

Dec. 28, 1943.

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2,337,806

FLOTATION MACHINE

Filed Oct. 21, 1941

2 Sheets-Sheet 1

FIG. 1

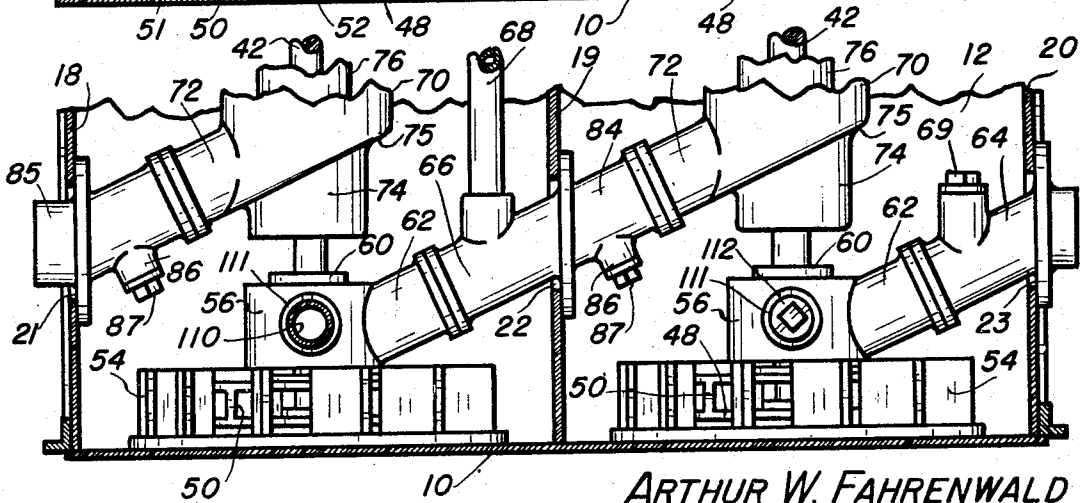
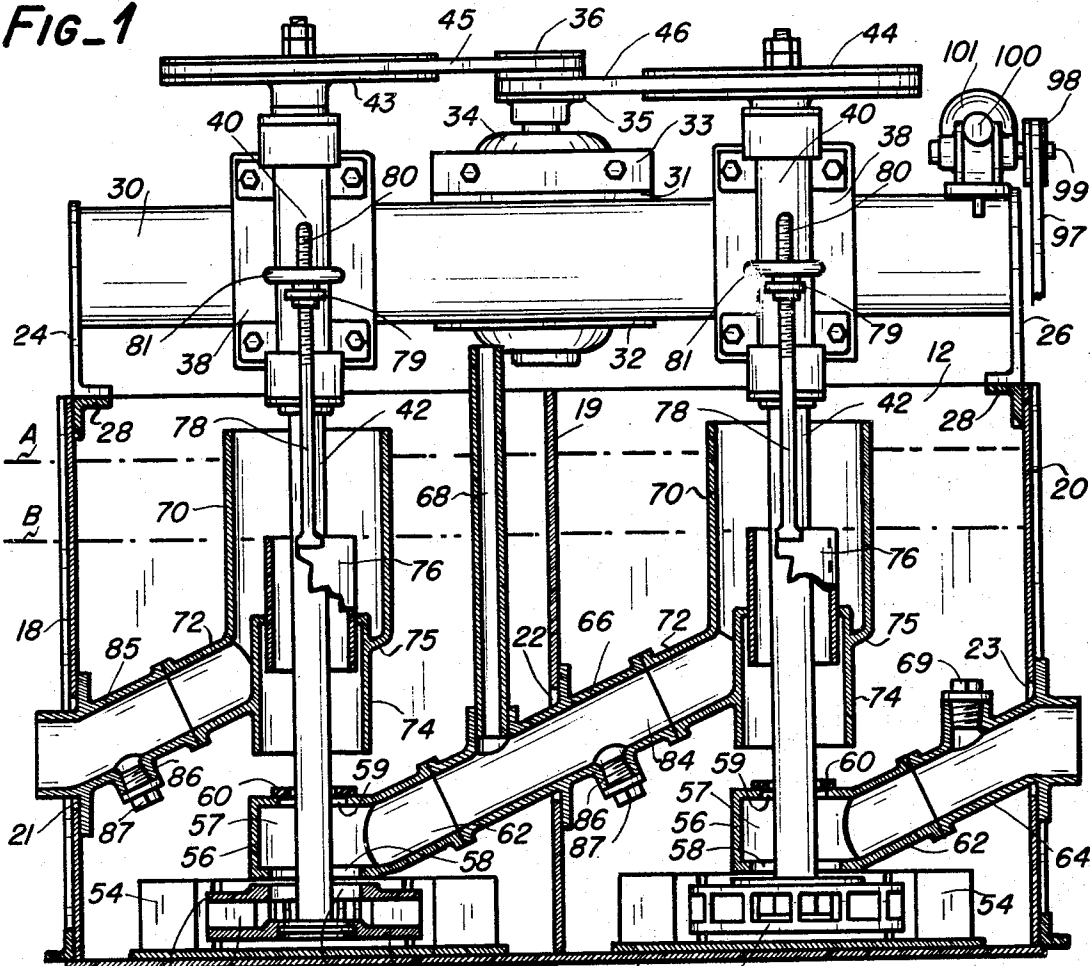


FIG. 2

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2 Sheets-Sheet 2

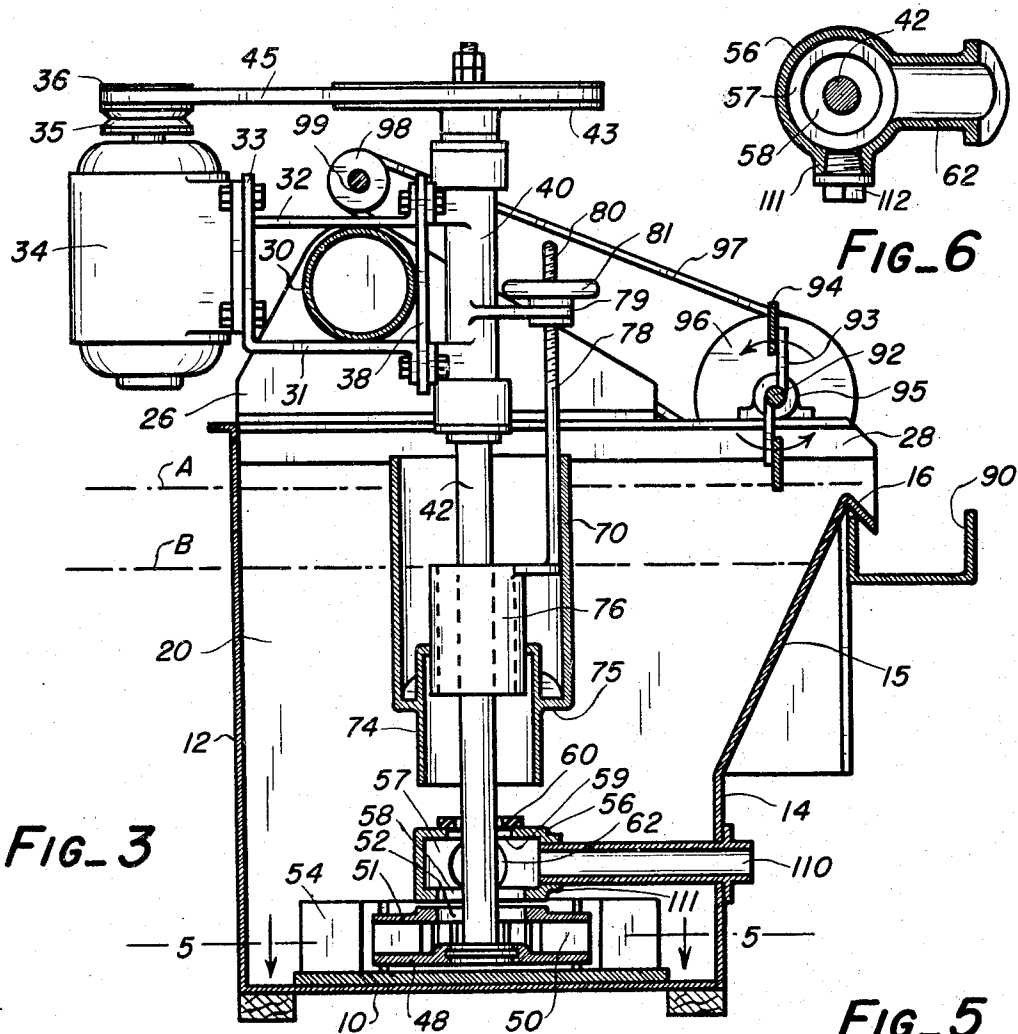


FIG. 3

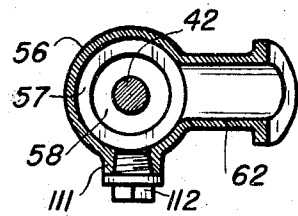


FIG. 6

FIG. 5

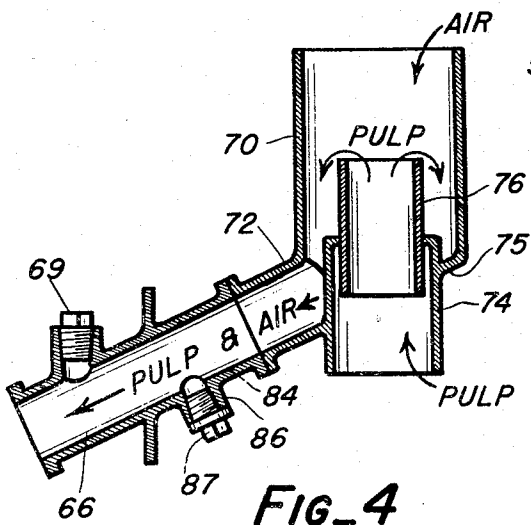
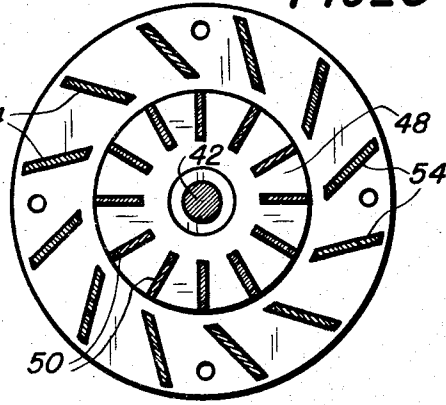


FIG. 4

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FLOTATION MACHINE

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Application October 21, 1941, Serial No. 415,893

6 Claims. (Cl. 209—169)

This invention relates to a flotation machine which, among other uses, is particularly useful in ore dressing methods or processes in which it is desirable to agitate, circulate, and aerate mineral bearing liquids.

In the conventional practice relating to the flotation of mineral particles to effect separation from the conveyant liquid, it is the usual practice to employ a cell or a series of cells into which a stream of mineral bearing liquid is introduced, treated to aerate the material and then conveyed away for disposal. Such cells are usually provided with an impeller, either of the rotary or oscillatory type, and, when material to be treated is introduced to the cell, these impellers circulate it, agitate it, and aerate it to produce a froth which rises to the surface of the contained liquid and carries with it minute mineral particles. Often the frothing action is enhanced by the employment of frothing agents, such, for example, as pine oil and other suitable chemicals which improve the production of the froth and increase the affinity of mineral particles being separated and the bubbles of the froth. The froth rises to the surface of the cell and forms a blanket which may be skimmed or otherwise drawn off. The operation of such flotation cells is usually carried on in a continuous manner and, as material is fed to the cells to be treated, other material is drawn off the cell for subsequent treating stages or otherwise to be disposed of according to the dictates of the process. The froth that is skimmed from the cell is conveyed away for further treatment and such treatment may include settling, concentrating in filters or other dehydrators, or drying by exposure to air.

Among important objects of my invention, one object is to improve pulp agitation in the flotation machine.

Another relates to improving the pulp handling in a cell in the manner in which it is collected and discharged from the cell after being subjected to the action thereof.

A further object is to simplify the pulp aeration, agitation and circulation means and consequently to improve the operation of the unit.

Another object of my invention is the provision of an improved primary pulp feed for a flotation cell so arranged that the fed material is delivered to the impeller adjacent its upper face to insure the pulp being acted upon by the impeller as soon as introduced to the cell.

A further object of the invention relates to the provision of means whereby internal pulp recir-

ulation may be effected within an individual cell.

Still another object of the invention is to provide auxiliary pulp feed means that may operate simultaneously to the primary pulp feed for effective retreatment of certain materials.

A still further and important object of the invention has been the provision of novel pulp outlet means including a pulp launder located centrally of a cell to raise the efficiency of such operation and to eliminate cross-currents in the pulp flow and its detrimental effect upon the froth produced. And in this connection, an associated object has been the provision of novel means for controlling the pulp level and for permitting the outgoing flow of pulp from a zone below its surface.

Still other and further objects of invention are to provide novel inter-cell conduit means for handling the flow of pulp and air and also to provide anti-swirl means adjacent the impeller for deflecting and directing agitated and aerated pulp to enhance the formation of the froth.

Another object of the invention has been to incorporate all the foregoing objects in a single unitary mechanism that is simple to construct, that will operate continuously with low maintenance and operation cost, and that will produce results highly improved over conventional practices.

Other objects and advantages of the invention will be more apparent during the course of the following description, wherein I have set forth and described a preferred embodiment of my invention. This description, taken in view of the accompanying drawings, constitutes a full disclosure of the invention and serves as a basis for the subjoined claims.

Throughout the various views of the drawings, like reference numerals refer to like parts and in the drawings,

Figure 1 is a vertical, longitudinal sectional view through a pair of cells on the axis of the impeller,

Figure 2 is a fragmentary, sectional view similar to Figure 1, but showing certain parts of the flotation cell of my invention in elevation,

Figure 3 is a lateral section of a single cell as though taken at right angles to the showing of Figure 1 along the impeller axis,

Figure 4 is a vertical, sectional view of my launder showing the outlet conduit associated therewith for the handling of pulp and air to an adjacent cell or to other disposal means,

Figure 5 is a cross-section taken on lines 5—5

of Figure 3 showing the details of an impeller and an associated anti-swirl gauge, and

Figure 6 is a horizontal sectional view of a pulp inlet chamber and illustrating conduit means associated therewith.

I employ a cell for my flotation machine which comprises a bottom 10 having a back wall 12, a front wall 14, that may be directed outwardly, as at 15, and which terminate in an upper overflow lip 16. The side walls 18, 19 and 20 join with the front and back wall according to the showing of Figure 1 to provide a pair of adjacent cells that are shown as rectangular in shape but which may be formed in any suitable shape according to the requirements of space and the manufacturing processes. For the passage of pulp through the cells, the walls 18, 19 and 20 may be ported at 21, 22 and 23 respectively as desired.

The operating mechanism of the particular flotation cells shown herein is mounted on a superstructure comprising end plates 24 and 26 supported upon suitable structural members 28 in the cell and in turn supporting an overhead cross member 30 shown to be tubular. Upon the cross member 30, and by means of brackets 31 and 32, a mounting plate 33 for the motor 34 is provided. As shown in Figure 3 the motor 34 has a pair of sheaves 35 and 36 adapted to receive a drive belt for purposes later to be described.

A bearing base plate 38 is attached to the member 30 and, upon this plate I mount the spindle bearing 40 adapted to receive and journal the impeller spindle shaft 42, 42.

The shaft 42 passes through the bearing 40 and on its upper end is provided a sheave 43 or 44. The belts 45 and 46 pass around the driver sheaves 44, 44 and around the drive sheaves 36 and 35, respectively, so that when the motor is actuated in the customary manner, and its sheaves caused to rotate, rotary motion is transmitted to the shafts 42.

At its lower end shaft 42 is coupled to the base plate 48 of the impeller. Upon the base plate and arranged in any suitable manner such, for example, as the radial showing of Figure 5, are a plurality of impeller blades 50. Upon their upper surfaces the blades are joined to the cover plate 51 that has a central port 52. The impeller thus described is what is known as "closed" type of impeller but it is pointed out that other types may be used without departing from the principles of my invention so long as it is adapted to introduce fed pulp at or adjacent the center of the impeller. In certain instances such impellers may be driven from below and I do not wish to be limited, therefore, to the overhead drive herein shown and described as it merely exemplifies my invention.

I eliminate vortical swirling of the material being discharged from the impeller by employing a plurality of deflector blades 54 arranged around the impeller in the manner of a cage. As shown in Figure 5 the plane of the deflector blade is disposed away from the plane of the radial blades of the impeller so that material leaving the impeller may strike against its face and be brought to rest momentarily in order that air bubbles, and froth that is foaming in the mass, can be given an opportunity to start ascending through the pulp to the upper surface.

For the purposes of feeding pulp through the impeller, I employ hollow cylindrical housings 56 which form the feed chamber 57 in each cell

above, and approximately centrally located with respect to the axis of rotation of the impeller. The housings each have lower discharge openings 58 and upper openings 59 which, in the case of the overhead drive illustrated herein, accommodates the impeller shaft. A lid or cover plate 60 closes each of the openings 59 and encircles the shaft 42 to reduce unrestricted recirculation of the pulp in the cell through the opening 59. In certain cases, the opening in the lid 60 may however be loose enough in its fit around the shaft to permit limited recirculation of pulp.

Communicating with the chamber 57 and extending outwardly at one side of the housing, is the primary feed inlet 62 which, in the instant case, is directed downwardly to the housing from an upper elevation.

In the case of a multi-cell structure as shown in Figure 1 it is customary to employ a primary feed conduit 64, associated with wall opening 23, and a secondary feed conduit 66 communicating between the cells through the opening 22, both of which are adapted to receive an auxiliary vent tube 68 or be closed by a plug 69 according to the dictates of operation of the flotation machine. Pulp is fed through the primary inlet conduit 64 and flows down the inner inclined tube into the housing, out through the opening 58 to the impeller, and then is aerated and circulated in the usual manner.

Disposed centrally of the cell and surrounding the vertical impeller shaft, in the case of the overhead driven impeller, is my pulp launder shown as comprising a cylindrical basin 70 having a lower pulp discharge conduit 72 associated therewith at one side, and also an inlet riser 74 passing upwardly through the bottom wall 75. Pulp flows into the launder from underneath and rises through the inlet riser 74 and overflows its upper edges into the launder.

It is preferable to form the basin 70 with sufficient height so that it rises above the pulp and froth levels in the cell indicated by the letters B and A respectively so that the flow of pulp from the cell by means of the launder may be exposed to free air.

Under certain circumstances it is desirable to vary the pulp level within the cell. This is accomplished by providing the tubular hollow cylindrical gate 76 positioned in the riser 74 so that the outgoing pulp must rise to its upper terminal before leaving the cell. In this way the pulp level is defined in the cell.

The gate 76 has a draw bar 78 attached to it and rises therefrom passing through the bracket 79 on the superstructure, here shown attached to the bearing member 40. Threads at 80 on the draw bar are for the reception of a hand wheel 81. By turning the hand wheel in one direction or the other the draw bar and gate are raised or lowered as desired.

As pulp flows outwardly from the launder through the outlet 72, it may leave the cells through an intermediate conduit member 84 or through a terminal conduit 85 associated with opening 21. I prefer that gravity be employed to enhance the flow of the outgoing pulp and for that reason have disposed my conduit system at an angle to the horizontal position depending from the cell which is discharging pulp into the cell which receives the discharged pulp or downwardly into suitable pulp disposal means not shown in the drawings.

Under certain conditions it is necessary to eliminate heavy sand in the conduit that is pres-

ent in the pulp. Suitable outlets as 86 are provided. In the showing of the drawings these outlets are closed by plugs 87 but it should be apparent that such material may be piped away from this point by any conventional means.

As the bubbles formed in the pulp rise to the upper surface and joint the froth blanket thereabove, between the levels A and B, it is caused to pass out of the cell over the overflow lip 16 into the froth launder 90. A paddle wheel comprising the shaft 92, arm 93, and blades 94, journaled in suitable bearings 95 on the frame of the flotation cell, is rotated through power applied to the sheave 96 by the belt 97 that is in turn driven by sheave 98 on a shaft 99. A reducer element for the shaft 99 is indicated at 100 and a motor 101 rotates the elements of the speed reducer so that a relatively slow rotation is effected in the paddle wheel arrangement. As the blades 94 sweep in their respective arcs they engage and urge a portion of the froth blanket over the lip 16 for disposal in the launder 90.

In operation pulp enters the cell from the side and is conducted to the approximate axis of the impeller and discharged thereto. Through the rotation of the impeller it is circulated and ejected outwardly into the cell and against the blades of the deflector blades where bubbles formed therein begin their ascent through the pulp.

The entire tank, comprising an individual cell, is filled with pulp to a level defined by the gate 76, and, by my means, I have found that it is possible to obtain great and concentrated agitation in the neighborhood of the impeller and a relatively quiescent condition in the upper zone of the cell so as not to impede or restrict the movement of the rising froth.

The outgoing flow of pulp rises under the lower lip of the riser 74 and passes therethrough and also through the gate 76 where it overflows around the upper periphery of the gate into the launder basin 70. It is preferable that this outgoing flow be sufficient to fill the conduit approximately one-half full so that air may be drawn into the pulp by reason of the suction created in the lower ends of the conduit and adjacent the impeller.

In the case of the right cell in the showing of Figure 1, if it is desired to introduce auxiliary air the plug 69 is removed and the conduit or vent tube 68 is inserted in its place rising above the pulp and froth levels so that air may enter under the urgency of the suction at the impeller.

Internal pulp recirculation in a cell may be obtained by eliminating the plug 69 from the conduit and permitting pulp to flow through this opening—or recirculation may be obtained by varying the size of the opening in the lid 60 so that pulp may flow downwardly into the housing 56 and closing the chamber. Auxiliary pulp from other than the primary source, may be introduced to the feed housing 56 through an auxiliary pulp conduit 110 shown in Figure 3. When not used the boss 111, in the housing, is usually closed by a plug 112. (See Figure 2.)

In the operation of the cell, pulp is caused to travel outwardly from the impeller in the well-known manner of the operation of such a device. Upon striking the deflector blades 54 the swirling motion is arrested and the pulp rises in the tank during which period the propagation of air bubbles occurs. The bubbles, having an affinity for metallic particles, rise from the pulp and form the surface froth. Excess pulp is withdrawn from the cell in the middling zone by

means of the launder which gathers the outgoing material. Since the opening from the cell to the launder is axial thereof above the impeller and below the surface of the pulp, the path of travel of the pulp current is downward from where the aerated pulp leaves the mass at the surface. It can be seen that the path of travel of the pulp from the impeller is one of an upward curve to the pulp level where the curve is then bent downward toward the launder inlet. Since the action of the impeller is radial around the launder and its inlet is axial or symmetrical of the cell, the axes of the curved paths of travel of the pulp lie in a closed curve about the axis of the cell. In short, the path of travel is curved roughly semi-elliptically.

The aerated portion of the rising pulp leaves or is removed from the curved path at a station just prior to where the pulp enters the launder. The phrase "just prior to" is used with the thought that where objects are travelling in a path, a station in that path is just prior to another station when in the sequence of travel one precedes the other counter to the direction of travel. Thus it will appear that the pulp is induced to travel in a series of inverted curved paths symmetrical of the cell and in these paths the pulp has the froth removed just prior to its leaving the cell through the launder.

In those cases where the pulp is permitted to recirculate into and out of the impeller, the path becomes ring-like rather than merely curved since there is then a partially closed circuit. In such a closed path the principal stations are those where force is applied by the impeller, where aerated pulp is removed, where the excess pulp is removed and finally where the pulp being recirculated is returned to the impeller.

Having thus described my invention, I claim:

1. The process of flotation of ore bearing pulp contained in an open cell, which process comprises: aerating and moving the pulp in a plurality of closed curved paths the axes of which lie in a closed curve within said cell, removing aerated pulp at a similar station in each of said paths, and gathering an increment of the pulp from each said paths at another station thereof similar throughout the series, said removal stations being situated in said paths just prior to and outward of said gathering stations of the paths with respect to the axis of the cell, said gathering stations being below the pulp level of the cell.

2. The process of flotation of ore bearing pulp contained in an open cell, which process comprises: aerating and moving the pulp in a plurality of ring paths whose axes lie in a closed curve within said cell, removing aerated pulp at a similar station in each of each said paths, and gathering an increment of the pulp from each said paths at another station thereof similar throughout the series, said removal stations being situated in said paths just prior to and outward of said gathering stations of the paths with respect to the axis of the cell, said gathering stations being below the pulp level of the cell.

3. The process of flotation of ore bearing minerals contained in an open cell, which process comprises: aerating and moving the pulp in a plurality of curved paths whose axes lie in a closed curve within said cell, removing aerated pulp from each said paths at similar stations thereof, gathering an increment of the pulp in each said paths at other similar stations of each similar throughout the series, said removal sta-

tions being situated in said paths with respect to the axis of the cell just prior to said gathering stations and below the pulp level within the cell, and returning a portion of the pulp for recirculation.

4. Flotation mechanism comprising: an impeller for aerating and circulating pulp in a cell so that the pulp travels in an outwardly ascending closed curved path, means for removing a froth portion of the pulp from the cell, and means above said impeller and axial of the cell for withdrawing at least a portion of the pulp from its path in the cell, said pulp removal station in said path being outwardly located in said cell with respect to the pulp withdrawal station in the same path whereby the withdrawal from the cell is of pulp from which the froth portion has largely departed.

5. Flotation mechanism comprising: an impeller for aerating and circulating pulp in a cell so that the pulp travels in an outwardly ascending curved path, means for removing a froth portion of the pulp at the pulp level from the cell, and means for withdrawing at least a portion of said pulp from its path in the cell at a station below the pulp level of the cell, said withdrawal means comprising a cylindrical launder in said

cell rising above the froth and having a lower inlet opening centrally located in the cell to draw material symmetrically from said cell below its pulp level, whereby the froth portion is removed at a station just prior to and above the pulp withdrawal station in said path, and means in said launder above said inlet for determining the pulp level of the cell.

6. Flotation mechanism comprising: an impeller for aerating and circulating pulp in a cell so that the pulp travels in an outwardly ascending curved path, means for removing a froth portion of the pulp at the pulp level from the cell, and means for withdrawing at least a portion of said pulp from its path in the cell at a station below the pulp level of the cell, said withdrawal means comprising a hollow cylindrical launder having an upper opening rising above the froth level of the cell, said launder having a lower inlet opening axial of the cell to draw material symmetrically therefrom below the pulp level, whereby in said path the aerated portion is removed at a station just prior to and above the pulp withdrawal station, and means in said launder above said inlet for determining the pulp level of the cell.

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