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⑰ **A low hydrogen overvoltage cathode and method for producing the same.**

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**DE-A-3 116 032**  
**GB-A- 991 231**  
**US-A-4 331 517**

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## Description

### 1. Field of the invention

The present invention generally relates to a low hydrogen overvoltage cathode for use in electrolysis of water or alkali metal halides and method for producing the same. More particularly, it relates to the preparation of a low hydrogen overvoltage cathode having low hydrogen-generating electric potential and satisfactory durability specifically suitable for electrolysis of an aqueous alkali metal halide solution.

### 2. Description of prior art

In the electrolysis of water or an aqueous alkali metal halide solution using an asbestos diaphragm or an ion exchange membrane, punched mild steel plates, mild steel meshes and the like served as cathodes. These materials are advantageous in respect of cost, alkali-resistance, processability and the like, as compared with other materials. Moreover, mild steel shows hydrogen overvoltage of from 0.3 to 0.4 Volt, which is relatively low excepting platinum group metals.

Nonetheless, recently a rapid increase in energy cost accelerates the need of reducing more vastly hydrogen overvoltage of mild steel cathodes for use in hydrogen generation to thus lower energy cost and a variety of cathodes are proposed. Most of those improved cathodes employ iron group metals less expensive, easily processable and available as a cathode base, on the surface of which a coating of reducing hydrogen overvoltage is formed.

For example, there are known electrodes obtained by spray coating an iron group cathode base with nickel or tungsten carbide powder (US—A—4 049 841), electrodes spray coated with cobalt and zirconium (US—A—3 992 278), electrodes comprising nickel and cobalt subjected to leaching treatment after spray coating (US—A—4 024 044), electrodes obtained by spray coating an electrode base with Raney-nickel and then leaching with alkali a sacrificial metal contained in the coating layer (JP—A—122887/80), electrodes obtained by spray coating of an alkali-resistant metal on a cathode base and depositing a platinum group metal on the surface thereof (JP—A—131189/80, JP—A—158288/80), electrodes obtained by forming an activated layer by plating method on a cathode base, e.g., electrodes obtained by dispersing a platinum group metal powder into nickel (US—A—4 465 580 and US—A—4 543 265 or dispersing Raney-nickel into nickel (US—A—4 290 859 and US—A—4 302 322) and so on.

These activated cathodes, however, involve disadvantages including such as insufficient durability or high cost. In particular, when exposed to high temperature and high concentrated caustic soda, those are far from satisfaction as cathodes for use in ion exchange membrane electrolysis. That is, in, for example, a process for forming Raney-nickel-containing nickel or a nickel alloy coating layer, when the content of electroconduc-

tive fine particles is small, e.g., approximately less than 20%, the performance is insufficient while a firm coating layer with strong adhesion is obtained. Inversely, when electroconductive fine particles are contained in great amounts, e.g., in excess of 45%, a highly activated coating layer is obtained but strength as well as adhesion is not satisfactory. Accordingly it is difficult to provide cathodes which are thoroughly satisfactory in activity, adhesion and strength.

On the other hand, various methods for manufacturing low hydrogen overvoltage cathodes are proposed. As a structure of low hydrogen overvoltage cathode, a cathode base is at first considered. As a material for the cathode base, carbon-steel, stainless steel, nickel and the like are known but carbon steel is normally used from economical consideration. On the cathode plate is an activated layer of low hydrogen overvoltage deposited. In this case, when corrosion of the base is feared during the course of operation at low hydrogen overvoltage, it is necessary to provide a protective layer of alkali-resistance between the base and the activated layer. As the protective layer, nickel-plating bodies, copper-plating bodies and the like are normally employed and as the activated layer, it is prevailing to employ those of alkali-resistant metals designed so as to have large surface. For example, there are included a method for electroplating a Raney alloy (JP-Patent Examined Publication Nos. 4766/53, 6611/56, US—A—4 104 133), a method for codeposit plating Raney-nickel (JP—A—68795/79, US—A—4 290 859, US—A—4 302 322), a method for depositing a Raney alloy by spray coating, sintering and the like (US—A—4 024 044, US—A—4 116 804, US—A—4 169 025, JP—A—79803 80), a method for spray coating of metals such as nickel (US—A—4 049 841, JP—A—131189/80), a method for depositing by electroplating a coating, a sacrificial component of which is leached during operation (Patent Non-examined US—A—4 190 514, US—A—4 190 516, JP—A—22161/78, JP—A—102876/78 and JP—A—100987/80) and the like.

Notwithstanding, those cathodes manufactured by the foregoing methods are not always suited to industrial use in performance, i.e., those with low hydrogen overvoltage are inferior in durability for a prolonged period of time, while those with durability are high in hydrogen overvoltage.

GB—A—991 231 disclosed an electrode with a Raney-Ni base having activated Raney-Ni centers being covered with a thin layer of a metal of the Pt-group, US—A—4 331 517 describes a method of electrodepositing a catalyst metal and a sacrificial metal on an electroconductive substrate wherein the substrate is inserted into a solution of Co, Ni, Ru, Rh, Pd, Os, Pt, mixtures thereof and Al, Zn, Sn and mixtures thereof. Then an electrical current passes from the plating anode to the cathode to electrodeposit metal on the substrate.

### Summary of the invention

It is an object of the present invention to provide a method for producing a low hydrogen overvoltage cathode with low hydrogen overvoltage as well as adequate durability especially suited for example for the electrolysis of an aqueous alkali halide solution.

### Brief description of the drawings

Fig. 1 is a schematic representation illustrating an embodiment of a production method of the present invention.

Fig. 2 (X) is a schematic representation of a codeposit plating tank used in the present invention in which the surface to be plated is located to be substantially horizontal and to face upwardly, and Fig. 2 (Y) is a cross-sectional view taken on line A—A of Fig. 2 (X).

Fig 3 (X) is a schematic representation of a codeposit plating tank used in the present invention in which two sheets of cathodes, the surfaces to be plated being located substantially vertical, are codeposit plated at a time and Fig. 3 (Y) is a cross-sectional view taken on line B—B of Fig. 3 (X).

### Detailed description of the invention

The present invention encompasses a method for producing a low hydrogen overvoltage cathode which comprises using a codeposit plating tank in which an anode and an object to be plated of a non-perforated flat structure are positioned in parallel with each other, supplying a dispersant slurry through one side of the tank in a substantially horizontal way to thus allow it to flow in a space formed between the anode and the object, then removing the slurry through the opposite side and recirculating it back to the tank, whereby codeposit plating is applied to only one surface of the object, the dispersant comprising an alloy of a first metal selected from the group consisting of nickel, cobalt and silver, a second metal selected from the group consisting of aluminium, magnesium, zinc and tin, and third metal selected from the group consisting of platinum, palladium, rhodium, ruthenium, iridium and osmium. The cathode prepared according to the present invention is coated in such a manner that electroconductive fine particles of the alloy as defined above are for example dispersed in nickel or a nickel alloy, and is capable of reducing hydrogen generation electric potential by 200 to 300 mV as compared with conventional iron cathodes.

Examples for a cathode base, are iron, stainless steel, nickel and further, iron coated with nickel and a nickel alloy such as Ni-Mo, Ni-W.

As a coating layer, nickel or nickel alloys such as Ni-Mo, Ni-W and further, a mixture of nickel and oxides thereof may suitably be used.

As an active substance, a platinum group metal selected from the group consisting of platinum, ruthenium, iridium, rhodium, palladium and osmium, and an oxide thereof may be used singly or in combination of two or more.

Electroconductive fine particles should have electroconductivity and large surface area and be superior in resistance to caustic alkali which may be exemplified by Raney-nickel, Raney-cobalt and Raney-silver. When the Raney-nickel alloy is employed, it is necessary to leach by a known manner after formation of the coating layer. For example, adequate activity is obtained by immersing the coating layer in a 10 to 30% aqueous caustic soda solution at 40 to 60°C for more than one hour.

The foregoing fine particles should desirably be as fine as possible and their particle size should preferably be approximately 0.149 mm (100 mesh-pass) or less, more preferably 0.074 mm (200 mesh-pass) or less, though not limited in particular. An amount of 0.01% or more of the platinum group metal to be held by the fine particles provides cathodes having an adequate activity. An amount exceeding 50% leads to economical disadvantage. The thickness of the coating layer is not specifically limited but should preferably be 800  $\mu$ m or less, more preferably 400  $\mu$ m or less, taking into consideration economy. With a view to keeping activity for a prolonged period of time, thickness should be at least 10  $\mu$ m or more, more preferably 50  $\mu$ m or more.

On the other hand, an extensive series of studies have been made by the present inventors on a method for obtaining low hydrogen overvoltage cathodes satisfying low hydrogen overvoltage and long-term durability, and the following conclusion has been derived.

That is, cathodes having less durability are caused by many vacant spaces present in the active portion or insufficiency of adhesion force among particles, i.e., shortage of mechanical strength, whereas cathodes having high hydrogen overvoltage are caused by lack of active area actually working or activity per unit area. Looking into prior arts from the above viewpoint, cathodes produced by electroplating containing a sacrificial component dissolving during the electrolysis, when containing the sacrificial component in great amounts to lower hydrogen overvoltage, deteriorate in mechanical strength, thereby being inferior in durability. A process for codeposit plating of Raney-nickel is characterized in that the mechanical strength of the active portion is great but it has been found through studies by the present inventors that it is still insufficient in long-term durability. That is, for the purpose of minimizing hydrogen overvoltage, the content of Raney alloy in a codeposit plating coating layer has to be increased, but the increased content of Raney-nickel results in a decrease in the mechanical strength of the active portion.

A modified process of the foregoing Raney alloy codeposit plating method producing low hydrogen overvoltage cathodes is revealed by JP—A—133387/83. In this process, Raney alloy and a platinum group metal are admixed in powder, with which codeposit plating is made. However, it is not yet satisfactory though providing cathodes which are not only stronger in the

mechanical strength, but smaller in hydrogen overvoltage, as compared with the codeposit plating using Raney alloy alone. That may be because uniform codeposit plating is difficult due to the differences in particle size, specific gravity and the like between the Raney alloy and the platinum group metals. The platinum group metals, different from Raney alloy, shows no activity when buried in a nickel matrix.

In light of the situation, the present inventors have repeated studies on a new codeposit plating method which makes use of both activities of Raney alloy and platinum group metals and have arrived at an idea of adding as a third component platinum group metals to the Raney alloy. That is, it has been discovered that cathodes with sufficient strength, long-term durability and satisfactorily low hydrogen overvoltage can be provided by employing a three-component alloy as a dispersant which is comprised of a first metal selected from the group consisting of nickel, cobalt and silver, a second metal selected from the group consisting of aluminum, magnesium, zinc and tin, and a third metal selected from the group consisting of platinum, palladium, rhodium, ruthenium, iridium and osmium.

An apparatus for codeposit plating of Raney alloy is disclosed by, for example, JP—A—104491/80. According to the apparatus, however, it is impossible to perform codeposit plating uniformly and firmly, in cases where a cathode is a structure of a non-perforated flat plate and only one surface is subjected to codeposit plating. That is, in conventional Raney alloy codeposit plating, a dispersant slurry is flowed in a vertical way by the use of gas, a vibrating plate, a pump and the like. Notwithstanding, according to the study by the present inventors, a process for codeposit plating while flowing a dispersant slurry vertically involves a disadvantage that deposition of the dispersant onto an object to be plated is inferior. In an attempt to raise the deposition of the dispersant, processes of adding aluminium ions to a nickel plating bath or increasing the slurry concentration to 3 g/l or more have been proposed (JP—A—31091/83). It is surmised that decreased deposition in the case of the dispersant slurry being flowed vertically is attributable to rare colliding chances of dispersant particles against the object. Raney alloy is generally greater in density than a plating bath and therefore tends to precipitate.

The present invention has been completed on the thought that if a dispersant slurry is flowed horizontally rather than vertically, contacting and colliding chances between dispersant slurry particles and an object to be plated should be enhanced to thereby improve the deposition of the particles onto the object.

The cathode base usable for activated cathodes of the present invention may be in the form of a non-perforated flat plate. In an electrolytic cell for use in the electrolysis of an aqueous alkali metal halide solution, providing as a separator a cation

exchange membrane, in particular, operation is often carried out for saving energy cost by reducing an anode-cathode distance to 3 mm or less, often 2 mm or less. In those cases, non-perforated flat plate cathodes are capable of making uniform micro-distribution of current density over the cation exchange membrane and hence very desirable.

In practicing the present invention, only the necessary area of the cathode base is best being subjected to the treatment, i.e., only the area approximately equal to the cation exchange membrane is best treated.

Further, in the case of a perforated cathode, electric current, during operation, is liable to concentrate in edges in the vicinity of perforations to thus cause ununiformity in current density over the cathode. For this reason, there are raised problems including partial corrosion of nickel or a nickel alloy served as a coating layer base. Therefore, the present technique is applied to a cathode base of a flat structure having no perforations and preferably no edges.

The cathodes of the present invention obtained in such a manner as aforesaid are adapted for use as electrodes which generate hydrogen gas in, for example, the electrolysis of water or alkali metal halides.

The method for producing low hydrogen overvoltage cathodes of the present invention will be explained by referring to the drawings illustrating embodiments.

Fig. 1 depicts a schematic representation showing an example in which codeposit plating is effected according to the present invention. In a codeposit plating bath storage tank (1), a dispersant is well stirred to give a uniform slurry concentration. A dispersant slurry (2) is supplied by a pump (3) to a codeposit plating tank (4) through one side, then removed through the other side. The removed dispersant slurry is returned back to the codeposit plating bath storage tank (1) and recirculated between the plating bath storage tank (1) and the plating tank (4). Although uniform codeposit plating is possible without recirculating the dispersant slurry between the plating bath storage tank (1) and the plating tank (4), recirculation is carried out since a large quantity of dispersant slurry is needed.

The codeposit plating tank (4) is equipped with a cathode (6) to be plated and an anode (5), both being positioned in parallel with each other, to thus form a closed codeposit plating chamber (7). The cathode (6) is, needlessly, located so that the surface to be plated faces to the inside of the chamber. As the anode (5), any known anode for use in electroplating may be used and the shape is not specifically limited, including a flat plate, a perforated plate, a net, an aggregate of nickel tips and the like.

An amount of the dispersant contained in a codeposit plating coating in the present invention is variable according to the direction in which the object to be plated was placed, the concentration of the dispersant slurry, the average flow rate of

the dispersant slurry within the codeposit plating chamber and the like.

Fig. 2 and Fig. 3 are schematic representations showing the direction in which the object to be plated are placed. In Fig. 2, the object is located horizontal and faces upward, as in the case of Fig. 3. In Fig. 5, the object is located vertical. A preferred embodiment is to locate the object substantially horizontal to face upward, as shown by Fig. 1 and Fig. 2. It is also considered to locate the object to face downward, but in this case the same plated object as in the case of Fig. 1 and Fig. 2 can not be obtained because of a decrease in a deposition-improving effect caused by gravity, unless the slurry concentration is higher than in the case of Fig. 1 and Fig. 2.

An embodiment of locating the objects as shown by Fig. 3 is useful when two sheets of cathodes are produced at one time. That is, by locating two objects so that the backsides of the objects are in contact with each other, two sheets of hydrogen overvoltage cathodes can be produced through one operation of codeposit plating. In Fig. 3, colliding chances between the dispersant particles and the object are somewhat reduced as compared with the cases in Fig. 1 and Fig. 2, and hence codeposit plating should desirably be made with a higher slurry concentration.

The dispersant slurry should be flowed substantially horizontal in the codeposit plating tank. "Substantially horizontal" means an extent within which an increase in deposition of the dispersant particles resulting from gravity is achievable, i.e., the angle between the horizontal surface and the slurry flowing line being within 45 degrees, more preferably 30 degrees, regardless of upward or downward direction, most preferably 0 degree. The dispersant slurry is normally supplied through one side of the tank and removed through the opposite other side, but it is possible for the purpose of uniformization, to flow it to a reverse direction during the operation by changing an inlet and an outlet. It is further desired to position dispersing plates at an inlet and an outlet to improve uniformization.

The slurry concentration should preferably be not less than 0.01 g/l and less than 3 g/l, more preferably not less than 0.05 g/l and less than 3 g/l. In the case of less than 0.01 g/l, only the plated object containing a dispersant in less amounts is obtained and thus showing high hydrogen overvoltage. In the case of not less than 3 g/l, the plated object contains a dispersant in greater amounts, which shows low initial hydrogen overvoltage but is poor in the mechanical strength, thus lacking in long-term durability. The average flow rate of the dispersant slurry within the codeposit plating chamber should preferably be 0.05 m/sec or more, more preferably less than 10 m/sec. In the case of less than 0.05 m/sec, local unbalance of the dispersant content becomes great and thus the plated object of a uniform composition is not obtained. In the case of 10 m/sec or more the dispersant content decreases and the obtained plated object possesses high hydro-

gen overvoltage, further, equipment cost and energy cost increase due to an increased amount of the dispersant slurry recirculated.

As a bath solution forming the dispersant slurry, a well-known nickel plating bath may be suitably employed, including such as watts bath, all nickel chloride bath and high nickel chloride bath.

The particle size of the dispersant is not specifically limited, but should preferably be approximately 0.149 mm (100-mesh pass) or less, more preferably 0.074 mm (200-mesh pass) or less.

When the object to be plated is of great dimensions, it is separated into several parts and codeposit plated with requiring only some consideration.

The dispersant may be comprised of an optional combination of a first metal selected from the group consisting of nickel, cobalt and silver, a second metal selected from the group consisting of aluminium, magnesium, zinc and tin, and a third metal selected from the group consisting of platinum, palladium, rhodium, ruthenium, iridium and osmium. The second metal is leached by being immersed in an aqueous caustic alkali solution after codeposit plating, whereby a coating layer is made porous and thus activated. The content of the third metal is considered from both aspects of cost and activity, but should desirably be not higher than 50 weight %. In the case of less than 0.01 weight %, an effect of increasing activity is hardly expected.

As far as the changes in the dispersant slurry concentration are concerned, it is possible to start with an initial given concentration and end with a concentration lower than the initial concentration, or to keep the concentration constant from the beginning to the end by supplying the dispersant to the codeposit plating bath tank continuously or periodically, or to end with a higher concentration than the initial one.

Cathodes subjected to codeposit plating are stored for a prolonged period of time by being washed and dried. To use the cathodes as low hydrogen overvoltage cathodes, the second metals must be leached in an aqueous caustic alkali solution. This treatment may be made either before or after installing of the cathodes to an electrolytic cell, but the latter is preferred.

As cathodes used in the production of an aqueous alkali metal hydroxide solution by an ion exchange membrane process or an asbestos diaphragm process, expanded metals, perforated plates or net structure cathodes have been commonly employed. Notwithstanding, according to the study made by the present inventors, it has been made clear that cathodes of non-perforated flat plates, only one surface of which is codeposit plated provide the best results, when served as cathodes used in a horizontal type ion exchange membrane electrolytic cell. Moreover, it has been also discovered that even when an asbestos diaphragm electrolytic cell is retrofitted to an ion exchange membrane electrolytic cell, cells equipped with cathodes of non-perforated

flats plates, only one surface of which is codeposit plated possess low cell voltage. The non-perforated flat plate structure has numerous merits including such as highly uniform current distribution, reduction of electric resistance, high accuracy of dimensions on manufacturing and the like.

As stated above, the present invention is capable of production of epoch-making cells equipped with low hydrogen overvoltage cathodes, upsetting knowledge of persons skilled in the art that cells with non-perforated flat plate cathodes show high cell voltage (e.g. JP—A—174477/82, "Soda and Chlorine", 32, 281, 1981), and therefore exceedingly valuable in the industry.

The present invention will be explained in more detail by way of Examples that follow, to which the invention is in no way limited.

#### Example 1

Non-perforated flat plates of carbon steel, 660 mm×2,000 mm, were degreased, washed with an acid, and chemical plated with nickel to be 30 μm in thickness.

Two sheets of the obtained flat plates were placed vertically so that the backs are in contact with each other, as shown by Fig. 3. Anodes formed by wrapping nickel tips for electroplating in a titanium mesh were arranged in parallel and the non-perforated flat plates and the anodes were secured to hard rubber-lined iron frames to thus form two codeposit plating chambers.

On the other hand, in a codeposit plating bath storage tank having the inside capacity of 1.8 m<sup>3</sup>, a Raney alloy dispersant slurry (Al:Ni:Ru=50 wt%:45 wt %:5 wt %, Particle size: 200-mesh pass) was dispersed in a nickel plating bath (NiCl<sub>2</sub>·6H<sub>2</sub>O 300 g/l, H<sub>3</sub>BO<sub>3</sub> 38 g/l, PH 2~2.5) to prepare 1.5 m<sup>3</sup> codeposit plating bath containing the slurry concentration of 2 g/l.

The codeposit plating bath was removed with stirring by a pump and supplied into the codeposit plating chambers through one side to flow in a horizontal way. Codeposit plating was carried out under the conditions; temperature 50°C, current density 3 Å/dm<sup>2</sup>, time 90 minutes and average flow rate of the slurry within the chamber 1.0 m/sec. A plating coating thus obtained was hard and uniform in thickness.

From the resultant flat plates, only one surface was codeposit plated, 26 sheets of cathodes were made under the same conditions and installed to an asbestos diaphragm electrolytic cell (H-4 type, manufactured by Hooker Chem. Corp. Inc.). After assembling of the cell, the cathodes were subjected to leaching treatment by being immersed in a 25% aqueous NaOH solution for three hours. As a cation exchange membrane "Nafion 901" (Trade Mark) was used. Cell voltage was 3.4 V under the conditions; temperature 90°C, current density 23.5 Å/dm<sup>2</sup> and NaOH concentration 32%. Hydrogen overvoltage was 0.07 V.

#### Example 2

A cathode bottom plate (carbon steel), 1800 mm×11,000 mm, used in a mercury electrolytic cell was polished smooth and then chemical plated with nickel to be 30 μm in thickness.

The obtained plate was separated into six parts in a longitudinal way, by which the codeposit plating tank is formed substantially horizontal to allow the surface to be plated to face upward, as illustrated by Fig. 1 and Fig. 2.

Each part was codeposit plated in the same manner and the same conditions as in Example 1. A plating coating was hard and was approximately uniform in thickness in every part.

Using this cathode, a cell was assembled and leaching treatment was performed under the same conditions as in Example 1. "Nafion 901" (Trade Mark) was positioned and the electrolysis was effected. Cell voltage was 3.45 V under the conditions; temperature 90°C, current density 50 Å/dm<sup>2</sup> and NaOH 32%, and hydrogen overvoltage was 0.10 V.

#### Claims

1. A method for producing a low hydrogen overvoltage cathode which comprises using a codeposit plating tank in which an anode and an object to be plated of a non-perforated flat structure are positioned in parallel with each other, supplying a dispersant slurry through one side of the tank in a substantially horizontal way to thus allow it to flow in a space formed between the anode and the object, then removing the slurry through the opposite side and recirculating it back to the tank, whereby codeposit plating is applied to only one surface of the object, the dispersant comprising an alloy of a first metal selected from the group consisting of nickel, cobalt and silver, a second metal selected from the group consisting of aluminium, magnesium, zinc and tin, and third metal selected from the group consisting of platinum, palladium, rhodium, ruthenium, iridium and osmium.

2. The method of claim 1, wherein a solution forming said dispersant slurry is a nickel plating bath.

3. The method of claim 1, wherein the concentration of said dispersant slurry is not less than 0.01 g/l and less than 3 g/l.

4. The method of claim 1, wherein the average flow rate of said dispersant slurry in the tank is not less than 0.05 m/sec and less than 10 m/sec.

#### Patentansprüche

1. Verfahren zur Herstellung einer Kathode mit niedriger Wasserstoffüberspannung, das umfaßt Verwendung eines Behälters zur galvanischen Coabscheidung, bei dem eine Anode und ein zu beschichtender Gegenstand mit nicht-perforierter ebener Struktur parallel zueinander ausgerichtet sind, Einfüllen einer Dispersionsaufschlämmung durch eine Seite des Behälters auf im wesentlichen horizontale Weise, um den Fluß in den

Raum zwischen Anode und dem Gegenstand zu erlauben, dann Entfernen der Aufschlammung durch die gegenüberliegende Seite und Zurückführen der Aufschlammung zurück zum Tank, wobei die galvanische Coabscheidung nur auf eine Oberfläche des Gegenstands durchgeführt wird und wobei das Dispersionsmittel eine Legierung eines ersten Metalls umfaßt, ausgewählt aus der Gruppe, bestehend aus Nickel, Kobalt und Silber, eines zweiten metalls, ausgewählt aus der Gruppe, bestehend aus Aluminium, Magnesium, Zink und Zinn und eines dritten Metalls, ausgewählt aus der Gruppe, bestehend aus Platin, Palladium, Rhodium, Ruthenium, Iridium und Osmium.

2. Verfahren nach Anspruch 1, wobei eine Lösung, die die Dispersionsaufschlammung bildet, ein Nickel-Galvanisierbad ist.

3. Verfahren nach Anspruch 1, wobei die Konzentration der Dispersionsaufschlammung nicht weniger als 0,01 g/l und weniger als 3 g/l beträgt.

4. Verfahren nach Anspruch 1, wobei die Durchschnittsflußgeschwindigkeit der Dispersionsaufschlammung im Behälter nicht weniger als 0,05 m/sek. und weniger als 10 m/sek. beträgt.

#### Revendications

1. Procédé pour la production d'une cathode à surtension basse en hydrogène qui comprend

l'utilisation d'un réservoir de revêtement par dépôt simultané dans lequel on place en parallèle l'un avec l'autre, une anode et un objet à métalliser par électrolyse, de structure plate, non perforée, l'apport d'une suspension de dispersant par un côté du réservoir selon un trajet pratiquement horizontal pour lui permettre de s'écouler dans un espace formé entre l'anode et l'objet, puis le retrait de la suspension par le côté opposé et sa recirculation en retour vers le réservoir, le revêtement par dépôt simultané étant ainsi appliqué sur une seule surface de l'objet, le dispersant comprenant un alliage d'un premier métal choisi dans le groupe comprenant le nickel, le cobalt et l'argent, d'un second métal choisi dans le groupe comprenant l'aluminium, le magnésium, le zinc et l'étain, et d'un troisième métal choisi dans le groupe comprenant le platine, le palladium, le rhodium, le ruthénium, l'iridium et l'osmium.

2. Procédé selon la revendication 1, dans lequel une solution formant ladite suspension de dispersant est un bain de revêtement de nickel.

3. Procédé selon la revendication 1, dans lequel la concentration de ladite suspension de dispersant n'est pas inférieure à 0,01 g/l et est inférieure à 3 g/l.

4. Procédé selon la revendication 1, dans lequel le débit moyen de ladite suspension de dispersant dans le réservoir, n'est pas inférieur à 0,05 m/s et est inférieur à 10 m/s.

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FIG. 1

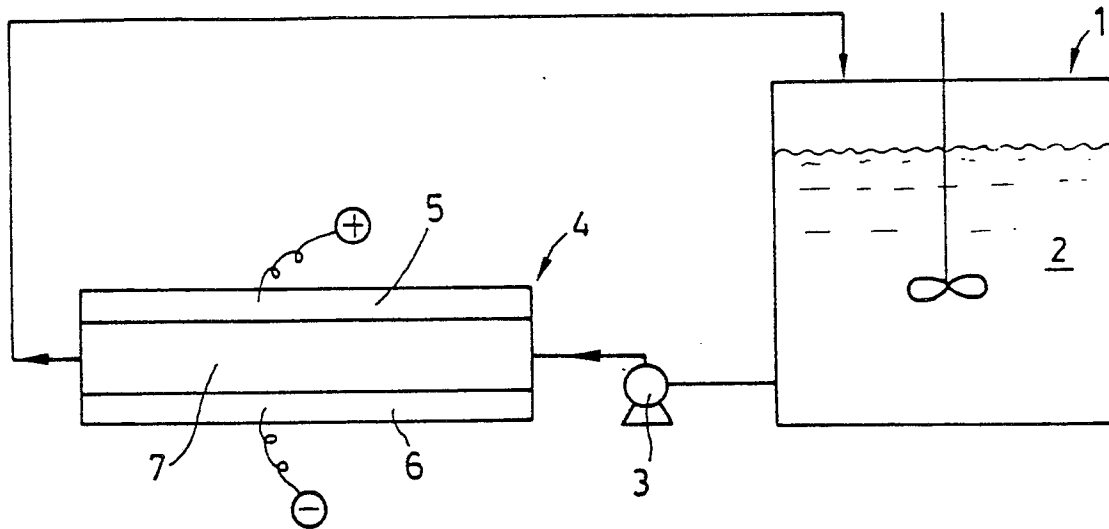
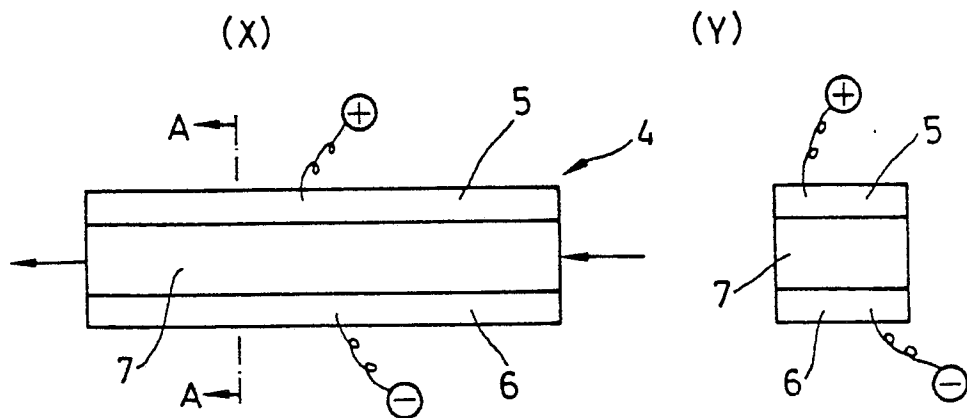


FIG. 2





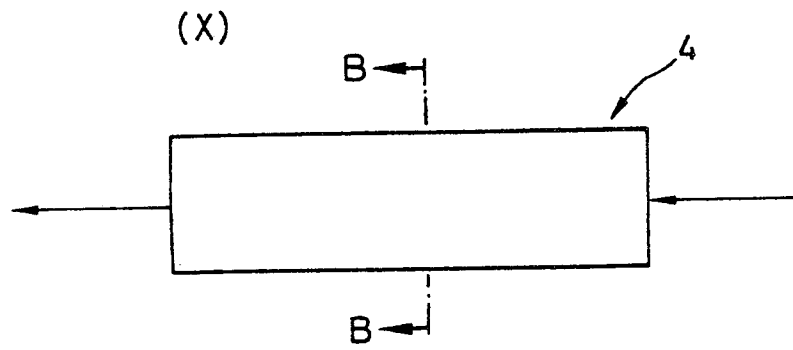


FIG. 3

