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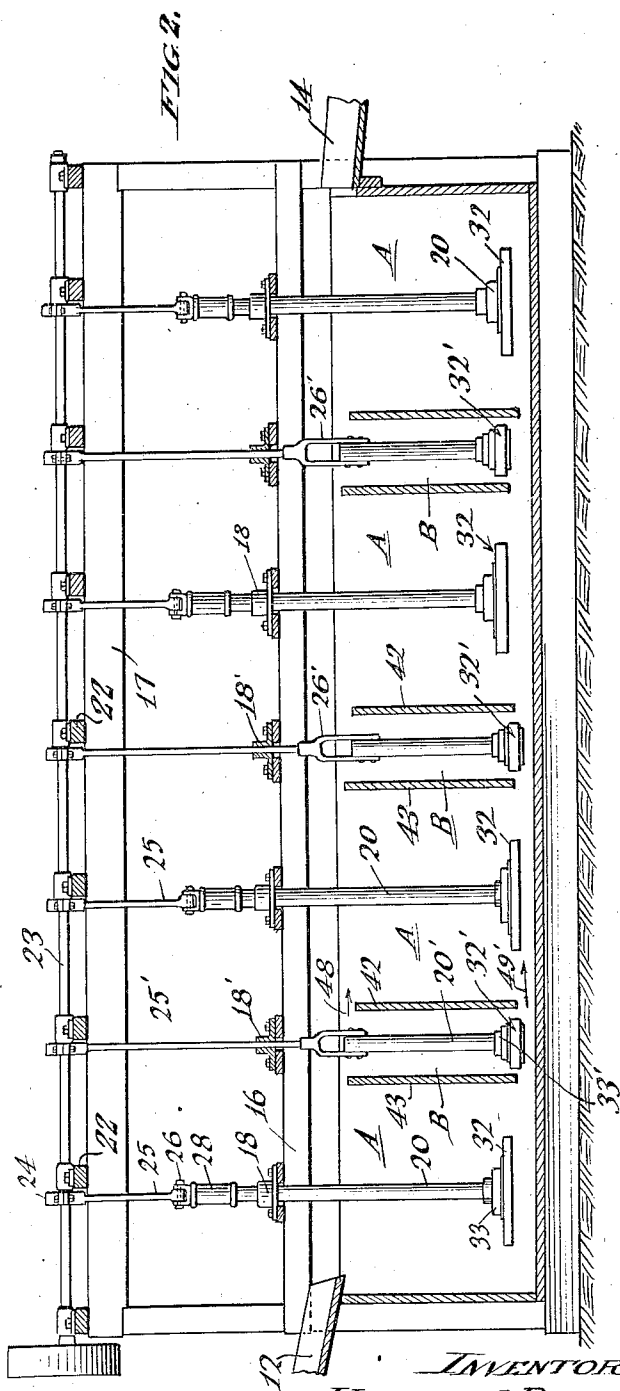
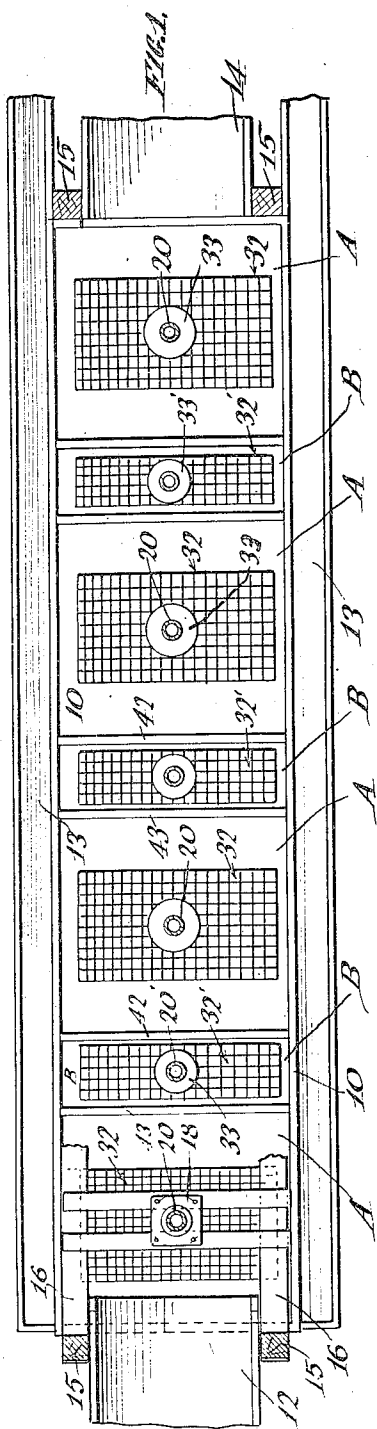
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FLOTATION CONCENTRATING MACHINE

Filed Feb. 8, 1928

2 Sheets-Sheet 1



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FIG. 3.

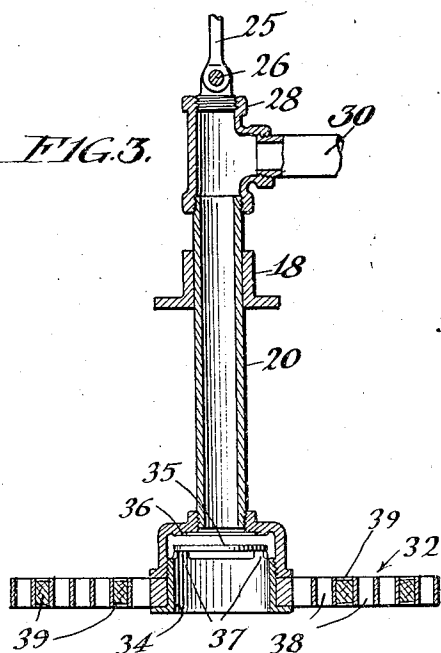


FIG. 4.

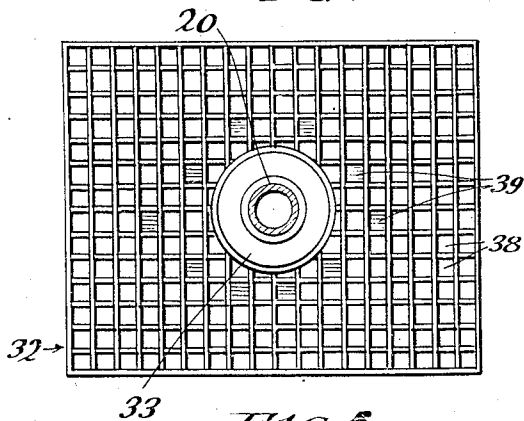


FIG. 5.

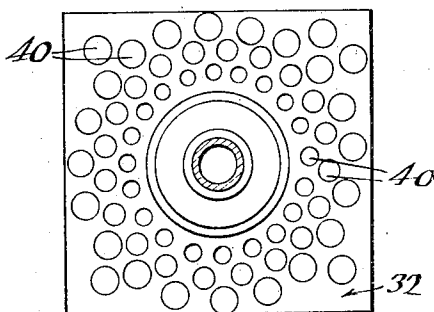
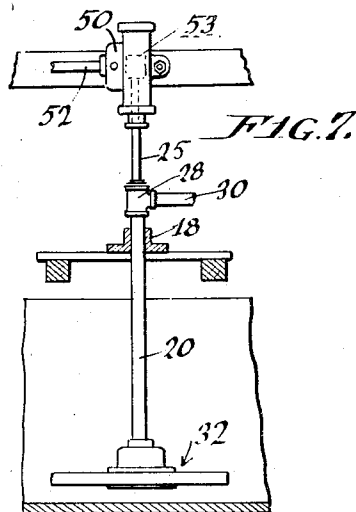
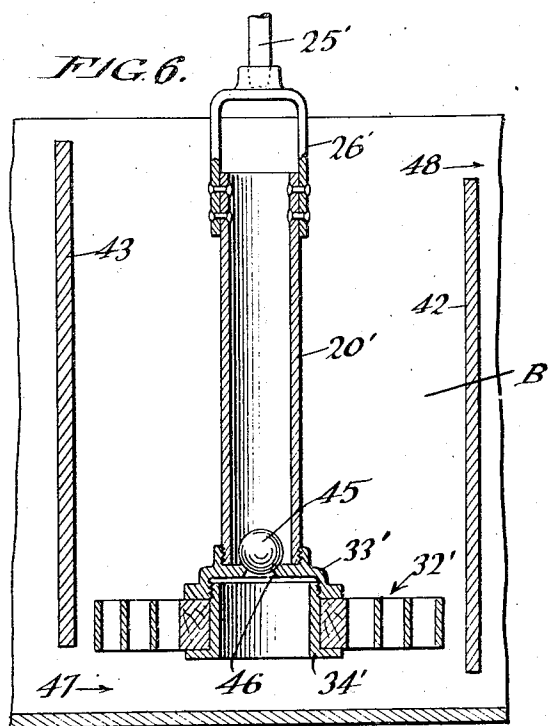


FIG. 6.



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## UNITED STATES PATENT OFFICE

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## FLOTATION CONCENTRATING MACHINE

Application filed February 8, 1928. Serial No. 252,722.

The invention relates to the art of recovery of mineral values by the so-called flotation method wherein a pulp containing the minerals to be concentrated is agitated and aerated to form a value-carrying froth which is collected.

One object of my invention is to provide a superior method and means for supplying air for the flotation and a more economical method and efficient means for agitating the pulp in the flotation machine. It is also an object of the invention to provide means which will closely regulate the amount of air supplied and the extent of the agitation so as to obtain the most efficient conditions.

Generally speaking, there are two types of flotation machines, one known as the agitator type and the other as the air blanket type. At the present stage of development of the flotation art, neither type is particularly suited to flotation conditions. In the agitator type, air is introduced into the pulp by a beater or by a vortex action, and in the air blanket type the air is forced through the meshes of the blanket and is thereby dispersed through the pulp. But the agitator machine agitates and disrupts the pulp too much, while with the other type, although a nice float is made, the blankets plug up altogether too fast and their efficiency is soon lost.

It is well established that finely divided air and a comparatively large amount of it under at least a slight pressure, is the most important feature in flotation. Also, my experience has shown me that some mechanical agitation is necessary, largely to prevent the settling out of the heavier particles. Therefore I have devised a machine which combines these two functions and accomplishes both results in a new and highly practical and efficient manner. With this machine I can easily and economically furnish to the pulp all the air that can ever be used, and at the same time produce sufficient agitation to prevent settling. Since I can make the air needed and give the agitation required within very close range of the most efficient conditions, I can operate my machine at a minimum expenditure of power.

Briefly stated, the invention resides broadly in a vertically reciprocating aerating-agitator which performs the combined functions of an air pump and a mechanical pulp-agitator. In a preferred form this device comprises a horizontal grid or perforated plate which acts as a pulp agitator and air distributor, said grid being carried upon the lower end of a hollow stem through which air enters and through the medium of which the device is vertically reciprocated. The reciprocation serves to pump air into the pulp, a valve being provided in connection with said hollow stem and preferably at the lower end thereof, said valve opening on each upstroke to permit air to be sucked in through the hollow stem by the tendency toward creation of a vacuum therebeneath, and closing on each downstroke to prevent return of the air and to insure mixing of the air with the pulp. Reciprocation is rapid and results in breaking up all of the large air bubbles and dissipating the air in fine streams through the pulp so that the finely diffused air may readily attach itself to the small metallic particles. Not only is the air thus properly conditioned and distributed, but the pulp is sufficiently agitated to prevent settling. Thus agitation is under control, settling is under control, and, since sufficient air is furnished in proper condition, efficient flotation results.

A plurality of these aerating agitators may be placed in separate cells feeding from one to another in series, or arranged in both parallel and series, and preferably an agitating circulator will be interposed between the cells in the series. The circulator is in the form of an agitating pump comprising a reciprocating horizontally disposed grid mounted on a hollow vertically reciprocating stem having a valve which opens on the downstroke and closes on the upstroke so as to force a stream of pulp up through the stem and discharge it adjacent the overflow to the next cell, each circulator being in an independent compartment which receives from the bottom of one cell and feeds by overflow to the top of the next cell.

The invention resides not only in the fea-

tures of novelty as above pointed out but also in such other novel features and combinations as may be elsewhere herein set out.

In the accompanying drawings wherein certain specific embodiments of the invention are disclosed by way of illustration:

Fig. 1 is a plan view with parts broken away of a modification wherein each aerating-agitator is disposed in a separate cell, the cells being arranged in series, and compartments being arranged between adjacent cells and containing circulating agitators for insuring proper circulation through the flotation unit.

Fig. 2 is a longitudinal section taken on line 5-5 of Fig. 4.

Fig. 3 is a vertical section through one of the aerating agitators.

Fig. 4 is a plan view of the grid of such aerating agitator.

Fig. 5 is a plan view of a modified form of grid or plate.

Fig. 6 is a vertical section through one of the agitating circulators; and

Fig. 7 indicates a modified form of reciprocating device for the agitators, this form being a compressed-air operated piston and cylinder.

The machine shown in assembled form in Figs. 1 and 2, comprises an open box 10 having a pulp feed 12, froth launders 13 at the sides, and a gangue overflow discharge 14. A plurality of supporting posts 15 carry horizontal rails 16 and 17 which respectively support guides 18 for the hollow stems 20 of the aerators 32, and mountings 22 for a line shaft 23 provided with eccentrics 24 which operate through pitmen 25 pivoted at 26 to reciprocate the hollow stems 20 and the aerating agitators 32 supported thereby. Connections 28 equipped if desired with throttling valves of usual form (not shown) and air hose 30 provide for the supply of air in regulated quantities, either free air or under slight pressure to said stem 20 through the hose 30. Each aerator-agitator 32 may be in the form of a grid or lattice-work structure as illustrated in Figs. 3 and 4, this grid being mounted on the respective hollow stem 20 through the medium of a head 33 and a flanged sleeve 34 threaded therein and retaining the grid. A plate or disk valve 35 adapted to engage a seat 36 in head 33, is mounted within said head and is also adapted to rest upon spacers 37 on the sleeve 34 to permit the passage of air around said valve and into the space below the head 33 and grid 32.

As the grid 32 is rapidly reciprocated through the line shaft 23, eccentrics 24, pitman 25 and stem 20, a considerable amount of agitation is produced even though the stroke be short. At the same time, each upstroke of the grid tends to produce a vacuum therebeneath and beneath the head 33, with the result that a quantity of air is drawn through

the stem 20 into the space within said head. Then, upon each downstroke the plate or disk valve 35 is forced up against its seat 36 and the air is forced to mingle with the pulp, and is broken into finely divided form and diffused by the action of the grid. In order to further distribute the air, some of the grid spaces are filled up so as to reduce the number of air spaces near the center and insure the working of the air out to the periphery of the grid. The open spaces are indicated at 38 while the filled spaces are indicated at 39. In Fig. 5, a modified form of grid is disclosed wherein a plate is drilled to provide the required number and distribution of holes 40, the holes being smaller and fewer near the center.

Box 10 is provided with a plurality of transverse partitions 42 to form individual cells —A— for the aerating agitators 32 whereby the pulp travels from one cell —A— to the next, and is positively subjected to aeration and agitation by each member 32 before it passes to the next cell. Any form of cell or pulp container in which the element 32 works may be employed.

Referring more particularly to Figs. 1 and 2, the pulp enters the feed trough 12 through the left end and gradually flows through the cells —A— from one aerator 32 to another, the heavy particles being kept in motion by the agitation resulting from the rapid reciprocating movement, while the finely diffused streams of air pick up the metallic values and carry them over the sides in the form of a froth which is discharged into the launders 13, the gangue being discharged over the overflow lip 14. If a blind spot develops at any place in any of the cells, the arms of the grid are extended to reach that spot and there produce the required agitation. As above described, the reciprocating movement causes the tendency toward development of a vacuum under the grid 32 and the head 33 on the upstroke which results in sucking air past the disk valve 35, this valve closing against its seat 36 on the downstroke and confining the air. This rapid reciprocating movement results in pumping ample air into the pulp beneath the grid and forcing it outward through the pulp in finely diffused form, which effect is materially facilitated by the rapid agitation. The stroke usually is short, being ordinarily only from one to two inches, but the rapidity of movement insures the desired functions and efficient flotation and recovery.

Superior results may be obtained by providing additional partitions 43 between the cells —A— so as to form small intervening cells or compartments —B— and in each of these cells —B— an agitating circulator 32' is located much like the agitator 32, this circulator being composed of a grid carried by a head 33' and flanged sleeve 34' on the lower end of a hollow stem 20' reciprocated from

the line shaft 23 by means of a pitman 25' passing through guide 18' and connected by a yoke 26' to the stem 20'. The pitman 25' has sufficient flexibility to care for the throw of the eccentric as the device is reciprocated. This device is different from the aerator 32 in that a ball valve 45 working on a seat 46 is adapted to open on the downstroke and close on the upstroke so that on each downstroke a quantity of pulp is forced through the hollow stem 20' and caused to overflow the top thereof. This action assists the entrance of pulp into the respective compartment —B— through the port 47 under the partition 43 and over the overflow at the top of partition 42 as indicated at 48 into the next cell —A—. In this fashion a positive movement of the pulp through the unit is assured together with proper agitation to keep the heavy values in circulation. In order that the heaviest gangue may work through the machine, gangue discharge ports 49' are provided below the partitions 42.

If desired, the aerators 32 and circulators 32' may be connected for reciprocation by some other means than the eccentrics, such as by air motors as indicated at 50 in Fig. 10, where a supply of compressed air entering through pipe 52 serves to actuate the motor piston 53.

From the foregoing it will be clear that I have provided a very efficient flotation apparatus in which the air supply and the agitation are properly controlled, only that amount of air and that amount of agitation being furnished which are necessary for the most efficient results. Power consumption also is under control because the grid need not have a great weight in itself and need not have a great weight of pulp above it, does not have to be deeply submerged, and does not have and does not need a long reciprocating stroke. Fineness of air bubbles, so essential to successful flotation, is assured by the rapidity of reciprocation and the form of the grid, and is thereby also under control.

I claim:

1. In flotation apparatus, a plurality of cells arranged in series, an aerator in each cell, compartments between the cells, and agitating circulators disposed in said compartments.

2. A flotation apparatus comprising a plurality of cells arranged in series, aerators in the cells, and agitating circulators disposed between the cells to insure circulation from one cell to the next.

3. An apparatus for mineral flotation comprising a plurality of cells arranged in series with circulation compartments therebetween, each of said cells being provided with a reciprocating device including a combined agitator and aerator, means to reciprocate said agitator, and agitating circulators disposed in said compartments.

4. An apparatus for mineral flotation comprising a plurality of interconnecting cells arranged in series with circulation compartments therebetween, an aerating agitator mounted in each cell, means to vertically reciprocate said agitators, an air valve in each of said agitators to pass air on the upstroke, each of said agitators including an extensively apertured grid for efficient distribution of the air, the air being discharged below the grids, and agitating circulators disposed in said compartments.

5. A mineral flotation apparatus including a plurality of interconnecting cells arranged in series with circulation compartments therebetween, a reciprocative agitator including an air pump connected to discharge below the agitator mounted in each cell, means to reciprocate said agitators, and agitating circulators disposed in said compartments.

6. A mineral flotation apparatus including a plurality of interconnecting cells arranged in series with circulation compartments therebetween, a reciprocative agitator including an air pump connected to discharge below the agitator mounted in each cell, and means to reciprocate said agitators with their pumps, each of said agitators being in the form of horizontally disposed extensively apertured grids adapted for thorough distribution of air through the mineral pump to be treated, and agitating circulators disposed in said compartments.

7. A mineral flotation apparatus including a plurality of interconnecting cells arranged in series with circulation compartments therebetween, a reciprocative agitator including an air pump connected to discharge below the agitator mounted in each cell, and means to reciprocate said agitators with their pumps, each of said air pumps including a valve to pass air on the upstroke and to close on the down stroke, and agitating circulators disposed in said compartments.

8. A mineral flotation apparatus including a plurality of interconnecting cells arranged in series with circulation compartments therebetween, aerating agitators each having an apertured grid adapted for thorough distribution of air, a hollow stem carrying each of said grids and adapted to conduct air thereto, a valve cooperating with each of said stems to discharge air below the grid upon reciprocation thereof, means to reciprocate said grids, and agitating circulators disposed in said compartments.

9. A mineral flotation apparatus including a plurality of interconnecting cells arranged in series with circulation compartments therebetween, a combined agitator and pump comprising a hollow stem mounted in each cell, a foraminous grid carried by each stem, and a valve mounted in each stem to pass fluid in one direction between the underside of the grids and the tops of the stems

upon reciprocation of the grids, means to reciprocate said grids successively, and agitating circulators disposed in said compartments.

- 5 10. A flotation apparatus comprising a plurality of cells arranged in series with circulation compartments therebetween, an agitator and an aerator mounted in each cell, each of said agitators and aerators comprising  
15 ing a hollow stem, a grid carried thereby, and a valve cooperating with said stem to pass fluid in one direction between the underside of the grid and the top of the stem upon reciprocation of the grid, means to  
20 reciprocate the grid, each of said grids having air passages therethrough of less area at the center in any radial line than at the periphery, and agitating circulators disposed in said compartments.

In testimony whereof I affix my signature.  
HERBERT WATMOUGH PUDAN.

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