METHOD OF MANUFACTURING AN INDIRECTLY HEATED DISK-LIKE CATHODE AND CATHODE MANUFACTURED BY SAID METHOD

Abstract: A method of manufacturing an indirectly heated cathode wherein a cup-shaped member having an end face provided with an aperture therein is secured to a disclike cathode support along an inner edge to form a wedge-shaped gap which is thereafter filled with a metal powder. The metal powder is then sintered to provide a thermally conductive body between the heater housing and the cathode disc from which metal particles do not work loose.
3,574,910

METHOD OF MANUFACTURING AN INDIRECTLY HEATED DISK-LIKE CATHODE AND CATHODE MANUFACTURED BY SAID METHOD

The invention relates to a method of manufacturing an indirectly heated disk-like cathode consisting of a support for the heating material which is secured to a metal holder containing the heating element, the space between the heating element and the support being filled with a sintered metal powder. The invention furthermore relates to a cathode manufactured by the said method.

It is known that the heat transfer between the heating element and the support for the emitting layer of a cathode can be improved when the space between the heating element and the support is entirely filled with sintered metal powder, for example, nickel powder. A drawback of the known constructions is, however, that as a result of the difference in coefficients of expansion of the various components the sintered metal powder easily works loose from the surface of the support and/or from the surface of the heating element. A heating element is to be understood to mean in this connection a filament which is coated with insulating material, generally aluminum oxide. Another drawback is that the heat content of the cathode is considerably increased by the comparatively large quantity of metal powder, which causes a prolongation of the heating up time.

The working loose of the metal powder causes unmanageable changes in the distribution of the cathode temperature and/or local overheating of the heating element. It is known to avoid this by making the sintered metal layer porous and somewhat flexible by using a mixture of coarse granular powder of, for example, nickel and a small quantity of fine grains of a different metal, for example, molybdenum or palladium. By heating above the alloying temperature of the metals the fine granular metal connects the coarse grains locally so that a porous mass is obtained. Although as a result of this the working loose of the metal powder can be avoided, the drawback remains of the increase of the heat mass while the method is complicated.

The said drawbacks can be avoided substantially entirely by using the method according to the invention, in which the holder for the heating element is formed like a cap the end face of which comprises an aperture, which holder is welded against the support with its end face in such a manner that as a result of the pressure and the local heating during welding, a gap has a cross section is formed between the inwardly directed edge of the end face and the support, after which the heating element which is dipped in a suspension of a suitable metal powder, is provided in the holder and the metal powder is released, for example, by dipping the support with the holder in a solvent for the suspension medium of the metal powder, so that it flows into the space between the support and the heating element and into the gap and fills it after which the solvent and the suspension medium are removed by heating and the metal powder is sintered after which the support is provided with emitting material. The lower side of the holder is preferably closed by means of a cover. This cover preferably consists of metal and may be formed integral with the holder. Alternatively, a few connection strips may be present and be formed integral with the holder.

The invention will be described with reference to the accompanying drawing, in which:

FIG. 1 is a perspective view of a support and a holder prior to welding; and

FIG. 2 is a cross-sectional view during welding of the holder to the support; and

FIG. 3 shows the holder and the heating element prior to assembling; and

FIG. 4 is a cross-sectional view of a cathode according to the invention.

Referring now to the FIGS., reference numeral 1 denotes the support for the emitting material, 2 denotes the holder for the heating element 8. The end face 3 of the holder 2 comprise an aperture 4. A cover 5 is formed integral with the holder 2 as well as the connection strips 14. The holder 2 is forced against the support 1 with the edge of its end face (FIG. 2) by means of a hollow welding terminal 6 and a flat welding terminal 7. The welding terminal 6 terminates in a sharp edge so that the holder 2 after welding is connected to the support 1 by means of a ring weld 13 (FIG. 3). Instead of a ring weld, a number of separate welds may alternatively be used. As a result of the pressure and the high local heating of the edge 3 during welding, the edge 3 bends inwardly so that a gap 12 which in this case is annular and has a wedge-like cross section is formed within the edge 3 and the support 1. The heating element 8 consisting of a tungsten filament 10 which is embedded in aluminum oxide, is dipped in a suspension consisting of nickel powder and a binder, for example, nitrocrocelulose, so that a layer 9 of this suspension covers the heating element 8. The heating element 8, after drying of the layer 9, is forced into the holder 2, the cover 5 is closed and the assembly is dipped in a solvent of the said binder, for example, acetone. The binder dissolves and the metal powder flows into the cavity between the element 8, the support 1 and the holder 2 fills the wedge-like gap 12. The metal powder is then sintered, during which the binder burns away. The sintered metal particles provide a ready heat conduction between the element 8 and the support 1 without the heat content of the cathode being increased noteworthy. As a result of the small quantity and the thin layer of metal powder, the expansion also is negligible so that working loose of the layer of metal powder from the support does not occur, more so since the thin-walled edge 3 is flexible so that mechanical stresses in the material remain small.

The support 1 is then provided with a layer 11 of barium strontium carbonate and the connection strips 14 are bent to the correct shape after which the cathode, a cross section of which is shown in FIG. 4, can be incorporated in an electron gun or a discharge tube.

In a particular embodiment the diameter of the cathode was 1.2 mm., the thickness 0.33 mm. The holder 2 was of a nickel-iron alloy, the coefficient of expansion of which is approximately 70 x 10⁻⁶ and which corresponds to that of the tungsten of the filament 20. The thickness of the support was 50 microns, the wall thickness of the holder 2 was 20 μ. The grain size of the nickel powder 9 was from 1 to 10 μ.

Instead of a nickel support 1 coated with emitting material, a porous support 1 compressed from tungsten powder may alternatively be used and afterwards be impregnated with emitting material. A profiled support 1 may alternatively be used which may comprise an emitting pill. Instead of nickel powder 9, a powder of any of the commonly used known metals, for example, tungsten, palladium, or molybdenum may be used.

1. A method of manufacturing an indirectly heated disk-like cathode consisting of a support for the emitting material which is secured to a metal holder containing a heating element, the space between the heating element and the support being filled with a sintered metal powder, comprising the steps of welding an end face of a cup-shaped holder for the heating element along an inwardly directed edge to the support to form therewith a gap having a wedge-like cross section between the inwardly directed edge of the end face and the support, said end face having an aperture therein, thereafter dipping the heating element in a suspension of a metal powder, placing the heating element in a sheet of the metal powder thereon in the holder, dipping the support with the holder in a suspension medium of the metal powder to fill the gap between the support and the holder, heating the support and the holder to remove the suspension medium, sintering the metal powder, and thereafter providing the support with emitting material.

2. A method as claimed in claim 1, wherein the open side of the holder is closed by means of a cover.
CERTIFICATE OF CORRECTION

Patent No. 3,574,910  Dated April 13, 1971

Inventor(s) ADRIANUS KULPER

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

COLUMN 2, line 40, change "70 x 10^{17}" to

\[ -7 \cdot 70 \times 10^{-7} \]

SIGNED AND SEALED THIS 13th DAY OF July, 1971

(SEAL)

EDWARD M. FLETCHER, JR.  WILLIAM E. SCHUYLER, JR.
Attesting Officer  Commissioner of Patents