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J. B. BROWN

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FROTH FLOTATION APPARATUS

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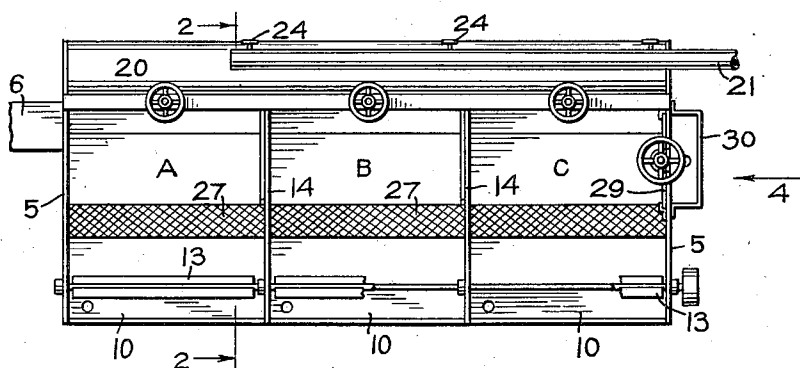


FIG. 1.

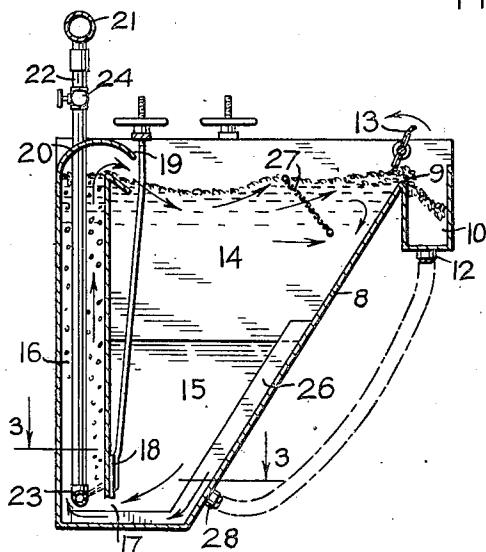


FIG. 2.

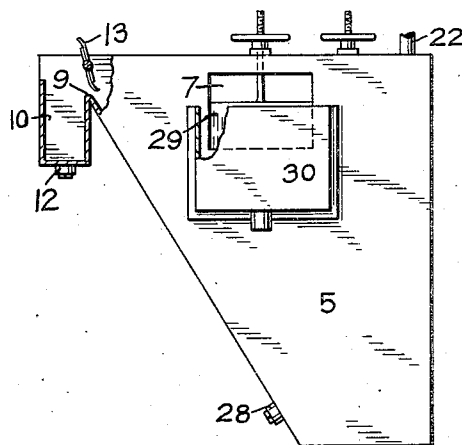


FIG. 4.

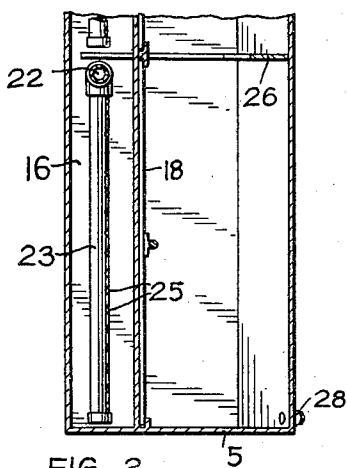


FIG. 3.

JAMES B. BROWN,
INVENTOR.

BY
Rolland et al, McEwen & Campbell
Attorneys.

UNITED STATES PATENT OFFICE

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FROTH FLOTATION APPARATUS

James B. Brown, Colorado Springs, Colo., assignor
to B. & B. Flotation Company, a common-law
trust of Denver, Colo., as trustee

Application February 23, 1942, Serial No. 431,958

10 Claims. (Cl. 209-168)

1

This invention relates to froth flotation apparatus and more particularly relates to apparatus of the type that performs both roughing and cleaning operations in a single treatment.

The present invention embodies improvements over the construction and operation disclosed in my United States Patent No. 1,351,155, issued August 31, 1920, for Ore-flotation apparatus.

In the apparatus disclosed in said patent pulp was introduced into each cell through a restricted feed compartment and then into an air lift discharging into the upper portion of the cell. Some recirculation of pulp within a given cell was accomplished by the provision of an opening from the bottom portion of such cell into the air lift compartment.

However, such inlet was of restricted size and the volume of recirculating matter was further limited by the volume and pressure of the feed traveling into the air lift compartment from the feed compartment. Similarly, the volume and pressure of recirculating pulp was a limiting factor on feed capacity.

In addition, when a succession of cells were operated as a unitary machine, pulp from a preceding cell was collected and delivered by suitable conduit means into the feed compartment of the next succeeding cell, and this involved a circuitous movement of pulp from the feed inlet to the discharge outlet of the machine.

As a result, the tonnage capacity of a machine of a given cell size was limited by the size of the conduits and passages through which the pulp was moved, and attempts to accelerate the movement of pulp through the machine as a means of increasing capacity would produce undue turbulence impairing metallurgical efficiency.

The improvements constituting the present invention were designed to create a machine of relative great treatment capacity with a given size of cell or tank, while utilizing the beneficial treatment feature of my patented invention.

In accomplishing the main purpose of the changed design, it was discovered that additional benefits were derived. These include reduction in wear, reduction in power requirements to attain a desired degree of aeration, and better metallurgical efficiency resulting from increased mixing of gas, solids and reagents, due largely to a substantially increased recirculation within the cells or treatment zones.

It is an object of the present invention to provide a machine in which a pulp body is subjected to a succession of flotation treatments, in a relatively short treatment interval without impairing metallurgical efficiency.

2

Another object of the invention is to provide froth flotation apparatus in which a high degree of aeration and gas-solids intermixture or contact is attained with relatively small power consumption.

A further object of the invention is to provide froth flotation apparatus in which substantially no wear on component parts is occasioned by movement of a gritty pulp through the apparatus.

Other objects reside in novel details of construction and novel combinations and arrangements of parts, all of which will be fully disclosed in the course of the following description.

To afford a better understanding of the practice of the invention, reference is made to the accompanying drawing illustrating a typical embodiment of said invention and in the drawing, in the several views of which like parts have been designated similarly,

Fig. 1 is a top plan view of a typical 3-cell arrangement embodying the improved features of my invention,

Fig. 2 is a section taken along the line 2-2, Fig. 1, and drawn to an enlarged scale,

Fig. 3 is a section taken along the line 3-3, Fig. 2, and

Fig. 4 is an end elevation illustrating the level regulating control of the machine of Fig. 1.

The machine illustrated in the drawing comprises a tank 5 provided at one end with a feed inlet 6 and at its opposite end with a discharge outlet 7 which determine a liquid level in the tank.

The tank preferably is of rectangular contour with one wall 8 disposed at a sharp downward inclination and terminating at its top in a froth overflow 9. A suitable launder 10 adjoins the overflow 9 and at suitable intervals is provided with drain openings 12, which may be plugged if desired in the manner illustrated in Figures 2 and 3.

Froth skimmers or paddles 13 are mounted for rotation adjacent overflow 9 and assist the froth removal from tank 5. The interior of tank 5 is divided by a plurality of partitions 14 into a series of treatment zones A, B and C. Preferably, the partitions 14 terminate at a substantial distance above the bottom of tank 5 to provide a succession of pulp passages 15 between inlet 6 and outlet 7.

Along the side of tank 5 opposite wall 8 a series of air lift compartments 16 are disposed with an intake 17 controlled by an adjustable gate or valve 18 in the bottom of tank 5, and terminating at the top in a discharge spout 19. This

spout is downwardly inclined due to curvature of the outer wall of compartment 16, as indicated at 20, and is positioned in the tank above and in proximity to the liquid level.

The air lift compartment 16 is illustrated as a single compartment extending through the several treatment zones therein, but it will be understood that variations and differences in construction are possible within the scope of this invention.

Gas for such compartments is delivered to a header 21 from a blower or other suitable source (not shown) and is then delivered through conduits or pipes 22 into distributor nozzles 23. Valves 24 control the flow through nozzles 23 and outlets 25 in such nozzles are positioned to impart an upward component to gas delivered into compartments 16.

To assist the recirculation action in each of the zones A, B and C, baffles 26 extend along the wall 8 and onto the bottom of tank 5 adjacent passages 15. Supernatant matter not entrapped in the froth together with settling solids descends along wall 8 and onto the bottom of the tank. Baffles 26 retard movement of such matter through passages 15 and on reaching the bottom it becomes subject to the suction influence exerted on intake 17 by the air lifts.

To restrain turbulence in the upper portion of the tank, screen baffles 27 are disposed within the liquid body adjacent its surface in the path of the stream moving from spout 19 to overflow 9. The screen is of large enough mesh to permit passage of the coarsest solids of the pulp and preferably is disposed at an inclination to the flow as illustrated in Figure 2, to exert its greatest restraint on turbulence.

At suitable distances along the tank 5, plugged openings 28 are provided near the bottom, and when a rougher-cleaner operation is desired froth discharged from any of the zones A, B or C may be returned to any of these outlets 28 for retreatment through connection of a suitable conduit, as indicated by the dotted line representation in Figure 2.

The level regulation of the machine is attained by the provision of a screw-actuated gate 29 movable relative to outlet 7 to vary the height of the overflow. A suitable box or launder 30 receives such discharge from which it may be conducted to waste or apparatus for further treatment.

After the tank 5 has been filled with pulp and a liquid level determined by regulation of gate 29, and the proper aeration for such pulp has been established by setting valves 24 and gate 18, the machine will operate continuously with only minor regulation.

Pulp entering through inlet 6 which is located near the bottom of the tank is drawn into compartment 16 through the intake 17 by the suction influence of the rising column. As the pulp reaches the top of compartment 16, it is caused to change direction by deflector plate 20 and discharges across the length of cell A in a downward lateral direction.

While undue turbulence is prevented by the provision of screen baffle 27, there is a steady flow of aerated pulp from spout 19 to overflow 9. Gangue materials descending into the relative quiescent liquid body beneath spout 19 settle through the same, while mineral responding to the action of reagent is elevated thereby and trapped in the froth in which it passes across overflow 9.

Some mineral, usually a middlings product,

which does not respond sufficiently to the reagent to carry into the froth, upon reaching wall 8 will descend therealong and return to the bottom of the tank. Baffles 26 prevent too rapid movement of this matter through the tank and insure adequate recirculation in one zone before discharge with the pulp through passage 15 and into the succeeding zone.

Some of the solids settling out of the pulp stream passing from spout 19 to overflow 9 are drawn through passage 15 into the next succeeding cell where the operation previously described is repeated.

In this way, the pulp from which substantially all mineral content has been removed in the froth by the succession of recirculation treatments reaches the overflow weir 7 after a relatively short period of retention in the tank. Despite this, the control of air introduction and the regulation of the size of the air lift intake insure considerable recirculation of the pulp through each treatment zone before the major portion of such pulp body passes into the next succeeding treatment zone.

Unlike the arrangement of my patented machine, the intake to the air lift compartment can be varied in size to feed into the same a volume of pulp corresponding to the volume which the air lift compartment 16 can accommodate. As the size of this compartment is greatly in excess of the size required to handle the normal volume of feed to the machine, this arrangement promotes a considerable amount of recirculation.

This feature is of particular advantage when abnormal feed conditions are encountered. For example, when a ball mill unloads and there is a sudden surge of a relatively large quantity of excess solids in the pulp as a result, the gate 18 can be moved to a wide-open position and such excess solids will be rapidly drawn through the air lift compartment and the disadvantages of this sudden density change are quickly overcome. In contradistinction, such an occurrence in the machine of my issued patent would result in plugging because of the opposing influences of the supply to the air lift compartment from both the feed compartment and the flotation cell.

Likewise, a sudden influx of excess feed in this way does not materially alter the liquid level in a given treatment zone as the provision of the series of openings 15 insures a uniform level throughout the tank and any tendency toward an abnormal rise in level throughout the machine can be quickly relieved by changing the position of overflow gate 29.

Thus we see that the control of the intake opening 17 provided by gate 18 permits accommodation of considerable variation in both density and volume within a given treatment zone without material effect upon the action in other similar zones. Similarly, control of the final overflow from the machine permits the introduction of a volume of pulp considerably in excess of normal into the respective treatment zones without reduction in froth recovery or otherwise impairing metallurgical efficiency.

In the aforesaid description no mention has been made of the introduction of reagent into the treatment. In present practice, the usual treatment involves the introduction of reagent in the grinding circuit, or in conditioning tanks ahead of the flotation operation, to insure adequate coating of the mineral surfaces before be-

ing subjected to the influences of aeration in the flotation treatment.

However, if a given treatment requires the introduction of reagent, it will be understood that suitable feeding devices can be associated with the respective treatment zones of the present machine so that reagent will be fed into the pulp therein and a high degree of intermixture and mineral surface coating will be attained by the agitation occurring in the air lift compartments, and the repetitions of such action induced by the recirculation provided in each zone.

Due to the fact that the air lift compartments are designed to accommodate a volume of pulp greatly in excess of the normal requirements of the machine and the further fact that the normal air supply to the machine is able to lift a pulp through such compartments of much greater density than the normal pulp density which the machine is designed to treat, it is possible in a given machine to greatly increase the treatment capacity thereof without enlarging the tank, through the simple expedient of employing substantially maximum gas volume and maintaining the intake 17 in a substantially wide-open position. As a result, plants requiring increased capacity are not put to the inconvenience of providing additional floor space and horsepower for operation when such machines are installed in the plant.

Another advantage of the present design resides in the fact that it is suited for either right or left hand operation by the simple expedient of reversing the feed inlet and discharge outlet. So far as the other components of the machine are concerned, it makes no difference in the metallurgical efficiency that the pulp flow is in one direction or the other.

It has been found that over long periods of operation, the aeration imparted to the rising column in the air lift compartments has a cushioning effect on the movement of the gritty pulp through the compartment inclusive of the deflector 20 and spout 19. Likewise, due to the fact that there is no excessive agitation in the lower portion of the tank as occurs in most flotation machines, the wear on the tank walls and bottom is relatively slight. Consequently, the present machine even when treating large volumes of pulp continuously over relatively long periods, will not require shutdowns for repair or replacement of parts.

In my issued patent there is repeated reference to the flotation of sulfide mineral. It will be understood that in present day flotation practice a great variety of materials are treated including chlorides and oxides, for example, and also many materials which generally are classed as non-metallics. The present machine is designed for general use in froth flotation treatments including compositions of the aforesaid character.

Due to the simplicity of design in the present machine, it is possible to utilize a variety of materials in its construction. The tank and compartment arrangement are particularly adapted for wooden construction and this is of particular advantage during the present metal shortage as tanks made of wood are adapted for long periods of service without repair or replacement.

Changes and modifications may be availed of within the spirit and scope of the invention as defined in the hereunto appended claims.

What I claim and desire to secure by Letters Patent is:

1. Froth flotation apparatus comprising a tank for pulp having a feed inlet and a discharge outlet determining a liquid level therein, an overflow lip extending along one side of the tank, means including an air lift for aerating and elevating solids of the pulp onto the surface of each treatment zone in the direction of the overflow lip, said air lift having an intake opening for settled solids at the bottom of the tank and a discharge outlet at approximately the surface of the liquid in the tank, and means having openings adjacent the surface of pulp and adapted to restrain surface agitation while permitting passage of solids to said overflow lip.

2. Froth flotation apparatus comprising a tank for pulp having a feed inlet and a discharge outlet determining a liquid level therein, partitioning means for dividing the upper portion of the pulp body into a plurality of treatment zones, an overflow lip extending along one side of the tank through the plurality of zones, means including an air lift for aerating and elevating solids of the pulp onto the surface of each treatment zone in the direction of the overflow lip, said air lift having an intake opening for settled solids at the bottom of the tank and a discharge outlet at approximately the surface of the liquid in the tank, and porous means adjacent the surface of each treatment zone constructed and arranged to restrain surface agitation while permitting passage of solids to the overflow lip.

3. Froth flotation apparatus comprising a tank for pulp having a feed inlet and a discharge outlet determining a liquid level therein, partitioning means for dividing the upper portion of the pulp body into a plurality of treatment zones, an overflow lip extending along one side of the tank through the plurality of zones, means including an air lift for aerating and elevating solids of the pulp onto the surface of each treatment zone in the direction of the overflow lip, said air lift having an intake opening for settled solids at the bottom of the tank and a discharge outlet at approximately the surface of the liquid in the tank, and a screen adjacent the surface of each treatment zone constructed and arranged to restrain surface agitation while permitting passage of solids to the overflow lip, said screen being of a mesh size permitting passage therethrough of the coarsest solids of the pulp.

4. Froth flotation apparatus comprising a tank for pulp having a feed inlet and a discharge outlet determining a liquid level therein, partitioning means for dividing the upper portion of the pulp body into a plurality of treatment zones, an overflow lip extending along one side of the tank through the plurality of zones, means including an air lift for aerating and elevating solids of the pulp onto the surface of each treatment zone in the direction of the overflow lip, said air lift having an intake opening for settled solids at the bottom of the tank and a discharge outlet at approximately the surface of the liquid in the tank, porous means adjacent the surface of pulp adapted to restrain surface agitation while permitting passage of solids to said overflow lip, and adjustable means for varying the volume of pulp delivered to said air lift means.

5. Froth flotation apparatus comprising a tank for pulp having a feed inlet and a discharge outlet determining a liquid level therein, partitioning means for dividing the upper portion of the pulp body into a plurality of treatment zones, an overflow lip extending along one wall of the tank for the discharge of supernatant matter from said

treatment zones, porous means adjacent the surface of pulp adapted to restrain surface agitation while permitting passage of solids to said overflow lip, and means including an air lift constructed and arranged to aerate pulp, to discharge the aerated pulp at approximately the surface of the liquid and toward said overflow lip, and to recirculate non-floated constituents of the pulp, said air lift means comprising an upright compartment spaced from said overflow lip, a curved deflector plate disposed in overhanging relation to the top of said compartment and defining a discharge outlet therefor, there being a plurality of intake openings between said compartment and the interior of the tank adjacent the bottom thereof of a size normally corresponding to the superficial area of the corresponding portion of the compartment, a gate mounted on a wall of the compartment adjacent each intake opening for sliding movement relative thereto to vary the intake capacity, and means for introducing gas under pressure into the lower portion of said air lift compartment.

6. Froth flotation apparatus comprising a tank for pulp having a feed inlet and a discharge outlet determining a liquid level therein, there being a discharge for supernatant matter extending along one side of the upper portion of the tank, means including an air lift for aerating and discharging solids of the pulp collecting in the bottom of the tank onto the surface of the pulp body and in the direction of said discharge for supernatant matter, and porous means adjacent the surface of pulp adapted to restrain surface agitation while permitting passage of solids to said overflow lip.

7. In froth flotation apparatus, a tank for pulp, an overflow lip extending along one side of the tank, an air lift spaced from said overflow lip and adapted to aerate and elevate solids of the pulp and discharge the same in a substantially horizontal direction onto the surface of the pulp and toward said overflow lip, porous means adjacent

the surface of pulp adapted to restrain surface agitation while permitting passage of solids to the overflow lip, and baffle means adapted to direct settling solids downwardly along the side wall of said tank beneath said overflow lip to the lower portion of the pulp body, said tank being constructed and arranged to permit a longitudinal flow of pulp in the lower portion thereof.

8. In froth flotation apparatus as set forth in claim 7, a plurality of adjustable intake openings adjacent the bottom of said air lift.

9. Froth flotation apparatus comprising a tank for pulp having a feed inlet and a discharge outlet determining a liquid level therein, an overflow lip extending along one side of the tank, means including an air lift for aerating and elevating solids of the pulp onto the surface of the pulp and in the direction of the overflow lip, said air lift having an intake opening for settled solids at the bottom of the tank and a discharge outlet at approximately the surface of the liquid in the tank, means having openings adjacent the surface of pulp and adapted to restrain surface agitation while permitting passage of solids to said overflow lip, and adjustable means for varying the volume of pulp delivered to said air lift means.

10. Froth flotation apparatus comprising a tank for pulp having a feed inlet and a discharge outlet determining a liquid level therein, an overflow lip extending along one side of the tank, means including an air lift for aerating and discharging solids of the pulp in a substantially horizontal direction onto the surface of the pulp and in the direction of the overflow lip, said air lift having an intake opening for settled solids at the bottom of the tank and a discharge outlet at approximately the surface of the liquid in the tank, porous means adjacent the surface of pulp adapted to restrain surface agitation while permitting passage of solids to said overflow lip, and adjustable means for varying the volume of pulp delivered to said air lift means.

JAMES B. BROWN.