METHOD OF COATING A CHROMIUM-NICKEL COMPONENT WITH A CHROMIUM OXIDE-CONTAINING LAYER, AND COMPONENT HAVING SUCH A LAYER

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References Cited

UNITED STATES PATENTS
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3,664,884 5/1972 Underwood ...................... 148/6.3
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ABSTRACT

A chromium-nickel component destined for prolonged heating in a vacuum, for example a part of a cathode, a grid or an anode, is heated in air, after cleaning in a hydrogen atmosphere, at 600°-900°C for 15 to 45 minutes and is then reduced in moist hydrogen.
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METHOD OF COATING A CHROMIUM-NICKEL COMPONENT WITH A CHROMIUM OXIDE-CONTAINING LAYER, AND COMPONENT HAVING SUCH A LAYER

The invention relates to a method of covering a component of an electron discharge tube consisting of a chromium-nickel alloy with a chromium oxide-containing layer which is resistant to paling in a vacuum, in which the component is first heated in a dry hydrogen atmosphere, then oxidised in air, and is then heated in a moist hydrogen atmosphere and is subsequently incorporated in the electron tube.

The invention relates in particular to a method of covering such a component, for example, a part of cathode, a grid or an anode, with a dark-coloured chromium oxide-containing layer which is resistant in a vacuum at an operating temperature of approximately 900°C or the colour of which during the life of the tube becomes darker.

From the U.S. Pat. No. 1,760,526 a method is known of covering a grid or an anode of an electron discharge tube consisting of chromium-nickel with a chromium oxide-containing layer in which the electrode is first cleaned by heating in a hydrogen atmosphere after which the electrode is allowed to cool in air, the chromium and the nickel being oxidised. The electrode is then heated in a dry or slightly moist hydrogen atmosphere at 800°C to 1000°C for 19 to 15 minutes, the nickel oxide being reduced but the chromium oxide being not reduced.

It has been found that a chromium oxide layer obtained in such manner is not resistant to paling in a vacuum at an operating temperature of approximately 900°C. The dark colour of the Cr2O3 layer goes gradually pale as a result of which the temperature of the electrode becomes higher and higher as a result of the decreasing thermal radiation.

It has been found from many investigations that this drawback can be avoided in an unexpectedly simple manner.

A chromium oxide-containing layer which is completely paling resistant in a vacuum at approximately 900°C can be obtained by using the said known method, if, according to the invention, the oxidation in air is carried out by heating for 15 to 45 minutes, preferably 25 to 35 minutes at a temperature of approximately 600°C to 900°C. By heating in air at a temperature of 600°C to 750°C for 15 to 45 minutes a nickel-containing chromium oxide layer is obtained after heating at 800°C to 1100°C in a moist hydrogen atmosphere the colour of which does not vary throughout the life of the electron tube. Upon heating in air for approximately 30 minutes at a temperature of 800°C to 900°C, a nickel-containing chromium oxide layer is obtained after heating in a moist hydrogen atmosphere the colour of which is initially less dark but which, instead becomes darker and darker during the life of the electron tube.

The invention will be described in greater detail with reference to one embodiment and a drawing, of which FIG. 1 is a cross-sectional view through a cathode for an electron ray tube, comprising a dark-coloured chromium oxide-containing layer according to the invention, while FIG. 2 is a cross-sectional view through a cylindrical cathode of the electron tube which also comprises such a layer.

FIG. 1 is a cross-sectional view through a cathode for an electron ray tube, comprising a dark-coloured chromium oxide-containing layer according to the invention, while FIG. 2 is a cross-sectional view through a cylindrical cathode of the electron tube which also comprises such a layer.

Reference numeral 1 in FIG. 1 denotes a nickel cap which serves as a support for the emissive layer 2. The cap 1 is welded to a cylindrical component 3 which consists of a chromium-nickel alloy having, for example, 80% by weight of Ni and which serves as an envelope of the heating member 8.

The cathode comprises suspension strips 4. After welding the cap 1 to the cylinder 3 and providing the suspension strips 4, this assembly is cleaned by heating in a dry hydrogen atmosphere at 800°C to 1100°C. Upon heating above 900°C the components must be separate from each other since otherwise they start sticking together as a result of diffusion.

The cylindrical part 3 is to be covered with a dark readily heat-radiating layer so that comparatively much heating energy has to be supplied to the cathode to maintain it at the operating temperature of 900°C. Since the radiation of the cylinder 3 increases by the 4th power of the temperature, the radiated thermal energy upon heating the cathode is small so that the comparatively large heating energy ensures a rapid heating of the cathode. The dark layer 5 on the chromium-nickel cylinder 3 is obtained according to the invention in that the assembly of cap 1 and cylinder 3 and the strips 4 is heated in air for 15 to 45 minutes after cleaning in hydrogen. Chromium oxide and nickel oxide are formed at the surface. By heating the assembly in a moist hydrogen atmosphere (dew point 15°C) for 1 hour at 800°C to 1100°C, the nickel oxide which has formed on the cap 1 and the cylinder 3 is reduced to Ni, whereas the Cr2O3 is not reduced. Since the moist hydrogen atmosphere has an oxidising effect for chromium, even more chromium oxide is formed by said prolonged heating at high temperature. After providing the emissive layer 2 and the heating member 8, the cathode is incorporated in an electron tube. It has been found that the chromium oxide-containing layer maintains a constant thermal radiation at the operating temperature of 900°C of the cathode in a vacuum throughout the life of the cathode. The heating in air proves to be critical.

A heating at 800°C to 1100°C for 30 minutes after the reduction in a wet hydrogen atmosphere provides a chromium oxide-containing layer which initially has a lower coefficient of thermal radiation than the above-mentioned layer but the coefficient of thermal radiation of which increases gradually during the life of the cathode. So the cathode temperature decreases gradually during the life, which is favourable in connection with the barium evaporation of the cathode. A given barium evaporation is favourable initially so as to bind residual gases which are detrimental to the emission.

In addition it has surprisingly been found that the initial oxidation and subsequent reduction of the surface of the nickel support 1, prior to providing the emissive oxide layer 2, provides an improvement of the emission contrary to all expectations, although it was feared generally that during the oxidation the impurities present in the nickel and serving as reducers for releasing barium from the emissive oxides, would become inoperative also by oxidation. Apparently such reducers diffuse afterwards from the interior of the nickel to the surface, while the reduced NiO provides a rough surface, which is favourable for the adhesion of the layer 2 and for the emission as a result of increase of the surface of the nickel substrate.

In FIG. 2 the support 6 for the emissive layer 2 was previously welded to a chromium nickel tube 7. The tube 7 projects on both sides from the cylindrical sup-
port 6 and serves for the connection of the cathode in mica members. As a result of the poor thermal conductivity of chromium nickel the heat dissipation of the cathode is restricted. The thermal radiation is stimulated in that the tube 7 is covered with a resistant chromium oxide layer 5 obtained by means of the method according to the invention. A heating member 9 is present in the tube 7.

Although the invention has been described with reference to a cathode as an application, it will be obvious that the invention is also of interest for other components which are maintained in a vacuum for a long period of time at a high temperature, for example, grids, anodes or screens in discharge tubes.

What is claimed is:

1. A method of covering a component of an electron discharge tube consisting essentially of a chromium-nickel alloy with a chromium oxide-containing layer which is resistant to paling in a vacuum, comprising the steps of heating said component in a dry hydrogen atmosphere to clean the surface thereof; heating said component in air at a temperature of approximately 600° to 900°C for about 15 to 45 minutes; heating said component in a moist hydrogen atmosphere to reduce the nickel oxide and subsequently incorporating the thus treated said component in the discharge tube.

2. A method as in claim 1, wherein said heating in air is carried out at a temperature of about 600° to 750°C.

3. A method as in claim 1, wherein said heating in air is carried out at a temperature of about 800° to 900°C.

4. A method as in claim 1, wherein said heating in air is carried out for about 35 to 35 minutes.

5. A component for an electron discharge tube, in particular a grid, an anode or a part of a cathode, that is covered with a darkcoloured chromium oxide-containing layer which is paling resistant in a vacuum at 900°C and produced according to the method recited in claim 1.

6. A component as in claim 5, comprising a cylindrical member on which a nickel support for the emissive layer of a cathode is previously secured.

7. A component for an electron tube, in particular a part of a cathode, produced according to the method recited in claim 1, wherein said component is characterized by being at least partly covered with a chromium oxide-containing layer whose color becomes darker during the life of said component.

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