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BLAMEY STEVENS, OF TRIUNFO, BAJA CALIFORNIA, MEXICO.

DIFFERENTIAL FLOTATION PROCESS.

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To all whom it may concern:

Be it known that I, BLAMEY STEVENS, a citizen of Great Britain, residing at Triunfo, Baja California, Mexico, have invented new and useful Improvements in Differential Flotation Processes, of which the following is a specification.

This invention relates generally to flotation processes for concentration of ores; without specific restriction to any particular method of producing the flotation of the ore—as, for instance, whether the floating of the ore is produced by oil action, or by froth action. The invention also relates generally to flotation processes as applied to any kind of ore.

The object of my invention is to produce an efficient process for differentially floating minerals; to produce a flotation process which will cause selective flotation and separation of any particular minerals or metals desired, and cause separation of floatable minerals or metals from each other.

I have discovered that, by the use of a suitable selective re-agent in the pulp, I can cause the selective flotation of ores in a commercially efficient manner. Such separation I form by using a solution that tends to dissolve, preferably, all of the minerals or metals present in the ore that I may desire to keep from floating; and I saturate this solution either with the particular metal which I desire to selectively float, or with a metal which is electro-negative to another metal or other metals which I desire to float; or with a metal which satisfies both of these conditions at once. It will be understood that I may use a solvent solution that, in itself, has a differential dissolving action on the different metals or minerals; and, in addition to directly utilizing that differential solubility I may saturate the solution with a metal, as herein set forth, for further selective action. For instance, cyanide will not readily dissolve molybdenite and, accordingly, I may use unmodified sodium cyanide as a selective re-agent to float molybdenite selectively from, say, copper, or almost any other mineral; and if then I wish to make further selection I may, in such circumstances saturate the cyanide with another metal, say copper; which would then cause the copper also to float.

This solvent as above described is my selective re-agent. Its use and its effect will be best understood, and the invention as a whole will be best understood, from a description of my process as applied more or less specifically to a certain class of ores in some well known process of flotation.

Accordingly, I will proceed, for the purposes of making my invention clear and explicit, but not for the purpose of limiting my invention to the specific details set forth, to a detailed description of the application of my process to that kind of ores which is most universally treated by flotation—namely, sulphide ores; taking for instance an ore which contains silver, copper, lead and zinc.

Suppose for instance, that I wish to selectively float the silver and copper and keep the lead and zinc in the pulp. I proceed generally as in any of the ordinary and well known methods of flotation. For instance, the pulp containing the sulphides of these four metals, is mixed with a floating element, say a suitable oil in proper proportions, all of which is well known; and also mixed with a suitable proportion of selective agent, either acid or alkali or neither as desired, and in suitable proportions, which is also all well known. To this pulp I add my specially prepared selective re-agent; which, in this case, is preferably sodium or potassium cyanide saturated with copper to make, for instance, a sodium copper cyanide. The amount of such selective re-agent necessary to carry on the process may vary with different kinds of ores and also with the percentages of the various metals present; but, to give a concrete instance, I may say that in a sulphide ore which contains silver 0.1 percent, copper 3.0 percent, lead 7.0 percent, zinc 2.0 percent, I find it effective to use about one pound of my selective re-agent to 250 pounds of ore, where the proportion of ore to water in the pulp is one to four. Little difference in result is noted, whether the solution is acid, neutral or alkaline.

When such a pulp, carrying my selective re-agent, is treated in any of the well known flotation machines, as for instance in a machine which beats air into the pulp and thus forms a froth—I find that the silver and copper sulphides are floated, whereas the lead and zinc are kept in the pulp. In general, I find that the metal with which

the cyanide solution is saturated will be floated; and that all metals which are electro-positive with relation to that saturation metal will also be floated; while all ores of metals relatively electro-negative to the metal of saturation (that is, having a greater solubility product or an ability to displace the metal of saturation in the solution) will be kept in the pulp. It is well understood that the electro-positive or electro-negative relation of similar compounds of metals is more or less the same as the relation of the metals themselves. This seems to be due to the fact that those metals which are relatively electro-negative have the power of going into the solution in spite of the fact that the solution is already saturated with one particular metal, in this case, copper. The lead and zinc in this case start to replace the copper in the solution, but do not have opportunity to displace any appreciable amount of it during the period of time that the pulp is in the flotation cells. I might state the matter in this way; that the affinity of the saturated selective solution for the lead and zinc prevents the lead and zinc from floating. The lead and zinc therefore drop down in the solution with the rest of the gangue, and may be separated from the solution with the remainder of the gangue in any of the usual manners.

The concentrate from the flotation operation may of course be carried through any number of subsequent flotation operations as may be necessary or desirable to clean the concentrate and, in this case, to exclude the lead and zinc sulphides. In a single operation of flotation concentration, according to my process, there may be a certain amount of the relatively electro-negative metals floated in the first concentrate; but when there are no grains containing two minerals or metals my process so effectively floats the disired metals, and so effectively cuts down the flotation of the undesired metals that, usually, one or two successive flotations of the concentrate will suffice to eliminate practically entirely the relatively electro-negative metals and give a relatively pure concentrate, with a high percentage of ultimate recovery, of the desired metal or metals.

The gangue, together with the metallic ores not floated, is separated from the liquid solution in any of the well known manners; and the solution is again used for forming a pulp with fresh ore; so that my selective re-agent is kept in the cycle of operations, with only the comparatively small loss which is caused by cyanicides and the dissolving of a certain small part of the relatively electro-negative metals in the cyanide.

And if, for instance, in such a case as here stated, it is desired next to selectively float the lead, the gangue may then be subjected to another flotation operation or a series of flotation operations, wherein the selective cyanide solution is saturated with lead. It will thus be understood that, by the use of a proper selective re-agent, or re-agents, any particular metal or metals may be floated selectively, and each and all of the metals in an ore amenable to flotation may be selectively floated and thus separated from the others. If both zinc and lead are desired, I may use zinc as the saturation metal; but lead and zinc, for instance, are so close together in their characteristics that the use of lead as the saturation metal may take out enough of the zinc along with the lead to make it economical in some cases to use lead (a metal which is slightly electro-positive as regards zinc) as the saturation metal rather than zinc. Thus, although I have said that the saturation metal should preferably be electro-negative with relation to the metal or mineral wished to be floated, it will be understood that a saturation metal which is not too much electro-positive (relatively) may be used effectively in some cases.

I find my process of general applicability, and I find it highly efficient as applied to the usually difficult separation of copper from such metals as lead, zinc and iron; or the separation of silver and copper on the one hand from such metals as lead, zinc and iron on the other hand. And I find it very efficient for separation of silver from such metals as lead, zinc and iron; a copper saturated solution being used also in this case just as when both silver and copper are present.

I wish to state, after giving this detailed description, that the gist of my invention consists in the use of a re-agent that tends to dissolve certain of the metals present and leaves others comparatively free; a re-agent that has a selective dissolving action on the several metals present. And when I speak of a tendency to dissolve or lack of such tendency I speak relatively and do not necessarily mean that the re-agent will dissolve one metal and have no action at all on another. I have described in detail one instance of such a selective dissolving re-agent; but it will be understood that I do not thereby limit my invention to that particular re-agent.

Having described a preferred form of my invention, I claim:

1. In a flotation process, preparing a flotation pulp, adding to that pulp a selective re-agent which is a solvent for floatable metals in the ore being treated and which is saturated with one of such metals, then floating that metal of saturation.

2. In a flotation process, preparing a flotation pulp, adding to that pulp a selective re-agent which is a solvent for floatable metals in the ore being treated and which

is saturated with one of such metals, then forming a froth in the solution and thereby floating that metal of saturation.

3. In a flotation process, preparing a flotation pulp, adding to that pulp a selective re-agent which is a solvent for floatable metals in the ore being treated and which is saturated with one of such metals, then forming a froth in the solution and thereby floating that metal of saturation and all metals electro-positive relatively to it.

4. In a flotation process, preparing a flotation pulp, adding to that pulp a selective re-agent which is a solvent for floatable metals in the ore being treated and which is saturated with a metal which is not substantially electro-positive relatively to the metal wished to be floated, and then floating that last mentioned metal.

5. In a process of floating metal in a pulp containing several different metals, the use in the pulp of a selective re-agent which is a solvent of the floatable metals in the ore being treated and which is saturated with a metal not substantially electro-positive to the metal wished to be floated.

In witness that I claim the foregoing I have hereunto subscribed my name this 23d day of February, 1920.

BLAMEY STEVENS.

Witness:
VIRGINIA BERINGER.