F. LACROIX.

ELECTROLYSIS OF METALLIC SOLUTIONS.

APPLICATION FILED FEB. 19, 1910.

1,019,969. Patented Mar. 12, 1912.

FIG. 1

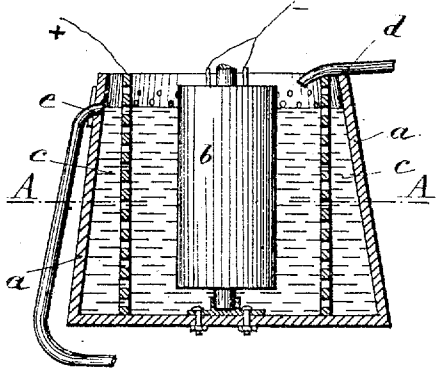
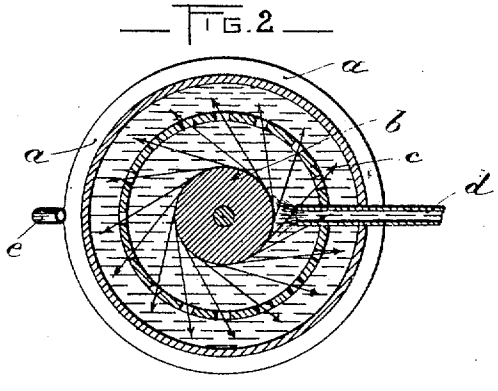


FIG. 2



WITNESSES.

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ELECTROLYSIS OF METALLIC SOLUTIONS.

1,019,969. Specification of Letters Patent. Patented Mar. 12, 1912.

Application filed February 19, 1910. Serial No. 544,875.

To all whom it may concern:

Be it known that I, FERNAND LACROIX, a citizen of the Republic of France, residing at Paris, in the Republic of France, have invented certain new and useful Improvements in or Relating to the Electrolysis of Metallic Solutions, of which the following is a specification.

The direct electrolysis of more or less rich and pure metallic solutions derived from the lixiviation of mineral ores, has been the subject of repeated experiments for many years past, because the practical success of such electrolysis seems to present the simplest solution of the treatment of ores.

In the metallurgy of copper, for instance, there are at present employed two kinds of processes. In the one known as the wet process, the ores are first subjected to a lixiviation preceded or otherwise by various operations such as roasting, exposure to air and so forth; and in the solutions thus obtained, the copper is precipitated in the condition of cement copper, the value of which is inferior to that of electrolytic copper. This precipitation is obtained by means of iron scrap and for each ton of precipitated copper, a consumption of iron rarely less than two tons must must be allowed for. The other processes, so-called dry processes, consist in gradually concentrating the copper contained in the ore by a series of operations, such as roasting and fusing, the number of these operations depending on the nature of the ore treated. The dry process yields as its final product ingots of raw copper.

Whether the copper be obtained in the cement form or in the form of ingots, it must be subjected to a final refining, which is ordinarily an electrolytic process, by means of which the raw copper obtained is brought into solution and deposited on a cathode in the condition of pure copper. This explanation makes it evident at once what a great simplification would be introduced in the metallurgy of copper by a process enabling chemically pure copper to be directly obtained by the electrolysis of cupreous solutions of any suitable kind, obtained by the lixiviation of the ore.

This invention relates to processes enabling this latter condition to be realized.

The processes according to the present invention consist in electrolyzing metallic solutions of any suitable percentage and composition between an insoluble anode, fixed or otherwise, and a suitable cathode, preferably metallic, having a sufficiently rapid movement of displacement.

In order to fully understand the importance and the novelty of the processes forming the subject of the present invention, it will be useful to ascertain what takes place in the electrolysis of impure cupreous solutions.

When the method of electrolysis is applied to a low percentage cupreous solution, such as the solutions which are formed by the lixiviation of the ores, (and which contain, for instance, 1% of copper, 3.5% of iron, and 2% of sulfuric acid etc.), the sulfate of copper is decomposed in the first place, and the copper is deposited on the cathode while the radical SO_4 is transferred to the anode; but in poor and impure cupreous solutions of this kind, the copper is no longer deposited in a coherent condition as soon as the intensity of the current exceeds 10–15 amperes per square meter of cathode. The radical SO_4 then meets at the anode the ferrous salts, and immediately converts them into ferric salts, which in their turn dissolve the copper deposited on the cathode in proportion as it is deposited, especially if this deposit is powdery and not very coherent, and therefore the result of the electrolysis is *nil* under such conditions. The yield of an apparatus composed, for instance, of lead or carbon anodes immersed opposite copper cathodes in a poor solution of copper is therefore absolutely prohibitive for practical purposes. It must also be pointed out that in such an apparatus there are local differences of resistance which cause the deposit to be of different composition, appearance and quantity on the different plates, so that local currents are caused to flow between the parts of the

plates themselves; the effect of these currents is to cover certain plates at the expense of others, so that under these conditions an abundant and spongy deposit is produced on certain plates, and no deposit on others.

Efforts have been made to remedy the solvent action of ferric salts by enveloping the anodes in diaphragms, the action of which is satisfactory at first but after a time becomes unsatisfactory, without taking into account the fact that this diaphragm is not very suitable for industrial use and is rapidly destroyed. Efforts have also been made since 1886, in Germany, since the appearance of the Marchese process, to depolarize the insoluble anodes by means of sulfurous acids derived from the roasting of the ore. This process while excellent in principle has not been practically carried out.

Now according to this invention the problem is solved by taking into account the causes of failure which have just been mentioned and applying thereto the following remedies.

The invention will be described in connection with the accompanying drawings in which:—

Figure 1 is a sectional elevation of the cell, and Fig. 2 is a sectional plan view of the same on the line A, A of Fig. 1.

The electrolyzer consists of an insoluble anode *c*, preferably perforated, and arranged around a cathode *b* formed of a metal cylinder to which a vigorous rotary movement is imparted. The electrolyte is admitted to the cathode compartment of the cell *a* by the inlet pipe *d*, passes through the holes in the anode and overflows by means of the pipe *e*. If the cathode employed has a surface of a square meter, for instance, the dimensions being 1 meter in length and 1 meter in circumference, and assuming that this cathode revolves at the rate of 40 revolutions per minute, there will be available for the cathodic deposit during one minute, a cathodic surface equal to 40 square meters; a current intensity can therefore be employed which is 40 times greater than that which can be utilized in an apparatus having fixed anodes and cathodes of 1 meter of surface, while moreover a good and compact deposit is obtained, because the surface of the cathode is constantly brought in contact with fresh molecules of sulfate of copper or of the metal treated. If however the surface is thus increased artificially to 40 times that of an apparatus with a fixed cathode, the action of the ferric salts will be practically the same and not certainly greater than before; hence, if in the fixed apparatus where the deposits are, for instance, 10 gr. per hour (movement of 10 amperes per square meter), the ferric salts will dissolve all the copper deposited, in the rotary apparatus in the same time they dissolve the same quantity say 10 gr., but these 10 gr. only represent from 2 to 4% of the deposit produced by the current. The yield of the rotary apparatus is therefore an excellent one, while the fixed apparatus only gives a *nil* yield. Of course, the anode may rotate in place of or in addition to the cathode. Comparing this with the processes employing fixed anodes and cathodes with depolarization by sulfurous acid, if must be noted that in such apparatus as has been hereinbefore stated, local couples arising from differences in the resistance existing between the anodes and cathodes produce irregularities in the deposit, such that on certain plates the copper is good while on the others it is spongy, and hence a metal is obtained which can only be compared as regards quality with cement copper. In the rotary electrolyzer on the contrary everything is symmetrical and there are no local couples between the various parts of the cathode; the deposits obtained are also absolutely regular and correct, even when employing current densities of 200 to 400 amperes per square meter of cathode, and working with impure solutions only containing 1% of copper and less.

Further the construction of the electrolyzer is such that the solution entering the cathode compartment is immediately brought by centrifugal force through the perforated anodes and escapes by an overflow placed between the anode and the inner wall of the electrolyzing vat.

By the use of this electrolyzer the deleterious action of the ferric salts is thus avoided and on the contrary is converted into a useful action, because the anode solution which is rich in ferric salts is sent on to the roasted metal, in order to dissolve the oxid and even the little sulfid of copper, which it may contain. From the lixiviation vats these copper solutions, enriched in consequence of the action of the ferric salts, and the acids which they contain, on the metallic oxids of the ore, return to the electrolyzers directly or after having passed into coke towers where they encounter the sulfurous gas derived from the roasting of the ore. In this case the ferric solutions are completely reduced to ferrous solutions with the production of sulfuric acid, before entering the compartment of the cathode where they can no longer have a deleterious action.

I declare that what I claim is:—

An electrolytic cell for separating metals from their impure solutions, comprising a rotating cathode, a stationary concentric anode dividing the cell into two parts and

provided with a large number of small perforations through which the whole of the electrolyte passes and carries away the impurities produced at the anode, an inlet pipe for admitting electrolyte to the space inside the cathode and an outlet pipe for the same outside the cathode.

In witness whereof, I have hereunto signed my name this 5th day of February 1910, in the presence of two subscribing witnesses.

FERNAND LACROIX.

Witnesses:

A[illegible] MÉJEAN,

[illegible] COXE.