

UNITED STATES PATENT OFFICE.

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ELECTRODEPOSITION.

SPECIFICATION forming part of Letters Patent No. 570,554, dated November 3, 1896.

Application filed June 29, 1896. Serial No. 597,462. (No specimens.) Patented in England June 8, 1895, No. 11,298, and in France June 8, 1895, No. 248,008.

To all whom it may concern:

Be it known that I, EDUARD JORDIS, a citizen of Germany, and a resident of Munich, Bavaria, Germany, have invented certain new and useful Improvements in Electrodeposition, (patented in Great Britain June 8, 1895, No. 11,298, and in France June 8, 1895, and November 6, 1895, No. 248,008,) of which the following is a specification.

10 This invention relates to the art of electrolysis and in particular to the art of obtaining metal or electrodeposits of metals or alloys from their compounds, alloys, mixtures, and salts, and also of scouring or cleaning by electrolysis.

15 The object of the present invention is to enable the formation of pure metallic, smooth and glossy metal deposits on the articles to be plated, which require no subsequent polishing or finishing and in which the color is perfect, and, moreover, to obtain electrodepositing baths or pickles which will not decompose or become moldy or evolve acids or substances which will injuriously affect or attack the electrodes or interfere with the current.

20 With this object in view my invention involves the use of an acid of the lactic-acid or oxyacid series having the general formula

30 $C_nH_{2n}O_3$ or $C_nH_{2n} \begin{smallmatrix} \text{OH} \\ \text{CO}_2H \end{smallmatrix}$, and particularly

lactic acid, $C_3H_5 \begin{smallmatrix} \text{OH} \\ \text{CO}_2H \end{smallmatrix}$, or its salts, in the electrolytic bath in the manner hereinafter set forth, and such other features, steps, and methods as will be described, and then particularly pointed out in the claims.

35 As an example of the facts on which my invention is based, it is to be noted that when solutions of metal lactates—which may be obtained directly by dissolving such lactates, or by double transposition between the salt of a mineral acid and an alkali or ammonia lactate or the lactate of an alkaline earth or a metal, *e. g.*, particularly by double transposition between metal sulphates and lactate of calcium or barium, or by directly dissolving a metal in lactic acid of the required degree of concentration, with the aid of an electric current if desired—are subjected to electrolysis the dissolved metal is deposited at the cathode. This metal, according to the various

conditions existing during such electrolysis, varies in appearance. It should be observed in particular that when employing pure solutions of the required metal lactate, without further additions, the metals will be deposited of a dark color, *e. g.*, nickel, iron, copper, and zinc, which will be deposited so as to present a velvety appearance, whereby decorative effects are obtained in coating with such metals.

By suitable additions to the electrolytic metal bath made according to my invention—for example, of the lactate, of an alkali-base, (including ammonium lactate,) an alkali, sulphate of ammonium, or an alkali or other salts, *e. g.*, salts of more electropositive metals which will not be deposited under the conditions which cause the electrodeposits of the metals to be deposited, such as aluminium, magnesium, &c.—the color of the deposited metal will be lighter to the desired degree, so that many shades, from the darkest to the pure-metal color, may be attained. By these additions, which, at the same time, are mostly so-called “conductive additions,” the resistance of the bath, which for pure lactate solutions is considerable, may be reduced to a small amount. I am, under this method, enabled, if observing certain conditions with regard to concentration, quantity, and tension of current and the temperature of the electrodepositing bath, to separate and deposit a large series of metals in the simplest and most successful manner—for example, platinum, nickel, copper, iron, &c. Lead is obtained in a pure metallic, compact, and homogeneous state, without the formation of oxides. Zinc is deposited in an excellent condition, very light, almost silver-white in color, and, according to circumstances, with a coarse or fine crystalline or dull-shining appearance.

My method is particularly useful in depositing silver directly upon amalgamized or “quicked” brass, for example, as a white, dull, compact pure metallic layer in any desired quantity by weight. It adheres with great power, may be polished or burnished with hematite without swelling, and is susceptible of a high polish. It will remain pure white without any particular precautions, if it has only been well rinsed off. The yellow cast, which so frequently and readily occurs in potassium-cyanide baths, is entirely absent

from the silver deposits when obtained by my method.

In the same manner as silver, my process permits the deposition of brass and the coating of iron or zinc with copper, resulting in the very important advantage of dispensing with the poisonous baths of potassium cyanide.

A particular advantage is the fact, already adverted to, of being enabled to obtain lustrous metallic deposits without any further precautions. This advantage is particularly apparent where it is desired to cover polished articles with a thin metal film, for example, as iron or brass with nickel or platinum, &c., all subsequent polishing being dispensed with.

Since it is possible to combine lactic acid in part directly and in part indirectly by double decomposition with all the metals, lactic acid or its salts is very signally adapted for galvanoplastic and similar purposes. In addition to this, I have found that lactic acid, as compared with other organic acids hitherto employed in this art, possesses still further advantages. Thus, for example, in contradistinction to tartaric, citric, and acetic acid it does not become moldy even in dilute solutions, except when impure, particularly if containing traces of butyric acid or mannit from its manufacture. The solutions of the metal lactates, such as the silver, platinum, nickel baths, &c., may, however, remain for months in open vessels without showing the slightest formation of mold or any other changes, except, perhaps, incipient crystallization. Moreover, the products of the decomposition of lactic acid, which result from the action of the electric current, *e. g.*, when employing insoluble anodes, such as platinum or anodes which dissolve with difficulty, such as nickel, in consequence of oxidation are completely neutral, since no new acids, but only carbon dioxide and aldehyde, are formed. The latter is not only highly volatile, (boiling point 21° centigrade,) but soluble in water, forming only products which are liquid and soluble in water, *viz.*, aldol or crotonic aldehyde. This feature essentially distinguishes lactic acid from the acids mentioned above, since these form either new acids, such as formic acid, or solid or resinous substances, which tend to make the bath turbid and gum or smear the electrodes.

As stated in the beginning, the composition of the baths may be considerably varied. As a general rule the cost of the lactates will govern. Some, for example, those of the lactates of iron or nickel, consist of solutions of considerable concentration, while their crystals or crystalline powders, when once formed by evaporation, are only soluble in part and with extreme difficulty, at any rate not in the former volume of liquid. Others, *e. g.*, the silver lactate, are decomposed by evaporation, while the solution of silver lactate remains unchanged in the cold. Hence, as a general rule, the bath will be so prepared that the lactate is formed in the bath itself

by double decomposition. According as it is desired to employ pure solutions of lactates, or to combine them with additions, the transposition between metal sulphates and lactate of calcium or barium, or that between the salts of a mineral acid and the lactate of an alkali, (such as potassium or ammonium,) or the like, is to be selected, since in the latter case a conducting addition, such as the alkali salt, (including salts of ammonium,) of a mineral acid is formed, and hence does not need to be separately added. From this it follows that it is not always necessary to carry out the transposition quantitatively. An excess of lactic acid is not injurious, except in cases of depositions in colors, but an excess of mineral acids is in general not desirable, except in some special cases.

The particular composition of the bath is governed in each case by the nature of the metal to be deposited and that of the articles to be plated or coated, as well as the object to be attained, *e. g.*, whether thick layers or only thin films, *e. g.*, for articles manufactured in large quantities, are desired. This is true particularly for baths or "pickles" from which alloys, such as brass, are to be deposited, since in this case the color and composition of the alloys vary greatly according to the nature of the bath. The lactic acid or lactate baths, moreover, enable one to obtain alloys which have not been hitherto produced by electrodeposition, such as alloy of lead and antimony. The conditions of the current are also varied according to the object to be subserved and the nature of the metals employed.

In general, the following factors are required per one hundred square centimeters for an interval of ten centimeters between the electrodes: Zinc on iron, 0.2 ampere, 0.4 volt; zinc on copper, 0.2 ampere, 0.4 volt; platinum on brass, 0.15–0.2 ampere, 1.2–1.6 volts; copper on iron, 0.4–0.6 ampere, 1.0–1.3 volts. When "quickened": Silver on brass, 0.06–0.075 ampere, 0.4–0.5 volt; nickel on iron, 0.2–0.4 ampere, 2.3–2.8 volts; iron on copper, 0.3 ampere, 0.8 volt; iron on zinc, 0.3 ampere, 1.4 volts.

Lactic acid may with advantage be employed for cleaning by the aid of electrolysis particularly in those cases where potassium cyanide is at present employed, *e. g.*, in the case of zinc, britannia metal, &c., and where highly-polished and sensitive articles, particularly those made of brass, are to be treated, for the lactic acid merely removes the oxid without appreciably attacking the metal, at least during the short duration of the scouring process. No harm will be done if some lactic acid should get into the bath through lack of care in rinsing.

As examples of baths or pickles prepared in accordance with my invention the following are given:

1. *Silver bath.*—One to three per cent nitrate of silver, (AgNO_3), three to five per cent am-

monium lactate, $(C_3H_5O_3.NH_4)$, ammonia in sufficient quantity to produce alkaline reaction. The ammonium lactate may be partly or entirely replaced by potassium lactate, particularly when electroplating weights.

2. *Platinum bath.*—a. One molecule platinum chlorid ($H_2Pt.Cl_6$) is treated with six molecules of sodium lactate ($C_3H_5O_3.Na$) just made alkaline by adding soda. From one to five per cent of platinum (computed for pure metal) is taken according to the amount of plating to be done.

b. The above may be modified by taking one molecule platinum sulphate, $Pt(SO_4)_2$, and causing it to act upon four molecules of ammonium lactate. This solution is so arranged that the bath or pickle contains from five to ten per cent of lactate of platinum, $(C_3H_5O_3)_4Pt$, from one to two per cent of ammonium or sodium lactate being added to cause the bath to give an alkaline reaction. This bath is susceptible of regeneration.

c. I may also employ sodium platinum chlorid, $(Na_2Pt.Cl_6)$, adding to from one to five per cent of this salt an equal quantity (one to five per cent) of sodium lactate and sufficient soda to cause alkaline reaction.

The above three baths all yield a glossy electrodeposit of platinum.

3. *Zinc bath.*—This may contain two per cent lactate of zinc, $(2C_3H_5O_3.Zn)$, two per cent ammonium sulphate, two per cent ammonium lactate. This bath must be neutral and should give no alkaline reaction.

4. *Nickel bath.*—From four to six per cent of sulphate of nickel are treated with from five to eight per cent of lactate of ammonium or alkali, two per cent of ammonium sulphate being added. This bath, when maintained in an alkaline condition, will yield a glossy coating of nickel, which may be obtained of considerable thickness.

The other metals require similar conditions, which, of course, are determined by their special nature.

While I have found lactic acid to best answer my purposes, I have found other acids of the lactic or oxyacid series having the general formula $C_nH_{2n}O_3$, (such as glycollic acid,) or their salts to act substantially like the same, and they are accordingly included within the scope of my invention, which includes any bath containing an acid radical of the oxyacid or lactic series, such as $CH_3.CH.CO_2$, the lactic acid radical.

What I claim, and desire to secure by Letters Patent of the United States, is—

1. In the art of electrolysis, the process which consists in preparing a bath containing a compound of the metal to be deposited with an acid radical of the series $C_nH_{2n}O_3$ excepting carbonic acid, and then precipitating the metal from said bath by an electric current.

2. In the art of electrolysis, the process which consists in preparing a bath containing the lactate of the metal to be deposited,

and then precipitating the metal by means of an electric current.

3. In the art of electrolysis, the process of making the bath which consists in adding to a salt of the metal to be deposited, a compound containing an acid radical of the series $C_nH_{2n}O_3$ excepting carbonic acid, thereby forming in the bath a compound of the metal to be deposited with said acid radical, and then depositing the metal by means of an electric current.

4. In the art of electrolysis, the process of making the bath which consists in adding to the salt of the metal to be deposited a compound containing a lactic-acid radical, thereby forming in the bath a lactate of the metal to be deposited, and then depositing the metal by means of an electric current.

5. In the art of electrolysis the process of preparing the bath which consists in adding to the solution of a salt of the metal to be deposited the lactate of an alkali base, thereby forming a bath of the lactate of the metal to be deposited, and then depositing the metal by means of an electric current.

6. In the art of electrolysis, the process of preparing the bath which consists in adding to a solution of a salt of the metal to be deposited a lactate of an alkali base, thereby forming in the bath a lactate of the metal to be deposited, and making the bath alkaline.

7. In the art of electrolysis, the process of preparing the bath which consists in adding to a salt of the metal to be deposited, a compound containing an acid radical of the series $C_nH_{2n}O_3$ excepting carbonic acid, thereby forming in the bath a compound of the metal to be deposited with said acid radical, and further adding the salt of a more electropositive metal which will not be deposited, under the conditions which cause the electrodeposit of the first metal, for the purpose of varying the color and appearance of the deposit, substantially as described.

8. In the art of electrolysis, the process of preparing the bath which consists in adding to a salt of the metal to be deposited a compound containing a lactic-acid radical, thereby forming in the bath a lactate of the metal to be deposited and further adding the salt of another more electropositive metal which will not be deposited under the conditions which cause the deposit of the first metal.

9. In the art of electrolysis, the process of preparing the bath, which consists in adding to the lactate of the metal to be deposited the lactate of an alkali base, for the purpose of varying the color and nature of the deposit.

In testimony that I claim the foregoing as my invention I have signed my name in presence of two subscribing witnesses.

EDUARD JORDIS.

Witnesses:

ALBERT WEICKMANN,
C. MAYER.