UNITED STATES PATENT OFFICE.

CLEMENT LINWOOD PERKINS, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO METALS RECOVERY COMPANY, OF NEW YORK, N. Y., A CORPORATION OF MAINE.

CONCENTRATION OF MINERALS.

1,394,640. Specification of Letters Patent. Patented Oct. 25, 1921.

No Drawing. Application filed December 3, 1918, Serial No. 265,165. Renewed March 12, 1921. Serial No. 451,840.

To all whom it may concern:

Be it known that I, CLEMENT L. PERKINS, a citizen of the United States, residing at Pittsburgh, in the county of Allegheny, State of Pennsylvania, have invented certain new and useful Improvements in Concentration of Minerals; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to the concentration of minerals, such as sulfid ores and the like, by flotation; and is based upon the discovery that improved results can be obtained by carrying out the flotation operation with the addition to the ore or mineral pulp of a compound flotation agent made up of a mixture of two or more amino compounds, which agent is readily miscible with the water of the mineral pulp.

Certain flotation agents, for example, alpha- and beta-naphthylamin, because of their solid character and their degree of insolubility, present certain difficulties in their uniform distribution throughout the ore pulp, although it is possible to effect such distribution and to carry out the flotation operation with advantage by their use.

I have found that such solid amino compounds can be more readily, and with advantage, distributed throughout the ore pulp by dissolving the solid amino compound in a liquid amino compound which is readily miscible with water; and the present invention, accordingly, provides a method of facilitating the incorporation with the ore pulp of such solid amino compounds as flotation agents.

Among the liquid amino compounds which may be referred to as solvents for the solid amino compounds may be mentioned anilin, xylidin, toluidin, quinolin, pyridin, dimethylanilin, &c. The liquid amino compounds may or may not in themselves be good flotation agents, although it will be evident that the process is one of added advantage where the liquid amino compound, as well as the solid amino compound, is itself a good flotation agent.

The flotation agent which I consider most advantageous and as particularly to be recommended in the process of the present invention is a solution of alpha-naphthylamin in xylidin, and the invention will be further described and illustrated in connection therewith. It is not necessary that chemically pure alpha-naphthylamin be used, but the commercial product may be used in its crude or unrefined state; similarly the xylidin can be used in its crude or unrefined state; but it will be evident that the compound flotation agent should be free from impurities prejudicial to the flotation operation.

The proportions of alpha-naphthylamin and xylidin can be varied, for example, between 70 parts of alpha-naphthylamin dissolved in 30 parts of xylidin, and 30 parts of alpha-naphthylamin dissolved in 70 parts of xylidin. The proportions which I have found of particular value are about 60 parts of alpha-naphthylamin in 40 parts of xylidin. The resulting solution is sufficiently liquid so that it can be readily handled with the ordinary oil feeders commonly employed in flotation operations. Owing to its liquid character, and its miscibility with water, it can be readily disseminated throughout the ore pulp, but this dissemination can of course be promoted by agitation.

The proportions of alpha-naphthylamin and xylidin may thus be varied to suit the temperature of the pulp; for instance, with a pulp containing quite cold water, the dissemination of the flotation agent is promoted by relatively larger proportions of xylidin, say from 50 to 60%, with resulting advantage to the flotation operation, particularly where not very much time is allowed to elapse between the addition of the agent and the beginning of the actual flotation, or if the pulp is not subjected to agitation or stirring in the meantime. On the other hand, where the water of the ore pulp is quite warm, or with sufficient time or stirring, the amount of xylidin might be reduced to about 25 or 30%.

After the addition of the flotation agent to the ore pulp, the pulp is subjected to the flotation operation, as in an ordinary Callow cell or in apparatus where the air is incorporated in the ore pulp by mechanical agitation. With some ore pulps it may be desirable to add either small amounts of acids or of alkalis, depending upon the nature of

the ore pulp to be treated, but in general no free acid should be present, or it should be present in but very small amount when the flotation agent is added.

With certain ores it is of advantage to subject the ore pulp to agitation with a small amount of lime prior to the addition of the flotation agent thereto. This lime may serve to neutralize small amounts of acid present, or it may act upon the slime or colloidal constituents of the ore pulp, or it may have some other action. Whatever the theoretical explanation of this action may be, a further marked improvement in the flotation process, in which the flotation agents above referred to are employed, has been noted when lime has thus been preliminarily employed. The preliminary agitation with lime should preferably be effected in the ball mill or other grinding machinery in which the ore is pulverized with water.

The following example will further illustrate the invention, as carried out on a copper sulfid ore (of the Utah Copper Co.).

The ore was preliminarily agitated with lime in the proportions of 4 pounds of lime per ton of ore (*i. e.*, solids in the ore pulp). It was subjected to a flotation operation in a Callow cell with the addition of three-fourths of a pound, per ton of ore, of the composite reagent made up of about 60% alpha-naphthylamin and 40% of xylidin.

The original ore treated contained 0.941% of copper. The resulting tails contained 0.145%; the resulting concentrate 37.60%; indicating a recovery of 84.90% of the total copper.

The amount of the solution of alpha-naphthylamin in xylidin may be varied somewhat, for example, between one-half pound or less and one and one-half pounds per ton of ore, (that is calculated on the weight of the ore and not of the ore pulp). Such amounts have been found suitable, for example, with porphyry ores of Utah, which are mainly chalcopyrite and chalcocite ores, with a silicious gangue. With such ores I have used to advantage from 2 to 4 pounds of lime per ton of ore in a treatment preliminary to the addition of the flotation agent.

Another advantageous composition for use as a flotation agent in the process of the present invention is a solution of alpha-naphthylamin in quinolin. Quinolin itself has advantages as a flotation agent, and, in the composition just referred to, such advantages are retained, as well as the other advantages characteristic of the composition.

It is a characteristic of the process of the invention that the froth obtained is readily broken up, and that part of the flotation agent can be recovered therefrom so that it is available for use in the treatment of further amounts of ore. That is to say, the circuit water recovered from the concentrate, and even that recovered from the tailings contains notable amounts of the ingredients of the compound flotation agent which can be thus returned to the process with resulting economy in the amount required to be added for subsequent operations.

It is a further characteristic advantage of the invention, when the solution of alpha-naphthylamin in xylidin is employed, that the marked selective qualities of the alpha-naphthylamin are supplemented by the marked frothing qualities of the xylidin, so that both good selective action and a good frothing action is obtained. Moreover, the xylidin is itself a flotation agent so that it will supplement and replace to a considerable extent the action of the alpha-naphthylamin, so that less of the alpha-naphthylamin is required, when used in solution in the xylidin, than when used alone. Accordingly, from one view point the process of the present invention may be considered to involve the carrying out of the flotation operation with a compound flotation agent, comprising two or more amino compounds, having a marked selective action and good frothing qualities.

I do not claim herein the compound flotation agents *per se* inasmuch as these form the subject matter of a separate application, Serial Number 265,164, filed December 3, 1918.

I claim:

1. The method of effecting the concentration of minerals by flotation, which comprises adding to the mineral pulp a small amount of a compound flotation agent comprising a mixture of a plurality of amino compounds, and subjecting the resulting mixture to a flotation operation, substantially as described.

2. The method of effecting the concentration of minerals by flotation, which comprises adding to the mineral pulp a small amount of a compound flotation agent made up of a solution of a solid amino compound in a liquid amino compound readily miscible with water, and subjecting the resulting mixture to a flotation operation, substantially as described.

3. The method of effecting the concentration of minerals by flotation, which comprises adding to the mineral pulp a small amount of a composite flotation agent comprising a mixture of amino compounds having marked selective action and good frothing qualities, and subjecting the resulting mixture to a flotation operation, substantially as described.

4. The method of effecting the concentration of minerals by flotation, which comprises adding to the mineral pulp a solution of a solid aromatic amino compound in a

liquid aromatic amino compound, and subjecting the resulting mixture to a flotation operation, substantially as described.

5. The method of effecting the concentration of minerals by flotation, which comprises adding to the mineral pulp a solution of alpha-naphthylamin in a liquid amino compound readily miscible with water, and subjecting the resulting mixture to a flotation operation, substantially as described.

6. The method of effecting the concentration of minerals by flotation, which comprises adding to the mineral pulp a solution of alpha-naphthylamin in xylidin, and subjecting the resulting mixture to a flotation operation, substantially as described.

7. The method of effecting the concentration of minerals by flotation, which comprises adding to the mineral pulp a solution of about 60 parts of alpha-naphthylamin in about 40 parts of xylidin, and subjecting the resulting mixture to a flotation operation, substantially as described.

8. The method of incorporating with mineral pulp to be concentrated by flotation a solid amino compound which comprises dissolving such solid amino compound in a liquid amino compound readily miscible with water, and adding the resulting solution to the mineral pulp, substantially as described.

9. The method of incorporating alpha-naphthylamin with the mineral pulp to be concentrated by flotation which comprises dissolving the alpha-naphthylamin in a liquid amino compound readily miscible with water, and adding the resulting solution to the mineral pulp to be concentrated, substantially as described.

10. The method of incorporating alpha-naphthylamin with the mineral pulp to be concentrated by flotation which comprises dissolving the alpha-naphthylamin in xylidin and adding the resulting solution to the mineral pulp to be concentrated, substantially as described.

In testimony whereof I affix my signature.

CLEMENT LINWOOD PERKIN.