Sept. 30, 1952 A. C. DAMAN 2,612,358

PUMPING-TYPE FLOTATION APPARATUS

Filed June 14, 1947 3 Sheets-Sheet 1

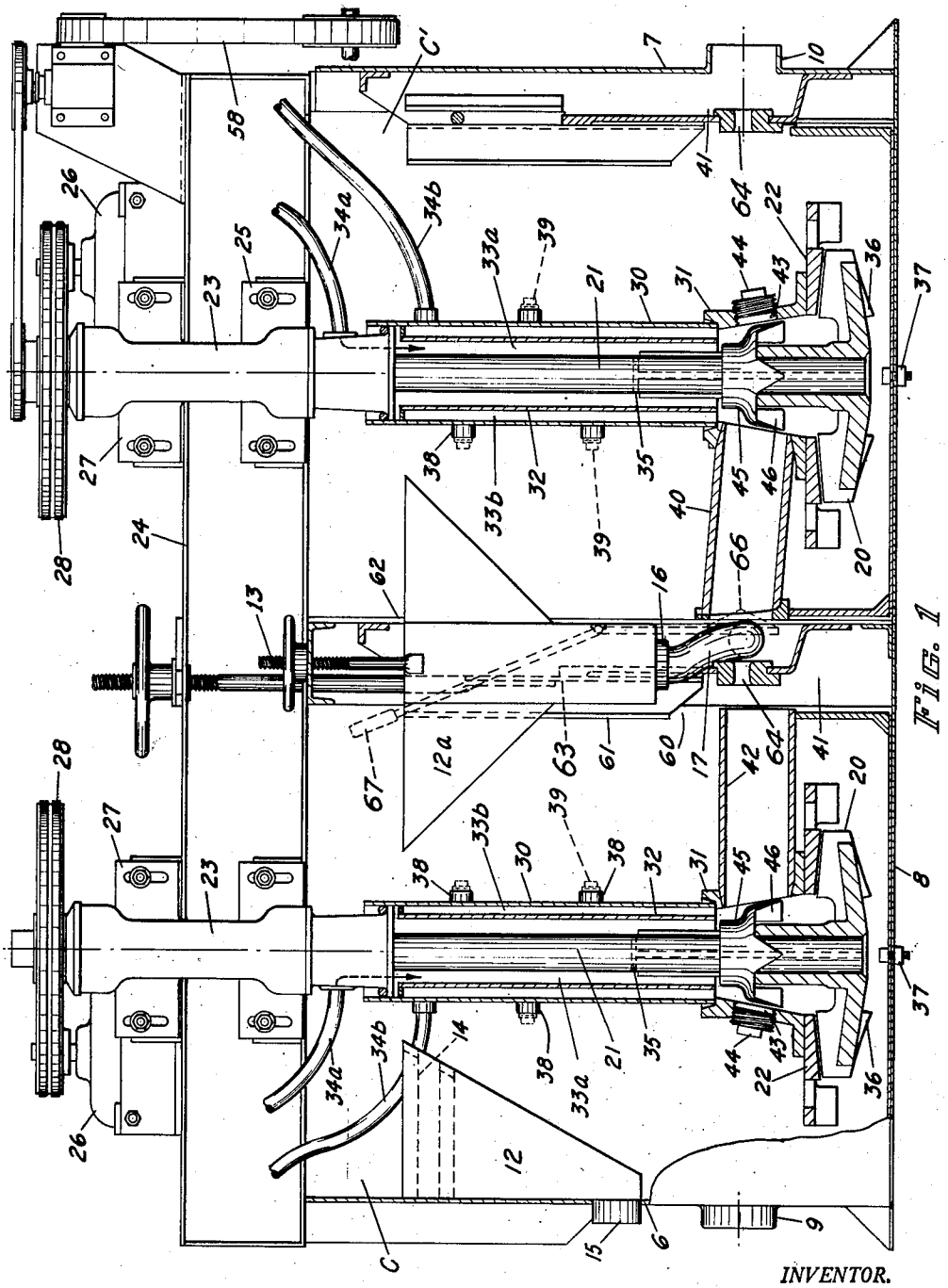


Fig. 1

INVENTOR.
ARTHUR C. DAMAN
BY
A. A. McGrew
ATTORNEY

Sept. 30, 1952 A. C. DAMAN 2,612,358

PUMPING-TYPE FLOTATION APPARATUS

Filed June 14, 1947 3 Sheets-Sheet 2

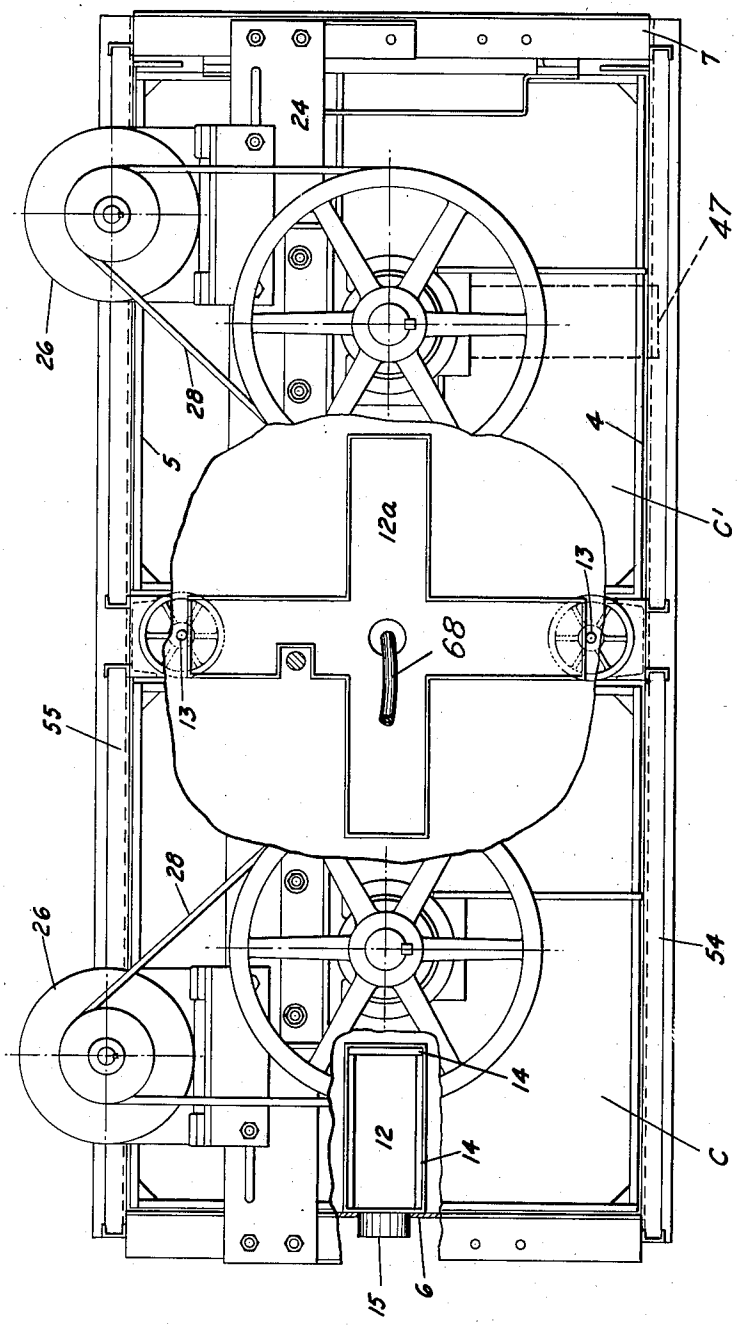


FIG. 2

INVENTOR.
ARTHUR C. DAMAN
BY
W. A. McGrew
ATTORNEY

Sept. 30, 1952 A. C. DAMAN 2,612,358

PUMPING-TYPE FLOTATION APPARATUS

Filed June 14, 1947 3 Sheets-Sheet 3

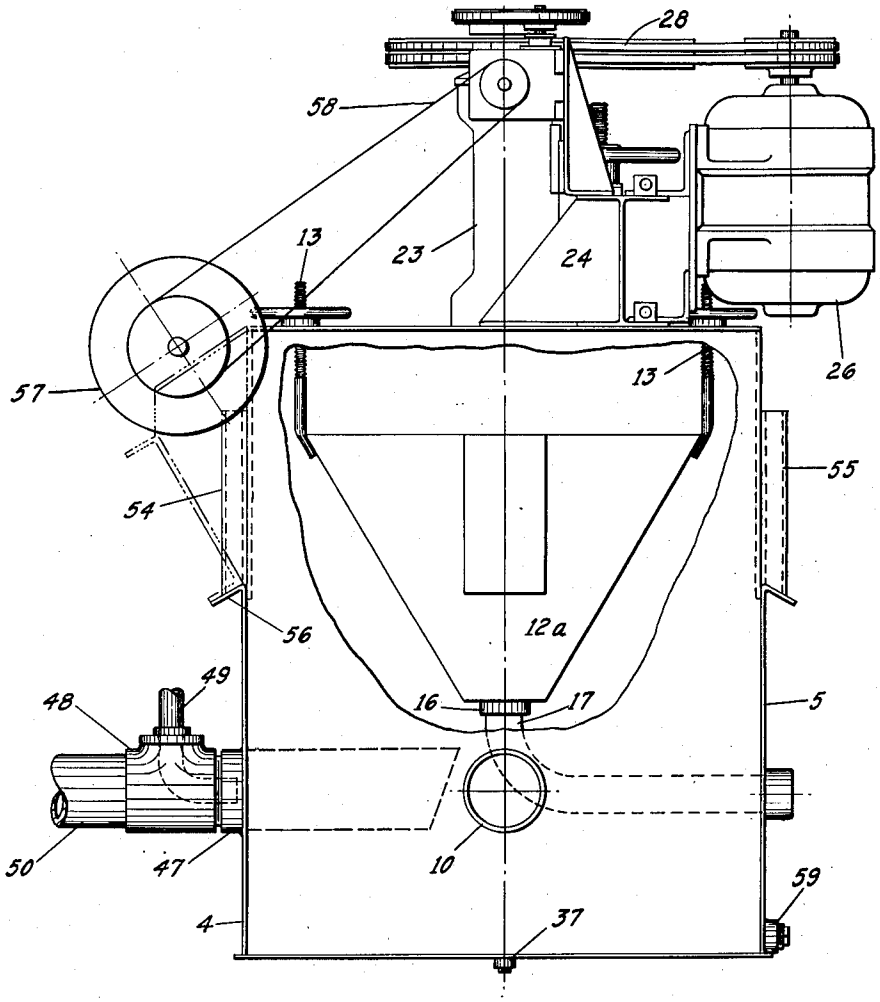


Fig. 3

INVENTOR.
ARTHUR C. DAMAN
BY
H. A. McGreen
ATTORNEY

Patented Sept. 30, 1952 2,612,358

UNITED STATES PATENT OFFICE

2,612,358

PUMPING-TYPE FLOTATION APPARATUS

Arthur C. Daman, Denver, Colo., assignor to Mining Process and Patent Company, Denver, Colo., a corporation of Delaware

Application June 14, 1947, Serial No. 754,653

17 Claims. (Cl. 261—93)

1

This invention relates to improvements in the froth flotation apparatus, and more particularly relates to certain improvements in the froth overflow and mixing function of froth flotation apparatus of the sub-aeration type.

In conventional froth flotation practices, it has been customary to provide a stationary froth overflow lip along one side of the flotation machine, usually the front side, and then regulate the liquid level in the machine or in individual cells of a machine to provide a bed of froth of selective depth to overflow a given portion of the concentrate. With the advent of new flotation reagents, the character of the froth or foam is being changed, and particularly there is a trend away from voluminous and tenacious froths. In most instances, a brittle froth will be preferred because of the reduced treatment time required in the handling of a concentrate material in subsequent treatments. Voluminous froths are frequently objectionable because of the coalescence occurring at the overflow zone with concentrate loss due to shattering of bubbles. However, to effectively use a brittle froth which is relatively shallow in depth, it is necessary to provide a close control of the overflow level and also to provide for a rapid discharge of the concentrate material after it reaches the froth bed.

It is an object of the present invention to provide simple, durable and efficient apparatus for insuring prompt removal of froth from a flotation cell at any desired elevation in the froth zone.

Another object of the invention is to provide an improved apparatus for mixing the pulp feed, air and recirculating pulp in the agitation zone of a flotation treatment.

A further object of the invention is to provide pumping means in association with the impeller of a flotation machine of the sub-aeration type to accelerate the mixing of matter at the intake side of the impeller.

Still another object of the invention is to provide improved means for mixing atmospheric air and air under pressure as the aerating medium in a froth flotation process.

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

The present inventive concept comprises two phases. The first involves the provision of a froth collecting launder positioned within a flotation cell and mounted for movement to selective elevations within said cell. The second involves the mixing function and includes the provision of a runner auxiliary impeller mounted at the lower end of the hollow column extending upwardly from the impeller, into which pulp and air are delivered for pre-mixing, prior to introduction onto the rotating impeller.

2

Preferably, the froth launder is of such size and shape as to substantially cover the feed box to a given cell and at the same time provides portions extending to a substantial distance in adjoining cells. The overflow level of the launder is predetermined to provide for the collection of a given amount of concentrate in the froth bed at the top of the cell.

The practice of the present invention will be best understood by reference to the accompanying drawings. In the drawings, in the several views of which like parts are designated similarly,

Fig. 1 is a vertical control section through a multi-cell flotation machine embodying features of the present invention;

Fig. 2 is a top plan view of the machine shown in Fig. 1, partially broken away to show the arrangement of interior parts; and

Fig. 3 is an end elevation, partially broken to show the arrangement of interior parts.

The apparatus illustrated in the drawings is a typical multi-cell flotation machine showing the detail of the first and last cell of a series of cells, which may be any plurality. Intermediate cells of any series of three or more would utilize an intake or feed arrangement corresponding to that shown in the last cell of the series while the discharge end of the cell would be substantially similar to the discharge end of the first cell illustrated.

As represented in Figs. 1 and 2, the first cell is designated C and the last cell is designated C'. The machine has front and rear walls 4 and 5, respectively, and end walls 6 and 7, which together with a bottom 8, define a tank divided into a plurality of cells, which as shown in the drawings, comprises the cells C and C'. Feed to the machine is introduced through an inlet 9, and the final discharge from the machine is through an outlet 10.

A series of launders 12 and 12a are arranged in the tank to collect froth forming in the tank which enters said launders by overflow. As illustrated, the launder 12 is held permanently in the position shown, but it may be vertically adjustable, if desired. Launder 12a is attached to

one or a plurality of screws 13 (here shown as 2) by which it may be moved to selective elevations in the cell.

In order to provide the necessary overflow level regulation for launder 12, I provide slat weirs 14 along both sides and the top and in this way its effective elevation can be made to correspond to the positioning of the launder 12a. The collected concentrate flows from a bottom opening 15 in launder 12 to any suitable conduit (not shown) and the concentrate collected by launder 12a flows through an outlet 16 and flexible conduit 17 to a point of discharge outside cell C'.

An impeller 20 is mounted for rotation on a shaft 21 near the bottom of each cell and has a stationary hood or cover member 22 overhanging the impeller in spaced and proximate relation. The shaft is journaled for rotation in a bearing assembly 23 supported from superstructure 24 and preferably arranged for adjustment to selective elevations in the cell through the provision of slotted plates 25 by which the bearing assembly is supported on the superstructure. The shaft is driven by a motor 26 or other prime mover, which, as illustrated in Fig. 1, also is supported from a slotted plate 27 for selective adjustment to different elevations in the cell. Suitable transmission 28 connects the motor to shaft in driving relation.

Each of said shafts is enclosed in a hollow column 30 supported from the hub portion 31 of cover plate 22 and a tubular partition member 32 divides the interior space of column 30 into inner and outer passages 33a and 33b respectively. Air or other aerating gas is introduced into two conduits 34a and 34b which empty into the passages 33a and 33b respectively. The gas delivered through passage 33a, or a portion of the same enters a T-shaped passage 35 in shaft 21 and discharges from the under surface of the impeller, and due to the provision of blades or vanes 36 this gas mixes with pulp on the bottom of the respective cells and subjects said materials to intensive mixing.

If additional mixing is required, air or other gas may be introduced through bottom inlets 37. Feed to the cell C enters through inlet 9 and then circulates about the cell for return through one or more nipples 38, which may be closed by screw plugs 39, if desired. A feed tube 40 may be utilized to conduct feed from inlet 9 or a feed box 41. As shown, such a tube is provided in cell C', but not in cell C. When the feed tube is not used, a return tube 42 is provided to recirculate pulp from a following feed box 41 to the impeller enclosure.

Sometimes a greater amount of recirculation is required, and an opening 43 in the hub normally closed by a plug 44 may be opened to effect this return. A runner 45 or auxiliary impeller of the pump-runner type is mounted on shaft 21 within hub 31 to pre-mix gas and pulp prior to its introduction onto and final mixing by the impeller 20. This runner has radial blades 46 of tapering section so that they will be equally effective in right-hand or left-hand operation.

In addition to the recirculating features hereinbefore described, provision is made, as shown in Fig. 3, for the delivery of pulp, or gas, or both, through a nipple 47 at the front of the machine. When both materials are so fed to the machine a T-fitting 48 is fitted on the nipple and a gas supply conduit 49 and a pulp-supply conduit 50 are connected in the T. When a rougher-cleaner circuit is used, collected froth from other cells is returned through conduit 50 into a given cell.

Also as shown in Fig. 3, the front wall 4 and rear wall 5 of the tank have their top surfaces at a much lower elevation than the end walls of the cell, and weirs 54 and 55 are mounted on such walls to permit a selective overflow level in the event froth removal is to be effected other than by collection in the launders 12 and 12a. Another froth overflow arrangement is to mount a forwardly-extending overflow lip section 56 on the flange of the front wall and attached to the end walls as by welding. In such event the usual paddle or scraper 57 is mounted above the overflow lip and is driven through a suitable transmission 58. A normally-plugged drain opening 59 is provided for cleanout purposes.

In the operation of a single cell, pulp is fed through a feed inlet 9 or a feed tube 40, while air or other aerating gas such as CO^2 or the like is introduced through supply conduits 34a and 34b into the passages 33a and 33b of hollow column 30 and may be introduced through the lower inlets 37, if extra aeration is required. If fed through the inlet 9 the entering pulp first mixes with circulating aerated pulp and a portion of this mixture is drawn under the impeller and subjected to additional mixing with gas entering either through the T-shaped passage 35, or the inlet, or both.

After this initial mixing, the aerated pulp recirculates into the impeller, through openings 38 or 43, or both, and due to the pumping action of the runner 45, this pulp mixes with gas fed downwardly through the passages 33a and 33b. The resulting mixture is forced downwardly onto the impeller where it is subjected to additional mixing by the centrifugal movement and the beating action of the impellers within the restricted space beneath the hood enclosure. Again, as the pulp discharges across the periphery it is subjected to further breaking up against the underhanging vanes of the hood structure.

In this way, the pulp is subjected to repeated aerating influences while circulating in the cell, and the froth formed by the aerating action rises to the surface carrying the mineral particles with it, and collects in a bed for subsequent discharge by overflow. If a middlings product tends to form below the froth bed and impedes the passage of the air bubbles and associated mineral thereto, the upper openings 38 are utilized to draw off the middlings for additional aeration and mixing at the impeller.

When multi-stage operation is utilized, an opening 60 is provided in the rear wall 61 of a preceding cell, which wall is separated from the front wall 62 of the succeeding cell to form the feed compartment 41. A partition having an overflow weir 63 in its upper portion regulates the liquid level in the preceding cell and a sand relief opening 64 is provided to pass non-floated material from a preceding to a succeeding cell.

Under some operating conditions, it will be desirable to regulate the volume of pulp entering a given cell through its feed conduit 40 from a feed box 41. A valve 66 (Fig. 1) controlled by a lever 67 is provided for this purpose and thus admits more or less feed to the impeller, or to the pulp body in the cell when the feed conduit 40 is removed as in cell C.

It should be noted additionally that the provision for pulp introduction into the pumping zone

above the impeller provides a liquid seal preventing escape of the aerating gas to atmosphere, except by following the intended course through the impeller and pulp body to the froth bed. Because of this, it is possible to utilize supercharged aeration of the type disclosed in Logue application, Serial No. 632,819 and his Patent No. 2,390,111, owned by the assignee of this application. In such event, the pump unit will assist in mixing the gas and pulp and also inducing discharge of the low pressure gas.

In order to get more recirculation of pulp, removal of plug **44** (Fig. 1) will permit runner **45** to exert a strong pumping action on opening **43** and this pulp, together with pulp entering from conduits **40** or **42**, or through passage **33***b*, will be premixed with the air stream descending through the passages **33***a* and **33***b* before passing onto the impeller. The arrangement of impeller blades, cover plate and associated vanes serves to produce an intense mixing and widespread dispersion of the gas under the centrifugal influence of the impeller, so that the aerated pulp on discharge from the impeller enclosure efficiently carries the mineral to the surface.

The froth overflowing the launders **12** and **12***a* will pass through the outlets **15** and **16** respectively, by gravity when in a sufficiently fluent condition and particularly when, as usual, these outlets are connected with pumps (not shown). However, when the concentrate is not of a free flowing character, or when air accelerated discharge is desired, a hose or water line **68** (Fig. 2) may be directed into such launders to provide a source of flush water.

From the foregoing description, it will be apparent that the structure and operations disclosed attain the several objects of the invention in an efficient manner. The arrangements illustrated in the drawings are intended merely as typical examples of the practice of the present invention, but not to limit the invention beyond the intended meaning of the hereunto appended claims.

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

1. The combination with a flotation cell and a rotary impeller in the lower portion of said cell, of a hood over the impeller, a hollow gas-supply column extending into the upper portion of the cell, a pulp-delivery conduit positioned at the bottom of said column for feeding pulp to the impeller, and an auxiliary impeller mounted above and spaced from the impeller within said column for forcefully discharging gas and pulp onto the impeller.

2. The combination with a flotation cell and a rotary impeller in the lower portion of the cell, of a hood over the impeller, a hollow gas-supply column extending into the upper portion of the cell and having its interior divided into a plurality of separated passages for gas, means for introducing an aerating gas into each said passage, a pulp-delivery conduit positioned at the bottom of said column for feeding pulp to the impeller, and an auxiliary impeller mounted above and spaced from the impeller within said column for forcefully discharging gas and pulp onto the impeller.

3. The combination with a flotation cell and a rotary impeller in the lower portion of the cell, of a hood over the impeller, a hollow gas-supply column extending into the upper portion of the cell and having its interior divided into inner and outer passages for gas, means for introducing an aerating gas into each said passage, a pulp-delivery conduit positioned at the bottom of said column for feeding pulp to the impeller, and an auxiliary impeller mounted above and spaced from the impeller within said column for forcefully discharging gas and pulp onto the impeller.

4. The combination with a flotation cell and a rotary impeller in the lower portion of the cell, of a hood over the impeller, a hollow gas-supply column extending into the upper portion of the cell and having its interior divided into a plurality of separated passages for gas, means for introducing an aerating gas into each said passage, a pulp-delivery conduit positioned at the bottom of said column for feeding pulp to the impeller, and an auxiliary impeller mounted above and spaced from the impeller within said column for forcefully discharging gas and pulp onto the impeller, said auxiliary impeller having radial blades of tapering section so arranged as to pump effectively in either clockwise or counterclockwise rotation.

5. In flotation apparatus, a cell, a shaft extending into said cell, an impeller carried at the bottom of said shaft, a hollow column extending upwardly from a point above the impeller into the upper portion of the cell and having its interior divided into a plurality of gas delivery passages, means for drawing pulp from the cell into one of the passages, means for supplying an aerating gas to the respective passages, suction means mounted in the lower portion of the column for pumping gas onto the impeller, and means, including a passageway, for conducting gas from another of said passages to a point of discharge below the impeller.

6. In flotation apparatus, a cell, a shaft extending into said cell, an impeller carried at the bottom of said shaft, a hollow column extending upwardly from a point above the impeller into the upper portion of the cell and having its interior divided into inner and outer gas-delivery passages, means for supplying an aerating gas to the respective passages, means for drawing pulp from the cell into the outer passage suction means mounted in the lower portion of the column for pumping gas onto the impeller, and means, including a passageway, for conducting gas from the inner passage to a point of discharge below the impeller.

7. In flotation apparatus, a cell, a shaft extending into said cell, an impeller carried at the bottom of said shaft, a hollow column extending upwardly from a point above the impeller into the upper portion of the cell and having its interior divided into inner and outer gas-delivery passages, means for supplying an aerating gas to the respective passages, means for drawing pulp from the cell into the outer passage, an auxiliary impeller mounted in the lower portion of the column above the impeller for pumping gas downwardly onto the impeller, and means, including a passageway, for conducting gas from the inner passage to a point of discharge below the impeller.

8. In a froth flotation device of the type having a plurality of interconnected, generally rectangular cells disposed in side-by-side relation, the improvement which comprises a froth launder disposed within and between adjacent cells and having portions projecting laterally into each of said adjacent cells for receiving froth therefrom, and a discharge conduit for discharging material collected in the launder at a point outside either of said cells.

9. In a froth flotation device of the type having a plurality of interconnected, generally rectangular cells disposed in side-by-side relation, the improvement which comprises a froth launder disposed within and between adjacent cells and having portions projecting laterally into each of said adjacent cells for receiving froth therefrom, a discharge conduit for discharging material collected in the launder at a point outside either of said cells, a support above the cells, and movable means carried by the support and connected to the launder for raising and lowering the launder.

10. In a froth flotation device of the type having a plurality of interconnected, generally rectangular cells disposed in side-by-side relation, the improvement which comprises a froth launder having a hollow open transverse leg disposed between adjacent cells and a hollow open longitudinal leg communicating with the transverse leg and projecting into each of said adjacent cells for receiving froth therefrom, and a discharge conduit for discharging material collected in the launder at a point outside either of said cells.

11. In a froth flotation apparatus, inclusive of a cell, a rotary impeller in the lower portion of the cell, and a hollow column extending from an elevation immediately over the impeller into the upper portion of the cell and having its upper end sealed against the discharge of gas, the improvement which comprises partitioning means in the column dividing its interior into two substantially coextensive passages terminating above and adjacent the impeller, agitating means disposed between said passages and the impeller, and conduit means for supplying gas selectively to each said passage.

12. In froth flotation apparatus, inclusive of a cell, a rotary impeller in the lower portion of the cell, and a hollow column extending from an elevation immediately over the impeller into the upper portion of the cell and having its upper end sealed against the discharge of gas, the improvement which comprises partitioning means in the column dividing its interior into two substantially coextensive passages terminating above and adjacent the impeller, agitating means disposed between said passages and the impeller, conduit means for supplying gas selectively to each said passage, and means for recirculating pulp from an upper portion of the cell into one said passage.

13. In a froth flotation apparatus, inclusive of a cell, a rotary impeller in the lower portion of the cell, and a hollow column extending from an elevation immediately over the impeller into the upper portion of the cell and having its upper end sealed against the discharge of gas, the improvement which comprises partitioning means in the column dividing its interior into two substantially coextensive concentric passages terminating above and adjacent the impeller, agitating means disposed between said passages and the impeller, conduit means for supplying gas selectively to each said passage, and means for recirculating pulp from an upper portion of the cell into the outermost passage.

14. In froth flotation apparatus, inclusive of a cell, a rotary impeller in the lower portion of the cell, and a hollow column extending from an elevation immediately over the impeller into the upper portion of the cell and having its upper end sealed against the discharge of gas, the improvement which comprises partitioning means in the column dividing its interior into two substantially coextensive passages terminating above and adjacent the impeller, conduit means for supplying gas selectively to each said passage, and pumping means beneath the passages for moving matter onto the impeller.

15. In froth flotation apparatus, including a cell of rectangular section having a froth overflow extending along one of its sides in the upper portion of the cell, the improvement which comprises a horizontally disposed launder in the cell adjacent the froth overflow level, including a plurality of divergent portions extending into areas of said cell remote from the froth overflow, and froth conducting means constructed and arranged to receive froth overflowing into said horizontal launder and to conduct the collected froth by gravity to a point of discharge outside said cell.

16. In froth flotation apparatus, including a cell of rectangular section having a froth overflow extending along one of its sides in the upper portion of the cell, the improvement which comprises a horizontally disposed launder in the cell adjacent the froth overflow level, including a plurality of divergent portions extending into areas of said cell remote from the froth overflow, froth conducting means constructed and arranged to receive froth overflowing into said horizontal launder and to conduct the collected froth by gravity to a point of discharge outside said cell, and means associated with the cell for varying the elevation of the horizontal launder in said cell.

17. In froth flotation apparatus, including a cell of rectangular section having a froth overflow extending along one of its sides in the upper portion of the cell, the improvement which comprises a horizontally disposed launder in the cell adjacent the froth overflow level, including three divergent portions extending into areas of said cell remote from the froth overflow, and froth conducting means constructed and arranged to receive froth overflowing into said horizontal launder and to conduct the collected froth by gravity to a point of discharge outside said cell.

ARTHUR C. DAMAN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,285,061	Daman	Nov. 19, 1918
1,761,136	Lord	June 3, 1930
1,921,220	Daman	Aug. 8, 1933
2,054,249	Fagergren	Sept. 15, 1936
2,238,139	Tucker	Apr. 15, 1941
2,393,976	Daman et al.	Feb. 5, 1946