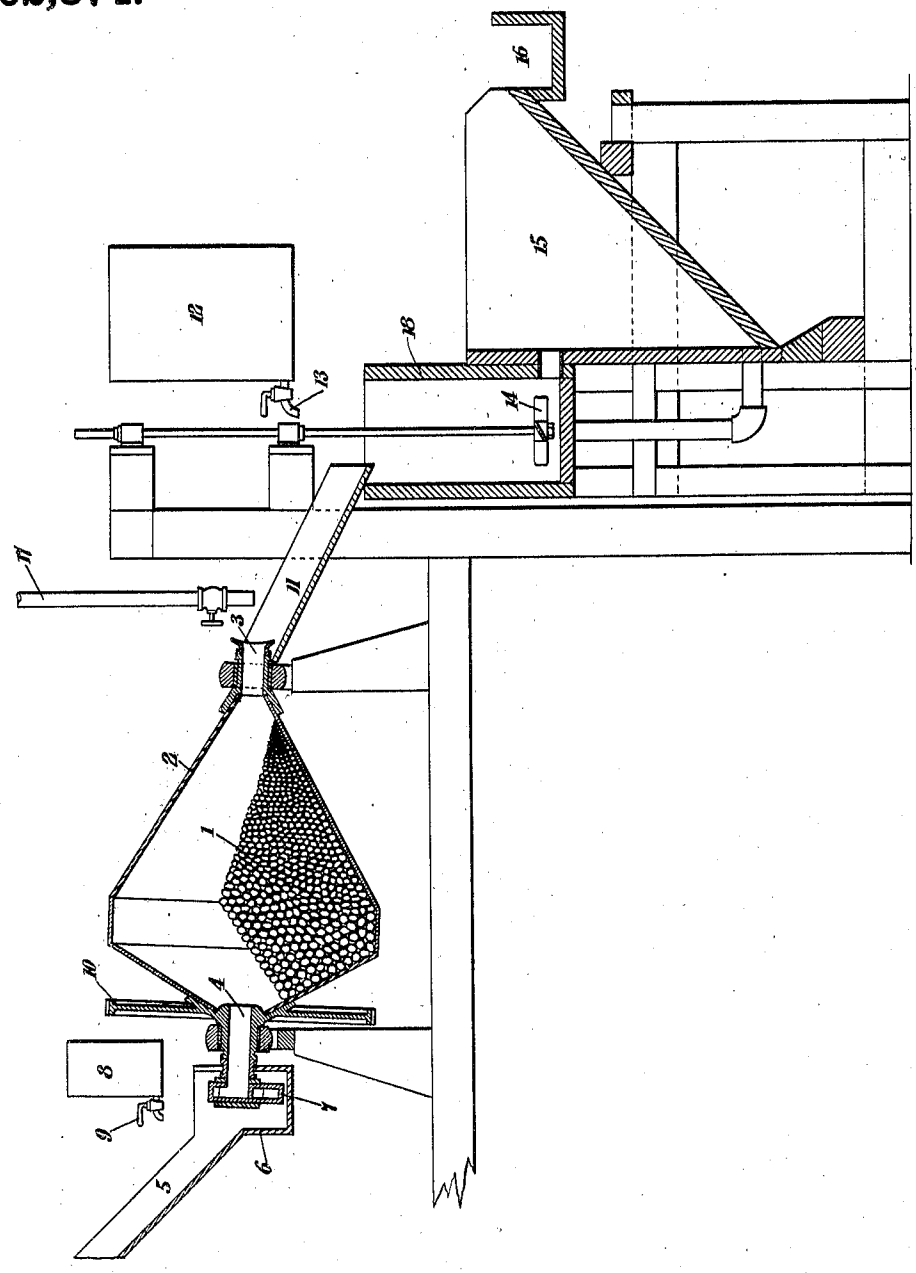
G. A. CHAPMAN.

ORE CONCENTRATION.

APPLICATION FILED MAY 8, 1913.

1,102,874. **Patented July 7, 1914.**



Witnesses:
Geom. A. Kelly
Victor D. Bond

Inventor
George A. Chapman
By his Attorney
Henry B. Williams

UNITED STATES PATENT OFFICE.

GEORGE A. CHAPMAN, OF LONDON, ENGLAND, ASSIGNOR TO MINERALS SEPARATION, LIMITED, OF LONDON, ENGLAND, A CORPORATION OF ENGLAND.

ORE CONCENTRATION.

1,102,874. Specification of Letters Patent. Patented July 7, 1914.

Application filed May 8, 1913. Serial No. 766,250.

To all whom it may concern:

Be it known that I, GEORGE A. CHAPMAN, a subject of the King of England, residing at London, England, have invented a certain new and useful Improvement in Ore Concentration, of which the following is a specification, reference being had therein to the accompanying drawings, forming part thereof.

This invention consists in improvements in or relating to ore concentration and has particular reference to the concentration of ores by flotation. Hitherto in the concentration of ores by flotation it has been the common practice to mix the powdered ore with about four times its weight of water and in most instances to add to the pulp a small quantity of sulfuric acid (say 1% on the weight of the ore) and also to add to the pulp a very small proportion of either an immiscible oily agent, such as oleic acid, Texas fuel oil, etc., or of a soluble mineral frothing agent, such as phenol, cresol, amyl-alcohol, amyl-acetate, etc., all as described, for example, in prior United States Patents No. 835,120 of November 6, 1906, No. 955,012 of April 12, 1910, and No. 962,678 of June 28, 1910, and British Patent No. 21,857 of 1910. It has also been common practice to utilize in the above processes mixtures of different mineral frothing agents, both oily or immiscible and soluble. These processes have usually been carried on at temperatures varying from atmospheric temperatures up to say 60° centigrade, or even higher. As stated in these earlier patents, the conditions most suitable and economical for the treatment of a particular ore have been best determined by simple preliminary trials.

It has heretofore been proposed to agitate the water with one or more agents known as modifying agents, such as oil of eucalyptus, phenol, cresol, amyl-alcohol, amyl-acetate, wood tar oil, wood alcohol, and the like, and mixtures containing them, before the agitation of the ore with the water, and such pre-agitation with one or more modifying agents has been found to improve the recovery of concentrates or the grade of the concentrates or both.

In the course of careful investigations on certain ores, it has been discovered that, if the ore is ground with water containing a modifying agent, there are many substantial improvements in efficiency and economy in the process of concentrating ores. For example, first, the newly exposed surfaces of the mineral are brought into contact with the water containing the modifying agent at the moment of the exposure of these surfaces; second, the power necessarily consumed in the work of grinding the ore additionally effects the agitation of the water containing the modifying agent, and this in contact with freshly ground ore; third, the output of the grinding process may be increased, since the freshly ground particles, as soon as they are brought into condition for floating, may be floated or carried off with the overflow or outflow of water, and thus automatically the mineral particles will flow away from the grinding stage of the process as soon as they are in floatable condition; fourth, a recovery by separation of floating particles may be had immediately following such a grinding operation; fifth, the ore pulp from the grinding operation may be delivered to agitation-froth apparatus and there subjected to agitation and beating in of air and separation of the agitation-froth by flotation, usually with the addition of a frothing agent, and greatly increased recoveries of mineral obtained in the floating froth or higher grades of concentrates, or both increase in recovery and in grade may be obtained; sixth, the agitation-froth process may be carried on at ordinary atmospheric temperatures and, indeed, in some instances, at a temperature so low that the froth, when produced, is frozen; and, seventh, the agitation-froth process may be carried on without the use of any mineral acid, such as sulfuric acid.

In carrying out this invention in practice, the best results have been obtained by first subjecting the ore to a primary grinding, either wet or dry, and thereafter subjecting the partly crushed ore with water containing the modifying agent, to a secondary or final grinding, in which the ore is ground in contact with the water containing the modifying agent, and the water containing the modifying agent is agitated. The ore as thus ground with water containing a modifying agent may be delivered to an apparatus suitable for carrying out the agitation-froth process, and then subjected to that process. The following is an example of the application of this invention:

A chalcocite ore containing 1.80 per cent. of copper was subjected to regrinding or final grinding with water containing, as the modifying agent, cresol in the proportion of 0.05 per cent. on the ore. The finely ground ore and water were delivered to an agitation-froth apparatus and in the first mixer a frothing agent was fed into the pulp consisting of American turpentine in the proportion of 0.05 per cent. on the ore. The concentrates delivered from the agitation-froth apparatus assayed 34.80 per cent. of copper and showed a recovery of 92.00 per cent. of copper.

The accompanying drawing illustrates diagrammatically the arrangement of apparatus which was employed in the example above given and which is well adapted for carrying out my invention in practice. This drawing shows a vertical longitudinal section of a conical mill and a transverse vertical section of an apparatus for carrying out the agitation-froth process.

The mill shown in the drawing is the well known Hardinge conical mill wherein the material to be ground is subjected to grinding action, preferably of pebbles or balls 1, in a conical chamber 2 rotated on a nearly horizontal axis at such speed as will assure effective grinding. The slight variation from horizontal position conveniently locates the outlet 3 at a somewhat lower position than the inlet 4, thus assuring an automatic discharge of the finely ground ore. Coarse ground ore from a primary grinding mill (not shown) is fed by a launder 5 into the feed box 6. A scoop 7 on the rotating part of the mill picks up a charge of ore and water once in each rotation and discharges the same into the mill chamber through the inlet 4. The modifying agent is conveniently fed into the feed box of the mill from a supply tank 8 through a supply pipe and tap 9. The rotating mill is actuated in any suitable manner, as by a gear wheel 10 fixed upon the rotating part and meshing with suitable driving gearing. From the mill outlet 3 the finely ground ore and water are delivered into a launder 11 and thence into the mixer or agitating box 18 of the agitation-froth apparatus, and here a suitable frothing agent may be fed to the pulp from a second supply tank 12 through a supply pipe and tap 13. In the feed launder 11 an additional quantity of water may be added through a water feed pipe and tap 17. The water and ore are usually present in the mill in equal proportions, and the water added in the feed launder brings the amount of water up to about three and one-half to four times the weight of the ore. Within the mixer or agitation box is arranged to rotate an impeller or agitator 14 to perform its usual function of violently agitating the pulp and beating in air, and the agitated pulp flows into a spitzkasten 15, from which the froth is separated by flotation in the usual manner, discharging into a concentrates launder 16. The tailings from the spitzkasten may be drawn into another agitation box or mixer and the agitation and froth separation repeated, and this repetition of the agitation-froth operation may be made as many times as is desirable, and the concentrates may also be retreated, all as well known in the agitation-froth process.

The substances suitable for use as modifying agents are essential oils, such as oil of eucalyptus and American turpentine, phenol, cresol, amyl-alcohol, amyl-acetate, wood tar oil, wood alcohol, and the like and the mixtures containing them. These are used in minute quantities, such as from 0.001 per cent. to 0.1 per cent. on the weight of the ore. These substances, upon agitation with water, bring about an emulsification of air in the water, and when thus agitated in contact with the ore as the ore is ground, in some way increase the selective floatability of the mineral or metalliferous part of the ore and also contribute greatly to the efficiency and economy of the agitation-froth process when the water thus modified and the ore thus ground are subjected to that process.

The frothing agents are any of the mineral frothing agents hitherto employed in the agitation-froth process, or mixtures of these, generally about 0.002 per cent. to 0.4 per cent. of the weight of the ore. The frothing agents may be the same material or materials as are used as the modifying agents. When a mixture is employed as the frothing agent, the lighter part thereof may be of the same materials as are used for the modifying agents, and for the heavier part Texas fuel oil, Russian crude petroleum and oleic acid have been found to be suitable.

The nature and arrangement of the apparatus used may be varied without departing from this invention, and in the application of this invention to various ores and under various conditions, the process as above particularly described may be modified without departing from this invention.

I claim:—

1. A process for concentrating ores, which consists in grinding the ore with water, in the presence of an agent for modifying the water, so that the agent modifies the physical characteristics of the water, and separating the floating mineral.

2. A process for concentrating ores, which consists in grinding the ore with water, in the presence of an agent for modifying the water, so that the agent modifies the physical characteristics of the water, and then agitating the pulp to form a froth and separating the froth.

3. A process for concentrating ores, which

consists in grinding the ore with water containing a water modifying agent so as to modify the physical characteristics of the water, and then adding to the pulp a frothing agent and agitating to form a froth and separating the froth.

4. A process for concentrating ores, which consists in grinding the ore with water containing an air emulsifying agent so as to form an air emulsion, and separating the floating mineral.

5. A process for concentrating ores, which consists in grinding the ore with water containing an air emulsifying agent so as to form an air emulsion, and then agitating the pulp to form a froth and separating the froth.

6. A process for concentrating ores, which consists in grinding the ore with water containing an air emulsifying agent so as to form an air emulsion, then adding to the pulp a frothing agent and agitating to form a froth and separating the froth.

7. A process for concentrating ores, which consists in grinding the ore with water containing a water modifying agent in a proportion not exceeding 0.1 per cent. on the weight of the ore so as to modify the physical characteristics of the water, and separating the floating mineral.

8. A process for concentrating ores, which consists in grinding the ore with water containing a water modifying agent in a proportion not exceeding 0.1 per cent. on the weight of the ore so as to modify the physical characteristics of the water, and then agitating the pulp to form a froth and separating the froth.

9. A process for concentrating ores, which consists in grinding the ore with water containing a water modifying agent in a proportion not exceeding 0.1 per cent. on the weight of the ore so as to modify the physical characteristics of the water, then adding to the pulp a frothing agent in a proportion not exceeding 0.4 per cent. on the weight of the ore, and agitating to form a froth and separating the froth.

10. A process for concentrating ores, which consists in grinding the ore with water containing cresol so as to modify the physical characteristics of the water, and separating the floating mineral.

11. A process for concentrating ores, which consists in grinding the ore with water containing cresol so as to modify the physical characteristics of the water, and then agitating the pulp to form a froth and separating the froth.

12. A process for concentrating ores, which consists in grinding the ore with water containing cresol so as to modify the physical characteristics of the water, then adding to the pulp a frothing agent and agitating to form a froth and separating the froth.

13. A process for concentrating ores, which consists in grinding the ore with water containing cresol in a proportion not exceeding 0.1 per cent. on the weight of the ore so as to modify the physical characteristics of the water, and separating the floating mineral.

14. A process for concentrating ores, which consists in grinding the ore with water containing cresol in a proportion not exceeding 0.1 per cent. on the weight of the ore so as to modify the physical characteristics of the water, and then agitating the pulp to form a froth and separating the froth.

15. A process for concentrating ores, which consists in grinding the ore with water containing cresol in a proportion not exceeding 0.1 per cent. on the weight of the ore so as to modify the physical characteristics of the water, then adding to the pulp a frothing agent in a proportion not exceeding 0.4 per cent. on the weight of the ore, and agitating to form a froth and separating the froth.

16. A process for concentrating ores, which consists in grinding the ore with water containing cresol so as to modify the physical characteristics of the water, then adding turpentine to the pulp and agitating to form a froth and separating the froth.

17. A process for concentrating ores, which consists in grinding the ore with water flowing through the grinding compartment and containing a small proportion of a water modifying agent so as to modify the physical characteristics of the water, and then separating the floating mineral.

18. The process for concentrating ores, which consists in so grinding the ore with water flowing through the grinding compartment and containing a small proportion of an air emulsifying agent as to form an air emulsion, and then separating the floating mineral.

In testimony whereof I have affixed by signature in presence of two witnesses.

GEORGE A. CHAPMAN.

Witnesses:

HENRY D. WILLIAMS,

VICTOR D. BORST.