

Dec. 4, 1945.

L. H. LOGUE

2,390,111

AERATING APPARATUS

Filed Aug. 7, 1943

2 Sheets-Sheet 1

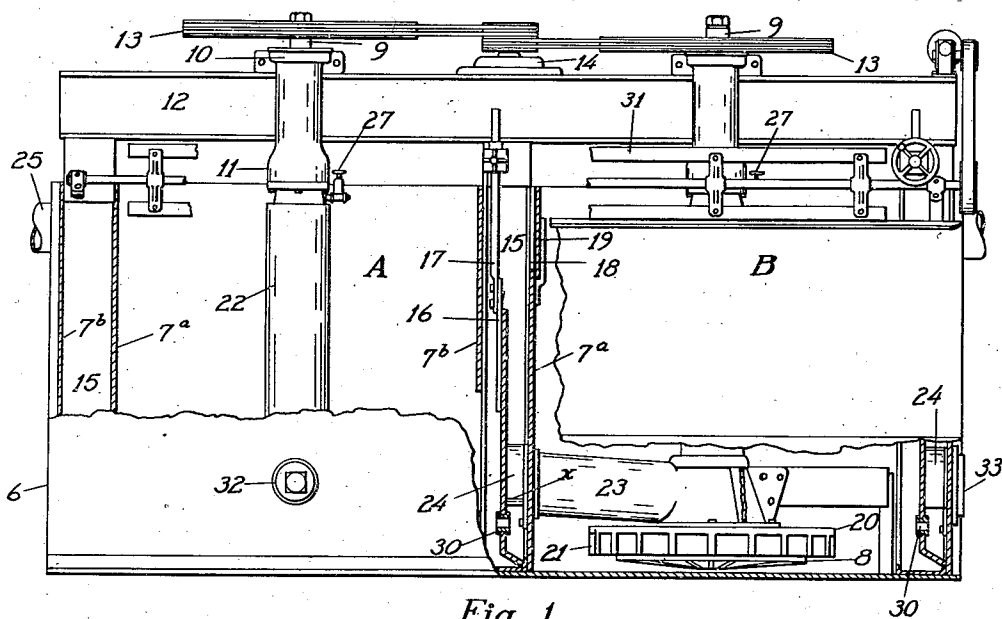


Fig. 1

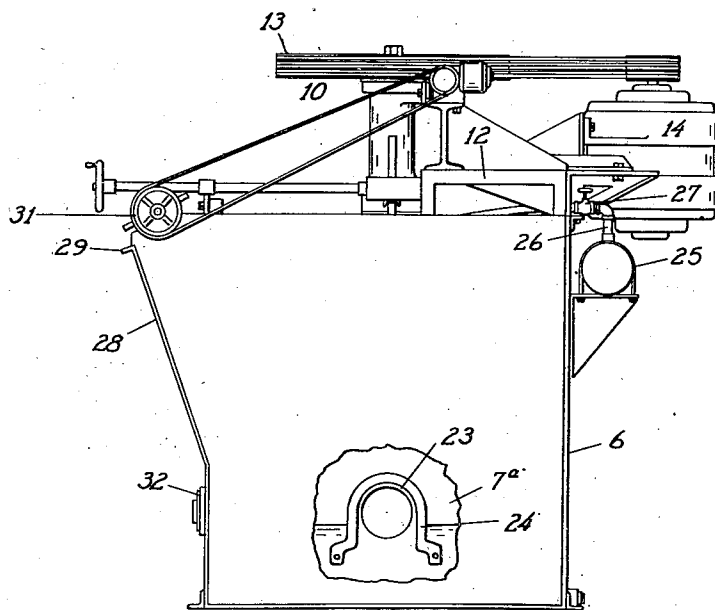


Fig. 2

LELAND H. LOGUE
INVENTOR.

BY *A. A. McEwen*
ATTORNEY

Dec. 4, 1945.

L. H. LOGUE

2,390,111

AERATING APPARATUS

Filed Aug. 7, 1943

2 Sheets-Sheet 2

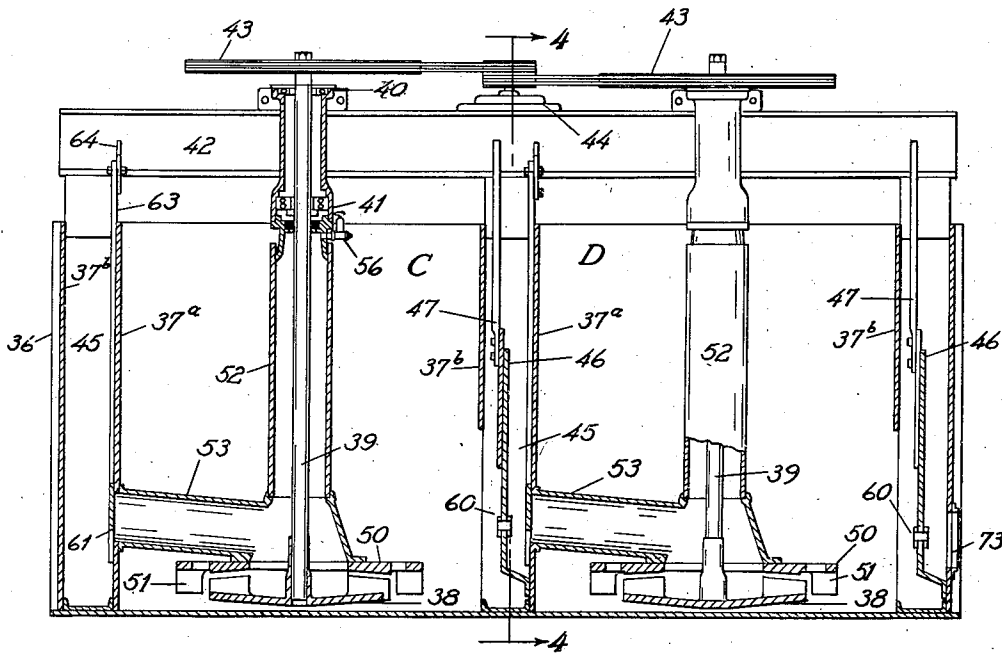


Fig. 3

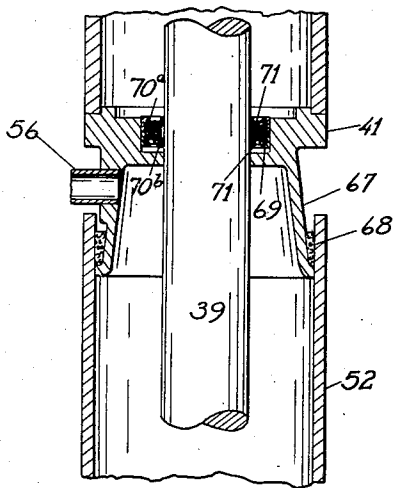


Fig. 5

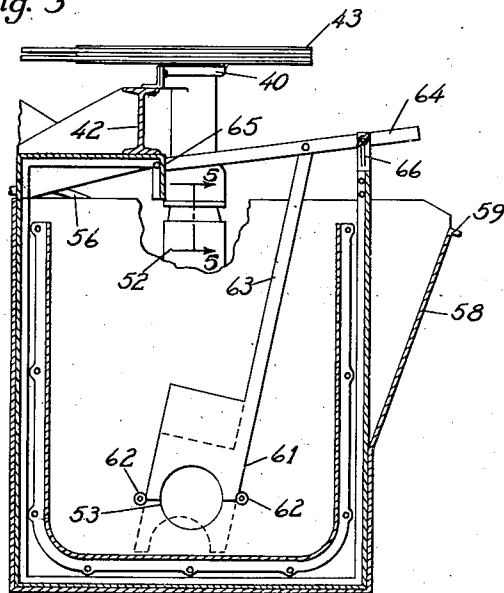


Fig. 4

LELAND H. LOGUE

INVENTOR.

BY *H. A. M. [Signature]*
ATTORNEY

UNITED STATES PATENT OFFICE

2,390,111

AERATING APPARATUS

Leland H. Logue, Denver, Colo., assignor to
Mining Process and Patent Company, Denver,
Colo., a corporation of Delaware

Application August 7, 1943, Serial No. 497,749

5 Claims. (Cl. 261-93)

This invention relates to aerating means and more particularly relates to aerating practices performed in conjunction with the froth flotation process.

Heretofore in flotation and similar treatments using mechanical type agitation, with air introduced under pressure, it has been customary to deliver air to the impeller at a pressure in excess of the hydrostatic pressure of the fluid body in which it is released.

This has involved high power consumption in proportion to the amount of air delivered and also has required high velocity discharge causing an undue amount of agitation. The combined effect of high pressure gas and high velocity discharge causes large bubble formation as the gas passes from the impeller, and the coalescence of these large bubbles impedes the flotation action.

It is an object of the present invention to provide a simple, economical and efficient apparatus for delivering an aerating gas within a liquid body at relatively low velocity and in relatively high volume.

Another object of the invention is to provide an aerating apparatus in which an aerating gas is distributed in volume throughout a liquid body in finely dispersed condition.

A further object of the invention is to provide simple, durable and efficient aerating apparatus which is capable of delivering a supercharged gas into a body of liquid to be aerated.

Other objects reside in novel details of construction and treatments, all of which will appear in the course of the following description.

In its broadest concept the present invention resides in the discovery that a supercharged gas can be delivered into a zone of centrifugal influence within a fluid body exposed to the atmosphere at pressures less than the hydrostatic pressure of said body and thereafter discharged by the centrifugal influence to permeate the liquid in finely dispersed condition.

By so introducing the gas, the effect in a machine of given capacity is to deliver a gas of greater density within a space of constant volume provided for reception of the gas and in this way attain the effect of having provided an increased volume of gas to the machine.

The method may be performed in a variety of standard treatments, such as froth flotation, conditioning pulps for flotation, and similar treatments where a considerable degree of aeration is required.

The accompanying drawings illustrate typical

apparatus embodying features of the present invention in which the aerating process is performed. In the drawings, in the several views of which like parts have been designated similarly:

Figure 1 is a front elevation of a multi-cell machine embodying features of the present invention, partially broken away to show interior parts in section;

Figure 2 is an end elevation of the machine of Figure 1, partially broken away to show details of the feed delivery seal;

Figure 3 is a vertical section through another form of multi-cell machine embodying features of the present invention;

Figure 4 is a section taken along the line 4-4, Figure 3; and

Figure 5 is a fragmentary section, drawn to an enlarged scale, and taken along the line 5-5, Figure 4.

In Figures 1 and 2 the invention has been shown as applied to a multi-cell flotation machine. This machine is of the type shown in Daman et al. Patent No. 2,243,309, and illustrates the simplicity of the changes required in applying supercharging to standard commercial machines. The machine comprises a tank 6, divided by forward end walls 7a and rearward end walls 7b into a plurality of flotation cells A and B, here shown as two, but which may be any desired number in series.

An impeller 8 carried on a shaft 9 is disposed for rotation adjacent the bottom of each of the cells A and B. The shaft is journaled in bearings 10 and 11 supported on superstructure 12 above the tank and sneaves 13 at the upper end of shaft 9 are provided for driving connection with a suitable prime mover, here indicated as an electric motor 14.

Pulp is fed to each cell in a series through a feed box or compartment 15 located between adjoining walls 10 and 7a, and in all compartments except the first in a series a weir overflow 16 controlled by a suitable gate or other regulating means 17 determines the volume of pulp discharging from a preceding cell to provide the feed to a succeeding cell.

Preferably each of the walls 7a will be apertured at its upper end as indicated at 18 in Figure 1 to recirculate middlings particles collecting in the upper portion of the pulp body back through the feed compartment 15. A gate or other regulating means 19 is provided to control this recirculation.

The impeller 8 preferably is covered by a hood 20 having peripheral vanes 21 and a hollow col-

umn 22 extends from a top opening in hood 20 in encasing relation to shaft 9 and at its top is sealed from the atmosphere in a manner hereinafter to be described. A feed delivery conduit 23 conducts pulp from compartment 15 to a point of discharge in column 22.

In the practice of the present invention it is necessary to seal the gas delivered to the impeller from escape to the atmosphere other than through release into the pulp body. For this reason provision is made to establish a liquid head above the intake to conduit 23 at all times and despite feed fluctuations and regulations of weir overflow 16.

As will be understood by reference to Figure 2, an arched casting 24 is mounted on wall 7a in overhanging relation to the intake opening of conduit 23 and fills the space between wall 7a and weir 16. As a consequence of this arrangement, pulp entering compartment 15 has to descend across the sides of arch 24 to the underside of same before it can enter conduit 23.

This deviation in flow causes the pulp to normally stand in compartment 15 at the approximate position indicated by the dotted line x in Figure 1. The height of the pulp level above arch 24 is determined by the factors of rate of pulp feed, volume of gas delivered to the impeller and the pressure at the impeller intake. As the pressure increases, the pulp level rises until the pressure is balanced by the hydrostatic pressure in compartment 15.

Gas is supplied to the machine through a header 25 and a conduit 26 connecting with the hollow column 22. Preferably, the gas supply of the header will be at constant pressure through use of a centrifugal blower (not shown) and under such circumstances individual valve regulation of conduits 26 will be unnecessary, although when desired a valve 27 may be provided to control the gas introduction.

The impellers of such machines are designed to operate at a capacity considerably in excess of any normal volume of feed that is supplied to them and consequently exert a suction influence on matter descending through column 15. Advantage is taken of this in the present invention to deliver the supercharged gas into the impeller at a relatively high density.

The action may be likened to the supercharging of an internal combustion engine. The cylinder is of constant volume and its piston has only a fixed displacement. Obviously, the volume of the gas charge is absolutely limited by these factors, and no increase beyond such limits can be effected. However, by supercharging, the density of the gas is increased to a considerable extent, and the effect of this on the fuel-gas intermixture is equivalent to an increase in volume of air.

In the aerating action of the present invention, it is possible, even at the relatively low pressures employed, to deliver a gas having a density of about two atmospheres. Consequently, the intermixing at the impeller intake and within the impeller 8 serves to entrain and entrap the gas in the high velocity pulp streams moving in and through the impeller.

The subsequent discharge of these intermixtures into the pulp body in cells A and B releases the finely-dispersed gas which rises through the liquid to the surface. Due to the fact that the gas is introduced into the impeller at a pressure less than the hydrostatic pressure above the impeller there is no high velocity discharge of gas

across the impeller and consequently turbulence in the aerating zone is greatly reduced.

The machine illustrated in Figures 1 and 2 has a sand relief hole 30 located in the lower portion of weir partition 16, and heavy solids not elevated across the weir are moved through this opening from a preceding cell to a succeeding cell in the series.

In the multi-cell operation illustrated in Figures 1 and 2, conditioned pulp is delivered from a source (not shown) into the feed compartment 15 of cell A and passes under an arch member 24 to enter feed delivery conduit 23. A desired pulp level is maintained in cell A by regulation of its overflow gate 17.

Air from header 25 is delivered through line 26 into column 22 at a constant pressure which is less than the hydrostatic pressure above the impeller 8, and of greater density than normal atmospheric density. This air stream initially mixes with pulp flowing through conduit 23 at the intake side of the impeller and substantial quantities are entrained, as a result.

Thereafter the pulp and gas streams are drawn into the impeller by its suction influence and the centrifugal action completes the entrainment and entrapment of gas in the circulating pulp. Because of the low pressure gas employed, there is no forceful gas discharge from the impeller except as it is carried into the pulp body by the associated pulp streams in the impeller.

Upon release in the pulp body beyond the zone of influence of the impeller, the gas rises as small bubbles without appreciable coalescence until it reaches the surface. The action of the collector reagents in the aerated pulp causes the mineral to be recovered to respond to this aerating influence and rise to the surface and collect in a froth, which is pushed across an overflow lip 29 by rotary skimmers or paddles 30.

The froth so collected is conducted by a launder (not shown) to a suitable collection or retreatment stage. Where a rougher-cleaner operation is employed, cell A may be a rougher cell in which event the collected froth would be recirculated through a subsequent cleaner cell, or cell A may be a cleaner cell in which collected froth from subsequent cells will be returned for retreatment. Where the latter practice is followed a normally closed opening 32 in the front wall 28 of the machine is utilized as the connection for the returned concentrate, and preferably a conduit will conduct such concentrate from the opening 32 to the intake side of impeller 8.

The pulp residue of this initial separation is passed across weir 16 or through sand relief hole 30 into the feed compartment of a second cell B which may be the end cell of a series, as illustrated, or an intermediate cell of such series. The action in cell B is the same as that described with reference to cell A except that the gate 19 is set to permit some recirculation of middlings from cell B back through compartment 15 and it is this middlings product together with the pulp from cell A which constitutes the pulp feed through conduit 23 of cell B.

After the pulp is aerated in cell B in the manner hereinbefore described, the mineral collected as a froth is skimmed across overflow lip 29, while the non-floated solids discharge across the overflow weir or through the sand relief hole 30 and finally discharge through the opening 33.

If this opening is the final tailings discharge of the machine a suitable conduit (not shown) is connected into the opening for removal of the

tailings. However, if the cell B is an intermediate cell in a series, then the opening 33 acts as a seat for the feed delivery conduit 23 in the next cell in the series.

The form of the invention shown in Figures 3, 4 and 5 involves the same type of aerating action. A two cell machine has been illustrated which may be used as a conditioner unit or as a flotation machine. The tank 36 of this form also is divided by double wall partitions 37a and 37b into two cells C and D.

An impeller 38 is mounted on a shaft 39 for rotation in each cell and the shaft is journaled in bearings 40 and 41 supported on superstructure 43. Sheaves 43 on the shafts 39 are driven by a prime mover such as a motor 44.

The space between adjoining partitions 37b and 37a serves as a feed compartment 45 which may be either the original feed box of the machine as in cell C, or an intermediate compartment as in cell D. In the intermediate and final compartments of the machine, the compartment 45 is divided by a weir 46, the overflow level of which is varied by an adjustable gate 47.

Preferably the impeller 38 is covered by a hood 50 having downwardly projecting blades 51 encompassing the periphery of the impeller. A hollow column 52 extends upwardly from the hood in enclosing relation to shaft 39, and a feed delivery conduit 53 conducts pulp from the feed compartment 45 into the lower end of column 52 immediately above the impeller.

Supercharged gas is supplied to the machine by a header (not shown) and supply conduits 56 deliver the gas from the header into hollow column 52. The gas, after delivery into column 52, is sealed from the atmosphere until it passes into the impeller and is subsequently discharged by the centrifugal influence of the impeller.

This involves sealing the intake end of feed delivery conduit 53 and the upper end of column 52. A gate 61 is mounted in guides 62 for sliding movement. An extension arm 63 on the gate is pivotally connected with a lever 64 pivoted to superstructure 42 as indicated at 65 and having its outer end fitted in a slotted guide permitting precision adjustment of the gate 61 relative to the intake of conduit 53.

The sealing arrangement for column 52 has been illustrated on an enlarged scale in Figure 5. The bearing housing 41 terminates in a skirt portion 67 which is inserted in and has a friction fit with the end of column 52 and suitable packing 68 is fitted between skirt 67 and column 52 to prevent any escape therethrough.

The bearing housing has a bore for reception of the shaft 39 and is recessed in its upper portion adjacent the bore as indicated by the reference numeral 69. In this recess, two cup washers 70a and 70b of leather or other suitable flexible material are held in close contact with shaft 39 by springs 71. The upper of said washers 70a prevents descent of grease along the shaft, while washer 70b prevents upward escape of the supercharged gas along shaft 39.

When the machine of Figures 3, 4 and 5 is used as a conditioner unit, pulp is fed into feed compartment 45 of cell C and the restriction gate 61 is adjusted relative to the intake end of feed delivery conduit 53 to initially determine the maximum volume of pulp that can be delivered to said conduit.

The weir overflow gate 47 also is set for optimum conditions and the cell is filled with pulp to the overflow level determined by this weir reg-

ulation. Reagent, such as a flotation collector reagent, or a depressant, which may be either wet or dry, is fed into compartment 45, or directly into cell C.

Supercharged air is supplied to the treatment through line 56, passing into column 52 where it is effectively sealed from the atmosphere by cup washer 70b in bearing 41 and by a liquid head above the intake to column 53 provided by the setting of restriction gate 61. The mixture of air, pulp and reagent delivered onto impeller 38 through the lower end of column 52 is initially mixed by the cascading action of the separate streams, and is further mixed within the impeller by the centrifugal action causing substantially the entire volume of gas to be entrained in the circulating pulp streams.

The intermixture, upon discharge into the pulp body in cell C, by the centrifugal action of the impeller distributes throughout the cell and the released gas rises through the liquid as minute bubbles effecting a gentle but thorough aeration of the pulp.

The reagent is caused to go into solution or becomes highly emulsified by the initial mixing and subsequent aeration. As a result, the mineral particles are surface coated. The conditioned mineral may be collected as a froth and separately removed for treatment at a subsequent stage, while the pulp residue is passed over weir 46 and through sands relief hole 60 to constitute the feed to compartment 45 of cell D.

In the latter cell, the aforesaid action is repeated with the balance of the pulp conditioned therein and discharged through a tailings outlet 73 for treatment at a subsequent stage of the operation. While the aforesaid treatment is effective with many reagents, some materials will require a greater degree of mixing than is afforded by the aforesaid action.

In such instances, the cells C and D are provided with the recirculation overflows shown at 18, 19 in Figure 1 and the aerated matter collecting as froth is overflowed into compartment 45 and in that way subjected to repetitions of the mixing and aerating actions. When so operated, no froth is overflowed from the machine and the discharge through outlet 73 is the final conditioned pulp passing to a subsequent treatment stage.

From the foregoing description, it will be apparent that whether applied to conditioning tanks, flotation machines, or other forms of aerating apparatus, the embodiments of the present invention are essentially the same. The structural forms may vary, but in each instance the operation is essentially the same and the same end result is attained.

In this connection, it should be noted that the bearing structure 41 of Figure 1 and the bearing 41 of Figure 3 are duplicates. Therefore, the detail view Figure 5 applies equally to the structure of Figures 1 and 3, although it has been drawn with special reference to the structure of Figure 3.

In all of these operations, air is added under a pressure less than that created by the hydrostatic head of pulp above the impeller, and the air delivered to the impeller intake is of a density in excess of the prevailing atmospheric density at the location of the machine.

In utilizing a hollow column as the means for delivering the supercharged gas to the impeller, it is necessary to seal the upper end of the column so that the gas does not escape to the atmosphere along the shaft. And when the pulp is fed into

this column to supply the impeller, it is necessary that no escape of gas through the incoming feed shall be permitted.

Two means of sealing the feed intake have been shown. In the form shown in Figure 1 no regulation is provided but in the form shown in Figure 3, selective regulation of the head above the feed intake opening can be obtained.

Since the atmospheric pressure is uniform at any given stage in the operation, a uniform air supply is most desirable. For this reason, individual valve regulation of the air supplied to individual cells is not recommended, as involving undue operator attention. However, under special circumstances such regulation may be advantageous, and the arrangement has been illustrated in Figure 1 for that purpose.

It will be obvious from the foregoing description, that the introduction of supercharged gas to aerating apparatus has highly beneficial effects, and as typified by the arrangements illustrated in the drawings, may be applied to a variety of apparatus in which such treatments are performed. 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. Aerating apparatus comprising a tank for fluent matter open to the atmosphere, a rotary impeller in the lower portion of the tank, a cover member overhanging the impeller and having a central opening, a hollow column extending upwardly from the opening and sealing it from the atmosphere, a source of gas under constant pressure, means for delivering gas from the source into said column at a pressure less than the hydrostatic pressure of said body at the impeller, a feed delivery conduit having a discharge outlet in the hollow column above the central opening, and means for at least partially restricting the conduit to maintain a head of liquid over its intake opening, whereby feed discharged into said column forms a vortex in its passage into the central opening under the pumping action of the impeller and entrains the low-pressure gas in said movement.

2. Aerating apparatus comprising a tank for fluent matter open to the atmosphere, a rotary impeller in the lower portion of the tank, a cover member overhanging the impeller and having a central opening, a hollow column extending upwardly from the opening and sealing it from the atmosphere, a source of gas under constant pressure, means for delivering gas from the source into said column at a pressure less than the hydrostatic pressure of said body at the impeller, a feed delivery conduit having a discharge outlet in the hollow column above the central opening, and an adjustable gate member for partially restricting the intake of the conduit and sealing it from the atmosphere, whereby feed discharged into said column forms a vortex in its passage into the central opening under the pumping action of the impeller and entrains the low-pressure gas in said movement.

3. Froth flotation apparatus comprising a cell for the pulp having one of its sides providing a froth overflow, a pulp-delivery compartment at one end of the cell adjacent the overflow, an

adjustable weir overflow at the opposite end of said cell controlling the discharge of pulp therefrom, a rotary impeller in the cell, a cover member overhanging the impeller and having a central opening, a hollow column extending upwardly from the opening and sealing it from the atmosphere, a source of gas under constant pressure, means for delivering gas from the source into said column at a pressure less than the hydrostatic pressure of said body at the impeller, a feed conduit arranged with its intake in the pulp-delivery conduit having a discharge outlet in the hollow column above the central opening, and means for at least partially restricting the conduit to maintain a head of liquid over its intake opening, whereby pulp discharged into said column forms a vortex in its passage into the central opening under the pumping action of the impeller and entrains the low-pressure gas in said movement.

4. Froth flotation apparatus comprising a cell for the pulp having one of its sides providing a froth overflow, a pulp-delivery compartment at one end of the cell adjacent the overflow, an adjustable weir overflow at the opposite end of said cell controlling the discharge of pulp therefrom, a rotary impeller in the cell, a cover member overhanging the impeller and having a central opening, a hollow column extending upwardly from the opening and sealing it from the atmosphere, a source of gas under constant pressure, means for delivering gas from the source into said column at a pressure less than the hydrostatic pressure of said body at the impeller, and a feed conduit arranged with its intake in the pulp-delivery conduit and having a discharge outlet in the hollow column above the central opening, and flow-control means at least partially restricting the conduit to maintain a head of liquid over its intake opening, whereby pulp discharged into said column forms a vortex in its passage into the central opening under the pumping action of the impeller and entrains the low-pressure gas in said movement.

5. Froth flotation apparatus comprising a cell for the pulp having one of its sides providing a froth overflow, a pulp-delivery compartment at one end of the cell adjacent the overflow, an adjustable weir overflow at the opposite end of said cell controlling the discharge of pulp therefrom, a rotary impeller in the cell, a cover member overhanging the impeller and having a central opening, a hollow column extending upwardly from the opening and sealing it from the atmosphere, a source of gas under constant pressure, means for delivering gas from the source into said column at a pressure less than the hydrostatic pressure of said body at the impeller, a feed conduit arranged with its intake in the pulp-delivery conduit and having a discharge outlet in the hollow column above the central opening, an adjustable gate member for partially restricting the intake of the conduit sealing it from the atmosphere, whereby pulp discharged into said column forms a vortex in its passage into the opening under the pumping action of the impeller and entrains the low-pressure gas in said movement, and control means for said gate mounted at the top of said cell.

LELAND H. LOGUE.