No. 730,835. Patented June 9, 1903.

UNITED STATES PATENT OFFICE.

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AMMONIA-CYANID PROCESS OF TREATING COPPER, NICKEL, OR ZINC ORES CONTAINING PRECIOUS METALS.

SPECIFICATION forming part of Letters Patent No. 730,835, dated June 9, 1903.

Application filed January 19, 1903. Serial No. 139,628. (No specimens.)

To all whom it may concern:

Be it known that I, DAVID MOSHER, a citizen of the United States, residing at San Francisco, in the county of San Francisco and State of California, have invented certain new and useful Improvements in the Ammonia-Cyanid Process of Treating Refractory Copper, Nickel, or Zinc Ores Containing Precious Metals, of which the following is a specification.

It has been proposed to apply ammonia as a solvent for the extraction of such metals from ores as have oxids or hydroxids readily soluble in an ammoniacal solution, and while ammonia thus acts as a powerful solvent and extractor of such metals as nickel, zinc, or copper from a refractory sulfid or arsenical ore containing the above metals, particularly after roasting, it will not conjointly extract any gold and only partial amounts of the silver.

Now the aim of this invention is to simultaneously extract all the metals—such as gold, silver, copper, zinc, and nickel—in a highly base and refractory ore containing also sulfur, arsenic, and tellurium in large percentage by means of an aqueous solution of ammonia and potassic cyanid under conditions which will maintain the stability and oxidizing character of such solution without any excessive consumption of potassic or sodic cyanid and without any interference from reducing salts, as cuprous (Cu″) or ferrous (Fe′) salts, present in the roasted-ore product or inherently formed during the reaction of air and moisture upon the ore *in situ*.

It is well known that ammoniacal cyanid solutions—that is, solutions of ammonia-water and potassium cyanid—are very unstable, resulting in the decomposition of the cyanid into organic products thereafter having no gold or silver solvent properties. It is of the greatest importance to the success of the process to avoid such decomposition in routine work, while to get a good gold and silver extraction an oxidizing condition must be present in such solution and must be obtained without undue destruction of the cyanid and without adding any expensive oxidizing chemicals. This result I obtain by maintaining an ammoniacal cyanid solution with an excess of a metallic hydroxid soluble in ammonia—such as copper, zinc, or nickel oxid or hydroxid—over and above that necessary to form the double potassic metallic cyanid—such as, for instance, potassium cupric cyanid, $Cu(Cn)_2KCn$. The copper oxid or hydroxid is always to be preferred to zinc or nickel oxids or hydroxids. An ammoniacal cyanid solution containing an excess of copper, nickel, or zinc hydroxid has not only great chemical stability on account of binding or uniting the cyanogen $(Cn)_2$ molecules to the molecules of cupric oxid (CuO) as readily as they break off from the parent salt, but the excess of cupric hydroxid, $CuO(H_2O,)$ in an ammoniacal cyanid solution has important oxidizing qualities, rapidly absorbing oxygen from the air, which will transform any reducing salts (such as ferrous and cuprous salts or compounds present in the roasted ore-product or ore which has been found chemically changed by natural agencies) into an inert condition. All these reducing salts or products are readily oxidized by an ammoniacal cupric hydroxid solution and transformed into compounds insoluble or inert as to the process. Unoxidized ores containing arsenic, antimony, sulfur, and tellurium associated with copper, nickel, zinc, gold, and silver are roasted to transform the sulfids, arsenids, &c., into sulfates, arsenates, &c., a dead or strong oxidizing roast being avoided. Care must be taken to leave none of the sulfids or arsenids in the roasted product, as that will demand tedious and lengthy oxidizing by an ammoniacal solution containing cupric hydroxid and air agitation and will seriously interfere with the gold extraction. It is recommended, therefore, to carefully handle the roasting. This method of ore-roasting is termed "sulfate" or "pyritic" roasting and forms a valuable step in my process. Gold-bearing pyrites containing nickel, zinc, or copper may be treated at low cost by my process in furnaces of the McDougall or Spence type using no extraneous fuel. I nevertheless wish it understood that certain ores may demand a small proportion of carbonaceous fuel, and I there-

fore do not confine myself in all cases to sulfate or pyritic roasting.

Arsenical ores, refractory copper, and gold-bearing pyrites or sulfurets, as well as cinders from sulfuric-acid works containing small percentages of copper, gold, and silver, can by the above process be treated without any difficulty.

My solutions of cupric hydroxid in ammonia-water containing potassic cyanid may be prepared of the following percentage composition, although I do not limit the invention to these proportions: KCy, potassium cyanid, 0.05 per cent. to 0.50 per cent.; $CuO(H_2O)$, cupric hydroxid, 0.50 per cent. to two per cent.; NH_3, ammonia in any form, one per cent. to ten per cent.

Ores containing copper will of course need no addition of cupric oxid or hydroxid, as that may readily be produced by moistening the roasted or naturally existing ore after being ground with very dilute ammonia-water and short exposure to the atmosphere before charging into the leaching-tanks and the necessary amount of cyanid added to the resulting solution of cupric hydroxid in ammonia of the required strength. Arsenical or pyritic ores containing no copper should after roasting be leached with ammoniacal cyanid solutions containing an excess of cupric hydroxid, $CuO(H_2O)$, in proportions as above described.

In practice I proceed as follows: The ore ground between twenty and forty mesh and containing arsenic, sulfur, or tellurium is roasted at a low red heat until analyses indicate no presence of unoxidized sulfur or other reducing compounds. The ore containing copper is then moistened with very dilute ammonia-water and exposed by raking or other mechanical means to the air to oxidize and transform all reducing compounds to an inert condition, after which the ore is charged into leaching-tanks or rotating vessels and leached with an ammoniacal cyanid solution containing an excess of cupric hydroxid, ($CuOH_2O$,) proportioned to extract the copper, gold, and silver or other metals. A salt of ammonia and an alkali or alkaline earth oxid, such as calcium oxid, (CaO,) after slaking may also be used to liberate ammonia in the ore-body. Chemists will readily understand that no hard or fast rules can be applied, and individual conditions must be studied in the successful practice of this process.

The metals are recovered from the solutions as follows: The copper, nickel, or zinc by boiling out as cupric, nickel, or zinc oxid or hydroxid by electrolysis or by precipitation by an alkaline sulfid the gold and silver are recovered by filtering the solution through spongy metals or metal shavings or agitating with finely-divided metals more electropositive than the gold or silver in an ammoniacal cyanid solution. A mixture of spongy iron and charcoal or lead shavings and charcoal forms an active precipitant for the gold and silver from an ammoniacal cyanid solution containing an excess of cupric hydroxid, as previously described.

Mechanically the process does not differ from other leaching processes for extracting metals from ores, and I use such appliances as will avoid undue loss of ammonia and will be adapted to the leaching qualities of the ore.

What I claim is—

1. The process of treating refractory sulfur, tellurium and arsenical ores containing copper, zinc, nickel, gold and silver, consisting; in first roasting such ores at a low, red heat to transform the metals so transformable into sulfates, arsenates or tellurates; then oxidizing reducing compounds by very dilute ammonia; and subsequently extracting the metals with an ammoniacal cyanid solution containing an excess of cupric oxid or hydroxid over and above that necessary to form metallic cyanid double salts, substantially as described.

2. The process of treating refractory ores containing gold and silver which consists in adding to an ammoniacal cyanid solution cupric or other metallic oxid or hydroxid soluble in ammonia in excess over and above that necessary to form metallic cyanid double salts, to maintain the stability and oxidizing character of such solution, and leaching said ores with said solution, substantially as described.

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

DAVID MOSHER.

Witnesses:

FRANCIS M. WRIGHT,

BESSIE GORFINKEL.