UNITED STATES PATENT OFFICE.

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FLOTATION OF MINERALS.

1,364,859. Specification of Letters Patent. Patented Jan. 4, 1921.

No Drawing. Application filed July 13, 1920. Serial No. 395,998.

To all whom it may concern:

Be known that we, CLEMENT L. PERKINS and RALPH E. SAYRE, citizens of the United States, residing at Pittsburgh, Allegheny county, State of Pennsylvania, have invented certain new and useful Improvements in Flotation of Minerals; and we 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.

In our prior applications Serial No. 337,322, filed November 11, 1919, and Serial No. 284,981, filed March 25, 1919, we have described and claimed certain improvements in the flotation of minerals with the aid of nitrogen-sulfur compounds, *e. g.*, thio-amido and thio-urea compounds. In the specific claims of said applications we have claimed a process in which mixtures of different agents are added simultaneously as flotation agents. The claims of the present application relate to an alternative and specifically different procedure in which the flotation agents are added in successive operations, instead of simultaneously.

Thiocarbanilid, and other organic thio-urea compounds are non-oleaginous compounds which themselves have substantially no frothing properties, but which have valuable properties as selective or collecting or mineral-modifying agents. Such agents, although substantially non-frothing, nevertheless materially assist in the recovery of the minerals when used in connection with a suitable frothing agent.

According to the present invention the substantially non-frothing nitrogen-sulfur compounds, such as thiocarbanilid, etc., are used in conjunction with a frothing agent, and the collecting and frothing agents are successively incorporated with the ore pulp. In the preferred embodiment of the invention, the non-frothing collecting agent is incorporated with the ore in the tube mill or ball mill during the grinding operation, and the frothing agent is of such a character that it can be subsequently incorporated, prior to or during the flotation operation.

As pointed out in said prior applications, thiocarbanilid, etc., has substantially no frothing properties, but has valuable selective or collecting or mineral-modifying properties, and very materially assists in the recovery of the minerals when used in connection with a suitable frothing agent. The action of such agent appears to be a selective modifying action upon the mineral surface, rather than any action of importance upon the water itself, any modifying effect upon the water apparently being incidental and insufficient to effect any frothing thereof.

Inasmuch as the collecting agents are substantially non-frothing, it is important to supplement their action by an agent which will provide an appropriate amount of froth, but the frothing agent used may be entirely inadequate to perform the flotation process by itself, inasmuch as its function appears to be merely to provide bubbles in sufficient quantity and of sufficient persistency to overflow into the launder of the flotation machine, thereby mechanically facilitating the removal of the mineral concentrate. The frothing agent, may, however, have selective or collecting properties, as well as frothing properties. The frothing agent is, according to the present invention, added at some time subsequent to the incorporation of the collecting agent. It may thus be added in the launder leading to the flotation cell, or even in the cell itself.

The flotation operation can be carried out in the common forms of flotation apparatus, such as an ordinary Callow cell, or apparatus where the air is incorporated in the ore pulp by mechanical agitation.

It is of advantage in many cases to add to the ore pulp a small amount of alkali, which may be sufficient in amount to give to the ore pulp a distinct alkaline reaction. When alkalis are used, it is desirable to give them an appreciable time of contact with the ore pulp before subjecting the latter to flotation. When possible, it appears preferable to add the alkalis in the grinding mill, so that they will be present during the grinding operation. The alkali may be caustic alkali, such as sodium hydrate, or an alkaline salt, such as sodium carbonate, or even lime or calcium oxid or hydrate can be used.

The amount of the nitrogen-sulfur compound, used as collecting agent, may vary somewhat, and may be as little as one-fifth or one-tenth of a pound per ton of ore. Larger amounts may, however, be used, as well as smaller amounts in certain cases.

The invention will be further illustrated by the following specific examples of tests made upon a copper sulfid ore having a silicious gangue containing its floatable or sulfid copper in the form of a mixture of chalcocite and chalcopyrite, that is, so-called porphyry ores, such as those of the Utah Copper Company. In general, treatment of the ore with alkalis, as above noted, gives improved results, the alkalis themselves apparently having a valuable effect upon the ores in improving the flotation thereof.

500 parts by weight of the Utah Copper Company's ore was ground in a pebble mill with 250 parts of water, sodium hydroxid equivalent to two pounds per ton of dry ore, and thiocarbanilid equivalent to one-fifth pound per ton of dry ore. The ground pulp was then transferred to a Callow rougher cell, diluted with water, and floated with the addition of terpineol equivalent to about one-tenth pound per ton of dry ore. A satisfactory concentrate and high recovery were obtained.

Instead of thiocarbanilid, other substantially non-frothing nitrogen-sulfur compounds, such as other thio-ureas, can be similarly used, and also other frothing agents, or agents which may be both frothing and collecting agents, such as pine oil, etc. The nitrogen-sulfur compound can thus be used in conjunction with many of the usual oil mixtures which are commonly employed in flotation, particularly those which are good frothing agents, such as pine oil and other wood distillation oils, inasmuch as they supplement the action of the collecting agent and are themselves supplemented in their ore floating properties by the collecting or selective action of the collecting agents.

It is characteristic of the invention that the froth obtained is readily broken up, while a relatively clean concentrate and high recovery can nevertheless be obtained.

The addition of the flotation agents successively has the advantage that the grinding of the ore pulp and the preliminary incorporation of the substantially non-frothing collecting agent can be effected without any objectionable froth formation, and the ore pulp can thus be kept free from objectionable froth formation until the frothing agent is added, which addition may take place during or immediately preceding the flotation operation.

We claim:

1. The method of effecting the concentration of minerals by flotation, which comprises adding to the mineral pulp a small amount of a substantially non-frothing, non-oleaginous organic nitrogen-sulfur compound as collecting agent, subsequently adding an agent having good frothing properties, 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 grinding the ore with the addition thereto of a small amount of a substantially non-frothing, non-oleaginous organic nitrogen-sulfur compound as collecting agent, subsequently adding a small amount of an agent having good frothing qualities, and subjecting the resulting mixture to a flotation operation; substantially as described.

3. The method of effecting the concentration of copper ores by flotation, which comprises intimately incorporating with the ore pulp a small amount of alkali and a small amount of a substantially non-frothing, non-oleaginous organic nitrogen-sulfur compound as collecting agent, subsequently adding an agent having good frothing qualities, and subjecting the resulting mixture to a floatation operation; substantially as described.

4. The method of effecting the concentration of copper ores by flotation, which comprises grinding the ore in admixture with a small amount of alkali and a small amount of substantially non-frothing, non-oleaginous organic nitrogen-sulfur compound as collecting agent, subsequently adding a small amount of an agent having good frothing properties, 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 small amount of thiocarbanilid, subsequently adding an agent having good frothing properties, 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 grinding the ore with the addition thereto of a small amount of thiocarbanilid, subsequently adding a small amount of an agent having good frothing qualities, and subjecting the resulting mixture to a flotation operation; substantially as described.

7. The method of effecting the concentration of copper ores by flotation, which comprises intimately incorporating with the ore pulp a small amount of alkali and a small amount of thiocarbanilid, subsequently adding an agent having good frothing qualities, and subjecting the resulting mixture to a flotation operation; substantially as described.

8. The method of effecting the concentra-

tion of copper ores by flotation, which comprises grinding the ore in admixture with a small amount of alkali and a small amount of thiocarbanilid, subsequently adding a small amount of an agent having good frothing properties, and subjecting the resulting mixture to a flotation operation; substantially as described.

In testimony whereof we affix our signatures.

CLEMENT L. PERKINS.
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