UNITED STATES PATENT OFFICE.

JUAN FRANCISCO NEPOMUCENO MACAY, OF CHARAPOTO, ECUADOR.

METHOD OF EXTRACTING SILVER FROM ORES.

SPECIFICATION forming part of Letters Patent No. 504,109, dated August 29, 1893.

Application filed May 17, 1888. Serial No. 274,227. (No specimens.)

To all whom it may concern:

Be it known that I, JUAN FRANCISCO NEPOMUCENO MACAY, of Charapoto, in the Republic of Ecuador, South America, and at present residing at Bahia de Caraquez, Ecuador, have invented new and useful Improvements in Processes of Extracting Silver from Ores, of which the following is a full, clear, and exact description.

My invention relates to an improved process for extracting silver from free milling ores without roasting, or from rebellious ores after they have been submitted to an oxidizing roasting, and my improved process is not only available for the treatment of rich ores but for the economical treatment of low grade ores and ores which heretofore could not by well known processes be worked economically.

In treating silver sulphides with cupric chloride and chloride of sodium in solution, I have found in practice that in the methods heretofore known, owing to the insufficient amount of chloride of sodium, the chloridized silver forms a coating on the particles of ore and prevents the further action on the sulphide of silver; hence considerable loss arises by the imperfect character of the operation. I have discovered that when an excess of chloride of sodium is made use of, with the cupric chloride, in about the proportions hereinafter specified, the chloridized silver is taken up in solution as fast as it is formed until the whole of the silver is dissolved. By my improved process it is possible to extract from about 98 to 98.5 per cent. of the silver from raw free milling ores when this is present in the free state as native silver, sulphide of silver or oxide of silver and also to extract a high percentage of silver from raw free milling ores when they carry some sulphide of antimony, sulphide of arsenic, sulphide of lead or sulphide of copper either in chemical combination or in mechanical mixture, and also to extract a higher percentage of silver from rebellious ores after they have been submitted to an oxidizing roasting.

In the carrying out of my improved process I may employ any desired character of apparatus (not to be acted upon by the reagents employed) suitable for the stages of the process, but as the same forms no necessary part of my present application, it is not essential that its details be described.

My improved process is carried out in the following manner:—The ore whether native silver, sulphide of silver or oxide of silver is first thoroughly crushed or pulverized so as to pass through an eighty mesh screen, and a careful assay is made to demonstrate the value per ton of the silver in the ore. I then mix a solution slightly less than saturated, which solution contains cupric chloride and chloride of sodium, there being for each part by weight of metallic silver in the ore eighty-six minimum to one hundred and fifty maximum parts by weight of cupric chloride and from four hundred and twenty-four minimum to five hundred and fifty maximum parts by weight of chloride or sodium, these ingredients being dissolved in a quantity of water about three and one tenth (3.1) times greater than their mass by weight. I would remark that while about eighty-six parts of cupric chloride and about four hundred and twenty-four parts of chloride of sodium are necessary as a minimum quantity to chloridize and dissolve or take up about one part by weight of metallic silver,—I desire and prefer to have a slight excess of these dissolving and chloridizing agents so as to make sure of the proper reactions. The quantity of ore and of the solution of cupric chloride and chloride of sodium in the relative proportions just stated are brought together in a suitable vessel (not metallic) and are boiled with hot air or super-heated or live steam from two to four hours, in which time the silver will have been completely chloridized and dissolved, the heat of the boiling liquid making it possible for the chloride of sodium in solution to take up almost twice as much chloride of silver than if the solution acted when cold.

The action of chloride of sodium in solution is to dissolve the argentic chloride first formed and to present a new clean surface of metallic silver, sulphide of silver or oxide of silver as the case may be, to the chloridizing action of the cupric chloride and cuprous chloride until the whole of the silver present has been converted into argentic chloride, and it is absolutely necessary that an excess of cupric chloride and chloride of sodium be employed to chloridize and dissolve each atom

or quantity of metallic silver. Otherwise the chloridizing action will be paralyzed by the formation on the silver particles of a layer of argentic chloride which will prevent the action of the cupric chloride. Five minutes more or less before the boiling of the reagents with the ore is finished, I add to the contents of the tub a certain quantity (to be determined in the laboratory) of hydrochloric acid, or instead of it a certain quantity of ferrous chloride ($FeCl_2$) or ferric chloride (Fe_2Cl_6) or instead of any of the above named reagents there may be used ferrous sulphate ($FeSO_4 7O H_2$) and chloride of sodium or sulphuric acid and chloride of sodium. I then allow the materials to cool and stand about eighteen to twenty-four hours, exposed to the atmosphere. During the cooling of the contents of the boiling tub, the cuprous chloride in the presence of the oxygen of the air is converted first into cupric oxychloride, and this in the nascent state whether in the presence first of hydrochloric acid, or second, of ferrous chloride, or third of ferric chloride, or fourth, of ferrous sulphate and chloride of sodium, or fifth, of sulphuric acid and chloride of sodium, by a mutual exchange of elements is converted in the first case into the cupric chloride and water, and in the second and third cases, into cupric chloride and hydrated ferric oxide, and in the fourth case into cupric chloride ($CuCl_2$) hydrated ferric oxide and sulphate of soda, or in the fifth case, into ($CuCl_2$) cupric chloride, sulphate of soda and water. During the cooling of the liquid about one half of the argentic chloride held in solution by the boiling liquid will have been precipitated on the ore. After cooling the liquid contents of the boiling tub are decanted and this is called liquid A which carries in solution cupric chloride, chloride of sodium and some argentic chloride. This liquid A after each operation may be used again to treat new batches of ore "*ad infinitum*," if from time to time the small mechanical loss of cupric chloride and chloride of sodium that takes place during each operation is replaced by adding from time to time a small additional quantity of these reagents. The solid matter and the argentic chloride remaining in the boiling tub after the boiling and cooling operations and after the liquid A has been drawn off are put into Macay's rotary decanting filter (I here make reference to my apparatus patented October 25, 1881, No. 248,768, for the device that I term Macay's rotary decanting filter) and are washed with water to extract the cupric chloride and chloride of sodium, that may remain with the solid matter, and this solution is filtered and is added to the solution A and serves to replace in volume the water evaporated by the boiling operation and this solution is employed for future mixing and for chloridizing each new batch of the pulverized ore so that the operations just named may be continuously repeated. The further treatment of the solid matter containing the argentic chloride is conducted in Macay's rotary filter by a cold dilute solution of hyposulphite of soda and the precipitation of the silver as sulphide of silver from such solution by an alkaline sulphide and the reduction of sulphide of silver to metallic silver are effected by well known processes for such purposes, the same however forming no essential feature of my present invention.

I claim as my invention—

The method of extracting silver from ores, which consists in subjecting the ore to a solution of cupric chloride with excess of chloride of sodium in substantially the proportion, by weight, of eighty six parts of cupric chloride, and four hundred and twenty-four parts of chloride of sodium to each one part of native silver, or silver in the state of sulphide of silver, for the purposes set forth.

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

JUAN FRANCISCO NEPOMUCENO MACAY.

Witnesses:
F. CHECE,
P. LORGE GOMEZ.