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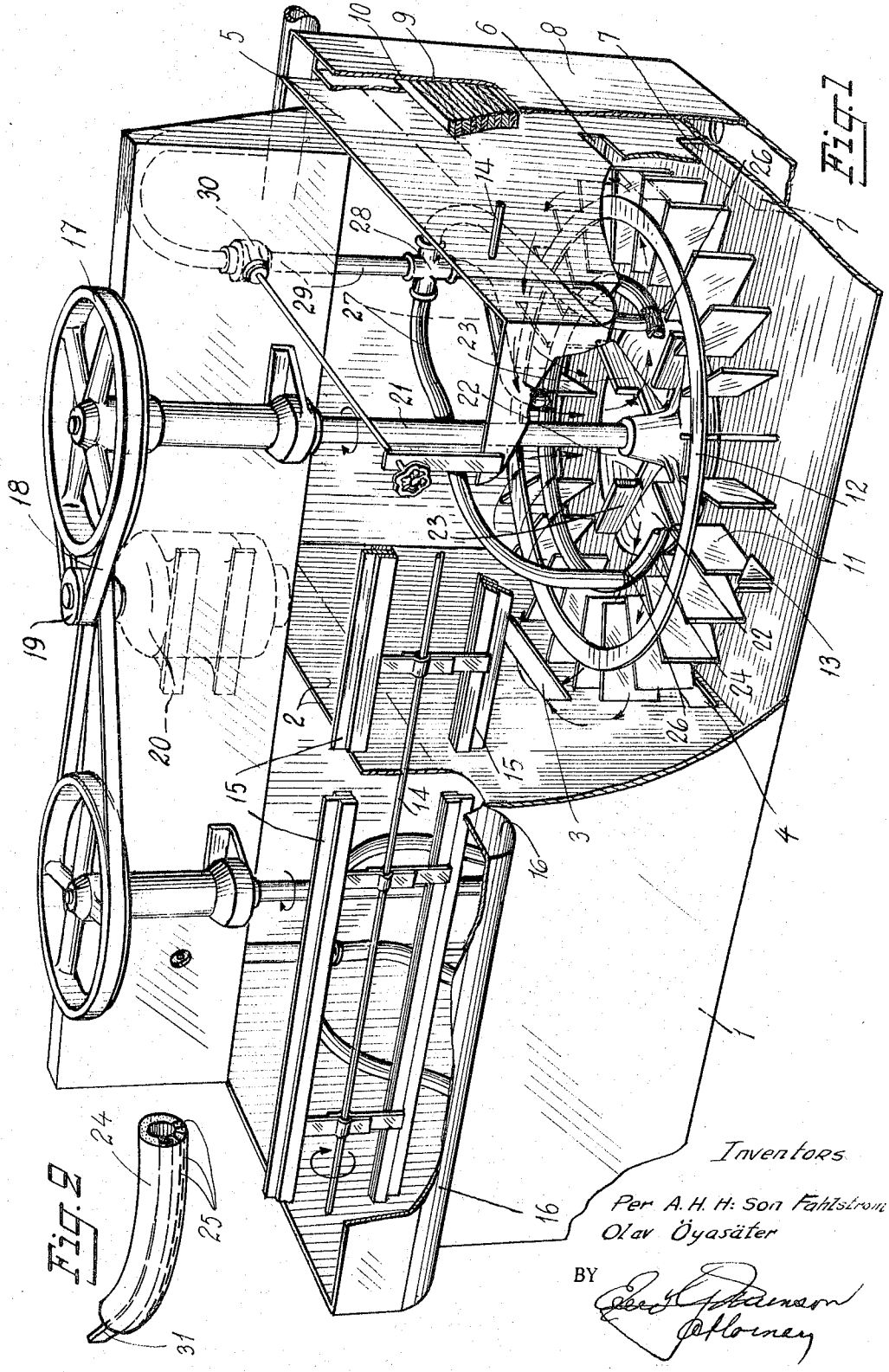

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APPARATUS FOR FROTH FLOTATION

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In froth flotation air is introduced in finely divided form into an aqueous suspension of finely ground material, hereafter called pulp, by means of an aeration device. The air bubbles thus formed rise through the pulp and carry out the actual work of flotation.

It is known how to design the aeration device as an agitator, consisting of a disc attached to a vertically mounted shaft, the upper side of the disc being provided with a number of blades with or without notches between them. Outside the agitator there are, as a rule, radially placed stationary discs or baffles which form an angle with the radial direction in order to counteract the rotation of the pulp. The air fed to the pulp between the said agitator and a disc securely attached to the outside of the agitator, is either sucked in because of the centrifugal action at the blades or, when greater quantities of air are required, it is also fed under positive pressure from an air compressor, is dispersed in the pulp partly through the mixture of air and pulp being struck against the blades, partly through the said mixture being ejected from the agitator and pressed between the surrounding discs or baffles.

Although apparatuses of this kind are among the most effective, it is a disadvantage with such aeration devices that the air bubbles formed cannot be reduced to the size desired and that the air distribution and the maximum permissible amount of air are limited.

The present invention relates to an apparatus for froth flotation in which the above mentioned disadvantages are considerably reduced, a better and more effective dispersion and distribution of the air feed being obtained at the same time that the amount of air fed to the pulp is, per unit of volume, substantially increased, resulting in a more selective operation in the apparatus.

The froth flotation apparatus according to the invention is of the type consisting of a trough provided with inlets for the pulp intended for flotation, outlets for tailing, and an overflow for concentrate; an agitator attached to a vertically mounted shaft in the trough, comprising a substantially circular horizontal disc which on its upper side is provided with radial or helical blades; a stationary baffle device secured around the agitator; and an air-feeding device for injecting and finely dispersing the air in the pulp. The apparatus in the invention is characterised in that the air-feeding device comprises a number of annularly arranged dispersers, the dispersers being located between the outer ends of the blades and the inner sides of the baffles for the purpose of injecting air vertically into the pulp.

In an embodiment of the invention the air dispersers are arranged in a ring coaxially with the rotor shaft in a horizontal plane above the plane of the disc and arranged to eject the air substantially vertically downwards at right angles to the pulp ejected by the blades.

The air dispersers are preferably in the form of slots taken up in the longitudinal direction of a ring-shaped tube made of an elastomeric material, e.g. soft rubber. The ring is secured in the apparatus preferably by a stiffening band of a rigid ductile material e.g. hoop iron, vulcanized into the ring, by means of which band the shape and position of the ring are maintained. The ring is so

placed between the agitator and the baffle device that the main part of the pulp ejected by the blades of the agitator is forced to pass it, the air being blown out from the dispersers flowing at right angles to the pulp which is quickly flowing horizontally outwards. This has proved to be of fundamental significance for maintaining an effective distribution of air with small bubbles.

The invention will be further explained in the following with reference to the attached drawings which illustrate diagrammatically an embodiment of the invention, and in connection with this, further characterising qualities of the invention will be set forth.

FIG. 1 is a diagrammatic perspective view of a froth flotation apparatus according to the invention, and

FIG. 2 shows a detail of an air disperser.

The froth flotation apparatus according to the invention consists of a trough **1** in the form of a box-shaped container suitably made of sheet steel with a level square bottom and vertical walls. In one of the side walls **2** of the trough there are an upper and a lower inlet, **3** and **4** respectively, for the pulp intended for flotation. The upper inlet **3** is intended for feeding the finer-grained and preferred part of the pulp, while the lower inlet **4** is intended for feeding the more coarsely grained part which contains the coarser and more quickly sedimenting grains. In a corresponding manner there are an upper and a lower outlet **6** and **7** respectively, in the wall **5** opposite wall **2** for non-floated material, the upper outlet **6** being intended for discharging the finer-grained pulp and the lower outlet **7** for the more coarsely grained pulp.

Outside the second wall **5** there is an outlet box **8** with an overflow device of known construction comprising a recess **9** and loosely inserted weir bar **10**, by means of which the level of the pulp in the flotation trough can be adjusted to the desired height. Furthermore, the froth flotation apparatus is provided with a baffle device comprising a curb of stationary, vertically standing baffles **11** the upper edges of which are welded to an iron ring **12** above the baffles. Alternatively, the baffles can be welded to such an iron ring by their lower edges, or an iron ring can be attached to both the upper and lower edges of the baffles. The baffle device rests at a number of points or brackets **13** and is held together by the iron ring **12**. Both the baffles **11** and the iron ring **12** can with advantage be covered with rubber. In the upper part of the flotation tank, near the front wall, one or more scrapers **15** are attached to a horizontally mounted shaft, arranged so as to carry away the column of froth gathered upon the pulp level to an adjacent discharge channel **16**. The shaft **16** is driven over a countershaft transmission **17, 18, 19** by an electric motor **20**. The apparatus as described thus far is in its main parts already known.

An agitator is attached to the lower end of a vertically mounted shaft in the flotation trough, comprising a circular, horizontal disc **22**, the upper side of which is provided with radial or helical blades **23**. The inner edges of the above mentioned baffles **11** lie along the periphery of a circle the diameter of which is sufficiently greater than the outer diameter of the disc **22** for a circular space to be formed between the disc **22** and the inner edges of the baffles **11**. In the invention a number of air dispersers for the vertical injection of air into the pulp have been arranged in this circular space above a plane in the radial extension of the disc. The diffusers are suitably given the form of slots **25** (FIG. 2) in the longitudinal direction of an annular tube **24** made of elastomeric material. The ring **24**, which suitably consists of soft rubber, is placed with its under part lying very close, but not at a tangent to, a plane which can be considered to lie on the upper edges of the blades. The ring **24** is suitably divided into three different sections bound together by T-junctions **26**. Flexible tubes **27**, which are

connected to a compressed air tube 29 with a stopcock 30 via a branch tube 28, are coupled to the T-junction. An iron band 31 is vulcanized to that part of the rubber ring 24 which is turned outwards towards the baffles 11, the end of the iron band extending beyond the tubing part in each section of the ring. These free ends of the iron band are bent radially outwards at an angle of 90° and provided with apertures for securing the ring in the baffle device in such a way that each pair of the outwardly bent ends of the iron band clasp a baffle which is provided with a corresponding aperture, the parts being fastened together by means of wedges.

The slots are so made in the rubber tubing that they are sealed by the rubber's elasticity as long as positive pressure does not prevail inside the tubing but are opened by air under positive pressure.

A suitable outer diameter of the rubber tubing is between 50 and 100 mm. and the thickness of its walls between 7 and 20 mm. The tubing 27 can display one single long slot or several slots in a row which for example have a length of between 7 and 20 mm. Likewise, two or three or possibly more parallel lines of such slots can be used to advantage.

The way in which the flotation apparatus operates is as follows:

When the agitator 22 with the blades 23 are rotated by the shaft 21, pulp is ejected from the agitator by centrifugal action against the baffles 11. With a suitable angle between the baffles 11 and the radius of the agitator, the rotation of the pulp compelled by the agitator is counteracted. Instead, a flow directed vertically upwards along the wall of the apparatus is obtained, which passes into a horizontal flow in towards the rotor shaft. Here pulp is sucked in anew and describes a new path through the air disperser as shown by the arrows in FIG. 1. Because of the position of the ring 24 close to the agitator 22, the main part of the pulp mass ejected from the agitator is forced to pass straight through the curtain of air bubbles. Bubbles and floatable particles are brought into contact with each other mainly in the zone outside the tubing and between the baffles. During the vertical and horizontal recirculation of pulp to the rotor, the air-borne particles rise out of the pulp and reach up to the froth zone of the apparatus where they are transmitted to the discharge channel 16. The compressed air that is fed to the air distribution device through the pipe 29, the amount of which is regulated by the valve 30, is distribluted by means of the junction piece 28 through the tubes 27 to the T-junctions 26. An even distribution of air to the ring 24 is thereby attained. The air is fed to the pulp through the slots 25 on the underside of the ring when the pressure of the air inside the ring exceeds the opening pressure of the slots and the counter-pressure of the pulp. When the air pressure inside the tubing drops because, for example, the air compressor stops working, the slots are sealed because of the resiliency of the ring whereby the pulp is prevented from penetrating into the ring.

The air is introduced into a zone between the blades 23 and the baffles 11, at right angles to the quickly and horizontally flowing pulp. Because of the previously described vertically-horizontally circulating flow of pulp which arises with the agitator and baffles being so constructed, the pulp passes the air dispersing zone several times during its passage through the flotation trough 1. An effective distribution of air is hereby attained. The prior conditions for this are that there is pulp and that this is fed to the aeration device in such quantity that all the air can be carried away finely suspended in the pulp. This in turn implies that the finer the bubbles that are desired the greater the volume of pulp that must circulate through the air disperser. By feeding a large quantity of pulp to the agitator an effective agitation of the pulp is obtained which prevents the settling of the material in the flotation trough, even if the pulp is very coarsely

grained. In order to reduce wear and tear on the agitator and the baffles these are covered with rubber in a known way. By vulcanizing the securing and stiffening device for the ring 24, i.e. the iron band 31, to that part of the ring which is turned towards the baffles, wear and tear on this are completely avoided. The circulation of pulp in the apparatus can be varied by choosing a suitable blade-height and r.p.m. of the agitator.

Several trials have been carried out with the froth flotation apparatus shown in FIG. 1, in which the mode of operation of the apparatus was compared with that of an apparatus designed in accordance with the Swedish patent specifications 142,927 and 148,136. During the comparison the trial conditions were exactly the same. Typical operation results from flotation treatment of different starting materials have been collected in Tables 1–3. In these the froth flotation apparatus with the air dispersal device as in the invention is called "Apparatus I" and the apparatus with air dispersal device of conventional type "Apparatuas II."

TABLE 1

[Starting material: Feed to copper-lead-co-flotation]

	Percent	
	Cu	Pb
Period I:		
Feed	1.44	1.42
Concentrate Apparatus I	16.0	12.7
Concentrate Apparatus II	9.5	11.6
Tailing Apparatus I	.78	.89
Tailing Apparatus II	.99	1.01
Period II:		
Feed	1.74	1.42
Concentrate Apparatus I	14.7	11.8
Concentrate Apparatus II	13.3	10.9
Tailing Apparatus I	1.18	0.96
Tailing Apparatus II	1.24	1.06

TABLE 2

[Starting material: Feed to copper flotation]

	Percent Cu
Period I:	
Feed	1.23
Concentrate Apparatus I	11.8
Concentrate Apparatus II	9.4
Tailing Apparatus I	0.76
Tailing Apparatus II	0.93
Period II:	
Feed	1.39
Concentrate Apparatus I	16.3
Concentrate Apparatus II	10.5
Tailing Apparatus I	.99
Tailing Apparatus II	1.03

TABLE 3

[Starting material: Tailing from zinc flotation]

	Percent Zn
Period I:	
Feed	.24
Concentrate Apparatus I	4.65
Concentrate Apparatus II	2.14
Tailing Apparatus I	.21
Tailing Apparatus II	.22
Period II:	
Feed	.27
Concentrate Apparatus I	2.13
Concentrate Apparatus II	.95
Tailing Apparatus I	.18
Tailing Apparatus II	.18

The results show that the froth flotation apparatus of the invention, i.e. Apparatus I, gave both a higher proportions of concentrate and a lower proportions of tailing than Apparatus II with the conventional air dispersal device, and that consequently a clearly greater degree of selectivity is attained with the former apparatus.

Only one example of the construction of a froth flotation apparatus according to the invention has been shown

in this description. Constructions which lie within the compass of the invention are for example:

(1) An agitator which provides a horizontally outward-directed pumping action, e.g. conical discs provided with blades;

(2) Annular tubing made of rubber or other material that can be vulcanized, with slots cut after vulcanization as well as being formed before vulcanization. A single continuous slot as well as one or more rows of longer or shorter slots can be used;

(3) Annular tubing of stiff or elastic material, provided with a number of spray nozzles; and

(4) Baffle device comprising a number of vertically placed, radial baffles, a obliquely placed or curved baffles in relation to the radial direction.

What is claimed is:

1. In a froth flotation apparatus having a tank, inlets for the pulp intended for flotation, outlets for the tailing, an overflow for the froth, and a means for circulation and aeration of the pulp in the tank, the improvement wherein said means comprises:

a disc type agitator in said tank rotating about a vertical axis, said agitator moving the pulp which is adjacent thereto in a uniform, substantially horizontal, radial stream outwardly from the center of the agitator and beyond the peripheral edge thereof;

a plurality of baffles fixed relative to said tank, said baffles being uniformly distributed around and spaced from said agitator, and positioned at substantially the same level as the agitator so as to intercept the substantially horizontal, radial stream of pulp therefrom;

a ring-shaped air feeding element substantially coaxial with said agitator and said baffles, said element in a radial direction being positioned between said baffles and the periphery of said agitator, but in an axial direction being offset from said agitator, said ring-shaped element further having air feeding openings spaced entirely therearound which are directed toward a plane coincident with the plane of said agitator so as to direct a uniform curtain of air substantially perpendicular to the flow path of the radial stream of pulp from said agitator;

said intersecting air and pulp flow paths and the action of the fixed blades achieving an intimate and highly efficient mixture of air and pulp within the tank.

2. Apparatus according to claim **1**, characterized in that the disc type agitator consists of a substantially circular, horizontal disc, the upper side of which is provided with radial blades.

3. Apparatus according to claim **1**, characterized in that the air feeding element has the form of an annular tube made of an elastomeric material such as soft rubber, provided with rows of short slots in the longitudinal direction of the tube.

4. Apparatus according to claim **1**, characterized by the fastening of the elastomeric air feeding element in the apparatus by attachment to a rigid ring of ductile material such as iron, vulcanized to the said air feeding element.

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