June 14, 1938. E. W. WILKINSON 2,120,535

CONCENTRATION OF MINERALS

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Fig. 1.

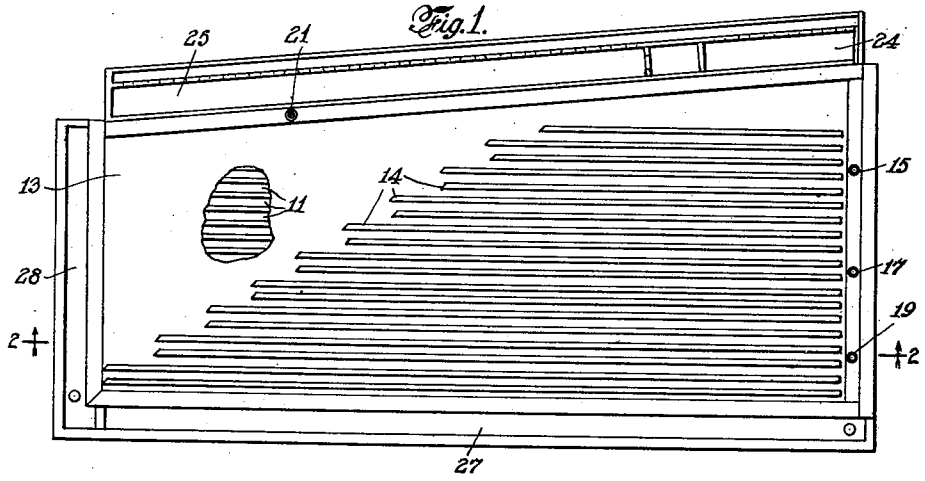


Fig. 2.

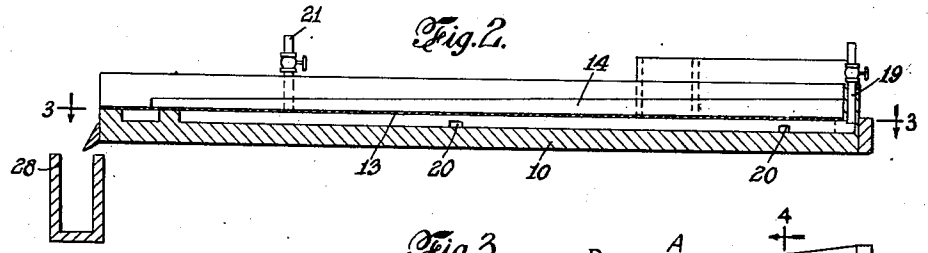


Fig. 3.

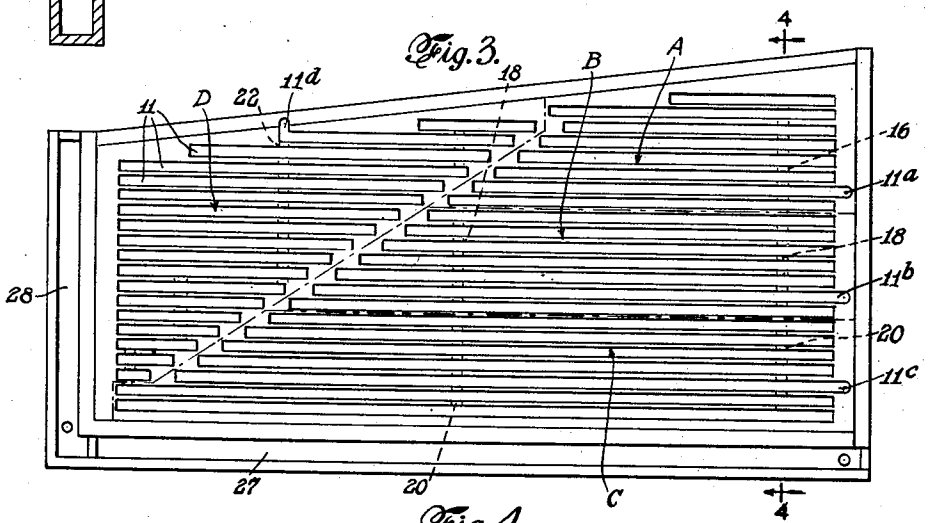
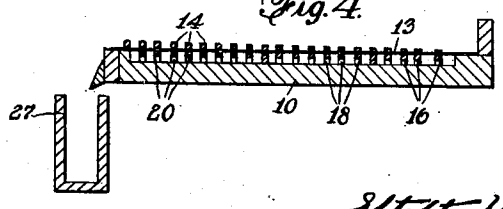


Fig. 4.



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Fig. 5.

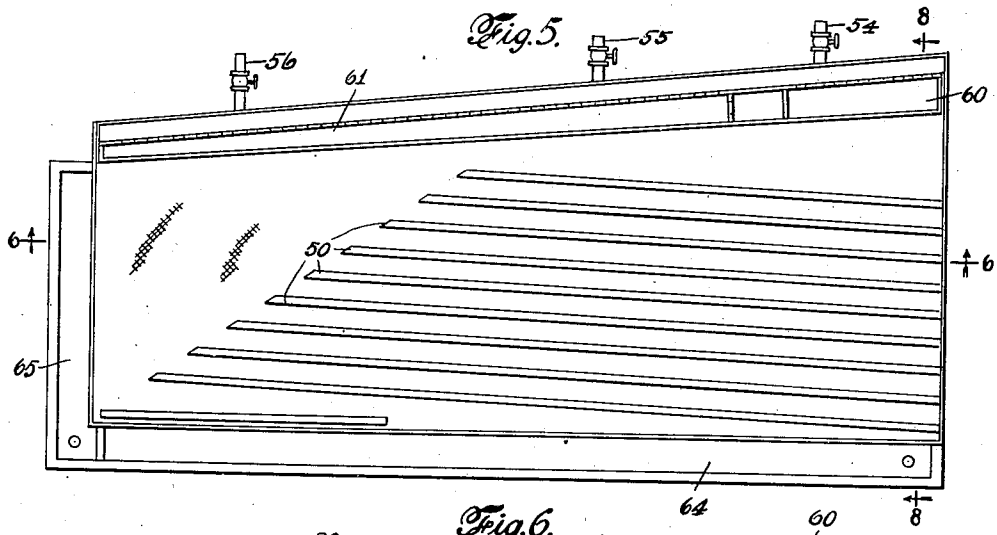


Fig. 6.

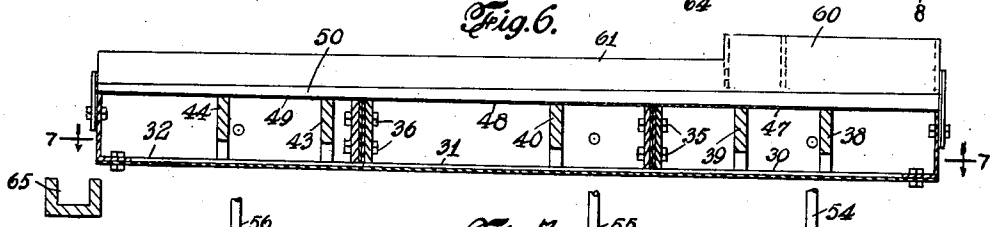


Fig. 7.

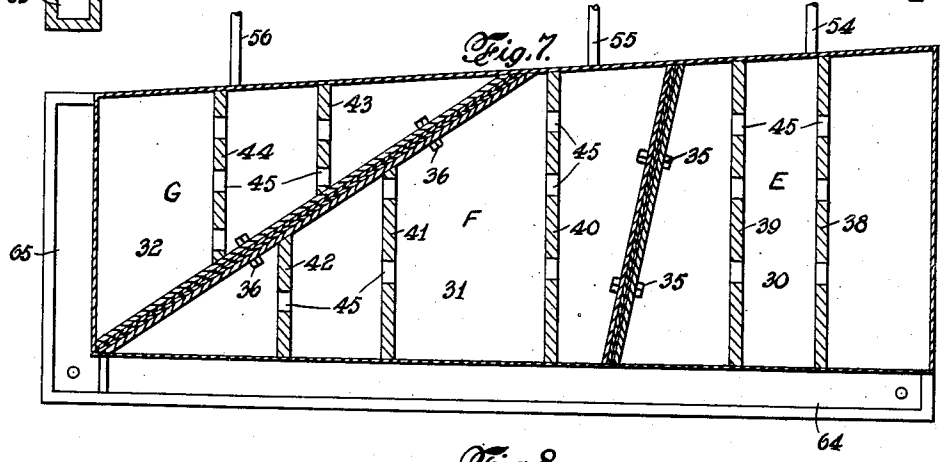
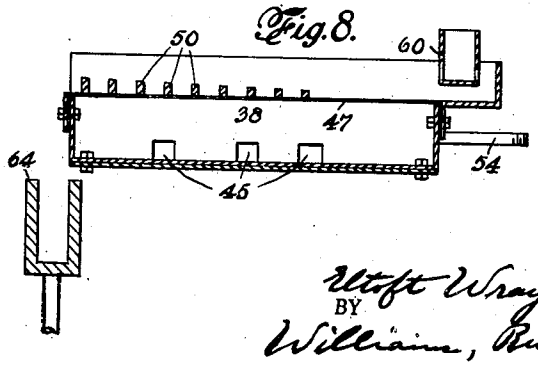


Fig. 8.



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UNITED STATES PATENT OFFICE

2,120,535

CONCENTRATION OF MINERALS

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Application December 21, 1936, Serial No. 116,866

2 Claims. (Cl. 209—49)

This invention relates to the concentration of non-sulphide minerals. It has been found to be particularly useful in the concentration of phosphate-bearing material, but it is not to be regarded as limited in usefulness to that material, since it is also usefully applicable to the following minerals: Cassiterite, copper carbonate, beauxite, manganese oxide, iron oxide, barytes, lead carbonate, zinc carbonate and zinc silicate, as is true of the process described and claimed in United States Letters Patent to George Albert Chapman and John W. Littleford, No. 1,968,008, issued July 24, 1934.

The invention may be regarded as an improvement upon the process described and claimed in the aforesaid Letters Patent to George Albert Chapman and John W. Littleford. As explained in that patent, when the process of that patent is employed for concentration of phosphate-bearing material, with the use of a shaking table, many phosphate particles float on the water surface as a skin or film float and are carried off into the concentrates launder by the stream of water flowing transversely across the table; and other phosphate particles, many of them in flocks associated with air bubbles, form aggregates or loosely bonded agglomerates and, in suspension in the water, or resting lightly on the silica or other impurities, are carried transversely across the table into the concentrates launder by the transversely flowing stream of water; while the silica or other impurities settle on the table between the riffles and, owing to the endwise movement of the table, pass off the table at or near the end thereof.

The present invention is the result of the discovery that if a mineral pulp, which has been suitably conditioned with agents promoting the formation of skin-floated particles and loosely bonded agglomerates of particles, for example in the manner described in the aforesaid Chapman & Littleford patent, is aerated by passing air upwardly through it during its treatment upon a shaking table or equivalent apparatus, then the production of the skin or film float and of the loosely bonded agglomerates is greatly facilitated, with the result that a greatly increased amount of material to be treated may be fed to the shaking table or equivalent apparatus per unit of time, with satisfactory results so far as the grade and the recovery of the phosphate or other material are concerned. This is equivalent to saying that the amount of material which may be treated in a given time, upon a table or equivalent apparatus having a given area, may be greatly increased by the use of the present invention.

While each of the forms of the apparatus hereinafter described for practicing the present invention is essentially a shaking table provided with a porous deck through which air passes upwardly into the pulp and water flowing across it, it is to be understood that the invention may be practiced with other forms of apparatus.

The invention will be understood from the following description of it, taken in connection with the accompanying drawings in which are illustrated two forms of shaking table by the use of which the process may be practiced. Referring to the drawings, Fig. 1 is a plan view of one form of shaking table deck which may be used in practicing the invention; Fig. 2 is a sectional elevation of said deck on the line 2—2 of Fig. 1; Fig. 3 is a sectional plan view of said deck on the line 3—3 of Fig. 2; Fig. 4 is a sectional elevation of said deck on the line 4—4 of Fig. 3; Fig. 5 is a plan view of another kind of shaking table deck which may be used in practicing the invention; Fig. 6 is a sectional elevation of said deck on the line 6—6 of Fig. 5; Fig. 7 is a sectional plan view of said deck on the line 7—7 of Fig. 6; and Fig. 8 is a sectional elevation of said deck on the line 8—8 of Fig. 5. Like parts are referred to throughout the drawings by the same or similar reference characters.

It will be understood that the table decks illustrated in the drawings are supported so as to permit adjustment of their transverse inclination, and are reciprocated longitudinally, by any well known means, which it is unnecessary to illustrate.

Referring first to Figs. 1 to 4, the bottom or base portion of the deck, shown at 10, may be made of wood or other suitable material. In the top of the base 10 are channels 11, the form and arrangement of which are shown in Figs. 2, 3 and 4. These channels may be cut or otherwise formed in the base 10, or may be formed by ribs secured to the base. Stretched over and secured to the base 10 over the channels 11, is a porous medium such as a sheet of canvas 13. On the top of the canvas 13 and secured thereto, preferably on top of the ribs beneath it, are riffles 14. In order that the air which is fed under pressure to the channels 11 beneath the porous medium 13 may be suitably controlled, the channels 11 are divided into groups or zones to each of which the compressed air may be separately fed. The groups or zones into which the table deck is thus divided are bounded by the dot-and-dash lines in

Fig. 3; and, for convenience of reference, the various zones are lettered A, B, C and D. It will be apparent from Figs. 2, 3 and 4 that air entering the pipe 15, leading to one of the channels 11a in zone A, can pass from that channel into the other channels in that zone through openings 16 in the bottoms of the ribs thereof; that the air entering zone B, through the pipe 17, is free to pass from the channel 11b with which that pipe 17 connects to the other channels in that zone, through the openings 18 in the bottoms of the ribs in that zone; that the air entering zone C through the pipe 19 is free to pass from the channel 11c with which that pipe 19 connects to the other channels in that zone, through the openings 20 in the bottoms of the ribs of that zone; and that the air from the pipe 21, communicating with one of the channels 11d of zone D, is free to pass from that channel into the other channels of that zone, through the openings 22 at the bottoms of the ribs of that zone. The usual feed box is indicated at 24; and the usual water-distributing box is indicated at 25. Along the lower side of the table deck is the concentrates launder 27; and along the end of the table deck is the tailings launder 28.

The table deck illustrated in Figs. 5 to 8 differs from the table deck shown in Figs. 1 to 4 principally in the fact that it is divided into three zones E, F and G arranged differently from the zones A, B, C and D of the table deck shown in Figs. 1 to 4. Referring to Figs. 5 to 8, the bottom or base portion of the deck is shown as composed of shallow metal boxes or trays 30, 31 and 32 having the shape of the zones E, F and G, as best shown in Fig. 7. One side of the box 30 is secured to one side of the box 31 by bolts 35; and the other side of the box F is secured to one side of the box G by the bolts 36. Secured within the boxes 30, 31 and 32, as best shown in Fig. 7, are ribs 38, 39, 40, 41, 42, 43 and 44 having the same height as the sides of the boxes. These ribs are provided with openings 45 so as to permit the free passage of air through them. The tops of each of the boxes 30, 31 and 32 are covered by a porous medium such as sheets of canvas 47, 48 and 49, the edges of which are secured to the walls of the boxes in any suitable manner. On the top of the canvas sheets, and secured thereto and to the ribs 38 to 42, are riffles 50. A preferred arrangement of the riffles 50 is shown in Fig. 5, but it will be understood that other arrangements of riffles may be used. Compressed air may be fed to the boxes 30, 31 and 32, of the zones E, F and G, through pipes 54, 55 and 56. The usual feed box is indicated at 60; and the usual water-distributing box is indicated at 61. The concentrates launder 64 extends along the lower side of the table deck; and the tailings launder 65 extends along the end of the table deck.

The riffles 14 (in the form of table top shown in Figs. 1 to 4) and the riffles 50 (in the form of table top shown in Figs. 5 to 8) are considerably higher than the riffles used on ordinary shaking tables employed for practicing the process of the aforesaid Chapman and Littleford patent. Each riffle decreases in height from the feed end of the table toward the delivery end thereof, as shown in Figs. 2 and 6. Moreover, said riffles preferably increase in height from the upper or feed side to the lower or delivery side of the table deck, as is shown in Figs. 4 and 8. Riffles having a maximum height of ¾ of an inch at the feed end of the table and a minimum height of ¼ of an inch at the other end, have been found to give satisfactory results in treating a Florida phosphate feed prepared by screening through a 14-mesh screen.

In practicing the present invention, it has been found desirable to incline the table toward the delivery side thereof considerably more than when practicing the process of the aforesaid Chapman and Littleford patent with ordinary shaking tables. For example, an inclination from the horizontal approximately of 8° to 10° has been found to give satisfactory results. It will be understood, of course, that the inclination of the table should be adjusted by the operator so as to give the best results, according to his observations.

It will be understood that the conditioned feed, usually with additional water, is fed to the feed box from which it flows on to the table; and that water is fed to the distributing box from which it flows on to the table in the usual way. Compressed air is fed to the zones of the table, under the control of the operator who will regulate the supply of air so as to produce the most useful aeration of the pulp. It will, of course, be understood that it may not be necessary or desirable to supply compressed air to all of the zones of the table. When the process is carried out with the form of table top shown in Figs. 1 to 4, it will be found that the advantage resulting from the aeration of the pulp decreases from zones A to D; and with the form of table top shown in Figs. 5 to 8, that the advantage arising from aeration of the pulp decreases from zones E to G. As the supply of air to each of the zones is controllable, the operator can regulate the aeration of the pulp in the way be finds most advantageous, and can even shut off the supply of air entirely to one or more of the zones.

In practicing the present invention, the material to be concentrated is, of course, made amenable to the process by conditioning it with any suitable selective agents promoting the formation of skin-floated particles and loosely bonded agglomerates of particles, such as, for example, soap (made separately or in situ from fatty acids and caustic soda) and fuel oil, as described in the aforesaid Chapman and Littleford patent.

In practicing the process which is the present invention, the separation of the mineral values from the gangue takes place in the manner hereinbefore described in referring to the Chapman and Littleford patent, except that, due to the aeration of the pulp by the air passing up through it, the production of the skin or film float and of the loosely bonded agglomerates is greatly facilitated. For this reason, it is possible to treat by this process, with satisfactory results so far as the grade and the recovery of the phosphate or other mineral values are concerned, a greatly increased amount of material in a given time upon a table or equivalent apparatus having a given area.

I claim:

1. The method of concentrating a non-sulphide material containing valuable and gangue particles, which consists in conditioning the said material with selective flocculating agents promoting the formation of skin-floated particles and loosely bonded agglomerates of particles, then flowing a pulp of said conditioned material in a thin layer over a porous moving surface through which air is passing upwardly, thereby facilitating the creation on and in the pulp of

skin-floated particles of one kind and loosely bonded agglomerates of particles of the same kind, and together delivering and collecting the said skin-floated particles and the said loosely bonded agglomerates from said surface separately from the other particles.

2. The method of concentrating a non-sulphide material containing valuable and gangue particles, which consists in conditioning the said material with selective flocculating agents promoting the formation of skin-floated particles and loosely bonded agglomerates of particles, then flowing a pulp of said conditioned material in a thin layer over a riffled, porous, inclined moving surface through which air is passing upwardly, thereby facilitating the creation on and in the pulp of skin-floated particles of one kind and loosely bonded agglomerates of particles of the same kind, and together delivering and collecting the said skin-floated particles and the said loosely bonded agglomerates from said surface separately from the other particles.

ELTOFT WRAY WILKINSON.