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(12) # EUROPEAN PATENT APPLICATION

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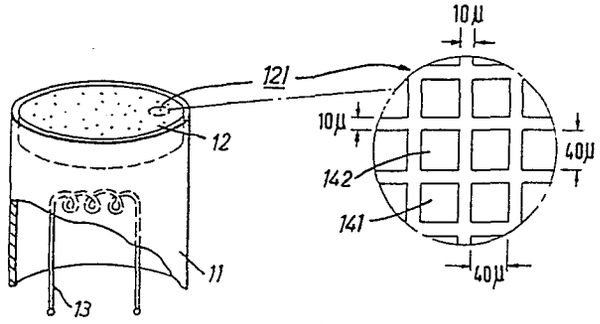
(54) **Thermionic cathode.**

(57) An example of a thermionic cathode (Figure 1) comprises a porous body (12) of Tungsten impregnated with Barium Calcium Aluminate. The body has a coating of Osmium in isolated squares (142) such that no portion of the surface of the coating is more than 30 micron from an exposed surface of the body. Materials other than Tungsten, Barium Calcium Aluminate, and Osmium may be used. The coating may be in a predetermined pattern other than squares. By providing a large amount of interface between the coating and the exposed surface of the body, electron emission is enhanced.



EP 0 004 424 A1

THERMIONIC CATHODE

The present invention relates to a thermionic cathode.

A known thermionic cathode comprises a porous body of tungsten impregnated with Barium Calcium Aluminate and coated with Osmium over its entire surface. The coating may be 0.2 microns thick.

According to one aspect of the present invention there is provided a thermionic cathode comprising:

a porous body of refractory metal selected from the group consisting of Tungsten and Molybdenum and alloys thereof;

a material, dispersed within the body, constituted by a mixture of Barium Oxide, an oxide of an alkaline earth metal other than Barium and at least one oxide selected from the group consisting of Aluminium Oxide and Boron oxide; and a predetermined pattern comprising a coating of a metal selected from the group consisting of Osmium, Iridium, Ruthenium, Rhodium and Rhenium and alloys thereof on the surface of the said body and exposed surface of the body, the predetermined pattern being such that no portion of the surface of the coating is more than 30 micron from the exposed surface of the body.

According to another aspect of the present invention, there is provided a method of making a thermionic cathode comprising the step of forming, on a porous body of refractory metal selected from the group consisting of Tungsten and Molybdenum and alloys thereof, there being dispersed within the cathode a material constituted by a mixture of Barium Oxide, an oxide of an alkaline earth metal other than Barium and at least one oxide

selected from the group consisting pf Aluminium Oxide and Boro Oxide, a predetermined pattern comprising a coating of a metal selected from the group consisting of Osmium, Iridium, Ruthenium, Rhodium and Rhenium and alloys thereof on the surfa of the body and exposed surface of the body, the predetermined pattern being such that no portion of the surface of the coati is more than 30 micron from the exposed surface of the body.

It will be appreciated that the cathode of the invention h a long interface between the coating and the exposed surface of the body. This is because the invention has discovered that electron emission at an interface between the coating and the exposed surface is enhanced.

The coating may have a thickness in the range 0.1 to 1.0 microns although 0.2 to 0.4 microns is preferred.

The coating may be in zones separated by exposed surfaces the body, adjacent zones being spaced apart at a distance in th range 1 to 20 microns. The zones may be regularly or irregularly positioned on the body. The zones may be in the form of squares, or strips having a width or widths in the rang 5 to 50 microns. Alternatively the coating may be in the form of a convoluted strip, e.g. a spiral.

Embodiments of the invention are now described, by way of example, with reference to the accompanying drawings, in which:-

Figures 1, 2 and 3 show portions of electron emitters according to the invention,

Figure 4 shows a graph useful in the description of the invention.

Figure 1 shows in schematic form a dispenser cathode form o electron emitter. A thin walled tube 11 of refractory metal, such as molybdenum, has at one end a tablet of refractory material, 12, such as tungsten sponge, impregnated with an alkaline earth compound such as barium calcium aluminate. An osmium coating is applied to body 12 as a film 121. The film has hitherto been applied in a generally uniform manner with the body 12 as a substrate. The film may be 1000 to 10,000 A thick

A conductive filament, 13, heatable by the passage of electric current, is provided inside tube 11. The arrangement of such cathodes is well-known and is not specifically described further.

It has now been found that electron emission occurs more readily at an interface between the edge of the film and the body. Figure 4 is a graph of emission, in arbitrary units X, against distance, plotted along a line crossing the interface. The interface is at about the 60 micron point. The uncoated area A of refractory body, to the left in Figure 4, has an emission of some 1 unit, while the coated area B to the right has an emission of some 3 units. However the interface, C, has a much higher emission, a peak of some 9 units, over a width of some 10 to 20 micron.

The reasons for the higher emission at the interface region are not known but it is likely that in this region the rate of supply of Ba/Ba O actuator material to the substrate, and the substrate composition there present, are more nearly optimum than on either of the coated and uncoated portions.

A similar but less pronounced effect is produced on scribing a line through the osmium film.

Thus, in accordance with the present invention, the coating is formed in a predetermined pattern such that no portion of the surface of the coating is more than 30 micron from an exposed surface of the body. This increases the length of interface for a given area of substrate.

Figure 1 shows in the enlarged portion one form of osmium coating, 121, in accordance with the invention, which increases the interface length for a given area of substrate. The osmium film is present in elements 141, 142 some 40 microns square spaced by 10 microns from each other. These sizes and spacings are chosen with reference to measurements such as are shown in Figure 4 which suggest that a 10 to 20 micron region at the edge of, and probably extending into, the osmium film, is the more effective emitter. A suitable method for the production of an osmium film in such a form is to sputter coat or evaporate

through a fine mesh. A suitable mesh is 750 threads per inch electrolytic mesh, as used in camera tubes. Before coating the cathode surface this should be polished to assist in good registration and the production of accurate, well-formed osmium film elements.

Using the above technique, or similar techniques, a cathode can be produced with a considerable proportion, in some cases over 50%, of the surface formed as the interface region, having a film coating which is no more than 30 micron and preferably 10 to 20 micron from the uncoated surface. The film is preferably 0.2 to 0.4 microns thick.

Other suitable methods are to deposit a uniform film over the whole surface and etch or cut away the film to leave the elements. Material may be cut away by ion-beam milling or mechanical scribing. Masking techniques, for example photo-resist masks, may also be used.

Figures 2 and 3 show other patterns in which the film can be deposited, Figure 2 shows strips 241, 242 of osmium film 221 some 30 micron wide spaced 15 micron apart. These could be separate parallel strips or successive turns of a single spiral strip.

Figure 3 shows portions 341, 342 of continuous film 321 having a channel 35, which produces the extended interface, to the substrate surface. The channel is 15 microns wide and the portions are 40 micron wide.

The elements such as 141, 241, 341, 342 can have sizes of some 5 microns up to 50 microns across and be a strip, square, round or have irregular form. The elements can be spaced by some 1 to 20 or more microns in a regular or irregular pattern. The cathode surface may be plane or curved preferably into a concave form. The area of the coating may be greater than the area of exposed surface of the tungsten body.

The coating has been described as a film but clearly particles or other forms of material can be used to make the coating. For example the particles, some 40 to 50 micron across, could be pressed into the surface of a green tungsten

compact and sintered. The surface is then impregnated with an activator, e.g. tungsten/barium aluminate, and may be polished if desired.

Materials other than osmium, e.g. iridium, ruthenium, rhodium, rhenium and alloys of two or more of these five materials are also suitable using appropriate deposition techniques. Instead of barium calcium aluminate, other materials may be used as impregnant for the tungsten body. Such materials are disclosed in U.S. Patent 3,201,639 (Levi). Furthermore, instead of tungsten, molybdenum may be used.

The technique described above permit the production of cathodes with emission increased by factors of 2 or 3 for osmium. Typically "islands" of osmium should enhance output by 30% to 90% and stripes by 60%-140% for a given area of cathode.

Claims

1. A thermionic cathode comprising:

a porous body of refractory metal selected from the group consisting of Tungsten and Molybdenum and alloys thereof;

a material, dispersed within the body, constituted by a mixture of Barium Oxide, an oxide of an alkaline earth metal other than Barium and at least one oxide selected from the group consisting of Aluminium Oxide and Boron oxide; and a predetermined pattern comprising a coating of a metal selected from the group consisting of Osmium, Iridium, Ruthenium, Rhodium and Rhenium and alloys thereof on the surface of the said body and exposed surface of the body, the predetermined pattern being such that no portion of the surface of the coating is more than 30 micron from the exposed surface of the body.

2. A cathode according to Claim 1, wherein the coating has a thickness in the range of 0.1 to 1.0 microns.

3. A cathode according to Claim 1, wherein the coating has a thickness in the range 0.2 to 0.4 microns.

4. A cathode according to Claim 1, 2 or 3, wherein the said coating is in zones separated by exposed surfaces of the body, adjacent zones being spaced apart at a distance in the range 1 to 20 microns.

5. A cathode according to Claim 4, wherein the zones are in the form of strips each having a width in the range 5 to 50 microns.

6. A cathode according to Claim 1, 2, 3 or 4, wherein the zones are in the form of squares, the sides of each of which have a length in the range 5 to 50 microns.

7. A cathode according to Claim 4, 5 or 6, wherein the zones are arranged regularly over the surface of the body.

8. A cathode according to Claim 4, 5 or 6, wherein the zones are arranged irregularly over the surface of the body.

9. A cathode according to any one of claims 1 to 3, wherein the coating is in the form of a single convoluted strip.

10. A cathode according to Claim 9, wherein the strip is in the form of a spiral.

11. A cathode according to any preceding claim wherein the coating is in the form of a film.

12. A cathode according to any one of claims 1 to 10 wherein the coating is in particulate form.

13. A cathode according to any preceding claim, wherein the oxide of an alkaline earth metal other than Barium is Calcium Oxide.

14. A method of making a thermionic cathode comprising the step of forming, on a porous body of refractory metal selected from the group consisting of Tungsten and Molybdenum and alloys thereof, there being dispersed within the cathode a material constituted by a mixture of Barium Oxide, an oxide of an alkali earth metal other than Barium and at least one oxide selected from the group consisting of Aluminium Oxide and Boron Oxide, a predetermined pattern comprising

a coating of a metal selected from the group consisting of Osmium, Iridium, Ruthenium, Rhodium and Rhenium and alloys thereof on the surface of the body, and exposed surface of the body, the predetermined pattern being such that no portion of the surface of the coating is more than 30 micron from an exposed surface of the body.

15. A method according to Claim 14, wherein the coating is formed in the predetermined pattern by sputtering or evaporating through a mask defining the pattern.

16. A method according to Claim 14, wherein the coating is formed in the predetermined pattern by coating the surface of the body and selectively removing the coating to form the pattern.

17. A method according to Claim 14, wherein the said body is formed by compacting and sintering powder of the said refractory metal, the said coating is formed by pressing particles of the said metal into the surface of the body, and the said material is dispersed within the cathode by impregnating the surface thereof with the said material.

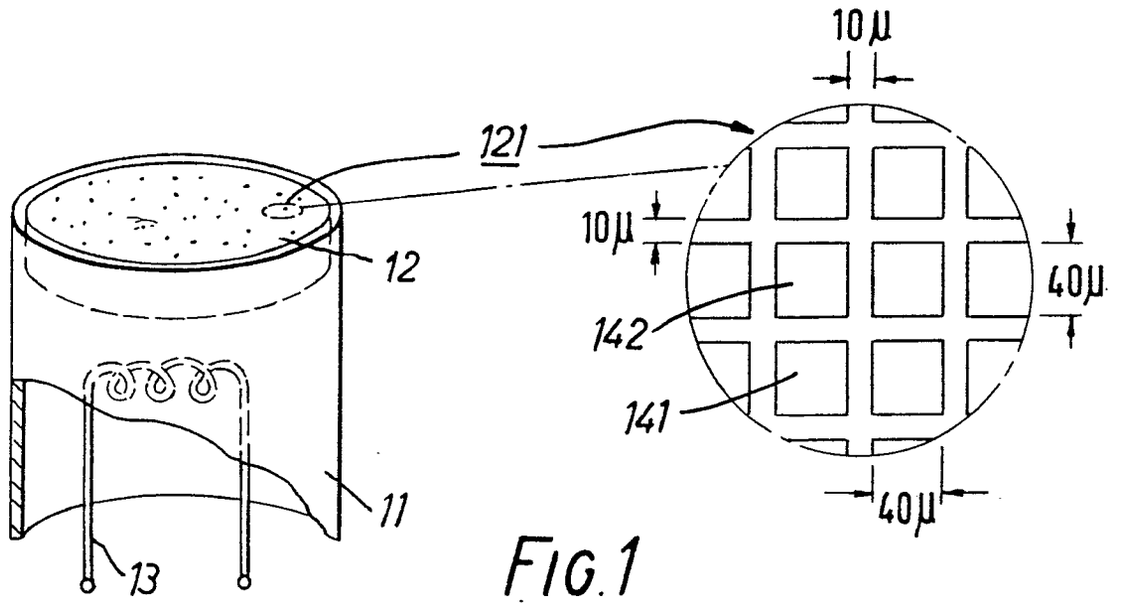


FIG. 1

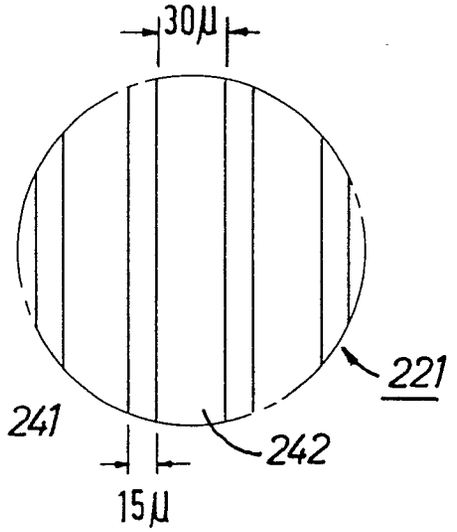


FIG. 2

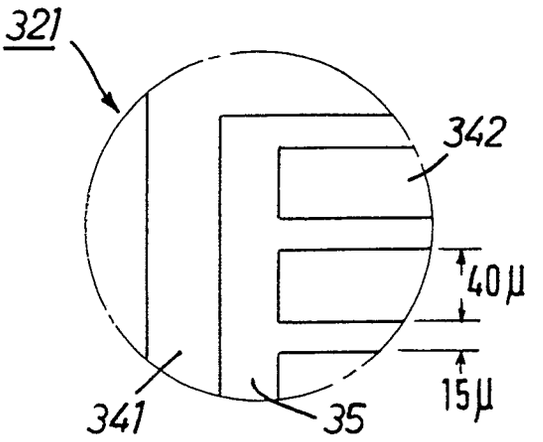


FIG. 3

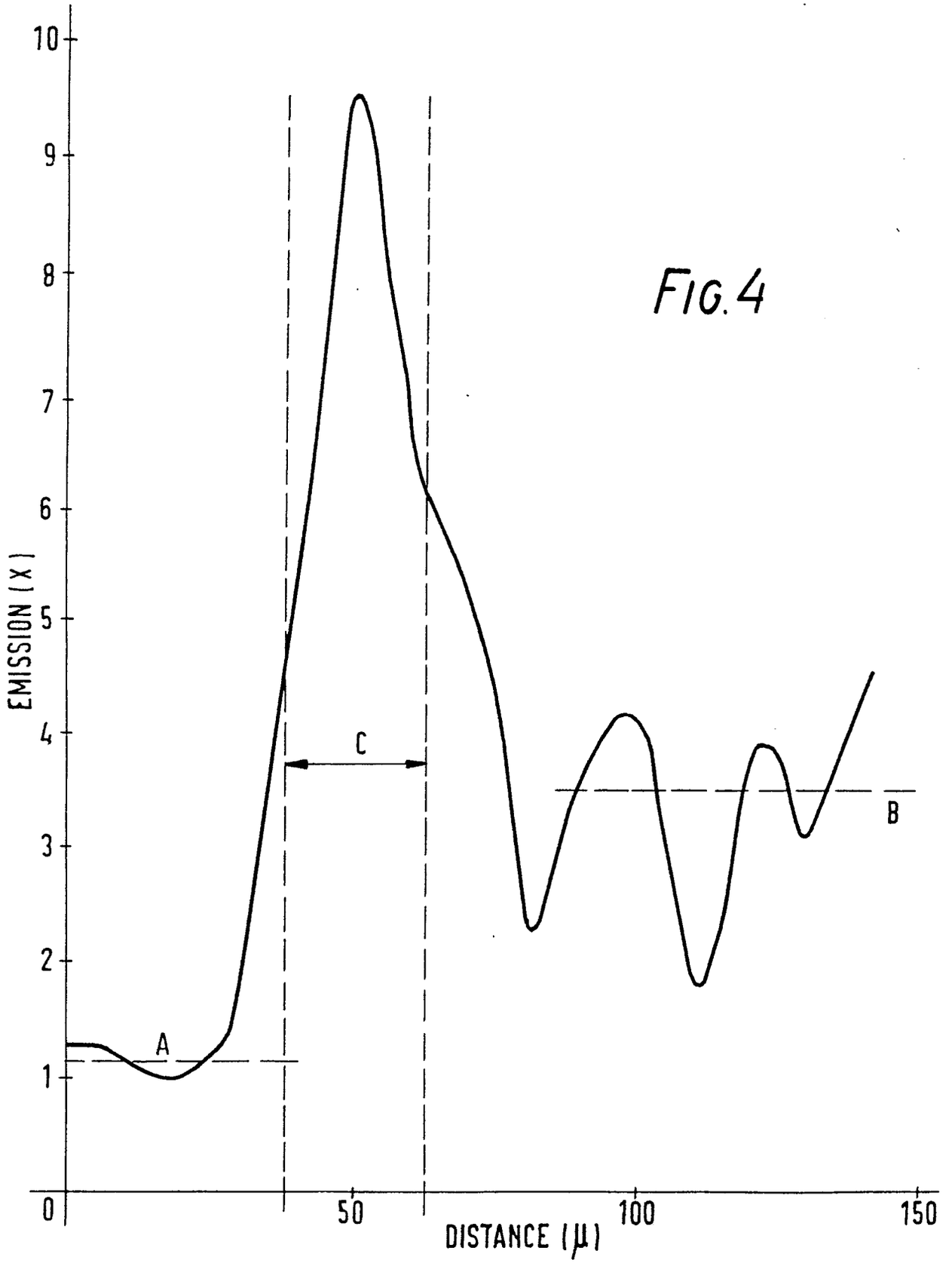


FIG. 4

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EUROPEAN SEARCH REPORT

0004424
Application number
EP 79 30 0334

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
	US - A - 3 648 096 (J.E. BEGGS) * Abstract; column 1, line 65 - column 2, line 3, 20-55; figures 1,2 * & NL - A - 69 14678 & DE - A - 1 948 820 & GB - A - 1 281 913	1,4,6, 7,11, 14,15, 17
	US - A - 3 717 503 (J.E. BEGGS) * Abstract; column 2, lines 21-36 and line 56 - column 3, line 30 * & DE - A - 1 948 820 & NL - A - 69 14678	1,4,6, 7,11, 14,15, 17
	US - A - 3 402 314 (M.T. VLAARDINGERBROEK et al.) * Abstract; column 1, line 62 - column 2, line 7 and lines 28-62 and line 67 - column 3, line 14; figures 1,3 * & FR - A - 1 475 212	1,4,5, 7,14, 15
	US - A - 3 373 307 (P. ZALM et al.) * Column 1, abstract and lines 29-66; column 2, line 32 - column 3, line 24 and 47 - column 4, lines 29-44, 57-75; column 5, lines 1-32 and 49 - column 6, line 43; claims 1-6; figures 2,3 *	1-3,11 14,15, 17
	FR - A - 1 555 031 (PHILIPS) * Entire abstract *	1-2,11 14,15

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CLASSIFICATION OF THE APPLICATION (Int. Cl.²)

H 01 J 1/28
9/04

TECHNICAL FIELDS SEARCHED (Int.Cl.²)

H 01 J 1/13
1/28
9/04

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	23-05-1979	MAUGAIN

EPO Form 1503.1 06.78

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.³)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
	& GB - A - 1 164 413 & DE - A - 1 639 344 & NL - A - 67 01867 & NL - A - 68 00278 & US - A - 3 497 757 --		
	FR - A - 1 457 839 (SIEMENS) * Page 1, left-hand column, first alinea, right-hand column, first alinea * --	13	
D	US - A - 3 201 639 (R. LEVI) * Column 1, lines 14-25 and line 47 - column 2, line 51 * & FR - A - 1 140 832 & GB - A - 795 566 ----	13	TECHNICAL FIELDS SEARCHED (Int. Cl.³)