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[54] **METHOD AND MEANS FOR FROTH FLOTATION CONCENTRATION UTILIZING AN AERATOR HAVING A VENTURI PASSAGE**

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[52] **U.S. Cl.** **209/164,** 209/170, 261/87, 261/77, 261/123, 261/DIG. 75

[51] **Int. Cl.** **B01f 3/04**

[58] **Field of Search**.....209/168–170, 164, 209/165; 261/87, 93, 77, 123, DIG. 75; 210/44, 221, 197

[56] **References Cited**

UNITED STATES PATENTS

1,310,051	7/1919	Blomfield	209/170
1,746,682	2/1930	Ruth	209/170
1,869,241	7/1932	Elie	209/168 X
2,293,183	8/1942	Walker	261/93
3,228,526	1/1966	Ciabattari et al.	210/221

FOREIGN PATENTS OR APPLICATIONS

602,202	3/1926	France	209/169 X
548,664	10/1942	Great Britain	261/93
58,314	7/1922	Sweden	209/170

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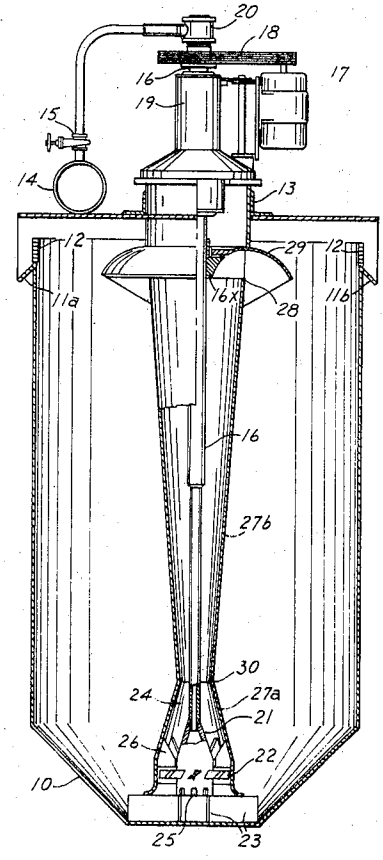
[57] **ABSTRACT**

Method and means concepts are disclosed for concentration of minerals and the like by froth flotation treatment in a cell utilizing a venturi tube aerator in a submerged upright position having a shorter flaring portion of a wider angle at its intake end and a longer portion of lesser angle at its upper discharge end with induced flow from intake to discharge causing dissolution of gas in the pulp flow through the intake portion and precipitation of dissolved gas on reagent coated mineral of the pulp flow through the discharge portion. Aerated pulp discharge from aerator onto pulp surface shielded to prevent bubble breakage during direct surface travel to overflow.

14 Claims, 7 Drawing Figures



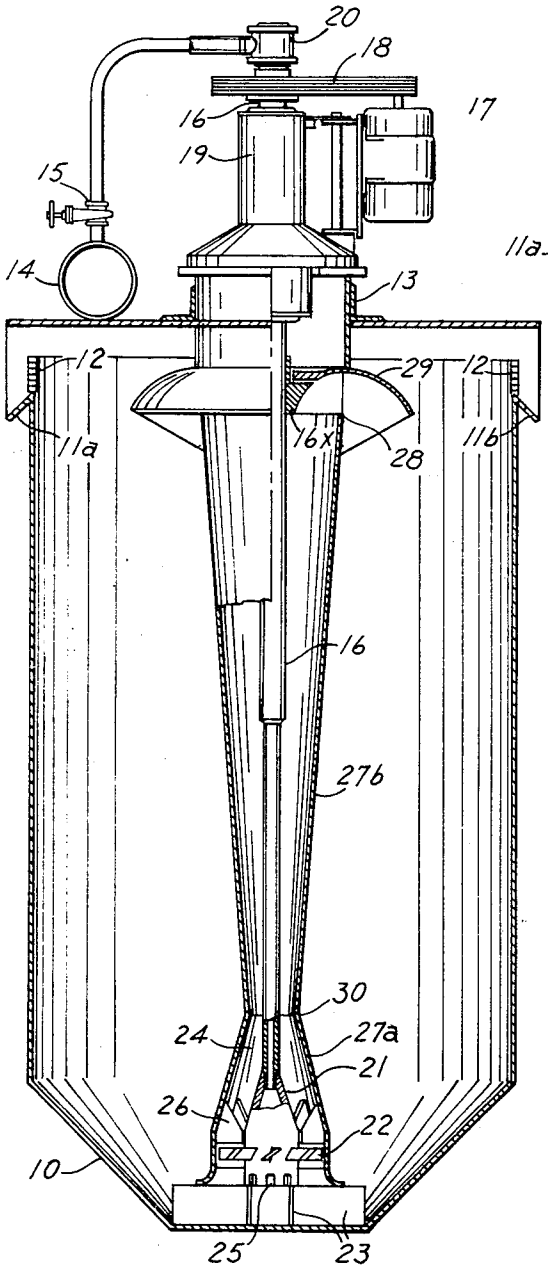


FIG. 1

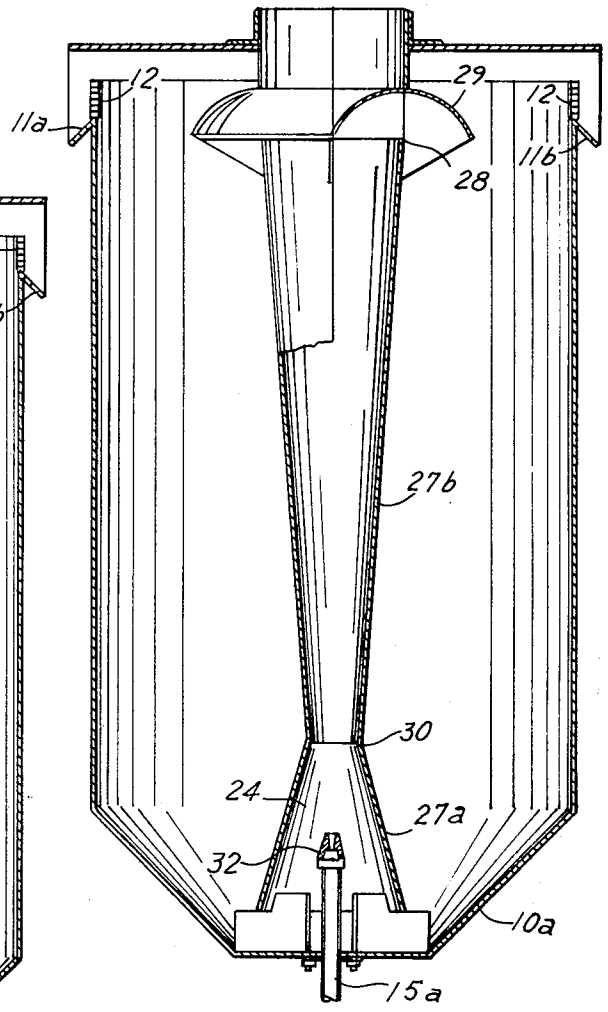


FIG. 4

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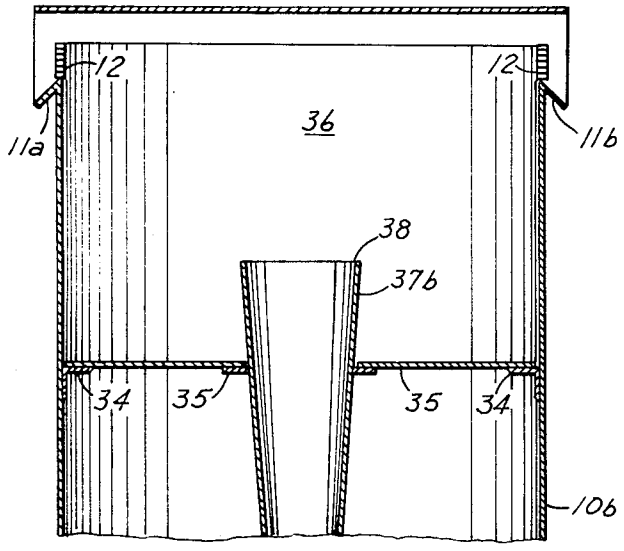

FIG. 3

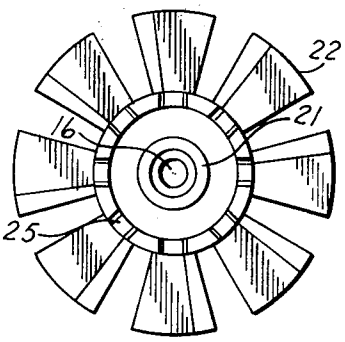

FIG. 2

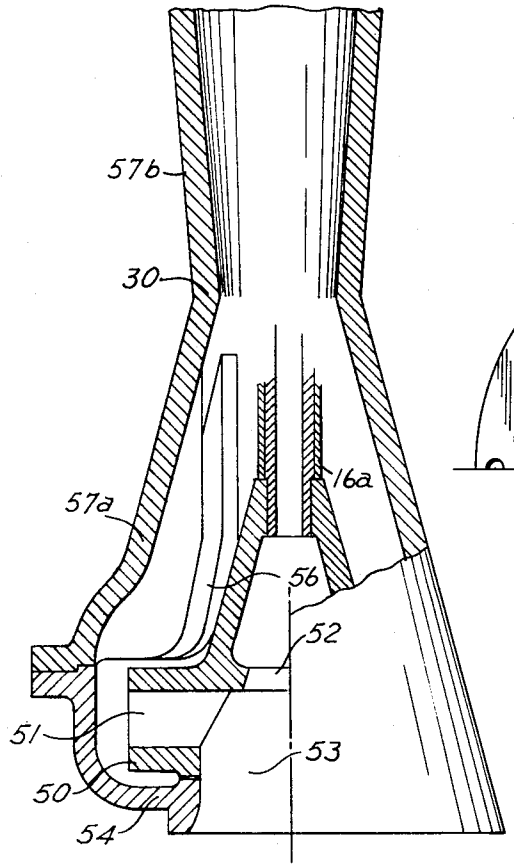

FIG. 6

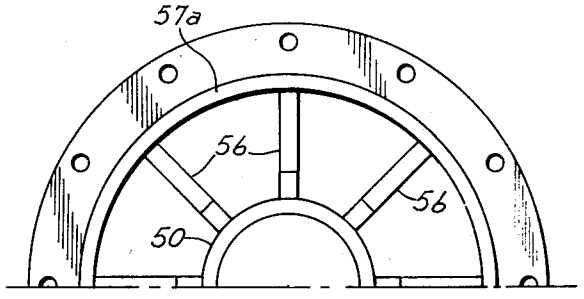

FIG. 7

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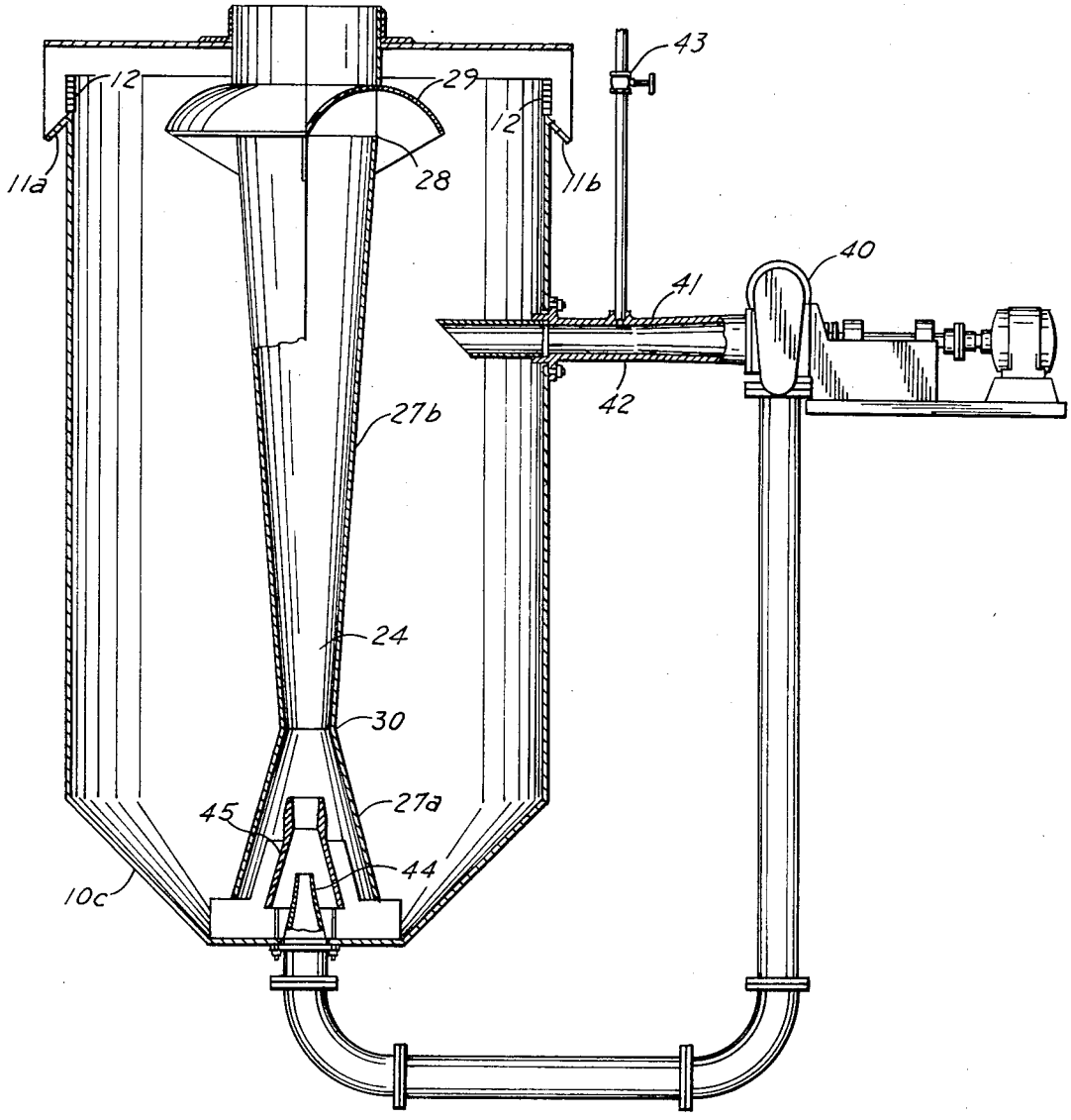

FIG. 5

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METHOD AND MEANS FOR FROTH FLOTATION CONCENTRATION UTILIZING AN AERATOR HAVING A VENTURI PASSAGE

My invention relates to methods and means for aerating solids in liquids which are particularly effective in flotation concentration of minerals and other materials amenable to froth flotation separations of a selected constituent from other pulp constituents.

The flotation machine in which the novel aerating practices of my invention are performed is of the general class of mechanical machines with venturi aerator assist added, inclusive of some form of pump means providing an induced elevating flow directed to produce a specific zone of increased pressure for gas dissolution followed by a zone of rapid reduction in pressure for efficient gas precipitation from solution. The pulp mass under treatment and carrying the selectively conditioned mineral particles is then flowed to the surface of the flotation cell without the turbulence that often peels the bubbles from attachment to their particles in other flotation cells.

The flotation machines predominantly used in commercial plants are of the mechanical agitation type wherein violent agitation creates areas of increased and decreased pressure within the circulating liquid pulp body conducive to gas precipitation onto selected mineral particles. The intensity of the mechanical agitation and the swirl imparted to the circulating pulp result in considerable impedance to bubble-attached particles rising directly to the surface and passing from the treatment. In the present treatment, the circulating pulp is first directed into a zone of increased pressure for air dissolution and on passing the constriction where the velocity of pulp flow decreases, the pressure decreases rapidly causing precipitation of dissolved air on coated mineral particles and flows to discharge without turbulence which would strip particles from bubbles.

The combining of the induced circulation of the pumping means and the differential pressure regulating effect of the venturi tube throat constriction is believed to be a novel arrangement in the froth flotation art and one which is productive of highly beneficial results. In fact, both the novel aeration procedure and the method and apparatus arrangements for concentrating minerals and the like by froth flotation effects are submitted as constituting innovations in the froth flotation art which are highly beneficial with respect to both the economy and efficiency of the concentration.

Accordingly, it is an object of my invention to provide simple, economical and efficient flotation practices for the treatment of minerals and the like by promoting gas dissolution and selective precipitation for the recovery of a desired constituent as a high grade concentrate.

Another object of my invention is to provide flotation concentration apparatus which is simple, durable and efficient and provides controls for aerating gas distribution by promoting gas dissolution and selective precipitation which assist in the recovery of a high grade concentrate.

A further object of my invention is to provide a venturi tube assist assembly as the aerating stage of a flotation concentration, said assembly being capable of regulating gas-dissolving pressures established at the intake end of a venturi cone and rapid pressure reduction resulting adjacent the throat end thereof for producing selective bubble precipitation onto reagent coated mineral surfaces in the concentration treatment.

Still another object of my invention is to provide an induced circulation of conditioned pulp through a venturitube stage inclusive of pumping means for establishing the rate of induced flow through said stage.

Yet a further object of my invention is to provide flotation concentration apparatus provided with a venturi assist aerator promoting pulp circulation in conjunction with controlled gas dissolution and gas precipitation so as to provide a surface overflow discharge action in which an ample quantity of air bubbles travels with and on the conditioned concentrate material directed onto the surface in a direct travel to discharge.

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

In particular, the present invention provides a novel type of "dissolved air" flotation applicable to materials other than minerals of which napthalene, textile wastes, paper mill "white water", colloidal suspensions in sewage plant effluents, colloidal suspensions of turbid river waters and industrial plant effluents are representative.

The innovations and practices of the present invention will be described with reference to the accompanying drawings illustrating typical embodiments of apparatus used in performing the novel steps and treatments. In the drawings, in the several views of which like parts bear similar reference numerals,

FIG. 1 is a vertical central section through one embodiment of a flotation cell provided with a venturi tube assist assembly according to my invention;

FIG. 2 is a bottom plan view of the rotary bladed impeller shown in FIG. 1 and arranged as the impeller of the pumping assembly providing the induced flow and desired pressure through the venturi assembly;

FIG. 3 is a fragmentary vertical section of another arrangement of a venturi tube aerator in relation to the overflow discharge of the cell utilizing features of my invention;

FIG. 4 is a vertical section through another embodiment of a flotation cell and venturi tube aerator according to my invention, in which the induced flow through the venturi section is imparted by a high pressure air jet and by an air lift action;

FIG. 5 is still another vertical section through another embodiment of a flotation cell and venturi tube aerator according to my invention in which a pump assembly controls induced flow through the venturi section and provides high pressure for maximum gas dissolution for "dissolved air" processes;

FIG. 6 is a fragmentary front elevation, partially broken to show interior parts in section, of a centrifugal pump assembly installed at the bottom or intake end of a venturi assist aerator; and

FIG. 7 is a fragmentary bottom plan view of the baffling arrangement utilizing in the assembly of FIG. 6.

The practice of my invention will be first described with reference to the structural embodiment shown in FIG. 1. The flotation cell 10 of this embodiment may be of any suitable dimension and is here shown as being of substantial vertical extent with side froth overflows 11a

and 11b adjacent its top and adjacent weirs 12 determining the effective overflow level. The lengthwise dimension of cell 10 has not been shown and may be varied from a length permitting use of a plurality of aerator units to a simple combination of one tank and one aerator. The cell 10 is provided with a pulp inlet (not shown) at one end and a pulp discharge outlet (not shown) at its opposite end so as to operate continuously and a high degree of recirculation is provided for several treatment cycles of the feed flow in each cell.

The cell arrangement with one aerator unit will be described and the multiple arrangement with a lengthwise spacing of the aerator units of the cell will be obvious from such description. Angle members 13 at the top of cell 10 space and stabilize the venturi tube aeration assembly. A header 14 conducting an aerating gas from a suitable source of supply (not shown) and a valve controlled branch 15 delivers a selected volume of gas from header 14 through a rotary valve 20 into the upper end of a hollow rotary shaft 16. A motor 17 and suitable belt transmission 18 provide the drive for shaft 16 at its upper end which is supported in a bearing assembly 19. Shaft 16 carries at its lower end a hollow hub member 21 and a bladed impeller 22 carried by the hub.

Shaft 16 depends vertically through the structure defining the venturi tube assist passage 24 which is the aerator stage of this assembly. At its lower end, the entrance of passage 24 is open and spaced from the bottom of cell 10 by a plurality of baffles 23 so as to entrain circulating pulp from cell 10. The gas delivered into shaft 16 through branch 15 discharges at the bottom of hollow hub member 21 through a series of openings 25 and is drawn by the pumping action of impeller 22 into the ascending pulp movement through the bladed impeller 22 into passage 24 at high velocity and mixes with the entering pulp to dissolve substantial quantities of said gas in the liquid of the pulp. Impeller 22 discharges such high velocity flow across a series of helical baffle members 26. In this intake portion wall section 27*a* defining the lower end of passage 24 narrows sharply and the adjoining portion 27*b* then widens progressively at a lesser angle to a point of discharge 28 near overflows 11*a* and 11*b*. A deflecting and shielding member 29 curves outwardly and downwardly over the overflow discharge 28 and directs the discharge onto the surface of the pulp body outwardly from the discharge end of passage 24. A collar 16*x* on shaft 16 provides a seal with the stationary surface of member 29.

As shown in FIG. 1, the portion of passage 24 enclosed by the venturi portion 27*a* is the intake portion and portion 27*a* being seated on baffles 23 provides a space for the pulp intake flow. The portion 27*b* confines the pressure reduction and discharge flow. The high volume flow from entrance through the constriction 30 develops high pressures in said flow causing substantial quantities of the gas to dissolve in the liquid of the pulp. The intake cone enclosure preferably has an included angle in the range of 25° to 30° and the exit cone included angle usually is in the range of 5° to 7½°. This arrangement produces uniform laminar flow lines with substantially no turbulence.

After passing constriction 30, there is a sharp pressure drop in the flow resulting in air precipitation. The pulp-air mixture rises in passage 24 without turbulence and the pressure drop is progressive along the length of exit portion 27*b* and to a substantially uniform degree thereby precipitating additional air throughout the progress of its travel from constriction 30 to the overflow 28 at or near the surface of the pulp. This overflow is directed by shield 29 to cascade the pulp-air mixture into the surface pulp with its superimposed froth column. The selected mineral or other concentrate material with attached air bubbles is carried up through the froth column and is discharged across one of the side overflows 11*a* or 11*b*. The volume capacity of axial flow impeller 22 is greater than the volume of the incoming feed stream and unfloated minerals are carried in a downward circulation to the intake of passage 24 for a retreatment in the described cycle.

The arrangement of FIG. 1 provides two means of controlling the rate and amount of gas dissolution and of gas precipitation, namely, changing the size of the constriction 30 and changing the motor and transmission assembly which regulates the speed of impeller 22. Vanes 26 prevent turbulent flow of matter acted on by the impeller and shield 29 prevents breaking of bubbles in the overflow at 28 while directing such discharged flow outwardly and onto the froth or the scum passing to the weirs 12.

Another embodiment is shown in FIG. 4 which is an air injection type of cell without supplemental mechanical action. The cell 10*a* of this form is essentially a duplicate of cell 10 and has side overflows 11a and 11b regulated by adjustable weir members 12. The venturi tube housing portions 27*a* and 27*b* are the same as shown in FIG. 1, as are the overflow 28, shield 29 and passage 24. Air or other aerating gas under relatively high pressure is delivered through a supply line 15*a* entering the cell at its bottom and discharging through an upwardly directed nozzle 32.

In operation, cell 10*a* is fed with a conditioned pulp at one end and discharges treated pulp at its opposite end so as to maintain a progressive circulation between feed and discharge. Gas is delivered through nozzle 32 at a selected volume and due to the crowding effect of portion 27*a* substantial quantities of the gas dissolve in the liquid of the pulp before passing constriction 30. In the subsequent flow through portion 27*b*, a pressure drop of progressively increasing magnitude precipitates gas from solution in fine bubble formation. On discharging across overflow 28, the aerated material is directed by the deflector or shield 29 across side overflows 11*a* and 11*b* in the same manner as in FIG. 1. Circulation in this embodiment results from the educer action of the air jet and the air lift forces in the exit section of the venturi assembly. The air jet constitutes the sole pumping means of this assembly.

FIG. 3 illustrates another method of discharging the aerated pulp from the exit open end 38 of the portion 37*b*. In the flotation treatment of some minerals it is often difficult to maintain a stable froth column on the surface of the flotation cell and air in excess of normal requirements may be needed in the form of bubbles supplied to the base of the froth column to carry the selected minerals to the froth discharge lip.

As shown, the tank **10***b* is generally similar to tank **10** and has side overflows **11***a* and **11***b* at its top controlled by adjustable weirs **12**. The upper or downstream portion **37***b* of the aerator assembly terminates in an open end **38** submerged in the pulp body **36** in the upper part of cell **10**b below the overflow level. The aerated pulp discharges across end **38** into pulp body **36** and provides a high degree of contact to concentrate solids in the upper portion of the pulp body. Supports **34** are provided for attachment of rods **35** or other connectors which stabilize the upper portion of body **38** while permitting descent of settling solids to recirculate through the venturi assist aerator, which may have its pumping action of the type shown in the several embodiments herein. This arrangement would usually be preferred in "dissolved air" treatment circuits as the product separated by this flotation method often reports to the surface of the treatment vessel as a scum rather than in the froth form associated with froth flotation.

FIG. **5** illustrates an arrangement in which a centrifugal pump **40** induces the circulation through the venturi assist passage **24** defined by conical portions **27***a* and **27***b*. The arrangement shown in FIG. **5** is particularly adaptable to flotation separations of the type commonly referred to as "dissolved air" flotation which utilize a relatively small volume of air as compared to the air requirements of the usual froth flotation process.

As shown, the intake **41** to pump **40** is a relatively elongated, large volume conduit having a slight constriction **42** intermediate its ends, and gas is induced into intake **41** through a valve-controlled branch **43** adjacent said constriction. The extended end of intake **41** terminates in an upper portion of cell **10***c* which is essentially a duplication of cell **10** except for the circulation features. The pump discharge containing a substantial amount of dissolved gas is conducted to an upwardly directed nozzle **44**, the discharge end of which is enclosed within an open-ended flaring baffle **45**. A nozzle diameter is chosen to develop a predetermined pressure with the pump capacity, for example 50–60 lbs. per square inch. The quantity of air induced into the pump intake is on the order of 3–5 percent of pump flow and under the high pressure in the discharge line, this air all goes into solution. For comparison, air in the FIG. **1** assembly would approximate 15 percent of the flow with possibly 10 to 20 percent of such air in solution and the balance comprising air bubbles. In the FIG. **4** arrangement air would constitute about 25 percent of the flow, of which 5 to 10 percent would be in solution and the balance formed as air bubbles.

The FIG. **5** arrangement permits utilizing the energy from the nozzle discharge in a jet pump assembly for improved efficiency and reduced turbulence in producing the required flow through the pressure zone in the intake portion **27***a* of the venturi passage **24**. The pumping action induces a recirculating flow passing between the open intake end of passage **24** and the bottom of cell **10***c*.

Still another aerator embodiment is shown in FIG. **6** which may be incorporated in flotation cells, such as **10**. In this arrangement a hollow shaft **16***a* of the general form of shaft **16** of FIG. **1** and similarly driven carries at its lower end a hollow impeller similar to a centrifugal pump runner **50** having peripheral ports **51** between a central air intake **52** on its top and an enlarged intake **53** at its bottom for recirculating pulp. A bottom casing section **54** is disposed in spaced but close proximity to runner **50** and has a flanged portion providing a seat for a corresponding flanged section at the bottom of venturi portion **57***a* which is generally similar to section **27***a* of FIG. **1**. The entrance to cone portion **57***a* contains a series of blades **56** disposed in radial arrangement on its interior surface adjacent the bottom of the enclosure as shown in FIG. **7** to eliminate swirl in the pressure discharge from runner **50**.

Referring again to FIG. **6**, the impeller or runner **50** is designed with a blade width greater than needed to supply the pulp volume passing through the intake opening **53**. The air requirement for the system is added under pressure through the hollow shaft **16***a* and gas intake **52** and is drawn into the runner **50** for mixing with the pulp flow by the internal suction in the impeller created by the additional blade width described above. The action within this venturi tube assembly is similar to that of FIG. **1**. The pressure required to force the circulated volume of the pulp-gas mixture through the constriction **30** results in gas going into solution in the entrance cone **57***a*. This gas is released from solution for selective precipitation on the condition particles by pressure drop at and beyond constriction **30**.

The various forms of froth flotation apparatus disclosed herein have features in common, both structural and functional, which provide a highly efficient apparatus assembly and mode of operation in this art. In all the forms disclosed, the treatment in a given cell includes the circulation of a conditioned pulp between a feed inlet at one end and a discharge outlet at the opposite end extending throughout several cycles and providing sufficient contact between the conditioned mineral surfaces and the aerating gas to obtain a high percentage recovery of the concentrate mineral with little entrainment of other solids of the pulp which tend to lessen grade.

In each form, a submerged venturi tube is disposed in an upright position having a lower conical portion at the cell bottom and an upper conical portion at the top. The intake of the lower portion is near but spaced from the bottom of the cell to admit a recirculating flow and the discharge outlet of the upper portion is at the approximate level of the froth overflow from the cell. Also, the bottom portion is shorter and of wider angle and the upper portion is longer and of a lesser angle with a constriction separating the two said portions. Such a venturi tube contains the aerator assembly of the apparatus including means for delivering an aerating gas under pressure into the intake or bottom portion in sufficient volume to provide a rapid upward flow, usually induced by a pumping means causing dissolution of a substantial quantity of aerating gas in the laminar flow through the inlet portion, and after the pressure drop initiated at the constriction, a continuing precipitation of dissolved gas onto the coated mineral surfaces occurs during the progress of the laminar flow through the discharge section.

On reaching the discharge end of the venturi tube, the deflecting and shielding member directs the discharge in a gentle spreading movement onto the pulp surface without an abrupt change in direction. On reaching the surface the discharge flow progresses

unobstructed to the froth overflows and in such travel the surface is maintained essentially quiescent with most of the froth comprising fine bubbles which hold attached mineral particles in the flow until it passes over the overflow lips in the discharge action.

Whatever coated mineral particles fail to reach the overflow in a first cycle become entrained in the descending pulp recirculating through the intake end of the venturi passage when they receive a repetition of the first cycle treatment and eventually pass the overflow to discharge with the froth concentrate.

Pumping means have been included in all the forms and in most operations it is preferable that the pumping action provides a high volume induced flow through the venturi tube establishing pressures in the venturi passage which dissolve substantial quantities of aerating gas in the intake portion and the provision of the constriction and the venturi shaping of the passage causes an effective degree of precipitation of such gas onto coated mineral surfaces during the progress of the flow from constriction to outlet.

In all of the forms illustrated in the drawings the action throughout the treatment cycle is quiescent with no areas of intense agitation established, and the flows throughout the venturi passage are laminar and from venturi discharge to concentrate overflow the flow is direct and rapid. Because of such controls, the bubble formation is essentially in fine sizes and very little breaking of bubbles with concentrate attachment occurs while a high degree of gas attachment is obtained from the precipitation of dissolved gas onto the coated concentrate surfaces in the movement through the venturi discharge passage.

As there are no chemical actions required in the procedure, all the structural forms are effective with known types of froth flotation treatments where the pulp is conditioned prior to flotation to selectively coat or film surfaces of the particles comprising the material to be concentrated, and in general the practices of the present invention will provide satisfactory results when the concentrate material is floated by the reagent composition known to be an effective collector for the concentrate.

I claim:

1. The combination of a flotation cell for a body of circulating pulp of substantial vertical extent having a top overflow for concentrate, and an aerator assembly submerged in and extending substantially throughout the vertical extent of the pulp body, said assembly including a body shaped as a venturi tube with a lower intake portion narrowing upwardly and of a length short with respect to the length of the tube, an upper discharge portion of greater length than the intake portion and flaring upwardly at a lesser angle than the angle of narrowing of said lower portion and a constriction between the portions, means for admitting pulp from the pulp body to said intake portion of said tube, means for delivering an aerating gas under pressure into the intake end of the venturi passage and for producing an upward flow of pulp through said tube, and means at the discharge end of the upper portion for directing the discharge therefrom outwardly and onto the surface of the pulp body.

2. A combination as defined in claim 1, in which pumping means induces the flow into and through the venturi tube.

3. A combination as defined in claim 2, in which the pumping means has an intake for circulating pulp, a discharge into the intake end of the venturi passage, and a passage through which air is conducted into the pumping means between the pump intake and discharge and is discharged under pressure thereby causing dissolution of entrained gases in the pulp.

4. A combination as defined in claim 1, in which an air jet induces the flow into and through the venturi tube.

5. A combination as defined in claim 1, in which a rotary impeller produces the flow into and through the venturi tube.

6. A combined aerator and flotation cell as defined in claim 1, including deflecting means overhanging the discharge end of the venturi passage having a curved surface directing the discharge from the venturi tube directly to and across said top overflow.

7. A combined aerator and flotation cell as defined in claim 6, in which the deflecting means is at approximately the froth overflow level.

8. A combined aerator and flotation cell as defined in claim 1, in which the gas delivery means includes a valve controlled conduit having outlet in the intake of the venturi passage.

9. A combined aerator and flotation cell as defined in claim 1, in which the gas delivery means includes an upwardly directed conduit having a jet outlet in the intake of the venturi passage.

10. The combination of a flotation cell for a body of circulating pulp of substantial vertical extent having a top overflow for concentrate, and an aerator assembly submerged in and extending substantially throughout the vertical extent of the pulp body, said assembly including a tubular body defining an upright venturi passage open at its ends and shielded from the pulp body intermediate its ends, said tubular body having oppositely flaring wall portions, the lower portion constituting the intake end and being of a length short with respect to the passage and flaring at a greater angle to the vertical than the flare of the upper portion, the intersection between said flaring portions forming a constriction to flow, means for admitting pulp from the pulp body to the lower portion of said tubular body, and the top end of the upper portion being the outlet of the passage and being near the level of the concentrate overflow permitting unimpeded flow of pulp through the venturi passage to the overflow, means for delivering an aerating gas under pressure into the intake end of the venturi passage, and pumping means arranged in said lower portion for producing an upward flow of fluid through said venturi passage and a downward return of fluid through the cell outside said tubular body and cooperative with the gas input for inducing laminar flow through the venturi passage under predetermined pressures causing gas dissolution in the lower portion, gas precipitation in the upper portion, and a recirculation of unfloated solids of the pulp from the cell through the venturi intake passage.

11. A combined aerator and flotation cell as defined in claim 10, in which said pumping means entrains aerating gas for entry into the laminar flow through the venturi passage of the aerator assembly.

12. The method of froth flotation concentration which comprises:

circulating a confined body of conditioned pulp of substantial vertical extent open to the atmosphere at its top and providing a surface overflow for concentrate solids,

providing a confined submerged zone extending throughout substantially the vertical extent of the pulp body interiorly thereof having a lower intake for pulp from the confined body, admitting pulp to the lower intake and mixing aerating gas and pulp in the confined zone, moving the pulp and gas mixture upwardly through the confined zone by an induced flow and discharging the mixture from the zone onto the confined body and toward the overflow in proximity to the elevation of the overflow, providing in said confined submerged zone a venturi portion intermediate the ends thereof and separated from the pulp body for establishing a selected pressure within said induced flow so as to dissolve gas in a lower portion of said flow and a lower pressure above the venturi portion to cause rapid gas precipitation from solution onto surfaces of pulp particles in the upper portion of said flow,

and discharging the mixture from an upper portion of the submerged zone onto the confined pulp body, whereby a gas-buoyed concentrate of the pulp passes to surface overflow substantially free from turbulence thereby preventing undue separation of bubbles and concentrate particles in the travel to discharge.

13. The method of froth flotation concentration which comprises:

circulating a confined body of conditioned pulp of substantial vertical extent open to the atmosphere at its top and having a surface overflow for concentrate solids,

providing a confined submerged zone for mixing aerating gas and pulp extending throughout substantially the vertical extent of the pulp body interiorly thereof and having adjacent its lower end an intake for pulp from the confined body, moving the pulp and gas mixture entering the intake in an induced flow to an upper pulp discharge in proximity to the elevation of the overflow, said induced flow being produced by a pumping action, said submerged zone including a venturi portion shielded from the pulp body intermediate its ends for establishing selected pressures within said induced flow so as to dissolve gas in a lower portion of said flow and to cause rapid gas precipitation from solution onto pulp particle surfaces in the upper portion of said flow,

and discharging the flow from an upper portion of the submerged zone onto the confined body and toward the overflow, whereby a gas-buoyed concentrate of the pulp passes to surface overflow substantially free from turbulence thereby preventing undue separation of bubbles and concentrate particles in the travel to discharge.

14. An aerator unit for froth flotation apparatus comprising an elongated hollow body open at its ends and adapted to be mounted in an upright position in a flotation cell and submerged in pulp contained therein, the body defining a venturi passage including a lower intake portion in open communication with pulp in the cell, an upper discharge portion and a constriction between said portions, the lower portion of the body being short with respect to the length of the body and having its wall converging at an included angle in the range of 25°–30° and the discharge portion being substantially longer and its wall flaring at an included angle in the range of 5° to 7½°, means for discharging gas into the lower intake portion of said body and for producing an upward flow of pulp through said venturi passage, whereby gas and conditioned pulp flowing through the passage are maintained in laminar flow with gas dissolution in the intake portion and gas precipitation onto pulp particle surfaces in the discharge portion of the venturi passage.

* * * * *