March 7, 1944. T. S. BAILEY, JR., ET AL 2,343,274

FLOTATION MACHINE

Filed Oct. 29, 1940 2 Sheets-Sheet 1

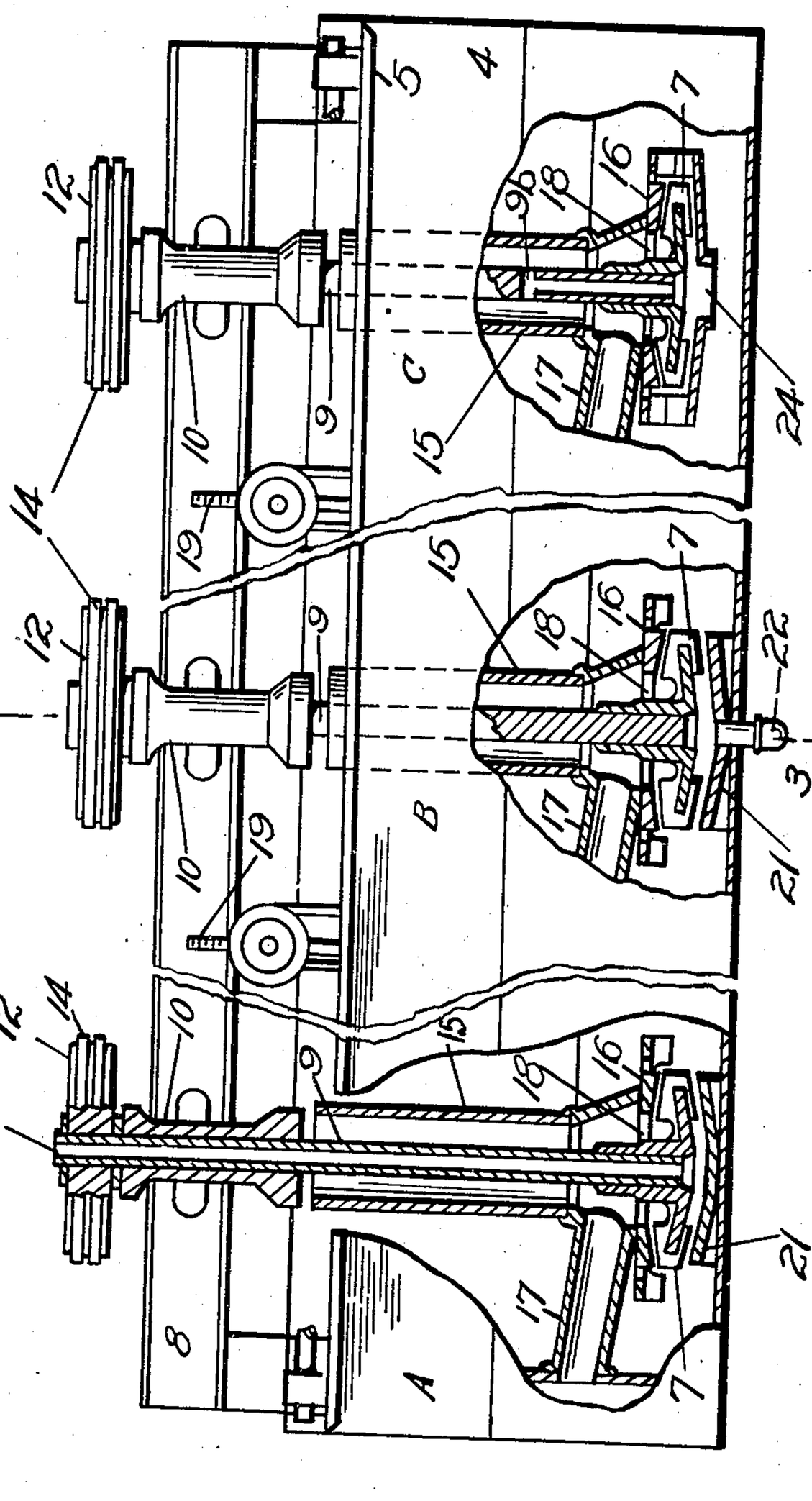

Fig. 1C.

Fig. 1B

Fig. 1A.

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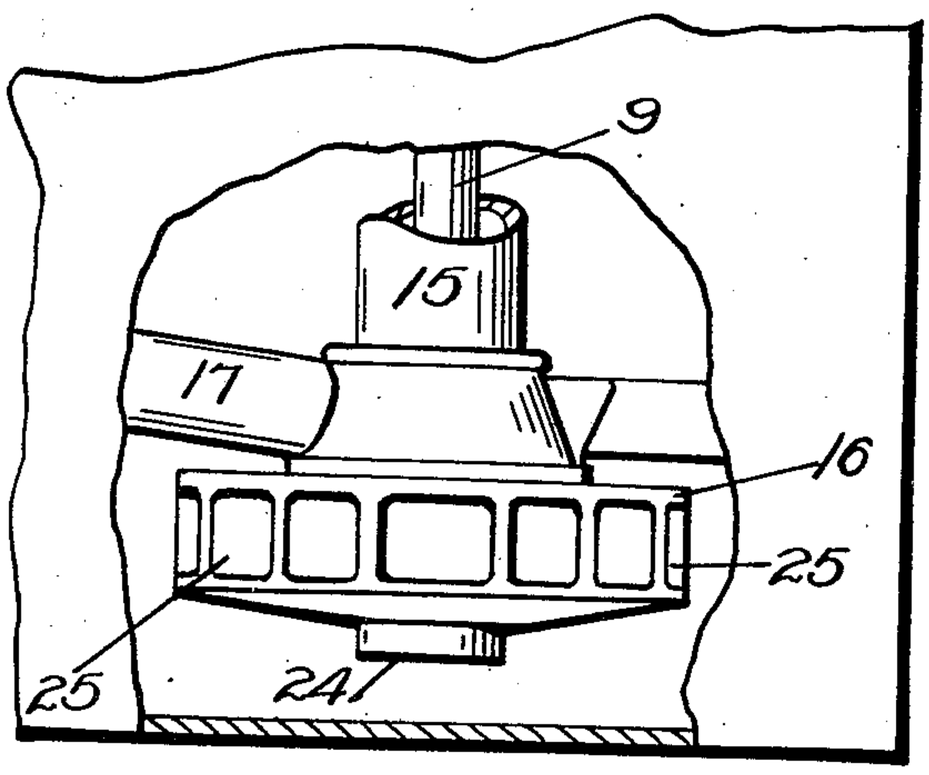

Fig. 2.

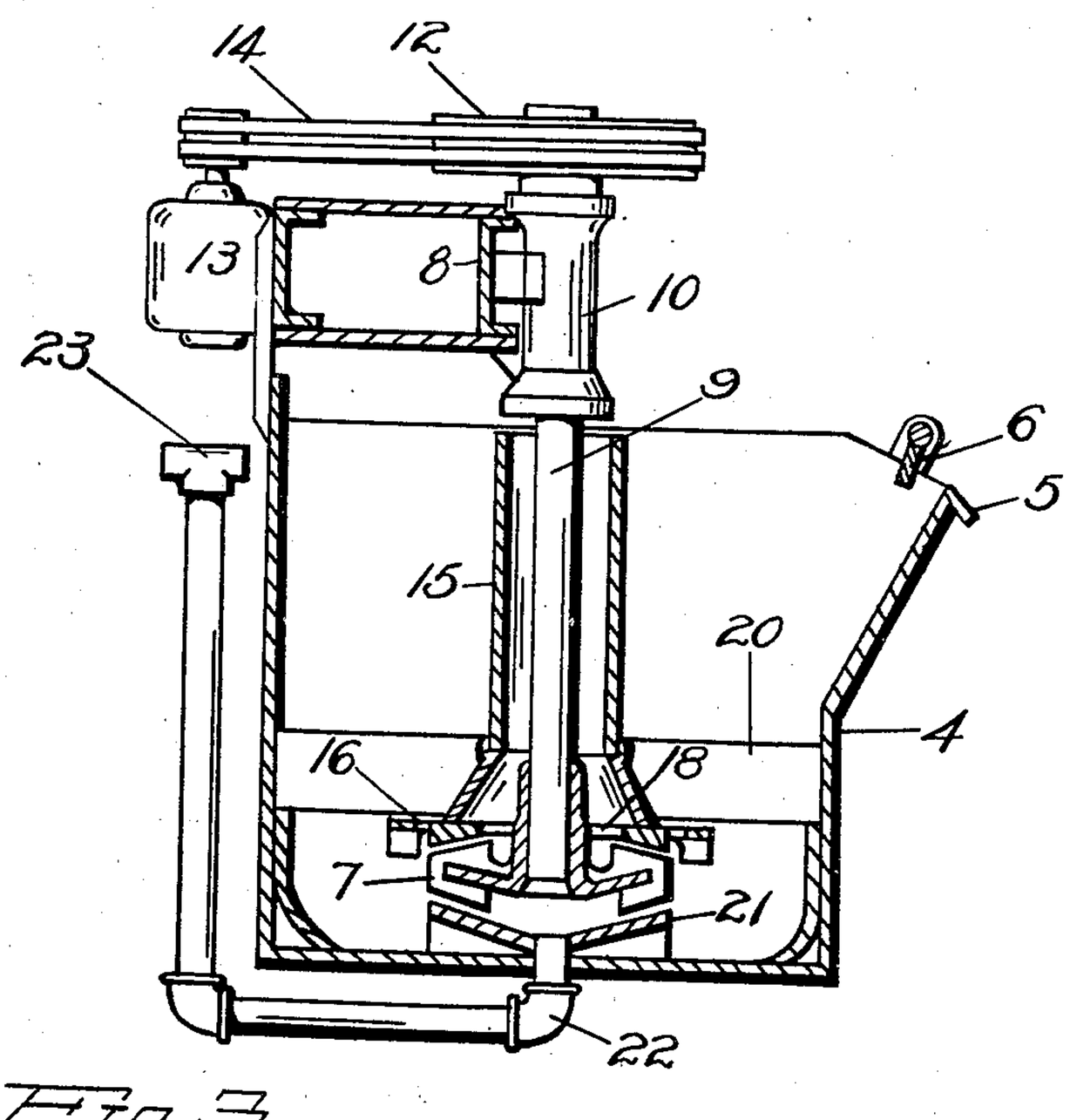

Fig. 3.

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FLOTATION MACHINE

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12 Claims. (Cl. 261—93)

This invention relates to froth flotation apparatus, and more particularly to improved methods of aeration in such treatments.

The invention has particular application to flotation machines of the mechanical agitation type, in which atmospheric air is drawn in by the suction influence of the impellers. However, the invention is intended for general application to a variety of treatments, inclusive of those requiring the introduction of gas under pressure.

It is an object of the present invention to provide an adequate supply of gas for intermixture with a body of pulp being agitated by rotary impellers to permit sufficient diffusion of gas throughout the material acted on by the impellers without rotation of such impellers at excessively high speeds.

Another object of the invention is the provision of means to insure an adequate supply of atmospheric air for the aeration requirements of froth flotation apparatus under all conditions of operation.

A further object of the invention is the provision of novel means for promoting aeration in froth flotation treatments.

Still another object of the invention is the provision of a novel means of recirculating pulp through the agitative stage of the flotation process, particularly coarse solids tending to settle out of suspension.

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

To afford a better understanding of the invention, reference is made to the accompanying drawings, in the several views of which like parts have been designated similarly and in which:

Figures 1A, 1B and 1C represent a side elevation of a three-cell machine, partially broken away to illustrate a variety of structural embodiments of the present invention in which Figure 1A illustrates one form of gas introduction, Figure 1B illustrates a modified form, and Figure 1C illustrates a further modified form of gas introduction into a cell;

Figure 2 is an enlarged fragmentary side elevation of the impeller housing illustrated in Figure 1C; and

Figure 3 is a section taken along the line 3—3 of Figure 1B.

Referring now to Figures 1A, 1B and 1C, the machine comprises a tank 4 terminating at its forward edge in a froth overflow lip 5, adjacent which suitable scrapers 6 may be located, if desired. Within the tank, three rotary impellers 7 are suspended at intervals from a superstructure 8 at the top of the tank through the medium of shafts 9 journalled in bearings 10. Pulleys 12 mounted on the upper ends of shafts 9 are disposed for driving connection with the motor 13 or other prime mover, preferably through the provision of belts 14.

Preferably, a hollow column 15 surrounds each shaft and carries at its lower end a hood structure 16 in encompassing relation to each impeller 7.

A hollow conduit 17 acting as a feed inlet, extends into the hollow column and delivers pulp through openings 18 in the hood directly onto impeller 7. The upper end of column 15 extends above the tank and is open to the atmosphere to permit entrainment of atmospheric air under the suction influence of the impeller.

Each cell is provided with suitable means for regulating the flow of pulp to the next succeeding cell in the machine, and as here illustrated, this control comprises screw actuated gates 19. If desired, radial baffles 20 may be provided for restraining agitation in the upper portion of the cell, and these baffles may be utilized as the suspension means for the hood 16 and column 15 in the manner illustrated in Figure 3. The features thus far described are in general practice in the art, except for the specific features of novelty which will be described in detail hereinafter.

The form of impeller construction in Figure 1A involves the use of a hollow shaft 9 open to the atmosphere at 9*a*, with the impeller in the form of a dished disc mounted at the lower end of the hollow shaft 9 and provided with the usual blades. Below the impeller 7 of Figure 1A, a dished plate 21 extends upwardly from the cell bottom in substantially parallel relationship to the undersurface of impeller 7. In the action of this cell, pulp admitted through feed inlet 17 passes through openings 18 of the hood 16 and descends onto the impeller 7 which is rotating at relatively high speed.

The suction influence of impeller 7 tends to draw air through hollow column 15 and openings 18 onto impeller 7, but inasmuch as irregularities in feed and other causes frequently create a conrdition in which liquid stands to a limited distance in column 15, the aeration requirements of the operation may not be satisfied by such volume of air as is drawn in through hollow column 15. To compensate for this deficiency, the opening in shaft 9 under the suction influence of the impeller causes air to be drawn

down and delivered beneath the impeller onto the upper surface of plate 21. The hood 16 and plate 21 cooperate to provide a substantial closure for impeller 7 and air and pulp delivered within such enclosure, as aforesaid, is subjected to intense agitation and intimate intermixture under the agitative action of the impeller.

After mixing, the pulp discharges through the peripheral space between hood 16 and plate 21 and passes into the cell for completion of the flotation action in a manner well-known in the art.

This method of aeration permits substantial reduction in horsepower requirements of the machine, as sufficient aeration to satisfy treatment requirements can be obtained when impeller speeds are materially reduced, as compared with the same structure entraining air only through column 15.

Likewise, the provision of the plate 21 in parallel with the bottom of impeller 7 serves to eliminate the collection of coarse particles below the impeller, with a consequent reduction in friction and elimination of excessive wear. A further advantage is derived from the fact that more gas is delivered to the periphery of the impeller where the material rising along plate 21 impinges on the stream of material forced downwardly by cover plate 16.

As illustrated in Figure 1A, the impeller is provided with vanes on its bottom surface, in addition to the blades on its upper surface, and these vanes serve to accelerate movement of fluid upwardly along the dished surface of plate 21.

In Figure 1B, the arrangement is generally similar to that shown in Figure 1A, except that the shaft 9 in this form is solid and gas is admitted through a conduit 22, entering the tank 4 through the bottom and extending to the upper surface of plate 21. As shown in Figure 3, this conduit extends from beneath the cell to an elevated terminus above overflow lip 5 and preferably is provided with a T fitting 23 so that either atmospheric air or gas under pressure may be delivered to the impeller. It will be understood that where gas under pressure is to be used, one end of the T will be connected with a suitable header or other source of supply (not shown) and the other enclosed by insertion of a suitable plug.

In other respects, the structure and operation of this cell is the same as Figure 1A, as the gas supplied through conduit 22 acts in the same way as the gas delivered through hollow shaft 9 in Figure 1A.

In Figure 1C another modification is illustrated, in which the shaft 9 is drilled from the bottom and a lateral bore 9b is placed in shaft 9 at the upper end of the tapped portion and above the level at which liquid will stand in column 15 in the ordinary action of the machine.

With this arrangement, any deficiency in gas supply which otherwise might result from liquid standing above the impeller 7, is compensated for through the delivery of atmospheric air initially entering column 15 and subsequently passing through the openings in shaft 9 to be ejected at the lower end thereof.

The hood construction of this form of the invention is changed to provide a complete closure for the impeller and a series of peripheral openings 25 at intervals about hood 16 permit the discharge of matter acted on by the impeller. A central opening 24 in the bottom portion of the hood 16 permits matter to be sucked in by the impeller and moved upwardly along the inclined bottom of hood 16 for ejection.

This form of construction is particularly suited for the recirculation of solids tending to settle on the bottom of the tank, as the suction influence is sufficiently strong, due to the type of closure and the high peripheral speeds of the impeller, to draw up relatively heavy particles through opening 24. Thereafter, the action corresponds to that in the other forms of the invention, with the material beneath the impeller being thrown outwardly through the openings 25 by the action of the vanes on the bottom of impeller 7, while the pulp and gas delivered onto the impeller from above is forced outwardly between the disc and the upper surface of cover 16 by the action of the impeller blades to impinge upon the other stream adjacent the peripheral openings 25, and after intermixture therewith to pass from the same and rise through the liquid body in the tank.

In all these forms of impeller construction, the construction and action is generally similar to the apparatus disclosed is Daman et al. Patent No. 2,243,309, issued May 27, 1941, for Flotation apparatus, and features described but not claimed herein have been claimed in said copending application.

It will be understood that the various methods of aeration may be employed with any of the structural forms described herein, and where it is desired to rely only on atmospheric air for the supply of the aerating gas, any of the forms illustrated in Figures 1A, 1B or 1C may be used with the hood structures of either Figure 1A or 1C. Similarly, when gas under pressure is preferred to entrainment of atmospheric air, the conduit arrangement of Figure 1B may be incorporated with the hood structure of Figure 1C, if preferred.

With whatever structural arrangement is selected, the aerating action will be substantially the same. Pulp will enter through openings 18 onto the upper surface of impeller 7, and during entry, will entrain atmospheric air descending onto the impeller through column 15. At the same time, gas delivered through the shaft 9 or conduit 22 will move upwardly along the bottom of impeller 7 to its periphery. The matter delivered onto the impeller 7 will be intimately intermixed by the centrifugal influence, coupled with the beating action of the impeller blades, and because of the restriction on discharge provided by the hood and its depending blades, will result in a compression of the aerated body prior to its movement past the peripheral confines of the hood.

Also in this action, the rising stream of gas is impinged upon by the descending compressed body at the periphery of the impeller and thoroughly intermixed, and increased diffusion of gas results from this action.

In the forms illustrated in Figures 1A and 1B, little, if any, pulp will enter between plate 21 and impeller 7, for which reason the matter acted on beneath the impeller is largely gaseous and subjected to an intense mixing action upon being brought into contact with the liquid contents at the peripheral zone of intermixture.

However, in the form illustrated in Figure 1C, substantial quantities of pulp are drawn in through the bottom opening and initially mix with gas entering through opening 9b centrally of the impeller, after which the resulting intermixture moves outwardly to the periphery of the

impeller and is again subjected to mixing with a stream of pulp descending from above. The restrictions provided by the peripheral enclosure serve to limit the rate of ejection, with the result that a high degree of compression and consequent widespread diffusion of gas is attained in the operation of this device.

While the provision of the plate 21, as described, involves the shaping of its upper surface substantially parallel with the undersurface of the impeller, it will be understood that the parallel relationship is not absolutely essential to attainment of the desired action. Therefore, it is within contemplation of the present invention that plates positioned other than parallel to the undersurface of the impeller, may be used for the purposes described.

Where the form of the invention illustrated in Figure 1C is used, the provision of a stationary closure about a rotary impeller, with gas delivered to the undersurface of the impeller to accelerate the suction influence at the bottom intake opening, insures the intake of substantial quantities of solids otherwise tending to settle along the bottom of the cell. Various means of cleaning the cell are known in the art, but the combined action of the impeller and the gas discharge provide an efficient means for attaining these results, as well as insuring adequate gas supply for mixing adjacent the periphery of the closure member.

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

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

1. Froth flotation apparatus comprising a tank for pulp, a rotary dished impeller in the lower portion of the tank, a dished plate supported on the bottom of the tank directly beneath the impeller and in close proximity thereto to provide a pulp-free zone immediately underneath the impeller, a hood overhanging the impeller, a hollow column extending upwardly from the hood and terminating above the tank, means for delivering pulp through the column onto the upper surface of the impeller, and conductive means for delivering gas between the dished plate and the bottom of the impeller centrally thereof for movement through said pulp-free zone.

2. Froth flotation apparatus comprising a tank for pulp, a rotary dished impeller in the lower portion of the tank, a dished plate supported on the bottom of the tank directly beneath the impeller and in close proximity thereto to provide a pulp-free zone immediately underneath the impeller, a hood overhanging the impeller, a hollow column extending upwardly from the hood and terminating above the tank, means for delivering pulp and gas onto the upper surface of the impeller, and conductive means for delivering gas under pressure into the pulp-free zone between the dished plate and the bottom of the impeller.

3. Froth flotation apparatus comprising a tank for pulp, a rotary dished impeller in the lower portion of the tank, a dished plate supported on the bottom of the tank directly beneath the impeller and in close proximity thereto to provide a pulp-free zone immediately underneath the impeller, a hood overhanging the impeller, a hollow column extending upwardly from the hood and terminating above the tank, means for delivering pulp and gas onto the upper surface of the impeller, and conductive means for delivering atmospheric air into the pulp-free zone between the dished plate and the bottom of the impeller.

4. Froth flotation apparatus comprising a tank for pulp, a rotary disc in the lower portion of the tank, a plate member supported on the bottom of the tank directly beneath the disc having its upper surface substantially parallel with the undersurface of the disc to provide a pulp-free zone immediately underneath the impeller, a hood overhanging the disc, means for delivering aerated pulp onto the upper surface of the disc, conductive means for delivering gas between the plate and the bottom of the disc centrally thereof for movement through said pulp-free zone, and vanes on the upper and lower surfaces of the disc for acting on matter contacted therewith.

5. Froth flotation apparatus comprising a tank for pulp, a hollow shaft supported above the tank and extending into the lower portion thereof, an impeller mounted on the hollow shaft with its upper surface above the lower opening of the shaft, a hood overhanging the impeller, a plate beneath the impeller having its upper surface substantially parallel with the undersurface of the impeller, means for delivering aerated pulp onto the upper surface of the impeller, and conductive means for delivering gas through the hollow shaft to a point between the plate and the bottom of the impeller centrally thereof.

6. In flotation apparatus, a tank for pulp, a rotary impeller submerged in the pulp in the lower portion of the tank, a stationary closure for the impeller comprising top and bottom members, imperforate except for central intake openings, disposed adjacent the top and bottom surfaces of the impeller, and a peripheral connection-member having a series of discharge apertures at intervals about its circumference, a hollow column extending upwardly from the central intake opening of the upper closure member and terminating above the tank, and conductive means exclusive of said column for delivering gas to a point between the bottom closure member and the bottom of the impeller centrally thereof.

7. In flotation apparatus, a tank for pulp, a rotary impeller submerged in the pulp in the lower portion of the tank, a stationary closure for the impeller comprising top and bottom members, imperforate except for central intake openings, and a peripheral connection-member having a series of discharge apertures at intervals about its circumference, means for delivering gas beneath the impeller adjacent the intake opening of the bottom closure member, a hollow column extending upwardly from the central intake opening of the upper closure member and having an atmospheric air intake above the pulp in the tank, and vanes on the upper and lower surfaces of the impeller positioned to exert a suction influence on the intake openings in the top and bottom closure members.

8. Froth flotation apparatus, comprising a tank for pulp, a shaft supported above the tank and extending into the lower portion thereof, an impeller mounted on the shaft at its lower end, said shaft having a hollow portion inclusive of an intake communicating with a source of gas supply externally of the tank and a discharge outlet below the upper surface of the impeller, top and bottom stationary covers for the impeller, said bottom cover being arranged substantially parallel to the undersurface of the impeller, and means for delivering aerated pulp onto the upper surface of the impeller.

9. Froth flotation apparatus, comprising a tank

for pulp, a shaft supported above the tank and extending into the lower portion thereof, an impeller mounted on the shaft at its lower end, top and bottom stationary covers for the impeller, a hollow column surrounding the shaft having an intake opening in the atmosphere above the tank and delivering gas to a point between the top closure member and the upper surface of the impeller, said shaft having a hollow portion inclusive of an intake communicating with the interior of the hollow column and having a discharge outlet below the upper surface of the impeller, and means for delivering aerated pulp onto the upper surface of the impeller.

10. Froth flotation apparatus, comprising a tank for pulp, a shaft supported above the tank and extending into the lower portion thereof, an impeller mounted on the shaft at its lower end, top and bottom stationary covers for the impeller, a hollow column surrounding the shaft having an intake opening in the atmosphere above the tank and delivering gas to a point between the top closure member and the upper surface of the impeller, said shaft having a hollow portion inclusive of an intake communicating with the interior of the hollow column and having a discharge outlet below the upper surface of the impeller, vanes on the impeller positioned to exert a suction influence on the discharge outlet of the shaft, and means for delivering aerated pulp onto the upper surface of the impeller.

11. In flotation apparatus, a tank for pulp, a rotary dished impeller submerged in the pulp in the lower portion of the tank, stationary cooperative members mounted in the tank in enclosing relation to the impeller, said members comprising a top closure member having a central passage, and a bottom closure member having a contour corresponding to the under surface of the impeller, said bottom closure being in close proximity to the impeller to provide a pulp-free zone underneath the impeller, means comprising a hollow column for delivering gas onto the upper surface of the impeller through the central passage of the top member, separate conductive means for delivering gas between the bottom closure member and the under surface of the impeller centrally thereof, and vanes on the impeller for moving the discharged gas in separate streams toward the periphery of the impeller.

12. Froth flotation apparatus comprising a tank for pulp, a hollow shaft supported above the tank and extending into the lower portion thereof, an impeller mounted on the hollow shaft with its upper surface above the lower opening of the shaft, a hood overhanging the impeller, a plate beneath the impeller in close proximity thereto, means for delivering pulp onto the upper surface of the impeller, and conductive means for delivering gas through the hollow shaft to a point between the plate and the bottom of the impeller centrally thereof.

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