

# UNITED STATES PATENT OFFICE.

LUCIEN JUMAU, OF PARIS, FRANCE.

## ELECTROMETALLURGICAL PROCESS FOR EXTRACTING COPPER FROM ITS ORES.

No. 867,046.

Specification of Letters Patent.

Patented Sept. 24, 1907.

Application filed December 29, 1905. Serial No. 293,826.

To all whom it may concern:

Be it known that I, LUCIEN JUMAU, a citizen of France, residing at Paris, in the said Republic, have invented new and useful Improvements in Processes  
5 Electrometallurgical for Extracting Copper from Its Ores, (for which a French patent has been filed November 29, 1905,) of which the following is a specification.

This invention relates to an electro-metallurgical  
10 process for extracting copper from its ores, whereby a product is obtained of greater purity than that obtained by analogous processes now in use, while the working is more economical both in cost of electricity and in cost of reagents.

15 The invention also includes certain improvements in the construction of electrolytic vats wherein the process is to be conducted.

The process comprises the following successive operations:—

20 *Preparation of an ammoniacal solution of the copper contained in the ore.*—For this purpose the ore, previously rotated or not, according to its nature, is leached with a solution of ammonia preferably mixed with an ammoniacal salt to increase the solubility of the copper; a solution of ammonium sulfate or sulfite in presence of free ammonia is particularly suitable. The  
25 leaching dissolves all the copper from the ore, and, in most cases, the copper only, which is especially advantageous, since when the solution is electrolyzed pure copper is deposited and the paths are not dirtied as in the processes at present in use. The ammoniacal solution of copper thus obtained may be electrolyzed directly if the qualities of copper electrolytically deposited from an ammoniacal solution are suitable for  
30 the purpose to which the metal is to be put. Or the solution may be first treated by either of the two following methods. The ammonia wherewith the ore was treated may be recovered by evaporation and again used in a subsequent lixiviation of the ore. During  
40 the evaporation of the ammonia the copper is precipitated as oxid and may be again dissolved, for instance in an acid such as sulfuric acid or in ammonia; there is thus obtained a solution which contains only copper.

The cupric salts contained in the ammoniacal solution obtained by leaching the ores or by re-dissolving the copper precipitated by evaporating the original solution, may be converted into cuprous salts, a proceeding particularly applicable when sulfite ores are under treatment; the reduction may be effected by passing  
50 a current of sulfur dioxid into the ammoniacal solution, whereby cuprous sulfite, or cuproso-cupric sulfite, or a double sulfite of copper and ammonia is formed, these salts being able to co-exist in the solution treated with sulfur dioxid, in proportions varying according to the duration of the treatment. The solu-  
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tion thus treated may be electrolyzed in a neutral, acid or basic condition.

The reduction of the cupric salts to cuprous salts effects an important economy in electricity; for whereas 1 ampere-hour deposits 1.186 grams of copper from a cupric salt, it deposits 2.372 grams from a cuprous salt under like conditions. 60

The sulfur dioxid necessary for the reduction need cost nothing when sulfid ores are being dealt with, as it is produced by the preliminary roasting of the ore; in other cases the cost of the sulfur dioxid is largely compensated by the economy in electricity. 65

When the ammoniacal solution containing the copper of the ore has been treated in the manner described, it is electrolyzed. This operation in actual practice is distinguished by being conducted in presence of a depolarizing agent whereby the potential at the anode is kept sufficiently low to avoid liberation of oxygen or the formation of peroxid of lead when the anode is of lead. This depolarizer is the ammoniacal cuprous solution itself, when the aforesaid reduction with sulfur dioxid has been carried out, or it may be a solution of ammonium sulfite which is basic, neutral or acid. It is obvious that oxygen will not be liberated at the anode so long as the sulfites in the solution are not oxidized. The invention therefore, secures an electrolysis with a minimum cost for electricity and with production of pure copper at the cathode. 70 75 80

After the electrolysis the ammonia is recovered from the solution now free from copper, by mixing it with an alkaline earth, preferably lime for cheapness' sake, to liberate the ammonia. It may be remarked that, in most cases, the small cost involved in this treatment with lime may be eliminated; for the majority of copper ores contain a certain proportion of lime, magnesia or baryta, generally as carbonate, so that the ore itself, whether roasted or not, may be substituted for lime in recovering the ammonia. 85 90

For the process which has now been described, there is used an electrolytic vat which may or may not have a diaphragm and wherein the liquid and the electrodes may or may not move. If there is a diaphragm, it may consist of a porous material, not liable to be attacked by the electrolyte, and impregnated with gelatinous silica such as asbestos used, for example, in the form of blue asbestos cloth which has been impregnated with gelatinous silica by immersion in a mixture of sulfuric acid and silicate of soda; such a diaphragm is very effective and has a low resistance to the passage of the electric current. 100 105

The cathode is, of course, a thin sheet, a plate, a cylinder or the like, of copper or of any other metal or suitable conducting material; the anode is a metal capable of resisting the electrolyte, such as lead or carbon, preferably in a graphitic condition. 110



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

1. The herein described process for extracting copper from its ores, which consists in dissolving the copper of the ore in an ammoniacal solution by leaching said ore with a solution of ammonia mixed with an ammoniacal salt, reducing to cuprous salts, the cupric salts in the said ammoniacal solution, by passing a current of sulfur dioxide into said solution, and electrolyzing the reduced solution, said reduced solution acting meanwhile as a depolarizer at the anode, substantially as described.
2. The herein described process for extracting copper from its ores, which consists in dissolving the copper of the ore in an ammoniacal solution by leaching said ore with a solution of ammonia mixed with an ammoniacal salt, reducing to cuprous salts, the cupric salts in the said ammoniacal solution, by passing a current of sulfur dioxide into said solution, electrolyzing said reduced solution which acts as a depolarizer at the anode, and recovering the ammonia contained in the solution after the electrolysis by treating such solution with an alkaline-earth, substantially as described.
3. The herein described process for extracting copper from its sulfid ores, which consists in roasting said ores to drive off sulfur dioxide and reduce the ores to an oxid, collecting the sulfur dioxide evolved, leaching said oxid

with an ammoniacal solution consisting of a solution of ammonia mixed with an ammoniacal salt, passing said collected sulfur dioxide through said ammoniacal solution for reducing the cupric salts to cuprous salts, electrolyzing said reduced solution which acts as a depolarizer at the anode, and recovering the ammonia contained in the solution after electrolysis by treating said solution with the hydrate of an alkaline earth metal.

4. The herein described process for extracting copper from its sulfid ores, which consists in roasting said ores to drive off sulfur dioxide and reduce the ores to an oxid, collecting the sulfur dioxide evolved, leaching said oxid with an ammoniacal solution consisting of a solution of ammonia mixed with an ammonium sulfite, passing said collected sulfur dioxide through said ammoniacal solution for reducing the cupric salts to cuprous salts, electrolyzing said reduced solution which acts as a depolarizer at the anode, and recovering the ammonia contained in the solution after electrolysis by treating said solution with milk of lime.

In witness whereof I have hereunto set my hand in the presence of two witnesses.

LUCIEN JUMAU.

Witnesses:

JULES FAYOLLET,  
EUGENE PICHON