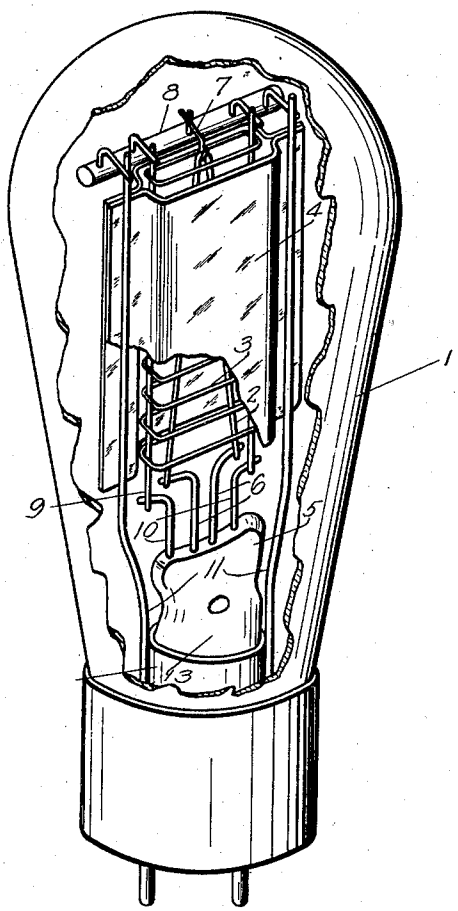
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ELECTRODE

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ELECTRODE

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This invention relates to an electron discharge device employing, as the active electron emitting element, a cathode coated with the oxides of the alkaline earth metals and more particularly it relates to the cooperating electrodes in such a device.

Considerable difficulty has been experienced, heretofore, in the manufacture of electron discharge devices employing oxide coated cathodes, due to electron emission from the cooperating electrodes caused by deposition on these electrodes of the alkaline earth oxides from the cathode coating. This trouble is particularly objectionable in electron discharge devices which operate at high voltages, whereby the grid and anode become heated during operation of the tube. In high wattage rectifiers, or triodes, for instance, the anode may attain a sufficient temperature to show a perceptible dull red color and the electron emission from such electrode may be sufficient, in the absence of some provision for destroying such emission, to heavily bombard the cathode and quickly disintegrate the same, thus rendering the device short lived.

It has been proposed, heretofore, to restrict this grid or anode emission by forming these electrodes of nickel, the surface of which is oxidized or of an alloy of nickel and chromium having an oxidized surface. The oxidation of the electrodes has proven helpful in reducing this emission from the grid and anode but such oxidized electrodes are objectionable in that the nickel oxide, apparently resist the flow of plate current when the electrode is cold so that the plate current does not start immediately when the voltage is applied thereto, but gradually rises to full value as the anode heats up.

One of the objects of the present invention is to overcome these difficulties and to produce an electron discharge device employing an oxide coated cathode, in which objectionable electron emission from the grid and anode will be absent and in which the plate current starts immediately after the voltage is applied to the electrodes of the tube.

Another object is to provide an improved grid and anode electrode material and a method of treating the same.

Other objects and advantages will appear hereinafter.

In accordance with my invention I utilize, cooperating electrodes comprised of an alloy of chromium with another metal, such as nickel or iron, the oxide of which is more readily reducible than chromium oxide, and so treat the electrode as to form a surface having the chromium content oxidized but in which the other metal is substantially unoxidized. The chromium oxide reacts with any alkaline earth oxide deposited on the electrode to convert such oxides to thermionically inactive compounds, such as alkaline earth chromites, while the unoxidized nickel or iron content of the alloy permits the plate current to start immediately without the usual delay incident to the heating up of the electrode.

In order that the invention may be more fully understood reference will be had to the accompanying drawing in which the single figure represents a three electrode tube of the hot cathode, high vacuum type.

The electron discharge tube illustrated, comprises an evacuated glass envelope 1, having a cathode 2, grid 3 and anode 4 therein, mounted on the press 5.

The cathode 2 consists of a suitable metallic base such as nickel having a coating of the oxides of the alkaline earth metals. It is of inverted V-shape, the terminals being secured to conducting supports sealed in the press 5 and the apex being supported by a resilient hook 7 carried by the insulating bead 8.

The grid or control electrode 3 comprises a pair of vertical supports 9 about which the grid wires are wound. The grid is carried by the press 5. The anode 4 is mounted by support wires 11 on a collar 12 clamped about the stem 13 of the device. The bead 8 is mounted on the upper ends of the support wires 11.

The grid 3 and anode 4 are composed of an alloy of chromium and nickel or of chromium, nickel and iron, the chromium content being oxidized at the surface of the elec-

trodes and the nickel or nickel and iron being substantially unoxidized.

In order to obtain this oxidation of the chromium only on the surface of the electrode, the following procedure is followed. The electrodes after they have been formed are first cleaned by baking in hydrogen or in any other approved method and are then oxidized by allowing them to cool in the atmosphere. This treatment causes oxidation of the chromium and also of the nickel or iron. The electrodes are then heated in hydrogen or other reducing atmosphere at a temperature and time sufficient to reduce the nickel and iron oxides without effecting a reduction of the chromium oxide. Since the chromium oxide is very much more stable, this may be readily accomplished, the temperature of treatment not being very critical. Satisfactory results are obtainable by heating the oxidized electrodes in pure dry hydrogen at a temperature of from 800 to 1000° C. for 10 to 15 minutes. Care should be taken, however, to prevent the formation of chromium nitride or carbide during this treatment, due to the presence of nitrogen or saturated hydrocarbons in the hydrogen gas. A slight amount of water vapor may be allowed in the hydrogen providing it is present in an amount below the permissible limit for the reduction of the nickel or iron oxide. A slight amount of water vapor may assist in the prevention of the formation of chromium nitride or chromium carbide.

The electrodes having the chromium content only of its surface oxidized are mounted on the stem of the tube, with an oxide coated cathode and the stem assembled in the envelope.

While I have described a preferred embodiment of my invention it is to be understood that various modifications and changes may be made therein without departing from the spirit and scope of the invention and I do not mean to be limited except by the appended claims.

What is claimed is:

1. An electron discharge device having a cathode comprising at least in part an oxide of an alkaline earth metal and a second electrode composed of an alloy including chromium, the chromium content only of the surface of said second electrode being oxidized.

2. In an electron discharge device, a cathode comprising alkaline earth oxides and a cooperating electrode composed of an alloy of chromium and another metal, the oxide of which is less stable than chromium oxide, the chromium content only of the surface of said electrode being oxidized.

3. In an electron discharge device a cathode comprising alkaline earth oxide and a cooperating electrode composed of an alloy of chromium and nickel, the surface of said electrode having chromium oxide thereon but being free from nickel oxide.

4. In an electron discharge device, a cathode composed of alkaline earth oxide and another electrode composed of an alloy of chromium, nickel and iron, said nickel and iron being oxide free and said chromium being oxidized on its surface.

5. The method of forming an electrode for an electron discharge tube employing a cathode coated with alkaline earth oxide, comprising making said electrode of an alloy composed of chromium and nickel, oxidizing the surface of said electrode and subsequently treating the electrode in hydrogen above the reducing temperature of nickel oxide and below the reducing temperature of chromium oxide.

In testimony whereof, I have hereunto subscribed my name this 15th day of February, 1929.

HARVEY CLAYTON RENTSCHLER.