W. E. GREENAWALT.

FLOTATION APPARATUS.

APPLICATION FILED DEC. 4, 1915.

1,250,303.

Patented Dec. 18, 1917.

2 SHEETS—SHEET 1.

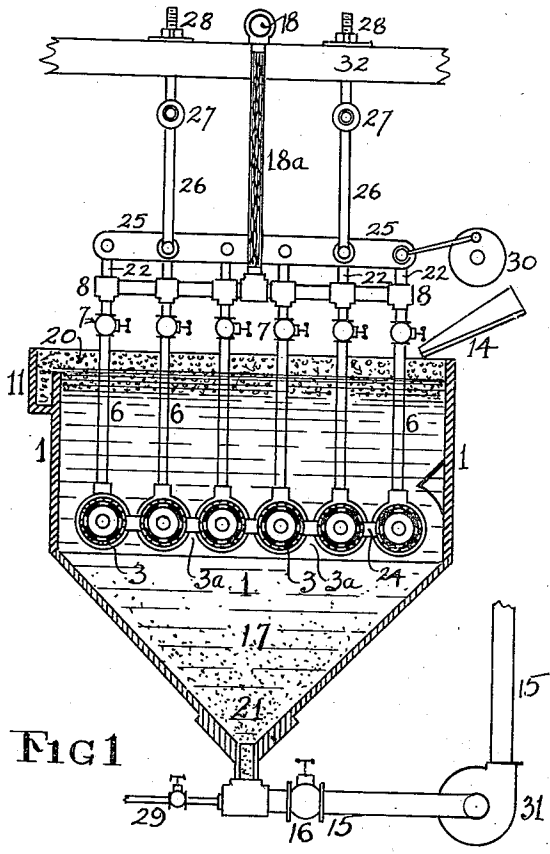


FIG 1

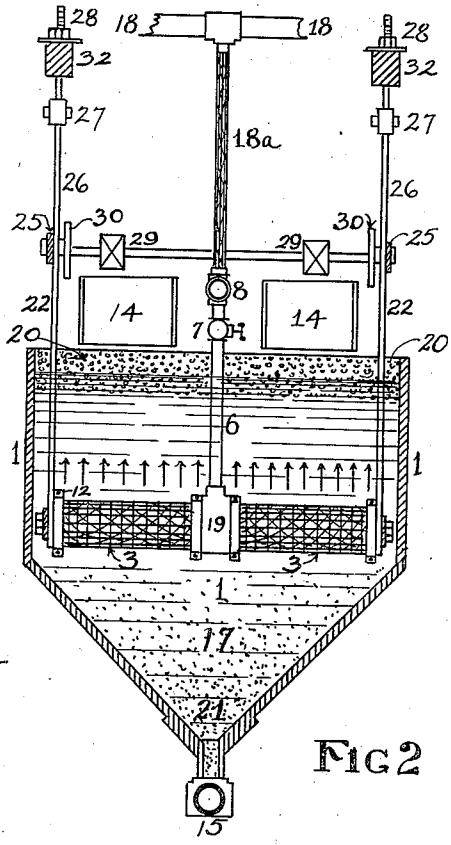


FIG 2

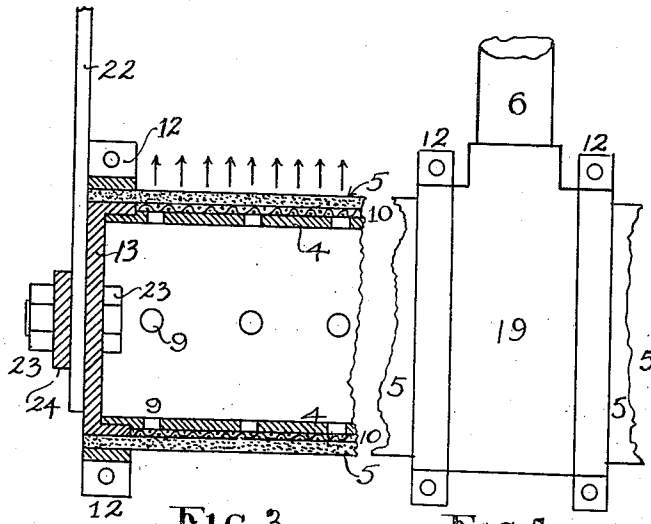


FIG 3

FIG 5

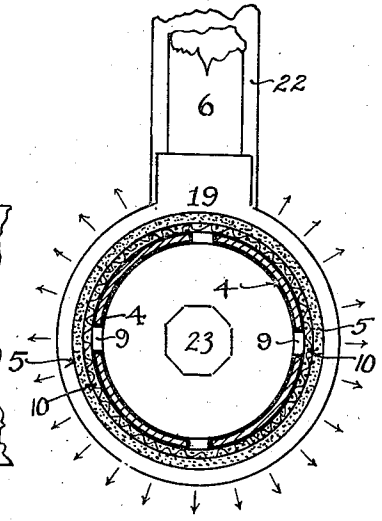


FIG 4

WITNESSES

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2 SHEETS—SHEET 2.

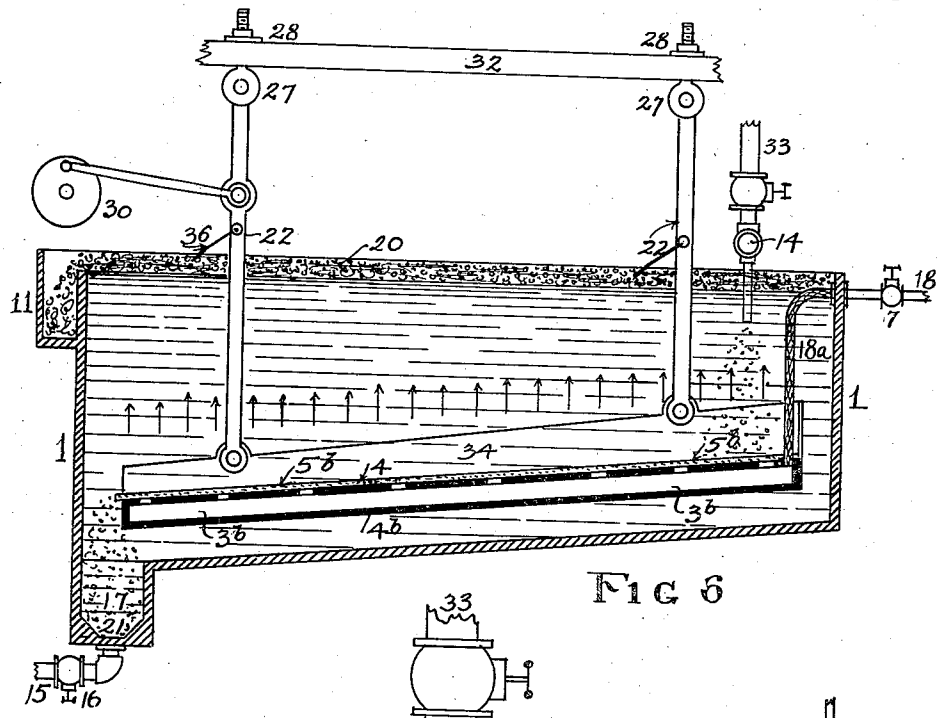


FIG 6

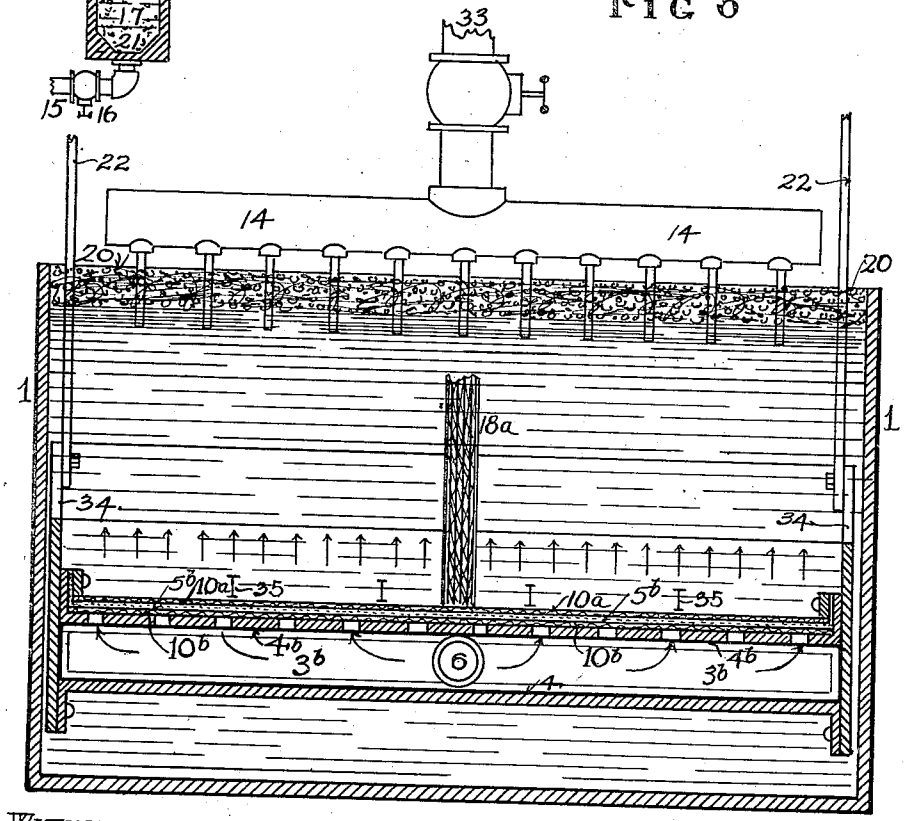


FIG 7

WITNESSES

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FLOTATION APPARATUS.

1,250,303. Specification of Letters Patent. Patented Dec. 18, 1917.

Application filed December 4, 1915. Serial No. 64,996.

To all whom it may concern:

Be it known that I, WILLIAM E. GREENAWALT, a citizen of the United States, residing in the city and county of Denver and State of Colorado, have invented certain new and useful Improvements in Flotation Apparatus, of which the following is a specification.

My invention relates to the separation of mineral values from their gangue by flotation, and has for its object the cheap and effective recovery of the mineral values by flotation in an apparatus which is cheaply installed and which is simple in its operation.

The invention is best described by referring to the accompanying drawings, in which Figure 1 represents a longitudinal section of the apparatus; Fig. 2, a cross-section, and Figs. 3, 4, and 5, a detail section taken longitudinally, a detail cross-section, a detail elevation of a portion, respectively, of one of the atomizers. Fig. 6 represents a longitudinal section of a modified arrangement, and Fig. 7, a corresponding cross-section, although on a larger scale, of the modification as shown in Fig. 6.

In the drawings, 1 represents a tank containing a liquid, which will usually be the ore ground to sixty or eighty mesh and mixed with water and small amounts of oil, and possibly small amounts of acid. The hoppered bottom of the tank is designated by 17. 3 represents a series of atomizers, which may be arranged horizontally or at an incline. These atomizers are used to introduce a gas into the liquid in the tank and are, preferably, each composed of a perforated pipe 4, which is supplied with air or gas under pressure through the pipes 6 and the main 18. Surrounding the perforated pipes 4, is a porous material, or fabric, 5, through which the gas is passed into the liquid in the tank in a finely divided condition, or atomized. In order that the gas may escape entirely in a finely divided condition, the ends of the porous material are securely clamped to the perforated pipe 4, by means of the clamps 12. In order that the gas may flow freely from the holes 9, in the pipe 4, to all parts of the porous covering, a screen, or wire netting 10, is interposed between the pipe and the porous material. The ends of the pipe 4, are secured by caps 13, into which the pipe is screwed. 14 represents a feeder for supplying the material to be treated to the tank. The resulting froth is represented by 20, on top of the liquid, and the gangue, or waste material by 21, in the hopper. The mineral froth 20, is removed through the launder 11 into which it flows, due partly to the overflowing liquid, and, if the atomizers are reciprocated, due partly to the reciprocal action of the atomizers and accessory parts. The waste material, or gangue, dropping into the hopper 17, is removed through the pipe 15, and its amount is regulated by the valve 16. A small air or water jet may be introduced into the pipe 15 through the pipe 29, to remove or prevent clogging of the outflowing waste material.

The atomizers are preferably moved in the liquid, depending upon the results desired and the ore treated. If the atomizers are reciprocated, as shown in the drawings, they are suspended by suspenders 22, and the spacing between the atomizers adjusted by the bars 24, so that the atomizers act as a whole when reciprocated. The suspenders 22 and the spacing bars 24 are attached to the atomizers by the bolts 23. 25 is a top cross-bar, from which the atomizers and connecting parts are suspended as a whole by the suspenders 26, oscillating about the pivotal points 27, which are suspended from the supports 32, and vertically adjustable by means of the screws 28. 18^a is a flexible pipe used to conduct the gas into the atomizers when the atomizers are reciprocating, and 30 represents the mechanism by means of which the atomizers are given a reciprocal motion. If it is desired to re-treat the ore in the same apparatus, or to pass it on to another similar apparatus, it is elevated by means of the centrifugal pump 31. It is very desirable to regulate the height of the liquid above the atomizers: this is done by the screws 28, by means of which the atomizers may be raised or lowered as desired.

The atomizers, themselves, may be variously constructed. A good arrangement is shown in the drawings, in which two pipes 4, are screwed into a T, 19, and caps 13, screwed on the ends of the pipes. The gas supply pipe 6, is also screwed into the T. Perforations are made in the pipes 4, as desired. Wire screen is then wrapped around each pipe, shown by 10, and a woven cloth of the desired porosity placed over the wire

screen, as shown by 5. Clamps 12, are then placed on the pipe and the porous fabric tightly clamped to the pipe, so that all the air admitted to the pipe must escape through the pores of the porous material, and in an atomized, or finely divided condition.

The passage of the material over the porous surface, in either Figs. 1 and 2, or in Figs. 6 and 7, may be governed by the inclination of the porous surface and by the air blast, or by the regulation of the air. If, in Fig. 1, the air is varied so as to be stronger at one end than at the other, only the gangue which is quite unaffected by flotation will pass through the region of intensified action of the first space, and as the intensity of the action is diminished more of the gangue will pass through the successive spaces until finally all the gangue that is eliminated will be eliminated toward or at the end. The currents of atomized air, passing up through the spaces 3^a, between the atomizers, give an intensified action at the spaces, and thus the material which is affected by flotation will pass on over the atomizers until it is either finally floated or passes off with the gangue. In Fig. 6, much the same results may be obtained by varying the inclination of the porous surface, and this inclination in both Figs. 1 and 6 can be regulated by the adjusting screws 28.

The reciprocating motion, on an inclined surface, tends to advance the material, and this advance can be regulated to a nicety. The action is somewhat similar to some form of concentrating tables, except that in my apparatus the surface is porous and submerged, and air is passing through the submerged porous surface. The exact nature of the reciprocating motion need not be here considered, but such a motion as used in many of the standard concentrating tables will give excellent results.

The reciprocating motion of the atomizers and accessory parts will tend to aid the escape of the froth into the launder 11, but this can be expedited by blades 36, Fig. 6, working on pivots, and attached to the reciprocating suspenders 22. If the atomizers are reciprocated, the gas is introduced into the atomizers through a flexible tubing 18^a.

The feeder 14, is so arranged as to spread the material to be treated in a thin sheet or layer into the liquid of the tank and on the porous surface.

In operating the apparatus in the treatment of ores by flotation, the ore crushed to 60 or 80 mesh, usually mixed with from two to five times its weight of water, and having thoroughly incorporated in it frothing ingredients such as oil and possibly a small amount of acid, is introduced into the tank 1, through the feeder 14. The air flowing through the main 18 and pipe 18^a is distributed to the pipes 6 through the pipe 8, and is regulated by the valves 7. The air thus introduced into the pipes 4, or air chambers, passes out through the perforations 9, and, due to the pressure, is forced through the porous material 5, in finely divided bubbles, or in an atomized condition. These bubbles rise through the water, and under the conditions, float the floatable mineral particles, while the waste material, or gangue, passes over the porous surface and down through the ends, or spaces between the atomizers into the hopper 17 and is removed through the pipe 15. The mineral froth 20, on top of the water, flows with the overflow water into the launder 11 and is removed from the apparatus. The reciprocal motion of the porous surface tends to give uniformity to the operation, and in the modification as shown in Fig. 6, the reciprocal motion and the inclination can be so arranged that the material will travel slowly or rapidly over the porous surface, so that the apparatus can readily be adjusted to the results desired.

Figs. 6 and 7 represent a modified arrangement of the apparatus, in which a rectangular air chamber 3^b, provided with a flat perforated surface 4^b, takes the place of the round atomizers as shown by 3 and 4, in Figs. 1, 2, 3, and 4. The screen, or wire netting, is indicated by 10^b, and the porous fabric by 5^b. A coarse wire screen is also preferably placed on top of the porous fabric to hold it down, or prevent it from bulging, as shown at 10^a, and this is further strengthened by the I-beams 35.

In operating this modified apparatus, the pulp is fed into the tank by the feeder 14^b, and, in passing through the liquid charged with air, the finer particles are held in suspension, from which the mineral is floated, while the coarser particles settle on the flat porous surface, and, due to the combined action of the air and oscillating motion, are gradually worked toward the discharge end and into the hopper 17, while the floatable material rises and is recovered as froth 20, in the launder 11.

The rate of flow of the material over the porous surface is governed by the rate of oscillation, and the inclination, so that the rate of flow is at all times under control. The oscillatory motion serves three well defined purposes: to prevent the pores from clogging by keeping the material moving, to give greater uniformity to the action of the atomized air, and to regulate and give greater uniformity to the flow of the pulp over the porous surface.

The difficulties enumerated have been more or less pronounced in all previous types of sub-aerated flotation machines, especially those having porous means for finely dividing the gas: it is obvious that in my appara-

tus, either as set forth in Figs. 1 and 2, or in Figs. 6 and 7, these difficulties are largely overcome, if not entirely eliminated.

The spacing of the porous arms, or atomizers, in Fig. 1, may vary. The escaping jets may commingle or not: in either case the thorough mixing or commingling of the gas is effected afterward by the reciprocating motion of the atomizers, and none of the material being treated can pass downwardly through a zone where there is no gas. Neither is it necessary to have the atomizers parallel although it is desirable not to have them vary too much. The reciprocating motion of the atomizers causes a uniformity of action not capable of being obtained with stationary atomizers. The degree to which mixing of the gas takes place is governed by the speed of reciprocation and the amplitude of oscillation. The reciprocal movement of the atomizers also keeps the pores of the atomizers free from settled solids.

I claim;

1. In apparatus for separating minerals from their gangue by flotation, a tank adapted to contain a liquid, a series of pipes suspended within the tank and submerged in the liquid and arranged transversely of the tank, a porous material surrounding the pipes, means for passing a gas into the pipes and through the porous material into the liquid in the tank thus gaseating the liquid, means for introducing the material to be treated into the tank and passing it through the gaseated liquid, means for imparting to the pipes a reciprocal motion transversely of the axes of the pipes and across the path of sinking particles, means for withdrawing the gangue from below the level of the introduction of the gas through the porous surface into the liquid, and means for recovering the mineral froth from the surface of the liquid in the tank.

2. In apparatus for separating minerals from their gangue by flotation, a tank adapted to contain a liquid, a porous surface suspended within the tank and submerged in the liquid, means for passing a gas through the porous surface into the liquid, means for introducing the material to be treated into the tank and passing it through the gaseated liquid, means for imparting to the porous surface a reciprocal motion in a direction of the flow of the liquid and across the path of the sinking particles of material, means for withdrawing the gangue from below the level of the introduction of the gas through the porous surface into the liquid, and means for recovering the mineral froth from the surface of the liquid in the tank.

3. In apparatus for separating minerals from their gangue by flotation, a tank adapted to contain a liquid, a series of atomizers arranged transversely of the tank suspended within the tank and submerged in the liquid, means for passing a gas through the atomizers into the liquid in the tank, means for introducing the material to be treated into the tank to pass through the gaseated liquid, means for reciprocating the atomizers transversely of their longitudinal axes and across the path of sinking particles of material, means for recovering the mineral froth from the surface of the liquid, means for removing the gangue from below the level of the atomizers, and means for varying the volume and pressure of the gas delivered to the respective atomizers.

4. In apparatus for separating minerals from their gangue by flotation, a tank adapted to contain a liquid, a series of atomizers suspended within the tank and submerged in the liquid and arranged transversely of the tank, means for passing a gas through the atomizers into the liquid, means for adjusting the atomizers to varying depths of liquid, means for introducing the material to be treated into the tank to pass through the gaseated liquid, means for reciprocating the atomizers across the path of sinking particles of material, means for recovering the mineral froth from the surface of the liquid, and means for removing the gangue from below the level of the atomizers.

5. In apparatus for separating minerals from their gangue by flotation, a tank adapted to contain a liquid, a series of atomizers suspended within the tank and submerged in the liquid, means for passing a gas through the atomizers into the liquid in the tank, means for adjusting the atomizers to varying depths of liquid, means for varying the volume and pressure of the gas delivered to the respective atomizers, means for introducing the material to be treated into the tank to pass through the gaseated liquid, means for imparting to the atomizers a reciprocating motion across the path of sinking particles of material, means for recovering the mineral froth from the surface of the liquid, and means for removing the gangue from below the level of the atomizers.

6. In apparatus for separating minerals from their gangue by flotation, a tank adapted to contain a liquid and having a tailings outlet at the lower portion and a froth overflow at the upper portion, a series of atomizers suspended within the tank and submerged in the liquid and arranged transversely of the tank, flexible means for supplying the atomizers with gas, means for introducing the material to be treated into the tank and into the gaseated liquid, and means for reciprocating the atomizers transversely of their longitudinal axes and across the path of sinking particles of material.

7. In apparatus for separating minerals from their gangue by flotation, a tank adapted to contain a liquid and having a tailings

outlet at the lower portion and a froth overflow at the upper portion, a series of atomizers suspended within the tank extending transversely of the tank at a distance from the bottom thereof, means for maintaining the zone occupied by the atomizers free from settled solids, means for supplying a gas to the atomizers, means for introducing the material to be treated into the tank to pass through the gaseated liquid, and means for reciprocating the atomizers transversely of their longitudinal axes and across the path of sinking particles of material.

8. In apparatus for separating minerals from their gangue by flotation, a tank adapted to contain a liquid and having a tailings outlet at the lower portion and a froth overflow at the upper portion, gas atomizers suspended within the tank and submerged in the liquid, means for supplying the atomizers with a gas, means for introducing the material to be treated into the tank and into the gaseated liquid, means for removing the gangue from below the level of the atomizers, means for reciprocating the atomizers, and means attached to the suspenders of the atomizers for working the mineral froth toward the froth overflow at the upper portion of the tank.

9. In apparatus for separating minerals from their gangue by flotation, a tank adapted to contain a liquid and having a tailings outlet at the lower portion and a froth overflow at the upper portion, gas atomizers suspended within the tank and submerged in the liquid, means for supplying the atomizers with gas, means for varying the intensity of gaseation in the liquid, means for introducing the material to be treated into the tank in the region of the greatest intensity of gaseation so as to cause a selective action toward the region of diminishing intensity of gaseation, and means for reciprocating the atomizer in a direction of the flow of the liquid and across the path of sinking particles of material being treated.

10. In apparatus for separating minerals from their gangue by flotation, a tank adapted to contain a liquid and having a tailings outlet at the lower portion and a froth overflow at the upper portion, a series of gas atomizers arranged with spaces between them, means for supplying the atomizers with gas, means for varying the intensity of the gaseation in the spaces between the respective atomizers so as to produce a selective action of the material being treated from one end of the series of atomizers toward the other end, means for introducing the material to be treated into the tank and into the gaseated liquid, means for reciprocating the atomizers transversely of their longitudinal axes and across the path of sinking particles, and means for removing the gangue from below the atomizers.

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Witnesses:
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CORA M. GREENAWALT.