Aug. 27, 1946. A. W. FAHRENWALD 2,406,532

FLOTATION MACHINE

Filed July 12, 1943 3 Sheets-Sheet 1

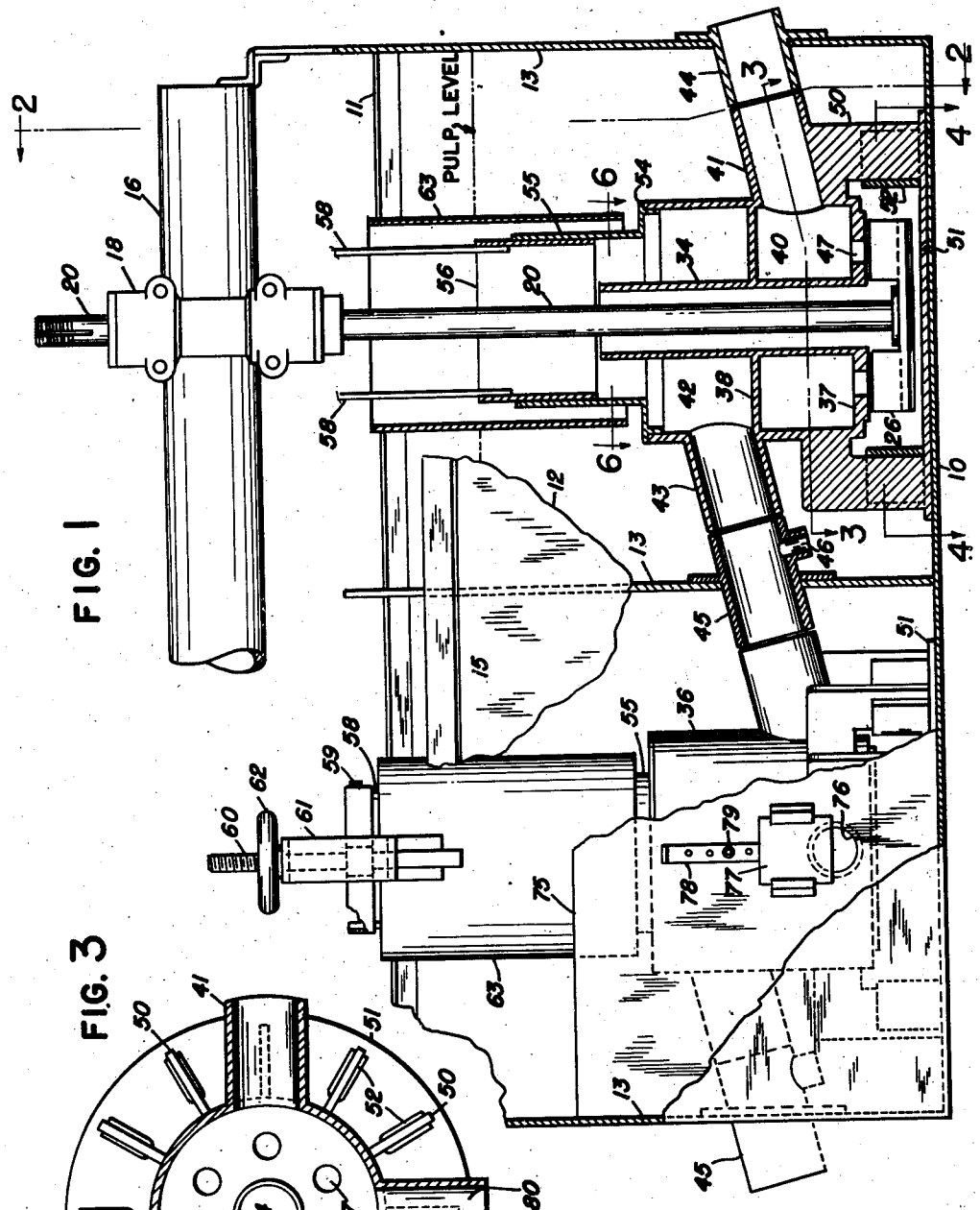


FIG. 1

FIG. 3

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FIG. 2

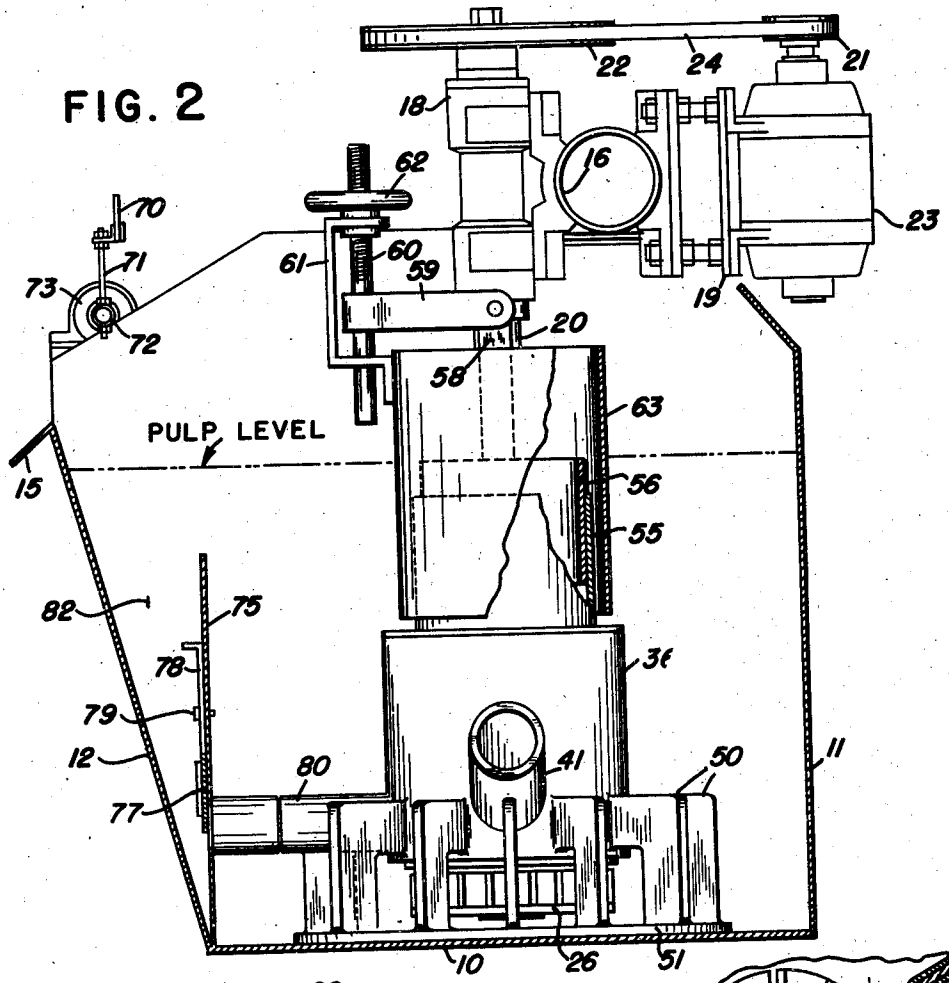
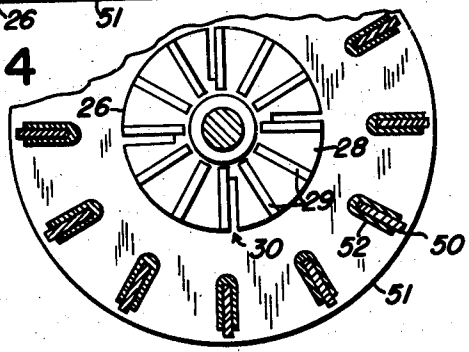


FIG. 4



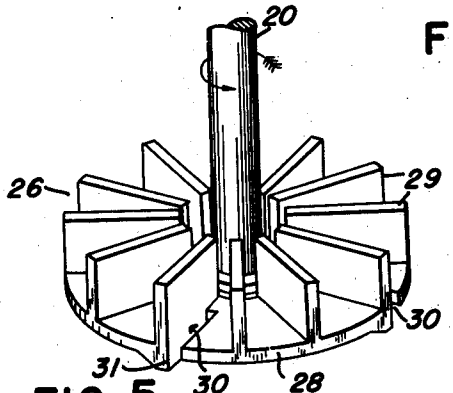


FIG. 5

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FIG. 6

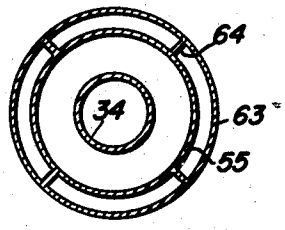


FIG. 9

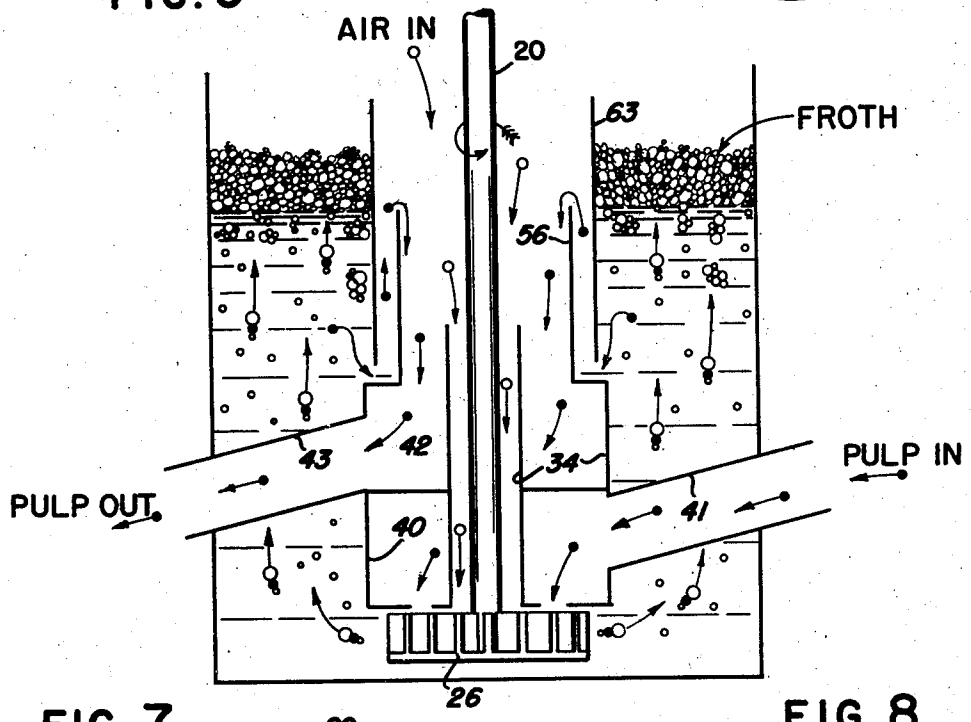


FIG. 7

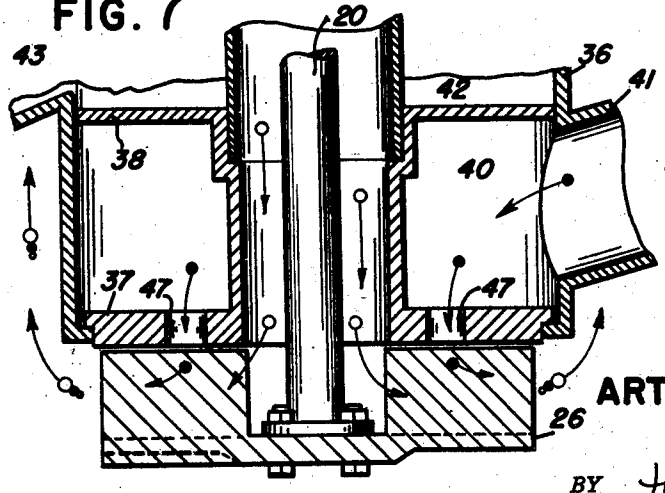
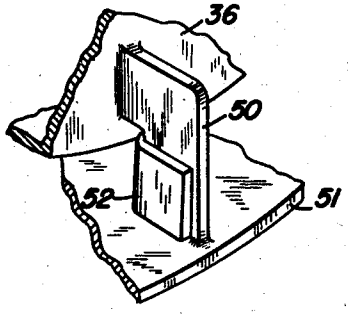


FIG. 8



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UNITED STATES PATENT OFFICE

2,406,532

FLOTATION MACHINE

Arthur W. Fahrenwald, Moscow, Idaho

Application July 12, 1943, Serial No. 494,319

17 Claims. (Cl. 209—169)

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This invention relates to a flotation machine useful in ore dressing processes wherein mineral bearing pulp is circulated, agitated and aerated to facilitate the separation and recovery of the various component elements.

Reference is made to my co-pending application, Serial No. 415,893, filed October 21, 1941, for a Flotation machine, now matured into United States Patent No. 2,337,806, patented December 28, 1943, of which this application is a continuation-in-part. Also see my Patent No. 2,291,031, issued July 28, 1942, and entitled "Flotation cell."

The general objects of this invention are to provide a new and improved machine for the treatment of ore-bearing pulp whereby an increase in production relative to the conventional input of power is obtained; wherein a higher rate of mineral recovery per unit of cell volume is possible over earlier equipment; wherein a higher grade quality of concentrate is produced or attained than has heretofore been thought possible; and wherein a foolproof system of handling ore-bearing pulps is provided to eliminate to a large extent the necessity of the exercise of a high degree of human judgment in the operation of the machine.

The dressing of mineral pulps is not new and has been performed in various ways by several types of machines, most of which employ a cell into which and from which pulp is moved and in which the moving pulp is aerated to produce a froth that is skimmed to separate the concentrate from the pulp residue passing on. One of the earlier practices that I have determined to be bad in principle and inefficient in operation is that accompanying the operation of flotation cells wherein pulp and the incoming air is jointly fed to the impeller through a stand pipe close to the axis of the impeller hub and around the shaft thereof. This condition is impracticable and objectionable for several reasons and it is an important object of this invention to provide mechanism to cure these conditions, which are, generally, a strangulation of air intake due to uneven pulp flow blocking the air intake, thus producing uneven aeration, undesirable pulp and air centrifuging, improper pulp swirls in the cell, and unnecessarily high power consumption. The feeding of pulp at or near the hub of the impeller is improper because of the slow lineal velocity of the blades of the impeller and their consequent inability to properly impart force and pressure to the pulp.

In accordance with my invention, this machine provides for the introduction of both original and

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recirculatory pulp in a gravity flow that reduces power requirements, and it also includes the introduction of the two prime elements, pulp and air, to the cell and its impeller through a separate and distinct passageway for each. Further advantages are gained by sequentially delivering first the air and then the pulp to the impeller at different portions thereof. This feed is accomplished by leading the air to the impeller at its hub where the impeller blades most naturally receive the air and impart velocity to it, while the pulp is delivered to the impeller blades at a point where their peripheral velocity is greater than at the hub and they are better adapted to act upon the semi-solid matter in producing its aeration. By the actual scientific comparison of the present machine with those of the earlier art, it is possible to accurately measure the advantages gained by this new principle of pulp and air feed. I have done so and the results show that aeration can be doubled in this machine with a given volume of pulp over the aeration accomplished where both pulp and air are fed simultaneously to the impeller hub.

These advantages are partially due to the increased air moving capacity of the impeller blades that are thus freed at their axial ends to "bite" into the air and start it into high velocity movement, and also to the more efficient application of force to the incoming stream of pulp. In addition, this principle eliminates the formation of undesirable vacuum pockets that may form in the earlier machines and retard and disrupt the operation thereof.

I have also been able in this machine to prevent the formation of a vacuum under the impeller which normally draws gangue thereunder to increase the resistance against rotation of the impeller. In addition, I have made it possible for the space under the impeller to be filled with aerated pulp having a low viscosity and consequently less resistance to the impeller.

According to the preferred embodiment of my invention I provide a cell structure adapted to contain fluid pulp and having suitable pulp inlet and outlet openings as well as a froth overflow lip to a froth launder. This cell may be used singly or in multiples in series and their use is permissible in every type of mineral recovery circuit. Since the individual cell contains the nucleus of the invention as well as its appurtenances, I shall confine this description to a single cell. Upon suitable structural support members I mount a cylindrical beam which forms the backbone of the moving parts of the cell, pri-

marily to support the upright shaft that carries the impeller in rotation, the drive means for this shaft, and the bearings in which this shaft is journalled.

As is customary, the impeller, which has upper blades, is disposed in the cell adjacent its floor and usually coincident with the vertical median of the cell. The impeller consists of a horizontal plate attached to a shaft rotatable in a vertical axis. Upon the plate are blades that radiate from the axis toward the edge and provide during rotation the draft for the air inlet column and the aeration of the pulp fed thereto. The plate is slotted at several places so that there is communication from above to below the plate, the under side of which also has minor blade elements to aerate the pulp that may be located under the impeller and to, at the same time, destroy any vacuum that otherwise would exist below the impeller disc if it were solid.

I surround the impeller with a plurality of anti-swirl deflector blades which receive and tend to collimate the tangentially moving streams of aerated pulp and permit their upward ascension in substantially vertical paths. Rising upward from the impeller at its hub is an air inlet column through which air is drawn down by the rotary action of the impeller. Surrounding the lower end of the inlet column is a pulp feed chamber that has a floor or bottom wall that covers the impeller and is provided with a plurality of pulp feed passages arranged to deliver pulp to the impeller blades at approximately one-half the distance from the hub to their outer ends. For convenience I have found it desirable to support the structure forming the pulp feed chamber upon the deflector blades and in certain cases these blades are attached to and form integral legs for this chamber structure. An inlet to the pulp feed chamber is arranged with a conduit to receive pulp entering the cell pulp inlet in the wall thereof and, on occasion, a recirculatory feed of pulp may be permitted from a pulp return trough of V-shape and contiguous with the cell and which receives overflow pulp in measured quantities.

Above the aforementioned chamber is an accumulator chamber for the outgoing pulp from the cell. These two chambers are preferably distinct from each other and the latter has an outlet coupled with the outlet opening of the cell. Rising from the accumulator chamber is a column having an overflow lip for outgoing pulp and the lip of this column may be formed as a vertically movable sleeve to vary the relative height of the lip above the flow to determine the pulp level of the cell. Means are provided for the manual movement of this sleeve from exterior of the cell. The overflow lip is surrounded by a baffle that rises from a point below the pulp level in the cell to above the level of the froth that forms upon the fluid pulp within the cell. A rotary froth paddle, adjustable as to its radius of sweep, is mounted on the cell in a position to assist the froth over the froth overflow lip and into the launder.

To facilitate the recirculation of pulp in an individual cell or in combination with other similar cells, I employ the pulp return trough mentioned above which is V-shaped and formed on a side of the cell preferably below the portion of the cell over which the outgoing froth passes. Conduits as desired are connected with the accumulator chamber as well as the pulp feed chamber and the passage of pulp thus recirculated is controlled by means of suitable gates or other valving elements.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment when read in connection with the accompanying drawings, in which

Figure 1 is a view in elevation of a pair of flotation cells embodying my invention, which view has portions broken away and others shown in section for convenience of illustration;

Figure 2 is a vertical sectional view of a cell showing the general interior arrangement of parts as taken on line 2—2 of Figure 1;

Figure 3 is a plan view in section taken on line 3—3 of Figure 1;

Figure 4 is a plan view in section taken on line 4—4 of Figure 1;

Figure 5 is a perspective view of the impeller employed in my flotation cell;

Figure 6 is a sectional view taken on line 6—6 of Figure 1;

Figure 7 is an enlarged detailed sectional view of the impeller and of the pulp feed chamber and air conduit illustrating the flow of material and its mixing and aeration in my flotation cell;

Figure 8 is a fragmentary perspective view of a deflector plate employed at the discharge of the impeller; and

Figure 9 is an upright diagrammatic view of a cell embodying my invention and illustrating the principle of operation thereof.

A preferred embodiment of my invention, referring to Figures 1 and 2 of the drawings, is constituted by a cell into which are placed the operating elements for the reception, aeration, and the passing on of mineral bearing pulp. A cell is made up of a plurality of walls including the bottom 10, back wall 12, front wall 12 and side walls 13. When a plurality of cells are operated together, usually one of the side walls forms a common wall between adjacent cells. The front wall has an overflow lip 15 across which the froth produced in the cell passes into a suitable launder (not shown). Supported at its ends above the cell is a longitudinal beam 16, here shown as tubular in shape. Upon this beam and over each cell I mount a quill-bearing 18 which receives and supports the impeller shaft or spindle 20 for rotation. Also mounted upon the beam 16 is a suitable motor base 19 to which motor 23 may be attached. Between the sheave 21 of the motor and a driven sheave 22 on the shaft 20 is drive belt 24, whereby rotary motion is transmitted from the motor to the impeller shaft.

An impeller, designated as a whole by the numeral 26, is shown in Figure 5 to comprise a base plate 28 that is secured to the bottom end of the shaft 20 and supports on its upper face a plurality of radiating blades 29. The inner ends of the blades 29 are preferably spaced a short distance from the shaft 20 for a purpose later to be described. At suitable places around the periphery of the plate 28 slots 30 are formed therein and adjacent one side of the slots 30, preferably on its trailing edge, in the normal direction of rotation, is a buttressed blade or vane 31 that extends axisward of the impeller at least the length of the slot 30.

During the operation of the cell, air is conducted to a point adjacent the hub of the im-

peller and interior of the ends of the blades 29 by means of the air conduit 34 which rises from a point directly above the impeller to about the mid-portion of the cell vertically. Surrounding this air conduit is a cylindrical wall 36 which has a bottom 37, and intermediate divider wall 38 which separates the annular spaced enclosed around the conduit 34 into a feed chamber 40 and a pulp accumulator chamber 42.

Pulp is fed to the chamber 40 by the conduit 41 and pulp is withdrawn from the chamber 42 by the conduit 43. Pulp is delivered from externally of the cell to the conduit 41 through the connector 44 and pulp passes from the conduit 43 to externally of the cell through the connector 45. Pulp may also be introduced from the cell into the connector 44 by means of the by-pass opening 46.

The bottom wall 37 of the chamber 40 is ported as shown in Figure 6 by several openings 47 which are arranged to discharge pulp to the upright blades of the impeller in approximately the mid-portion thereof.

The structure forming chambers 40 and 42 and including the conduit 34 is supported above the impeller and above the floor of the cell by means of inverted L-shaped legs 50 which rise from a base or wear plate 51. A plurality of these legs are arranged around the periphery of the impeller in radial fashion and serve to deflect discharge aerated pulp therefrom into upwardly directed paths of travel. Since the action of the discharging pulp upon the deflector legs 50 is abrasive, I protect them by individually removable sheaths 52 which may assume the form of U-shaped clips of wear-resisting material such as rubber or hard iron or the like.

The upper portion of chamber 42 is closed by a cover 54 having a sleeve 55 rising therefrom and forming a pulp overflow throat in the mouth of which is positioned a vertically adjustable sleeve 56 the upper lip of which determines and defines pulp level within the cell. It is preferable that the overflow lip 56 be cylindrical so that it is substantially axial of the cell proper.

The sleeve 56 is vertically adjustable and this adjustment is attained by attaching to the legs 58 a yoke 59 which is raised or lowered by the action of the screw 60 mounted in the bracket 61. The screw is raised or lowered by the hand wheel 62 when turned. The bracket 61 is secured to a cylindrical baffle 63 which surrounds the overflow lip of sleeve 56 from a point substantially below the pulp level to a point above the froth within the cell. Sleeve 63 is rigidly mounted upon the sleeve 55 by means of fillets 64 as shown in Figure 6.

Froth overflows across lip 15 from the cell under the urgence of the froth paddle 70 mounted on arm 71 which is swung by the rotary shaft 72 turned by motor 73.

It will be seen that the front wall 12 of the cell which slopes outwardly as it rises has interiorly thereof a septum 75 rising from the bottom of the cell upward to the pulp level. Septum 75, whose height is about two-thirds of the depth of the pulp, is ported at 76 and the size of this port may be varied by movement of the gate 77 that is mounted for vertically adjustable positioning by means of the arm 78 and pin 79. From the port 76 to the interior of chamber 40 a conduit 80 is provided for the conveying of pulp from the V-shaped settling chamber 82 formed between walls 12 and 75 into the pulp feed chamber above the impeller.

Method of operation

This flotation machine operates according to the well-known phenomena underlying the process of froth flotation. Air bubbles are introduced into a prepared pulp containing finely pulverized ore particles suspended in water. Upon the contact of the air bubbles with certain mineral particles the latter are attracted to and will adhere upon the skin of the bubbles and be levitated through the pulp body to the surface where a froth is formed and skimmed for the recovery of the thus accumulated values. It is well known that by the discriminate use of various flotation reagents the air bubbles can be made particularly attractive to certain values in the pulp while others will not adhere and will remain suspended in the pulp body for passage to other cells for recovery there or for ultimate disposal in any manner desired. Both bulk and differential flotation can be accomplished in the invention here described with the advantages set forth above.

My machine improves the present modes of flotation cell operation and function by providing means whereby better air-bubble mineral particle contact is effected to produce a more discriminate froth having better particle-suspending properties and the mineral bearing pulp from which a desired value has been withdrawn by the air bubbles is thereafter handled in a manner that enhances froth formation while at the same time it does not interrupt it or destroy the bubbles by cross currents that have an abrading and deleterious action on the froth. In my machine it will be apparent that I employ sub-aeration of the pulp with the air being drawn or forced to the impeller at the hub thereof while the pulp is fed to the impeller at about the middle of the blades of the impeller to produce a better air-bubble formation, an improved mechanical pulp dispersion, and a highly improved air-bubble mineral particle contact.

Pulp is fed to the cell through the connection 44 and conduit 41 into the feed chamber 40 which is toroidal in shape and is supported directly above the impeller 26. Air is passed directly to the hub of the impeller through conduit 34 which descends through the central opening of the torus shaped feed chamber but out of communication with that chamber. The blades of the impeller, being such that their inner or axisward ends are spaced from the hub or shaft of the impeller, easily bite into and scoop the air delivered thereto through conduit 34 and start that air into high velocity movement outward of the impeller without interference in its initial movement from pulp as is so often the case with those cells where pulp and air are fed together.

Pulp from the chamber 40 is delivered to or deposited upon the blades of the spinning impeller at points outward of the air pickup zone through the openings 47. It will be recognized that the speed of the impeller blades at the greater radius where the pulp is deposited is several times that at the hub radius which is smaller. Thus air is started freely into movement between the impeller blades while the blades outward of the hub are striking the streams of descending pulp at high velocity which in normal operation can be some 6000 times per minute. The effect is to finely disperse the pulp in streams of air and, in effect, atomization takes place. This atomized pulp is then ejected into the surrounding body of more solid pulp where bubble formation oc-

curs and particle adherence and levitation begins, with aeration being materially increased over that of conventional cells of different structure and modes of operation.

In addition to the above mentioned operation of the impeller, there are other functions provided by the slots **30** and the minor blades **31** on the lower side of the impeller plate **28**. The impeller rotates in a clockwise direction as viewed in Figure 5 and thus the slots **30** trail the blades **29** and **31**. While in unslotted blades it is customary for a vacuum to form under the impeller, with this arrangement any material drawn under the impeller is frothed and dispersed. The result is in operation a totally free impeller not operating against a highly viscous mass of pulp drawn thereunder as is true in the conventional machines.

As the dispersed air and pulp is ejected from the impeller it is deflected by blades **50** in a manner to collimate it and prevent swirling or boiling and by thus being deflected it immediately begins its ascent through the pulp toward the surface of the cell where the froth is formed.

As illustrated in Figure 9, the mineral particle pulp-bearing air bubbles leave the impeller and rise through the pulp body in the cell totward the surface. Since ejection is all around the periphery of the impeller there is a cylindrical sheet of potential froth rising in the pulp around the central feed and the accumulator chamber toward the surface of the cell. Axisward of this rising froth potentiation is the pulp withdrawal port between the baffle **63** and the exterior walls of the throat formed by members **55** and **56**. The outgoing pulp passes through this port evenly all around the cell interiorly of the rising froth potential in a manner that avoids cross currents and at a station that is subsequent in the course of travel of the pulp with respect to the station at which the froth leaves the pulp and forms on the pulp surface. In effect the pulp course is a closed circuit that provides very definite advantages in the cell operation. It can be definitely stated that this arrangement provides an increased rate of mineral recovery because the air bubbles reach the surface faster with less abrasion than is the case with cells wherein there are counter-currents between the pulp and the bubble flow. My cell is further marked in its operation by a complete absence of eddying currents, pulp boiling and bubble centrifuging and all well known to be bad conditions in flotation practices.

The pulp level within the cell may be varied by vertical movement of the overflow lip **56** through the raising or lowering of the yoke **59** under the action of the screw **60** produced by manual operation of handwheel **62**. The position of lip **56** is largely determined by the nature of the ore pulp being handled and other circumstances such as time and rate of recovery desired in a particular cell.

As pulp overflows the lip **56** it descends through the throat **55** into the accumulator chamber **42** and thence outward of the cell through conduit **43** and connector **45** where it may discharge into an adjacent cell or be passed along in the mineral recovery circuit in accordance with flotation practices. It is to be noted that the outgoing pulp is not permitted to flow to the impeller again. While air also passes downward through throat **55** to the air tube **34** the relative size of the two is such that the sheet of descending pulp clinging close to the inner wall of the throat does not interfere with the air stream as so often is the case with conventional cells.

Froth that accumulates on the surface of the pulp is drawn off the cell along one side thereof largely by gravity and assisted by the rotary froth paddle **70**. As the froth overflows lip **15** it may be deposited in a launder or other disposal means as is convenient or desirable.

It should be noted that the froth passes over the upper surface of the settling chamber **82** formed to one side of the cell just prior to the overflow of the froth from the cell. In this passage over chamber **82** the only mineral content that can return to the impeller must descend or settle through the relative still pool of the chamber, then only after it has made a complete circuit of the cell. In other words, there is no shortening of the recirculatory pulp from the impeller through the pulp mass and back to the impeller with an avoidance of its travel through the entire froth formation circuit. Such pulp as passes through chamber **82** is returned to the feed chamber **40** by way of conduit **80** under the control of valve **77** in its mouth. Thus recirculation is at all times under the control of the operator and can be critically adjusted to a particular condition.

I claim:

1. A flotation machine, comprising: a tank having pulp inlet and outlet openings and a froth overflow lip, an impeller rotatable in the lower portion of the tank, an air tube rising axially above said impeller for delivering air to the hub of the impeller, radial deflectors surrounding said impeller, a pulp feed chamber above said impeller surrounding the lower end of the air tube and having outlets for delivering pulp to the impeller radially outward from and independently of the air supply thereto, means for conveying incoming pulp from the tank inlet to the feed chamber, a pulp accumulator cup above said feed chamber and around the air tube, the upper edge of the accumulator cup defining the pulp level in said tank, a baffle surrounding said lip from a point therebelow and extending above the froth formed on the pulp in the tank, means for conducting pulp accumulated in said cup to exterior of the tank through the pulp outlet, a settling chamber in said tank and having its open mouth below the pulp level and under the froth just prior to its passage to the froth overflow lip of the tank, and means for conveying pulp from said settling chamber to the pulp chamber.

2. A flotation machine, comprising: a tank having pulp inlet and outlet openings and a froth overflow lip, an impeller rotatable in the lower portion of the tank, an air tube rising axially above said impeller for delivering air to the hub of the impeller, radial deflectors surrounding said impeller, a pulp feed chamber above said impeller surrounding the lower end of the air tube and having outlets for delivering pulp to the impeller radially outward from and independently of the air supply thereto, means for conveying incoming pulp from the tank inlet to the feed chamber, a pulp accumulator cup above said feed chamber and around the air tube, the upper edge of the accumulator cup defining the pulp level in said tank, a baffle surrounding said lip from a point therebelow and extending above the froth formed on the pulp in the tank, means for conducting pulp accumulated in said cup to exterior of the tank through the pulp outlet, a settling chamber in said tank and having its open mouth below the pulp level and under the froth just prior to its passage to the froth overflow lip of

the tank, and means for withdrawing pulp from said settling chamber for separate disposal.

3. A flotation machine comprising: a tank having pulp inlet and outlet openings and a froth overflow lip, an upwardly directed blade impeller rotatable in the lower portion of said tank means for rotating said impeller, an air tube rising above said impeller axially thereof, a pulp feed chamber above said impeller and surrounding the lower end of said air tube, said feed chamber having outlets for delivering pulp to the impeller blades outward from their inner ends and independently of the air supply thereto, means for conveying incoming pulp from the tank inlet to said chamber, and means for gathering pulp leaving the tank and for conducting it to the pulp outlet from the tank.

4. A flotation machine comprising: a tank having pulp inlet and outlet openings and a froth overflow lip, an upwardly directed blade impeller rotatable in the lower portion of said tank means for rotating said impeller, an air tube rising above said impeller axially thereof, a pulp feed chamber above said impeller and surrounding the lower end of said air tube, said feed chamber having outlets for delivering pulp to the impeller blades outward from their inner ends and independently of the air supply thereto, means for conveying incoming pulp from the tank inlet to said chamber, and means for gathering outgoing pulp axially of the tank and for conveying it to the pulp outlet of the tank.

5. A flotation machine, comprising: a tank having pulp inlet and outlet openings and a froth overflow lip, an upwardly directed blade impeller rotatable in the lower portion of said tank means for rotating said impeller, an air tube rising axially above said impeller, a toroidal shaped pulp feed chamber surrounding the lower end of said air tube and having a bottom wall provided with a ring of openings spaced outwardly from the lower discharge end of the air tube and located to deliver pulp to the mid-portions of said blades, a pulp conduit from the tank inlet to said feed chamber, and means for gathering pulp leaving said tank and for conducting it to the pulp outlet from the tank.

6. A flotation machine, comprising: a tank having a froth overflow lip, an upwardly directed blade impeller rotatable in the lower portion of said tank means for rotating said impeller, an air tube rising axially above said impeller, a toroidal shaped pulp feed chamber surrounding the lower end of said air tube and having a bottom wall extending outward from the air tube and a downwardly directed outlet to the impeller at a point spaced outwardly from the inner wall of said chamber and located to deliver pulp to the mid-portions of said blades, means for conveying pulp to said feed chamber, means for gathering pulp leaving said tank, a settling chamber in said tank below the froth overflow lip and over which outgoing froth flows to said lip, and a spigot for said settling chamber.

7. A flotation machine, comprising: a tank having a froth overflow lip, an upwardly directed blade impeller rotatable in the lower portion of said tank means for rotating said impeller, an air tube rising axially above said impeller, a toroidal shaped pulp feed chamber surrounding the lower end of said air tube and having a bottom wall extending outward from the air tube and a downwardly directed outlet to the impeller at a point spaced outwardly from the inner wall of said chamber and located to deliver pulp to the mid-portions of said blades, means for conveying pulp to said feed chamber, means for gathering pulp leaving said tank, a settling chamber in said tank below the froth overflow lip and over which outgoing froth flows to said lip, and a spigot for said settling chamber to convey pulp settling therein to the feed chamber.

8. A flotation machine, comprising: a tank having an upwardly directed blade impeller in the lower portion thereof, means for axially feeding air to said impeller, means for feeding pulp to said impeller outward from the air feed thereto and midway of the impeller blades, means for centrally gathering pulp from said tank above the impeller and for conveying it exteriorly of the tank, a settling chamber in said tank to one side of the impeller and below the pulp level of the tank, a conduit from the settling chamber to the primary pulp feed means for the impeller, a by-pass conduit from the settling chamber to the primary pulp feed means, separately operated valves for each conduit, and an overflow lip in the wall of the tank toward which froth flows in passing over the settling chamber.

9. In a flotation cell, an impeller, comprising: a base plate, a single set of uncovered blades extending from the axis of the upper surface of said base plate, each blade on its axisward end being free from the others, means for supplying air to said blades at their free ends, means for independently supplying pulp to said blades at a point intermediate their ends and outwardly from the air supply thereto, and means for rotating said impeller.

10. In a flotation cell, an impeller, comprising: a base plate, a single set of uncovered blades on the upper surface of said base plate, each blade being radial of the axis of the base plate and having its axisward end free from the other blades, means for supplying air to said blades at their free ends, means for independently supplying pulp to said blades at a point intermediate their ends and outwardly from the air supply thereto, and means for rotating said impeller.

11. In a flotation cell, an impeller, comprising: a base plate, a single set of uncovered blades extending from the axis of the upper surface of said base plate, each blade on its axisward end being free from the others, said base plate having slits therethrough closely adjacent the trailing side of certain of the impeller blades, means for supplying air to said blades at their free ends, means for independently supplying pulp to said blades at a point intermediate their ends and outwardly from the air supply thereto, and means for rotating said impeller.

12. In a flotation cell, an impeller, comprising: a base plate, a single set of uncovered blades extending from the axis of the upper surface of said base plate, each blade on its axisward end being free from the others, said base plate having slits therethrough closely adjacent the trailing side of certain of the impeller blades, minor blades on the under side of the impeller base plate in advance of said slits, means for supplying air to said blades at their free ends, means for independently supplying pulp to said blades at a point intermediate their ends and outwardly from the air supply thereto, and means for rotating said impeller.

13. An impeller, comprising: a base plate, a single set of uncovered blades extending from the axis of the upper surface of said base plate, each blade on its axisward end being free from the others, said base plate having slits therethrough

closely adjacent the trailing side of certain of the impeller blades.

14. An impeller, comprising: a base plate, a single set of uncovered blades extending from the axis of the upper surface of said base plate, each blade on its axisward end being free from the others, said base plate having slits therethrough closely adjacent the trailing side of certain of the impeller blades, and minor blades on the under side of the base plate in advance of said slits.

15. In a flotation cell, a rotatable impeller in the lower portion of the cell and including means for rotating the same; above said impeller, an air tube having a lower discharge opening axially adjacent the upper surface of the impeller; walls forming an annular pulp feed chamber surrounding said air tube above the impeller; a supply conduit from exterior of said cell to said annular chamber; the bottom wall of said annular chamber having pulp discharge openings immediately adjacent said impeller; a collection cup above said annular chamber around said air tube for the reception, by overflow, of pulp from said cell; a movable sleeve for said cup lip including means for moving same; conduit means from said cup to without the cell; and walls forming a sleeve baffle around the lip of said cup rising from a point therebelow to above the froth surface within said cell.

16. A flotation machine, comprising: a tank having pulp inlet and outlet openings and a froth overflow lip, an impeller rotatable in the lower portion of said tank and comprising a plate having upwardly directed uncovered blades, means for rotating said impeller, an air inlet tube rising above said impeller co-axially thereof to deliver incoming air to the axisward portions of said blades, a pulp feed chamber above said impeller and around said air inlet tube and having outlets above the edges of said blades between their axisward and outward portions for delivering pulp thereto independently of the air supply, means for conveying incoming pulp from the tank inlet to said feed chamber, and means for gathering pulp to leave said tank and for conducting it to the pulp outlet opening therefrom.

17. In a flotation machine, sub-surface aeration mechanism, comprising: an impeller and means for rotating the same, said impeller having upwardly directed uncovered blades radiating from the impeller's axis, means for delivering air to the axisward portions of said impeller blades, and means for delivering fluent material to be aerated to said blades at stations located intermediate the ends of said impeller blades and outward in spaced apart relation from the point of delivery of the air.

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