Feb. 24, 1942. F. A. DROMGOLD 2,274,401

AGITATING AND AERATING MEANS FOR FLOTATION CELLS

Filed Aug. 5, 1940

Fig-1-

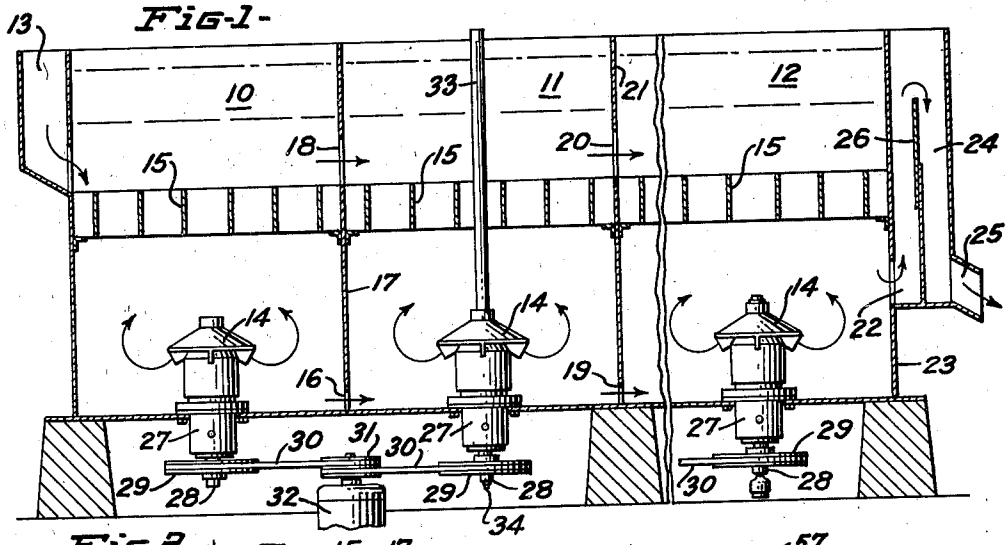


Fig-2-

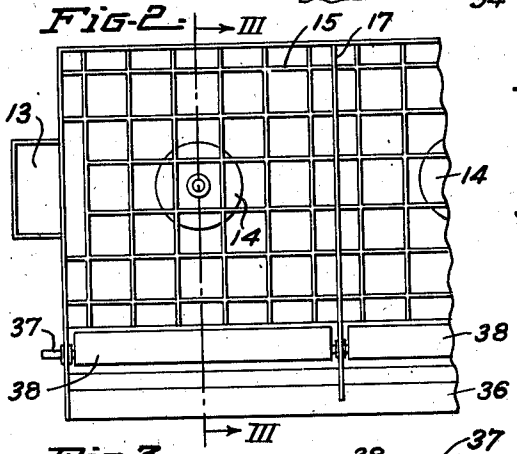


Fig-3-

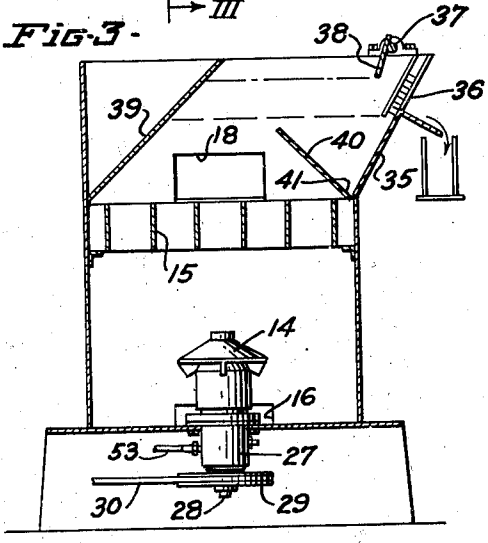
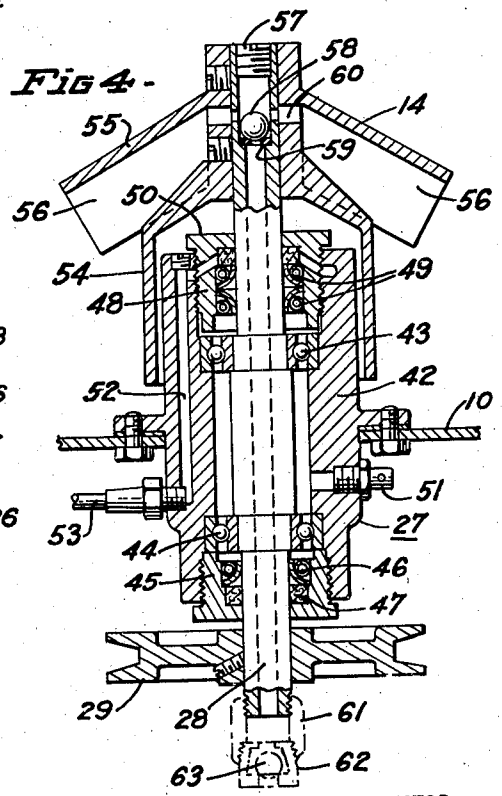


Fig 4-



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AGITATING AND AERATING MEANS FOR FLOTATION CELLS

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6 Claims. (Cl. 261—93)

My present invention relates to improvements in flotation apparatus and more particularly to a new and improved cell in which a pulp agitating and aerating means is journalled in the bottom of the cell and driven by means located below the cell.

An object of my invention is to provide a new and improved rotary agitating and aerating device for flotation apparatus which may be journalled in the bottom of any suitable pulp containing cell and driven from a source of power located therebelow in a convenient and efficient manner.

Another object of my invention is to provide a new and improved rotary agitating and aerating device for flotation cells and a mounting therefor by means of which air and/or a re-agent may be introduced through the bottom of the flotation cell.

Another object of the invention is to provide an improved rotary agitating and aerating device that is journalled upon bearings mounted in the bottom of a flotation cell and which has novel means to protect the bearings and prevent the escape of pulp from the cell at this point.

In the operation of ore separating flotation cells employing rotary agitating and aerating members it has always been a problem to provide a suitable journal support for the rotary agitating and aerating member. This is due to the fact that the rotary agitating and aerating member is submerged below the surface of the pulp where, because of leakage and the abrasive action of the solid particles of the pulp, it has been found difficult to provide a suitable bearing support for the rotary agitating and aerating member. To remedy this situation it has generally been the practice to mount the rotary agitating and aerating member upon the lower end of a shaft which is suspended from bearings located above and in an overhanging position with respect to the cell. While this arrangement provides a bearing support for the rotary agitating and aerating member which is free from attack by the abrasive action of the pulp and avoids an opening in the bottom of the cell, it has the disadvantage that the overhanging supporting structure for the bearings renders the cells more or less inaccessible at the top thereof and is subject to the possibility of oil dripping into the pulp from these bearings. A more serious objection, however, is that with this type of mounting it is difficult to maintain the fine balance in the rotary agitating and aerating member which is necessary in order to prevent excessive vibration when the apparatus is in operation. It is, therefore, a further object of my invention to provide a rotary agitating and aerating device which may be mounted upon a relatively short shaft that is journalled in a bearing secured in the bottom of the cell and which is adapted to be driven by power means located below the cell.

Other objects and advantages of the invention will be in part evident to those skilled in the art and in part pointed out hereinafter as the description thereof taken in connection with the accompanying drawing proceeds.

In the accompanying drawing wherein there is shown by way of illustration and not of limitation

Figure 1 is a vertical sectional view taken centrally through a series of flotation cells and having agitating and aerating means constructed in accordance with the present invention;

Figure 2 is a fragmentary plan view showing a portion of the cell arrangement illustrated in Figure 1 of the drawing;

Figure 3 is a vertical sectional view taken along line 3—3 of Figure 2 looking in direction of the arrows, and

Figure 4 is an enlarged sectional view taken centrally through a preferred form of my improved agitating and aerating device and the mounting therefor.

In the separation of mineral values from ore by means of the flotation process it is important that a sufficient amount of air be introduced into the pulp during agitation to thoroughly aerate the pulp and produce a maximum amount of foam as it is under these conditions that the oils and/or other re-agent chemicals can best operate to thoroughly separate the metallic values from the non-metallic particles of the pulp.

The most efficient arrangement for introducing air into the pulp during agitation is through the agitating means, as it is at this point that the air can be most thoroughly discharged into the pulp, and since the agitating means is generally located near the bottom of a flotation cell, it is important that the introduced air be directed in such a manner that the air will be distributed substantially uniformly throughout the pulp.

The present invention is considered to be an improvement upon the arrangement described and claimed in my copending application Serial Number 254,493 filed February 3, 1939, and entitled Material separation devices in that the present construction and arrangement of the agitating element and impeller blades more effectively cooperate to distribute the aerating air

and includes additional means by which a more effective sealing of the flotation cell about the agitator supporting bearing is effected.

Reference is now made to the drawing for a more detailed description of my invention. As is well understood flotation ore concentrating apparatus of the type contemplated generally consists of a series of cells through which the ore containing pulp is successively circulated and subjected to removal of the mineral values by the discharge of a foam or froth at the side of each of the cells. In Figure 1, there is shown the first two cells of a series designated by the numerals 10 and 11 and a portion of a third cell 12, which it is to be understood will be the end cell of a series of similar cells. The cell 10, which is the first of the series has a feed hopper 13 through which the ore containing pulp is originally introduced into the flotation apparatus where it will be subjected to agitation and aeration, as will hereinafter appear, by means of a combined agitating and aerating device designated generally by the numeral 14. As the pulp is thus subjected to agitation and aeration in the presence of a suitable re-agent, the mineral values will be taken up by the bubbles formed due to this agitation and aeration and will rise through a horizontal baffle 15 which will tend to cause the mineral value carrying foam to rise substantially vertically. At the same time the tailings accumulating in the cell 10 will pass through a communicating passageway 16 formed in a wall 17 between the cells 10 and 11 and the froth or foam in the cells 10 and 11 will obtain a corresponding level due to a second passageway 18 which is formed above the baffles 15 in the wall 17 between the cells 10 and 11. Similarly the tailings accumulating in and the froth produced in cell 11 will flow on to the succeeding cells of the series through openings 19 and 20 formed in walls 21 between the next and following cells. As the tailings and the value bearing foam produced in each of the cells circulates through the apparatus to the succeeding cells, the uppermost portions of the value bearing foam will be spilled over the sides of the cells and collected in a launder where they may be subjected to further recovery processes. After the pulp has thus circulated through the series of cells 10, 11, etc., it will finally collect in the last cell 12 of the series where the tailings will be discharged through an outlet 22 formed in an end wall 23 and into a chamber 24 from which it will be finally discharged through a conduit 25. As here shown, the chamber 24 has an adjustable weir gate 26 which may be raised and lowered to maintain any desired level of pulp throughout the series of cells.

Before passing on to the remaining figures of the drawing, it should be noted that the agitating and aerating devices 14 are shown as carried by suitable supporting bearings 27 that are secured in openings formed centrally in the bottoms of the cells 10, 11 and 12. These agitating and aerating devices 14 are carried by hollow shafts 28 that are journaled in the supports 27. The shafts 28 also carry suitable pulleys 29 at their lower ends, about which driving belts 30 pass. Two of the driving belts 30 are here shown as connecting the pulleys 29 upon the shafts 28 of the cells 10 and 11 to a double pulley 31 that is driven by a vertically disposed electric motor 32. In practice it is contemplated that a single motor 32 may be utilized to drive a plurality of agitating and aerating devices 14 and in this manner the number of motors required may be reduced to a minimum as the character of the agitating and aerating devices 14 and their journaled supports will require a relatively small amount of power to maintain successful operation thereof. The agitating and aerating devices 14, three of which are shown in Figure 1 of the drawing, are of substantially identical construction, except for certain details that have to do with the manner in which the flow of air and/or a re-agent to the agitating and aerating devices 14 is controlled. The agitating device 14, shown as disposed in the cell 10, is of a construction corresponding to that illustrated in detail in Figure 4 of the drawing. It has a ball check valve at the upper end of the hollow shaft 28, as is shown at the upper end of the assembly illustrated in Figure 4 of the drawing. The agitating device 14 located in the cell 11 is similar to the assembly illustrated in detail in Figure 4 of the drawing, except that no check valves are provided in the hollow shaft 28. In this arrangement the hollow shaft 28 which supports the agitating device 14 is provided with a pipe-like extension 33 that extends upwardly above the level of the pulp in the cell 11 and at its lower end the hollow shaft 28 is provided with a suitable plug 34. When the hollow shaft 28 is equipped in this manner, it will be understood that the aerating air will be drawn downwardly through the pipe-like extension 33 and discharged into the pulp by the agitating and aerating device 14. The agitating device 14 shown as disposed in the cell 12 is identical with the agitating device 14 shown in cell 10, except that the check valve shown in full lines in Figure 4 of the drawing is positioned at the lower end of the hollow shaft 28, as shown by dot and dash lines in this latter figure of the drawing.

Upon referring to Figures 2 and 3 of the drawing, it will be seen that the horizontal baffles 15 extend across the entire area of each of the cells and provide a series of rectangular passageways through which the agitated pulp will rise in a substantially vertical direction. In other words, the baffles 15 will serve to limit a swirling of the pulp by the agitators 14 to the area therebelow and thus permit the froth or foam to rise in the cells when the mineral values have been collected thereby. As the froth or foam with the mineral values continues to rise through the baffles 15, it will spill over the sides of each of the cells and be collected by a launder to be subjected to further recovery processes. As shown, particularly in Figure 3 of the drawing, a corresponding side of each of the cells 10, 11, etc. is provided with an outwardly inclined wall 35 in which there is provided a weir 36 comprised of a series of superimposed slats that may be positioned therein to determine the level of the froth in the particular cell. Associated with this weir 36 there is also a longitudinally extending shaft 37 that carries a rotatable paddle 38 which, when rotated in the direction of arrows as here shown, will serve to propel the froth with its mineral values over the weir 36. As an additional improvement, each of the cells 10, 11, 12, etc. is here shown as provided with an inwardly disposed baffle 39 which tends to direct the flow of froth toward the weir 36 and a second inwardly disposed baffle 40 which directs the flow of froth or foam at this point toward the baffle 39 of each of the cells. A small by-pass port 41 is shown at the bottom of the baffle 40 through which unspilled pulp may return to the agitating zone of the cells.

Reference is now made to Figure 4 of the drawing for a detailed description of the agitating and aerating device 14 and its support. As here illustrated, it will be noted that the support 27 comprises a cylindrical housing 42 which extends upwardly through the bottom of the cell 10 to form a pedestal-like support for an upper bearing 43. At its lower end the cylindrical housing 42 carries a similar bearing 44. These bearings 43 and 44 are here shown as of the roller type and serve to support the hollow shaft 28 in the conventional manner. At the lower end of the support 27 and below the bearing 44 there is provided a packing gland 45 which carries a suitable sealing ring 46 and a porous packing 47, and screwed into the upper end of the tubular portion 42 of the support 27 there is a packing gland 48 that carries two opposed sealing rings 49 and a porous packing ring 50. When the packing glands 45 and 48 are screwed into the tubular portion 42 of the support 27, they will normally serve to retain lubricating grease which is supplied through a grease connection 51, in the bearings 43 and 44. In order to provide against the escape of liquid pulp along the hollow shaft 28, the present invention also contemplates the provsion of a conduit 52 in the tubular portion 42 through which air, gas or other fluid from a source 53 may flow to the porous packing ring 50 and out through the end of the packing gland 48. Cooperating with this flow of air, gas or other fluid under pressure through the conduit 52 and the packing gland 48, the agitating and aerating device 14 carries a depending flange or skirt 54 that telescopes downwardly over the upwardly extending end of the support 27 so as to provide what may be termed an inverted bell into which air may accumulate and prevent the entrance of pulp upwardly into this space. With this construction, it will be seen that when air, gas or other fluid flows through the conduit 52 from the source 53, a pressure will be created in the inverted bell thus formed and as a result the shaft, sealing rings and packings, and also the bearings of the shaft 28 will be protected against the abrasive action of the pulp under treatment in the cell.

While the shape and the construction of the agitating and aerating members 14 may take many forms, it will be found that when these devices are provided with a frusto-conical top or web forming portion 55 and a plurality of downwardly extending blades 56 arranged radially with respect to the axis of the hollow shaft 28, the agitation set up thereby will be most effective as the air and general motion of the pulp will be outwardly and downwardly at the center of the cells. As here shown, the upper end of the hollow shaft 28 is closed by a plug 57 and carries a ball check valve 58 which cooperates with a rubber seat 59 to prevent the passage of liquid pulp downwardly through the hollow shaft 28. At the same time, when the agitating and aerating device 14 is in rotation, the blades 56 carried thereby will throw the liquid outwardly and thus create a suction which will lift the ball valve 58 from its seat 59 and permit a flow of air and/or a re-agent through ports 60 and into the space beneath the frusto-conical web forming portion 55 where it will be discharged outwardly and into the pulp to aerate same. To ilustrate a modified arrangement in which a check valve is provided at the lower end of the hollow shaft 28, there is shown in this figure of the drawing at the lower end of the hollow shaft 28, by dot and dash lines, a connnecting collar 61 that carries a check valve cage 62 and a ball valve 63 which may be substituted for the check valve 58 or which may be used simultaneously therewith.

With the above described arrangement it will be readily seen that when the flotation apparatus is in operation and pulp is introduced into cell 10 through the feed hopper 13, the pulp will flow through the successive cells and be agitated by the respective agitating and aerating means 14. At the same time the froth or foam carrying the mineral values will be carried upwardly through the baffles 15 and discharged over the weirs 36 provided upon the several cells and finally collected in the launder for further recovery treatment. Due to the agitating and air propelling action of the blades 56 upon the agitating device 14, it will also be understod that air and/or a re-agent will be drawn into each of the cells through the hollow shafts 28 associated with their respective agitating and aerating devices 14. Additional air may also be injected into the pulp from the source 53 through the conduit 52. If the source 53 is adapted to supply an oil or oily re-agent, this fluid may be substituted for air and in this event it will be seen that such oil will, in addition to preventing the escape of pulp from the cell, also supplement the normal lubricating function of the grease which is normally supplied to the bearings 43 and 44 through the grease coupling 51. In the event that the apparatus is required to be shut down without draining the cells, it will also be seen that the check valve 58 and/or the check valve 63 will become operative immediately upon a stopping of the agitating and aerating device 14 and prevent the escape of pulp from the cells through the hollow shafts 28.

While I have, for the sake of clearness and in order to disclose my invention so that the same can be readily understood, described and illustrated specific devices and arrangements, I desire to have it understood that this invention is not limited to the specific means disclosed, but may be embodied in other ways that will suggest themselves to persons skilled in the art. For example, where the term "air" is used in the claims, it is to be understod that gas and other fluids may be substituted therefor. It is believed that this invention is new and it is desired to claim it so that all such changes as come within the scope of the appended claims are to be considered as part of this invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is—

1. In flotation apparatus of the character described, the combination of a pulp receiving receptacle, a bearing pedestal secured to and extended through the bottom of said receptacle, a shaft journalled in and projected upwardly through said pedestal to rotate about a vertical axis, a pulp agitating and aerating means secured to the upper end of said shaft and disposed below the surface of the pulp within said pulp receiving receptacle, said agitating and aerating means having a hub with a circular web forming portion and radially extending impeller blades depending therefrom which produce a downward circulation of entrained air, and a downwardly extending cylindrical flange carried by said hub adapted to telescope over said pedestal and provide an inverted bell in which a portion of said entrained air may accumulate and form an air seal about said shaft which will prevent contact of the pulp with said shaft and the

escape of pulp from said receptacle through said bearing pedestal.

2. In flotation apparatus of the character described, the combination of a pulp receiving receptacle, a vertically disposed bearing supporting pedestal extended through the bottom of said pulp receiving receptacle, anti-friction ball bearing means carried by said pedestal, a shaft journalled in said anti-friction ball bearing means and extending upwardly through said pedestal, a pulp agitating and aerating means secured to the upper end of said shaft having a downwardly extending cylindrical flange that telescopes over said bearing pedestal and provides an inverted air retaining bell into which the upper end of said bearing supporting pedestal extends, and means for introducing air under pressure into said inverted air retaining bell to thus form an air seal which will prevent the pulp in said receptacle from coming into contact with said shaft or escaping through said anti-friction ball bearing means.

3. In an agitating and aerating means for flotation ore concentrating apparatus, the combination of an ore pulp containing receptacle, a vertically disposed shaft supporting pedestal secured to and extending upwardly from the bottom of said ore pulp containing receptacle, a hollow shaft journalled in said pedestal and communicating with the atmosphere adapted to rotate about a vertical axis, a pulp agitating member secured to the upper end of said shaft having a frusto-conical top portion and ports located beneath said frusto-conical top portion communicating with the interior of said hollow shaft, a series of radially extending agitator blades depending from said frusto-conical portion, means for driving said hollow vertical shaft, whereby air will be drawn through said hollow shaft to said ports and discharged downwardly by said blades into the pulp as said agitating member is rotated by said shaft driving means, and means carried by said pulp agitating member forming an inverted bell over said shaft supported pedestal, said inverted bell being adapted to entrap a portion of the air discharged downwardly by said blades and form an air seal about said hollow shaft which will prevent the escape of pulp from the pulp containing receptacle at this point.

4. In an agitating and aerating means for flotation ore concentrating apparatus, the combination of an ore pulp containing receptacle having an opening in the bottom thereof, a vertically disposed shaft supporting pedestal secured in said opening and extending upwardly into the ore pulp containing receptacle, a hollow shaft journalled in said pedestal and adapted to rotate about a vertical axis, said hollow shaft being closed at its upper and open to the atmosphere at its lower end, a rotary pulp agitating member secured upon said shaft having a frusto-conical portion and ports located beneath said frusto-conical portion communicating with the interior of said hollow shaft, a series of radially extending agitator blades depending from said frusto-conical portion, means located below the bottom of said cell for driving said hollow vertical shaft, whereby air will be drawn through said hollow shaft to said ports and discharged downwardly by said blades into the pulp as said agitating member is rotated by said shaft driving means, and a skirt-like member carried by said agitating member forming an inverted bell over said shaft supported pedestal, said inverted bell being adapted to entrap a portion of the air discharged downwardly by said blades and form an air seal about said hollow shaft which will prevent the escape of pulp from said receptacle at this point.

5. In an agitating and aerating means for flotation ore concentrating apparatus, the combination of an ore pulp containing receptacle having an opening in the bottom thereof, a vertically disposed shaft supporting pedestal in and closing said opening and extending upwardly into the ore pulp containing receptacle, a hollow shaft journalled in said pedestal and adapted to rotate about a vertical axis, a rotary pulp agitating member secured to the upper end of said shaft having a conical web forming portion with ports located therebelow communicating with the interior of said hollow shaft, a series of radially extending agitator blades adjacent said ports and depending from said conical web forming portion, means for driving said hollow vertical shaft, whereby air will be drawn through said hollow shaft to said ports and discharged downwardly by said blades into the pulp as said agitating member is rotated by said shaft driving means, and a skirt-forming flange below the radially extending blades upon said agitating member adapted to telescope over the upwardly extending end of said pedestal and form an inverted bell in which some of the air discharged downwardly by said blades will be entrapped to provide an air seal and prevent the escape of pulp along said shaft and through said bearing pedestal.

6. In flotation apparatus of the character described, the combination of a pulp receiving receptacle, a bearing pedestal secured to and extended through the bottom of said receptacle, a shaft journaled in and projected upwardly through said pedestal to rotate about a vertical axis, a pulp aerating means secured to the upper end of said shaft and disposed below the surface of pulp within said pulp receiving receptacle, said pulp aerating means having radially extending impeller blades depending therefrom which produce a downward circulation of entrained air, a downwardly extending cylindrical flange carried by said means below said blades and adapted to telescope over said pedestal and provide an inverted bell in which a portion of said entrained air will accumulate and form an air seal about said shaft which will prevent contact of the pulp with said shaft and the escape of pulp from said receptacle through said bearing pedestal, and means including a conduit extending upwardly through said pedestal for introducing additional air under pressure into said inverted bell.

FRANK A. DROMGOLD.