

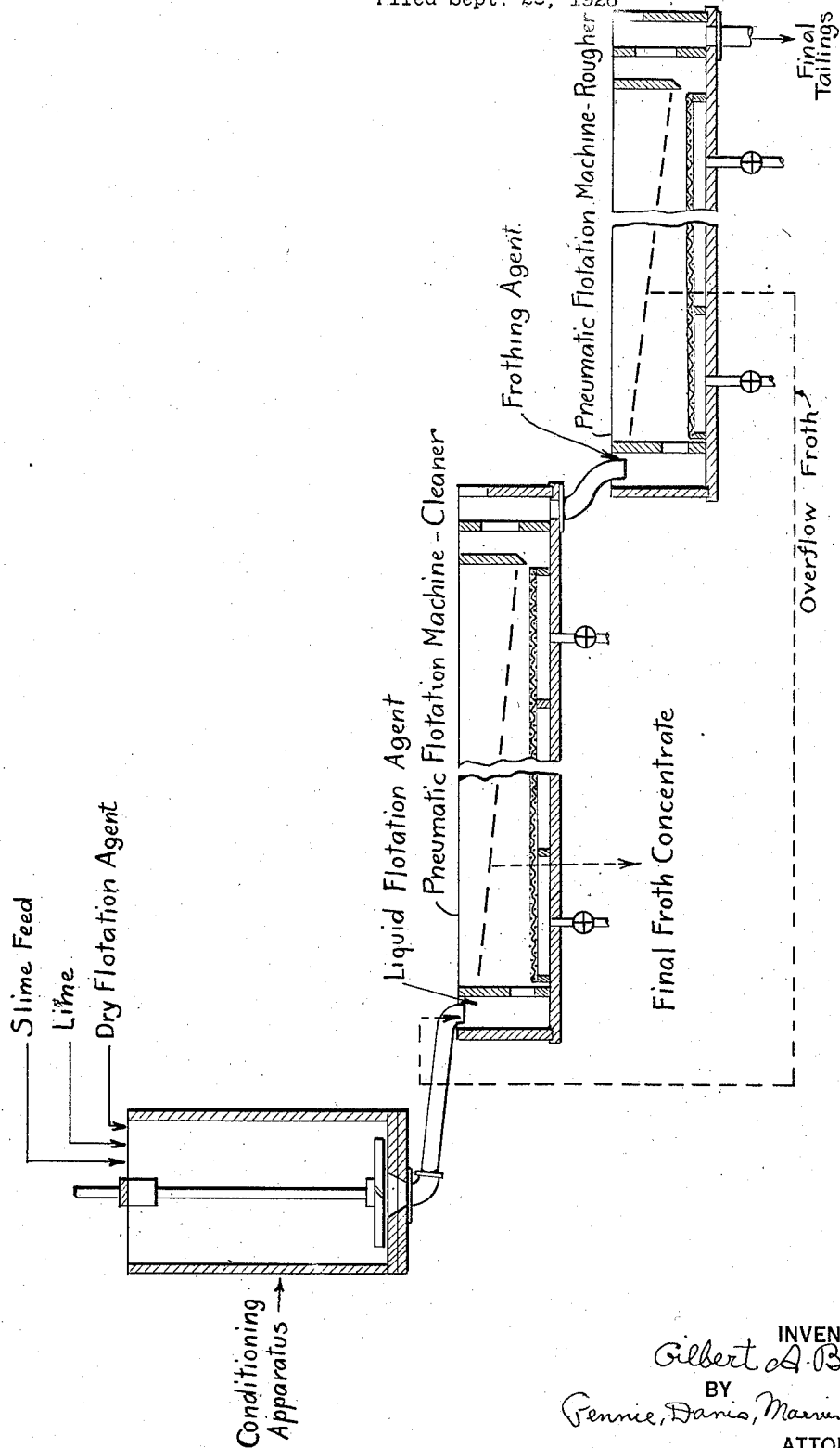
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CONCENTRATION OF SLIMES BY FLOTATION

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CONCENTRATION OF SLIMES BY FLOTATION.

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This invention relates to the concentration of slimes by flotation, and has for its object the provision of certain improvements in concentrating slimes by flotation.

5 In ore milling operations, it is frequently the practice to deslime an ore pulp in order to separate the very finely divided solid particles from coarser solid particles. The very fine particles often interfere with the
10 separative treatments to which coarser particles are amenable, and in such cases it is therefore advantageous to carry out the desliming operation. In general, it is customary to speak of that portion of the pulp containing the very fine ore particles and re-
15 sulting from the desliming operation as "slimes".

The desliming operation is ordinarily in the nature of a classifying treatment and the
20 slimes then usually contain approximately the same proportions of the mineral constituents as present in the ore pulp prior to desliming. The slimes, while amenable to flotation treatment, possess certain physical char-
25 acteristics that make the application of flotation concentration thereof difficult and in some instances uneconomical. Heretofore no entirely satisfactory method of concentrating slimes by flotation has been available.
30 This is more particularly true where attempts have been made to use the so-called non-oleaginous chemical flotation agents such as typified by thiocarbonyl and xanthate.

35 I have discovered that the flotation of slimes can be advantageously promoted by preagitation of the slimes with an alkaline agent such as lime. The conditioning action of the lime on the sulfide mineral particles in the slime appears to require both time and
40 vigorous agitation. This is probably due to the fact that the film coatings adsorbed on or otherwise attached to the sulfide mineral particles tenaciously adhere to the particles and are difficultly removed or otherwise con-
45 ditioned by the lime treatment. In practice, I have secured excellent results by vigorous mechanical agitation for a period of from 5 to 20 minutes.

50 As a result of my experiments and investigations, I have found that the conditioning of the slime by preagitation with lime is essential to the successful flotation of the slime with chemical flotation agents such as thio-
55 carbonyl and xanthate. After the condi-

tioning of the slime with lime has been completed, the mineral-collecting agent such as thiocarbonyl or xanthate and the frothing agent, such as pine oil, are added to the slime and the flotation operation is then conducted
60 in pneumatic flotation apparatus, such, for example, as the Callow or subaeration machines.

In addition to the conditioning treatment, I have found it essential, using chemical re-
65 agents, to conduct the flotation operation in machines giving a relatively high degree of aeration. This appears to be due to the fact that more air is required in the flotation of the slime, using chemical reagents, than
70 is available in flotation machines of the mechanical agitation type. I prefer to carry out the flotation operation in pneumatic machines, but satisfactory results can be ob-
75 tained in other types of flotation machines that give, inherently or as a result of modified conditions of operation, the necessary high degree of aeration.

I will describe my present preferred practice of the invention as applied to Anaconda
80 slimes. In the milling of Anaconda copper ores, the ore is first subjected to coarse crushing and is then jigged to separate a finished concentrate and a tailing. The tail-
85 ing is subjected to further grinding and the ground tailings are then classified or deslimed in appropriate classifiers, the overflow of the classifiers constituting the slimes to which my present invention relates. The
90 slimes contain about 3 to 4% copper. From 90 to 95% of the solid particles in the slime will be through 200 mesh, while less than one percent will be on 100 mesh, the remain-
95 ing 4 to 9% being between 100 and 200 mesh. The slime usually contains from 10 to 14% solids.

The single figure of the accompanying drawing diagrammatically illustrates my present preferred arrangement of apparatus for practicing the invention. The
100 drawing will be understood by the legends thereon taken in conjunction with the following description.

The slime is conducted in any appropriate manner to the conditioning apparatus or
105 preagitators. This apparatus may advantageously consist of four agitation compartments of a standard minerals separation machine. The spitzkastens belonging to these agitation compartments may be blocked
110

off, or removed. The slime flows through the four agitation compartments in series. Narrow vertical baffles just submerged in the slime prevent it from whirling with the agitators and vortexing in each agitation compartment. The reason for preventing the vortexing is that it lowers the volume of pulp being agitated in each compartment and consequently lessens the time of agitation. The agitation compartments are about three feet square and the pulp is about three feet deep in each compartment. Each compartment of the conditioning apparatus is provided with the usual cruciform agitator 24 inches in diameter and rotating at 240 R. P. M. Lime and thiocarbanilid are added to the slime as it flows into the first cell or compartment of the pre-agitator. Each compartment of the pre-agitator has a conditioning capacity of about 12 tons of slime per 24 hours. Where more than about 12 tons of slime per 24 hours are put through each compartment or cell of the pre-agitator, the copper content of the final tailings increases, whereas when 12 tons or less per 24 hours per cell or compartment are treated the copper content of the tailings is not materially lowered. This rate of flow of the slimes through the pre-agitator gives about 15 minutes preagitation of the slime with the lime.

I have found that the temperature of the slime should be around 70° F. for the best results in the subsequent flotation operation. Where the temperature of the slime as fed to the preagitators is substantially less than 70° F., I prefer to heat the slime as, for example, by introducing steam into the first cell or compartment of the preagitator in amount sufficient to raise the temperature of the slime to about 70° F. Any other convenient means may, of course, be employed for regulating the temperature of the slime to give the optimum results in the flotation operation.

The conditioned slime is now conducted to pneumatic flotation apparatus. In my present preferred practice, this apparatus consists of two Callow flotation machines arranged to operate as a cleaner and a rougher respectively. The slime first enters the cleaner and a finished froth concentrate is taken off this machine. The tailings from the cleaner constitute the feed of the rougher. The overflow froth from the rougher joins the original slime feed to the cleaner and the pulp discharged from the rougher may be sent to waste as final tailings. A mixture of thiocarbanilid and orthotoluidin (the so-called T—T mixture containing approximately 20% of thiocarbanilid) is added to the slime feed as it drops into the cleaner. A frothing agent, such as steam-distilled pine oil, is added to the pulp discharging from the cleaner and going into the rougher. The following specific figures are given

by way of example to illustrate the foregoing preferred practice of the invention with Anaconda slimes. In the conditioning operation, about 10 pounds of lime and about 0.25 pounds of thiocarbanilid are used per ton of solids in the slime. About 0.50 pounds of the T—T mixture per ton of solids is added to the slime feed to the cleaner or initial flotation machine and about 0.06 pounds of steam distilled pine oil per ton of solids is added to the feed to the rougher or secondary flotation machine. The original slime assayed 3.06% copper, of which 0.30% was oxidized copper. The final concentrate assayed 14.86% copper and 33.3% insoluble. The final tailings assayed 0.30% copper, of which 0.19% was oxidized copper. The tailings from the cleaner or primary flotation machine assayed 0.80% copper.

During another run on Anaconda slimes, assaying 3.21% copper of which 0.40% was oxidized copper, the final concentrate assayed 15.35% copper and 36.50% insoluble, and the final tailings assayed 0.37% copper of which 0.23% was oxidized copper. In this run 10.8 pounds of lime, 0.36 pounds of thiocarbanilid, 0.52 pounds of T—T mixture and 0.01 pounds of No. 5 steam-distilled pine oil were used per ton of solids in the slime.

Where potassium or sodium xanthate is used as the mineral-collecting agent, good results have been secured with about 7 pounds of lime, 0.8 pounds of the xanthate, 0.04 pounds of steam-distilled pine oil and 0.16 pounds of No. 11 crude pine oil per ton of solids in the slime. Xanthate is dissolved in water and the solution added to the later cells or compartments of the pre-agitator. The steam-distilled pine oil is added to the secondary flotation feed and the No. 11 crude pine oil to the primary flotation feed. With a slime feed assaying 4.24% copper a final concentrate assaying 14.97% copper was obtained. The final tailings contained 0.26% copper (0.19% oxidized copper).

As a result of my experiments and investigations, I have found that ore slimes, such as Anaconda slimes, can not be satisfactorily concentrated by flotation in machines of the agitation froth type as ordinarily operated using chemical mineral-collecting agents such as thiocarbanilid and xanthate. I have moreover found that such slimes, using chemical mineral-collecting agents, cannot be satisfactorily concentrated by flotation in pneumatic flotation machines, in the absence of the conditioning treatment hereinbefore prescribed. My investigations have indicated that both agitation and aeration are essential for the successful treatment by flotation of ore slimes when using chemical mineral-collecting agents.

Anaconda slimes have heretofore been concentrated by flotation in standard min-

erals separation machines using kerosene acid sludge and sulfuric acid. My present invention provides an improved method of treating these slimes by flotation in which use may be made of chemical mineral-collecting agents whereby a higher grade of concentrate and lower tailings are obtained. In its broad aspect the present invention involves the combination of three features namely, (1) conditioning of the slime by preagitation with lime (2) pneumatic flotation of the conditioned slime in (3) the presence of a non-oleaginous mineral-collecting agent.

By chemical mineral-collecting agent, I mean a non-oleaginous organic mineral-collecting agent such as typified by thiocarbamilid, potassium or sodium xanthate, diazo-amino-benzene, and the like:

I am aware that ores have been ground with lime, preparatory to flotation in pneumatic or other apparatus. Such grinding operation is necessary to comminute the ore to flotatable size. The comminution of the ore exposes fresh ore surfaces and the desired action of the lime is thereby promoted. The solid particles in an ore slime to which my invention relates are for the most part of a size that will pass through a 200 mesh screen, and by "most part" I mean 70% or more, of the total solids present in the slime, while the solid particles that will remain on a 100 mesh screen will be relatively small, usually less than 5% of the total solids in the slime. The solid particles in an ore slime are, therefore, already as finely comminuted as practicable, and there is, accordingly, no occasion to subject the slime to a grinding operation, and the violent agitation to which the slime is subjected in the conditioning treatment of the invention does not involve any substantial comminution of the ore particles in the slime.

I claim:

1. The improvement in the treatment by flotation of ore slimes in which the solid particles are for the most part of a size that will pass through 200 mesh which comprises subjecting the slime to violent agitation with lime for a sufficient length of time to condition the sulfide minerals in the slime for subsequent flotation, and then subjecting the so-conditioned slime to a pneumatic flotation operation in the presence of a non-oleaginous mineral-collecting agent.

2. The improvement in the treatment by flotation of ore slimes in which the solid particles are for the most part of a size that will pass through 200 mesh, which comprises subjecting the slime to violent agitation with lime for a sufficient length of time to condition the sulfide minerals in the slime for subsequent flotation, a part at least of said conditioning treatment being carried out in the presence of a non-oleaginous min-

eral-collecting agent, and then subjecting the so-conditioned slime to a pneumatic flotation operation in the presence of a non-oleaginous mineral-collecting agent.

3. The improvement in the treatment by flotation of ore slimes in which the solid particles are for the most part of a size that will pass through 200 mesh, which comprises subjecting the slime to violent agitation with lime for a sufficient length of time to condition the sulfide minerals in the slime for subsequent flotation, subjecting the so-conditioned slime to an initial pneumatic flotation operation in the presence of a non-oleaginous mineral-collecting agent and thereby obtaining a final froth concentrate, subjecting the tailings from said initial flotation operation to a secondary pneumatic flotation operation, and retreating the froth overflow from said secondary flotation operation in said initial flotation operation.

4. The improvement in the treatment by flotation of ore slimes in which the solid particles are for the most part of a size that will pass through 200 mesh, which comprises subjecting the slime to violent agitation with lime for a sufficient length of time to condition the sulfide minerals in the slime for subsequent flotation, a part at least of said conditioning treatment being carried out in the presence of a non-oleaginous mineral-collecting agent, subjecting the so-conditioned slime to an initial pneumatic flotation operation in the presence of a non-oleaginous mineral-collecting agent and thereby obtaining a final froth concentrate, subjecting the tailings from said initial flotation operation to a secondary pneumatic flotation operation, and retreating the froth overflow from said secondary flotation operation in said initial flotation operation.

5. The improvement in the treatment by flotation of ore slimes in which the solid particles are for the most part of a size that will pass through 200 mesh, which comprises subjecting the slime to violent agitation with lime for a sufficient length of time to condition the sulfide minerals in the slime for subsequent flotation, subjecting the so-conditioned slime to an initial pneumatic flotation operation in the presence of a non-oleaginous mineral-collecting agent and thereby obtaining a final froth concentrate, subjecting the tailings from said initial flotation operation together with an added frothing agent to a secondary pneumatic flotation operation, and retreating the froth overflow from said secondary flotation operation in said initial flotation operation.

6. The improvement in the treatment by flotation of ore slimes in which the solid particles are for the most part of a size that will pass through 200 mesh, which comprises subjecting the slime to violent agitation with lime for a sufficient length of time to condi-

tion the sulfide minerals in the slime for subsequent flotation, a part at least of said conditioning treatment being carried out in the presence of a non-oleaginous mineral-
 5 collecting agent, subjecting the so-conditioned slime to an initial pneumatic flotation operation in the presence of a non-oleaginous mineral-collecting agent and thereby obtaining a final froth concentrate, subjecting the
 10 tailings from said initial flotation operation together with an added frothing agent to a secondary pneumatic flotation operation, and re-treating the froth overflow from said secondary flotation operation in said initial
 15 flotation operation.

7. The improvement in the treatment by flotation of ore slimes in which the solid particles are for the most part of a size that will pass through 200 mesh, which comprises
 20 subjecting the slime to violent agitation with lime for a sufficient length of time to condition the sulfide minerals in the slime for subsequent flotation, a part at least of said conditioning treatment being carried out in the presence of thiocarbanilid, and then sub-
 25 jecting the so-conditioned slime to a pneumatic flotation operation in the presence of thiocarbanilid and orthotoluidin.

8. The improvement in the treatment by
 30 flotation of ore slimes in which the solid particles are for the most part of a size that will pass through 200 mesh, which comprises subjecting the slime to violent agitation with lime for a sufficient length of time to condi-
 35 tion the sulfide minerals in the slime for subsequent flotation, a part at least of said conditioning treatment being carried out in the presence of thiocarbanilid, subjecting the so-conditioned slime to an initial pneumatic
 40 flotation operation in the presence of thiocarbanilid and orthotoluidin and thereby obtaining a final froth concentrate, subjecting the tailings from said initial flotation
 45 operation to a secondary pneumatic flotation operation, and re-treating the froth overflow from said secondary flotation operation in said initial flotation operation.

9. The improvement in the treatment by

flotation of ore slimes in which the solid particles are for the most part of a size that
 50 will pass through 200 mesh, which comprises subjecting the slime to violent agitation with lime for a sufficient length of time to condition the sulfide minerals in the slime for sub-
 55 sequent flotation, a part at least of said conditioning treatment being carried out in the presence of thiocarbanilid, subjecting the so-conditioned slime to an initial pneumatic
 60 flotation operation in the presence of thiocarbanilid and orthotoluidin and thereby obtaining a final froth concentrate, subjecting the tailings from said initial flotation oper-
 65 ation together with an added frothing agent to a secondary pneumatic flotation operation, and re-treating the froth overflow from said secondary flotation operation in said
 70 initial flotation operation.

10. The improvement in the treatment by flotation of ore slimes in which the solid particles are for the most part of a size that
 70 will pass through 200 mesh, which comprises subjecting the slime to violent agitation with lime for a sufficient length of time to condition the sulfide minerals in the slime for sub-
 75 sequent flotation, and then subjecting the so-conditioned slime in the presence of a non-oleaginous mineral-collecting agent to a flotation operation giving a relatively high degree of
 80 aeration.

11. The improvement in the treatment by
 80 flotation of ore slimes in which the solid particles are for the most part of a size that will pass through 200 mesh, which comprises subjecting the slime to violent agitation with
 85 lime for a sufficient length of time to condition the sulfide minerals in the slime for subsequent flotation, a part at least of said conditioning treatment being carried out in the presence of a non-oleaginous mineral-collect-
 90 ing agent, and then subjecting the so-conditioned slime in the presence of a non-oleaginous mineral-collecting agent to a flotation operation giving a relatively high degree of
 95 aeration.

In testimony whereof I affix my signature.
 GILBERT A. BRAGG.