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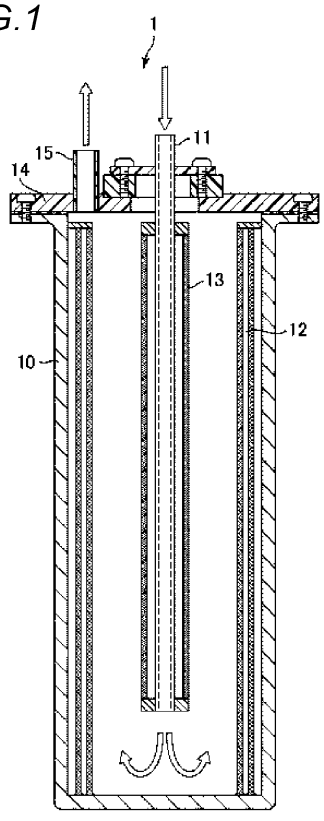
# (54) PRECIOUS METAL RECOVERY DEVICE AND RECOVERY METHOD

(57) Provided is a precious metal recovery device for recovering precious metals from waste fluids containing precious metals using an electrolytic method that can allow uniform precious metals to be deposited stably by suppressing the defect of the short circuit because of the variability in the amount of deposition or deposited particles caused by current abnormality or because of abnormal deposition of precious metals caused by current concentration, and its recovery method. In a precious metal recovery device including a cylindrical expander cathode disposed along an inner circumference of a metallic container that constitutes an electrolytic bath, and a cylindrical expander anode disposed along an outer circumference of the pipe-shaped anode, an upper section of the expander cathode is connected and secured to an upper shoulder section of the metallic container in an inverted L-shape in cross section, a lower section of the expander cathode is connected and secured to a bottom section of the metallic container, and both ends of the expander anode are connected and secured to the pipe-shaped anode in a U-shape in cross section.

*FIG.1*

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## Description

### Technical Field

**[0001]** The present invention relates to a recovery device and a recovery method for recovering precious metals from waste fluids containing precious metals using an electrolytic method.

### Background Art

**[0002]** For example, an electrolytic (reduction) method is generally used as means for recovering precious metals remaining in various kinds of waste fluids, such as a precious metal plating solution. In a precious metal recovery device using this electrolytic method, a waste fluid is introduced into an electrolytic bath, insoluble anode and cathode are immersed inside the waste fluid and electricity is applied thereby to reduce and deposit metal ions inside the fluid.

**[0003]** As an aspect of the precious metal recovery device, a precious metal recovery device 2 is available in which a cylindrical container 217 (an electrolytic bath) shown in FIG. 3 is used (refer to Patent Literature 1). This recovery device 2 is formed of the cylindrical container 217, an anode 211 provided at the central section thereof, and a cylindrical cathode 216 disposed along the inner circumference of the container. In addition, when precious metals are recovered, a waste fluid is introduced from an inlet provided at the lower section of the container, electrolyzed using the anode 211 and the cylindrical cathode 216, and then discharged from the opening of the anode through an outlet. Furthermore, by virtue of these steps, precious metals to be recovered are electrolyzed, reduced and deposited on the surface of the cathode 216 and become a state in which recovery is possible.

**[0004]** This kind of cylindrical recovery device is used to enable a waste fluid to be circulated continuously. For this reason, the recovery device is advantageous in that it is superior in working efficiency and is relatively compact in comparison with, for example, conventional recovery devices (JP-A-7-300692 etc.) in which plate-shaped anodes and cathodes are stacked continuously.

**[0005]** However, the recovery device described in Patent Literature 1 to which the above-mentioned cylindrical container is applied has a problem. In other words, deposited precious metals are peeled off from the cathode in some cases, and the anode is short-circuited to the cathode by the precious metals having been peeled off, whereby dissipation of the anode is accelerated and electrolysis cannot be performed continuously in some cases. This short circuit is apt to occur in the case that deposited precious metals are formed into a plate shape or a foil shape.

**[0006]** To solve this problem, as another aspect, a precious metal recovery device 3 is available that is equipped with a cylindrical container 310 constituting an electrolytic bath shown in FIG. 4; a pipe-shaped anode 311 disposed at the center of the container and having an opening at the bottom section thereof to allow a waste fluid to pass from the upper section of the container to the bottom section of the container; and a cylindrical cathode 312 disposed along the inner circumference of the container, wherein a net-shaped first cylinder electrically connected to the cathode is disposed around the inner circumference of the cathode (refer to Patent Literature 2). In this recovery device 3, first, punching metals made of titanium are wound along the inner circumference of the cathode into a cylindrical shape so as to be overlaid doubly and are used as a first cylinder. Since this first cylinder acts as the cathode, deposited precious metals attach to the cylinder and also attach to the surface of the cylinder and the inner walls of holes in the cylinder in the form of a powdery or granular shape. The deposited precious metals are held on the cylinder in a high adhesion state, whereby the short circuit to the anode due to peeling hardly occurs. Furthermore, precious metals deposited on the smooth cylindrical cathode are held in the clearance between the cylinder and the cathode even if peeling occurs; hence, no short circuit occurs due to the peeling. Moreover, the waste fluid is supplied to the anode and the bottom section of the pipe-shaped anode is opened, whereby the waste fluid is passed through from the upper section of the anode to the bottom section thereof. In the technology described in Patent Literature 2, in the case that powdery deposited precious metals are peeled off from the first cylinder and accumulate at the bottom section of the container, there is a danger that the bottom section of the container may be short-circuited to the anode. Hence, the waste fluid is supplied from the bottom section of the anode and passed continuously, whereby the deposited powdery precious metals accumulated on the bottom section of the container can be washed away to the outer circumference of the bottom section of the container by the stream of the waste fluid and the short circuit can be prevented.

### Citation List

### Patent Literature

**[0007]** Patent Literature 1: JP-A-2000-45089
Patent Literature 2: JP-A-2006-28555 (Japanese Patent No. 4151904)

### Summary of Invention

### Technical Problem

**[0008]** However, even in the technology described in Patent Literature 2, because of the variability in the amount of deposition caused by current abnormality due to the wobbling of the first cylinder acting as the cathode or because of abnormal deposition of precious metals caused by current concentration at the end sections of

the cylinder, the precious metals drop as metal powder, and the defect of the short circuit due to the drop cannot be suppressed completely.

**[0009]** Accordingly, an object of the present invention is to provide a precious metal recovery device and a precious metal recovery method capable of allowing uniform precious metals to be deposited stably so as to be convenient for dissolution during the refining of recovered substances by suppressing the defect of the short circuit because of the variability in the amount of deposition or deposited particles caused by current abnormality described above or because of abnormal deposition of precious metals caused by current concentration described above. Furthermore, another object of the present invention is to provide a precious metal recovery device and a precious metal recovery method capable of allowing precious metals to be deposited uniformly and stably, thereby recovering the precious metals efficiently.

Solution to Problem

**[0010]** After keen investigation, the inventors have made a plurality of improvements in a recovery device and a recovery method to which a cylindrical container is applied and have developed a recovery device and a recovery method capable of solving the above-mentioned problem.

**[0011]** An aspect of the present invention is described in detail as follows.

A precious metal recovery device, includes: a cylindrical metallic container that constitutes an electrolytic bath; a detachable insulating cover that hermetically seals the metallic container, and has a waste fluid outlet; a pipe-shaped anode passing through a center of the insulating cover, that allows a waste fluid to pass through from an upper section to a bottom section of the pipe-shaped anode; a cylindrical expander cathode that is disposed along an inner circumference of the metallic container; and a cylindrical expander anode that is disposed along an outer circumference of the pipe-shaped anode, wherein an upper section of the expander cathode is connected and secured to an upper shoulder section of the metallic container in an inverted L-shape in cross section, and a lower section of the expander cathode is connected and secured to a bottom section of the metallic container, and both ends of the expander anode are connected and secured to the pipe-shaped anode in a U-shape in cross section.

It is preferable that the length of the expander anode is a length obtained by multiplying 0.5 to 0.95 to the length of the expander cathode.

It is preferable that each of the metallic container and the expander cathode is made of one, two or more kinds of metals selected from a group consisting of titanium, tantalum, niobium, zirconium and hafnium or alloys thereof.

Further, it is preferable that a central section of the expander cathode is formed into a shape bulging toward the expander anode.

Further, it is preferable that at least a surface of each of the pipe-shaped anode and the expander anode is made of a platinum-group metal or its alloy or its oxide.

On the other hand, a precious metal recovery method according to an aspect of the present invention, provides: a pipe-shaped anode passing through a center of a detachable insulating cover that is provided on a cylindrical metallic container that constitutes an electrolytic bath to hermetically seal the metallic container; the metallic container and an expander anode that is disposed along an inner circumference of the metallic container; and a cylindrical expander anode that is disposed along an outer circumference of the pipe-shaped anode, wherein the method including the steps of: feeding a waste fluid from a waste fluid bath for recovery that accommodates the waste fluid containing a precious metal; passing the fed waste fluid through the pipe-shaped anode from an upper section to a bottom section of the pipe-shaped anode; electrolyzing the passed waste fluid while the waste fluid flows reversely from a bottom section to an upper section between the expander cathode and the pipe-shaped anode; discharging the waste fluid from a waste fluid outlet, returning the waste fluid to the waste fluid bath for recovery through a filter, and circulating the electrolyzed waste fluid, wherein an upper section of the expander cathode is connected and secured to an upper shoulder section of the metallic container in an inverted L-shape in cross section, and a lower section of the expander cathode is connected and secured to a bottom section of the metallic container, and both ends of the expander anode are connected and secured to the pipe-shaped anode in a U-shape in cross section.

It is preferable that the length of the expander anode is a length obtained by multiplying 0.5 to 0.95 to the length of the expander cathode.

It is preferable that each of the metallic container and the expander cathode is made of one, two or more kinds of metals selected from a group consisting of titanium, tantalum, niobium, zirconium and hafnium or alloys thereof.

Further, it is preferable that a central section of the expander cathode is formed into a shape bulging toward the expander anode.

Further, it is preferable that at least a surface of each of the pipe-shaped anode and the expander anode is made of a platinum-group metal or its alloy or its oxide.

Advantageous Effects of Invention

**[0012]** The precious metal recovery device and the precious metal recovery method according to an aspect of the present invention can allow uniform precious metals to be deposited stably so as to be convenient for dissolution during the refining of recovered substances by suppressing the defect of the short circuit because of the variability in the amount of deposition or deposited particles caused by current abnormality or because of abnormal deposition of precious metals caused by current concentration. Furthermore, the precious metal recovery

device and the precious metal recovery method according to the present invention can allow precious metals to be deposited uniformly and stably and can recover precious metals efficiently.

Brief Description of Drawings

**[0013]**

FIG. 1 is a schematic sectional diagram showing an embodiment of a precious metal recovery device according to the present invention;
FIG. 2 is a schematic view showing an embodiment of a precious metal recovery method according to the present invention;
FIG. 3 is a sectional diagram showing a structure of the conventional precious metal recovery device (Patent Literature 1); and
FIG. 4 is a sectional diagram showing a structure of the conventional precious metal recovery device (Patent Literature 2).

Modes for Carrying out Invention

**[0014]** An embodiment according to the present invention will be described below referring to a sectional diagram (FIG. 1) showing a precious metal recovery device for recovering precious metals from a waste fluid containing precious metals by electrolysis. In a precious metal recovery device 1 according to the embodiment, since the upper section of an expander cathode 12 is connected and secured to the upper shoulder section of a metallic container 10 in an inverted L-shape in cross section and the lower section thereof is connected and secured to the bottom section of the metallic container 10, it is possible to suppress the short circuit to the anode due to the wobbling of the cathode or to suppress the short circuit due to abnormal deposition caused by current abnormality or drop of deposited substances. Furthermore, since both end sections of the expander cathode 12 are electrically connected to the metallic container 10, current concentration at both end sections of the cathode can be suppressed and the short circuit due to abnormal deposition of precious metals caused thereby can be suppressed, while current concentration occurs at both end sections of the expander cathode 12 if they are not connected. The connection and securing may be performed between the upper and lower sections of the expander cathode 12 and the metallic container 10 around the entire circumferences or at parts of the circumferences thereof. The connection and securing may be performed by welding the expander cathode 12 directly or via a spacer. In the case that the connection and securing is performed around the entire circumferences via the spacer, it is preferable that the spacer should have a shape with holes in consideration of the flow of the waste fluid. In the case that the connection and securing is performed partly, it is also preferable that each of the upper section and the lower section should be secured at two or more positions in consideration of suppressing the wobbling. Although ordinary spot welding, pressure welding, etc. can be performed as a connection method, the connection method is not limited to the above-mentioned methods, provided that electrical connection is made possible. The expander cathode 12 according to the embodiment may have a single layer or a plurality of layers. However, it is preferable that the expander cathode 12 should have a plurality of layers in consideration of recovery efficiency. Furthermore, it is more preferable that the expander cathode 12 should have two to five layers in consideration of the production cost and operation cost of the apparatus.

**[0015]** Both end sections of an expander anode 13 according to the embodiment are connected and secured to a pipe-shaped anode 11 in a U-shape in cross section, whereby current abnormality due to the wobbling of the anode can be avoided. The connection and securing may be performed between both ends of the expander anode 13 and the pipe-shaped anode 11 around the entire circumferences or at parts of the circumferences thereof. The connection and securing may be performed by welding the expander anode 13 directly or via a spacer. In the case that the connection and securing is performed around the entire circumferences, it is preferable that a shape with holes should be provided at the connections between the upper and lower sections to the pipe-shaped anode 11. In the case that the connection and securing is performed partly, it is also preferable that each of both ends should be secured at two or more positions in consideration of suppressing the wobbling. It is preferable that the lower section of the expander anode 13 and the lower section of the pipe-shaped anode 11 should be equidistant from the bottom section of the electrolytic bath.

**[0016]** It is preferable that the length of the expander anode 13 according to the embodiment should be a length obtained by multiplying 0.5 to 0.95 to the length of the expander cathode 12. In the case that the length of the expander anode 13 is more than the length obtained by multiplying 0.95 to the length of the expander cathode 12, deposited powdery precious metals accumulate at the bottom section of the metallic container 10; as a result, not only a short circuit is apt to occur, but also abnormal deposition occurs at the bottom section of the expander cathode 12. In the case that the length of the expander anode 13 is less than the length obtained by multiplying 0.5 to the length of the expander cathode 12, a large imbalance occurs in the current distribution on the cathode, the deposition amounts and the shapes of deposited metals become non-uniform, and the dissolution time for refining becomes long, for example, thereby causing a decrease in recovery efficiency. Furthermore, in consideration of suppressing the decrease in recovery efficiency, it is more preferable that the length of the expander anode 13 should be a length obtained by multiplying 0.7 to 0.95 to the length of the expander cathode

12.

**[0017]** It is preferable that the metallic container 10 and the expander cathode 12 according to the embodiment should be made of one, two or more kinds of metals selected from the group consisting of titanium, tantalum, niobium, zirconium and hafnium or alloys thereof. In the case that metals or alloys other than those described above are used, if aqua regia that is frequently used when precious metals (gold, platinum, etc.) electrolyzed and deposited on the metallic container 10 and the expander cathode 12 are dissolved and recovered from the electrode for the purpose of refining after the recovery, the metallic container 10 and the expander cathode 12 may be dissolved in some cases. On the other hand, even in the case that an insoluble metal, such as stainless steel, is used, a small amount of lead that is difficult to separate from a recovered portion is eluted and causes a problem in the refining to be performed later. Furthermore, in consideration of low cost, high workability and insolubility in aqua regia, it is more preferable that titanium or its alloy should be used.

**[0018]** In the case that the central section of the expander cathode 12 according to the embodiment is formed into a shape bulging outward, more uniform deposition can be attained and precious metals can be deposited at high recovery efficiency while suppressing current abnormality. The shape bulging outward is a shape in which the cross-section thereof has a circular shape such that the central section of the expander cathode 12 approaches closest to the anode. The reason why this shape is adopted is that the current imbalance at the end sections of the cathode is further suppressed and more uniform electrolysis can be performed.

**[0019]** It is preferable that the pipe-shaped anode 11 and the expander anode 13 according to the embodiment should be made of an insoluble material, and it is preferable that at least the surface of the material should be made of a platinum-group metal or its alloy or its oxide. Moreover, it is more preferable that the material should be a valve metal, such as titanium, plated with platinum or a platinum alloy or coated with iridium oxide or ruthenium oxide in consideration of cost and durability.

**[0020]** It is preferable that the respective lengths of the long and short axes serving as the diagonal lines of the rhombic holes in the expander cathode 12 and the expander anode 13 should be 4×2 mm to 16×8 mm. In the case that the lengths are less than 4×2 mm, the holes are clogged promptly by electro-deposition; in the case that the lengths are more than 16×8 mm, the surface area decreases and recovery efficiency lowers.

**[0021]** Next, a precious metal recovery method using the precious metal recovery device 1 configured as described above will be described referring to FIGS. 1 and 2. In the precious metal recovery method according to the embodiment, a waste fluid is fed using a pump 21 or the like from a waste fluid bath 20 for recovery that accommodates the waste fluid containing precious metals, the fed waste fluid passes through the inside of the pipe-shaped anode 11 from the upper section to the bottom section thereof, the passed waste fluid is electrolyzed while flowing reversely from the bottom section to the upper section between the expander cathode 12 and the pipe-shaped anode 11, the waste fluid is discharged from a waste fluid outlet 15 and returned to the waste fluid bath 20 for recovery via a filter 22, and the returned waste fluid is circulated. At this time, since the upper section of the expander cathode 12 is connected and secured to the upper shoulder section of the metallic container 10 in an inverted L-shape in cross section and the lower section of the expander cathode 12 is connected and secured to the bottom section of the metallic container 10, it is possible to suppress the short circuit to the anode due to the wobbling of the cathode or to suppress the short circuit due to abnormal deposition caused by current abnormality or drop of deposited substances. Furthermore, since both end sections of the expander cathode 12 are connected and secured to the metallic container 10, current concentration at both end sections of the cathode can be suppressed and the short circuit due to abnormal deposition of precious metals caused thereby can be suppressed, while current concentration occurs at both end sections of the expander cathode 12 if they are not connected. Since the both ends of the expander anode 13 are connected and secured to the pipe-shaped anode 11 in a U-shape in cross section, the short circuit to the cathode can be suppressed. Metal powder flowing out together with the waste fluid from the waste fluid outlet 15 is trapped by the filter 22 provided in the next step, whereby the short circuit between the electrodes can be further suppressed.

**[0022]** In the precious metal recovery method according to the embodiment, it is preferable that the length of the expander anode 13 according to the embodiment should be a length obtained by multiplying 0.5 to 0.95 to the length of the expander cathode 12. In the case that the length of the expander anode 13 is more than the length obtained by multiplying 0.95 to the length of the expander cathode 12, deposited powdery precious metals accumulate at the bottom section of the metallic container 10; as a result, not only a short circuit is apt to occur, but also abnormal deposition occurs at the bottom section of the expander cathode 12. In the case that the length of the expander anode 13 is less than the length obtained by multiplying 0.5 to the length of the expander cathode 12, a large imbalance occurs in the current distribution on the cathode, the deposition amounts and the shapes of deposited metals become non-uniform, and dissolution time for refining becomes long, for example, thereby causing a decrease in recovery efficiency. Furthermore, in consideration of suppressing the decrease in recovery efficiency, it is more preferable that the length of the expander anode 13 should be a length obtained by multiplying 0.7 to 0.95 to the length of the expander cathode 12.

**[0023]** It is preferable that the metallic container 10 and the expander cathode 12 should be made of one, two or

more kinds of metals selected from the group consisting of titanium, tantalum, niobium, zirconium, and hafnium or alloys thereof. In the case that metals or alloys other than those described above are used, if aqua regia that is frequently used when precious metals (gold, platinum, etc.) electrolyzed and deposited on the metallic container 10 and the expander cathode 12 are dissolved and recovered from the electrode for the purpose of refining after the recovery, the metallic container 10 and the expander cathode 12 may be dissolved in some cases. On the other hand, even in the case that an insoluble metal, such as stainless steel, is used, a small amount of lead that is difficult to separate from the recovered portion is eluted and causes a problem in the refining to be performed later. Furthermore, in consideration of low cost, high workability and insolubility in aqua regia, it is more preferable that titanium or its alloy should be used.

**[0024]** It is preferable that the central section of the expander cathode 12 should be formed into a shape bulging outward. In that case, more uniform deposition can be attained and precious metals can be deposited at high recovery efficiency while suppressing current abnormality. The shape bulging outward is a shape in which the cross-section thereof has a circular shape such that the central section of the expander cathode 12 approaches closest to the anode. The reason why this shape is adopted is that the current imbalance at the end sections of the cathode is further suppressed and more uniform electrolysis can be performed.

**[0025]** It is preferable that at least the surface of each of the pipe-shaped anode 11 and the expander anode 13 should be made of a platinum-group metal or its alloy or its oxide. Moreover, it is more preferable that the material should be a valve metal, such as titanium, plated with platinum or a platinum alloy or coated with iridium oxide or ruthenium oxide in consideration of cost and durability.

**[0026]** In the precious metal recovery device according to the embodiment, it is preferable that the fluid feeding speed of the waste fluid for recovery inside the precious metal recovery device should be 5 to 30 L/min although the speed is different depending on the metal ion species in the waste fluid to be processed, electrolysis conditions, etc. In the case that the fluid feeding speed is less than 5 L/min, imbalance occurs in the concentration of precious metals in the electrolytic chamber, and non-uniform deposition is apt to occur; in the case that the fluid feeding speed is more than 30 L/min, the electrolytic recovery efficiency lowers and the recovery takes a long time, whereby the speed is inappropriate. It is preferable that the current density at the metallic container and the expander cathode should be in the range from 0.05 to 0.30 A/dm2. In the case that the current density at the metallic container and the expander cathode is less than 0.05 A/dm2, the recovery takes a long time; in the case that the current density is more than 0.30 A/dm2, the recovery efficiency is not improved, but the cost increases.

**[0027]** In the precious metal recovery method according to the embodiment, the precious metals attached to the metallic container 10 or the expander cathode 12, the precious metals accumulated in the bottom section of the metallic container 10, and the precious metals trapped in the filter 22 are suppressed from being subjected to abnormal deposition etc., whereby the precious metals are peeled off and dissolved easily by aqua regia or a KCN solution serving as a peeling solution and can be refined so that the purity values thereof are raised approximately to a one-digit level. As the peeling solution, it is preferable that aqua regia should be used that can dissolve various kinds of precious metals.

Example

**[0028]** An aspect of the embodiment of the precious metal recovery device according to the present invention will be described below referring to FIGS. 1 and 2. The cylindrical metallic container 10 serving as an electrolytic bath (measuring 150 mm in inner diameter and 700 mm in height) is disposed, the first layer of the cylindrical expander cathode 12 (measuring 140 mm in diameter, 1 mm in thickness, 685 mm in length, and 6 (long axis) × 3 (short axis) mm serving as the diagonal lines of rhombic holes) is disposed along the inner circumference of the metallic container 10, and the second layer of the cylindrical expander cathode 12 (measuring 130 mm in diameter, 1 mm in thickness, 685 mm in length, and 6 (long axis) × 3 (short axis) mm serving as the diagonal lines of rhombic holes) is also disposed along the inner circumference of the metallic container 10. On the other hand, the pipe-shaped anode 11 (measuring 22 mm in outer diameter, 690 mm in length, and 2 mm in thickness) is inserted in the central section of the metallic container 10, and the cylindrical expander anode 13 (measuring 38 mm in outer diameter, 1 mm in thickness, 590 mm in length, and 8 (long axis) × 4 (short axis) mm serving as the diagonal lines of rhombic holes) is disposed along the outer circumference of the pipe-shaped anode 11. The bottom section of the pipe-shaped anode 11 is open and spaced at a constant distance (95 mm) from the bottom surface of the metallic container 10. The length of the expander anode 13 in the above-mentioned case is a length obtained by multiplying 0.86 to the length of the expander cathode 12.

**[0029]** The upper section of the expander cathode 12 is integrally connected and secured by welding to the upper shoulder section of the metallic container 10 using four continuous metal plates (measuring 8 mm × 12 mm and 1 mm in thickness) in an inverted L-shape in cross section as a whole. The lower section of the expander cathode 12 is connected and secured to the bottom section of the metallic container 10 at four positions as in the case of the upper section thereof. Both ends of the expander anode 13 are integrally connected and secured by welding to the pipe-shaped anode 11 using ring-shaped continuous metal plates (measuring 38 mm in outer diameter, 18 mm in inner bore diameter, and 1 mm

in thickness) in a U-shape in cross section as a whole.

**[0030]** The metallic container 10, the expander cathode 12 and the continuous metal plates of the cathode are made of titanium, and the pipe-shaped anode 11, the expander anode 13 and the continuous metal plates of the anode are made of titanium as a base material and plated with iridium.

**[0031]** As one aspect of the precious metal recovery method according to the embodiment, a waste fluid is fed using the pump 21 from the waste fluid bath 20 for recovery that accommodates the waste fluid containing precious metals, the fed waste fluid passes through the pipe-shaped anode 11 from the upper section to the bottom section thereof and flows to the bottom section of the metallic container 10. The passed waste fluid is electrolyzed while flowing reversely from the bottom section to the upper section between the cathode and the anode 11. The electrolyzed waste fluid is discharged from the waste fluid outlet 15 being open in an insulating cover 14 on the upper section of the metallic container 10 and returned to the waste fluid bath for recovery through the thread wound filter 22, and the returned waste fluid is circulated. Although the feeding speed of the circulated fluid is different depending on the metal ion species in the waste fluid to be processed, electrolysis conditions, etc., the feeding is performed at a feeding speed of 10 to 20 L/min in the case of the electrolytic recovery of gold from a plating solution of 500 L containing gold (a gold concentration of 1.5 g/L). Furthermore, electrolysis was performed at a current density ranging from 0.1 to 0.2 A/dm2 as an electrolysis condition during recovery. The time required for one recovery operation is 12 to 18 hours at the above-mentioned fluid feeding speed and under the above-mentioned electrolysis conditions.

**[0032]** In the case of the recovery of gold from a plating waste fluid containing gold, after the electrolysis, the metallic container 10 of the precious metal recovery device 1, including the expander cathode 12 on which gold has been deposited, is removed in some cases together with the filter 22 to which gold powder has attached. As a solution for refining the deposited gold, aqua regia or the like is used. Titanium is not dissolved by aqua regia or the like. Gold can be dissolved by pouring the solution into the metallic container and by performing stirring inside the recovery device. Furthermore, gold can also be dissolved by putting the metallic container 10 including the expander cathode 12 on which gold has been deposited into a solution bath. The deposited gold is dissolved easily in aqua regia or the like.

**[0033]** Satisfactory results were obtained in the above-mentioned recovery of gold from the plating waste fluid containing gold using the precious metal recovery device according to the present invention. More specifically, the short circuit due to abnormal deposition of gold caused by current concentration at both end sections of the cathode did not occur at all. Furthermore, deposition was performed uniformly at a deposited metal thickness of 0.5 to 3.0 mm, and dissolution in aqua regia during the refining of recovered substances was able to be carried out easily. The recovery rate of gold from the waste fluid for recovery was 99.9%.

## Claims

**1.** A precious metal recovery device, comprising:

a cylindrical metallic container that constitutes an electrolytic bath;
a detachable insulating cover that hermetically seals the metallic container, and has a waste fluid outlet;
a pipe-shaped anode passing through a center of the insulating cover, that allows a waste fluid to pass through from an upper section to a bottom section of the pipe-shaped anode;
a cylindrical expander cathode that is disposed along an inner circumference of the metallic container; and
a cylindrical expander anode that is disposed along an outer circumference of the pipe-shaped anode, wherein
an upper section of the expander cathode is connected and secured to an upper shoulder section of the metallic container in an inverted L-shape in cross section, and a lower section of the expander cathode is connected and secured to a bottom section of the metallic container, and both ends of the expander anode are connected and secured to the pipe-shaped anode in a U-shape in cross section.

**2.** The precious metal recovery device according to claim 1, wherein
the length of the expander anode is a length obtained by multiplying 0.5 to 0.95 to the length of the expander cathode.

**3.** The precious metal recovery device according to claim 1, wherein
each of the metallic container and the expander cathode is made of one, two or more kinds of metals selected from a group consisting of titanium, tantalum, niobium, zirconium and hafnium or alloys thereof.

**4.** The precious metal recovery device according to claim 1, wherein
a central section of the expander cathode is formed into a shape bulging toward the expander anode.

**5.** The precious metal recovery device according to claim 1, wherein
at least a surface of each of the pipe-shaped anode and the expander anode is made of a platinum-group metal or its alloy or its oxide.

**6.** A precious metal recovery method, providing:

a pipe-shaped anode passing through a center of a detachable insulating cover that is provided on a cylindrical metallic container that constitutes an electrolytic bath to hermetically seal the metallic container;
the metallic container and an expander anode that is disposed along an inner circumference of the metallic container; and
a cylindrical expander anode that is disposed along an outer circumference of the pipe-shaped anode, wherein

the method comprising the steps of:

feeding a waste fluid from a waste fluid bath for recovery that accommodates the waste fluid containing a precious metal;
passing the fed waste fluid through the pipe-shaped anode from an upper section to a bottom section of the pipe-shaped anode;
electrolyzing the passed waste fluid while the waste fluid flows reversely from a bottom section to an upper section between the expander cathode and the pipe-shaped anode;
discharging the waste fluid from a waste fluid outlet, returning the waste fluid to the waste fluid bath for recovery through a filter, and circulating the electrolyzed waste fluid, wherein
an upper section of the expander cathode is connected and secured to an upper shoulder section of the metallic container in an inverted L-shape in cross section, and a lower section of the expander cathode is connected and secured to a bottom section of the metallic container, and both ends of the expander anode are connected and secured to the pipe-shaped anode in a U-shape in cross section.

**7.** The precious metal recovery method according to claim 6, wherein
the length of the expander anode is a length obtained by multiplying 0.5 to 0.95 to the length of the expander cathode.

**8.** The precious metal recovery method according to claim 6, wherein
each of the metallic container and the expander cathode is made of one, two or more kinds of metals selected from a group consisting of titanium, tantalum, niobium, zirconium and hafnium or alloys thereof.

**9.** The precious metal recovery method according to claim 6, wherein
a central section of the expander cathode is formed into a shape bulging toward the expander anode.

**10.** The precious metal recovery method according to claim 6, wherein
at least a surface of each of the pipe-shaped anode and the expander anode is made of a platinum-group metal or its alloy or its oxide.

FIG.1

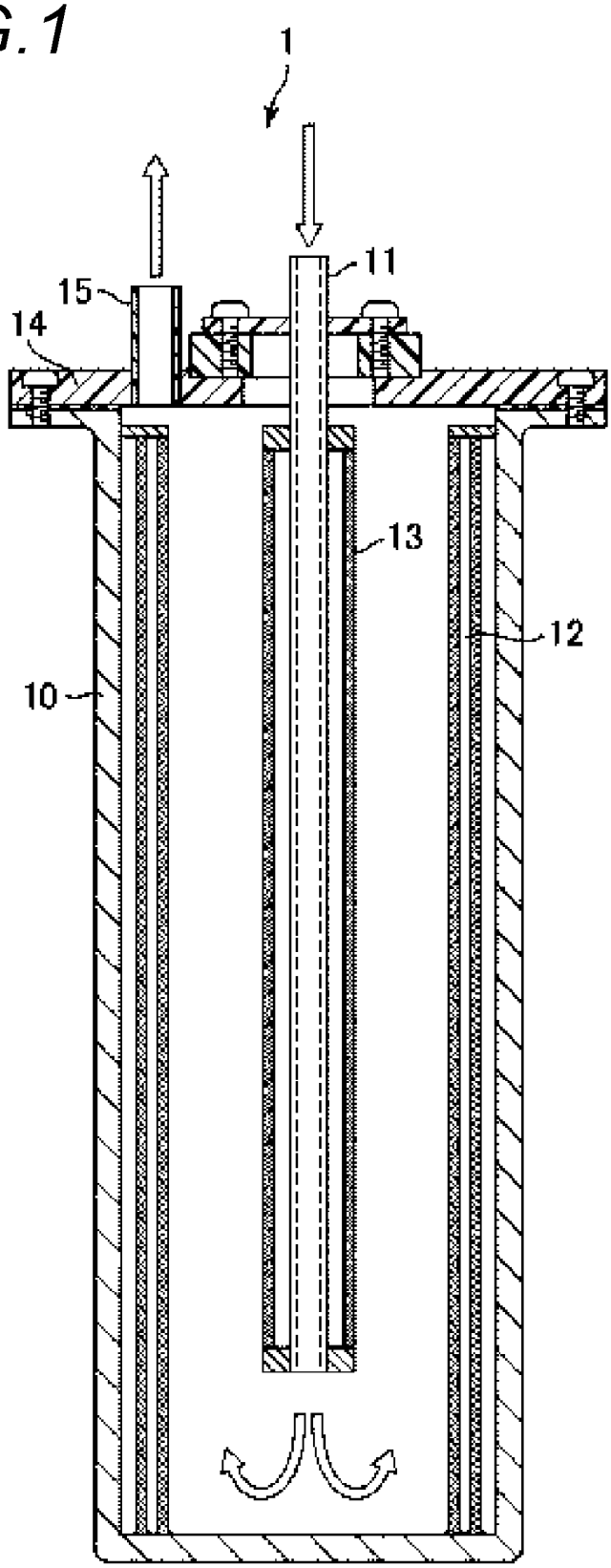


FIG.2

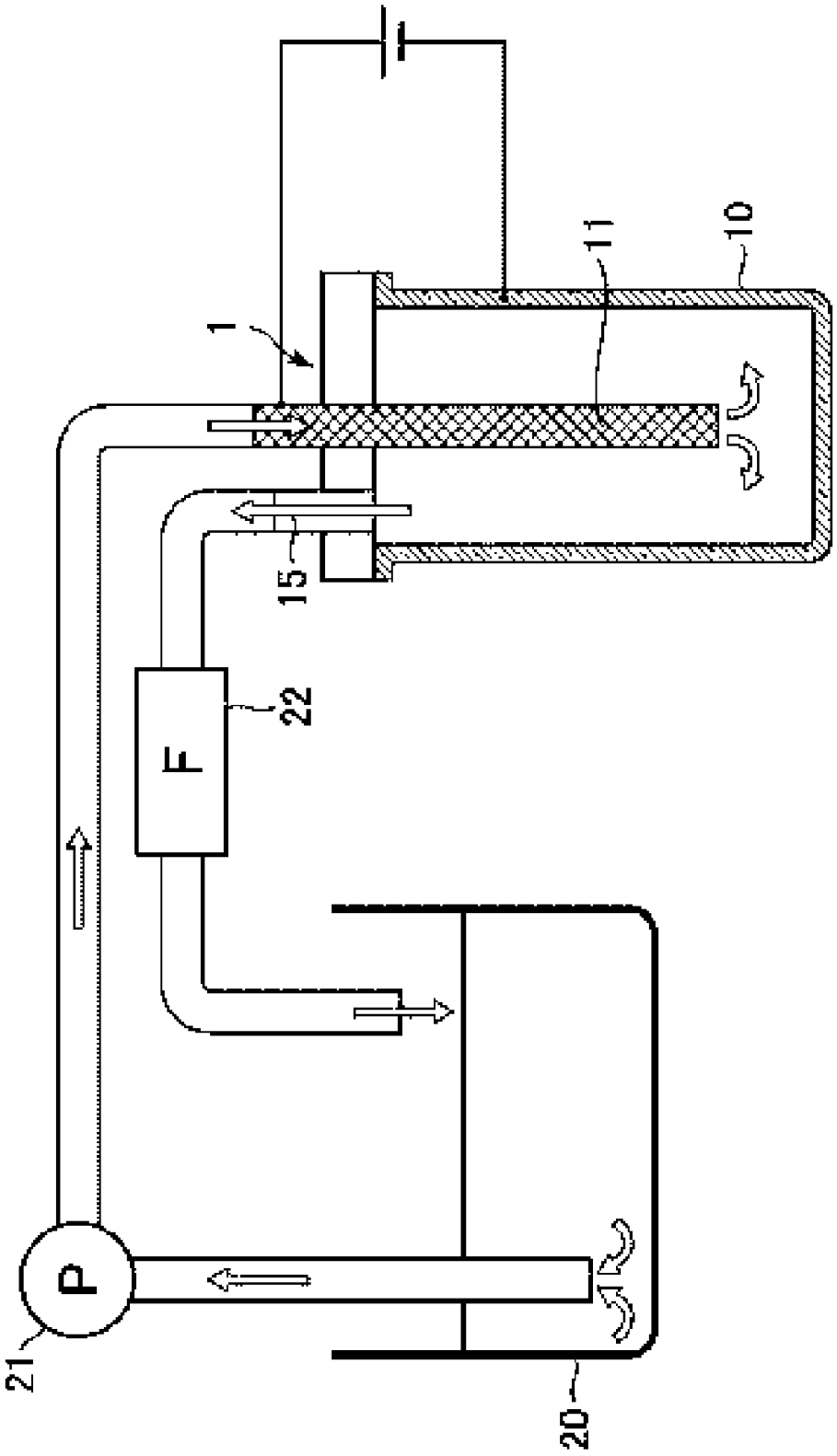


FIG.3

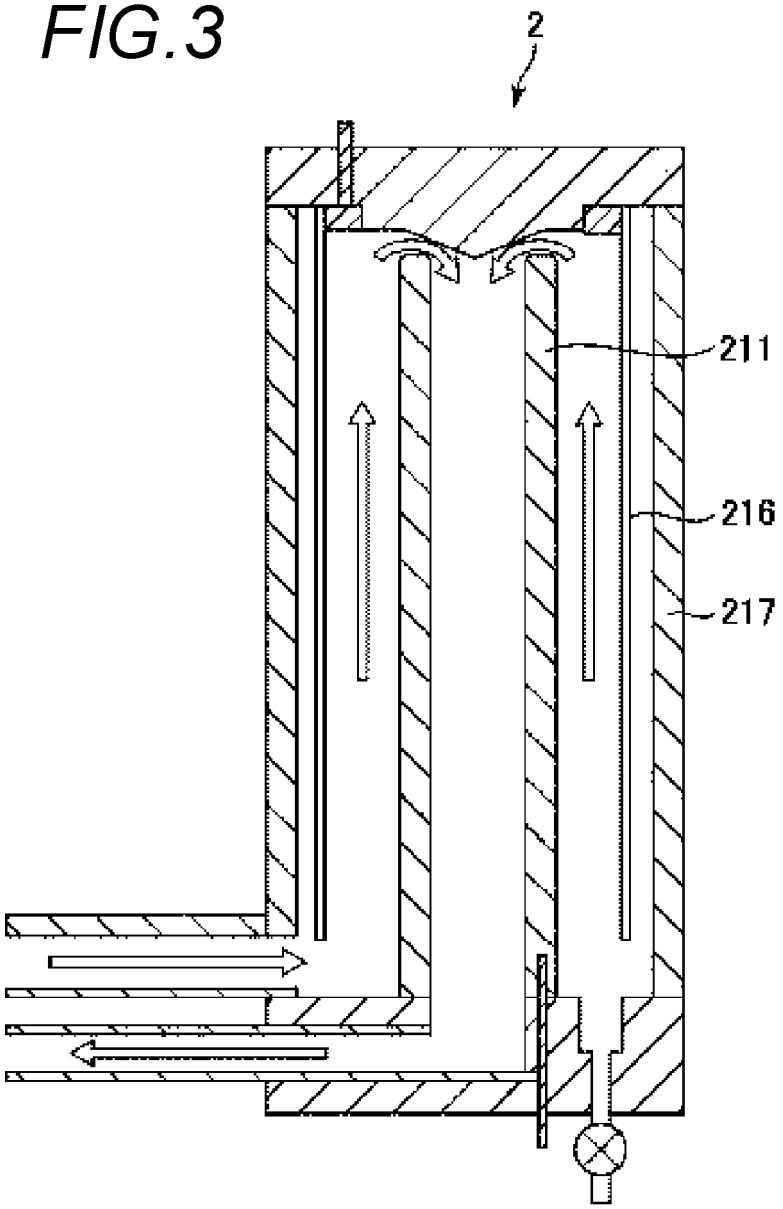
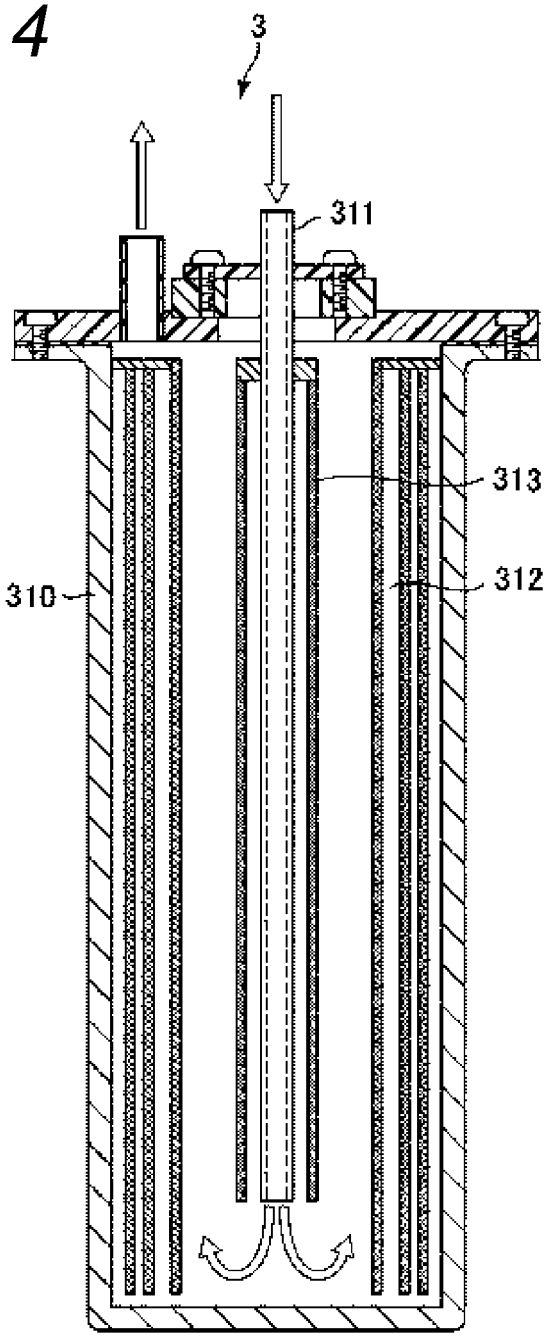


FIG.4



**INTERNATIONAL SEARCH REPORT**

International application No.
PCT/JP2011/065495

A. CLASSIFICATION OF SUBJECT MATTER
*C25C7/00*(2006.01)i, *C25C1/20*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C25C7/00, C25C1/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2011
Kokai Jitsuyo Shinan Koho 1971-2011 Toroku Jitsuyo Shinan Koho 1994-2011

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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| A | JP 2006-28555 A (Tanaka Kikinzoku Kogyo Kabushiki Kaisha), 02 February 2006 (02.02.2006), (Family: none) | 1-10 |

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 04 October, 2011 (04.10.11) | 11 October, 2011 (11.10.11) |
| Name and mailing address of the ISA/ Japanese Patent Office<br>Facsimile No. | Authorized officer<br>Telephone No. |

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**INTERNATIONAL SEARCH REPORT**

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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|---|---|---|
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## REFERENCES CITED IN THE DESCRIPTION

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- JP 4151904 B **[0007]**