Patented Dec. 15, 1942

2,305,133

UNITED STATES PATENT OFFICE

2,305,133

ANODE

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No Drawing. Application September 1, 1939, Serial No. 293,060. In Chile August 2, 1939

6 Claims. (Cl. 204—293)

This invention relates to the electrodeposition of copper, and has for its principal objects the provision of an improved method for electrodepositing copper with the aid of an insoluble anode from copper-bearing electrolytes which are substantially corrosive to ordinary insoluble anodes of lead or antimony-lead, and the provision of an improved anode substantially resistant to corrosion by such electrolytes.

Insoluble anodes of lead or antimony-lead are commonly used for electrodepositing copper from copper-bearing electrolytes. Insoluble anodes of soft lead have been employed successfully in the electrodeposition of copper from copper-bearing electrolytes, such for example as non-corrosive copper sulphate solutions, but such anodes are unsatisfactory when the electrolyte contains corrosive materials, such for example as nitric acid.

In electrodepositing copper from corrosive electrolytes, it has been common practice to employ anodes of antimony-lead, which is harder and generally more resistant to corrosion than is ordinary soft lead. In electrodepositing copper from electrolytes containing substantial amounts of nitric acid, however, even lead anodes containing relatively high percentages of antimony are corroded to a substantial degree. For example, in the electrolytic copper tank house of the Chile Exploration Company at Chuquicamata, Chile, anodes of antimony-lead containing about 18% antimony and about 82% lead have been employed for electrodepositing copper from copper sulphate electrolytes containing approximately 2 grams per liter of nitric acid. Even the relatively high percentage of antimony present in these anodes does not prevent substantial corrosion of the anodes by the electrolyte. Anode corrosion in this case proceeds at the rate of about 4 kilograms per metric ton of copper deposited at the cathodes. This relatively high rate of anode corrosion is serious for two reasons. In the first place, it results in substantial losses of anode metal during the course of the electrolytic process, with accompanying high anode costs. In the second place, a part of the corroded lead finds its way to the cathode and becomes included in the cathode copper deposit, resulting in the production of impure cathodes.

The present invention provides an improved process for electrodepositing copper from corrosive electrolytes, involving the use in a new and improved insoluble anode which is highly resistant to corrosion by electrolytes containing nitric acid and like substances capable of corroding ordinary insoluble anodes of lead or antimony-lead. In accordance with the process of the invention, copper is deposited from such corrosive copper-bearing electrolytes with a minimum of anode corrosion by employing an insoluble anode composed of an alloy consisting largely of lead containing silver in an amount sufficient to reduce corrosion of the anode to a substantial extent. Ordinarily an amount of silver in excess of 0.5% by weight of the anode should be alloyed with the lead of the anode in order to secure the benefits of reduced anode corrosion made available by the invention. In addition to lead and silver, the anode preferably also contains a substantial amount of antimony and may with advantage contain a small percentage of arsenic. A preferred anode is composed of an alloy consisting largely of lead, preferably between about 78% and 87% of lead by weight of the alloy, together with a substantial amount of antimony, preferably between about 9% and 18% by weight of antimony, a small amount of silver, preferably of the order of 0.5% to 1.5% by weight of silver, and a small amount of arsenic, preferably 0.2% to 1.5% by weight.

The new anode may be prepared by incorporating appropriate amounts of antimony, silver, and, if desired, arsenic in molten commercial lead or antimony-lead. Antimony, silver, and arsenic all are readily miscible with lead, and no difficulty is encountered in incorporating these materials in the molten lead by adding weighed amounts thereof to the lead and stirring the resulting molten mixture slightly. Stirring may be unnecessary. Anodes are prepared from the molten alloy by casting into appropriate anode shapes.

The process of the invention is carried out by immersing an anode prepared in accordance with the invention in the corrosive copper-bearing electrolyte from which it is desired to electrodeposit copper. Current is passed through the electrolyte in the usual manner between the anode of the invention and any suitable cathode, such for example as a cathode starting sheet of electrodeposited copper.

The efficiency of the new process, making use of the new anode, has been demonstrated by tests conducted on a commercial scale in the electrolytic copper tank house of the Chile Exploration Company at Chuquicamata, Chile. In these tests anodes of commercial size composed of the preferred alloy consisting of about 81% lead, about 18% antimony, and about 0.8% silver were employed for a period of over a year in electrodepositing copper on a commercial scale from cop-

per-bearing electrolytes containing approximately 2 grams per liter of nitric acid. Anode corrosion over the period of the test amounted to about 0.6 kilogram per metric ton of copper deposited on the cathode. This compares with an anode corrosion rate of about 3.8 kilograms per metric ton of copper deposited during the same period from the same electrolyte and under the same operating conditions in an adjoining electrolytic tank, using anodes of antimony-lead containing about 82% lead and about 18% antimony, but no appreciable amount silver. Thus the new process, involving the use of the new preferred anode, resulted in a 6- to 7-fold reduction in the loss of anode metal due to corrosion during electrolysis, and the deposited copper was materially less contaminated with lead than the copper deposited with the aid of the silver-free anodes. It was also discovered that the new process may be carried out at a lower cell voltage and with less oxidation of the ferrous iron present in the electrolyte than accompanies the use of silver-free anodes, and in consequence the power consumption per unit of deposited copper is materially lessened.

I claim:

1. In the electrodeposition of copper with the aid of an insoluble anode from a copper-bearing electrolyte containing nitric acid which is substantially corrosive to ordinary insoluble anodes of lead or antimony-lead, the improvement which comprises employing an insoluble anode made of an alloy composed largely of lead and containing about 9% to 18% antimony and silver in an amount in excess of 0.5% by weight of the anode, whereby anode corrosion is substantially reduced.

2. In the electrodeposition of copper with the aid of an insoluble anode from a copper-bearing electrolyte containing nitric acid which is corrosive to ordinary insoluble anodes of lead or antimony-lead, the improvement which comprises employing an insoluble anode made of an alloy composed largely of lead and containing about 9% to 18% antimony and a small amount of silver in the range of about 0.5% to 1.5%, whereby anode corrosion is substantially reduced.

3. In the electrodeposition of copper with the aid of an insoluble anode from a copper-bearing electrolyte containing nitric acid which is corrosive to ordinary insoluble anodes of lead or antimony-lead, the improvement which comprises employing an insoluble anode composed largely of lead alloyed with about 9% to 18% antimony and substantially 1% of silver, whereby anode corrosion is substantially reduced.

4. In the electrodeposition of copper with the aid of an insoluble anode from a copper-bearing electrolyte containing nitric acid which is corrosive to ordinary insoluble anodes of lead or antimony-lead, the improvement which comprises employing an insoluble anode consisting of at least about 78% to 87% by weight of lead alloyed with between about 9% and 18% by weight of antimony, between about 0.5% and 1.5% by weight of silver, and between about 0.2% and 1.5% by weight of arsenic, whereby anode corrosion is substantially reduced.

5. An insoluble anode substantially resistant to corrosion by copper-bearing electrolytes containing nitric acid, which anode is composed of an alloy composed largely of lead alloyed with between about 9% and 18% by weight of antimony and with a small amount of the order of 0.5% to 1.5% by weight of silver.

6. An insoluble anode substantially resistant to corrosion by copper-bearing electrolytes containing nitric acid, which anode is composed of an alloy consisting of between about 78% and 87% by weight of lead, between about 9% and 18% by weight of antimony, between about 0.5% and 1.5% by weight of silver, and between about 0.2% and 1.5% by weight of arsenic.

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