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(54) **Method of manufacturing a scandat cathode.**

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EP-A- 0 091 161
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PATENT ABSTRACTS OF JAPAN, vol. 8, no. 190 (E-263)[1627], 31st August 1984 & JP-A-59 79 934 (HITACHI SEISAKUSHO K.K.) 09-05-1984

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Description

The invention relates to a method of manufacturing a dispenser cathode comprising a barium compound for dispensing barium to an emissive surface of a porous cathode body substantially comprising a metal melting at a high temperature.

The invention also relates to an electron tube provided with a cathode manufactured by such a method.

A characteristic feature of dispenser cathodes is that there is a functional separation between the electron emissive surface on the one hand and a store of the emitter material for realizing a sufficiently low work function on the emissive surface on the other hand. The emitter material is present in the pores of the porous metal cathode body.

A method of the type mentioned in the opening paragraph is described in United States Patent No. 4,077,393. This patent describes how a cathode body with a porosity of approximately 20% compressed from tungsten powder and subsequently sintered is impregnated with a mixture which comprises calcium oxide, aluminium oxide and scandium oxide in addition to barium oxide.

European Patent Specification No. 0,091,161 describes how such cathodes can be improved on sensitivity to and recovery after ion bombardment by compressing the cathode body (notably the top layer) from a mixture of tungsten powder and scandium oxide and by subsequently sintering it. To obtain a cathode body with a thin top layer (approximately 0.1 mm) which is as homogeneous as possible the compressing operation is generally performed in two steps. Firstly, the tungsten portion of the cathode body is slightly pre-compressed. Subsequently, the top layer powder is evenly distributed over a surface of the tungsten portion whereafter the definitive compressing operation is performed.

European Patent Specification 0.179.513 describes a method in which the porous body is obtained from a mixture of scandium hydride-tungsten powder and tungsten powder. The scandium hydride-tungsten powder is obtained by compressing tungsten powder into a porous plug, into the pores if which scandium is drawn. After cooling in hydrogen the plug becomes brittle due to the fact that scandium is partly converted into scandium-hydride. The plug is then pulverized and the fragments are heated in a hydrogen atmosphere. After cooling substantially all the scandium is converted into scandium hydride. The fragments are then ground to a powder consisting of tungsten grains having scandium hydride in their pores.

It is an object of the invention to provide a different method of manufacturing such a dispenser cathode which method is simpler and leads to similar results as regards current density and lifetime.

To this end a method according to the invention is characterized in that the cathode body is compressed from a quantity of metal powder which is mixed with scandium or scandium hydride whereafter the body is sintered and the cathode is provided with emitter material. The quantity of scandium hydride in the quantity of metal powder is preferably 0.3-0.7 % by weight.

From a manufacturing technical point of view such a method is more advantageous because compressing is only to be performed in one operation and the distribution of the top-layer powder is no longer necessary. Also the method of preparing scandium hydride/tungsten grains can be dispensed with. After the introduction of the impregnant the cathode bodies manufactured by means of such a method can undergo mechanical treatments such as turning or other types of shaping without any detrimental effects.

In order to prevent as much as possible that scandium is lost during sintering which is preferably performed in a hydrogen atmosphere, this sintering operation is preferably performed at a temperature which is lower than the melting point of scandium (1539 °C). However, on the other hand the sintering temperature must be chosen to be as high as possible in order to obtain a sufficiently robust cathode body.

A preferred embodiment of a method according to the invention is therefore characterized in that the sintering temperature is between 1430 °C and 1500 °C.

The invention will now be described in greater detail by way of example with reference to the accompanying drawing, in which:

Figure 1 is a longitudinal cross-section of a cathode according to the invention and

Figure 2 is an elevational view of a cylindrical cathode according to the invention.

Figure 1 is a longitudinal cross-section of a cathode according to the invention. The cathode body 1 is compressed from a mixture of tungsten powder and approximately 0.5% by weight of scandium or scandium-hydride. After compressing at a pressure of approximately 3.5 atmosphere and sintering in hydrogen for approximately one hour at 1450 °, the cathode body of scandium and tungsten has a porosity of approximately 20%. The cathode body 1 now has, for example, a thickness of 0.5 mm and a diameter of approximately 1.8 mm.

Subsequently, the cathode body 1 is impregnated in a hydrogen atmosphere with barium calcium aluminate (for example, $5BaO; 2Al_2O_3; 3CaO$ or $4BaO; 1Al_2O_3; 1CaO$), compressed in a holder 2 and welded onto the cathode shank 3. The cathode

shank 3 accommodates a coiled cathode filament 4 comprising a helically wound metal core 5 and an aluminium oxide insulating layer 6. The emission of the emissive surface 7 of such a cathode was approximately 100 A/cm^2 at 950 °C obtained at a pulse load at 1000 V in a diode with a cathode-anode distance of 0.3 mm. Such an emission is comparable to that of a cathode with a top layer of tungsten and scandium oxide as described in European Patent Application No. 0,178,716 (PHN 11,169) which is more difficult to manufacture. The recovery after ion bombardment was comparable to that of the cathode described in that Application with a cathode body sintered at approximately 1900 °C (approximately 65%). In a cathode according to the invention, sintered at 1500 °C this recovery was poorer and was approximately 58%. For the significance of the recovery percentages and the way in which they have been determined reference is made to the European Patent Application No. 0,178,716 or to the magazine Article "Properties and manufacture of top layer scandate cathodes" in Applied Surface Science 26 (1986), pages 173-195.

In the above-mentioned example the impregnant absorption was approximately 4.5%. Upon raising the quantity of scandium (hydride) in the mixture to be compressed to 1 percent by weight this absorption decreased to approximately 2% which shortens the life time of the cathode. For a quantity of 0.3-0.7% by weight of scandium (hydride) the quantity of absorbed impregnant is sufficient; the recovery after ion bombardment did not show any significant change in this range.

A cylinder 20 with an emissive surface 21 in which a heating element is provided and which is shown in an elevational view in Figure 2 can also be turned from a tungsten body compressed in accordance with the method as described hereinbefore.

The cathodes according to the invention may be used in electron tubes such as, for example magnetrons, transmitter tubes, etc., but also in cathode-ray tubes for e.g. television applications and electron microscopy.

Claims

1. A method of manufacturing a dispenser cathode comprising a barium compound for dispensing barium to an emissive surface of a porous cathode body substantially comprising a metal melting at a high temperature, characterized in that the cathode body is compressed from a quantity of metal powder which is mixed with scandium or scandium hydride whereafter the body is sintered and the cathode is provided with emitter material.

2. A method as claimed in Claim 1, characterized in that the quantity of scandium or scandium hydride in the mixture of metal powder and scandium or scandium hydride is approximately between 0.3 and 0.7 % by weight.

3. A method as claimed in Claim 1 or 2, characterized in that the sintering temperature is lower than the melting point of scandium.

4. A method as claimed in Claim 3, characterized in that the sintering temperature is between 1430 ° C and 1500 ° C.

5. A method as claimed in any one of the preceding Claims, characterized in that the cathode body is definitively shaped after it has been provided with emitter material.

6. An electron tube provided with a cathode manufactured by means of a method as claimed in Claims 1 to 5

Patentansprüche

1. Verfahren zum Herstellen einer Nachlieferkathode mit einer Bariumverbindung zum Nachliefern von Barium nach einer emittierenden Oberfläche eines porösen Kathodenkörpers, der im wesentlichen ein bei hoher Temperatur schmelzendes Metall enthält, dadurch gekennzeichnet, daß der Kathodenkörper aus einer Metallpulvermenge gepreßt wird, wobei das Metallpulver mit Scandium oder Scandiumhydrid vermischt ist, wonach der Körper gesintert und die Kathode mit Emittermaterial versehen wird.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die Scandium- oder Scandiumhydridmenge in der Mischung aus Metallpulver und Scandium oder Scandiumhydrid etwa 0,3 bis 0,7 Gew. % beträgt.

3. Verfahren nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Sintertemperatur niedriger als die Schmelztemperatur des Scandiums ist.

4. Verfahren nach Anspruch 3, dadurch gekennzeichnet, daß die Sintertemperatur zwischen 1430 °C und 1500 °C liegt.

5. Verfahren nach einem oder mehreren der vorangehenden Ansprüche, dadurch gekennzeichnet, daß der Kathodenkörper eine endgültige Form erhält, nachdem er mit Emittermaterial versehen ist.

6. Elektronenröhre mit einer Kathode, die mit Hilfe eines Verfahrens nach den Ansprüchen 1 bis 5 hergestellt worden ist.

Revendications

1. Procédé de fabrication d'une cathode de délivrance en supplément comprenant un composé du baryum pour délivrer du baryum à une surface émissive d'un corps de cathode poreux comprenant en substance un métal fondant à une température élevée, caractérisé en ce que le corps de cathode est pressé à partir d'une quantité de poudre de métal qui est mélangée avec du scandium ou de l'hydrure de scandium, après quoi le corps est fritté et la cathode est pourvue d'une matière émissive.

2. Procédé suivant la revendication 1, caractérisé en ce que la quantité de scandium ou d'hydrure de scandium dans le mélange de poudre de métal et de scandium ou d'hydrure de scandium est d'environ 0,3 à 0,7% en poids.

3. Procédé suivant la revendication 1 ou 2, caractérisé en ce que la température de frittage est inférieure au point de fusion du scandium.

4. Procédé suivant la revendication 3, caractérisé en ce que la température de frittage est située entre 1430 °C et 1500 °C.

5. Procédé suivant l'une quelconque des revendications précédentes, caractérisé en ce que le corps de cathode est façonné définitivement après qu'il a été pourvu de la matière émissive.

6. Tube électronique équipé d'une cathode fabriqué par la mise en oeuvre d'un procédé suivant les revendications 1 à 5.

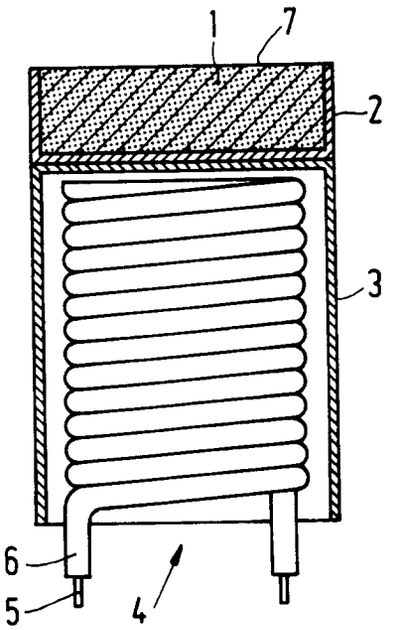

FIG.1

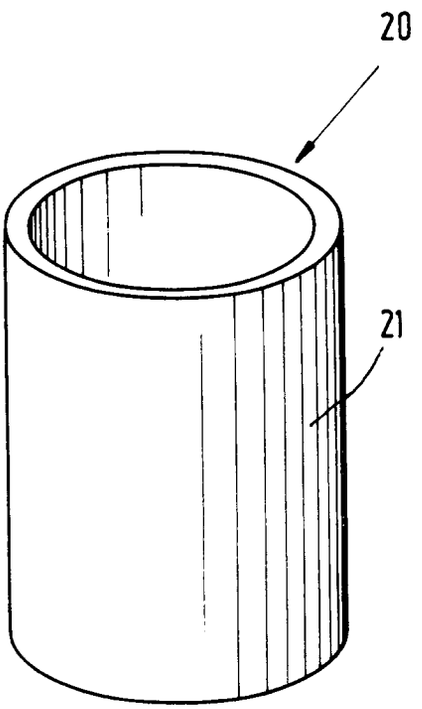

FIG. 2