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UNITED STATES PATENT OFFICE.

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RECOVERY OF VALUES.

No Drawing. Application filed September 7, 1923. Serial No. 661,531.

To all whom it may concern:

Be it known that we, GEORGE D. VAN ARSDALE and HAROLD W. ALDRICH and WALTER G. SCOTT, citizens of the United States, residing at Los Angeles, county of Los Angeles, State of California, and Inspiration, in the county of Gila and State of Arizona, respectively, have invented new and useful Improvements in the Recovery of Values, of which the following is a specification.

This invention comprises an improved method of recovering dissolved values; and it is believed to be especially suitable for use in connection with leaching processes applied to ores, such as copper ores, or the like.

Although our present invention provides a highly efficient method for washing out dissolved copper after the application of any desired leaching process to copper ores, or the like, this invention, in one of its aspects, may be regarded as comprising a novel combination of a countercurrent method of washing with an exhaustive or circulation method of washing, involving cementation, or the like; and it may also be regarded as comprising a combination of countercurrent methods of washing with a subsequent precipitation, as hereinafter described.

The usual leaching methods applied to copper ore may be divided into two classes: (1) those in which the ores are treated by percolation, and (2) those in which agitation is used. In either case, after contact with the leaching solution has been sufficient to dissolve the copper, it is necessary to separate the resultant solution or rich liquor, and subsequently to remove, by washing methods, that dissolved copper which would otherwise remain associated with the residual moisture in the tailings, after separation of the main body of solution therefrom.

For example, in washing by percolation, a number of successive washes are applied, each of which removes a fraction of the remaining copper. Usually it is desirable to have the volume of the respective washes so adjusted that the total volume of solution remains practically a constant. To do this, the unit volume of wash water may be adjusted to be approximately equal to the volume of liquid finally discharged, as residual moisture, in the tailings, allowance being made for such moisture as comes into the system with the ore, and for evaporation during the cycle of operations.

When the total volume of solution is controlled in the manner above referred to, the strongest wash water being finally added to the main solution of rich liquor to be treated for the recovery of a metal, or regeneration, subsequent washes are successively advanced, in the next following cycle.

In some cases, by reason of the accumulation of dissolved impurities, a solution discard is required; but when the ores undergoing treatment do not yield, per cycle, more dissolved impurities than are lost in the volume of residual moisture discharged with the tailings, no discard is necessary for the purpose referred to.

It has heretofore been recognized and it can be shown mathematically that, for any system of washing, the total percentage of dissolved values washed out increases with the number of successive washings; and also that, with a sufficient number of washings, the removal of values will approach, but can never equal, one hundred percent. It has also been recognized that, for any given total volume of wash liquid, the highest efficiency will be obtained by dividing such total volume into the greatest practicable number of individual washes.

However, from an operating standpoint, and also in view of installation expense for storage of washes, it is not practicable to carry more than limited number of stock washes. For example, in leaching copper ores, the last wash in a system of say six to eight washes may carry from 0.15% to 0.25% or more of copper; and the discharge of tailings carrying residual moisture with such percentages of copper results in appreciable losses. On the other hand it is often perfectly practicable and economical to precipitate copper, for example by cementation, from solutions carrying much less than the above mentioned percentages; and this is due to the facts that pumping costs are ordinarily comparatively low and that cementation costs are per-pound costs.

In connection with the new system of washing herein described and claimed, we point out that our novel method of washing may obviously be applied in connection with various methods of leaching copper ores, or

the like, for example, agitation methods of leaching; and it may also be applied with advantage in other wet methods of removing values from subdivided solid materials; for example, in cyaniding gold and silver ores; and it may indeed be generally applicable as a method of treating subdivided solids containing soluble values by the employment of a circulating wash liquid brought alternately into contact with such subdivided solids and into a system capable of precipitating or removing the values therefrom.

As applied in connection with a leaching of copper ores by percolation, our method is as follows: After the application of a sufficient number of washes to leached ore residues, as in usual practice, which may be substantially as outlined above, the washed ore is drained; and thereafter water, in any quantity suitable to convenient manipulation, is pumped onto the ore. The water takes up remaining dissolved values, and it is then removed from the leaching or other tank and passed through an iron launder system or other means of precipitating copper, and is then returned to the ore. This operation, which may involve a continuous or intermittent circulation, is repeated until a complete or exhaustive extraction is obtained, or until the extraction is as nearly complete as is economically practicable, it being understood that when a cementation process, in which the more electropositive metal goes into solution, is employed, the circulated wash liquor tends to become increasingly rich in iron salts, in proportion as copper is precipitated therefrom.

It will be appreciated that there are numerous cases in which use is made of leaching systems employing iron salts as an essential constituent of the leach liquors; and, in treating certain copper ores, use may advantageously be made of a liquid whose iron content may be due to its previous employment in our method of exhaustive washing, various processes involving leaching or electrodeposition and in connection with which our invention may be employed having been described in copending applications by George D. van Arsdale, Serial Nos. 639,968 and 639,970, filed May 18, 1923, and Ser. No. 665,463, filed September 28, 1923.

There are, of course, numerous ways in which such a circulating or exhaustive wash as we have herein described may be applied. For example, it may follow either say four, five, six or another number of ordinary countercurrent washes, the preferred number of washes depending upon the amount of copper that it may be economical to leave for precipitation by cementation and final recovery by known methods applicable to "cement" copper. Usually, however, our system of exhaustive washing aims to recover approximately that amount of copper which would otherwise be lost after the employment of a countercurrent or other known washing system.

As a practical proposition, our washing system as described and consisting essentially of a countercurrent washing followed by a circulation or exhaustive washing has shown very considerable advantages. It has been shown to be practicable and economical to wash ore, by our new method, down to 0.01% dissolved copper, corresponding to less than one-fourth (¼) pound of copper lost per ton of ore; and even more complete recovery is possible. In fact, as implied above, pumping costs are often sufficiently low to render economical a practically complete recovery of dissolved values. As a comparison, the application of the ordinary leaching systems with a practicable number of the usual countercurrent washes has been found to result in tailings, on the same ore on which the above results were obtained, carrying well over a pound of dissolved copper per ton of ore; and where large tonnages of ore are treated daily the removal and recovery of such amounts of dissolved copper is a very important matter.

It should be understood that although we have herein referred to a complete washing process, as well as to subprocesses, in which our invention may be exemplified, various features of our invention might be independently employed, and various modifications might obviously be made, without departure from the spirit and scope of our invention as the same is indicated above and in the following claims.

What is claimed is:

1. In the recovery of values, the steps which comprise washing residual subdivided solids by a countercurrent method to obtain a solution suitable to be added to a rich liquor for a usual treatment, and thereafter removing residual values by circulating a body of liquid therethrough and precipitating values from said body of liquid during its circulation, in a form permitting of a substantially complete recovery.

2. In a recovery of values, the steps which comprise washing residual subdivided solids by a countercurrent method to obtain a solution suitable to be added to a rich liquor for a usual treatment, and thereafter removing residual values by circulating a body of liquid therethrough and precipitating values from said body of liquid by cementation during such circulation.

In testimony whereof we have signed our names to this specification.

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