UNITED STATES PATENT OFFICE.

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ORE CONCENTRATION.

1,067,485. Specification of Letters Patent. Patented July 15, 1913.

No Drawing. Application filed September 1, 1911. Serial No. 647,239.

To all whom it may concern:

Be it known that we, EDWARD HOIT NUTTER, a citizen of the United States, and HENRY LAVERS, a subject of the King of England, residing at Berkeley, Alameda county, State of California, and Broken Hill, New South Wales, Australia, respectively, have invented certain new and useful Improvements in Ore Concentration, of which the following is a specification.

This invention is for improvements in or relating to ore concentration by flotation processes and relates more particularly to differential flotation, that is to say, to the separation of different metallic sulfids from one another when flotation processes are used.

The processes described in the previous patents relating to the flotation of metalliferous matter in the form of a froth as for example in the United States Patents No. 835,120, granted November 6, 1906, to Sulman, Picard and Ballot, No. 955,012, granted April 12, 1910, to Sulman, and No. 962,678, granted June 28, 1910, to Sulman, Greenway and Higgins, have hitherto been used in practice for the separation of metallic sulfids from gangue. It is now found that by varying certain conditions in the flotation processes a separation can be effected between the different metallic sulfids.

It has been observed that when controlling conditions are varied according to this invention the sulfids of various metals have a tendency to float in different ratios to one another. This tendency is dependent upon a number of factors, such as the amount and character of the agitation or aeration or agitation and aeration, the chemical constitution of the solution employed, the degree of dilution, the temperature and the amount and nature of the different frothing agents. The word aeration is used in this specification to mean the supplying of air or other gas or gases. We have found that by varying and modifying these factors and conditions we can obtain effective separation between galena and zinc sulfid as well as between other sulfids and metals. Thus according to this invention an ore mixed with water and with agents necessary to bring about the formation of a mineral-bearing froth are agitated together with a certain limited degree of agitation or are aerated to a limited extent or are subjected to limited agitation and aeration so as to cause the flotation of a froth containing the sulfids in a different ratio than obtains in the original ore, or in an ordinary froth. This froth may be removed and re-treated under similar differentiating conditions. This re-treatment may be repeated so as to effect a separation of one sulfid from another. Or again with an ore or product which contains several mixed sulfids, such for example as an ore containing sulfids of copper, lead and zinc, the agitation of the ore pulp may first be effected with the addition merely of a frothing agent such for example as cresol but without mineral acid whereby a froth is obtained containing mainly copper sulfid, which froth may be re-treated under these differentiating conditions. If the remaining pulp containing the unfloated sulfids is now agitated again with the addition of sulfuric acid as well as the frothing agent, a froth may be obtained containing a larger proportion of lead and finally by the addition of an oily substance such as oleic acid all the remaining sulfids may be floated, the last froth having a preponderating proportion of zinc sulfid. By varying the conditions under which the float is obtained in this way a series of froths are obtained which differ from one another in their constituents and by re-treatment it is possible to obtain froths containing such a preponderance of one metallic sulfid that the concentrate can be supplied direct to the smelter without further separation of its constituents.

This process can be carried out in an apparatus comprising a series of preliminary mixers connected to spitzkasten or separating boxes for the collection of the froth with successive series of mixers to which the froths are supplied for re-treatment.

There are various well known means of concentrating ores or separating mineral particles of different character as by concentrating tables, vanners, jigs, buddles and various other forms of classifying apparatus depending for their effect upon relative differences in size and specific gravity of the particles or relative differences between the particles as regards falling power in water. However, efficient separation by these means can generally be obtained only

in those cases where a somewhat definite size relationship between the constituents of the product treated already exists or has already been produced by preliminary treatment. In other words an apparatus like a concentrating table or vanner will not effectively treat a complicated product like a crushed ore containing perhaps three or four different metalliferous constituents and one or more gangue constituents all in sizes varying from coarse particles to fine slimes: but if the product be submitted to a preliminary treatment which divides the product into fractions which are simpler and more definite in the size relationship of their constituents, the above methods of ore dressing or separation of mineral particles can be effectively employed on the fractions.

In experimenting with the various known flotation processes of ore treatment—that is to say those processes in which the ore mixed with water containing certain agents is agitated or otherwise treated to cause certain constituents to float in the form of a froth or scum—it is found that when successive froths are produced from a powdered ore (for example by the repeated treatment of the ore pulp under different conditions) the powdered mixtures contained in these successive froths differ widely from the original powdered ore and may differ also from one another as regards the size relationship of their constituents. That is to say if two or more froths are taken from a powdered ore under different conditions, the powdered mixture contained in the first froth may have its constituents in a certain ratio of sizes; the second froth may have its constituents in another ratio of sizes and so on. The powdered mixture contained in or obtained from each of these froths may now be separately treated on a classifying apparatus such as a concentrating table and an effective separation of the different constituents can be obtained. Such a combination of steps affords means both for the separation of metalliferous matter from gangue and for the separation of different metalliferous ore constituents from one another. One process therefore of concentrating ores according to this invention consists in treating the crushed ore by a flotation process two or more times under different conditions to obtain froths or scums having the constituents of each in certain ratios of size, and thereafter treating the powdered mixture contained in each froth separately on a classifying apparatus to separate the constituents. The processes employed to obtain these froths or scums may be any of the well known flotation processes as described for example in United States Patents No. 879,985, granted February 25, 1908, to Sulman, Picard and Ballot, and Nos. 835,120, 955,012 and 962,678, hereinbefore mentioned.

The classifying apparatus employed may be concentrating tables, vanners, buddles or the like.

The following are examples of applications of this invention:—In the case of an ore containing gangue and sulfids of copper and zinc, if the crushed ore is agitated with water containing a minute proportion of a frothing agent such for example as cresol or eucalyptus oil (but without the use of any acid), the froth produced may contain a proportion of the copper minerals, some comparatively fine zinc and some still finer gangue. If the remaining pulp is heated and a small amount of sulfuric acid is added another float can be taken off which will have a greater proportion of coarser zinc and copper in it than in the first float and in general the zinc will be finer than the copper. If oleic acid is added and another froth taken after the usual agitation the remaining metalliferous constituents will be floated containing much of the coarsest material. The bulk of the gangue will remain unfloated. These froths could then be treated separately and independently by vanning machines or concentrating tables and separation as between the different metalliferous constituents present could be better obtained than if the whole metalliferous contents were obtained in one mixed froth and treated together.

In a frothing apparatus of the general type described in the previous Patent No. 979,857, granted December 17, 1910, to Hoover, or in the concurrent application Serial No. 651,188, filed September 25, 1911, the formation of a froth can be effected under different conditions in the different agitators. The various froths can be collected from the different mixers or the different spitzkasten separately and the powdered mixtures obtained from these froths can be treated separately on concentrating tables or the like to obtain an effective separation of the constituents.

In some cases by varying the conditions under which the various froths are formed, the froths obtained will differ from one another both as regards their constituents and as regards their range of size and this invention includes the treatment of a complex ore or product by taking from it two or more froths under different conditions as described so as to obtain froths differing from one another in their character and thereafter re-treating the froths so as to effect a substantial separation of one metalliferous constituent of the ore from another.

What we claim as our invention and desire to secure by Letters Patent is:—

1. The herein-described process of concentrating ores which consists in agitating

the ore with water containing mineral-frothing agent so as to yield a certain froth containing a fraction of the floatable minerals and removing the froth, agitating the pulp again with the addition of another agent which results in the production of another froth containing a second fraction of the floatable mineral and so on, substantially as described.

2. The herein-described process of concentrating ores which consists in agitating the ore pulp first with the addition merely of a mineral-frothing agent but without mineral acid and removing the froth, agitating the remaining pulp again with the addition of mineral acid as well as the mineral-frothing agent, removing the froth and thereafter agitating the pulp again with the addition of an oily substance such as oleic acid and removing the froth, and retreating each of the froths under differentiating conditions.

3. The herein-described process for concentrating ores which consists in treating the crushed ore by a flotation process two or more times under different conditions to obtain froths or scums having the constituents of each in certain ratios of size, and thereafter subjecting the powdered mixture contained in each froth to a classifying step to separate the constituents.

4. The herein described process of concentrating ores containing copper and zinc, which consists in mixing the ore pulp with a frothing agent and without acid and agitating it to produce a froth and removing the froth, then adding an acid to the remaining pulp and again agitating to produce a froth and removing the froth, then adding a different frothing agent to the remaining pulp and agitating to produce a froth and removing the froth.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

EDWARD HOIT NUTTER.
HENRY LAVERS.

Witnesses to the signature of Edward Hoit Nutter:

A. B. CLAUSS,
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Witnesses to the signature of Henry Lavers:

CHARLES NICHOLAS COLLISON,
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