are so spaced relative to each other that upon evaporation of tungsten atoms from the source substantially all of the outer surface of the alumina layer will be coated with tungsten. (On evaporation, the tungsten atoms radiate outwardly in straight lines from the source.)

The ends of tungsten wires **5** are supported by and connected to binding posts **6** through which electrical power can be delivered to wires **5** in order to resistively heat them to the evaporating temperature of tungsten. The apparatus is disposed within container **7** which can be evacuated to the vacuum necessary for vapor deposition.

In one example, heater coils **2** were each made of 67 mm of 4.6 mil tungsten wire and had a body diameter of 70 mils and a body length of 4.5 mm. The heater coils were electrophoretically coated with alumina and then sintered to harden the coating, the alumina coating weight on each heater being about 5.8 mg.

The heater coils were disposed in support fixture **3** and spaced apart sufficiently to avoid shielding each other from the tungsten source. The tungsten source consisted of five parallel strands of 6.3 mil tungsten wire, 87 mm long, spaced 20 mm apart and disposed about 100 mm above support fixture **3**.

Container **7** was evacuated to a vacuum of 10^5 Torr and electrical power was gradually applied to tungsten wires **5** in two volt increments until the current began to decrease, indicating that evaporation of tungsten was occurring. Evaporation occurred at 21 volts and 22 amperes and was permitted to continue for 15 minutes.

Under these conditions a dark overcoat of tungsten was deposited on the white alumina coated heaters, the dark color being between **6** and **7** on the Kodak Shade scale. The weight of tungsten coating deposited on each heater was about 0.3 mg, which is less than 1 percent of the weight of alumina thereon.

Although satisfactory results were obtained in this example where the tungsten source lay in only one plane relative to the heaters, it may be necessary in some cases to arrange the tungsten source in different planes and directions in order to adequately dark coat a large number of heaters in one batch. And it is not necessary that all of the alumina coating be dark coated. It is sufficient if the outermost surface of the alumina coating on the body of the heater be dark coated, since that is where most of the heat transfer to the cathode occurs. Thus it is not necessary that the white coating on the legs of the heater be dark coated or even of the one or two turns of the coil adjacent to the legs.

I claim:

1. A process of manufacturing heaters for indirectly heated cathodes comprising the steps of coating a tungsten heater coil with an insulating coating of aluminum

oxide, sintering said coating, and vapor depositing an overcoat of metallic tungsten on said coating by electrically heating a tungsten source within a vacuum chamber to its evaporating temperature whereby tungsten is evaporated from said source and deposited on said heater.

2. The process of claim 1 wherein said tungsten source comprises a plurality of tungsten wires.

3. The process of claim 1 wherein the weight of tungsten deposited on a heater is less than 1% of the weight of said aluminum oxide coating.

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