

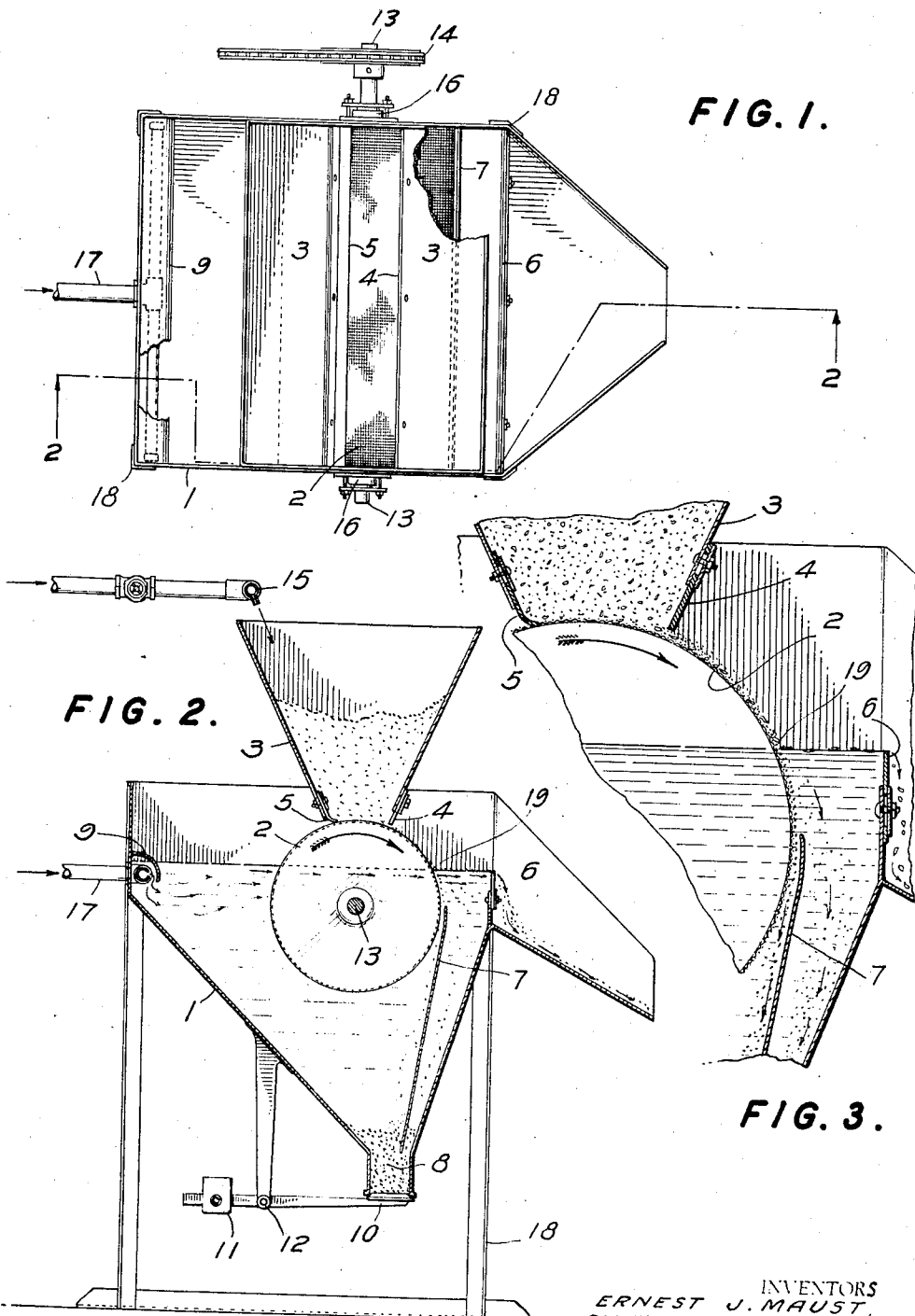
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FILM FLOTATION

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INVENTORS
ERNEST J. MAUST
CLINTON A. HOLLINGSWORTH,

John W. Lee
ATTORNEY.

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FILM FLOTATION

Ernest J. Maust and Clinton A. Hollingsworth,
Brewster, Fla., assignors to American Cyan-
amid Company, New York, N. Y., a corporation
of Maine

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The present invention relates to improved apparatus and process for the concentration or separation of ore materials by film flotation.

One of the well-known processes of recovering values from ore materials is by the adoption of the film flotation principle in which the surface tension of water is taken advantage of to selectively float certain ore constituents while other ore constituents not supported by the surface film sink. The concentrating of ore materials by film flotation is most frequently employed for concentrating ore materials of a relatively coarse size range, for example the process is usually adopted to effect a classification of ore materials ranging in size from a minus 10 mesh to about a plus 28 mesh. Ore materials falling within this size range represent a rather coarse or awkward fraction which cannot be profitably concentrated by the ordinary flotation methods or in which the reagent cost would be too high for froth flotation.

According to the present invention an improved apparatus and process is provided for depositing ore materials on the surface of liquids and effecting a separation of the ore constituents by the film flotation principle.

While the present invention can be applied to the film flotation of either metallic or non-metallic ore materials, it has been found to be particularly well-suited for the concentration of materials such as phosphate rock. We do not desire, however, to limit the present application to the film flotation of phosphate rock or silica in the phosphate industry and it can be applied to various other material, for example concentration of iron ore, cleaning of coal, the classification of cement rock, bauxite, graphite, feldspar, kyanite, barytes chromite, and also the various metallic ore materials.

The improved apparatus and process of the present invention is particularly well suited for the concentration of the B. P. L. values from phosphate rock in which the particles are coarser than 28 mesh. This coarse fraction of phosphate rock cannot profitably be concentrated by froth flotation. When attempting to concentrate by froth flotation, if enough reagents are added to effectively float these coarse particles, usually the finest portion of the gangue is also floated, and thus a low grade concentrate is produced. When the finer particles are separated from the coarse particles and the coarse fraction is subjected to a froth flotation treatment, an excessively large amount of reagent is required. Even with the excessive and expensive amount of reagent used on this coarse fraction in froth flotation, it is still difficult to obtain satisfactory recovery, since in the absence of the finer particles it is very difficult to maintain a stable froth.

It is an advantage of the preferred embodiment

of the present invention, therefore, that the B. P. L. values from the coarser fractions of phosphate rock are obtained in higher yields of improved grade and with a lower reagent cost than by froth flotation methods.

The improved film flotation machine of the present invention also offers advantages over other methods of film flotation such as concentrating tables, vanners, etc., in that the initial cost is lower, less floor space, operating attention, and power is required, reagents cost is lower, and a coarser fraction can be recovered.

In carrying out the present invention the ore materials or particles are distributed upon the surface of a perforated drum, cylinder, revolving belt or the like, which upon rotation dips beneath the surface of a separating medium, usually water, while causing water to flow through the perforated roll or belt so that the water meets the particles from beneath at the point of contact with the surface of the separating medium, to gently deposit the particles upon the surface of said separating medium, whereupon certain particles are supported by the surface film and may be separated from those particles which are not supported by the surface film, and hence sink. The ore materials prior to deposition on the perforated roll or belt may be treated with various reagents to render some of the ore constituents more readily floatable than other ore constituents and in this manner effecting a preferential film of one or more of the ore constituents. For example, in the recovery of the values from phosphate rock, the material if treated with a reagent mixture of fatty acid, fuel oil and caustic soda will result in the phosphate particles being floated while the silica sinks, or if treated with a cationic wetting agent will result in the silica being more readily floatable than the phosphate particles.

The improved apparatus of the present invention is illustrated by the following drawing in which:

Fig. 1 is a top plan view of the improved apparatus partly in section;

Fig. 2 is a vertical sectional view taken along the line 2—2 of Fig. 1; and

Fig. 3 is a view similar to Fig. 2 on an enlarged scale showing a portion thereof.

In the drawing like reference numerals indicate corresponding parts in the different figures.

A retaining tank 1 which is preferably of the construction shown, namely, of a general triangular shape from the side view, and supported by a suitable framework 18, and a perforated roll or cylinder 2 is shown positioned in the upper portion of the tank underneath a feed hopper 3. The retaining tank has a water inlet 17 located behind a shield 9 and on the opposite side an overflow lip or adjustable overflow weir 6. A baffle 7 is shown positioned in the retaining

tank intermediate the perforated drum or cylinder 2 and the adjustable overflow weir 6 in such a manner that water must pass through the perforated roll in order to reach the overflow 6. The bottom of the retaining tank is normally closed by a valve 10 held in position by a weight 11 acting upon a pivot 12. The feed hopper 3 is shown mounted above the perforated roll 2 and has a rubber guard 5 and an adjustable rubber feed lip 4. The rubber guard 5 and the adjustable feed lip 4 are positioned with respect to the perforated roll 2 in such a manner that rotation of the roll results in ore materials contained in the feed hopper being deposited or fed onto the roll in a layer approximately one particle thick. Referring now particularly to Fig. 1, the perforated roll is shown mounted on a shaft 13, rotatably mounted on the retaining tank 1 by means of the bearings 16. A sprocket drive wheel 14 is shown mounted on one end of the shaft 13 which is adapted to be driven by means of a sprocket chain from a suitable source of power (not shown).

In utilizing the improved apparatus for concentrating ore materials the ore material preferably ground to approximately minus 10 to plus 28 mesh is placed in the feed hopper 3. The perforated roll 2 is rotated by means of the sprocket 14 and shaft 13, whereupon a thin layer of the ore particles is deposited upon the upper surface of the perforated cylinder. The perforations of the cylinder are of a size that substantially none of the solids pass through them but through which water flows freely. Water is fed into the retaining tank behind the shield 9 and flows toward the overflow lip 6 whereupon the baffle 7 causes the water to pass through the perforated roll. As the solid particles on the perforated roll reach the point 19, water passing through the roll contacts the solid particles at this point and gently deposits the particles upon the surface of the water, whereupon certain of the ore constituents which are readily wettable sink and are collected as the tailings 8 in the bottom of the retaining tank. The ore constituents that are not readily wettable are supported by the surface film and are carried over the overflow lip 6 and may be collected by any suitable method. The particles that sink to the bottom of the retaining tank are collected as shown at 8 until the weight of such particles is sufficient to overcome the effect of the weight 11 to open the discharge valve 10, the arm of which is pivoted at 12. Material is discharged until the weight 11 again closes the valve. Water may conveniently be added to the feed by means of a spray 15 located about the feed hopper.

One of the important features of this improved apparatus is the manner in which the adjustable rubber feed lip 4 operates to deposit a uniform layer of approximately one particle thick upon the surface of the perforated cylinder. It is readily seen that if the material is fed onto the perforated roll in too thick a stream or layer, and thence onto the surface of the separating medium, the particles that one wishes to sink are carried mechanically over with the particles one wishes to float. In order to obtain the full capacity of the apparatus the entire length of the feed roll along the surface should be covered at all times with a one-particle layer of the particles. The adjustable rubber feed lip can be regulated to produce this desired effect much more efficiently than an ordinary fixed or rigid feed opening.

Another advantage of the rubber feed lip is that stray particles, coarser than the opening between the lip and the perforated roll when present in the feed do not clog the opening. With a rigid lip these stray coarse particles would accumulate and clog the small opening, that has to be maintained, which would result in a loss of production and possible damage to the machine. With the adjustable rubber feed lip the opening between the lip and the perforated roll can easily be adjusted to deposit a layer of the desired thickness onto the perforated roll and when a stray coarse particle comes along, it pauses a moment at the lip, and then due to friction contact with the roll and other particles the rubber lip flips open and the coarse particle is discharged. Without the rubber lip the machine would require constant operating attention with possible failure in operation, whereas with the rubber lip it operates with very little attention to insure the most efficient and desirable results.

The relationship of the rubber lip and the perforated roll are such that in spite of the small opening the capacity of the apparatus compares favorably with machines of the prior art. The capacity of the small opening is compensated for by the speed at which the roll operates. The speed is variable and can be adjusted to obtain the maximum recovery from a particular ore and without danger of the machine clogging or choking.

Another operating feature is the use of a small amount of water with the feed. The feed is more evenly and properly distributed on the roll when a small amount of water is added to the feed hopper. The amount of water to be added will vary with different materials and the spray located above the feed hopper can be very conveniently regulated to insure the correct amount as the character of the ore or other conditions change.

Still another important operation feature is the regulation of the amount of water that passes through the perforated roll. When a high grade concentrate is wanted, the rate of water flow is reduced, thus giving the gangue more time to drop out. When the speed of the roll is increased or decreased, the character of the feed, or the reagents altered, the water flow can be regulated to produce the maximum recovery under the altered conditions.

The following examples illustrate the operativeness of the present invention when utilized in concentrating phosphate rock.

EXAMPLE 1

A phosphate rock feed of -10 mesh with about 15% passing through 20 mesh was conditioned with a reagent mixture of a fatty acid, fuel oil, and caustic soda and subjected to a film flotation operation utilizing the improved apparatus of the present invention. The results were as follows:

Floating phosphate

	B. P. L.	Insol.
Feed.....	60.97	
Concentrate.....	76.65	5.90
Tails.....	14.90	
Ratio.....		1.34
Recovery.....		93.8%

EXAMPLE 2

A second sample of the phosphate rock described in Example 1 was pretreated with a cationic wetting agent to render the phosphate more readily wettable than the silica, and the silica was floated using the improved apparatus of the present invention. The results of the silica flotation are as follows:

Floating silica

	B. P. L.	Insol.
Feed.....	66.41	-----
Concentrate.....	77.22	3.95
Tails.....	13.21	-----
Ratio.....	-----	1.20
Recovery.....	-----	96.9%

The grade and recoveries in the above examples were not only good but the reagent cost and consumption were also well below the economical limit for such an ore.

While the examples relate to the utilization of the improved apparatus and process of the present invention in connection with phosphate rock, and which represents a preferred embodiment of the invention, the invention is not limited thereto, and may be employed to concentrate any ore material, whether metallic or non-metallic.

We claim:

1. A film flotation apparatus comprising a liquid retaining tank having an overflow lip and means for introducing water into said tank, a horizontally rotatable perforated cylinder positioned in the upper central portion of the tank and parallel to the overflow lip, said cylinder be-

ing partially immersed in water when the retaining tank is filled to overflowing, a feed hopper located above the perforated cylinder, said cylinder forming the bottom of the hopper, and having an adjustable flexible feed lip engaging the cylinder for depositing solid materials in a thin layer upon the upper surface of the perforated cylinder, a baffle extending from a point below the water level immediately adjacent the perforated cylinder causing water flowing toward the overflow lip of the tank to pass through said perforated member and co-acting with the overflow lip to create a zone in the tank in which there is no upward current of water.

2. A film flotation apparatus comprising a liquid retaining tank having a water inlet on one side and an overflow lip on the opposite side, a horizontally rotatable perforated cylinder positioned in the upper central portion of the tank, and parallel to the overflow lip, said cylinder being partially immersed in water when the retaining tank is filled to overflowing, a feed hopper located above the perforated cylinder, said cylinder forming the bottom of the hopper, and having an adjustable rubber feed lip engaging the cylinder for depositing solid particles in a thin layer upon the upper surface of said perforated cylinder, and a baffle extending from a point below the water level immediately adjacent the perforated cylinder causing water flowing toward the overflow lip of the tank to pass through said perforated member and co-acting with the overflow lip to create a zone in the tank in which there is no upward current of water.

ERNEST J. MAUST.

CLINTON A. HOLLINGSWORTH.