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ELECTRODEPOSITION OF COPPER.

No Drawing. Application filed March 10, 1921. Serial No. 451,424.

To all whom it may concern:

Be it known that I, COLIN G. FINK, a citizen of the United States, residing at Yonkers, in the county of Westchester, State of New York, have invented certain new and useful Improvements in Electrodeposition of Copper; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to improvements in the electrodeposition of copper with insoluble anodes; and more particularly to the electro-deposition of copper from copper sulfate electrolytes containing iron and copper sulfate electrolytes containing chlorides and nitrates.

According to the present invention, the electro-deposition of copper from copper-containing electrolytes is carried out with an insoluble anode, i. e., an anode highly resistant to anodic disintegration, which is made of an alloy composed for the most part of copper.

The invention is based upon the discovery that by using an anode consisting principally of copper, silicon and lead, the electro-deposition of copper can be carried out with a remarkably low corrosion loss or disintegration of the anode, without objectionable contamination of the electrolyte, with low anodic potential and low power consumption, with high current efficiency, etc.

The insoluble anodes which I use in the process of the present invention are composed for the most part of copper, and their most important constituents are copper, silicon and lead. In addition, I have found it advantageous to have present in the anode small amounts of certain other elements or materials, particularly manganese. The anode may thus be made of an alloy containing from about 15 to 20% of silicon, from ½ to 10% of lead, from 2 to 15% of manganese, and the balance copper; although small amounts of other elements may advantageously be present. Elements such as tin, iron, tungsten, chromium, nickel, etc., may thus, under certain conditions, be unobjectionable in the anode, or may even be advantageous therein,

One preferred way of making the anode is to use an alloy of lead with an alkali earth metal, such as calcium or barium, and to combine this lead alloy, in a molten state, with an alloy of copper and silicon. Another advantageous mode of making the alloy is to add the lead in the form of lead sulfide or galena to a molten bath containing copper and silicon. The specific gravity of the galena is such that the lead can be readily combined with the copper and silicon, or with copper, silicon and manganese, etc.

Such anodes, although composed for the most part of copper, are nevertheless insoluble anodes. Instead of dissolving in the copper electrolyte like ordinary copper anodes, they are highly resistant to anodic disintegration and have a remarkably low loss during electro-deposition of copper from the electrolyte.

I have found that such anodes can be used to particular advantage in the electro-deposition of copper from copper sulfate electrolytes containing chlorides and nitrates, and that, even with such electrolytes, the electro-deposition can be carried out with low anodic disintegration. The electro-deposition can, moreover, be carried out without objectionable contamination of the electrolyte by such slight disintegration of the anode as may take place during prolonged use, inasmuch as copper sulfate is the principal metallic salt going into solution as the result of such disintegration.

It is a further characteristic advantage of the invention, that the electro-deposition can be carried out with low anodic potential, and with high current efficiency and consequent saving in power, particularly in copper sulfate electrolytes containing iron, which is usually present to a greater or less extent in copper sulfate solutions resulting from the commercial leaching of ore. I have found, for example, that the electro-deposition of copper from copper sulfate electrolytes containing nitrates and chlorides when operating at a current density of around 15 to 20 amperes per sq. ft. of anode surface, can be carried out with an anode potential as low as from 2.5 to 2 volts, and with an anode loss as low as 1% or less of the electro-deposited copper.

The improved process of the present invention is of particular advantage in the electro-deposition of copper from such

copper sulfate electrolytes, containing chlorides and nitrates. The proces of the invention is also of particular value in the electrodeposition of copper from copper sulfate electrolytes resulting from the leaching of ores and which usually contain iron in appreciable amount. For example, the leaching of an oxidized or roasted copper ore can be carried out with a dilute sulfuric acid solution and the resulting copper sulfate solution, also containing more or less iron, can be subjected to electro-deposition, according to the present invention, for the electro-deposition of copper therefrom. The copper may thus be electro-deposited from the solution to a greater or less extent, with resulting increase of the electrolyte in acidity, and the resulting electrolyte, without complete removal of copper therefrom, can be used for the leaching of further amounts of ore. That is, the leaching and electrolytic operations may be carried out as cyclic operations with recirculation of the electrolyte, and its successive use for leaching and for electro-deposition of copper therefrom.

Heretofore in cyclic operations, where copper is leached from its ores, and the copper deposited electrolytically from the resulting solution, with recirculation and reuse of the electrolyte, lead and ferro-silicon anodes have been used as the so-called insoluble anodes. The present invention has the advantage over the use of ferro-silicon anodes that a normally lower voltage can be used and substantially no iron is introduced into the electrolyte by corrosion of the anode, whereas with ferro-silicon anodes a very considerable contamination of the electrolyte by introduction of iron takes place, and this contamination increases progressively with recirculation of the electrolyte. By avoiding such introduction of iron from the anode, the present invention materially decreases the cost of maintaining a low iron content in the electrolyte, since the electrolyte can be used for longer periods of time without requiring purification, thus saving in the cost of purification, reducing the acid lost with the impure electrolyte or in purifying the electrolyte, and reducing the amount of impure copper formed. As compared with the use of a lead anode, the present invention presents the advantage of increased efficiency, particularly in electrolytes containing iron, inasmuch as lead anodes give extremely low current efficiency with such electrolytes unless special precautions are taken to keep the iron in the ferrous condition. The present invention precents the further advantages that the anode loss is materially less than with either ferro-silicon or lead anodes, with certain electrolytes, particularly copper sulfate electrolytes containing chlorides and nitrates.

Owing to the relatively low cost of the anodes themselves in the first instance, and their resistance to breakage during handling and ordinary use, as well as their resistance to anodic disintegration, the process can be carried out for long periods of time, with resulting low cost of operation for the anodes, as well as with economy of operation in low voltage and power consumption and high current efficiency.

I do not claim herein the anode itself, which I make use of in the process of the present invention, as this forms the subject-matter of a co-pending application, Serial No. 446,070, filed February 18, 1921.

I claim:

1. The improvement in the electrodeposition of copper which comprises electrolytically depositing copper from a copper sulfate electrolyte with an anode composed for the most part of copper and highly resistant to anodic disintegration.

2. The improvement in the electrodeposition of copper which comprises electrolytically depositing copper from a copper sulfate electrolyte with an anode composed principally of copper and silicon and highly resistant to anodic disintegration.

3. The improvement in the electrodeposition of copper which comprises electrolytically depositing copper from a copper sulfate electrolyte with an anode composed principally of copper and silicon and containing lead.

4. The improvement in the electrodeposition of copper which comprises electrolytically depositing copper from a copper sulfate electrolyte with an anode composed principally of copper and silicon and containing lead and manganese.

5. The improvement in the electrodeposition of copper, which comprises electrolytically depositing copper from a copper sulfate electrolyte with an anode of an alloy composed for the most part of copper and of such resistance to anodic disintegration that the anode loss does not materially exceed 1% by weight of the electrodeposited copper.

6. The improvement in the electrodeposition of copper, which comprises electrolytically depositing copper from a copper sulfate electrolyte with an anode composed for the most part of copper and of such low anodic potential and resistance to anodic disintegration that the power consumption is relatively low and the anode loss less than about 1% by weight of the electrodeposited copper.

7. The improvement in the electrodeposition of copper, which comprises electrolytically depositing copper from a copper sulfate electrolyte with an anode composed principally of copper, silicon and lead and of such low anodic potential and resistance to anodic disintegration that the power con-

sumption is relatively low and the anode loss less than about 1% by weight of the electrodeposited copper.

8. The improvement in the electrodeposition of copper, which comprises electrolytically depositing copper from a copper sulfate electrolyte containing iron with an anode of an alloy composed for the most part of copper and highly resistant to anodic disintegration.

9. The improvement in the electrodeposition of copper, which comprises electrolytically depositing copper from a copper sulfate electrolyte containing iron with an anode composed principally of copper, silicon and lead and highly resistant to anodic disintegration.

10. The improvement in the electrodeposition of copper, which comprises electrolytically depositing copper from a copper sulfate electrolyte containing chlorides and nitrates with an anode of an alloy composed for the most part of copper and highly resistant to anodic disintegration.

11. The improvement in the electrodeposition of copper, which comprises electrolytically depositing copper from a copper sulfate electrolyte containing chlorides and nitrates with an anode composed principally of copper, silicon and lead and highly resistant to anodic disintegration.

12. The improvement in the electro-deposition of copper, which comprises electrolytically depositing copper from a copper sulfate electrolyte containing chlorides and nitrates with an anode composed principally of copper and silicon and containing lead and tin, and highly resistant to anodic disintegration.

13. The improvement in the electro-deposition of copper, which comprises electrolytically depositing copper from a copper sulfate electroylte containing iron with a anode composed principally of copper and silicon and containing lead and tin.

14. The improvement in the electro-deposition of copper, which comprises electrolytically depositing copper from a copper sulfate electrolyte with an anode composed principally of copper and silicon and containing lead and tin, and highly resistant to anodic disintegration.

In testimony whereof I affix my signature.

COLIN G. FINK.