F. L. ANTISELL.

ELECTROLYTIC PROCESS AND ANODE.

APPLICATION FILED AUG. 17, 1918.

1,313,246.

Patented Aug. 19, 1919.

2 SHEETS—SHEET 1.

Fig. 1.

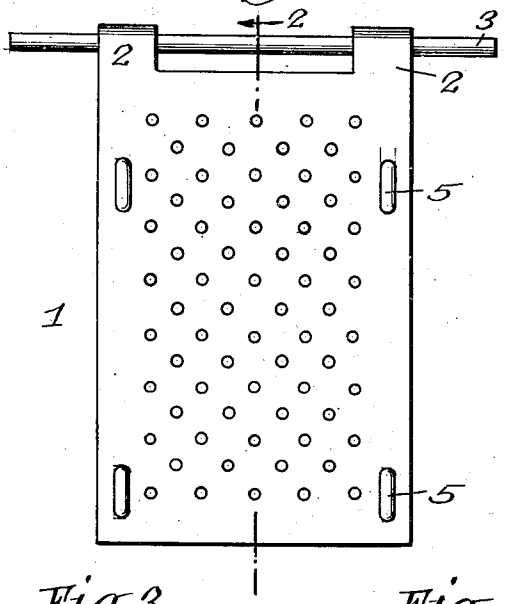


Fig. 2.

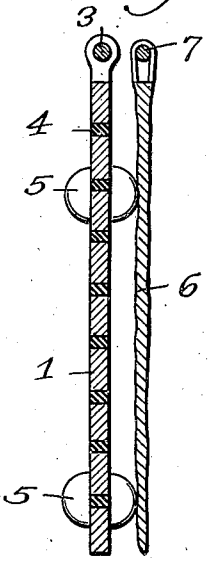


Fig. 3.

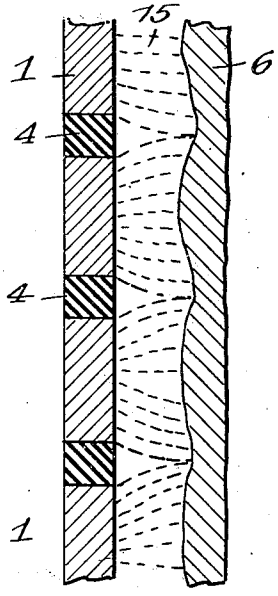


Fig. 4.

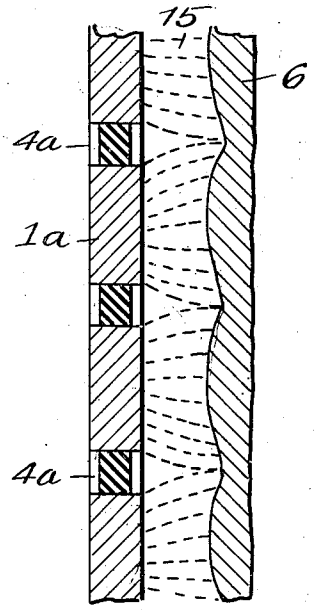
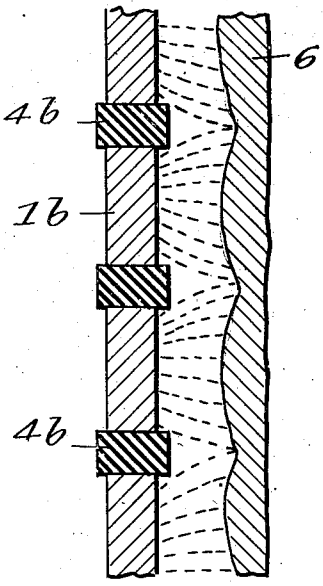


Fig. 5.



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2 SHEETS—SHEET 2.

Fig. 6.

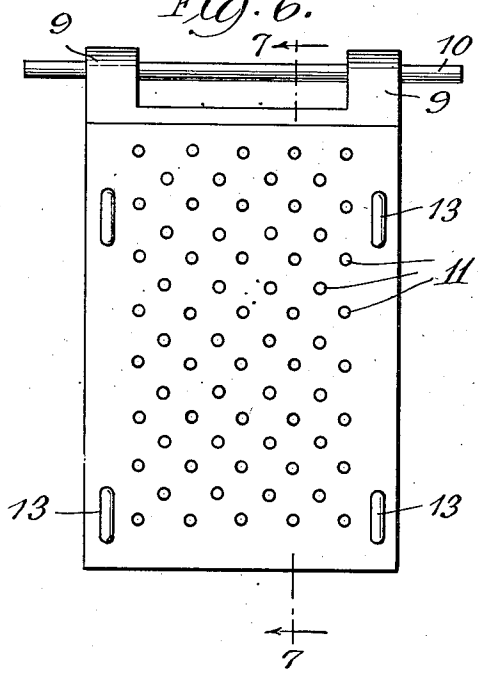


Fig. 7.

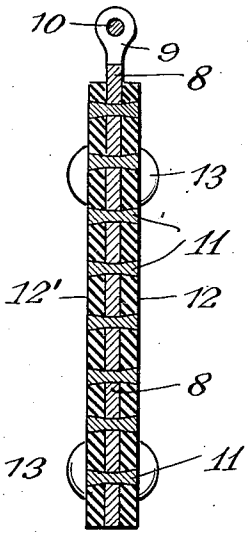


Fig. 8.

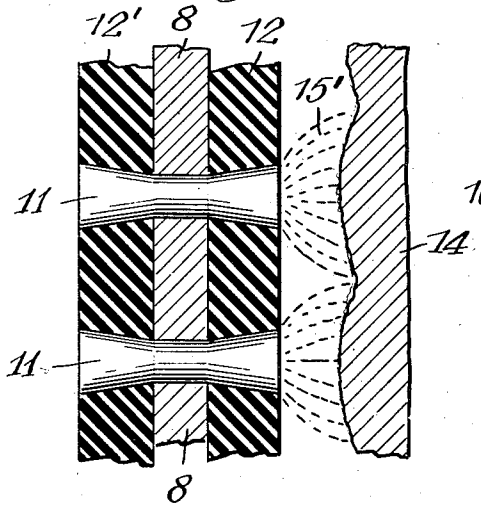


Fig. 9.

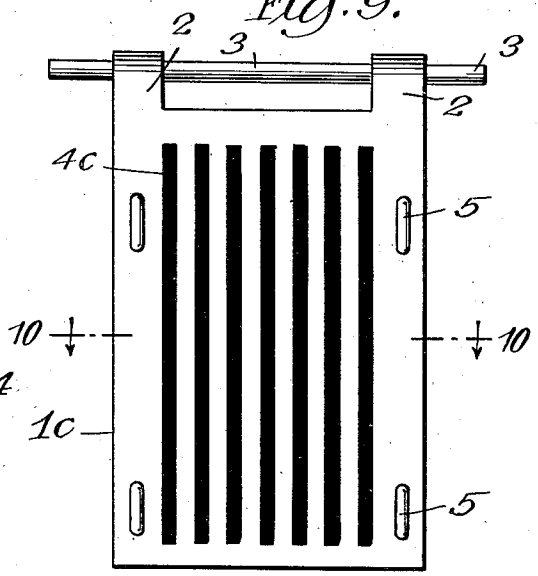
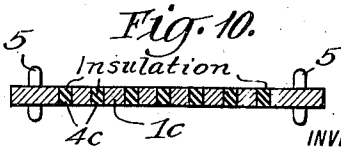


Fig. 10.



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ELECTROLYTIC PROCESS AND ANODE.

1,313,246. Specification of Letters Patent. Patented Aug. 19, 1919.

Application filed August 17, 1918. Serial No. 250,291.

To all whom it may concern:

Be it known that I, FRANK LINDEN ANTISELL, a citizen of the United States, and a resident of Perth Amboy, county of Middlesex, State of New Jersey, have invented certain new and useful Improvements in Electrolytic Processes and Anodes, of which the following is a specification.

My invention relates to electrolytic processes and to anodes suitable for use in the electrolysis of metalliferous solutions, particularly solutions containing copper such as those obtained by leaching copper bearing ores with solutions of dilute sulfuric acid.

The anodes of my invention relate particularly to those of the so called insoluble type which are not attacked by the anion set free during the electrolysis.

One of the objects of my invention is to so construct my insoluble anodes that their active ampere carrying capacity or current density will be increased and the formation of undesirable superoxidized compounds as ferric sulfate thereby prevented. As the solution is lower in ferric sulfate the cathode is not dissolved at so great a rate and the production for a given current is greater.

Another object of my invention is to prevent or greatly decrease the occurrence of undesirable secondary reactions at the anode and thus do away with the necessity of using depolarizing chemicals. Another object is to construct the anodes in such manner that they and the corresponding cathodes can be placed close together whereby the power required for the recovery of the metal from the solution is decreased and the capacity of a deposition tank increased. Another object is to so construct the anode that during the operation of my process the formation of eddy currents or an increase of circulation on the surface of the anodes will be minimized to such a degree that they will be practically effectively prevented and thereby eliminated. Another object is to construct a cheaper anode when an expensive metal must be used to withstand the action of corrosive acids in solution. Other objects will appear from the hereinafter description.

This application is filed as a continuation in part of my application, Serial No. 227,426, filed April 9, 1918.

My anode is particularly applicable to the electrolysis of solutions containing sulfate of copper, such as are obtained by leaching copper bearing ores containing a comparatively small percentage of copper with dilute sulfuric acid, for instance, in the manner set forth in my co-pending application, Serial No. 911, filed January 7, 1915. Such a solution might contain about 2½ per cent. of copper, 1½ per cent. of total iron and 2 or 3 per cent. of other metals, and 4 per cent. of sulfuric acid. By far the larger part of the iron in this solution is present as ferrous sulfate, and during the electrolysis there is ordinarily formed a certain quantity of ferric sulfate, on account of the anion (SO_4) combining with the ferrous sulfate. This formation of ferric sulfate is objectionable for the reason that the ferric sulfate is capable of re-dissolving the copper and thus lowering the ampere efficiency of the tank and thereby the total energy efficiency of the same, and it consequently lowers the production of copper from a tank and increases the labor of attendance. The ferric sulfate thus formed is ordinarily reduced to ferrous sulfate again by the introduction of sulfur-dioxid gas (SO_2). The tendency to the formation of ferric sulfate at the anode is largely dependent on the surface of the anode. A large anode surface and consequently a small current density causes a greater production of ferric sulfate than a small anode surface and a consequent high current density.

I am enabled to overcome the above mentioned disadvantages by providing an anode of improved construction, the total surface of which is divided into a number of areas of active electroconductive material and adjoining areas of inert insulating material. These surface areas are arranged in such a manner that when the current passes from the anode to the cathode a very large area of the electrolyte will be in the path of the current between the anode and the cathode. This is of importance because the electrolytic conductivity of a solution of the character described is relatively small, as its resistance is about 3½ ohms per inch cube, as compared with a resistance of .75 ohms per inch cube, which is that of the electrolyte usually employed in the electrolytic copper refineries.

The surface of the areas of insulating material may be either depressed or elevated

to some extent with respect to the surface of the areas of active material, but it is preferable to make the entire surface of the anode substantially smooth and in the same plane so that the surface of the areas of insulating material and the surface of the areas of the active material will be substantially flush with each other for the reason that when the surface of the anode is of such construction that the formation of eddy currents or an increase of circulation on the surface of the anodes will be more effectively prevented and thereby practically eliminated.

By this construction, not only will the formation of eddy currents or an increase of circulation on the surface of the anode be prevented, but the anodes can be placed nearer to the cathodes, and thus the workable tank space is utilized to better advantage and the tank capacity is increased.

The construction of my anode is shown in the accompanying drawing.

Figure 1 is a front elevation of an anode embodying one form of my invention.

Fig. 2 is a longitudinal cross section thereof along the line 2—2 in Fig. 1, showing also a cathode in longitudinal cross section.

Fig. 3 is an enlarged longitudinal cross section through a portion of the anode and cathode.

Fig. 4 is a section, partly broken away, of an anode in which the surfaces of the insulating material are slightly depressed with respect to the surfaces of the active material.

Fig. 5 is a section of an anode, partly broken away, in which the surfaces of the insulating material is slightly elevated with respect to the surfaces of the active material.

Fig. 6 is a front elevation of another form of my construction.

Fig. 7 is a longitudinal cross section thereof along the line 7—7 of Fig. 6.

Fig. 8 is an enlarged longitudinal cross section through a portion of the anode and a corresponding portion of a cathode.

Fig. 9 is a plan view of an anode having a modified surface formation.

Fig. 10 is a cross section on line 10—10 of Fig. 9.

Like numerals in the different figures refer to like parts.

The anode shown in Fig. 1 is composed of a sheet of lead or other insoluble electro-conductive material 1, which is suspended by lugs 2 from a copper rod 3 supporting it. The said anode is provided with a series of insulating plugs 4, for the purpose of decreasing the active surface of the anode 1, and arranged in staggered rows on the surface of the said active anode portion 1. The surfaces of the said insulating plugs 4 on both sides of the anode are made substantially flush with the respective surfaces of the active portion 1 of the anode. The said insulating plugs 4 may be made of insulating cement or any other non-conductive material suitable for the purpose.

The anode 1 is provided with insulators 5 of porcelain or any other suitable material for the purpose of keeping the anodes and cathodes apart and preventing them from coming in metallic contact with each other.

Figs. 2 and 3 show a cathode 6 of copper arranged opposite the anode 1, the said cathode being suspended from a copper rod 7 in a manner similar to that of the anode.

As will be seen, Figs. 4 and 5 show a section of an anode in which the surface areas respectively, of the inert material and the ative material are in different planes slightly removed from each other.

In Fig. 4 the surface areas of the insulating or inert material 4^a are slightly depressed from the surface areas of the active material 1^a, and in Fig. 5 the surface areas of the insulating or inert material 4^b are slightly elevated from the surface areas of the active anode portion 1^b.

Figs. 6, 7 and 8 show another form of my anode in which the material forming the active surface of the anode is embedded in a relatively good conductor which forms the main body of the anode and the source by which the current is conducted to the active surface of the anode. It consists as shown in Fig. 7, of a sheet of lead or other good conducting material 8, which is suspended by means of lugs 9 from a copper rod 10. The active surface of the anode consists of plugs 11 of electro-conductive material having a comparatively low electric conductivity, such as fused oxid of iron or similar material insoluble in the electrolyte. Both sides of the conducting sheet 1 are covered with insulating material 12 and 12′, such as acid proof cement, the respective layers of acid proof cement being made flush with the outer surface of the said plugs 11. A series of said plugs 11 are shown located in staggered relation on the front elevation of my anode in Fig. 6. Insulators 13 of porcelain are provided for the same purpose as mentioned above, namely, for keeping the anode from metallic contact with the cathode. A portion of a cathode 14 is also shown in the enlarged section in Fig. 8.

Instead of arranging the insulating plugs 4 as shown in Fig. 1, or the conductive plugs 11, as shown in Fig. 6, in staggered relation on the surface of the anode, I may arrange the same in horizontal or vertical rows, or in any other desired relation to each other.

The dotted lines 15 and 15′ in Figs. 3 and 8 represent the lines of current flowing from the anode to the cathode, and illustrate that when the current passes from the anode to

the cathode, a very large area of electrolyte will be in the path of the current from the anode to the cathode, and thus produce a saving in operation as explained above.

In Figs. 9 and 10 I have shown a modified construction of anode in which the surface areas of insulating or inert material 4c and the surface areas of active material 1c alternate with each other and are arranged in continuous integral lines instead of being broken, as illustrated in Fig. 1.

It is obvious that the anode plate when formed with a smooth surface over its entire area, that is, when the surface areas of the inert or insulating material are substantially flush with the surface areas of the active material, which is the preferred form, or when the surface is formed as illustrated in Fig. 4, then after the anode has been used a certain length of time the surface will ultimately have the formation which is substantially that shown in Fig. 5.

As has been heretofore stated, while the preferred form of anode has a smooth surface the entire area of which lies in substantially the same plane, when it is initially used, yet it is within the scope of my invention to slightly elevate or slightly depress, as the case may be, one set of surface areas from the other set of surface areas.

When carrying out the electrolysis with solutions of the kind described, the current density is high at the active surfaces owing to the fact that considerable portions of the anode surface are made inactive by the areas of insulating material, and consequently the generation of ferric sulfate from ferrous sulfate is largely decreased or practically done away with, while at the same time the transfer resistance between the anode and cathode is approximately the same as if the full area of the anode was active. By reason of the substantially smooth surface the eddy currents are reduced which tends to bring a minimum of solution into contact with the anode. At the same time the cathode growth will be greatest opposite the center of the active surface of the anode, which is a desirable feature inasmuch as it increases the affected area of the cathode, even though it be of slight degree. This is a very noticeable advantage in practice and tends to improve conditions in the electrolyzing tank.

An additional saving is obtained by reason of the small amount of slimes adhering to the anode.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:

1. An insoluble anode for electrolysis having a substantially smooth surface which is divided into areas composed of electro-conductive material and areas composed of non-conductive material.

2. An insoluble anode for electrolysis, the surface of which is divided into areas composed of electro-conductive material and areas composed of non-conductive material, the entire surface being smooth and the conductive areas flush with the non-conductive areas.

3. An insoluble anode for electrolysis having a substantially smooth surface which is divided into areas composed of electro-conductive material and areas composed of non-conductive material arranged in staggered relation with respect to each other.

4. An insoluble anode for electrolysis, the surface of which is divided into areas composed of electro-conductive material and areas composed of non-conductive material arranged in staggered relation with respect to each other, the entire surface being smooth and the conductive areas flush with the non-conductive areas.

5. An insoluble anode for electrolysis composed of a sheet of electro-conductive material interposed between two sheets of insulating material, and a series of plugs of electro-conductive material passing transversely through the structure thus produced, the outer surfaces of the said plugs being flush with the respective outer surfaces of the said sheets of insulating material.

6. An insoluble anode for electrolysis composed of a sheet of electro-conductive material interposed between two sheets of insulating material and a series of plugs of electro-conductive material passing transversely through the structure thus produced, the outer surfaces of the said plugs being flush with the respective outer surfaces of the said sheets of insulating material and the entire outer surfaces being smooth.

7. An insoluble anode for electrolysis composed of a sheet of lead interposed between two sheets of insulating material and a series of plugs of electro-conductive material passing transversely through the structure thus produced, the outer surfaces of the said plugs being flush with the respective outer surfaces of the said sheets of insulating material and the entire outer surfaces being smooth.

8. An insoluble anode for electrolysis composed of a sheet of lead interposed between two sheets of insulating material, and a series of plugs of fused magnetic oxid of iron passing transversely through the structure thus produced, the outer surfaces of the said plugs being flush with the respective outer surfaces of the said sheets of insulating material and the entire outer surfaces being smooth.

9. An insoluble anode for electrolysis composed of a sheet of lead interposed between two sheets of insulating material and a series of plugs of fused magnetic oxid of iron in staggered rows, passing transversely through the structure thus produced, the

outer surfaces of the said plugs being flush with the respective outer surfaces of the said sheets of insulating material and the entire outer surfaces being smooth.

10. An insoluble anode for electrolysis, the entire surface of which is substantially flat and divided into areas composed of electro-conductive material and areas composed of non-conductive material.

11. An insoluble anode for electrolysis, the surface of a side of which is divided into areas composed of electro-conductive material, the surfaces of said areas being substantially smooth, and areas composed of non-conductive material the surfaces of said areas being also substantially smooth.

12. An insoluble anode for electrolysis having a surface divided into areas of conductive material and non-conductive material respectively, the exposed surfaces of which on one side lie in substantially the same plane.

13. An anode the face of which is provided with conductive and non-conductive surfaces distributed substantially uniformly throughout its area.

14. An insoluble anode for electrolysis, having inserts of conductive material, the exposed surfaces of which on a side of the anode lie in substantially the same plane.

15. An insoluble anode for electrolysis, made of conductive and non-conductive materials, all the electrolytic contacting surfaces on one side of said anode lying in substantially the same plane.

16. An insoluble anode for electrolysis made of conductive and non-conductive materials, the surfaces of the non-conductive materials on a side of said anode lying in substantially the same plane.

17. An insoluble anode for electrolysis made of conductive and non-conductive materials, the surfaces of the conductive materials on a side of the said anode lying in the same plane.

18. An anode for electrolysis having insulating lugs projecting from a face thereof to contact with the cathode.

19. An anode for electrolysis having insulating lugs secured to and projecting from its face to contact with the cathode.

20. An insoluble anode for electrolysis made of conductive and non-conductive materials, said anode having projections from a face thereof consisting of an insulating lug to contact with the cathode.

21. The method of reducing the formation of ferric sulfate in electrolysis which comprises providing separate areas on the anode surface which in the aggregate is appreciably smaller than the area of the cathode surface in an electrolytic cell, and passing current through said cell.

22. The improvement in electrolytic processes which consists in providing an appreciably higher current density at the anode than at the cathode of an electrolytic cell.

23. In an electrolytic process, the step which comprises passing current from the anode to the cathode so that the cross sectional area of the electrolyte through which the current passes is substantially as great as the cathode surface and substantially less than the anode surface.

24. In an electrolytic process, the step which includes forcing the current to enter the electrolyte from selected separated areas of contact between the anode and the electrolyte, and permitting the current to spread out in the electrolyte.

25. The method of reducing oxidation in electrolysis which comprises providing an appreciably smaller anode surface than cathode surface in an electrolytic cell, and passing current therethrough.

In witness whereof I have hereunto set my hand at borough of Manhattan, city and State of New York, this 16th day of August, 1918.

FRANK L. ANTISELL.

In presence of—

C. C. BILLINGS.