May 16, 1944. H. L. McNEILL 2,348,990

AERATING APPARATUS

Filed July 1, 1940

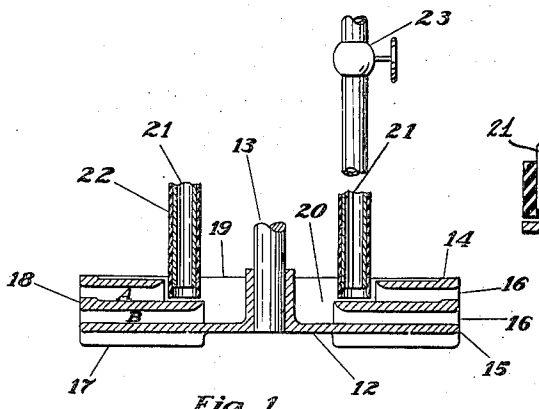


Fig. 1

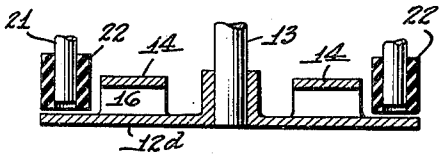


Fig. 6.

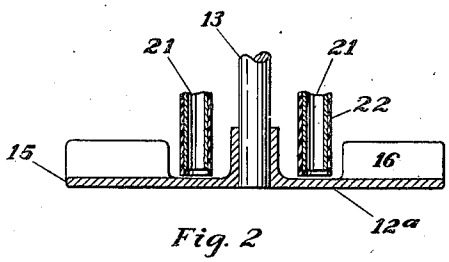


Fig. 2

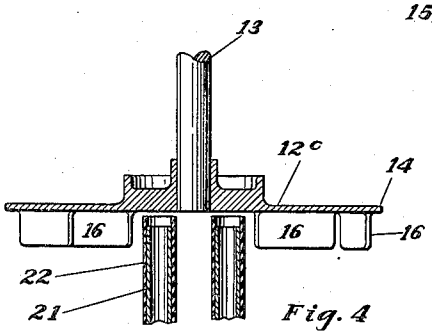


Fig. 4

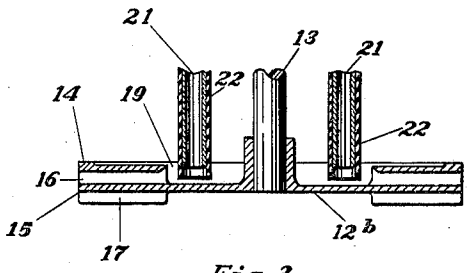


Fig. 3

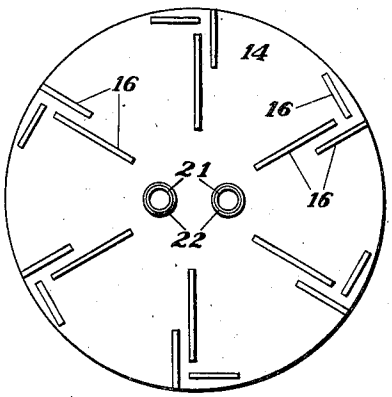


Fig. 5

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Patented May 16, 1944 2,348,990

UNITED STATES PATENT OFFICE

2,348,990

AERATING APPARATUS

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Application July 1, 1940, Serial No. 343,458

3 Claims. (Cl. 261—93)

This invention relates to aerating apparatus, and more particularly relates to aerating treatments employed in conjunction with the well-known froth flotation process.

In the art of flotation, many different types of machines have been developed. At one end of the range there is the air or pneumatic machine, using about three hundred cubic feet of gas to one cubic foot of pulp treated, while at the other end, there is the machine of the mechanical agitation type which in its agitation of the ore, entrains about ten cubic feet of air for every cubic foot of pulp treated. Intermediate the aforesaid machines, there are numerous other types which combine the features of these machines or variations thereof.

Since both the pneumatic and mechanical machines do the same type of work, it is logical to assume that much of the gas in the form of bubbles in the pneumatic machines does practically no work. It is also a logical assumption that the strictly mechanical machine expends far too much horsepower in order to entrain a relatively small amount of air.

Despite the many variations in the types of froth flotation treatments, there is one condition common to all, namely, without aeration, there is no flotation. This fact emphasizes the importance of air bubbles in the treatment and more particularly the types of bubbles which improve flotation and those which retard it.

In the conventional pneumatic type machine, air is forced under pressure through a tightly woven blanket. Minute bubbles begin to form on the upper side of the blanket. Many of them coalesce before separating from the blanket, and comparatively few remain small. With this type of machine, there is not enough pulp to disperse the large volume of air and coalescence predominates.

Large bubbles have relatively low surface tension. Because of their buoyancy, they cut across the pulp currents in the cell and rise quickly to the surface. Upon reaching atmosphere, they frequently break and drop the mineral entrapments.

Small bubbles, on the other hand, have a much higher surface tension and tend to follow the pulp currents. Because of their low buoyancy, they remain down in the pulp body a much longer time than large bubbles and consequently have a longer working interval and more frequent contact with mineral in which to form the attachments before rising to the surface.

It also is obvious that a given quantity of air broken down into small bubbles presents a much larger surface on which the mineral load may be transported.

Heretofore in the art, there has been no control to vary the volume of gas admitted to a flotation cell without also varying the velocity at which such gas is admitted. Through lack of this control, the pneumatic type of machines have wasted tremendous volumes of gas and the mechanical machines have had an unnecessary horsepower consumption.

The present means for introducing gas into the pulp provides a regulation of the velocity at which gas enters the pulp body even though the volume of air be kept constant. Conversely, the velocity of the entering air or gas may be kept constant, although the volume is varied.

In previous practice, low velocity air has been introduced into high velocity impellers, running at approximately 1500 feet per minute, peripheral speed. The violent action of the pulp within the impeller is used to break up the entering air. In contradistinction, the operation utilizing the present invention reverses the process and employs a relatively low peripheral speed impeller into which high velocity air is broken up upon delivery thereto, for which reason the impeller is relieved of this work.

In this treatment, the duty of the impeller is to circulate enough pulp to keep the bubbles dispersed and prevent coalescence, for which reason the bubbles delivered into the impeller do not require further reduction in size.

In any flotation problem, the element of time is an important factor. The time required to make a tailing will be reduced if a given quantity of air is broken down to present a large surface to the mineral content in the pulp, while the time necessary to make the same tailing increases when incoming air is not finely divided, as well as requiring more air.

An object of the invention is the provision of a gas-delivery means in association with mechanical agitators, permitting operation of the agitators at low peripheral speeds to attain a desired degree of distribution of gas throughout a body of material treated by such agitators.

A further object of the invention is the provision of an aeration means for use in the froth flotation process, applicable to various mechanical agitation types, which permits control of the volume of gas admitted to the treatment zone independently of its velocity and also provides a control of the velocity independent of the volume.

A still further object of the invention is the provision of a means for aeration control, permitting regulation of the volume of gas and its distribution throughout a fluent body under treatment.

Other objects reside in novel combinations and arrangements of parts, all of which will become apparent in the course of the following description.

To clarify understanding of the present invention, the accompanying drawing illustrates a variety of structures embodying the features of the present invention, which will be described as typifying the variety of ways in which the present invention may be practiced.

In the accompanying drawing, in the several views of which like parts have been designated similarly,

Figure 1 represents a vertical central section of an agitator embodying features of the present invention;

Figure 2 is a corresponding section through a modified form of agitator;

Figure 3 is a corresponding section through another type of agitator;

Figure 4 is a corresponding section of still another form of agitator;

Figure 5 is a bottom plan view of the agitator illustrated in Figure 4; and

Figure 6 is a vertical central section through another form of impeller construction.

Referring first to Figure 1, an impeller or agitator 12 mounted on a shaft 13 has been illustrated, which impeller is of the type described and claimed in the co-pending application of Weinig et al. Serial No. 287,718, filed August 1, 1939, for Flotation machine, and issued as Patent No. 2,246,560 on June 24, 1941.

In this form of construction, the impeller comprises top and bottom plates 14 and 15 respectively, which, together with a dividing member 18, define upper and lower agitation compartments A and B. The usual sweeping vanes 17 are provided on the bottom of plate 15.

Blades 16 in compartments A and B are provided to give impellent movement to pulp delivered thereto, and a central opening 19 in plate 14 acts as a feed inlet to the impeller, while a second central opening 20 in dividing member 18 of lesser diameter than the opening 19 provides the feed inlet to compartment B.

The aforesaid arrangement of parts has been described and claimed in the previously identified application and no claim to such features per se is made in the present application. In said former application, gas for aeration was delivered through pipes 21, terminating in inclined discharge outlets 22 maintained in spaced relation to the surface of the dividing member.

In the present construction, gas is delivered through a pipe or conduit 21 terminating in spaced relation to dividing member 18. A sleeve 22 is mounted at the lower end of conduit 21 for adjustment lengthwise thereof and is disposed in close proximity to the upper surface of dividing member 18. Preferably, the sleeve 22 is formed of a flexible, wear-resistant composition, such as rubber tubing, for example.

In most operations, it will be desirable to have the end of sleeve 22 barely out of engagement with dividing member 18, and when the impeller 12 is rotated, some contact may occur between parts 18 and 22, due to irregularities in their respective surfaces.

For this reason, it is desirable to have the sleeve 22 resilient to prevent damage to parts through such contact and to avoid excessive wear thereon. With different treatments, the amount of spacing may be varied, but not to exceed one-third of the diameter of the gas-discharge orifice. In certain froth flotation treatments results have been obtained when the amount of space adjoining a seven-sixteenths inch orifice was not in excess of three-eighths of an inch, and best results were obtained when the spacing was one-eighth of an inch or less.

An important factor in breaking up the air as it enters in the thickness of the rubber in the sleeve. Obviously, as this dimension is increased, the air is held in contact with a rotating impeller face for a longer interval with a more widespread shearing action resulting.

The velocity of gas discharge is a factor in the efficiency of the operation, for which reason regulation of the flow of gas through conduit 21 is desirable. A valve 23 or other suitable regulating means is therefore provided between the source of gas supply (not shown) and the outlet of conduit 21 and preferably is located above the fluent body being aerated to facilitate adjustment.

When such aerating mechanism is employed in the froth flotation process, the impeller 12 is located at or near the bottom of a flotation cell and rotated continuously throughout the treatment. Pulp in the cell descends into the impeller through opening 19 by reason of the hydrostatic pressure and the suction influence of the impeller. After entering the impeller, the pulp stream divides, with a portion flowing through opening 20 into compartment B for subsequent discharge at the periphery of the impeller under the impelling influence of blades 16, while the remainder travels through compartment A to its peripheral discharge.

After the initial setting of sleeve 22 and regulation of valve 23, gas is admitted into compartment A from conduit 21. Due to the close spacing of sleeve 22 and dividing member 18, only a thin passage is provided for the escape of gas from conduit 21 and the rotation of the impeller provides a shearing action on the discharging gas, with the result that it is thrown radially from conduit 21 in an extremely fine state of division.

The presence of substantial quantities of pulp in the zone of gas discharge, in conjunction with the aforesaid action, serves to distribute minute bubbles of gas between the solid particles of the pulp in the liquid medium. While so dispersed throughout the pulp body entering compartment A, the minute entrained gas bubbles are moved by the impellent action through the impeller without being brought in contact sufficiently with other gas bubbles to permit any coalescing action.

With the foregoing arrangement, it is possible to regulate the volume of gas through regulation of the valve 23, and by also regulating the position of sleeve 22 relative to the gas-deflecting surface of the impeller, the velocity may be varied for any volume of gas. Therefore, it is possible to regulate volume, independently of velocity, or to regulate velocity, independent of volume.

That portion of the gas moving centrally of the impeller from the discharge outlet of conduit 21 becomes entrained in a similar manner in the pulp stream passing into compartment B and passes therewith to its peripheral discharge. Due to the arrangement employed, only minor quantities of gas enter compartment B, whereas large quantities of gas are delivered to the cell through compartment A.

As a consequence, as in the other impellers

employing the same structural form, compartment A operates in an overloaded condition, while compartment B operates in an underloaded condition, and thus the peripheral mixing described in the aforesaid Weinig et al. application is attained in this form of aerating mechanism.

The form of impeller 12*a* illustrated in Figure 2 comprises a disc or bottom plate 15 on which the agitating blades 16 are mounted, usually in radial arrangement.

This impeller also is mounted on a rotary shaft 13 and the blades 16 terminate distantly from the center of the impeller. One or more gas conduits 21 extend into the space between shaft 13 and blades 16, terminating in close proximity to the plate 15. A sleeve 22 of the type hereinbefore described is mounted on conduit 21 in this form of invention and is spaced from plate 15 in the manner hereinbefore described.

When the impeller 12*a* is employed in the treatment of a fluent material, such as a body of pulp being subjected to a froth flotation treatment, it is rotated at relatively high speed and gas is delivered through conduit 21 at relatively high velocity. The shearing action previously described results, and the finely dispersed gas mixing with pulp entering into the space between shaft 13 and blades 16 becomes entrained in such pulp stream and moves outwardly along plate 15 under its centrifugal influence where it is beaten by blades 16 and discharged across the periphery of impeller 12*a*.

In Figure 3 another form of impeller 12*b* has been illustrated, which is similar to the impeller of Figure 1, with the dividing member 18 omitted. Because of the widespread dispersion of gas through the body of pulp treated in the impeller and the maintenance of the minute bubble condition in the treatment zone, the peripheral mixing obtained in the form of impeller illustrated in Figure 1 is not required.

Again in this form, the sleeve 22 is spaced from the plate 15 in the manner previously described and the discharged gas is mixed with pulp entering inlet opening 19 in the same way.

Figure 4 illustrates a different type of impeller 12*c* in which a top cover plate or disc 14 supports a series of vanes 16 on its undersurface. This form of impeller is covered in Weinig Patent No. 1,998,694 of April 23, 1935, for Impeller, and no claim is made herein for the impeller construction per se.

In the present arrangement, gas is delivered to the central space of the impeller through one or more conduits 21, located underneath the impeller and discharging upwardly against the undersurface of disc 14. Pulp or other fluent matter under treatment is drawn inwardly of the impeller by the slicing blades located adjacent the periphery, and upon entering the central space between the blades, is mixed with the discharging gas, and subsequently this pulp, inclusive of the entrained gas, is thrown outwardly by the pumping action of the radial vanes.

In this form of the invention, the gas is discharged in finely-divided condition by reason of the close positioning of sleeve 22 on conduits 21 relative to plate 14 and the rotation of the impeller 12c serves to provide the necessary shearing action previously described.

From the foregoing, it will be observed that in the various types of impellers illustrated, the gas discharge action and the mixing of gas with fluent matter is the same or substantially identical. This serves to illustrate the universal application of the present invention to various types of agitators, and the agitators illustrated in Figures 1 through 5 have been selected as representative of the entire range of such agitators which may be employed for this purpose, it being understood that other forms may be similarly adapted for the purposes of the present invention.

In Figure 6, a modified type of impeller 12*d* has been illustrated. In this form, the gas delivery conduits 21 terminate in proximity to the periphery of the impeller and blades 16 supporting an annular top plate 14 are disposed between the conduit 21 and shaft 13. Pulp entering centrally of the impeller passes under plate 14 by the impellent action of blades 16 and adjacent the periphery is subjected to the aerating influence of the gas discharge means, inclusive of the shearing action previously described.

This arrangement permits a relatively slow rotation of the impeller which functions in such an operation merely to circulate sufficient pulp to keep the bubbles dispersed and thus prevent coalescence. Even with slow rotation, the peripheral speed is sufficient to provide the necessary pulp distribution.

From the foregoing, it will be apparent that the gas may be delivered at any point from at or near the center to at or near the periphery, and the shearing action satisfies the requirements for delivery of the gas into the pulp body in an extremely fine state of division and in dispersed condition.

In Figure 6, the sleeve 22 has been illustrated as much thicker than the sleeve 22 of the other views. With this arrangement, the escaping gas is retained in contact with the rotating impeller face for a relatively long interval, in contradistinction with the arrangement illustrated in Figure 1, for example, and in this way the shearing action is increased.

There are strong indications that a partial vacuum formed behind the pumping vanes in conventional impellers induces coalescence of gas bubbles. It was to avoid such an action that the design shown in Figure 6 was developed. In this form of impeller, gas is introduced on the pressure side of the impeller and therefore is not subject to partial vacuum conditions of the suction influence.

The term "shearing," as used throughout the description and claims, is employed in the sense stated in Webster's New International Dictionary, second edition, as "To cut, clip, or sever something from or from something . . . to become more or less completely divided, as a body under the action of a shear."

In all the forms of aerating means illustrated, the thickness of the sleeves 21 or 31 is a matter of choice to be determined by initial testing, and sleeves of the type illustrated in Figure 6 may be substituted for the other type sleeves illustrated in the several views.

The feature of regulating velocity for any selected gas volume, and delivering a given volume of gas at variable velocities is intended to be of general application to all embodiments of the invention and is illustrated herein as applied to the form of Figure 1 merely as a typical example of its application to any of the forms.

In certain froth flotation operations, there will be quantities of soluble salts present in the pulp body under treatment, such as calcium sulphate, various alums, carbonates or silicates, and in the treatment a precipitation of such salts occurs,

filling the gas-discharge orifices of the present type of jets or nozzles.

The present invention is particularly suited for use in such a treatment, as it provides a self-cleaning orifice, the action of which prevents precipitated matter from entering and closing the passages 29. This is particularly true when a complete peripheral passage of the type illustrated is provided as the force of the discharging gas is sufficient to keep precipitating matter from lodging in such passage.

Changes and modifications may be availed of within the spirit and scope of the invention as defined in the hereunto appended claims.

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

1. Aerating apparatus comprising a gas-delivery conduit having a discharge outlet adapted to be positioned in a body of matter under treatment, and a rotary member cooperative with said discharge outlet having a gas-deflecting surface positioned adjacent thereto for directing gas passing from the outlet laterally of the conduit, and a resilient extension on the conduit disposed in such close proximity to the member that gas passing therefrom is subjected to a shearing action.

2. Aerating apparatus comprising a gas-delivery conduit having a discharge outlet adapted to be positioned in a body of matter under treatment, a rotary member cooperative with said discharge outlet having a gas-deflecting surface positioned adjacent thereto for directing gas passing from the outlet laterally of the conduit, and a rubber extension on the conduit disposed in such close proximity to the member that gas passing therefrom is subjected to a shearing action.

3. Aerating apparatus comprising a gas-delivery conduit having a discharge outlet adapted to be positioned in a body of matter under treatment, a rotary member cooperative with said discharge outlet having a gas-deflecting surface positioned adjacent thereto for directing gas passing from the outlet laterally of the conduit, and a flexible sleeve at the end of the conduit disposed in such close proximity to the member that gas passing therefrom is subjected to a shearing action.

HARRY L. McNEILL.