Oct. 4, 1949. E. W. GIESEKE 2,483,970

FLOTATION OF BARITE ORES

Filed Aug. 22, 1945 2 Sheets-Sheet 1

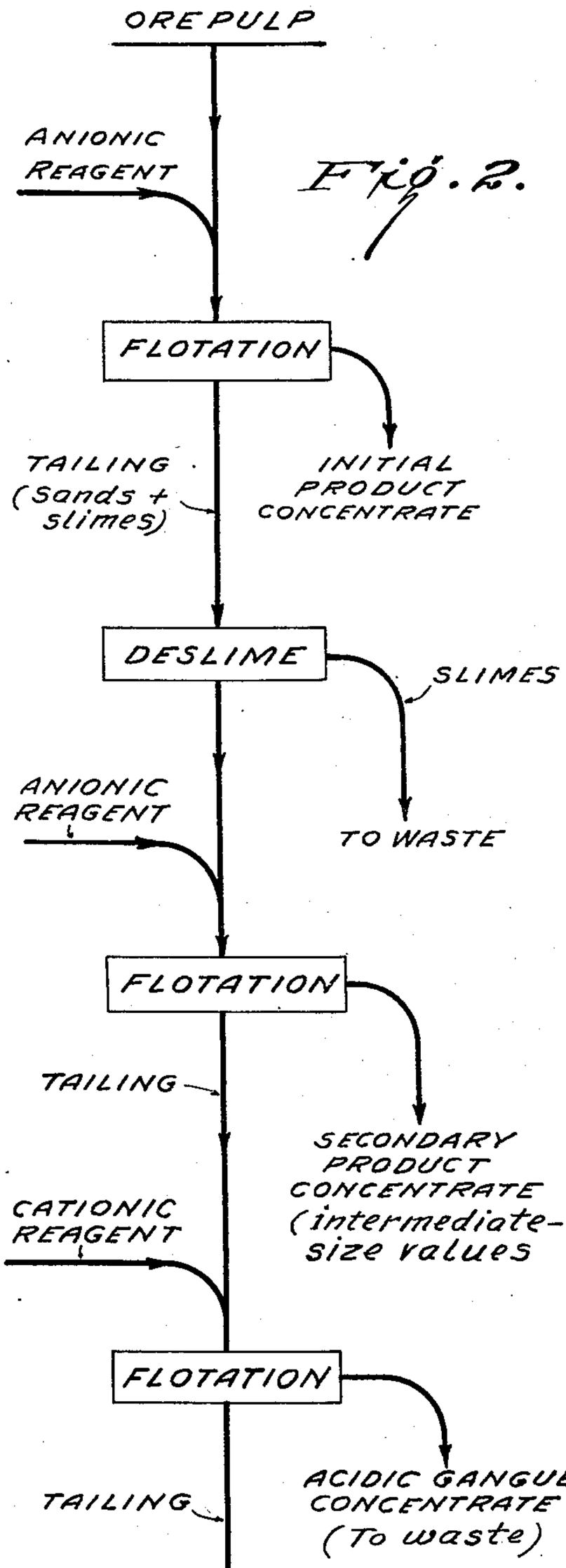

Fig. 2.

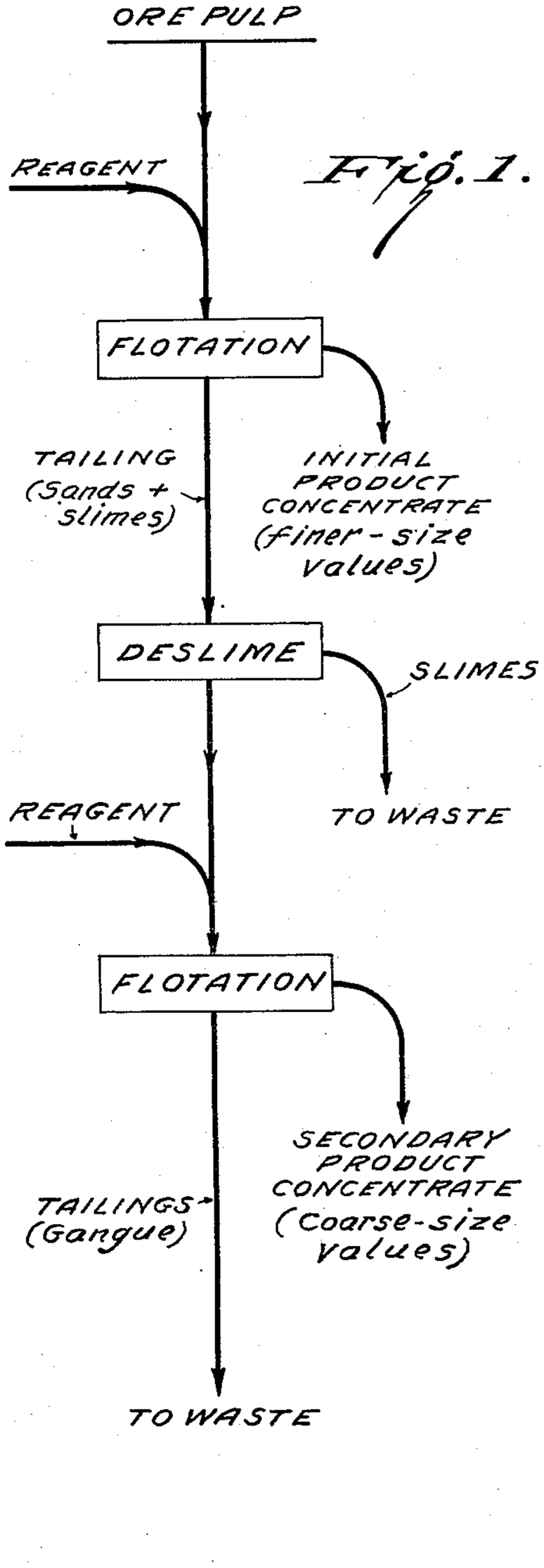

Fig. 1.

INVENTOR
ELMER W. GIESEKE,
Elmer W. Harmon
ATTORNEY

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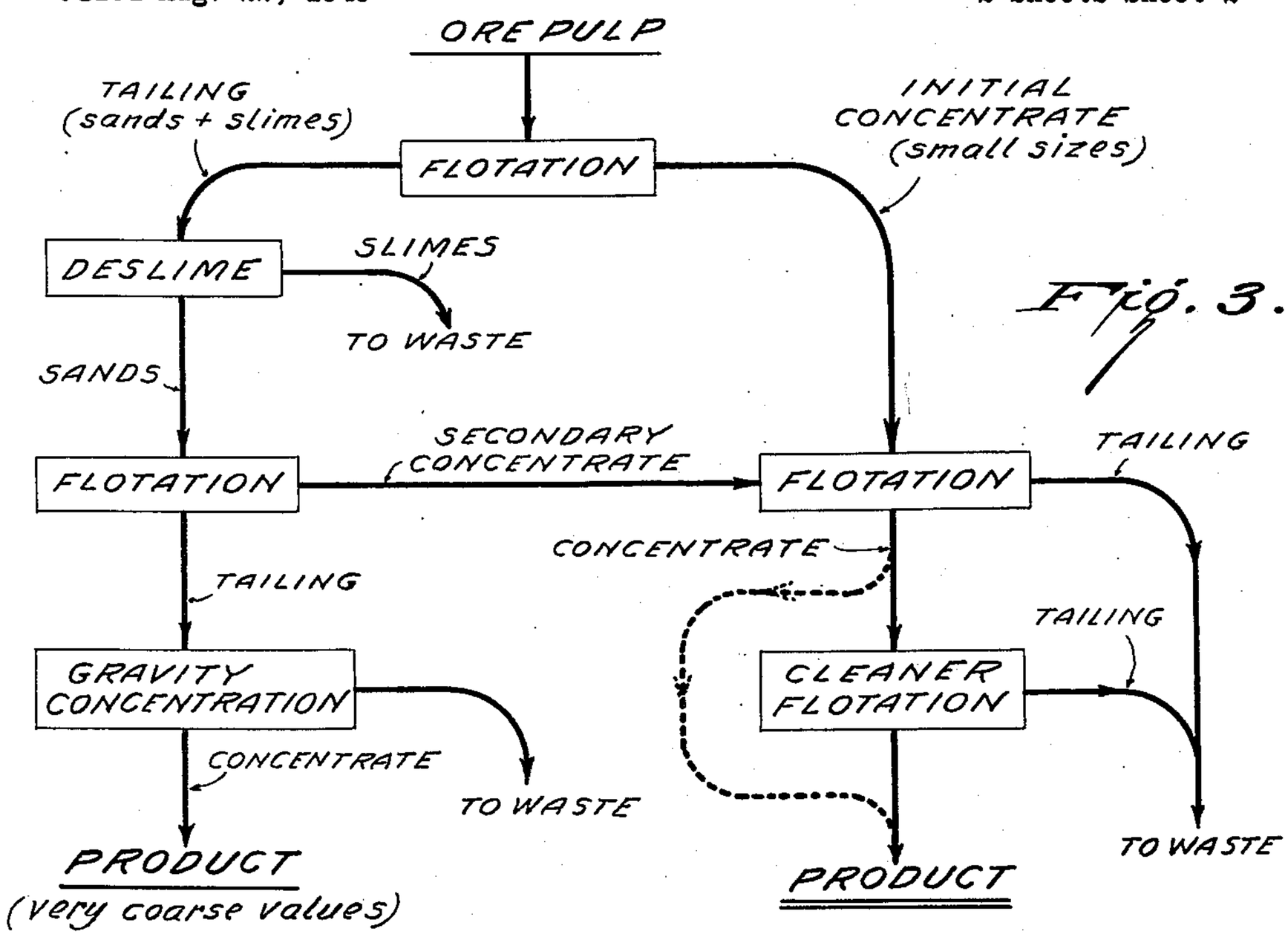

Fig. 3.

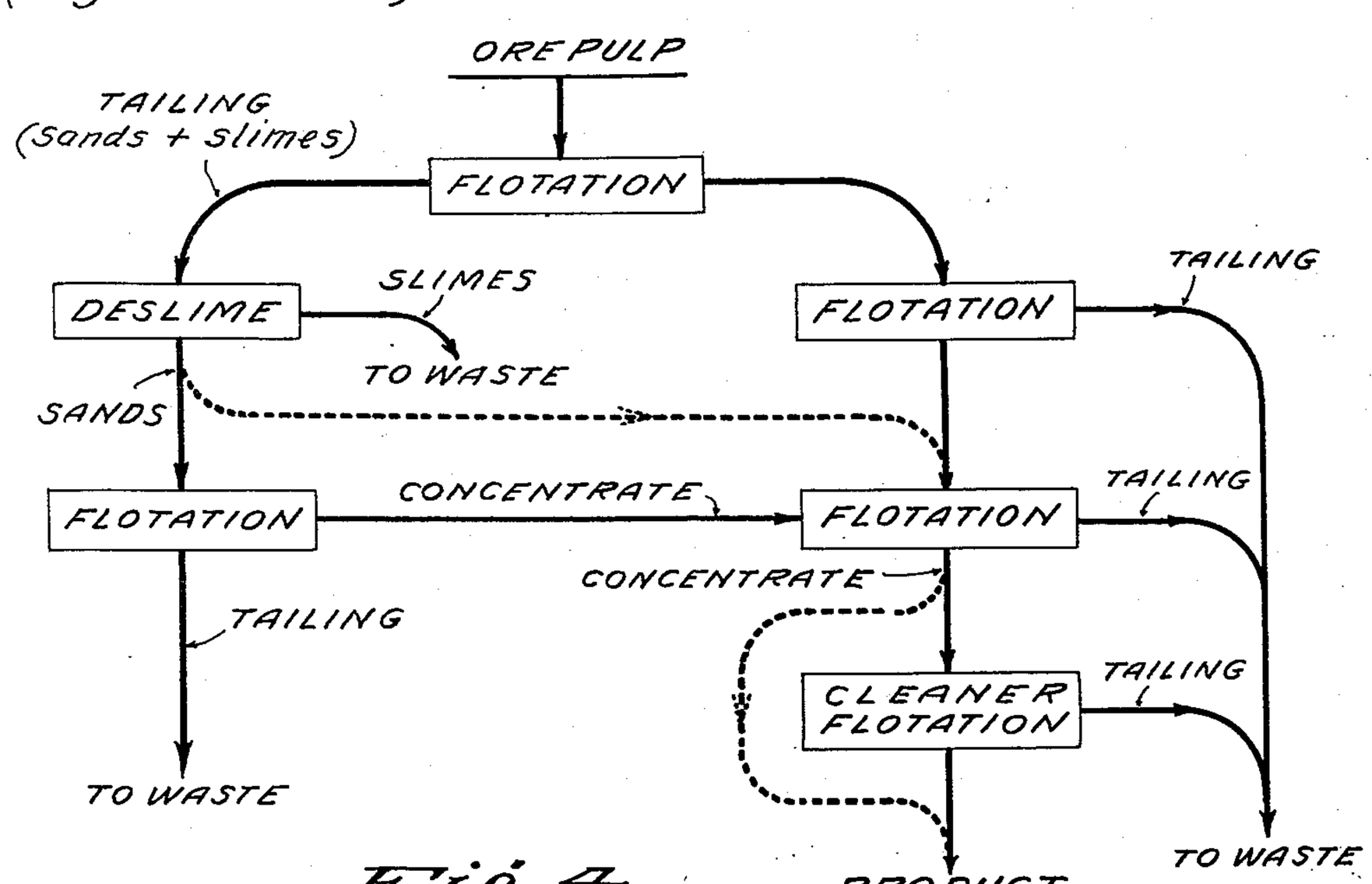

Fig. 4.

INVENTOR

ELMER W. GIESEKE,

BY Elmer W. Harmon

ATTORNEY

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FLOTATION OF BARITE ORES

Elmer William Gieseke, Old Greenwich, Conn., assignor to American Cyanamid Company, New York, N. Y., a corporation of Maine

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4 Claims. (Cl. 209—166)

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This invention relates to the flotation of mineral values from low grade ores. In particular, it relates to an improved process of concentrating the barite content of those ores and mill products which because of their tendency to slime are not amenable to ordinary methods of froth flotation.

The constituent minerals of many ores are sufficiently fine to require reduction to small particle size in order to free the mineral values. In many cases this is unfortunate because the nature of the ore is such that reduction to a small particle size produces an abundance of slimes. These latter may be either inherent in the ore or be caused by the size-reducing operation. Whatever the cause, the presence of such slimes interferes seriously with any subsequent attempt at beneficiation by froth flotation. Many proposals have been made to overcome this difficulty, as by the flotation of extremely dilute pulps or by the use of special reagents. Actually however, the most practical as well as the most commonly used remedy is desliming the ore by classification during preparation for flotation.

Many barite ores and mill products are particularly troublesome in this respect. Desliming procedures involving classification have been found impractical because of excessive losses of mineral values with the slimes. As in other fields, special procedures including the use of gangue depressants and dispersants have been proposed. With somewhat similar ores, it has also been proposed to remove the slimes by froth flotation rather than desliming by mechanical means. However, none of these proposed procedures have proved to be as satisfactory as could be desired. For example, the mineral value losses are often excessive. In other cases the reagent consumption is too great or the total manipulative cost exceeds that which can be economically expended.

It is therefore the principal object of the present invention to develop a procedure intended for the beneficiation of those barite ores which produce too much slimes for effective beneficiation by froth flotation in a normal way and which cannot be deslimed in the usual way without excessive losses in mineral value. It is particularly the object of the present invention to develop such a procedure adapted for the treatment of barite ores and mill products without being subject to the objectionable faults found in the procedural operations of the prior art.

According to the present invention, the principal objects are accomplished by subjecting the ore to a relatively incomplete flotation using restricted amounts of collecting agents and then

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subjecting the tailing therefrom to desliming and further beneficiation. Apparently the excessive loss in mineral values in any attempt to deslime the ore hydraulically before froth flotation is due to their small physical size which makes them buoyant in an ore pulp suspension. It is only this smaller size fraction of the mineral values which is collected before subjecting the residual tailing to desliming. That this fraction can be successfully concentrated before desliming is particularly surprising because previous experience would indicate that the presence of the slimes would lead to either low grade or poor concentration.

The invention will be more fully illustrated in conjunction with the accompanying drawings in which:

Figure 1 represents the flow sheet of the basic process of the invention in its simplest form;

Figure 2 represents a modified flow sheet in which an extra flotation step is utilized; and

Figures 3 and 4 represent additional modifications of the process, adapted for use with more difficultly concentrated ores.

In Figure 1 the basic steps of the present process are graphically set forth. A pulp of the ore which has been reduced to a suitable size for the liberation of values is subjected to a preliminary relatively incomplete, flotation operation in which a concentrate surprisingly free from gangue slimes is obtained. As noted above, this is a concentrate largely comprising that portion of the mineral values which is lost in any attempt at desliming by classification. Usually it comprises the bulk of the smaller-sized mineral values. The residual portion of the ore contains substantially all the gangue slimes as well as the coarser size mineral values and gangue.

If this residual portion is given an ordinary desliming treatment by classification, either hydraulically or on screens, it is found that most of the residual mineral value is in the coarser sizes. These sands are very easily settled which simplifies classification by hydraulic methods. The slimes from this operation usually can be sent to waste with very little loss in mineral values. After desliming, the residual sands are subjected to froth flotation in accordance with any desirable procedure. As shown in Figure 1, this is done by collecting the mineral values by froth flotation using a collector therefor.

The overall process when carried out in this way has a number of advantages. It enables the operation to produce readily an effective concentration with a high recovery, a desirable result

not attained by any ordinary practice. It has the additional advantages that desliming, and particularly the final beneficiation, are carried out on relatively smaller bulk. Because this is true, the process is particularly well suited for economy in the use of reagents.

It will be seen that the process of this invention involves three basic and essential operations:

1. Treatment of the undeslimed aqueous ore pulp to froth flotation with only sufficient reagents to remove the difficultly-settled, finer mineral values;
2. Desliming of the residual tailing by classification; and
3. Subjecting the deslimed sands to froth flotation in the presence of sufficient reagent to effectively concentrate the residual larger-size mineral values.

These three operations are always present in the process of the present invention. Actually, one or more of them may be carried out in successive steps. Also, if desired, any of a number of additional operations may be introduced, as for example combining the concentrates obtained and subjecting the mixture to further beneficiation in the basic steps.

Several specific variations in the procedure represented in Figure 1 also are shown in the accompanying drawings. As shown in Figure 2, an effective embodiment of the present invention may in some cases involve the use of both cationic and anioinc reagents. Here, as in Figure 1, the ore is first given a preliminary flotation to concentrate the finer size mineral values from the ore pulp. The tailing obtained is then deslimed, and the remaining sands and gangue subjected to flotation. In the process of Figure 2, this deslimed tailing is given an anionic flotation to remove a concentrate of the intermediate size values relatively free from gangue, and then a cationic flotation to remove a gangue concentrate leaving a concentrate of the coarser mineral values. Obviously these last two steps may be reversed if so desired. The final operation thus produces a froth concentrate of either the coarser-size mineral values or coarser-size gangue particles depending upon the nature of the particular reagent used in the final flotation operation.

A better grade product can be obtained by combining the initial concentrate of finer size mineral values and the value-containing concentrate or concentrates from subsequent operations, and subjecting the mixture to a cleaner, and if desired, a recleaner flotation. Such procedures are illustrated in Figures 3 and 4.

In Figure 3, the process of Figure 1 is amplified in two respects. Many ores in addition to the mineral value fines also produce large amounts of mineral values in sizes too coarse to be amenable to froth flotation. Higher recoveries are obtained by providing for agglomerate tabling or gravity concentration to collect this fraction as shown in Figure 3. At the same time, higher grade may be obtained if the initial and secondary concentrates are combined and subjected to a further flotation, and if desired an additional cleaning operation. Such procedure is also seen in Figure 3.

As shown in Figure 4, it is often advantageous to subject the initial finer-size concentrate to further flotation before combining it with the concentrate obtained from the initial tailings. As shown in both Figures 3 and 4, the deslimed sands may be directly combined with the initial finer-size values concentrate, either directly or after

further treatment of the latter, if the nature and physical properties of the ore are such that the amount of mineral values in very coarse sizes is small enough so that its separate recovery is not economically feasible.

The invention will be described in greater detail in conjunction with the following examples, which are illustrative only and not by way of limitation. All parts are by weight unless otherwise specified.

EXAMPLE 1

A California barite ore, containing as its principal constituents barite, silica and limonite was made into an aqueous pulp containing about 67% solids and then ground for two minutes, followed by conditioning for an additional two minutes with 0.5 lb. of sodium silicate per ton of ore. The so-treated pulp was then subjected to a rougher flotation operation for 8 minutes in the presence of 0.80 lb./ton of oleic acid stage-added 0.1 lb./ton at a time. The concentrate was cleaned for 2 minutes and recleaned for an additional 2 minutes with no reagents added in the latter operations. Illustrative results are shown in the following table:

Table I

Product	Per Cent Wt.	Assays, Per Cent		Per Cent Distribution	
		$BaSO_4$	Fe	$BaSO_4$	Fe
Recleaner Concentrate	54.08	96.90	0.36	71.48	12.04
Recleaner Tail	7.09	87.68	1.20	8.48	5.25
Cleaner Concentrate	61.17	95.83	0.46	79.96	17.29
Cleaner Tail	12.09	72.08	------	11.88	--------
Rougher Concentrate	73.26	91.91	------	91.84	--------
Rougher Tail	26.74	22.36	------	8.16	--------
Feed	100.00	73.31	1.62	100.00	100.00

EXAMPLE 2

A second portion of the barite ore of Example 1 was ground and conditioned with sodium silicate, following the procedure of that example. The so-treated pulp was floated for 2 minutes in the presence of 0.20 lb. of oleic acid per ton of ore treated, the reagent being added in two stages, 0.10 lb./ton at a time. The tailing therefrom was deslimed by hydraulic classification, the slimes being discarded and the sands floated for 3 minutes in the presence of 0.30 lb./ton additional oleic acid stage-added 0.10 lb./ton at a time. The concentrate so obtained was combined with the primary concentrate and subjected to cleaner and recleaner flotations of 2 minutes each. Illustrative metallurgical results are shown in Table II.

Table II

Product	Percent Wt.	Assays, Per Cent		Percent Distribution	
		$BaSO_4$	Fe	$BaSO_4$	Fe
Recleaner Concentrate	61.05	96.18	0.56	80.89	21.11
Recleaner Tail	4.95	75.60	2.33	5.15	7.10
Cleaner Concentrate [1]	66.00	94.64	0.69	86.04	28.21
Cleaner Tail	7.69	55.10	------	5.84	--------
Primary Concentrate	73.69	90.51	------	91.88	--------
Primary Tail	19.09	8.40	------	2.21	--------
Slime	7.22	59.40	------	5.91	--------
Feed	100.00	72.59	1.62	100.00	100.00

[1] Primary and secondary rougher concentrates combined before cleaning.

The chief advantage of the present invention will be immediately apparent from a comparison of the results of Examples 1 and 2. By floating off the finer mineral particles and then desliming

by classification before further flotation, recovery of a product of the same grade but 13% heavier than that of the prior art process of Example 1 was obtained. Another advantage of the present invention is well shown in that the increased recovery was made by the new process despite an overall reduction of about 37.5% in oleic acid consumption from 0.8 lb./ton to 0.5 lb./ton.

It should be noted that the present invention is in no sense limited to the use of any particular flotation agent. The oleic acid of Examples 1 and 2 is the reagent commonly used in this field but it may be replaced for example by other similar fatty acids such as coconut-oil fatty acid, lauric acid, talloel, and the like or by their sodium, potassium or ammonium soaps. Similarly the sodium silicate may be replaced by other depressants and/or dispersants such as quebracho, tannic acid, citric acid, various phosphates such as sodium acid pyrophosphate, lime and the like.

I claim:

1. In beneficiating those barite ores which on treatment produce sufficient slimes to adversely effect froth flotation of the barite, the improvement which comprises: forming an aqueous pulp of the ore; subjecting the pulp to froth flotation in the presence of a promoter selected from the group consisting of the higher fatty acids, talloel, their sodium, potassium, and ammonium soaps and mixtures thereof, said promoter being present in amount sufficient to selectively float barite fines but insufficient to float appreciable amounts of gangue slimes; removing the resultant initial froth concentrate of barite fines low in gangue slimes content; hydraulically desliming the residual tailing; subjecting the deslimed tailing to

froth flotation in the presence of an additional amount of promoter sufficient to float the major portion of the residual barite but insufficient to float appreciable amounts of gangue minerals; and collecting the resultant additional froth concentrate of barite particles low in gangue content.

2. A process according to claim 1 in which said deslimed tailing is admixed with said initial concentrate and the combined fractions subjected to an additional flotation, whereby a single higher-grade product fraction is produced.

3. A process according to claim 1 in which said additional concentrate is admixed with said initial concentrate and the combined fraction subjected to further beneficiation by flotation, whereby a single higher-grade product fraction is produced.

4. A process according to claim 1 in which said initial concentrate and said deslimed tailing are separately beneficiated by froth flotation, the mineral values concentrates therefrom admixed and the combined fraction is subjected to an additional flotation, whereby a single higher-grade product fraction is produced.

ELMER WILLIAM GIESEKE.

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