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Fedotov et al.

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[45] **May 29, 1973**

[54] **FLOTATION MACHINE WITH VERTICALLY RECIPROCATING AERATORS**

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[52] **U.S. Cl.** **209/169,** 261/82

[51] **Int. Cl.** **B03d 1/22**

[58] **Field of Search** 209/168, 169, 425, 209/475, 455, 468; 261/33, 81, 82, 87, 93; 210/14, 15, 221

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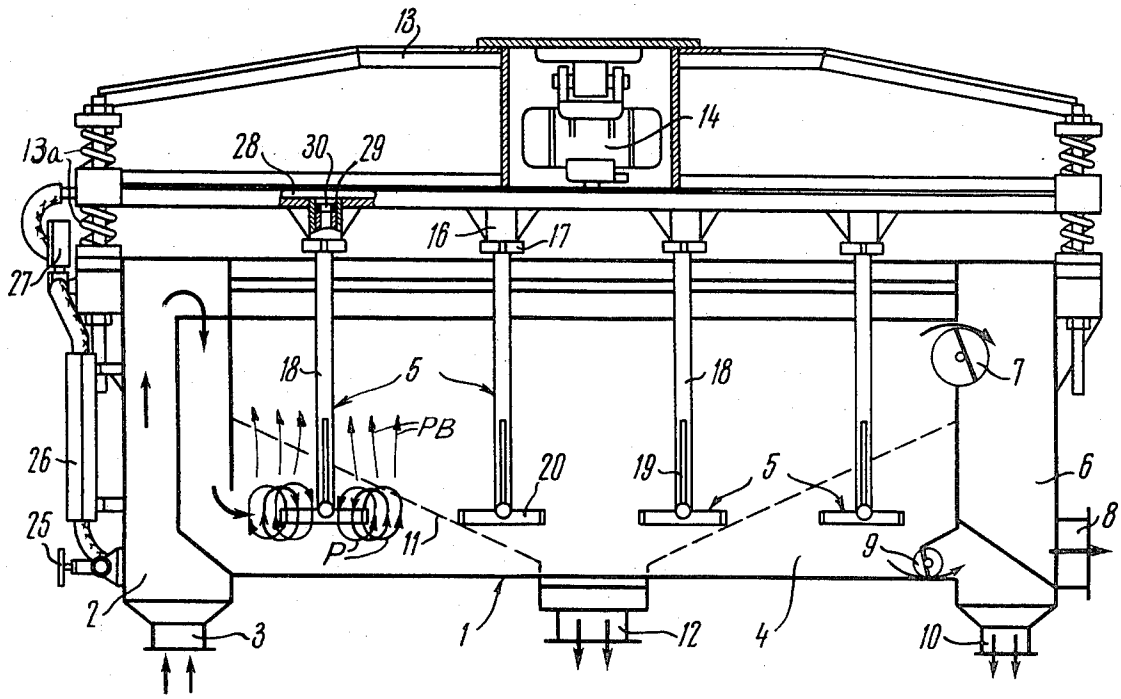
[57] **ABSTRACT**

A flotation machine incorporating a chamber for pulp and means for removing therefrom separated products, as well as vibration aerators disposed therein and having ducts for the supply of air to their piston-like portions having openings for the outlet of said air and openings for the passage of pulp during the upward stroke of the aerators.

The piston-like portion of each aerator is provided with flaps of elastic material adapted to close the openings for the passage of pulp in the course of the aerator downward stroke and open them in the course of the aerator upward stroke.

As a result of such an arrangement, the operation of the machine is accompanied with an intensive stirring and aeration of pulp at low values of the vibrational speed of the aerator, owing to which there takes place a considerable reduction of the electric energy consumption and aerator wear.

7 Claims, 8 Drawing Figures



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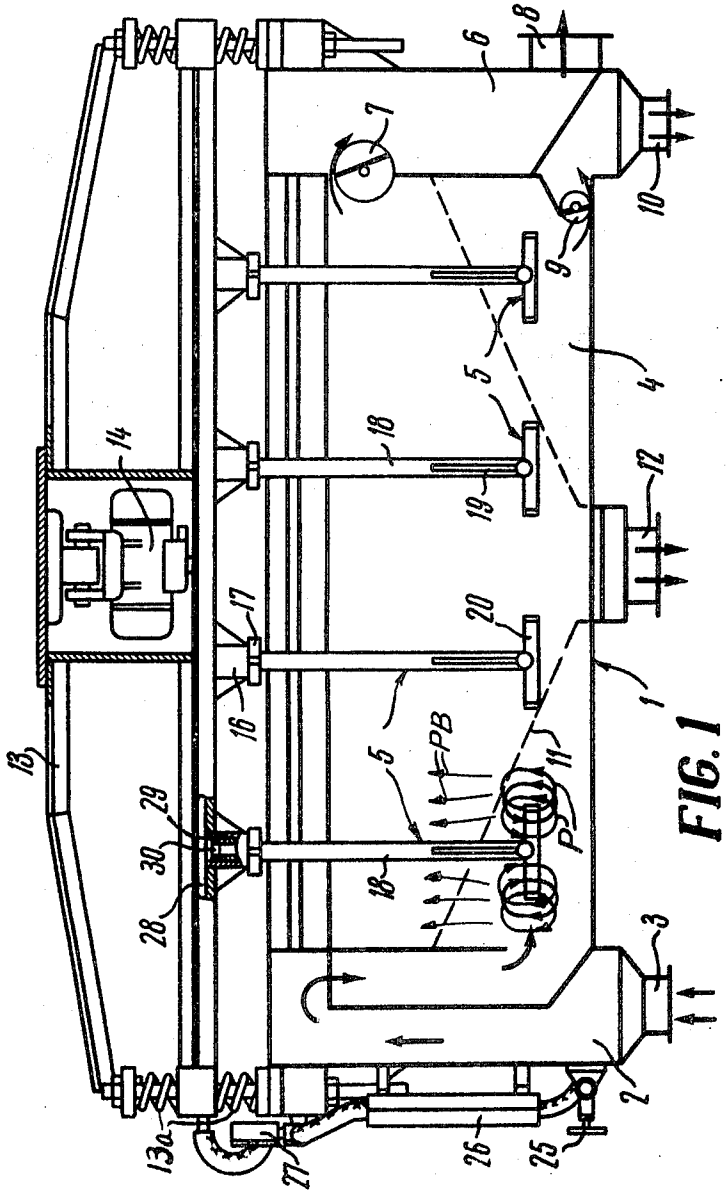


FIG. 1

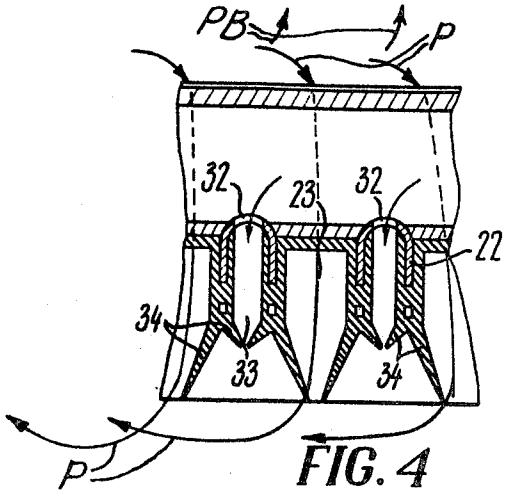


FIG. 4

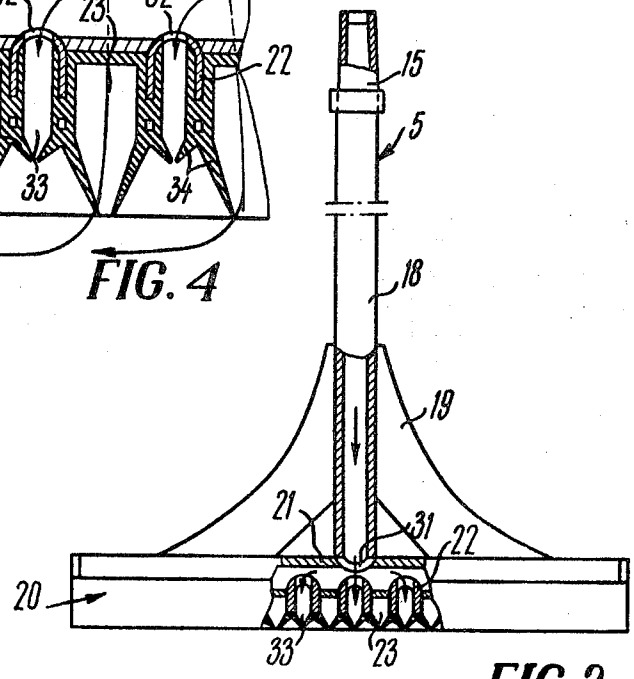


FIG. 2

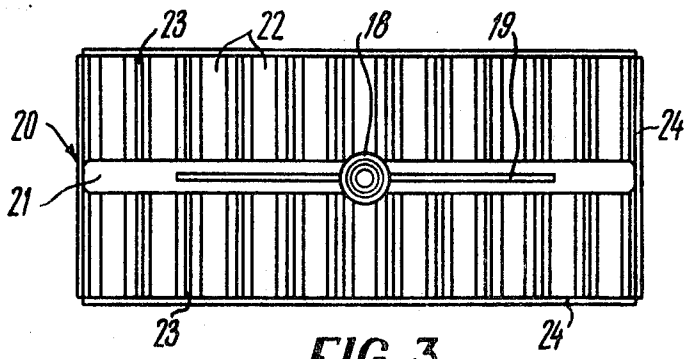


FIG. 3

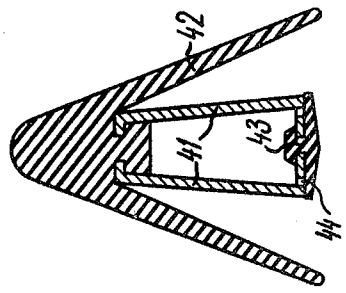


FIG. 7

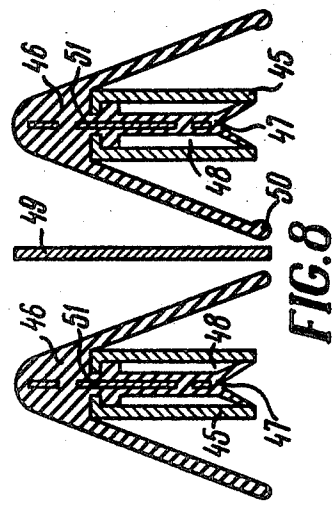


FIG. 8

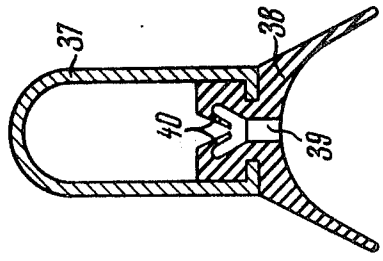


FIG. 6

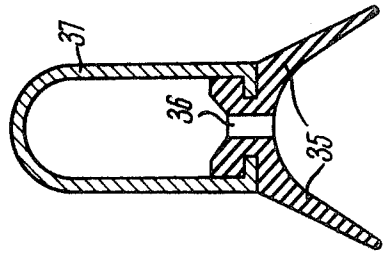


FIG. 5

FLOTATION MACHINE WITH VERTICALLY RECIPROCATING AERATORS

The present invention relates to flotation machines used in mineral dressing, preferably, in ore dressing.

There are known flotation machines of various designs, including those with an aerator provided with a vibration drive. Said known machines incorporate a chamber for pulp adapted for the removal of products separated from pulp (cf., F.R.G. Pat. No. 1,188,012).

The chamber (or chambers) accommodates vibration aerators designed for stirring the pulp and provided with ducts for the supply of air to the aerator piston-like portion.

The piston-like portion of the aerator is secured to a vertically extending pipe and made of a metal sheet featuring openings adapted for the passage of pulp. Said openings have the shape of a truncated cone with the wider base upward. Such a shape of the openings helps generate circulation flows in the flotation compartment of the chamber of the flotation machine.

However, said known machines feature a considerable energy capacity, do not provide for an adequate stirring of pulp and the rise of coarse-grained material in the chamber, as well as for an adequate dispersion of air; the operation of such aerators is accompanied with dimineralization of air bubbles. This is due to a low degree of perforation of the aerator piston-like portion, amounting but to 10–12 percent of the total area thereof.

With the above-mentioned perforated area, pulsating circulation flows passing through the cone-shaped openings are too small to provide in the lower portion of the chamber for an adequate velocity of ascending flows required to raise coarse-grained material.

In order to attain a better performance, aerators of this type were imparted an increased vibrational speed, however, this brought about a more rapid aerator wear, an increase of specific power consumed (per one cubic meter of the chamber) and emergence in the quiescent zone of the chamber of intensive low-frequency vibrations causing mineral particles to be shaken off from air bubbles.

Moreover, a sufficiently high degree of dispersion of the air bubbles cannot be provided, due to the fact that the linear velocity of air outflow from the openings of air-conducting pipes is considerably higher than the velocity of circulation jet flows of pulp which eject air and pass through the openings in the aerator piston-like portion.

It is an object of the present invention to eliminate the above-listed disadvantages of said known machines. Other objects and advantages of the invention will become apparent from the following disclosure.

This invention is aimed at the solution of a technical problem of developing a flotation machine featuring such a design of a vibration aerator as would make for increasing the machine efficiency, reducing the electric energy consumption and increasing the wear resistance of the aerator.

The problem of the invention can be solved in a flotation machine incorporating a chamber for pulp, adapted for removing therefrom separated products, and vibration aerators disposed therein and having ducts for the supply of air to their piston-like portions provided with openings for the outlet of said air and openings for the passage of pulp during the upward

stroke of the aerators, wherein, according to the invention, the piston-like portion of each aerator is composed of parts spaced from each other and having flaps of elastic material adapted to close the openings between said parts for the passage of pulp in the course of the aerator downward stroke and open them during the aerator upward stroke.

Such an arrangement of the machine of the invention results in its increased efficiency, reduced consumption of electric energy and reduced wear of the aerators incorporating members of elastic material, as well as in an increased intensity of stirring and aeration of pulp at low values of the vibrational speed of the aerators.

It is expedient that the piston-like portion of each aerator be composed of parts having a semitubular cross-section with flaps of elastic material secured alongside their walls, made forking downwards and adapted, during the downward stroke of the aerator, to simultaneously close the openings for the passage of pulp provided in the piston-like portion and openings for the outlet of air provided in the semitubes.

Such parts of the piston-like portions of the vibration aerators in the machine can be readily manufactured in a large-scale production by combining casting with rubberizing.

The piston-like portion of each aerator may be composed of parts having a horseshoe-shaped cross-section, securing in them flaps of elastic material that are combined in pairs to form shaped inserts having openings for the outlet of air.

Such parts with flaps of elastic material comprising the piston-like portions of the aerators can readily be manufactured in a small-scale production and easily replaced if worn out.

It is desirable that in said inserts of elastic material second flaps be provided before the openings for the outlet of air, adapted to close said openings during the downward stroke of the aerators.

This provides for an automatic intake of air into the machine chamber and prevents the pulp from getting into inner spaces of parts comprising the piston-like portion of the aerator.

It is advisable that the piston-like portion of the aerator be composed of parts each of which has a cross-section in the form of channel bars facing each other in pairs with their flanges, while flaps of elastic material made as inserts are inserted from above between them, the lower flanges of the channel bars have openings for the outlet of air and valves are inserted between said lower flanges for closing said openings during the downward stroke of the aerator.

This helps provide for an automatic intake of air into the chamber of a deep flotation machine, as well as to increase the wear resistance of metal parts of the piston-like portion of the aerator owing to the shielding effect of the outer flaps.

It is expedient that the piston-like portion of each aerator be made of parts each of which has a cross-section in the form of L-shaped beams facing each other in pairs with their shorter flanges, three-flap inserts of elastic material being inserted between the shorter flanges so that the middle flap is arranged between said pairs of beams, forks downward and serves to close air outlet openings between them during the downward stroke of the aerator, while the other two flaps serve to close in the piston-like portion of the aerator the openings for the passage of pulp.

This helps simplify the structure of the piston-like portion of the aerator, for in place of two inserts a single three-flap one can be used, while the inner flaps function more efficiently as valves.

Vertically extending partitions in the form of strips can be arranged between the parts comprising the piston-like portion of the aerator and alongside said parts.

This helps considerably increase the perforation coefficient of the piston-like portion of the aerator as a result of an increased distance between the parts thereof, as well as reduce the number of parts comprising the piston-like portion of the aerator.

The present invention will be better understood upon considering the following detailed description of an examplary embodiment of a flotation machine according to the invention, reference being had to the accompanying drawings, in which:

FIG. 1 illustrates a flotation machine of the invention, in longitudinal section, with part extracted;

FIG. 2 illustrates a vibration aerator of said flotation machine, with parts extracted;

FIG. 3 — ditto, plan view;

FIG. 4 shows on an enlarged scale flaps of elastic material in the piston-like portion of the machine aerator, extraction in FIG. 2;

FIG. 5 illustrates flaps made as inserts, in cross-section;

FIG. 6 illustrates flaps made as inserts with second flaps in an air outlet duct, in cross-section;

FIG. 7 shows a component part of the piston-like portion of the aerator, having channel bars with flaps between the upper flanges and with a valve between the lower ones, in cross-section; and

FIG. 8 shows parts comprising the piston-like portion of the aerator, featuring a cross-section in the form of L-shaped beam, three-flap inserts of elastic material and a partition between parts, in cross-section.

Now, referring to FIG. 1, the flotation machine according to the present invention incorporates a chamber 1 divided into compartments, namely, a compartment 2 with a connecting pipe 3 for the supply of pulp, a compartment 4 with vibration aerators 5 for the flotation of pulp, and a compartment 6 having a gate valve 7 and a connecting pipe 8 for tailings and a gate valve 9 and a connecting pipe 10 for sands. In addition, there is provided a compartment 11 with a connecting pipe 12 for the removal of foam product.

The machine has a bearing frame 13 on which is secured by coil springs 13*a* having vertical axes for vibration upwardly and downwardly, a vibration drive 14 of the aerators 5.

Each vibrators aerator 5 has cone-shaped shank portion 15 (FIG. 2) for coupling with a reducing pipe 16 (FIG. 1) and threaded ring 17 of the bearing frame 13.

The vibration aerator 5 is essentially a vertically extending hollow tube 18 (FIG. 2) provided with stiffening ribs 19 and serving to hold in place a horizontally extending piston-like portion 20 (FIG. 3) defined by a manifold 21 and parts 22 with semitubular cross-section. The manifold 21 is essentially a horizontally extending hollow tube communicating with the space of the vertically extending tube 18 and with the space of each of the parts (semitubes) 22 (FIG. 2). Said semitubes 22 (FIG. 4) face with their open sides down, are parallel with each other and spaced at equal distances from each other, forming between them openings 23 adapted for the passage of pulp during the upward stroke of the vibration aerator 5.

The manifold 21 and semitubes 22 are encased in a contour frame 24 (FIG. 3).

Air is supplied to the vibration aerators 5 (FIG. 1) of the machine via air supply system (not shown in the drawings) equipped with a valve 25, a rotameter 26 and a pressure gauge 27. In the lower portion of the bearing frame 13 provision is made of a longitudinally extending duct 28 serving for the supply of air to the vertically extending tubes 18 of the vibration aerators 5.

This is effected via the reducing pipes 16, the space of each of said pipes accommodating a throttling washer 29 with an opening 30 providing for the supply of a preset amount of air depending on the aerator 5 location in the flotation compartment 4 of the machine.

Each vertically extending tube 18 (FIG. 2) of the vibration aerator 5 communicates with the manifold 21 of the piston-like portion 20 via opening 31, while said manifold communicates with the semitubes 22 via openings 32.

The semitubes 22 defining the piston-like portion 20 of the vibration aerator 5 are closed from their end faces with the contour frame 24 and, therefore, they are provided for the outlet of air with a slot-shaped opening 33 (FIG. 4) defined by the longitudinal walls of the semitubes 22. Flaps 34 of elastic material are secured alongside said walls. Said flaps 34 are made forking in the downward direction so that they diverge (open) during the downward stroke of the aerator 5 and form a continuous surface of the piston-like portion 20, and, during the upward stroke of the aerator 5, they converge (fold together) opening simultaneously both the slot-shaped openings 33 in the semitubes 22 and the openings 23 between the semitubes 22, thereby forming the perforated piston-like portion 20 of the aerator 5.

The flotation machine according to the present invention operates in the following manner.

Pulp is pressure-fed via the connecting pipe 3 (FIG. 1) to the compartment 2 of the machine, fills it and flows over to the flotation compartment 4 where it is subjected to vibration effect of the aerators 5. The latter vibrate under the effect of the vibration drive 14, and perform a reciprocating motion in a vertical direction.

The flaps 34 (FIG. 4) of elastic material provided on the piston-like portion 20 (FIG. 2) of the aerator 5 diverge during the downward stroke of the latter and close the openings 23, whereby is formed a continuous surface which creates an ascending flow of pulp enveloping the piston-like portion 20.

During the upward stroke of the aerator 5, said flaps converge to open the openings 23, the pulp being divided into descending flows P which pass through the openings 23 between the semitubes 22, at a plurality of points of each vibration aerator (FIGS. 1 and 4).

As a result of frequently repeated displacements (vibrations) of the aerators 5, there takes place suspension of even coarse-grained particles of sand from the bottom of the chamber 1. Simultaneously, air coming in then jets from the longitudinal slots 33 of the semitubes 22 is broken by the flaps 34 into small bubbles and mixed with suspended solid particles of material subjected to dressing in the pulp flows P.

Such a structural embodiment of the piston-like portion 20 of the aerator 5 helps attain a high degree of its

perforation (60 to 80 percent). As a result, less energy is required for vibrating the aerator 5 than is the case with the known aerators, and there takes place a simultaneous ejection of air by the jets of pulp so that it can be supplied to the pulp at a lower pressure.

As a result of intensive stirring and aeration, along the contour of the piston-like portion 20 there form ascending flows PB (FIGS. 1 and 4) of pulp saturated with mineralized finely dispersed bubbles rising to the surface of pulp and forming foam.

The products formed in the course of the flotation of pulp are removed in the following manner: foam through the compartment 11 to the connecting pipe 12, tailings through the gate valve 7 to the connecting pipe 8, and sands through the gate valve 9 to the connecting pipe 10.

In other embodiments of the flotation machine of the invention the piston-like portion 20 of the vibration aerators 5 can be provided with flaps 35 (FIG. 5) of elastic material paired in shaped interests with openings 36 for the outlet of air. Said inserts are inserted in parts 37 forming the piston-like portion of the aerator and having horseshoe-shaped cross-section.

In this case, the flotation machine operates in a manner analogous to that described hereinabove.

However, during the downward stroke of the vibration aerator 5 the flaps 35 of the inserts do not close the openings 36 for the outlet of air and, consequently, part of air is capable of returning and suspended particles can be carried by the flow of pulp to the openings 36, and the effectiveness of dispersion of the air bubbles can also be reduced.

Still, as shown by the tests, such inserts are convenient in manufacture and operation (they are hard to clog and easy to replace).

In order to improve the operation of the piston-like portion 20 of the aerator 5, inserts 38 (FIG. 6) of elastic material can be made with second flaps 40 adapted to close during the downward stroke of the aerator 5 openings 39 for the outlet of air.

In this case, the danger of clogging the openings 39 with solid particles will be obviated.

Such a design of the inserts helps increase the degree of dispersion of air bubbles. At the same time, an air cushion is formed under the flaps of the insert 38, biased from below by the pulp. This gas-liquid boundary serves as a source of formation of a finely-dispersed pulp-air mixture ejected with the flows of pulp in the course of vibration of the aerator 5.

With a view to providing an automatic intake of air in deep flotation machines, the piston-like portion 20 of the aerator 5 can be composed of parts made of channel bars 41 (FIG. 7) facing each other in pairs with their flanges. Flaps 42 are inserted between the upper flanges of said channel bars.

Valves 43 of elastic material are inserted between the lower flanges. The flaps 42 and the valves 43 are made as inserts.

In the lower flanges of the channel bars 41 provision is made of air outlet openings 44 closed by the valve 43 during the downward stroke of the aerator 5.

For the same purpose, the parts comprising the piston-like portion of the aerator 5 can be made of L-shaped beams 45 (FIG. 8) facing each other in pairs with their shorter flanges. Between the shorter flanges of the beams 45 three-flap inserts 46 of elastic material are inserted so that a middle flap 47 is arranged between said pairs of beams 45, forks downward and closes openings 48 for the outlet of air from the beams 45 defining the piston-like portion 20 during the downward stroke of the aerator 5, while the other two flaps close in the piston-like portion 20 of the aerator 5 the openings 23 (FIG. 2) for the passage of pulp.

Vertically extending partitions 49 (FIG. 8) in the form of strips or bars can be arranged in the piston-like portion 20 of the aerator 5 between its parts (semi-tubes, channel bars, beams, etc.) and alongside said parts. This will help increase the perforation coefficient of the piston-like portion 20 of the aerator 5 by way of increasing the distance between the parts (22, 37, 41, 45), as well as reduce the number of these parts.

The above-mentioned flaps can be provided with a thickening 50 (FIG. 8) at their ends. This will help increase their lateral and longitudinal strength.

For imparting longitudinal and lateral rigidity to the middle flap 47 (FIG. 8), the latter can have a rigid reinforcement 51.

Tests have shown the proposed flotation machine provided with vibration aerators to have an energy capacity two or three times lower than that of the mechanical or pneumomechanical flotation machines.

At the same time, the aerators are capable of raising in the flotation compartment of the machine chamber particles that are considerably larger then particles raised by the impellers of the mechanical and pneumomechanical flotation machines, while the wear of the aerators is practically negligible.

In addition, the dispersion ability of the vibration aerators with respect to air is considerably higher than that featured by the mechanical and pneumomechanical flotation machines.

In the operations of slime and sand flotation, the rate of flotation process is considerably higher than in the mechanical and pneumatic flotation machines.

The herein disclosed machine provided with a vibration aerator can be easily started after a prolonged period of inaction despite the presence in the flotation compartment of solidified precipitate, owing to intensive washing off of solid particles from the bottom of the machine bath.

We claim:

1. A flotation machine of the type having a chamber for aerating and agitating pulp, means for introducing the pulp into the chamber, air supply means, a vibrator for up-and-down movement, and means for removal of products separated from the pulp; said machine also having vibration aerator means in said chamber, comprising: rigidly interconnected ducts for distributing air from the supply means into the pulp through a plurality of air discharge openings in the ducts, means for spacing the ducts apart to provide a plurality of openings therebetween for flow of pulp between the ducts, means connecting said ducts with the vibrator for upward and downward strokes of the ducts through the pulp, and flaps of elastic material attached to each of said ducts and forking downwards therefrom so that flaps of mutually adjacent ducts close such openings between the ducts to the passage of pulp during the downward strokes and thereby provide a plurality of large piston-like portions of the vibration aerator during the downward strokes, and that they open said openings between the ducts for the passage of pulp in the course of the upward strokes and thereby reduce

said piston-like portions to allow said flow of pulp during the upward strokes.

2. A flotation machine as set forth in claim 1, wherein said piston-like portions of each of the aforementioned aerators are composed of parts having a semitubular cross-section alongside whose walls are secured said flaps of elastic material said flaps being made forking downwards and being constructed and adapted, during the downward stroke of the aforementioned aerator, to simultaneously close the openings for the passage of pulp provided in said piston-like portion and the openings for the outlet of air.

3. A flotation machine as set forth in claim 1, wherein the aforementioned piston-like portions of each said aerator are composed of parts having a horseshoe-shaped cross-section, said flaps of elastic material being secured thereto in pairs to form shaped inserts provided with said openings for the outlet of air.

4. A flotation machine as set forth in claim 1, also including rigid vertically extending partitions in the form of strips arranged between said parts comprising the aforementioned piston-like portions of the aerator and alongside said parts.

5. A flotation machine as set forth in claim 1 wherein each of said rigidly interconnected ducts comprises elastic structure to provide said flaps and rigid structure at least partly inserted in said elastic structure to locate said flaps and said air discharge openings relative to one another.

6. A flotation machine as set forth in claim 5 wherein said rigid structure of each duct comprises a pair of structural parts, one facing the other and both being constructed and adapted to define said air discharge openings therebetween.

7. A flotation machine as set forth in claim 5 wherein said elastic structure of each duct comprises a body portion and three members forking downwards therefrom, two of them providing said flaps and the third being disposed therebetween and constructed and adapted to secure said rigid and elastic structures to one another.

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