

(19)



Europäisches Patentamt  
European Patent Office  
Office européen des brevets

(11) Publication number:

**0 248 470  
B1**

(12)

## EUROPEAN PATENT SPECIFICATION

(45) Date of publication of the patent specification:  
**28.03.90**

(51) Int. Cl. 4: **H01J 9/04, H01J 1/28**

(21) Application number: **87200951.9**

(22) Date of filing: **20.05.87**

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

(30) Priority: **29.05.86 NL 8601374**

(43) Date of publication of application:  
**09.12.87 Bulletin 87/50**

(45) Publication of the grant of the patent:  
**28.03.90 Bulletin 90/13**

(84) Designated Contracting States:  
**DE FR GB IT NL**

(56) References cited:  
**EP-A- 0 179 513**  
**US-A- 4 236 287**

**JOURNAL OF PHYSICS D, vol. 4, no. 1, January 1971,  
pages 39-46, Letchworth, Hertfordshire, GB; N.K.  
MITRA: "A small high current-density thermionic  
emitter"**

(73) Proprietor: **N.V. Philips' Gloeilampenfabrieken,  
Groenewoudseweg 1, NL-5621 BA Eindhoven(NL)**

(72) Inventor: **Van Esdonk, Johannes, c/o INT.  
OCTROOIBUREAU B.V. Prof. Holstlaan 6, NL-5656 AA  
Eindhoven(NL)**  
Inventor: **Hasker, Jan, c/o INT. OCTROOIBUREAU B.V.  
Prof. Holstlaan 6, NL-5656 AA Eindhoven(NL)**  
Inventor: **Swemmers, Antonius Hendrikus Maria, c/o  
INT. OCTROOIBUREAU B.V. Prof. Holstlaan 6,  
NL-5656 AA Eindhoven(NL)**

(74) Representative: **Raap, Adriaan Yde et al,  
INTERNATIONAAL OCTROOIBUREAU B.V. Prof.  
Holstlaan 6, NL-5656 AA Eindhoven(NL)**

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid (Art. 99(1) European patent convention).

## Description

The invention relates to a method of manufacturing a dispenser cathode comprising a porous tungsten body having a surface area intended for electron emission, which tungsten body incorporates scandium oxide at least in a layer adjacent the surface area intended for electron emission, and which tungsten body containing the scandium oxide is impregnated with an oxidic material after sintering.

In the manufacturing practice of dispenser cathodes the mechanical design of the hard and brittle tungsten body has often been found to be a problem.

In a known method for the mechanical design of porous tungsten bodies copper is therefore absorbed in the tungsten body prior to the mechanical design.

The tungsten body can then be given the required shape mechanically (US-A 2 669 008).

Subsequently the copper is removed from the tungsten body by evaporation in a vacuum.

According to US-A 2 986 799 the method using copper is time-consuming, costly and cumbersome. This patent describes the use of an oxidic barium-containing material instead of copper. This also simplifies processing of the tungsten body and this oxidic material does not have to be removed from the tungsten body because it is required anyway in the electron emission of the cathode.

In the further development of dispenser cathodes it has been found to be advantageous to incorporate scandium oxide in at least a layer adjacent a surface area of the tungsten body intended for electron emission during the manufacture of the tungsten body (NL-A 8 201 371).

It is found that the presence of scandium oxide in the tungsten body may reduce the absorption possibility of barium-containing oxidic material by the tungsten body. Moreover, the prospects for a satisfactory mechanical processing in the presence of scandium oxide are poor because sintered scandium oxide is much more difficult to process mechanically than sintered tungsten.

It is an object of the invention, *inter alia*, to obviate the described problem at least to a considerable extent.

According to the invention, the method described in the opening paragraph is therefore characterized in that molten copper is absorbed in the entire scandium oxide-containing sintered tungsten body prior to impregnation and in that the copper is removed from the tungsten body after a mechanical design treatment of the tungsten body which is effected at least on the side of the surface area intended for electron emission.

The method according to the invention is surprising because the processibility of the tungsten body, even if it contains a comparatively high percentage by volume of scandium oxide, is very satisfactory in the presence of copper. Furthermore, the copper can be removed in a comparatively simple manner after the mechanical operation so that there is certainly no question of an expensive, time-consuming and cumbersome method.

A scandium oxide content of preferably 2 to 10% by weight is used in the tungsten body.

A scandium oxide content of 3 to 7% by weight is used with special preference in the tungsten body.

The mechanical treatment preferably extends from the surface area intended for electron emission throughout a scandium oxide-containing layer adjacent the surface area.

The invention will now be described in greater detail with reference to an example and the accompanying drawing.

The drawing diagrammatically shows in a cross-section a part of a dispenser cathode manufactured by means of the method according to the invention.

In a method of manufacturing a dispenser cathode which has a porous tungsten body 1 with a surface area 2 intended for electron emission, scandium oxide is incorporated in a layer 3 adjacent the surface area 2 intended for electron emission. This is effected, for example, as follows. A 0.5 mm thick layer of tungsten powder is introduced into a mould having a circular opening with a diameter of 1.8 mm. A 0.1 mm thick layer of powder consisting of a mixture of tungsten and 5% by weight of scandium oxide is provided on the layer of tungsten powder.

After compression to a pellet the pellet is sintered in hydrogen at 1500°C for 1 hour. The total thickness of the sintered body is then approximately 0.6 mm and the thickness of the layer 3 is approximately 0.1 mm.

According to the invention, prior to impregnating the sintered tungsten body with an oxidic material, molten copper is absorbed in the entire scandium oxide-containing sintered tungsten body 1.

To this end the body is provided with oxygen-free copper as a plate or a pellet in a quantity which is at least equal to the free space in the sintered body (the free space in the sintered body is approximately 20%) and is absorbed as a melt in the tungsten body.

Subsequently the tungsten body 1 is subjected to a mechanical design treatment at least on the side of the surface area 2 intended for electron emission. The latter treatment may be a conventional treatment such as turning, drilling or milling.

In the case shown in the drawing, the design treatment extends throughout the layer 3 and the size of the scandium oxide-containing layer 3 is limited so that also the surface area 2 intended for electron emission is limited.

After the design treatment the copper is removed from the tungsten body. This is effected, for example, by means of nitric acid and water in a 1:1 ratio so that substantially all copper is removed. After cleaning and rinsing any possible last remainders of copper are removed by evaporation for several minutes at 1700°C in hydrogen. By burning the hydrogen flowing from the equipment the absence of copper can be established by the absence of a green colour. Subsequently the tungsten body is impregnated in a conventional manner with oxides of barium, calcium and aluminium (4:1:1), cleaned and welded to a shaft 4 provided with a heating element 5.

The dispenser cathode shown in the drawing is used, for example, as a component of a diode gun in a cathode ray tube. Such a gun accommodates above the cathode an anode 6 having a small aperture 7 (diameter, for example, 40  $\mu\text{m}$ ). The beam current passes through this aperture during operation while the anode potential is of course positive with respect to the cathode. Since the diameter of the electron emitting part is small ( $\sim 0.3$  mm) due to the processing operation, the thermal load of the anode may be sufficiently low.

### Claims

1. A method of manufacturing a dispenser cathode comprising a porous tungsten body having a surface area intended for electron emission, which tungsten body incorporates scandium oxide at least in a layer adjacent the surface area intended for electron emission and which tungsten body containing the scandium oxide is impregnated with an oxidic material after sintering, characterized in that molten copper is absorbed in the entire scandium oxide-containing sintered tungsten body prior to impregnation and in that the copper is removed from the tungsten body after a mechanical design treatment of the tungsten body which is effected at least on the side of the surface area intended for electron emission.

2. A method as claimed in Claim 1, characterized in that a scandium oxide content of 2 to 10% by weight is used in the tungsten body.

3. A method as claimed in Claim 2, characterized in that a scandium oxide content of 3 to 7% by weight is used in the tungsten body.

4. A method as claimed in any one of the preceding Claims, characterized in that the mechanical treatment extends from the surface area intended for electron emission throughout a scandium oxide-containing layer adjacent said surface area.

5. A cathode ray tube including a dispenser cathode manufactured by means of the method as claimed in any one of the preceding Claims.

### Patentansprüche

1. Verfahren zum Herstellen einer Nachlieferungskathode, die einen porösen Wolframkörper aufweist mit einem zur Elektronenemission bestimmten Oberflächengebiet, wobei dieser Wolframkörper wenigstens in einer an das für Elektronenemission bestimmte Oberflächengebiet grenzenden Schicht Skandiumoxid aufweist und wobei dieser skandiumoxidhaltige Wolframkörper nach dem Sintern mit einem oxidischen Material imprägniert wird, dadurch gekennzeichnet, daß in dem ganzen skandiumoxidhaltigen gesinterten Wolframkörper vor dem Imprägnieren geschmolzenes Kupfer absorbiert wird, und daß das Kupfer nach einer mechanischen Formgestaltungsbehandlung des Wolframkörpers das Kupfer aus dem Wolframkörper entfernt wird, wobei diese Behandlung an wenigstens derjenigen Seite des Oberflächengebietes erfolgt, die für Elektronenemission bestimmt ist.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß in dem Wolframkörper ein Skandiumoxidgehalt von 2 bis 10 Gew.-% verwendet wird.

3. Verfahren nach Anspruch 2, dadurch gekennzeichnet, daß in dem Wolframkörper ein Skandiumoxidgehalt von 3 bis 7 Gew.-% verwendet wird.

4. Verfahren nach einem der vorstehenden Ansprüche, dadurch gekennzeichnet, daß die mechanische Behandlung sich von dem für Elektronenemission bestimmten Oberflächengebiet durch eine an das genannte Gebiet grenzende skandiumoxidhaltige Schicht hindurch erstreckt.

5. Elektronenstrahlröhre mit einer Nachlieferungskathode, die nach dem Verfahren nach einem der vorstehenden Ansprüche hergestellt ist.

### Revendications

1. Procédé pour la réalisation d'une cathode à réserve comportant un corps en tungstène poreux présentant une surface destinée à l'émission d'électrons, corps en tungstène dans lequel est incorporé de l'oxyde de scandium au moins dans une couche adjacente à la surface destinée à l'émission d'électrons, lequel corps en tungstène contenant de l'oxyde de scandium est imprégné de matériau oxydique après frittage, caractérisé en ce que du cuivre fondu est absorbé dans tout le corps en tungstène fritté contenant de l'oxyde de scandium avant l'imprégnation et en ce que le cuivre est enlevé du corps en tungstène après un traitement de façonnage mécanique du corps en tungstène qui est effectué au moins du côté de la surface destinée à l'émission d'électrons.

2. Procédé selon la revendication 1, caractérisé en ce qu'une teneur en oxyde de scandium de 2 à 10% en poids est utilisée dans le corps en tungstène.

3. Procédé selon la revendication 2, caractérisé en ce qu'une teneur en oxyde de scandium de 3 à 7% est utilisée dans le corps en tungstène.

4. Procédé selon l'une des revendications précédentes, caractérisé en ce que le traitement mécanique s'étend à partir de la surface destinée à l'émission d'électrons à travers une couche contenant de l'oxyde de scandium voisine à ladite surface.

5. Tube à rayons cathodiques comportant une cathode réalisée à l'aide du procédé selon l'une des revendications précédentes.

