

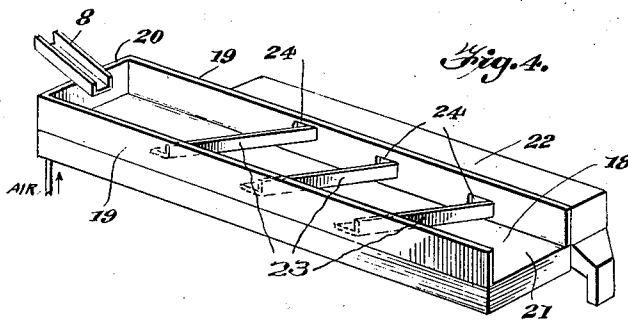
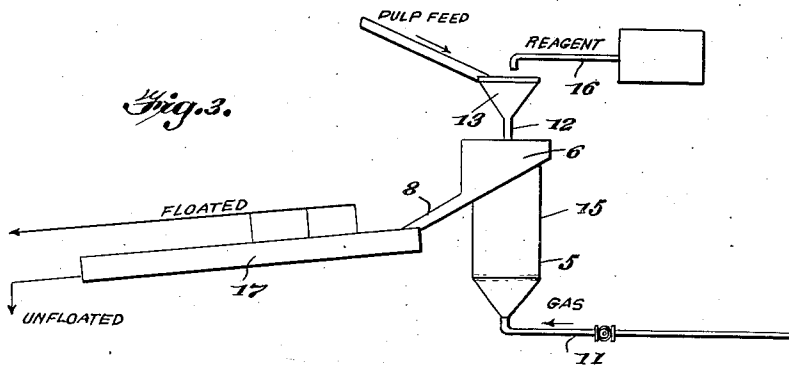
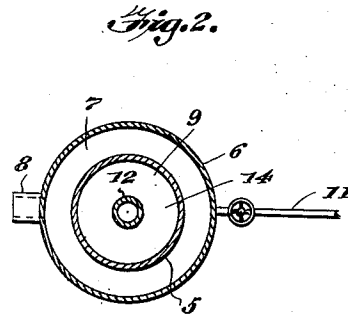
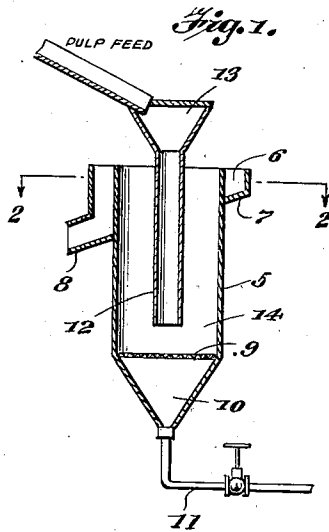
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2,330,875

METHOD FOR MIXING AND CONDITIONING PULP

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2,330,875

METHOD FOR MIXING AND CONDITIONING PULP

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Original application August 10, 1938, Serial No. 224,209, now Patent 2,267,496, dated December 23, 1941. Divided and this application November 19, 1941, Serial No. 419,786

8 Claims. (Cl. 209—8)

The present application is in part a division and in part a continuation of our copending application for Method for pneumatic flotation, Serial No. 224,209, filed August 10, 1938.

This application relates to apparatus and method for treating fluid pulps, the term "pulp" being used herein to define a mixture of solid particles with a liquid medium.

The method and apparatus of the present invention are intended primarily for forming pulps and subjecting the formed pulp to such physical treatment as causes a thorough circulation of the fluid medium of the pulp through and among the particles.

The apparatus and method of the invention are particularly adapted for treating certain types of mineral pulps made from ores, prior to subjecting them to a flotation process that permits separation of certain particle constituents of the pulp from others. In such processes it is necessary to treat the pulp with selective flotation agents which have preferential affinity for certain of the particles of the pulp and so affect such particles that separation subsequently can be effected. It is highly important that such flotation reagents be thoroughly dispersed throughout the pulp, so that it is brought into intimate contact with substantially all of the particles thereof. Such mixing of the pulp with the flotation reagents generally is designated "conditioning," and is an example of the intimate and thorough type of mixing that the method and apparatus of this invention are capable of performing.

Heretofore such mixing or conditioning of the pulp commonly has been performed by means of more or less violent agitation in machines of the impeller or tumbler type, which operate by agitating the entire body of pulp, including the solid particles. In such machines, the thoroughness of the circulation of the fluid medium through and among the solid particles of the pulp depends upon the violence of the agitation and the length of the period during which agitation is continued. In certain processes violent agitation is detrimental. Thus, in the conditioning of the fines rejected by phosphate washery plants employed to separate the larger phosphate particles from the raw phosphate rock, which fines are known as "phosphate debris," or "recovery plant feed," with soaps of fatty acids for flotation of the phosphate particles, a process well known in the phosphate industry, violent agitation tends to break down soft material that normally is present in the debris, and to form a certain amount of slimes. The presence of such slimes interferes

with the action of the flotation reagent and involves loss of both reagent and concentrates. Agitation may also destroy the effect of flotation reagents, as where the reagent forms coatings that are weakly bonded to certain of the particles, which weakly bonded coatings may be destroyed and dispelled when the pulp is agitated.

In most fields of mixing pulps it is highly desirable that the process be carried on continuously rather than in batches. In certain processes speed is essential, for example, the effect of certain reagents is fugitive and does not exist for a period sufficiently long to survive lengthy mixing even when accomplished with a minimum of agitation.

One of the applicants herein has discovered that certain flotation reagents of the so-called "cationic" type have preferential affinity for quartz sand over phosphate particles. Certain of these reagents exhibit this preferential affinity for quartz only when the proportion of reagent is rigidly restricted to such limits that the quartz particles are weakly and temporarily affected. Therefore, when using such reagents it is important that the entire conditioning procedure be carried out quickly and also with a minimum of agitation. Other cationic reagents which may have a more powerfully selective affinity for quartz, and which may therefore be used in larger quantities to provide a more lasting and less easily disrupted effect, are, for reasons of economy, preferably restricted to such proportions as give the more temporary and fragile effect.

The present method and apparatus are capable, among other uses, of conditioning fluid pulps of phosphate debris without harmful effect; resulting either from the breaking down of constituents of the pulp, as when soaps of fatty acids are used to render the phosphate particles floatable; or by such agitation or lapse of time, or by both agitation and lapse of time, as will destroy the effect of the reagent, as when cationic reagents are used to condition the quartz sand for flotation.

The above fields of usefulness are given solely by way of example, and the herein described method and apparatus may be used in any process where thorough mixing of a fluid pulp is to be accomplished continuously, and more especially where such mixing is to be accomplished with a minimum of agitation of the solid particles, or where such agitation should be carried out at high speed.

More specifically, the present invention involves

an apparatus and method for thoroughly, rapidly and continuously mixing a flowing stream of fluid pulp without subjecting it to violent agitation such as would be detrimental thereto. In obtaining such mixing the pulp is substantially continuously introduced into a quietly flowing body of the pulp, preferably at one end thereof, and continuously withdrawn therefrom, while simultaneously disseminating fine streams of gas bubbles throughout the body of pulp in a volume sufficient to cause a thorough circulation of the fluid medium without violent agitation of the solid constituents.

The method of mixing and conditioning pulp will be further described in connection with the accompanying drawing which shows a preferred form of apparatus in which the mixing and conditioning may be carried out. However, it is to be understood that such further description of the apparatus and method is merely by way of exemplification and that the invention is not limited thereto, except to the extent defined in the appended claims.

In the accompanying drawing:

Fig. 1 is a vertical median sectional view of a mixing or conditioning device constructed in accordance with the invention;

Fig. 2 is a horizontal section on line 2-2 of Fig. 1;

Fig. 3 is a diagrammatic view of a conditioning and separating plant embodying the mixer and arranged in a novel manner for effecting certain specialized processes; and

Fig. 4 is a perspective view of a flotation device that is peculiarly useful in combination with the mixer.

Referring now to the drawing, the mixer comprises an outer, vertically-disposed, substantially cylindrical container or shell 5 having an open top surrounded by an overflow trough 6 formed with an inclined bottom 7 arranged to deliver liquid in the trough to an outlet spout 8 arranged at the lowermost point of the bottom 7. The lower end of the shell 5 is closed by a porous bottom 9, which may be of canvas or of any other material that will permit gas to pass therethrough in finely disseminated streams. A gas chamber 10 is arranged beneath the shell 5 so that gas introduced into it under suitable pressure, as by a valved connection 11, will be delivered to the interior of the shell through the porous bottom 9 in fine streams distributed throughout the cross sectional area of the shell.

An induction pipe 12 is arranged to receive pulp delivered to a hopper 13 at a level higher than the top edge of the shell 5 and to conduct it to the lower portion of the shell. Advantageously the induction pipe 12 is cylindrical and located centrally of the shell 5, so that an annular space 14 is formed between the inner surface of the shell and the outer surface of the induction pipe 12. However, the essential arrangement of the induction pipe relative to the shell is that its bottom edge be adjacent but spaced from the bottom 9 of the shell, and that sufficient space be present within the shell and outside of the pipe for upward flow of the stream of pulp in a smooth, non-turbulent manner.

In operation the fluid pulp is continuously fed to the hopper 13 from which it flows downwardly through the pipe 12 and is delivered to the space 14 through which it flows upwardly in a gently and quietly flowing stream until it overflows at the top of the shell 5 into the delivery trough 6. Gas is continuously supplied to the chamber 10

under sufficient pressure to cause it to pass through the porous bottom 9 and into the stream of pulp, where it forms fine bubbles that rise in the flowing pulp stream and causes the liquid medium of the pulp to circulate among the solid particles and causes a thorough dispersion and mixture of the fluid medium among such particles.

The phosphate debris which remains after crude phosphate pebble ore has been subjected to washing and classifying operations has a free slime content of about 0.5% to 5.0% by weight and a particle size ranging substantially from plus 100 mesh to minus 20 mesh. Phosphate rock is present in such debris to the extent of about 15-35%, and quartz sand to the extent of about 80-50%. There is also usually some clay present both as particles, and adhering to the other particles in the nature of coatings.

As indicated above, and as is commonly known, the phosphate particles may be floated from the quartz by use of anionic reagents, such as soaps of fatty acids, which ordinarily are used with inert oily materials to promote agglomeration. In such cases the debris may be used as it comes from the washery. As is also indicated above, cationic reagents may be used to render the quartz sand particles floatable from the phosphate. In such case, it is advisable to break down the easily slimable material, such as clay or other soft substance present in the debris, and remove it from the debris prior to adding the flotation reagent, as such materials interfere very seriously with the action of the flotation reagent.

Fig. 3 illustrates a plant including the above-described mixer which is peculiarly suited for recovery of the phosphate content of phosphate debris. The debris is fed to the mixer, designated 15, in the form of a fluid pulp, a water content of about 40% producing a suitable degree of fluidity. The flotation reagent, of either cationic or anionic type, together with the inert oily material, if the latter is used, and any other desirable reagent is added to the pulp from a feeder, advantageously arranged to deliver to the hopper 13 into which the pulp is fed. As the pulp, after passing downwardly through the induction pipe 12, flows upwardly through the space 14, gas bubbles rising from the porous bottom 9 gently agitate the fluid medium of the pulp, causing such medium, and with it the reagent, to circulate through the pulp and flow between the solid particles thereof, dispersing the reagent thoroughly throughout the flowing pulp stream and bringing the reagent into contact with substantially every solid particle. As the rising gas bubbles move quite gently and are of small weight compared with the solid particles, they tend to pass around the particles without moving them violently or to any great degree. The particles therefore are not agitated with sufficient violence to set up attrition between them, and consequently harmful effects that may be caused by attrition, such as breaking or abrasion of the particles, or dispelling of reagent coatings from them, are substantially avoided.

The speed of the pulp stream is so related to the height of the shell 5 of the mixer and the rate of admission of air bubbles through the porous bottom 9 that just sufficient time for complete mixture and action of the reagent elapses during the upward travel of the pulp. When the top of the shell is reached the pulp, being then thoroughly conditioned, overflows into the trough 6 and is delivered by the spout 8 to a separation device 17, which may be of any

suitable type for the particular separation being performed. When a cationic reagent is being employed to float quartz, separation preferably is accomplished by the method and apparatus disclosed in our aforesaid application Serial No. 224,209, as it permits a very high speed separation with absence of vibration, and provides a very high capacity. Briefly, the method of that application comprises flowing the conditioned pulp in a shallow stream through a narrow trough, such as is disclosed in Fig. 4, having a canvas or other porous bottom 18, side walls 19, a head wall 20 and an open delivery end 21. The trough is inclined from the head to the delivery end at a degree that provides a rapid flow of the pulp and that prevents sedimentation thereof upon the porous bottom. A gas chamber enclosed by walls 22 underlies the porous bottom so that gas supplied thereto under suitable pressure will pass upwardly into the stream of pulp flowing through the trough in finely divided streams that rise in the stream of pulp by reason of their own buoyancy. The water-repellent particles that have been affected by the selective reagent used to condition the pulp are raised to the upper portions of the stream by the air bubbles, while the unaffected, water-wettable particles sink and are carried along in the lower portion of the stream. The upper portion of the stream, containing the bulk of the reagent-affected particles, together with any froth that may be floating on the surface of the stream, are intercepted and diverted from the stream through openings 24 to a delivery launder 22 by skimmers 23 spaced along the trough.

It will be seen that in the plant arrangement just described, the fast and gentle action of the mixer is continued by the particular separation trough disclosed in Fig. 4, so that the entire process is continuous, free from agitation and of such nature as to produce no violent agitation or attrition between the solid particles of the pulp, and is also very fast.

In utilizing cationic reagents, we regard it as preferable to so control the speed of the pulp stream with relation to the depth of the shell of the mixer, and to so arrange the inclination of the separation trough that the entire process of mixing and conditioning the pulp and separating the constituents thereof is completed within one minute from the introduction of the pulp to the hopper of the mixer. By inclining the separating trough to such a degree that the speed of the flow through it is of the order of 100 feet per minute the separation may be accomplished in about five seconds from the delivery of the pulp to the trough. Thorough conditioning may be accomplished by use of the bubble type mixing herein disclosed within a period of about 45 seconds, which period is of such length that at its expiration the cationic reagent will be fully effective.

What we claim is:

1. The method of dispersing a flotation reagent throughout a pulp of solid particles and a liquid medium, preparatory to selective separation of constituents forming the solid particles of the pulp, which comprises introducing the pulp and the reagent to be dispersed therein into a mixing zone in which pulp is flowing upwardly, introducing finely disseminated gas bubbles to pass upwardly through the body of pulp in the mixing zone at a speed greater than the upward speed of the pulp and in sufficient volume to keep the solid particles of the pulp in suspension and

to cause an upward movement of the liquid medium between and about the solid particles of the pulp so that the reagent is substantially uniformly dispersed throughout the body of pulp and is brought into contact with the solid particles thereof, the volume of air being insufficient to agitate the solid particles of the pulp with sufficient violence to cause attrition between them, such as would cause appreciable breaking or abrasion of the particles, or an appreciable dispelling of reagent coatings from them, and removing the pulp and dispersed reagent as an unseparated, intimate mixture from the upper portion of the body of the pulp.

2. The method of dispersing a flotation reagent throughout a pulp of solid particles and a liquid medium, preparatory to selective separation of constituents forming the solid particles of the pulp, which comprises substantially continuously introducing the pulp and the reagent to be dispersed therein into the lower portion of a quietly flowing body of the pulp, introducing finely disseminated gas bubbles to pass upwardly through the flowing body of pulp in sufficient volume to keep the solid particles of the pulp in suspension and to cause an upward movement of the liquid medium between and about the solid particles of the pulp so that the reagent is substantially uniformly dispersed throughout the flowing body of pulp and is brought into contact with the solid particles thereof, the volume of air being insufficient to agitate the solid particles of the pulp with sufficient violence to cause attrition between them, such as would cause appreciable breaking or abrasion of the particles, or an appreciable dispelling of reagent coatings from them, and substantially continuously removing the pulp and dispersed reagent as an unseparated, intimate mixture from the upper portion of the body of pulp at a rate substantially equal to that at which the pulp was introduced.

3. The method of dispersing a flotation reagent throughout a pulp of solid particles and a liquid medium, preparatory to selective separation of constituents forming the solid particles of the pulp, which comprises introducing the pulp and the reagent to be dispersed therein into a quietly flowing body of the pulp, introducing finely disseminated gas bubbles to pass upwardly through the quietly flowing body of the pulp in sufficient volume to keep the solid particles of the pulp in suspension and to cause an upward movement of the liquid medium between and about the solid particles of the pulp so that the reagent is substantially uniformly dispersed throughout the flowing body of pulp and is brought into contact with the solid particles thereof, the volume of air being insufficient to agitate the solid particles of the pulp with sufficient violence to cause attrition between them, such as would cause appreciable breaking or abrasion of the particles or an appreciable dispelling of reagent coatings from them, and substantially continuously removing the pulp and dispersed reagent as an unseparated, intimate mixture.

4. The method of dispersing a flotation reagent throughout a pulp of phosphate debris and a liquid medium, preparatory to selective separation of constituents forming the phosphate debris, which comprises introducing the pulp and the reagent to be dispersed therein into a quietly flowing body of pulp, introducing finely disseminated gas bubbles to pass upwardly through the body of pulp in sufficient volume to keep the par-

ticles of the phosphate debris of the pulp in suspension and to cause upward movement of the liquid medium about the particles of the phosphate debris so that the reagent is substantially uniformly dispersed throughout the flowing body of the pulp and is brought into contact with the particles of the phosphate debris, the volume of air being insufficient to agitate the particles of the phosphate debris of the pulp with sufficient violence to cause attrition between them, such as would cause appreciable breaking or abrasion of such particles, or an appreciable dispelling of reagent coatings from them, and substantially continuously removing the pulp and dispersed reagent as an unseparated, intimate mixture.

5. The method of dispersing a selective flotation reagent throughout a pulp of phosphate debris and a liquid medium, preparatory to selective separation of constituents of the phosphate debris which comprises introducing the pulp and the reagent to be dispersed therein into a quietly flowing body of the pulp, introducing finely disseminated gas bubbles to pass upwardly through the body of the pulp in sufficient volume to keep the particles of the phosphate debris in suspension and to cause an upward movement of the liquid medium between and about them so that the reagent is substantially uniformly dispersed throughout the flowing body of the pulp and is brought into contact with the particles of the phosphate debris, the volume of air being insufficient to agitate the particles of the phosphate debris with sufficient violence to cause attrition between them, such as would cause appreciable breaking or abrasion of the particles, or an appreciable dispelling of reagent coatings from them, and substantially continuously removing the pulp and dispersed reagent as an unseparated, intimate mixture at a rate substantially equal to that at which the pulp and reagent were introduced into the body of pulp.

6. The method of dispersing a flotation reagent throughout a pulp of phosphate debris and a liquid medium, preparatory to selective separation of constituents of the phosphate debris, which comprises substantially continuously introducing the pulp and the reagent to be dispersed therein into the lower portion of a mixing zone in which the pulp is flowing upwardly, introducing finely disseminated gas bubbles to pass upwardly through the body of pulp in the mixing zone at a speed greater than the upward speed of the pulp and in sufficient volume to keep the phosphate debris particles thereof in suspension and to cause an upward movement of the liquid medium between and about the particles of the phosphate debris so that the reagent is substantially uniformly dispersed throughout the body of pulp and is brought into contact with the particles of the phosphate debris, the volume of air being insufficient to agitate the particles of the phosphate debris with sufficient violence to cause attrition between them, such as would cause appreciable breaking or abrasion of the particles, or an appreciable dispelling of reagent coatings from them, and substantially continuously removing the pulp and dispersed reagent as an unseparated, intimate mixture from the upper portion of said mixing zone at a rate substantially

equal to that at which the pulp and reagent are introduced into the lower portion of the mixing zone, the rate of introduction and withdrawal of the pulp from said body being such that introduced pulp remains in said body for a period of time not substantially exceeding one minute.

7. The method of dispersing a flotation reagent throughout a pulp of phosphate debris and a liquid medium, preparatory to selective separation of constituents forming the solid particles of the pulp, which comprises substantially continuously introducing the pulp and a selective flotation reagent which has a preferential affinity for quartz sand over phosphate particles and forms weakly bonded coatings thereon into the lower portion of a quietly flowing body of such pulp, introducing finely disseminated gas bubbles to pass upwardly through the quietly flowing body of pulp in sufficient volume to keep the particles of phosphate debris of the pulp in suspension and to cause an upward movement of the liquid medium between and about the particles of the phosphate debris so that the reagent is substantially uniformly dispersed throughout the body of pulp and is brought into contact with the particles of the phosphate debris, the volume of air being insufficient to agitate the particles of phosphate debris with sufficient violence to cause attrition between them, such as would cause appreciable breaking or abrasion of the particles, or an appreciable dispelling of liquid coatings from them, and substantially continuously removing the pulp and dispersed reagent as an unseparated, intimate mixture from the upper portion of the body of pulp at a rate substantially equal to that at which the pulp and reagent are introduced into the lower portion thereof, the rate of introduction and withdrawal of pulp from the mixing zone being such that introduced pulp remains in said body for a period of time not substantially exceeding one minute.

8. The method of dispersing a flotation reagent throughout a pulp of solid particles and a liquid medium preparatory to selective separation of constituents forming the solid particles of the pulp, which comprises introducing the pulp and the reagent to be dispersed therein into the quietly flowing body of the pulp, introducing finely disseminated gas bubbles throughout substantially the entire cross-sectional area of the body of pulp in the mixing zone in sufficient volume to keep the solid particles of the pulp in suspension and to cause a circulation of the liquid medium between and about the solid particles of the pulp so that the reagent is substantially uniformly dispersed throughout the body of pulp and is brought into contact with the solid particles thereof, the volume of air being insufficient to agitate the solid particles of the pulp with sufficient violence to cause attrition between them, such as would cause appreciable breaking or abrasion of the particles, or an appreciable dispelling of reagent coatings from them, and substantially continuously removing the pulp and dispersed reagent as an unseparated, intimate mixture.

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