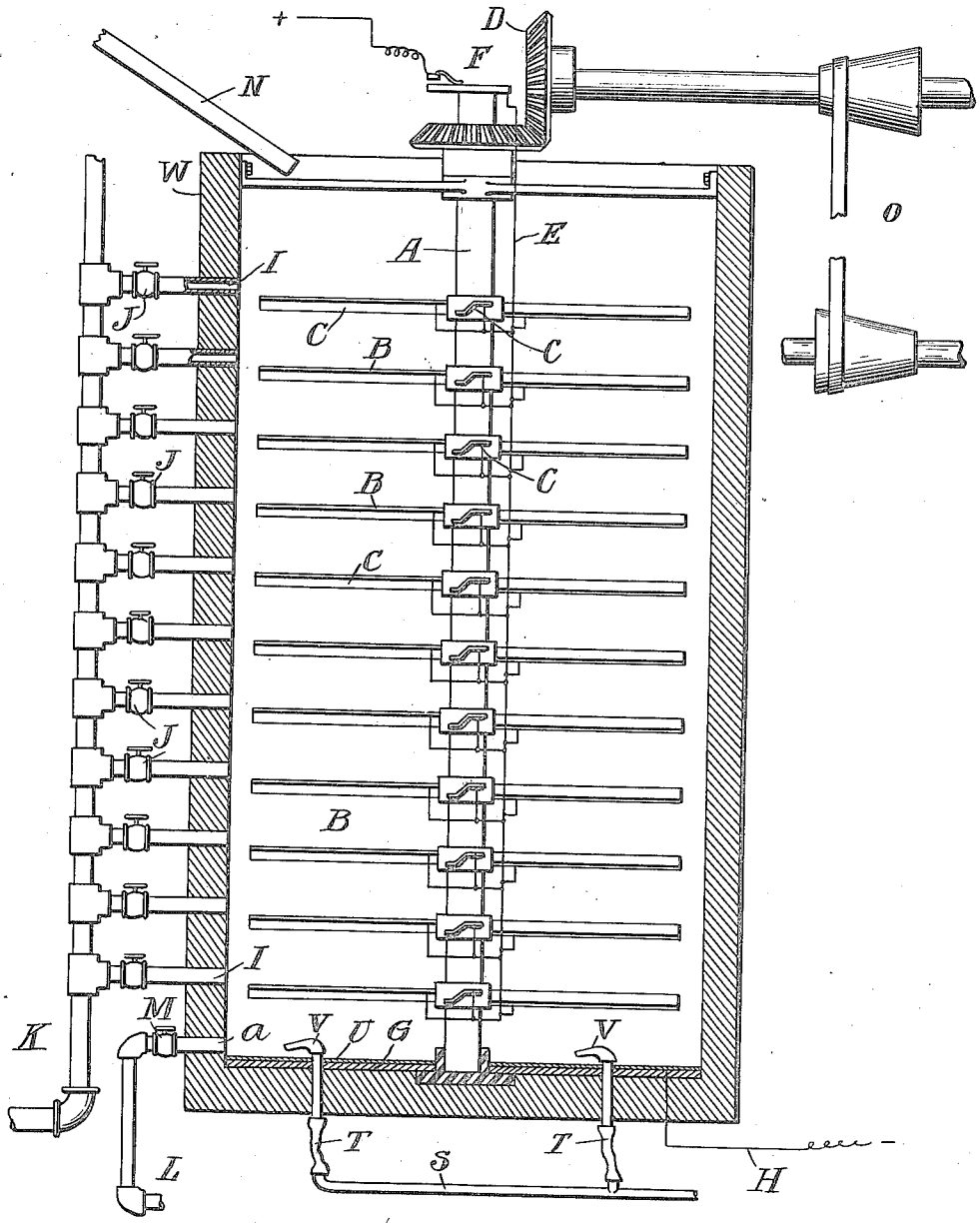
E. R. HOLDEN.

PROCESS OF TREATING ORES BEARING PRECIOUS METALS.

APPLICATION FILED AUG. 10, 1915.

1,181,077.

Patented Apr. 25, 1916.



Attest:

E. R. Holden Inventor:

by Oscar Gunz Atty

UNITED STATES PATENT OFFICE.

EDWARD R. HOLDEN, OF LOS ANGELES, CALIFORNIA.

PROCESS OF TREATING ORES BEARING PRECIOUS METALS.

1,181,077. Specification of Letters Patent. Patented Apr. 25, 1916.

Substitute for application Serial No. 34,328, filed June 16, 1915. This application filed August 10, 1915. Serial No. 44,684.

To all whom it may concern:

Be it known that I, EDWARD R. HOLDEN, a citizen of the United States, and resident of Los Angeles, in the county of Los Angeles and State of California, have invented certain new and useful Improvements in Processes of Treating Ores Bearing Precious Metals, of which the following is a specification.

This invention relates to an improved process of treating ores electrolytically.

The object of my invention is to treat ores containing precious metals, such as gold and silver, by a new process which is simple and economical.

In the accompanying drawing I have illustrated by a vertical sectional view, one embodiment of an apparatus for carrying out my improved process.

W in the drawing is a tank made of any suitable material, preferably wood, and should be constructed about twelve feet high and from six feet to eight feet in diameter although other sizes may be found advantageous. In this tank a vertical central shaft A is mounted, said shaft being constructed of any material not affected by the presence of dissolving solutions, and throughout its entire height is provided with radial wooden blades B or blades of any other suitable material, and being located about one foot apart vertically and having the underside covered with peroxidized sheets of lead, or other suitable metal, C. The said shaft is rotated by gearing D or other suitable appliance. Running downward and attached to said shaft is an electric conducting lead wire E which is connected with the sheet lead coverings C on all of the blades, the whole being charged with a positive current of electricity through a metallic disk F located on the top of said shaft, the lead sheets C thereby constituting the anode. The said tank is provided with a copper or other metallic cathode plate G covering the bottom. The said cathode plate G is connected with a negative current of electricity as shown by the wire H. The cathode surface is coated with mercury U for the purpose of absorbing metallic gold and silver, either as it occurs in the ore in the metallic state, or as it is precipitated out of the solution as will be hereafter more fully described.

The tank is provided with a series of equidistant openings or holes I located one above the other, the holes being one foot apart, more or less, beginning at the bottom of the tank and extending upward to within one foot of the top. Each of these holes or openings in the side of the tank, except the lowest one, are controlled by valves J, each of which, when opened, would allow all of the ore and solution in the tank above that opening, to be drawn off separately and consecutively from the top downward, and escape into the drawoff pipe K, which is connected with all of the openings, except the bottom one. The pipe K leads to settling tanks, not shown. The last opening *a* at the bottom of the tank is connected with a drawoff pipe L, having a valve M, and the mixture of concentrates and solution drawn from this bottom opening is carried by the pipe L into separate settling tanks, not shown. The launder N carries the finely pulverized ore from the crushing machinery direct into the tank.

For the regulation and variation of the speed and the rotation of the vertical central shaft A and the blades attached, a set of cone pulleys O, or other suitable mechanical means, are so arranged as to revolve the shaft to any exact desired number of revolutions per minute, for the important purposes as will appear hereinafter.

S in the drawing represents an air pipe having two connections passing through the bottom of the tank and having elbows inside the tank, into which nozzles V are set with small openings for the purpose of introducing air under pressure and the openings of the nozzles being set to point in the same direction as the moving body of solution.

T represents rubber tubes attached to the air pipe S and connected with the short pipes entering the bottom of the tank, the rubber connections being for the purpose of preventing electric contact with the pipe S. The air being introduced for the well known purpose of assisting in the oxidizing of basic compounds contained in the ore.

The operation is as follows: The pulverized ore and solvent solution is run into the tank until the same is filled, all the valves J and M being closed. The shaft A with blades attached is then set in motion and rotated at a speed sufficient to cause the smallest and lightest particles of ore and mineralized matter in the tank, to rise in the solution and find their equilibrium in the uppermost stratum or layer through the circuitous velocity of the solution, produced by the revolving blades. The next larger and heavier particles of ore and mineralized matter will form the next lower stratum of moving ore in the solution and through the maintained velocities, during the operation, it will be found that all of the ore mineralized matter, will be in different strata, according to their volume and specific gravity, the speed being so regulated, as to cause the largest particles of silica to be elevated from the bottom stratum into the stratum just above. The speed is then maintained without variation, for the necessary period to allow the solvent solution, for example, cyanid solution, to dissolve all of the gold and silver and other metals that are amenable to the solvent.

I find that from three to six hours is ample in which to circumgyrate the solution and finely divided ore, to cause all the finer particles of metallic gold and silver and the compounds of these metals to be acted upon by the solvent. While the chemical action of dissolution is progressing, an electric current of sufficient strength is simultaneously conducted through the mass of ore and solution, by means of the anode, formed of the lead blades, and the cathode formed of the copper bottom.

I found that by having a large area of anode surface, attached to revolving blades operating in a conducting solution in a tank and distributed throughout the solution from the bottom to the top of the tank, together with a suitable area of cathode surface, that the current is completely and thoroughly disseminated through the entire solution and thereby the electric precipitation of the metals from the solution is more fully and quickly performed; not only by the negative cathode attraction for positive metallic ions, but by their specific gravities being established by the molecular alteration from a soluble compound of gold and silver into the metallic condition. The entire cathode surface in the tank being amalgamated with mercury, the absorption of the particles of gold and silver, originally in the ore in metallic form, as well as the gold and silver precipitated out of the solution electrolytically, is at once absorbed and amalgamated by the coating of mercury on the cathode.

Tanks of more or less depth or with more or less openings, can, of course, be used without departing from the spirit of my invention. A regulated constant revolving velocity being imparted to the blades, the entire mass of ore in the tank begins to ascend until the various ore particles rotate in equilibrium in the solution, according to their volume and specific gravity, due to the regulated velocity imparted.

If the ore and solution is rotated at a certain uniform speed so as to impart a circumgyratory motion to the solution, the ore material will separate into various strata according to the size and gravity of the particles and the velocity used. The heaviest material will be in the lower part of the tank, and toward the top it will gradually diminish both in size and gravity.

The speed of rotation of the blades depends upon the fineness to which the ore and mineralized matter have been crushed, for example, if the material was not ground very fine, the rotation will have to be comparatively rapid, in order to produce a separation into different strata of the particles of material having different specific gravities and sizes, while if the material was ground very fine, the rotation need not be so rapid, to establish the different strata. Of course the finer the material the more soluble the gold, silver and other metals or compounds become and furthermore, all of the metals and metallic compounds contained in the ore that escaped fine crushing, and not dissolved, and not amenable to the solvent solution, will be found in the lowest stratum, in the bottom of the tank, that is, below the lowest outlet or opening I.

When the apparatus has been in operation for say six hours, all the chemically combined gold and silver, as well as the finer particles of metallic gold and silver in the strata above the lowest,—in the present case the eleven upper strata, will be practically dissolved and precipitated on the mercurized cathode surface, and the tailings as they are removed stratum by stratum consecutively, show by assay that the gangue removed from the eleven upper strata are uniformly without value in gold and silver, but as stated, the lowest stratum containing undissolved gold and silver and other metals and mineralized material will be found in every instance more valuable, per ton, than the original ore.

The motion, speed or velocity of the revolving body of solution and ore, should not be altered at anytime while discharging each stratum through its separate opening. When the operation of the process is finished, let us say after six hours, and the solution and ore is to be discharged, it will not do to remove the upper eleven strata si-

multaneously, as that would disturb the equilibrium of every stratum at one and the same time, and would cause such a commotion as would also destroy the equilibrium of the lower stratum, and therefore, cause a mixture of the lower stratum with some of the strata that were being discharged, and interfere with the deposit or concentration of the gold and silver and mineral compounds in the bottom stratum of the tank. For the successful operation, it is necessary to draw off each stratum beginning at the top, before the next one below is disturbed. We now open the top or uppermost valve J and when the upper stratum has been drawn off, we next open the second valve J, and when that stratum has been discharged, the third valve is opened and so down to, but not including the lowermost or last stratum, which is about one foot deep in the bottom of the tank. This last stratum is then drawn off by itself through the opening *a* and pipe L by opening valve M and conducted into a separate settling tank (not shown) for the undissolved metallic and concentrated mineral product exclusively. All of the other strata above the lowest one, having been diverted into one large settling tank (not shown) are allowed to settle for the purpose of drawing off, or decanting the solvent solution, to be pumped into the stock tanks for further use, and the tailings are then consigned to the waste dump. The lower stratum, which was drawn off into a separate settling tank, by the method and mechanism described, and which consists of undissolved mineral compounds, metallic particles of gold and silver and other metals, are then reground and passed through the same operation again or treated by any other method such as smelting, for the recovery of the gold, silver or other metals.

I am aware of the fact that there are many devices for which patents have been issued, for the simple concentration of ores, whereby a rotary or other motion is used to cause the lighter particles of ore to rise in a revolving or moving body of water, and the lighter particles allowed to continuously overflow out of one or more spouts, allowing the heavier particles to concentrate on the bottom to be thereafter removed, but I am not aware of any device or process having ever been used or patented, whereby the different sizes of ore, having different specific gravities, are separated into different strata and confined in a tank and rotated in bulk and kept in that stratified position in a solvent solution, until all the gold, silver and metallic contents, amenable to the solvent are dissolved and precipitated electrolytically in contact with a cathode covered with mercury and the remaining parts of the gangue from which the metallic contents were extracted, removed from the tank, stratum after stratum downward from the top, and retaining the undissolved and heavier particles of gold, silver and other metals and the compounds of these metals in the bottom of the tank, thereby performing the several actions of dissolution of the precious metals and their precipitation on mercurized cathodes, through the agency of electrolysis and concentration at one and the same time, of all metals and mineral compounds not amenable to the solvent used.

I am also aware of the fact that there are many devices for which patents have been granted for agitating ore in tanks containing a solvent solution, the object being, in all cases, to keep the ore in suspension, surrounded by the dissolving solution, until all of the gold, silver or other metals or compounds of metals that were amenable to the solvents are dissolved, when the entire mass in bulk is then removed from the tank, either by first allowing the ore to settle in the said tank and decanting and washing out the clear solvent liquor, containing the dissolved metals, or second, by passing the entire contents of the tank through filter presses to separate the liquor from the remaining ore, in both instances, however, consigning the entire ore in bulk to the waste dump as tailings. I am not, however, aware of any process or device or tank having ever been used or patented, whereby in the treatment of ores, the various particles of gold, silver or other metals, or the compounds of such metals, amenable to the solvents used, have been retained or concentrated and recovered simultaneously in the said tank, and only the gangue from which the metals were dissolved allowed to escape, stratum by stratum, consecutively through separate openings, while the body of ore and solution is kept in circumgyratory, or any other action and the metal or mineral compounds from which the metals were not dissolved, retained in the lower stratum and not mixed in the general mass of tailings discarded.

In all present agitating methods of treating ore, the waste tailings emptied in bulk from any agitating tank, now in use, may show by assay, merely as an illustration .03 oz. per ton in gold at $20.00 per oz., the value of 60 cents per ton, and 3. oz. of silver at 60 cents per oz., the value of $1.80 per ton, or a total average value of $2.40 per ton; due to the fact that the present agitating dissolving tank is not constructed to save mechanically any of the larger particles of metallic gold, silver or other metals that frequently occur in ores, owing to the great length of time required to dissolve particles of such sizes. Nor can the said tanks save

any concentrates of mineralized matter or the compounds of gold, silver or other metals, or cause a mechanical separation of any part of the ore contents and are only efficient and operated for dissolving purposes. I found that the cause of the largest part of the above illustrated loss of $2.40 per ton, in the tailings, was due to the lack of device, control and facilities in the present form of agitating or dissolving tanks, for the separation of those parts of the mineral contents that were not amenable to the solvent solution. In other words, the practice in all mills at present using the agitating method for dissolving precious or other metals, is to obtain the best dissolution of the amenable metals present and consign to the waste dump the entire ore product from which they were extracted.

For the purpose of illustrating this new method of saving the maximum amount of gold, silver and valuable mineral compounds, in ores of an oxidized or refractory nature, I set forth below the operation from actual results obtained from the treatment of one ton of low grade semi-oxidized ore, taken from a mine located in Arizona, and treated in an apparatus such as herein shown and described, the solvent used being potassium cyanid of the strength of 0.25% the consumption being 1.5 lbs. per ton of ore.

Weight 1 ton, assay of raw ore in gold 0.20 oz., value at $20 per oz	$4.00
Weight 1 ton, assay of raw ore in silver 3.00 oz., value at 50¢ per oz	1.50
Total value	$5.50

After an operation of six hours:

Wasted as tailings 1800 lbs., consisting of 11 top strata	Assay in gold per ton 0.002 oz., value per ton	0.04¢
	Assay in silver per ton 0.070 oz., value per ton	0.035¢
		0.075¢
Recovered 200 lbs., consisting of 12th or bottom stratum	Assay in gold per ton 0.38 oz., value per ton of concentrates	$7.60
	Assay in silver per ton 5.00 oz., value per ton of concentrates	2.50
		$10.10

It will be observed that the extraction obtained from the eleven top strata, shows 99% of the gold and 97.66% of the silver. It will also be observed, that if the entire contents of the tank, consisting of the twelve strata, were discarded as tailings,—as in the present mill practice—that the tailings would then have assayed .0389 oz. gold per ton and .563 oz. silver per ton and the extractions obtained would only have been as follows: 80.1% of the gold and 81.2% of the silver, or a loss in the operation, as compared with the results obtained in my tanks of 18.9% in gold and 16.46% in silver; the saving in favor of my tank amounting to 76¢ worth of gold and 25¢ worth of silver, or a total of $1.01 per ton of ore. It can also be noted that the saving, above enumerated, consisted solely in the recovery of the 200 lbs. of mineralized matter or concentrates, in which the gold and silver and other metallic compounds were not wholly dissolved by the solvent used. This 200 lbs. of concentrates is exclusive of the mercury, into which the dissolved gold and silver was precipitated electrolytically; which mercury contains all of the gold and silver extracted except the usual amount remaining in solution, which amounts to about 25 cents per ton of liquid, and after settling, is pumped back into the stock solution tanks, to be continually used over again.

It being well known that through the agency of an electric current, gold, silver and other metals that are dissolved in the presence of any of the well known solvents, can be precipitated as metallic ions of the metals, and be deposited from the solutions on negative cathodes of copper, mercury, zinc, etc., and recovered. It is also well known, that air simultaneously introduced in the solution, oxidizes the basic compounds present in the ore, and greatly assists in decomposing the bases, and altering their chemical composition, thereby allowing the solvents to exert the maximum efficiency in dissolving the precious metals. I am not claiming any rights with respect to these well known electrical and chemical reactions, but what is new, is the process by which these reactions are performed, and the mechanical manner in which the apparatus is manipulated, to produce new and important results in the saving of gold, silver and other metals and the compounds of these metals; enormous amounts of which are lost under the present methods of operation.

The apparatus herein shown and described but not claimed constitutes the subject matter of my copending application No. 41045, filed July 21, 1915, and set forth with other matter in my abandoned application, Serial No. 34,328, filed June 16, 1915.

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

1. In treating ores containing gold and silver, in a solution for dissolving the gold and silver, the improvement, which consists in producing in the solution containing the ore under treatment a rotary motion while the solution is subjected to an electrolytic action and gradually drawing off the liquid and ore from the top downward to a predetermined level, while, maintaining the rotary motion in the liquid and the ore therein, substantially as set forth.

2. In treating ores containing gold and silver, in a solution for dissolving the gold

and silver, the improvement, which consists in producing a rotary motion in the solution into which the ore has been placed and at the same time subjecting the ore and solution to an electrolytic action and to the action of a cathode coated with mercury, and after a predetermined time, gradually reducing the level of the liquid from the top downward, while continuing the rotary motion of the liquid and the ore contained therein, substantially as set forth.

Signed at New York in the county of New York and State of New York this 6th day of August, A. D. 1915.

EDWARD R. HOLDEN.

Witnesses:
OSCAR A. GUNRY,
J. CARRIGAN.