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(54) **Sleeve for hot cathode structure and method for manufacturing such sleeve**

Hülse für eine beheizte Kathode und Verfahren zu ihrer Herstellung

Manchon pour cathode chauffée et procédé de fabrication

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- **PATENT ABSTRACTS OF JAPAN** vol. 015, no. 295 (E-1094), 26 July 1991 (1991-07-26) & JP 03 105826 A (TOSHIBA CORP;OTHERS: 01), 2 May 1991 (1991-05-02)
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EP 1 302 969 B1

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a sleeve for a hot cathode structure used in an electron tube such as a color CRT and a manufacturing method for such a sleeve.

2. Description of the Related Art

[0002] In an electron tube such as a color CRT, a hot cathode is used for emitting an electron beam. An impregnated cathode is one known type of hot cathode.

[0003] An impregnated cathode has been used for an electron tube such as a traveling-wave tube and klystron. In recent years, the impregnated cathode has also come to be used in a large size, high resolution color CRT or the like, taking advantage of the high current density characteristic of the impregnated cathode.

[0004] Such an impregnated cathode structure is constructed, for example, as shown in Fig. 1. A short, column-shaped cathode substrate 1 onto which an electron emission material is impregnated is stored in a cup 2 having a cylindrical shape and a bottom. The cup 2 is inserted at one end, which is an opening, of a cylinder-shaped sleeve 3 from the bottom of the cup 2, and fixed to the sleeve 3 with the cathode substrate 1 in an exposed condition. A heater 4 is built into the sleeve 3. The heater 4 is constructed from a 3% rhenium-tungsten alloy wiring with an alumina coating at the surface for insulation. In order to enhance the heat radiation characteristic, a dark layer constructed from a mixture of tungsten and alumina is coated on the alumina surface. The sleeve 3, on the other hand, is coaxially supported and fixed at the central section of a holder 5, which has a cylindrical shape with a step, via three ribbons 6. A flare (widening) 3a is provided at one opening end of the sleeve 3 in order to facilitate insertion of the heater 4. The sleeve 3, cup 2, and three ribbons 6 are all constructed from tantalum, niobium, molybdenum, or an alloy having at least one of these elements as the main constituent. At the inner surface of the sleeve 3, a thin black coating 7 is adhered and formed for efficiently absorbing the heat generated by the heater to the sleeve. The sleeve 3 may be, for example, a thin pipe having a thickness of 15 to 20 μm , a diameter of 1.25 mm, and a length of 4.0 mm.

[0005] In order to adhere the black coating to such a sleeve, there exists the following method as disclosed in Japanese Patent Laid-Open Publication No. Hei 8-287824.

[0006] In this method, sputtering is used for adhering a thin film of aluminum to the inner surface of a sleeve which is constructed from molybdenum, a first heating process is performed wherein the sleeve is subjected to

heating for 30 minutes at 600 °C under a vacuum atmosphere, a second heating process is performed wherein the sleeve is subjected to heating for 1 hour at 800 °C under the same vacuum atmosphere, and a final heating process is performed wherein the sleeve is subjected to heating for 1 hour at 1000 °C under a wetting hydrogen atmosphere. A rough surface layer including intermetallic compound of aluminum and molybdenum, aluminum-molybdenum oxides, and alumina is formed. Because the rough surface layer has micro-bumps at the surface, the heat absorption area is increased, and thus, the rough surface layer has an advantage that it has a good heat absorption characteristic.

[0007] The conventional method for forming a black coating on a sleeve requires many steps and is costly when mass-production is desired.

[0008] With the conventional method, it has been difficult to form a black coating uniformly over the entire inner surface of the sleeve.

[0009] US-A-5762997 discloses a sleeve for a hot cathode structure forming part of an electron emission cathode which has a black surface formed on its inner surface. The coating is a sintered layer containing tungsten.

[0010] One object of embodiments of the present invention is to provide a sleeve for a hot cathode structure and a simple, low-cost manufacturing method for such sleeve, suitable for mass production, wherein a black heat absorbing coating is formed at the entire inner surface of the sleeve with sufficient mechanical strength and heat endurance.

SUMMARY OF THE INVENTION

[0011] According to the present invention, there is provided a black coating adhered and formed at the inner surface of the sleeve which constructs a portion of an electron emission cathode, wherein said black coating is a composite film of tantalum and one of a) tungsten, b) rhenium, or c) a mixture of tungsten and rhenium, with a micro-crack structure or micro-bump structure.

[0012] It is preferable that the composition of the black coating is in a range of 80 : 20 to 10 : 90 in mass ratio of tantalum with respect to the tungsten, the rhenium, or the mixture of tungsten and rhenium (tantalum : tungsten, rhenium, or the mixture of tungsten and rhenium).

[0013] Preferably also, the material of the sleeve to be used is tantalum or an alloy having tantalum as the main constituent, niobium or an alloy having niobium as the main constituent, or molybdenum or an alloy having molybdenum as the main constituent.

[0014] A sputtering method is used for forming the black coating. In the sputtering method, a sleeve placed between a sputtering anode and a sputtering cathode is electrically insulated from both electrodes.

[0015] According to the above means, a black, rough surface can be uniformly formed at the entire inner sur-

face of the sleeve.

[0016] Because the black coating that is formed has micro-cracks or micro-bumps on the surface, the heat absorption area is increased, and, thus, the black coating has superior heat absorption characteristic and sufficient mechanical strength such that a heat absorption layer which does not peel off during the assembly of the impregnated cathode or during the insertion of the heater can be obtained. Moreover, the degree of blackness does not change when a heater is inserted and heat is applied, and the constituents do not vaporize.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Fig. 1 is a diagram showing an impregnated cathode structure to which the present invention is applied.

Fig. 2 is a cross sectional view showing an example structure of a sputtering device according to the present invention.

Fig. 3 is an electron micrograph showing an embodiment of the present invention.

Fig. 4 is another electron micrograph showing an embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0018] The preferred embodiment of the present invention will now be described referring to the drawings.

[0019] Fig. 2 is a cross sectional view showing an example of a sputtering device used for adhering and forming a black coating according to the present invention.

[0020] As shown in Fig. 2, the sputtering device comprises a container 20; rotational axis 21; a sputtering anode 22 which is connected to the rotational axis 21; an insulator 23 which is connected to the rotational axis 21; a retaining plate 24 which is connected to the insulator; a target 25 which forms the sputtering cathode; a magnet 26, a shielding plate 27 surrounding the target 25; a high frequency power supply 28 which is connected between the container 20 and the target 25; a coolant insertion inlet 29; a vacuum emission outlet 30; and an inert gas insertion inlet 31. A hole 24a is provided at a portion of the retaining plate 24 for placing the sleeve 3.

[0021] The target 25 which forms the sputtering cathode is constructed by mixing tantalum powder and tungsten powder in a mass ratio (tantalum : tungsten) of (20 : 80). The mixture can be used in the powder form as the target or used as the target after the power is sintered.

[0022] When sputtering is performed using the sputtering device, the sleeve 3 is inserted into the hole 24a provided on the retaining plate 24 so that the sleeve 3 is held within the hole 24a by the flare section of the sleeve 3. Then, a high frequency voltage is applied by the high frequency power supply 28 between the sputtering anode 22 and the target 25, a coolant is supplied

from the coolant insertion inlet 29, air is emission from the vacuum emission outlet 30, emission argon gas is supplied from the inert gas insertion inlet 31, and the retaining plate 24 is rotated by the rotational axis 21.

[0023] By such sputtering, a composite coating of tantalum and tungsten is formed at the inner surface of the sleeve 3 with a thickness of about 1 μm and having a micro-crack structure at the surface of the coating.

[0024] During the sputtering, the composite coating is only formed at the inner surface of the sleeve 3, and no composite coating is adhered to the outer surface.

[0025] Fig. 3 shows an electron micrograph of a composite film of tantalum and tungsten which is formed at the inner surface of the sleeve 3 by the above method.

The coating has a black rough surface with micro-cracks at the surface. The composition of the film was (20 : 80) in mass ratio (tantalum : tungsten).

[0026] Fig. 4 shows an electron micrograph of a composite film of tantalum and tungsten which is formed at the inner surface of the sleeve 3 by a method similar to the above, using the sputtering device shown in Fig. 2 and a target which is obtained by mixing tantalum powder and tungsten powder in mass ratio (tantalum : tungsten) of (40 : 60). The coating has a black rough surface with micro-bumps on the surface. The composition of the film was (40 : 60) in mass ratio (tantalum : tungsten).

[0027] It was experimentally confirmed that the composite film with micro-crack structure or with micro-bump structure can be formed when the composition of the film is in a range between (80 : 20) and (10 : 90) in mass ratio (tantalum : tungsten). The adjustment of the composition can easily be attained by adjusting the mixing ratio between the tantalum powder and tungsten powder, which are the materials for the target, in a range between (80 : 20) and (10 : 90) in mass ratio (tantalum : tungsten).

[0028] In the above embodiment, the target which is the material for the black coating is formed by mixing tantalum and tungsten. However, the present invention is not limited to this configuration, and similarly uniform black coating was obtained by using rhenium or a mixture of tungsten and rhenium in place of tungsten.

[0029] A uniform black rough surface can be formed at the entire inner surface of the sleeve using the sputtering device as shown in Fig. 2, that is, a sputtering device having a structure in which the sleeve placed between the sputtering anode and sputtering cathode is electrically insulated from both electrodes. This is believed possible because, when the sputtering device of Fig. 2 is used, the inner surface of the sleeve which touches a plasma and which is electrically insulated is negatively charged during the sputtering operation. Therefore, the inner surface of the sleeve attracts positive ions and a migration layer of positive ions is generated in the space between the sputtering anode and the sputtering cathode. The migration layer then facilitates sputtered particles to move, and, therefore, a uniform thin film can be formed on the entire inner surface

of the sleeve.

[0030] A black rough surface with micro-crack structure or micro-bump structure can be formed using the sputtering device of Fig. 2 and a mixture of tantalum and tungsten as the material for the target.

[0031] It is known that, in general, when tantalum is heavily bombarded by ions and electrons, cracks tends to be generated in the tantalum thin film that is formed by sputtering and the surface tends to be not smooth.

[0032] In the embodiment, the sleeve placed between the sputtering anode and sputtering cathode is insulated from both electrodes. Because of this, the sleeve is negatively charged during the sputtering process and bombarded by ions. Thus, tantalum having appropriate amount of micro-cracks or micro-bumps is generated and mixed in the tungsten film, and a black rough surface is formed.

[0033] When the sputtering is performed using tantalum alone or tungsten alone as the material for the target, no black rough surface with sufficient mechanical strength and micro-cracks or micro-bumps could not obtained, unlike in the embodiment.

[0034] As described above, in the sputtering device of Fig. 2, the sleeve placed between the sputtering anode and the sputtering cathode is insulated. However, it is clear that similar effects can be achieved by applying an appropriate voltage between the anode potential and cathode potential to the insulated sleeve and performing bias sputtering.

[0035] In the description of the preferred embodiment, a high frequency magnetron sputtering method is used. However, the present invention is not limited to such a configuration, and similar effects can be achieved by other methods such as, for example, high frequency sputtering, magnetron sputtering, and DC sputtering methods.

[0036] The thickness of the black coating which can be obtained by the present invention is not limited to 1 μm as described above, but can be any other suitable thickness such as, for example, in a range between 0.5 μm and 5 μm .

[0037] It has been shown that the inner surface of the sleeve having the black coating formed by the embodiment has a thermal radiation ratio which is 0.3 to 0.4 higher than that for a sleeve without the black coating adhered, at a temperature range around 950°C which is the operation temperature of the impregnated cathode.

[0038] Moreover, the black coating according to the described embodiment is a heat absorption layer which has a sufficient mechanical strength wherein the degree of blackness is not changed when a heater is inserted into the sleeve and heat is applied, and there is no vaporization of the compositions.

[0039] The material for the sleeve having the black coating can be selected from among tantalum or an alloy having tantalum as the main constituent, niobium or an alloy having niobium as the main constituent, or molyb-

denum or an alloy having molybdenum as the main constituent.

[0040] As described above, a heat absorbing black coating which is a composite film of tantalum and tungsten, rhenium, or a mixture of tungsten and rhenium and which has a micro-crack structure or micro-bump structure at its surface is adhered, by a sputtering method, to the inner surface of a sleeve which forms a portion of an electron emission cathode.

[0041] In this manner, a heat absorption layer, which exhibits superior mechanical strength and superior heat endurance; a superior heat absorption characteristic, due to the fact that the heat absorption layer has an increased heat absorbing area by the presence of micro-cracks or micro-bumps; and wherein the degree of blackness does not change and the composition metals do not vaporize, can be obtained through a procedure comprising simple steps, at low cost, and using a method suitable for mass production.

Claims

1. A sleeve for a hot cathode structure which forms a portion of an electron emission cathode, said sleeve (3) having black coating (7) adhered and formed at its inner surface; **characterized in that**
said black coating is a composite film of tantalum and one of a) tungsten, b) rhenium, or c) a mixture of tungsten and rhenium, with a micro-crack structure or micro-bump structure at the surface.
2. A sleeve for a hot cathode structure according to claim 1, wherein the composition of said black coating of tantalum with respect to the tungsten, the rhenium, or said mixture of tungsten and rhenium is in a range between 80 : 20 and 10 : 90 in mass ratio of tantalum: tungsten, rhenium, or said mixture of tungsten and rhenium.
3. A sleeve for a hot cathode structure according to either of claims 1 or 2 wherein
said sleeve is constructed from tantalum or an alloy having tantalum as the main constituent, niobium or an alloy having niobium as the main constituent, or molybdenum or an alloy having molybdenum as the main constituent.
4. A method of manufacturing a sleeve for a hot cathode using a sputtering device having a structure with a retaining plate which is provided between a sputtering anode and a sputtering cathode and is electrically insulated from said sputtering anode and sputtering cathode, said method comprising the step of:

operating the sputtering device to adhere and form a black coating on the inner surface of a

sleeve placed on said retaining plate, said black coating including a composite film of tantalum and one of a) tungsten, b) rhenium, or c) a mixture of tungsten and rhenium with a micro-crack structure or a micro-bump structure on the surface.

5. A method of manufacturing a sleeve for a hot cathode as claimed in claim 4 wherein the retaining plate is biased at a bias potential between the anode potential and the cathode potential.

Patentansprüche

1. Hülse für eine heiße Kathodenstruktur, welche einen Teil einer Elektronenemissionskathode bildet, wobei die Hülse (3) eine auf ihrer inneren Oberfläche anhaftende und ausgebildete schwarze Beschichtung (7) aufweist,
dadurch gekennzeichnet, dass
die schwarze Beschichtung ein Verbundfilm aus Tantal und einem aus a) Wolfram, b) Rhenium oder c) einem Gemisch aus Wolfram und Rhenium mit einer Mikroriß-Struktur oder einer unebenen Mikrostruktur auf der Oberfläche ist.
2. Hülse für eine heiße Kathodenstruktur gemäß Anspruch 1, worin die Zusammensetzung der schwarzen Beschichtung aus Tantal in Bezug auf Wolfram, Rhenium oder dem Gemisch aus Wolfram und Rhenium in einem Bereich zwischen 80:20 und 10:90 des Massenverhältnisses Tantal : Wolfram, Rhenium oder dem Gemisch aus Wolfram und Rhenium liegt.
3. Hülse für eine heiße Kathodenstruktur gemäß Anspruch 1 oder Anspruch 2, worin die Hülse aus Tantal oder einer Tantal als Hauptbestandteil aufweisenden Legierung, Niob oder einer Niob als Hauptbestandteil aufweisenden Legierung oder Molybdän oder einer Molybdän als Hauptbestandteil aufweisenden Legierung gestaltet ist.
4. Verfahren zur Herstellung einer Hülse für eine heiße Kathode unter Verwendung einer Zerstäubungsvorrichtung, welche eine Struktur mit einer Halteplatte, die zwischen einer Zerstäuberanode und einer Zerstäuberanode bereitgestellt ist und die von der Zerstäuberanode und der Zerstäuberanode elektrisch isoliert ist, aufweist, wobei das Verfahren den Schritt umfasst:

Betreiben der Zerstäubungsvorrichtung zum Anhaften und Ausbilden einer schwarzen Beschichtung auf der inneren Oberfläche einer auf der Halteplatte platzierten Hülse, wobei die schwarze Beschichtung einen Verbundfilm aus

Tantal und einem aus a) Wolfram, b) Rhenium oder c) einem Gemisch aus Wolfram und Rhenium mit einer Mikroriß-Struktur oder einer unebenen Mikrostruktur auf der Oberfläche umfasst.

5. Verfahren zur Herstellung einer Hülse für eine heiße Elektrode wie in Anspruch 4 beansprucht, wobei die Halteplatte mit einem Vorspannungspotential zwischen dem Anodenpotential und dem Kathodenpotential vorgespannt ist.

Revendications

1. Manchon pour une structure de cathode chaude qui constitue une partie d'une cathode émettant des électrons, ledit manchon (3) comportant un revêtement noir (7) collé et formé sur sa surface interne ;
caractérisé en ce que
ledit revêtement noir est un film composite de tantale et d'un parmi a) le tungstène, b) le rhénium, ou c) un mélange de tungstène et de rhénium, pourvu d'une structure en microfissure ou en microsaillie à sa surface.
2. Manchon pour une structure de cathode chaude selon la revendication 1, dans laquelle la composition dudit revêtement noir de tantale par rapport au tungstène, au rhénium ou audit mélange de tungstène et de rhénium a un rapport de masses compris entre 80/20 et 10/90 de tantale, tungstène, rhénium ou audit mélange de tungstène et de rhénium.
3. Manchon pour une structure de cathode chaude selon l'une quelconque des revendications 1 ou 2, dans laquelle
ledit manchon est fabriqué en tantale ou dans un alliage dont le tantale est le composant principal, en niobium ou dans un alliage dont le niobium est le composant principal, ou en molybdène ou dans un alliage dont le molybdène est le composant principal.
4. Procédé de fabrication d'un manchon pour une cathode chaude utilisant un dispositif de pulvérisation dont la structure comporte une plaque de retenue qui est disposée entre une anode de pulvérisation et une cathode de pulvérisation et est isolée électriquement desdites anode de pulvérisation et cathode de pulvérisation, ledit procédé comportant l'étape consistant à :

actionner le dispositif de pulvérisation pour coller et former un revêtement noir sur la surface interne d'un manchon placé sur ladite plaque de retenue, ledit revêtement noir incluant un film composite de tantale et d'un parmi a) le

tungstène, b) le rhénium, ou c) un mélange de tungstène et de rhénium, pourvu d'une structure en microfissure ou en microsailie à sa surface.

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5. Procédé de fabrication d'un manchon pour une cathode chaude selon la revendication 4, dans lequel la plaque de retenue est polarisée selon un potentiel de polarisation compris entre le potentiel de l'anode et le potentiel de la cathode.

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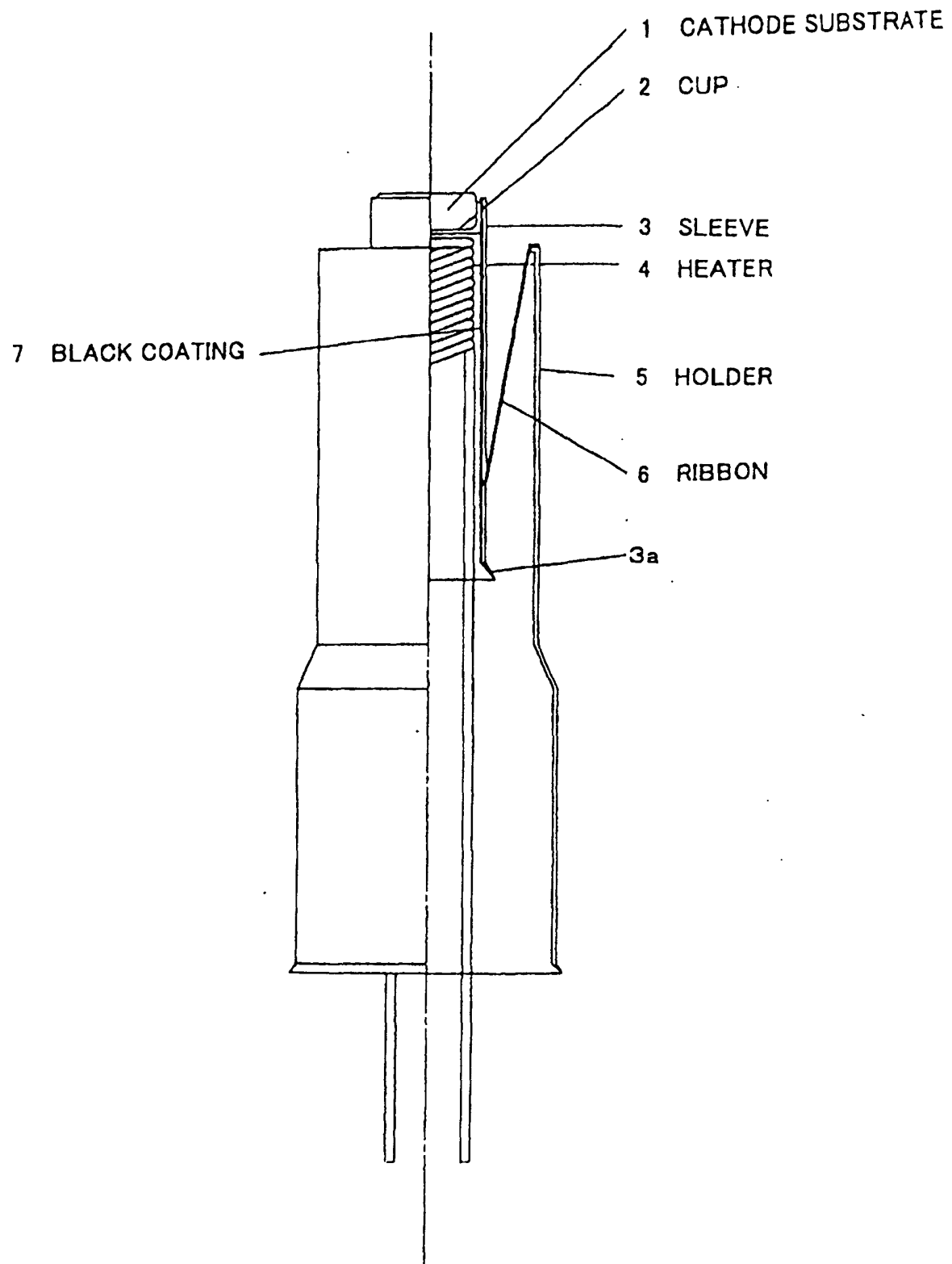


FIG. 1

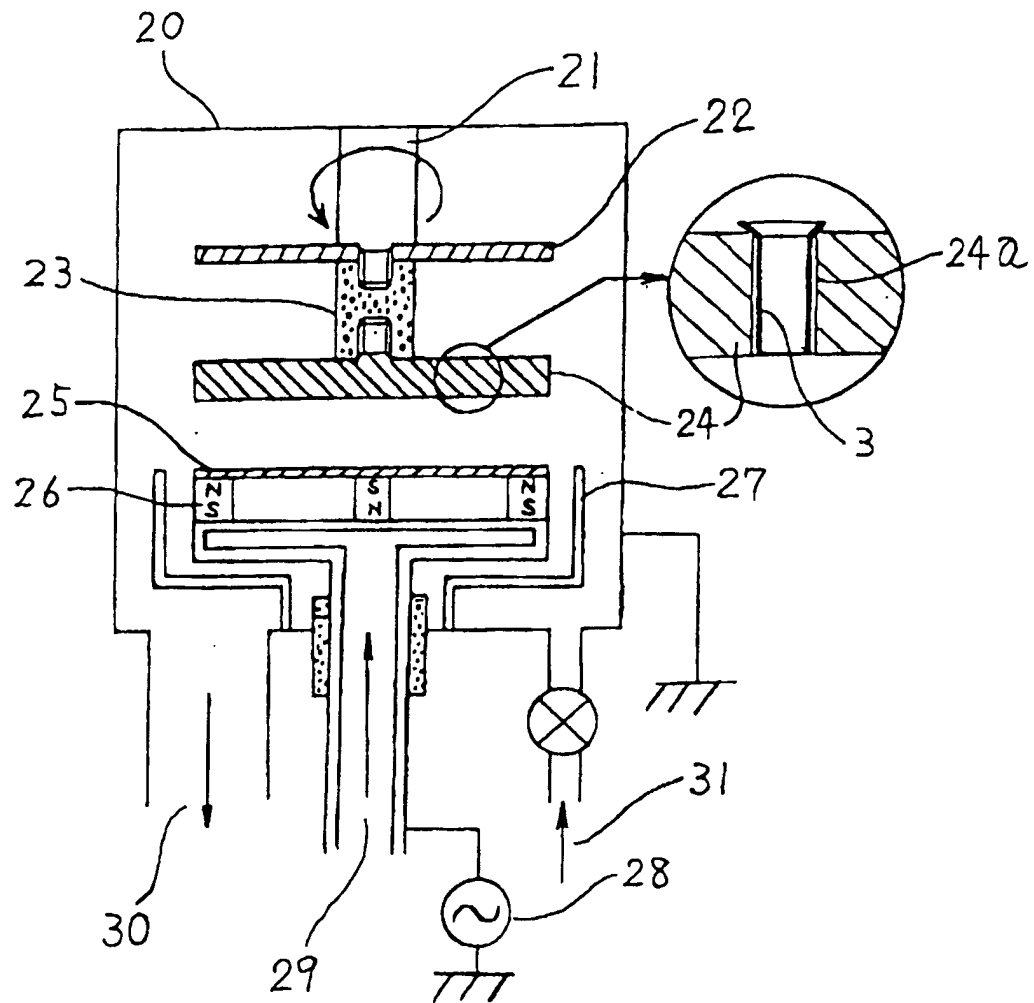


FIG. 2

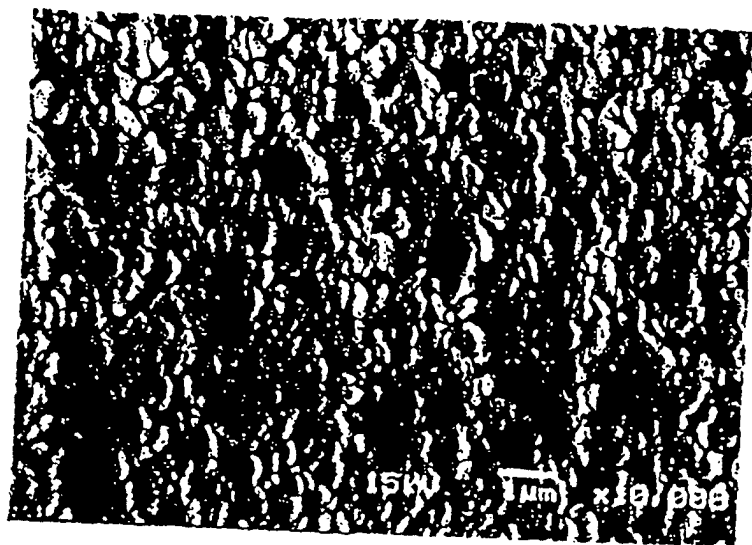


FIG. 3

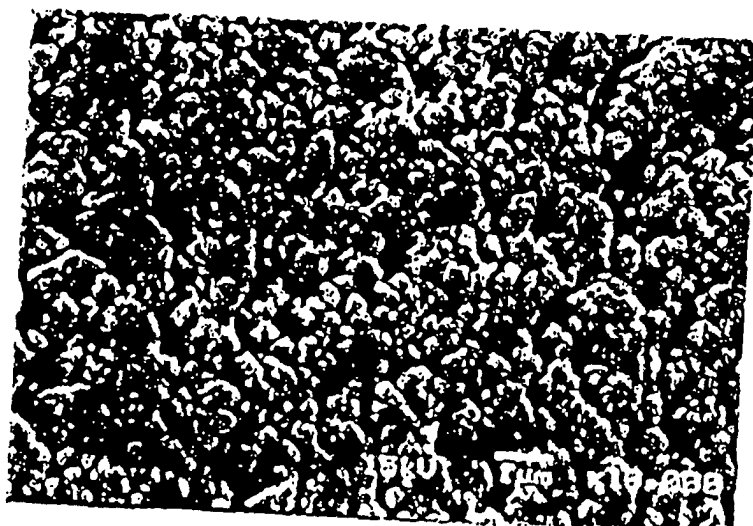


FIG. 4