Dec. 7, 1937. W. FAGERGREN 2,101,331

AERATING MACHINE

Original Filed Jan. 4, 1932 3 Sheets-Sheet 1

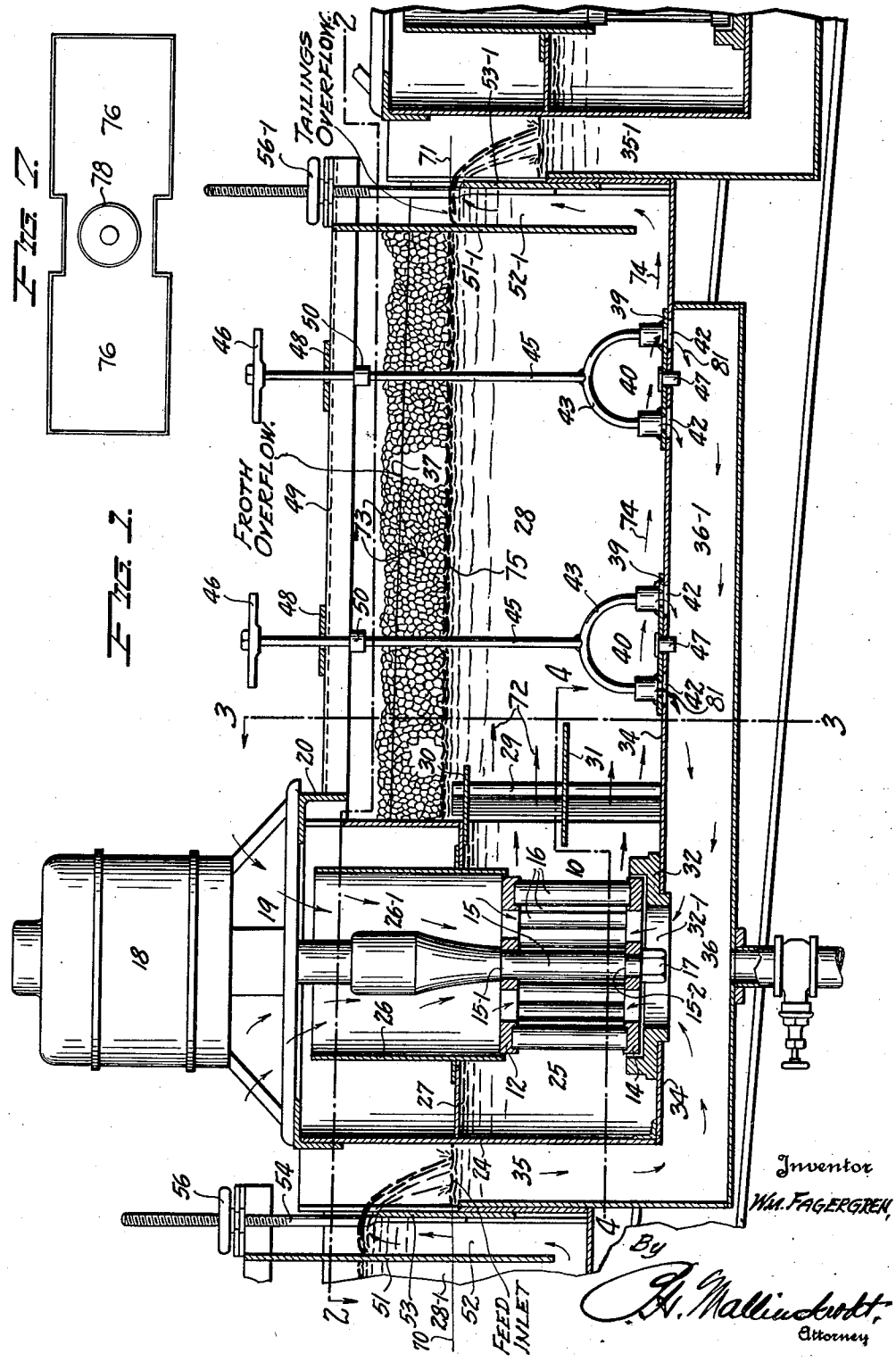


FIG. 2.

Dec. 7, 1937. W. FAGERGREN 2,101,331

AERATING MACHINE

Original Filed Jan. 4, 1932 3 Sheets-Sheet 2

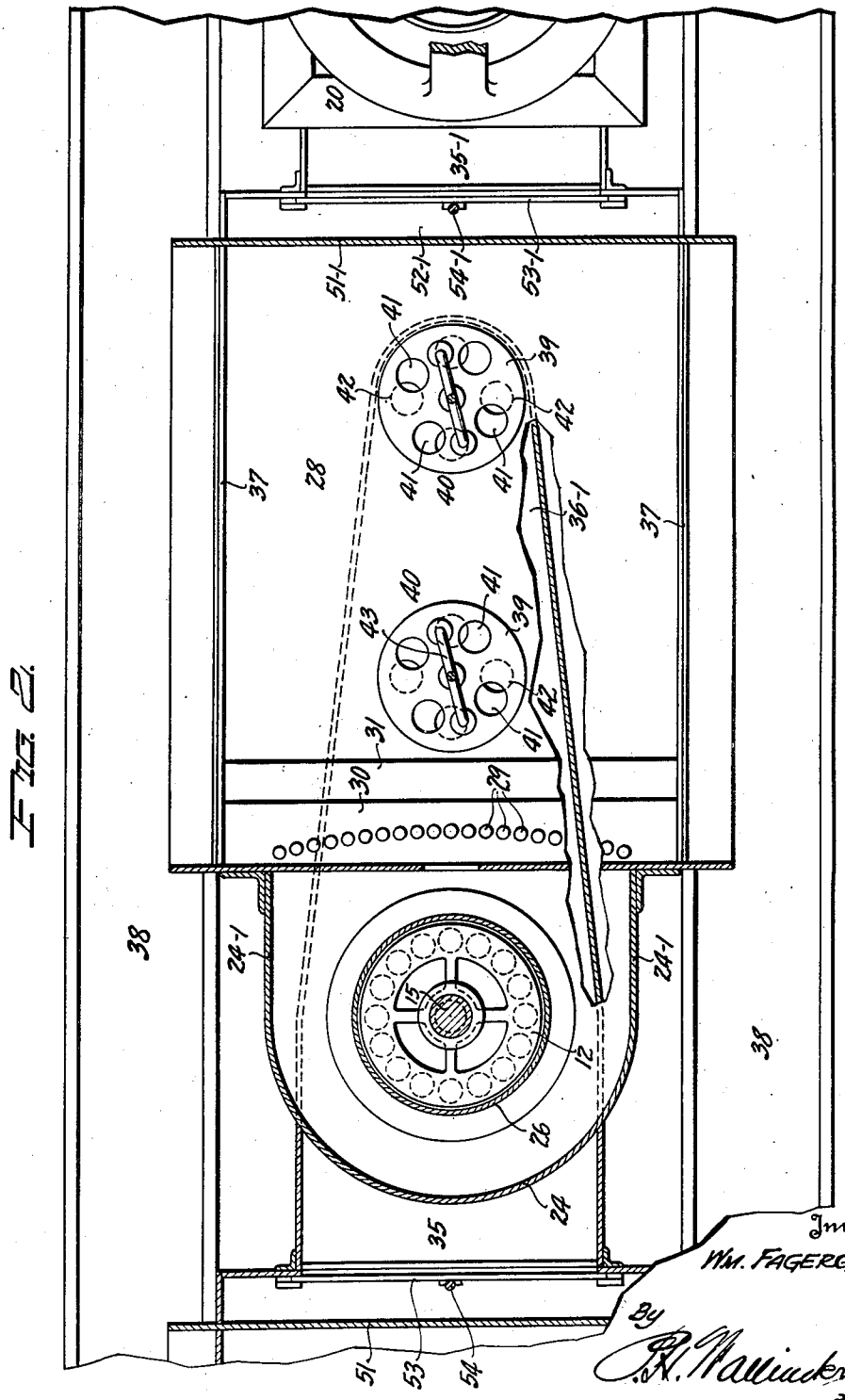


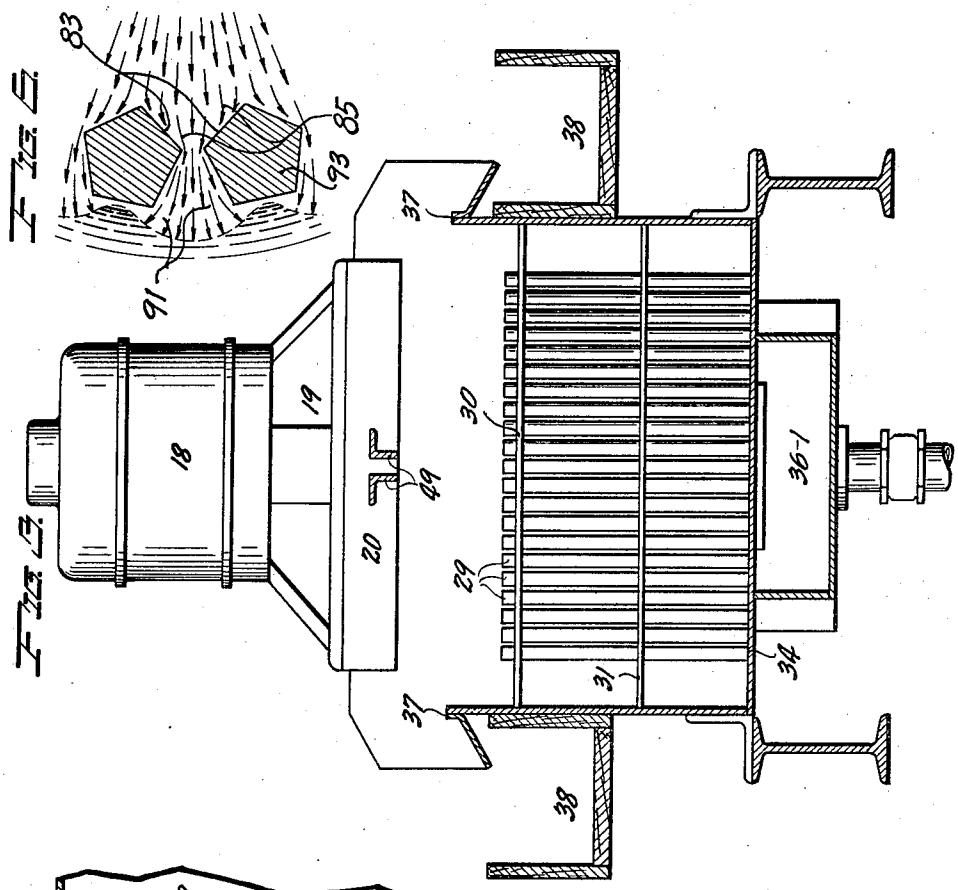
FIG. 2.

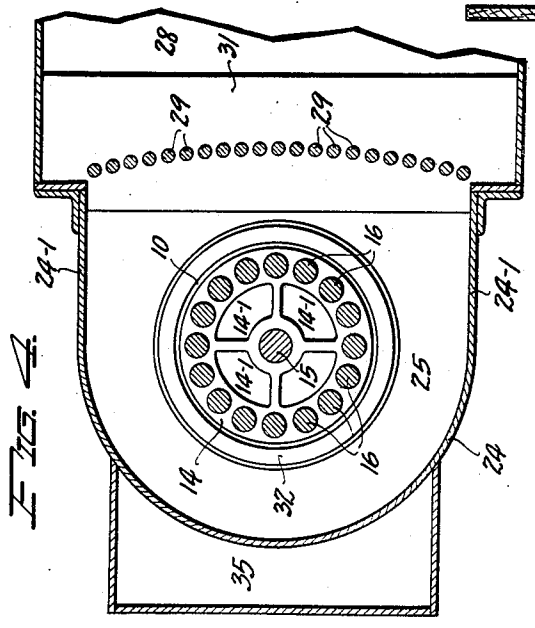
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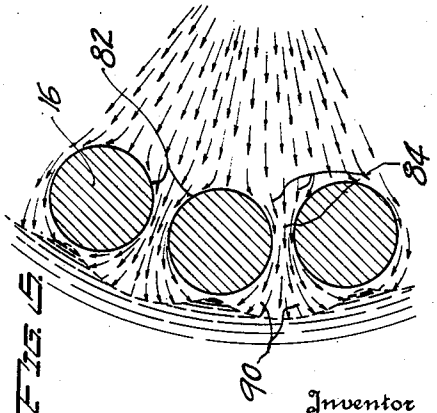
Dec. 7, 1937. W. FAGERGREN 2,101,331

AERATING MACHINE

Original Filed Jan. 4, 1932 3 Sheets-Sheet 3







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Patented Dec. 7, 1937 2,101,331

UNITED STATES PATENT OFFICE

2,101,331

AERATING MACHINE

William Fagergren, Salt Lake City, Utah

Application January 4, 1932, Serial No. 584,673
Renewed February 3, 1937

15 Claims. (Cl. 209—169)

This invention relates to an improved aerating machine, and its principal object is to economically and efficiently aerate a liquid or semi-liquid, such as flotation pulp, hence, the invention may also be called a flotation machine.

In particular, the present aerating machine is adapted to metallurgical work in the treatment of what are commonly known as low grade ores, by means of flotation.

In the present invention, I prefer to make use of the impeller shown and described in my U. S. Patent No. 1,963,122, issued June 19, 1934. This impeller in general, is of cylindrical form and is disposed with its axis of rotation substantially vertical. The structure of the impeller includes a plurality of staves having their longitudinal dimension transverse to the plane of rotation. The staves are preferably circular in cross-section, and are spaced apart from one another around the circumference of a circle substantially concentric with the axis of rotation. Each pair of staves serves to define a V-shaped space between them, and the extent of those spaces, in relation to the diameter of the staves, is important.

The peculiarity of the V-shaped spaces brings about an extremely efficient aeration in a body of liquid or semi-liquid such as flotation pulp, in which the rotating impeller is immersed.

The difference between the aerating machine which is the subject of U. S. Patent No. 1,963,122 and the present machine lies largely in the disposition of the separation chamber with respect to the aerating zone. In the present invention the separation chamber is a structure having substantial depth and relatively great length, its dimensions being such that no abrupt volumetric variations occur in a body of pulp passing through it. The aerating means is preferably mounted at one end of this separation chamber in such a manner that it projects a horizontal stream of aerated pulp into the body of pulp in the separation chamber, this stream extending throughout an area of projection substantially coextensive with the mean transverse sectional area of the body of pulp.

In the present invention, the variations introduced in the environment of the impeller possess advantages resulting in a large capacity with maximum unit efficiency when operating on low grade ores, such as those mined by the Utah Copper Company at Bingham, Utah.

The features of this invention, for which the protection of Letters Patent of the United States is desired, are collectively grouped in the claims concluding this specification.

In the drawings, which illustrate one embodiment of this invention,

Fig. 1 represents a vertical longitudinal center section;

Fig. 2, a plan, partly in section along line 2—2 in Fig. 1, and to a lesser extent in section along line 2A—2A in Fig. 1;

Fig. 3, a vertical cross-section taken on line 3—3 in Fig. 1;

Fig. 4, a horizontal section taken on line 4—4, Fig. 1;

Fig. 5, a fragmentary diagram illustrating a theoretical explanation of the action of the impeller staves, this diagram being drawn to an enlarged scale;

Fig. 6, a view similar to Fig. 5, but showing staves of an alternate shape; and

Fig. 7, a diagrammatic sketch of an alternate arrangement suggesting a plurality of bubble columns.

Referring to the drawings, the numeral 10 indicates an impeller, which in general, may be constructed similarly to the impeller shown in Patent No. 1,963,122 aforesaid and may consist of the spiders 12 and 14, both of which are rigidly mounted on the shaft 15. A plurality of staves 16, preferably circular in cross-section and spaced apart from each other, is mounted in corresponding openings in the spider rims. The dimensions in the clear between consecutive staves depend upon the results desired, but in any event, are equal to twice the diameter of a stave, or less. The spider 12 may bear against a shoulder 15—1 of the shaft, while the spider 14 bears against a shoulder 15—2, the entire impeller being secured in place by a nut 17, threaded on the lower extremity of the shaft.

The shaft 15 extends upwardly, and may, if desired, be integral with the shaft of an electric motor 18, this motor being supported upon a base spider 19, which in turn, is supported upon the frame 20, this frame forming a part of the general housing structure 21.

A pressure-charging aeration cell space 25 may be defined by a semi-circular casing 24 with extended walls 24—1, and surround the impeller the cell structure thus constituted being preferably concentric with the axis of the impeller. Extending upwardly from the impeller, and preferably around the spider 12 so as to just clear the same, is a circular air bell 26, the purpose of which is to conduct atmospheric air into the impeller. The casing 24 extends upwardly and supports the frame 20. The cell space 25 may have its upper limit defined by a liquid-tight stationary

partition 27 which extends from the air bell to the casing 24.

A separation chamber 28 is located to one side of, and in substantial horizontal alignment with the outlet of the pressure-charging aeration cell. The cell and the separation chamber are in direct communication with each other, such communication being either unrestricted or if desired, restricted, by a grating consisting of staves 29, spaced apart from one another as may be required, and secured in an upper plate 30 and a lower plate 31.

Below the impeller is a stationary flange 32 having an opening 32—1 which may be in substantial registry with openings 14—1 of spider 14. This flange may be secured to floor 34 of the housing structure and may have a circular counter-recess which conforms closely to the circumference of spider 14, but at the same time clears the same sufficiently so as to permit free rotation of the impeller.

Pulp from any suitable source may be fed into the machine at a level such as 70, Fig. 1, through a vertical channel 35, from which the pulp finds its way downwardly into a substantially horizontal channel 36, passing thence into the impeller through opening 32—1. In this instance, the feed is supposed to come in the shape of tailings from a preceding machine having a separation chamber 28—1, baffle partition 51, tailings discharge compartment 52, and a weir 53. Weir 53 may be movable up and down by means of a rod 54 attached thereto, said rod being threaded at its upper end and engaged by an adjusting handwheel 56.

As streams of air and pulp are discharged by the whirling impeller, due to the action of centrifugal force, they are flung into the body of pulp in chamber 25, the said body of pulp having a dynamically sustained impregnating surface extending around impeller 10. At the same time, air is being taken in by the impeller through space 26—1 within air bell 26, and entry of pulp feed and air together into chamber 25, causes a constant current of air-impregnated pulp to flow into bubble and sorting column 28 after the manner indicated by arrows 72.

The specific action in separation chamber 28, of the thoroughly aerated pulp, brings about the separation of mineral values from the gangue, and these values are carried upwardly and discharged in a froth 73 over the lips 37 into launders 38, while the separated sands or tailings follow paths denoted in general by arrows 74 leading through a relatively low outlet into tailings discharge compartment 52—1. Pulp level 75 is substantially on a level with tailings level 71 when the impeller is stationary or is running at a low speed and is regulated by means of a tailings overflow gate 53—1 which is operated through a handwheel 56—1. When the impeller is running at its normal speed, any pulp level is practically eliminated because of the superaeration of the pulp.

In order to regulate the quality and/or quantity of froth being formed, and also to equilibrate the action of the machine, valves 40 may be provided. These valves may consist of rotatable disks 39 having openings 41, which are adapted to register in varying degrees with corresponding openings 42, the latter being formed in floor 34. The valves may have bails 43 forming integral parts of rotatable rods 45, the latter carrying rigidly attached crossbars 46, by means of which, disks 39 may be rotated. The valves are centered by pins 47 at the bottom, and bearing plates 48 near the top, the plates being secured to angle bars 49. Collars 50 bearing against angle bars 49, hold the valves in working position. By means of the valves just described, a portion of the pulp in chamber 28 may be diverted downwardly into the portion 36—1 of passage 36, and re-passed with the regular feed through impeller 10.

It will be seen that valves 40 act in the capacity of gates by means of which a close control can be effected upon the performance of each machine.

An inspection of Fig. 1 will make manifest a distinct advantage possessed by this invention. In the figure, it will be noted that the feed inlet level 70 is at all times close to the level of tailings overflow 71, which latter level is determined by the tailings weir 53—1. At such times as the impeller is at rest or running at comparatively low speed, the feed inlet and the tailings overflow are substantially on the same level. When the impeller is running at normal speed, the suction created by the impeller will slightly depress (never more than a few inches) the level of the pulp in feed passage 35. Furthermore, the rotation of the impeller can never empty the vertical passage 35, and therefore, the load of dynamically sustaining any but a rather negligible hydrostatic head is never imposed upon the impeller. It will be noted too, that the fall of liquid over the weir 53 is never from any considerable height and therefore does not operate to entrain any appreciable quantity of air in its descent.

The relation between inlet level 70, tailings overflow level 71, and pulp level 75, as above described, is substantially maintained no matter what the positions of the weirs 53 and 53—1 may be.

An important feature to be noted in the present invention, is the disposition of the separation chamber, which is located to one side of the impeller and has a substantial length preferably in the direction of flow, indicated by arrows 72, of the aerated pulp as it leaves the impeller and travels from the near end to the far end of the separation chamber. By substantial length I mean a distance sufficient to allow the maximum separation between the bubble-carried mineral values and the tailings, to take place in their travel across the separation chamber. This distance, in any particular case, may easily be determined or verified by actual experiments.

The adjustable gates 40 are so located from end to end of the bottom of the separation chamber, that undertow currents from various points, indicated for instance, by arrows 81, can be created in the column, and by means of which, variable portions of the pulp may be returned to the impeller as hereinbefore touched upon.

In Figs. 5 and 6, the densifying effect upon the air as it is squeezed through the V-shaped passages 82, Fig. 5, and 83, Fig. 6, is visualized by arrows 84 and 85 respectively. The expansive action of the air, as it emerges from the restricted portion or neck of the V-shaped passages, and is projected into the dynamically sustained pulp portions, 86 and 87, is visualized by arrows 90 and 91, respectively.

Staves having a circular cross-section, as previously stated herein, and as shown at 16, are preferred, but staves of any polygonal form which provide passages having first, a converging form, reckoning from the inside to the outside of the

impeller, and second, a diverging form from where the converging form stops, with a restricted neck between them, may be used. An example of such other polygonal forms is the group of substantial pentagonal staves at **93**, Fig. 6.

If desired, a plurality of bubble or sorting columns **76** may be disposed radially around an impeller **78**, somewhat after the manner illustrated upon a reduced scale in the diagram, Fig. 7. Here, two such compartments are shown, but a greater number might in some cases prove useful. The diagram, Fig. 7, also represents cases where gratings, such as **29**, Fig. 1, are omitted.

The action of the impeller on the pulp in this invention, differs from other types of flotation machines, in that the discharge of aerated pulp from the agitating compartment, and its horizontal flow in the separation chamber is unobstructed, which together with the superaerating property of the impeller, practically eliminates the definite pulp level in the separation chamber, so that the pulp in the separation chamber is almost entirely an aerated mass.

Furthermore, the discharge of aerated pulp from the agitating compartment, enters the body of aerated pulp in the separation chamber, and continues in its flow through the separation chamber, at practically the same depth throughout. Consequently, there is the least amount of resistance offered to the aerated pulp in passing from the agitating compartment into the separation chamber.

The aerated pulp mass is substantially deaerated at the surface thereof during transit through the separation chamber, while at the same time, the pulp mass is traveling across the separation chamber from end to end, due to the displacing action of the incoming feed, the travel of the pulp through the separation chamber being substantially horizontal. The decelerating flow of pulp across the separation chamber, allows the tailings to gradually settle towards the substantially horizontal floor of the separation chamber, and to be carried away by an undertow current which passes through the opening under the wall **51**—**1**, this undertow current being finally discharged over the tailings weir. It will be noted that the tailings outlet is remote from the pulp inlet and at a low level of the separation chamber.

While specific aspects of the various details of this invention are herein shown and described, it is to be clearly understood that changes could be made therein without departing from the spirit and scope of the invention as defined in the following claims.

Having fully described my invention, what I claim is:

1. An aerating machine, including in combination, an aerating impeller having its rotative axis substantially vertical, and having an intake opening in its lower portion for material to be aerated, a structure defining a separation chamber located to one side of impeller and disposed to receive a substantially horizontal stream of material discharged by said impeller, means defining a feed inlet passage leading downwardly to said intake opening of impeller, means defining a return-feed channel extending from the far end of said separation chamber to said intake opening, and valves disposed in the bottom of said separation chamber for the purpose of regulating return communication between the separation chamber and impeller intake.

2. An aerating machine, including in combination, a liquid-containing structure having an impeller chamber at one end thereof and a separation chamber adjacent the impeller chamber, an aerating impeller disposed to rotate vertically in said impeller chamber so as to discharge material transversely into said separation chamber along direct lines, said impeller having an entry in its lower portion for material to be aerated, means defining a return-feed channel below said liquid-containing structure, said return-feed channel being in communication with the far end of said separation chamber and with said impeller entry, means defining a feed inlet passage in communication with said impeller entry, and an overflow weir operative to regulate the depth of liquid in said liquid-containing structure.

3. An aerating machine, including in combination, a liquid-containing structure having an aeration unit in an end portion thereof and a separation chamber in the remaining portion, said aeration unit including an impeller disposed to rotate vertically and having an air-intake and a pulp-intake, an air-intake bell extending upwardly from said impeller; means defining an aeration chamber around said impeller, said chamber being closed at the top, but opening sidewisely into said separation chamber along horizontal lines extending from the impeller; means defining a return-feed channel underneath said liquid container and available to afford communication between said separation chamber and said impeller pulp-intake, means defining a pulp feed inlet passage, and an overflow weir regulable as to the depth of liquid in said separation chamber and in said pulp feed inlet passage.

4. An aeration machine including in combination a structure confining a body of liquid having substantial depth and relatively great length, the dimensional extent of said structure being without abrupt volumetric variation, and means at one end of said structure effective to project aerated liquid horizontally into said body of liquid below the surface thereof throughout an area of projection substantially equal to the mean transverse sectional area of said body of liquid, the length of said body being sufficient to allow complete travel of said projected liquid there across until its velocity is effectively damped thereby, whereby a substantially horizontal flow of aerated liquid is caused through the entire volume of said body of liquid.

5. An aeration machine as recited in claim 4, in which the means effective to project aerated liquid horizontally into the body of liquid comprises an impeller with its rotative axis disposed vertically, said impeller being capable of projecting aerated liquid laterally of its axis with substantially no vertical component of projection.

6. An aeration machine as recited in claim 4 in which the aerating means comprises an impeller provided with an air inlet and a liquid inlet, and having a vertical axis of rotation, said impeller including staves extending transversely of the plane of rotation of said impeller and disposed in spaced relation respective to one another along a circle centered in said axis.

7. A flotation machine including in combination a separation chamber adapted to confine a body of pulp having substantial depth and relatively great length, said separation chamber having dimensions such that no abrupt volumetric variations occur in said body of pulp, and aerating means at one end of said separation chamber, said means being effective to project aerated pulp horizontally into said body of pulp, below the surface thereof, throughout an area

of projection substantially equal to the mean transverse sectional area of said body of pulp, whereby a substantially horizontal flow of aerated pulp is effected through the entire volume of said body of pulp, and mineral bearing bubbles are allowed to rise to the surface of said body of pulp by their own buoyancy, and tailings are caused to drop to a low level in said body of pulp, the length of said body being sufficient to allow the maximum separation between the bubble-carried mineral values and the tailings to take place in their travel across the separation chamber.

8. A flotation machine according to claim 7 wherein the body of pulp in the separation chamber is of uniform depth throughout.

9. A flotation machine according to claim 7 in which the aerating means comprises an impeller having its rotative axis disposed vertically, said impeller being capable of projecting aerated pulp laterally of its axis with substantially no vertical component of projection.

10. A flotation machine according to claim 7 in which the aerating means comprises an impeller provided with an air inlet and a pulp inlet, and having a vertical axis of rotation, said impeller including staves extending transverse of the plane of rotation and disposed in spaced relation respective to one another along a circle centered in said axis.

11. A flotation machine including in combination a separation chamber adapted to confine a body of pulp having substantial depth and relatively great length, said separation chamber having dimensions such that no abrupt volumetric variations occur in said body of pulp, and aerating means at one end of said separation chamber, said means being effective to project aerated pulp horizontally into said body of pulp, below the surface thereof, throughout an area of projection substantially equal to the mean transverse sectional area of said body of pulp, the length of said body being sufficient to allow the maximum separation between the bubble carried mineral values and the tailings to take place in their travel across the separation chamber, and tailings outlet at a low point in said separation chamber and remote from the said aerating means, whereby a substantially horizontal flow of aerated pulp is caused throughout the entire volume of said body of pulp, and mineral bearing bubbles are allowed to rise to the surface of said body of pulp by their own buoyancy, and tailings are caused to drop to a low level in said body of pulp and pass through said outlet.

12. A flotation machine including in combination a separation chamber adapted to confine a body of pulp having substantial depth and relatively great length, said separation chamber having dimensions such that no abrupt volumetric variations occur in said body of pulp, and aerating means at one end of said separation chamber, said means being effective to project aerated pulp horizontally into said body of pulp, below the surface thereof, throughout an area of projection substantially equal to the mean transverse sectional area of said body of pulp, the length of said body being sufficient to allow the maximum separation between the bubble carried mineral values and the tailings to take place in their travel across the separation chamber, and tailings outlet at the end of the separation chamber opposite the aerating means, and at a low level thereof, whereby a substantially horizontal flow of aerated pulp is caused throughout the entire volume of said body of pulp, and mineral bearing bubbles are allowed to rise to the surface of said body of pulp by their own buoyancy, and tailings are caused to drop to a low level in said body of pulp and pass through said outlet.

13. A flotation machine as recited in claim 15 in which the means for mixing a gas with pulp and for effecting a horizontal discharge of pulp from the pressure charging aeration cell comprises an impeller with its rotative axis disposed vertically, said impeller being capable of projecting aerated pulp laterally of its axis with substantially no vertical component of projection.

14. A flotation machine as recited in claim 15 in which the means for mixing a gas with pulp and for effecting a horizontal discharge of pulp from the pressure charging aeration cell comprises an impeller provided with an air inlet and a liquid inlet, and having a vertical axis of rotation, said impeller including staves extending transversely of the plane of rotation of said impeller and disposed in spaced relation respective to one another along a circle centered in said axis.

15. A flotation machine including in combination a pressure charging aeration cell, means for mixing a gas with pulp and for effecting a horizontal discharge of pulp from said cell, a set of staves defining a plurality of side outlets in said cell, a separation chamber having substantial depth and relatively great length in substantially horizontal alignment with said side outlets and being of a length sufficient to permit a long horizontal movement of pulp from the outlets of the cell, said separation chamber having dimensions such that no abrupt volumetric variations occur in the body of pulp therein, said set of staves being of a width and a depth approximately equal to the width and depth of the pulp in the separation chamber.

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