March 14, 1933. J. P. RUTH, JR 1,901,123

FLOTATION MACHINE

Filed Sept. 14, 1931 2 Sheets-Sheet 1

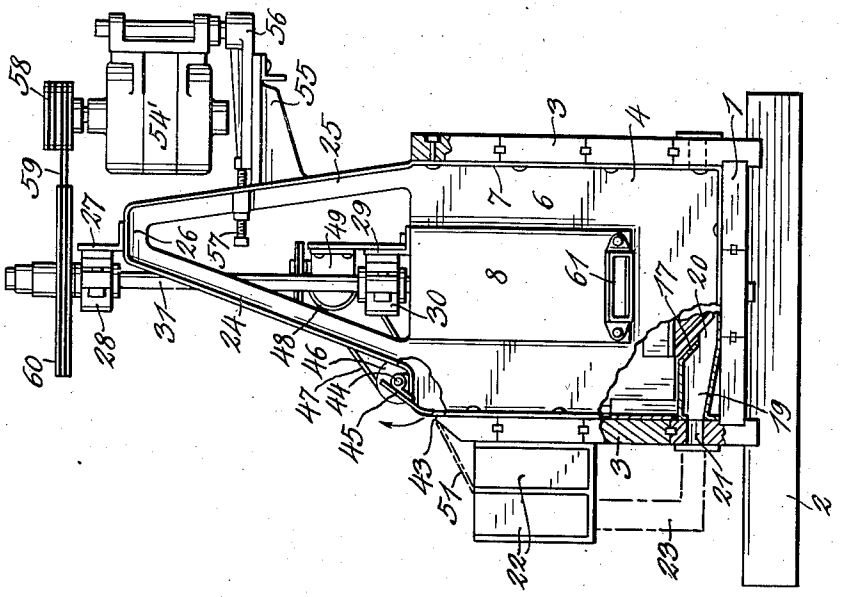


Fig. 2.

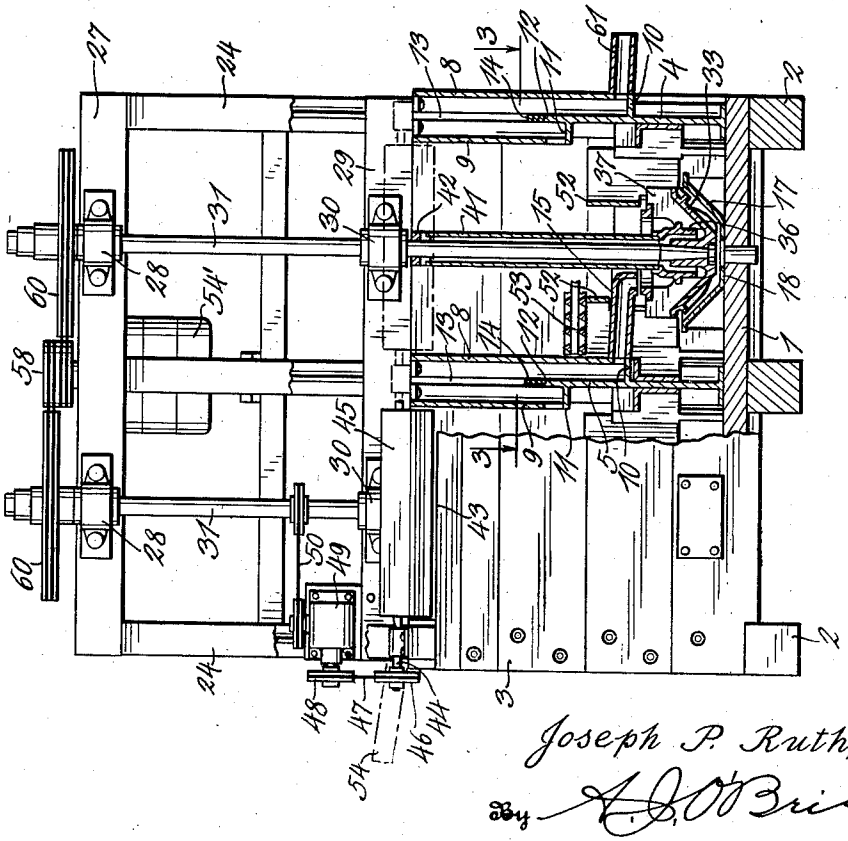


Fig. 1.

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Filed Sept. 14, 1931 2 Sheets-Sheet 2

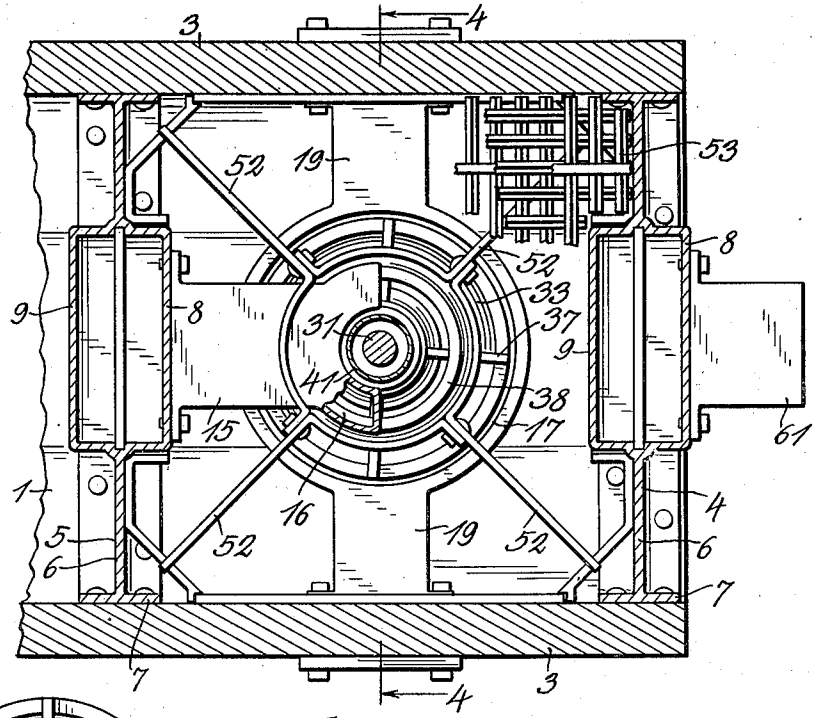


Fig. 3.

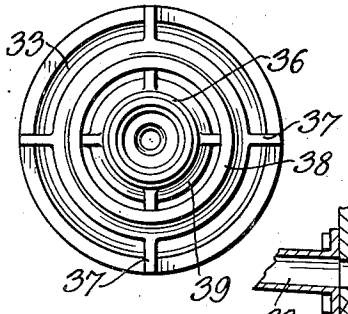


Fig. 5.

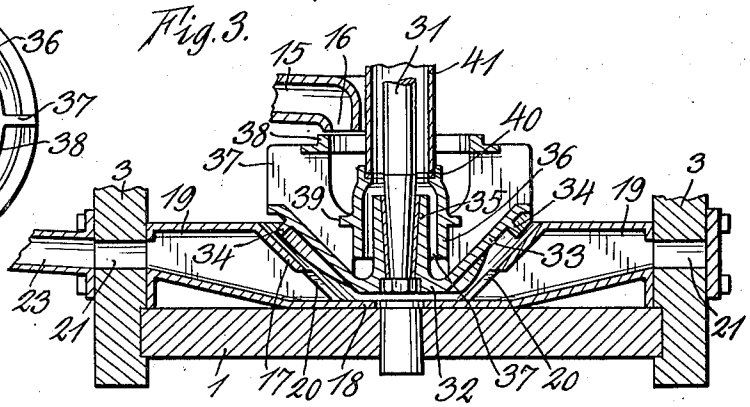


Fig. 4.

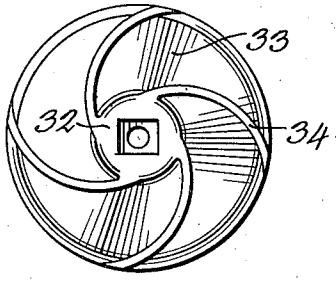


Fig. 6.

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UNITED STATES PATENT OFFICE

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FLOTATION MACHINE

Application filed September 14, 1931. Serial No. 562,750.

This invention relates to improvements in flotation machines of the type employed in separating mineral values from ore pulp.

In separating minerals by what is known as the "flotation method" the pulp is subjected to the action of an impeller by means of which air is mixed with it and agitated to such an extent that the air and pulp produce a froth consisting of air bubbles to which the minerals adhere.

Experience has demonstrated that the efficiency of this method of separation varies directly with the amount of air introduced into and mixed with the pulp and one of the objects of this invention is to produce a machine of the type referred to which is to be so constructed that it will introduce more air into the pulp with the same expenditure of power than the ordinary machine.

Another object of this invention is to produce a machine in which froth from the same, or from other cells, can be mixed with the aerated pulp just as it leaves the impeller and in this manner the capacity of the machine will be greater than if the froth were returned to the impeller through the same feed conduit through which the pulp enters.

A further object of this invention is to produce a machine of simpler construction than the ordinary machine and one in which a certain portion of the aerated pulp in the frothing chamber will be returned to the impeller for further treatment.

A still further object of this invention is to produce an improved construction of impeller bowl and an improved impeller that shall be so constructed that the above objects may be obtained.

The above and other objects that will become apparent as this description proceeds are attained by means of a construction and an arrangement of parts that will now be described in detail, reference for this purpose being had to the accompanying drawings in which the preferred form of the invention has been illustrated, and in which:

Fig. 1 is a front elevation, partly in section of a duplex cell, constructed in accordance with this invention;

Fig. 2 is an end elevation of the cell shown in Fig. 1, parts being broken away to better disclose the construction;

Fig. 3 is a section taken on line 3—3, Fig. 1;

Fig. 4 is a section taken on line 4—4, Fig. 3;

Fig. 5 is a top plan view of the impeller; and

Fig. 6 is a bottom plan view thereof.

This invention has been illustrated in connection with a duplex cell in which numeral 1 represents the bottom which rests on transverse supporting members 2. The sides are formed of planks 3 and the ends and center partition are formed from cast iron members 4 and 5. The planks 3 are bolted to the edges of the ends and partition member, as shown in the drawings. The end members and the central partition are of identical shape and size and each consists of a central web 6 having flanges 7. The central portion of the web terminates in a rectangular compartment having parallel spaced walls 8 and 9. Wall 8 extends farther down than wall 9, and terminates in a bottom member 10, and wall 9 terminates in the bottom 11. An opening is provided in wall 9 directly above the bottom and a corresponding opening is provided in wall 8 directly above the bottom 10. The partition extends upwardly a short distance as indicated by reference numeral 12 and the end walls of the partition are provided with grooves 13, which are adapted to receive removable bars 14 by means of which the pulp level can be determind. A feed spout 15 is bolted to the outside of wall 8 and extends towards the center of the cell in the manner shown most clearly in Fig. 3. The inner end of the feed spout terminates in a semi-circular downwardly projecting opening 16 that is located directly above the impeller whose construction will be described hereinafter.

Supported on the bottom of the cell is an impeller bowl. This bowl has conical walls 17 that extend upwardly from a flat circular bottom portion 18. Extending outwardly at opposite sides of the bowl are hollow arms 19 whose inner ends are in communication with the interior of the bowl through passages 20.

The outer ends are in contact with the inner surfaces of the sides of the cell walls and these are provided with openings 21 that communicate with the interior of the arms. Located on the outside of the cell are two launders 22, either of which can be connected with the interior of one of the arms by means of a conduit 23 that has been shown dotted in Fig. 2.

The end walls and partition member are each provided with an upstanding portion comprising two spaced arms 24 and 25 that are connected at their tops by the horizontal portions 26. Secured to the upper surface of these horizontal portions is an angle iron 27 to the vertical flange of which the bearings 28 are secured. Secured to the upper edge of the end and partition members is an angle iron 29 to which the bearings 30 are secured. An impeller shaft 31 is mounted for rotation in the bearings and secured to the lower end of this shaft is an impeller which has been shown in detail in Figs. 4, 5 and 6, from which it will be seen that this impeller has a bottom portion 32 from which outwardly and upwardly inclined side members 33 extend. The inclination of the sides 33 is the same as the inclination of sides 17 of the bowl. The lower surface of the sides or walls 33 is provided with spiral flanges 34, to which reference will be made hereinafter. A hub 35 extends upwardly from the center of the bottom member and this is provided with a tapered opening for the reception of the lower tapered end of shaft 31. Surrounding the hub is a cylindrical sleeve 36 that is concentric with it and which is formed integral with the impeller. Openings 37 afford communication between the annular space between the hub and the sleeve and the outside of the impeller. Blades 37 extend radially from the outer surface of the sleeve and are formed integral with it and with the wall 33. The upper ends of the blades are connected by a ring 38. A flange 39 extends outwardly from the sleeve and forms a deflector that directs the pulp outwardly when the machine is in operation. The upper end of the sleeve is provided with a rabbet 40 in which the lower end of pipe 41 is seated. Pipe 41 extends upwardly to a point above the froth level of the machine and is held in centered position by means of a sleeve 42. When the impeller is in place, the lower end of opening 16 in the feed or return spout is directly over the space between the inside of ring 38 and the outside of pipe 41, and therefore any pulp that enters through this spout is delivered to the center of the impeller. It will be seen from Fig. 3 that opening 16 extends half way around the impeller and the pulp is therefore fed into one-half of the impeller area by means of the spout 15, and this leaves the other half of the impeller free to receive pulp from the frothing chamber which is therefore recirculated in a proportion which is about equal to the amount of pulp fed through the spout When the impeller is operating and pulp is being fed thereto, it will be deflected outwardly by flange 39, thereby leaving an air space below this flange and this results in a suction that causes air to flow downwardly through the pipe 41 and to mix with the pulp. The construction of the impeller is such that a much greater proportion of air is mixed with the pulp than has heretofore been considered possible by the form of impeller in general use.

The cells are provided with a pulp overflow 43 that is located on one side thereof, and which in Fig. 2 has been shown above the launders 42. Located above the froth overflow is the shaft 44 to which a wiper blade 45 is attached. The outer end of the shaft is provided with a belt wheel 46 and this is connected by means of a belt 47 with another wheel or pulley 48 that is rotated by means of a reduction gear 49 operated by power derived from shaft 31 by means of a belt 50. The wiper plate rotates in the direction indicated by the arrow in Fig. 2 and helps to deliver the froth to the launders. By means of a plate like that indicated by dotted lines in Fig. 2 and designated by reference numeral 51 the froth can be directed to either of the launders.

Located above the impeller are baffle plates 52 that serve to obstruct the rotation of the pulp after it has left the impeller and also serve to support the cast iron grids 53. When the machine is in operation pulp is introduced into the compartment in the end partition at the left of Fig. 1 by means of a launder 54. The pulp then passes through the feed spout 15 and into the center of the rotating impeller, where it is thrown outwardly by the centrifugal action. The outward movement of the pulp produces a suction that induces air to flow downwardly through the interior of pipe 14 and to mix with the pulp thereby producing the desired aeration effect. Owing to the fact that one-half of the impeller is open at the top and in communication with the frothing compartment, aerated pulp will pass directly from the frothing compartment into the impeller, thereby producing a recirculation and retreatment of the pulp. This retreatment amounts to running the pulp through the machine twice because one-half of the impeller receives its feed from the feed spout and therefore, the recirculation amounts to substantially the same as the feed. The pulp level is determined by the height of the partition formed by the removable bars 14 and can be raised and lowered by adding or subtracting bars in a manner quite apparent.

The machine is provided with a motor 54' that is supported on a bracket 55 and carried directly by slide 56 that can be adjusted by

means of a screw 57. The upper end of the motor shaft has a pulley 58 that cooperates with belts 59 which transmit the power to the pulleys 60 on the upper ends of shafts 31.

Let us now assume that a quantity of pulp is fed to the left hand cell in Fig. 1 through the launder 54 and that the impellers are operating in the manner described. The pulp will pass through the feed spout 15 into the impeller and be thrown outwardly in the manner described. After sufficient pulp has been admitted to cover the impeller, a portion of the aerated pulp will be recirculated. After the machine has been running some time, pulp will pass from the first cell to the second and finally from the second to the discharge spout 61 in a manner quite apparent. The froth will pass over the froth overflow and part of it or all of it can be directed into one or the other of launders 22 from which it can be returned to the impeller of the same or of the adjacent cell, and thereby subject it to retreatment. The froth as above explained is acted upon by the vanes 34 on the outer surface of the impeller, while the pulp is acted upon by vanes 37 on the upper surface of the impeller, and therefore the capacity of the impeller is not diminished or interfered with due to the addition of the froth, and for this reason the capacity of the machine is greater than if the froth were introduced through the supply spout. The construction shown and described produces a very strong suction that results in a much greater amount of air being mixed with the pulp than has heretofore been considered possible, and this produces more efficient operation.

Having described the invention what is claimed as new is:

1. A flotation machine comprising, a casing having a bottom, an impeller bowl located near the bottom of the casing, the side of the bowl forming a conical surface, an impeller having a body portion whose outside shape corresponds to that of the inside of the bowl, means, including a shaft, for supporting the impeller so that it may rotate about an axis that coincides with the axis of the bowl, the upper surface of the impeller having a hub for the reception of the lower end of the shaft, a sleeve surrounding the hub, a pipe surrounding the shaft and having its lower end in contact with the upper end of the sleeve, a plurality of radial blades extending upwardly from the upper surface of the impeller, means for introducing pulp into the top of the impeller adjacent the shaft, and means for rotating the impeller.

2. A flotation machine having a casing, an impeller bowl having a side wall whose surface is conical and which is located near the base of the casing, an impeller located in the bowl and mounted for rotation about an axis concentric with the axis thereof, the impeller having its outer surface of substantially the same shape as the inner surface of the bowl and provided with a plurality of blades, the bowl having a passageway to the outside of the casing for introducing foam into the space between the bowl and the impeller, the upper surface of the impeller having a plurality of radial blades and a central hub, a sleeve enclosing the hub and spaced from it, a shaft connected with the hub and mounted for rotation, a pipe enclosing the shaft and having its lower end in contact with the upper end of the sleeve whereby an air passage is formed about the shaft and a tubular feed spout having its inner end in communication with the center of the impeller and its outer end in communication with the lower end of a receiving compartment.

3. A flotation machine comprising, in combination, a casing, an impeller bowl located in the casing near the bottom thereof, said bowl having a lateral tubular extension whose outer end is accessible from the outside of the casing, an impeller located in the bowl and mounted for rotation about a vertical axis concentric with the axis of the bowl, the inner surface of the bowl and the outer surface of the impeller being frusto-conical, the outer surface of the impeller having a plurality of radial blades, the upper surface of the impeller having a plurality of radial blades and a central hub surrounded by a sleeve, a shaft connected with the hub, a pipe surrounding the shaft and having its lower end connected with the sleeve, and a tubular feed spout having its outer end in communication with a feed compartment and its inner end in communication with the upper end of the impeller.

4. A flotation machine comprising, in combination, a casing, an impeller bowl located in the casing near the bottom thereof, said bowl having a lateral tubular extension whose outer end is accessible from the outside of the casing, an impeller located in the bowl and mounted for rotation about a vertical axis concentric with the axis of the bowl, the inner surface of the bowl and the outer surface of the impeller being frusto-conical, the outer surface of the impeller having a plurality of radial blades, the upper surface of the impeller having a plurality of radial blades and a central hub surrounded by a sleeve, a shaft connected with the hub, a pipe surrounding the shaft and having its lower end connected with the sleeve, and a tubular feed spout having its outer end in communication with a feed compartment, its inner end in communication with the upper end of the impeller and a plurality of baffle plates located above the impeller.

5. In a flotation machine, in combination, a casing having an impeller bowl located adjacent its bottom, the bowl having its side wall upwardly flaring and frusto-conical

shaped, said bowl having a laterally extending tubular extension, an impeller located in the bowl, the outer surface thereof being frusto-conical and provided with a plurality of blades, the upper surface of the impeller having a central hub, a sleeve surrounding the hub and spaced from it, a plurality of blades extending outwardly from the sleeve, a ring connecting the upper ends of the blades, a shaft secured in the hub and mounted for rotation, a pipe enclosing the shaft and connected with the upper end of the sleeve, means for rotating the shaft and propeller, and means for introducing pulp into the impeller and foam into the bowl whereby when the impeller is rotated the pulp will be mixed with air and discharged and simultaneously therewith foam will be discharged from the bowl and mixed with the aerated pulp.

6. An impeller having a frusto-conical wall provided on its outer surface with a plurality of blades, a central hub extending upwardly from its upper surface, a cylindrical sleeve surrounding the hub and spaced from it and blades extending outwardly from the sleeve.

7. An impeller having a frusto-conical wall provided on its outer surface with a plurality of blades, a central hub extending upwardly from its upper surface, a cylindrical sleeve surrounding the hub and spaced from it, blades extending outwardly from the sleeve and a ring concentric with the impeller and secured to the upper ends of the blades.

8. An impeller having a frusto-conical wall provided on its outer surface with a plurality of blades, a central hub extending upwardly from its upper surface, a cylindrical sleeve surrounding the hub and spaced from it, blades extending outwardly from the sleeve, a ring concentric with the impeller and secured to the upper ends of the blades and a deflector rib on the outside of the sleeve.

9. A flotation machine comprising, series of cells each having an agitator secured to the lower end of a verical shaft, the agitator having a plurality of vanes, an annular ring secured to the top of the vanes and spaced from the shaft, and means for dirceting the discharge from one cell to the opening between the ring and the shaft of the next cell in the series.

10. A flotation machine comprising a series of cells arranged in a group, each cell having a vertical shaft mounted for rotation, an agitator secured to the lower end of each shaft, said agitator having the shape of a pan, a hub projecting upwardly from the bottom, and provided with an opening for receiving the shaft, a sleeve surrounding the hub, a pipe surrounding the shaft and connected with the sleeve, a plurality of vanes extending radially from the sleeve, an annular deflector secured to the upper ends of the vanes, and a conduit for conducting liquid from the pulp overflow of the preceding cell to the central opening in the annular deflector whereby when the agitator is rotated liquid will be thrown outwardly by the vanes and mixed with air that enters through the pipe which surrounds the shaft.

11. In a flotation machine, in combination, an impeller having its lower surface substantially convex and its upper surface substantially concave, a plurality of blades on its upper surface, a central hub extending upwardly from the upper surface of the impeller, a substantially vertical shaft to the lower end of which the impeller is secured, the upper surface of the impeller being in communication with the atmosphere, an annular deflector flange located above the upper surface of the impeller, and a conduit for conveying pulp and discharging it to the concave part of the impeller at a point above the deflector flange.

12. In a flotation machine, in combination, an impeller having its lower surface substantially convex and its upper surface substantially concave, a plurality of blades on its lower surface, a central hub extending upwardly from the upper surface of the impeller, a substantially vertical shaft to the lower end of which the impeller is secured, the upper surface of the impeller being in communication with the atmosphere, an annular deflector flange located above the upper surface of the impeller, and a conduit for conveying pulp and discharging it to the concave part of the impeller at a point above the deflector flange.

13. In a flotation machine, in combination, an impeller having its lower surface substantially convex and its upper surface substantially concave, a plurality of blades on both the upper and lower surfaces, a central hub extending upwardly from the upper surface of the impeller, a substantially vertical shaft to the lower end of which the impeller is secured, the upper surface of the impeller being in communication with the atmosphere, an annular deflector flange located above the upper surface of the impeller, and a conduit for conveying pulp and discharging it to the concave part of the impeller at a point above the deflector flange.

In testimony whereof I affix my signature.

JOSEPH P. RUTH, JR.