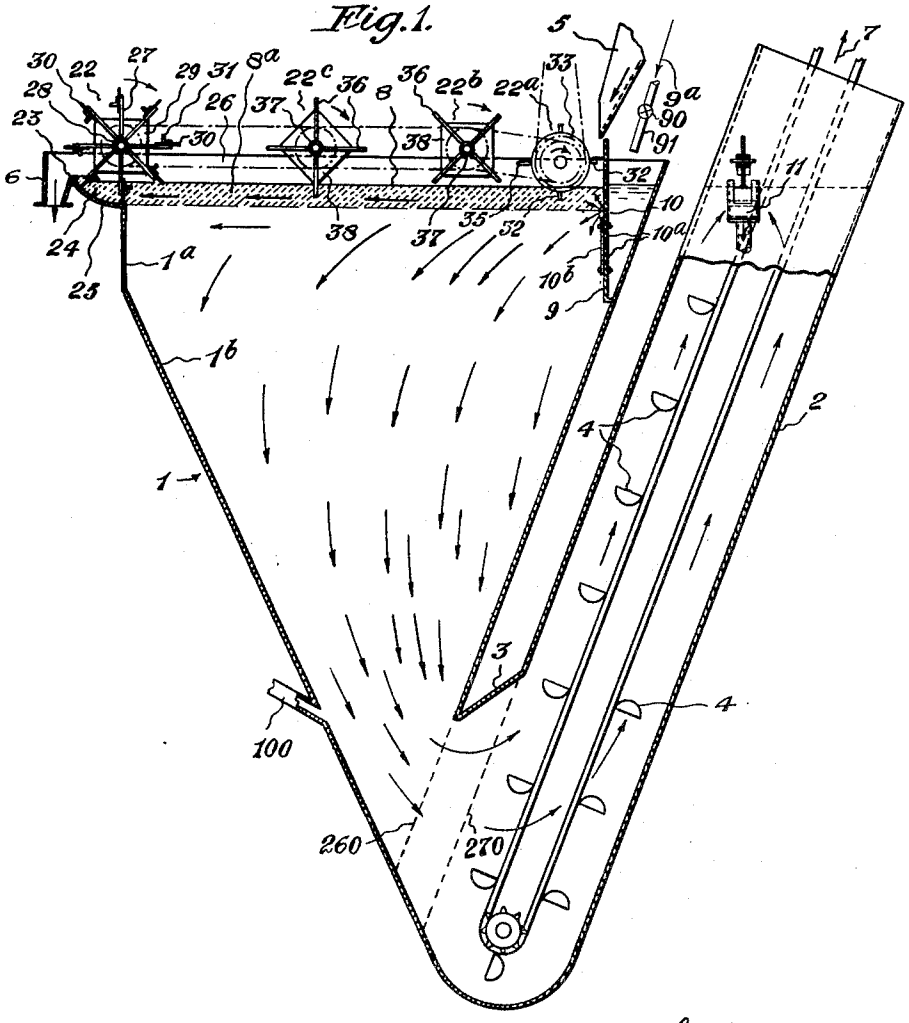
March 28, 1944. F. TROSTLER ET AL 2,345,513

SEPARATION OF SOLID MATERIAL OF DIFFERENT SPECIFIC GRAVITIES

Filed Dec. 26, 1940 2 Sheets-Sheet 1

Fig. 1.



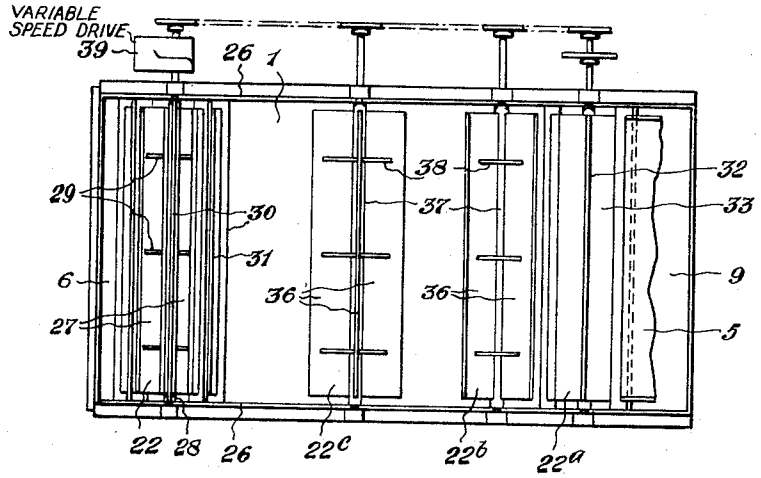
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SEPARATION OF SOLID MATERIAL OF DIFFERENT SPECIFIC GRAVITIES

Filed Dec. 26, 1940 2 Sheets-Sheet 2

Fig. 2.



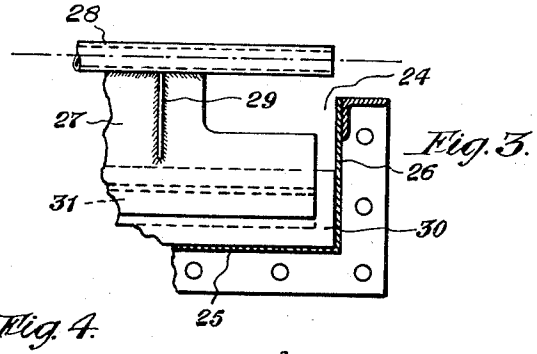
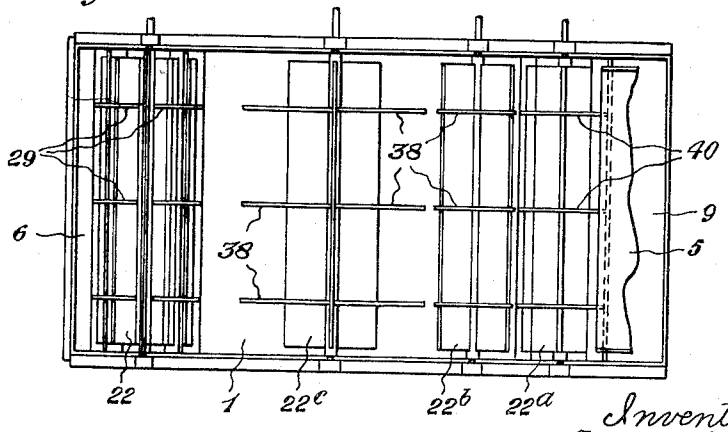


Fig. 3.

Fig. 4.



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UNITED STATES PATENT OFFICE

2,345,513

SEPARATION OF SOLID MATERIALS OF DIFFERENT SPECIFIC GRAVITIES

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Application December 26, 1940, Serial No. 371,838
In Great Britain November 7, 1940

10 Claims. (Cl. 209—173)

This invention relates to improved processes and apparatus concerned with the heavy medium separation of minerals or other divided solid materials of different specific gravities in media composed of substantially stable suspensions having a specific gravity intermediate between those of the lighter and heavier components of the minerals or the like. Such media, even when commonly termed "substantially stable," tend in greater or less degree to settle and stratify, in the absence of stabilizing currents, or agitation.

An object of the invention is the provision of improved methods of control of such separation, in which the close regulation of the rate of withdrawal of medium at one point in the separatory system (as, over the "boom" or outlet where separated "float" material is removed from the separating vessel), is a feature. Another object is the provision of improved apparatus by which such control may be accomplished. Other objects relate to improvements in various respects relating to such separatory systems, particularly in reference to the removal of medium, and control for the separation of float material, at the upper surface of the medium in the separator.

The invention is particularly adapted for use in a separating system in which medium is continuously admitted to the separating vessel at a determined rate, and is continuously removed therefrom from the top and bottom of the body of separating medium, as, over the boom and over a weir or weirs on the casing of the elevator by which the separated "sink" material is removed from the bottom of the separator. To maintain the medium at a constant level in the separator the rate of withdrawal at all points must equal the rate of admission. That is, the amount withdrawn at the boom and weirs in a unit of time (plus amount adhering to float and sink material and withdrawn therewith) must more or less closely equal the amount admitted in the same time. By the present invention control is established by removing medium positively in measured amounts at one point, and permitting the remainder of the amount admitted (less that which is removed with the separated particles) to overflow at another point. More specifically, medium may be removed from the upper surface in the separator by pushing or lifting measured amounts therefrom, successively, at a determined rate, which may be adjusted by varying the amounts raised and removed, or by varying the number of removals per unit of time, or by both means, while the amount overflowing at the weirs will vary accordingly, and will accordingly be closely controlled.

While the invention is not so limited, it is particularly adapted for use in connection with the process and apparatus described in the concurrent application of F. Trostler and T. Andrews (two of the joint applicants herein), Serial No. 371,839, entitled "Improvements in the separation of solid materials of different specific gravities," filed on even date herewith. In the process of that application particular attention is directed to the separation of sink particles of marginal density, that is, particles of the mineral or ore which is to be separated which have a density only slightly greater than that of the float or gangue particles, when they are crushed to predetermined sizes most advantageous for securing selective separation. Medium is admitted at a determined level below the level of the medium in the separator and removed at the boom and at the weir or weirs, that is, from the top and bottom of the body of medium. Small particles of marginal density, which would tend to teeter and crowd at or about the level at which medium is admitted, are drawn down therefrom by a current the velocity of which is determined by the rate of weir discharge; this rate must be sufficient to maintain substantial stability of a substantially stable medium (where a suspension of comminuted solids in a liquid is used as the medium), and also sufficient to give the required downward impetus to the particles of slowest falling velocity, while at the same time it should be insufficient to draw down any particles of true "float" from the separating zone situated above the medium admission level.

Unless a steady and positively controlled medium overflow is secured from the top surface, both being dependent on a constant quantity of medium being fed to the separating vessel or vessels, the weir discharge is also affected. Thus, if the gallonage of medium discharging at the weirs diminishes unduly, settling out of the solids of the medium in the case of suspensions is not properly counteracted so that the medium is liable to develop a gradually increasing density differential between the top and bottom of the separating vessel, thus retarding the descent of sink—or middlings—particles. The effect of this phenomenon, which is accompanied by simultaneous decrease of the conveying downward currents, will be crowding of teetering sink particles towards the bottom of the separating zone, and this in turn will tend to slow down circulation to a further extent so that very soon control over

the separating operation is liable to be completely upset. On the other hand, if the weir gallonage increases beyond the desired limits at the cost of the complementary boom or outlet discharge volume, the downward currents are apt to become so violent that an undue proportion of the float material or tailings may be pulled down in spite of the buoyancy of the medium. In addition, there is liability of upsetting the reseparation referred to in the concurrent application.

Considerable accuracy of regulation of the weir discharge is therefore highly important in the process referred to, and accurate regulation of the complementary top surface discharged may also be important for other reasons, such as the removal of moisture adhering to the one or other material to be separated. When ore is fed on to the top, and medium is admitted below, the water may be caused to form a thin layer on the top of the medium and removed before it can become too deep to interfere with separating practice, by suitable control of the boom discharge. The present invention provides the accurate regulation and adjustment which are so desirable in the process referred to, and in other sink-and-float separation processes in which similar problems may be presented. Selectiveness, accuracy and control of separation may, it is believed, be considerably enhanced thereby. By the present invention also improvements are effected in the feed of the material which is to be separated, across the bath to the discharge point, and in the separation process in other respects as will be further explained hereinafter.

It may be noted that the boom discharge of medium should vary in accordance with whether more or less moisture is contained in the ore or other material to be treated. Furthermore it is found that the removal of this water in the form of a thin supernatant film can be accomplished by the removal of medium plus water over the boom at a considerably less rate than has been the customary practice, in the sink and float separation of ores, this being true throughout the range of water contents of ores treated customarily by sink and float method. Such reduced rate of medium boom discharge is desirable, when practising the process described in said application of Trostler and Andrews, because it permits the upward current through the separating zone to be very gentle, that being one of the features of the process described in said application; and in any case a reduction of medium discharge is desirable, because of consequent saving in pumping costs. It should further be noted that the form of device for effecting medium discharge over the boom, particularly described herein, is peculiarly well adapted for effecting accurate medium removal at such reduced rate, and also that the means for ensuring the movement of float material across the top of the bath to the discharge point, particularly described herein, are particularly well adapted for cooperation with such discharge means, in that they keep the float moving as desired while at the same time they do not set up horizontal currents stronger than are required in connection with the reduced rate of medium removal.

In order that the invention may be more fully understood, attention is directed to the accompanying drawings, in which:

Figure 1 is a vertical section taken through a sink-and-float separating vessel, embodying one form of apparatus comprising the invention, in which the process of the invention may be practised.

Figure 2 is a plan view of the separating vessel shown in Figure 1.

Figure 3 is a fragmentary sectional front view of the trough 24 and paddle wheel 22 shown in Figure 1 to an enlarged scale.

Figure 4 is a view similar to Figure 2 but illustrating a modification.

Referring to the drawings, the separating vessel 1 may be, as shown, of downwardly tapered or other suitable form, this suitably being rectangular in plan, as shown. Heavy separating medium may be continuously fed into the vessel, for example as shown at 10 and ore or other material to be separated may be fed on to or slightly below the surface 8, of the medium, as shown for instance at 5. Discharge of float material and medium takes place over the boom 23, into chute 6. Sink particles, separated in vessel 1, may be removed in suitable fashion, as by the elevator 4 which lifts the sink particles through elevator casing 2. Medium is withdrawn at a desired rate from the bottom of the separator 1, preferably by overflow over a weir or weirs at 11, at the medium level in the elevator casing. The medium level in the separator 1 and the elevator casing 2 is the same, since these communicate at the bottom, and may be adjusted by adjusting the height of the weir or weirs at 11 as is well known. In the apparatus shown the medium admitted at 10 from a tank 9 divides into two streams, one flowing gently upward and across to the boom, while the other causes a gentle downward current from the level of the medium admission and overflows at the weir or weirs at 11. The rate of admission of medium into vessel 1 may be regulated and varied within certain limits in any desired manner, as by any desired means, such as valves, as at 90, for adjusting the area of the cross-section of the pipe 91 through which the medium is supplied to the tank 9.

In accordance with the invention, the medium is removed from the upper portion of the medium in the separator by pushing or scooping or lifting out definite quantities of the same, successively, at a determined rate. This may well be accomplished by the form of device illustrated, in which a paddle-wheel 22, is rotatably mounted above the trough or front extension 24 of the separating vessel. This trough is constituted as to its bottom by the upwardly curving part 25 of the vessel 1, and as to its sides by the parts of the side walls 26 of the vessel 1 which extend along the length of part 25. The bottom 25 of the trough is concentric with the paddle-wheel 22, so that the ends of the blades of the paddle-wheel may sweep along the curved bottom 25 during their rotation. The level 8 of the medium in the separator may be slightly below the boom 23.

Paddle-wheel 22 preferably has a comparatively large number (such as eight) of blades 27, attached to a central shaft or hub 28, as by welding, the attachment preferably being strengthened by one or more webs 29 to which the blades may also be welded, web or webs 29 being placed in a plane or planes at right angles to shaft 28 so as to offer minimum resistance to the flowing medium.

An important feature of the paddle-wheel is the rubber strips 30 secured one on each blade 27 by angle bars or other means 31 and adapted to provide sealing means for the paddle-wheel blades against the interior of the trough 24 at both the side edges and tips of the blades, so that the space in the trough beyond any particular blade in the

direction of rotation of the paddle-wheel shown by the arrow, may effectively be sealed against leakage of medium around or slippage of medium past the blades. In this manner medium may be discharged by the paddle-wheel over the boom 23 in precisely controlled quantities as will be understood. It should be noted that the provision of the sealing strips, together with a sufficient number of blades for the paddle, and a suitable relation of the blades to their curved seat, ensures complete enclosure and removal of a definite quantity of medium. This prevents any surging back of medium into the separator, which would create eddy currents and interfere with the delicacy of the separation. The employment of the paddle-wheel with the positive seal also permits the creation of a sufficient horizontal draught across the bath to the discharge point with a smaller gallonage discharge over the boom than has been customary in the usual commercial practice, this decreased rate of discharge being highly desirable under certain operating conditions, as above indicated.

The rate of medium discharge over the boom, with the form of apparatus illustrated, may be varied as required, as will now be described. Paddle-wheel 22, in the form of device illustrated, has the function of discharging the tailings or other float material over the boom, in addition to the function described above of removing medium at a desired rate. The speed of the paddle must therefore be adjusted for the desired rate of tailings discharge, which is related to the operating capacity of the plant. Variations of speed of the paddle, as required, may be provided for by any well known means, for example by the variable speed drive device 39 indicated in Figure 2.

If, then, the paddle-wheel 22 is operating at any speed, selected for a desired rate of tailings discharge, the rate of medium removal over the boom may be adjusted as required by lowering or raising the level of the medium in trough 24, which results in the corresponding and readily calculable variation of volume of medium in front of each blade of the paddle as it enters trough 24, which volume is pushed up the trough and over the boom. This adjustment of level is accomplished by the setting of the weir discharge, the height of the discharge at the weir or weirs at 11 on the elevator casing 2 being made adjustable in well-known manner, the level of the medium in the separator, and accordingly in trough 24, being thereby changed to the same extent.

If, now, the rate of tailings discharge must be varied, for any reason such as variation in the proportion of float material in the ore fed to the separator, the paddle-wheel 22 will be increased or decreased in speed, with a proportionate increase or decrease of the gallonage of medium discharge over the boom. If the necessity of tailings discharge variation also involves proportionate variation in the rate of medium boom discharge the latter will be automatically adjusted. If not, the medium discharge may be kept at any desired rate independently of the float discharge (or altered, if required, while the float discharge is kept constant), by altering the medium level in the separator, as described.

It will accordingly be noted that the rate of medium boom discharge may be varied by varying the medium level and hence the amount removed by each paddle-wheel blade or other removal device, or by varying the speed of the latter, or by a combination of both of these expedients, but that speed variation cannot alone be depended on in a device such as that illustrated, where the tailings are removed by the same means as the medium, unless a desired medium discharge variation is proportionate to a desired tailings discharge variation.

The described method of medium and tailings discharge is additionally advantageous in that it causes a positive, steady flow of medium across the surface of the bath towards the discharge end, which can at least partly replace the mechanical conveying of float across the surface which has commonly been performed by either the rake type, continuous drag type, or other known float disposal devices. The conditions for separation will be considerably improved by the elimination at least in part of such devices as those mentioned for propelling the float across the surface, since thereby the material approaching the discharge paddle will be allowed to float in an undisturbed manner on the surface of the pool of medium. This is particularly true when the improvements herein described are used in connection with the process described in the application of F. Trostler and T. Andrews referred to above, since in that case the lightest sink (or middling) particles tend to separate at the further, or float discharge, end of the separating zone, where there are substantially no upward currents to impede their fall. For the extreme accuracy of separation required in that case it is particularly important that the upper sector of the bath adjacent to the boom end should be as quiet and undisturbed as possible. The arrangement described above improves the results in that respect.

The length of this uninterrupted travel of the float across the bath may be chosen to suit specific purposes. In at least some cases it may be desirable to mount other devices, such as additional paddle-wheels, along the separating surface of the bath, while still leaving a sufficient length of undisturbed surface approaching the discharge paddle-wheel as described.

These paddle-wheels or similar devices will act as conveying means for forcing the ore towards the discharge point, and will additionally serve the purpose of immersing it to desired depth and thus facilitating the reorientation of particles, which is advantageous in the separation process. These paddles may be varied in their number and positions, as required by particular separating problems.

One form of arrangement, indicated in Figure 1, provides for comparatively frequent immersion at the first half of the separating surface, but allows the maintenance of more undisturbed conditions in the second half when (in the process disclosed in the application of Trostler and Thomas Andrews referred to), the bulk of the sink and middlings have dropped below the surface, so that virtually only tailings drift towards the discharge paddle-wheel.

In the construction illustrated the first additional paddle-wheel 22*a*, nearest to the ore-feed end of the separator, serves as an immersion paddle for dipping the incoming ore. It suitably may have four blades 32, secured preferably to a drum 33 or secured to a hollow boss or spindle which may approximately be four inches in diameter, and may also have the blades strengthened by a web or webs, which may be similar to the webs 29 aforesaid, as shown for instance at 40 in Figure 4. The blades, or some of them, may conveniently be provided with rubber edge strips 35, adapted to contact against the sides and/or ends

of the separating vessel during their travel, but the use of these tips is not essential.

The second and third additional paddle-wheels shown at 22*b*, 22*c*, positioned between paddle-wheels 22 and 22*a*, may have four long plain blades 36, secured to a hollow boss 37, and strengthened by a web or webs 38, and they are intended principally to act as conveying devices. The paddle-wheels, may be driven in any suitable manner from any suitable source and may be connected together by belts or chains, for example, as is indicated by dot-and-dash lines in the figure. The direction of rotation of the paddle-wheels 22*a*, 22*b* and 22*c* is also shown by arrows, this direction being clockwise to propel the float towards the boom. Paddle-wheel 22, as previously stated, is preferably provided with an independently controlled variable speed drive 39.

Other parts shown in Figure 1 are similar to those shown in Figure 2 of the drawings accompanying the concurrent application to which reference is directed for further information, additional reference numerals of the concurrent application being included in the present drawings for convenience of reference.

As stated above, all of the paddle-wheels used may be provided with stiffening webs, such as are shown at 29 and 38. These webs may be caused to perform an additional function, several of them being provided on each hub, as shown in Figure 4, for example, and those on different paddle-wheels being in line with each other, so that they will divide the surface of the bath into parallel lanes. For this purpose these webs would preferably be circular and they would, of course, be given diameters or sizes sufficient to enable them to dip below the surface of the medium at all times, to a desired distance. The object of this construction is to counteract the formation of any sidewise currents in the separating zone and consequent overcrowding of certain areas of the liquid surface, and it may be desirable if any tendency to the formation of such currents is discovered.

For one further point, when the volume of medium discharge is controlled by altering the level of the weir adjustment, the consequent variation of the medium level 8, may have to be considered in connection with the level at which medium is admitted to the separator; if the medium is admitted at a more or less closely determined distance below the surface, variations in the surface level will, of course, affect the distance from the surface level to the admission level, unless this is also made adjustable. This point is of interest in any process, such as that disclosed in the application of Trostler and Thomas Andrews above referred to, in which an excessively shallow separation zone is formed by admitting medium only a short distance below the surface level. In any such case the medium feed level should be selected to be below the lowest level of medium in trough 24 which, in our present preferred practice, is about 2½ inches below the normal operating surface 8, of the medium. Put more generally, care should be taken in establishing the medium entry level to compensate for lowering of the surface level which may occur if the medium boom discharge has to be decreased. If this measure is not observed, when and if the surface level is lowered in a process such as is described in the above-mentioned application, the depth of the effective separating zone may be diminished to such a degree that the immersed particles will be affected, before separation is complete, by the current which flows downwardly from the level of medium admission. For similar reasons the blades of paddle-wheels 22*a*, 22*b*, 22*c*, should not dip so deeply into the separating zone as to push particles down to the level at which the feed medium enters and where, in the process of the said application, the downward current commences.

It should be noted that the conjoint use of the sealed removal paddle and a series of float propelling paddles as described, gives rise to a number of advantages. The removal paddle as above described, permits the reduction of the rate of medium boom discharge in comparison with usual prior practice, and this is required if the velocity of the horizontal current across the separator is to be restricted to a limit dictated by the amount of moisture in the material feed. The current of the required gentle strength is made possible by the substitution of the spaced-apart propelling paddles for the usual rake conveyor, the paddle blades dipping below the surface through comparatively small arcs only. It is found that these paddles keep the float moving across the bath as required, without increasing the horizontal movement of the medium unduly. It is noted that continuously moving rake blades, if moving fast enough to dispose of the float as rapidly as is required by good commercial practice, and if not perforated or otherwise arranged to permit the relative passage back past the same of a considerable quantity of medium, would set up considerably stronger horizontal currents. These stronger currents would result in the piling up of medium at the discharge though more rapidly than it could be removed by the removal paddle, resulting in the formation of eddy currents, and the perforating of the blades of a rake, to restrict horizontal current caused thereby, would also cause conditions harmful to separation, because of the surging back of medium past the blades.

Furthermore, the use of propelling paddles as described in place of a continuous moving rake conveyor or the like provides other features which result in improved separation. Thus, the movement of the paddle blades down and up through the upper portion of the bath tends to submerge the material particles temporarily, and this, together with the increase of speed across the tank imparted to the particles by each propelling paddle, and the decrease of speed between the paddles, gives the particles a better re-orientation than is caused by the usual rake apparatus, thus improving separation. Likewise, the propelling paddles cause less congestion to the particles in their travel across the bath than does a rake conveyor. This is because particles tend to be crowded in front of each blade of a rake, causing congested areas which travel across the bath with the rake blades, through which sink particles cannot fall as freely as is desirable. With paddles spaced apart, however, there is momentary congestion in front of each blade during its short arc of travel through the bath, but upon the rise of the blade above the surface the particles travel freely for an interval with a diminishing speed and tend to spread out. Also, the blade of the next paddle which enters the stream at about the time when the particles just referred to reach the same will not cause congestion of the same group of particles as the previous paddle, so that the momentary concentrations of particles are being constantly broken up, and momentary re-groupings effected, this giving a better

distribution of particles of the material being treated across the bath, with consequent better separation. Another advantage of the paddle arrangement, already described, is that this permits a portion of the surface of the bath adjacent to the discharge trough, to be free from direct mechanical disturbance.

We claim:

1. A sink-and-float process of separating materials of different specific gravities by the use of a body of heavy suspension substantially stable medium in a separating vessel, comprising the steps of admitting medium to said body below the top thereof at a determined rate, feeding material to be separated on to the top of said body, removing medium and float material from the top of said body at a determined rate by pushing accurately measured amounts of medium from the upper portion thereof successively during determined time intervals, removing sink material from the bottom of said body, removing medium from the bottom of said body continuously at a rate equal to the admission rate less the sum of the top removal rate and the rate of removal of medium adhering to separated particles, and varying said top removal rate as required by operating conditions by varying the measured amounts pushed successively from the upper portion of said body and thereby correspondingly varying said bottom medium removal rate.

2. A sink-and-float process of separating materials of different specific gravities by the use of a body of heavy suspension substantially stable medium in a separating vessel having an extension into which medium flows from the top of said body to a known level, comprising the steps of continuously admitting medium to said body, feeding material to be separated on to the top of said body, removing medium continuously from the bottom of said body, removing sink material from the bottom of said body, continuously removing float material and medium from the top of said body at accurately determined rates by pushing substantially all of the medium in said extension and float material thereon therefrom successively at a determined rate, varying the rate of such successive removals to vary the float and medium removal rate when required by operating conditions, and varying the rate of removal of medium from the top of said body independently of the rate of float removal, when required by operating conditions, by varying the depth of medium in said extension.

3. Apparatus for separating materials of different specific gravities, comprising a separating vessel having a trough-like extension from one upper end thereof, having an upwardly curved bottom terminating in a discharge lip, a shaft above said extension at the centre of curvature of the bottom thereof, blades on said shaft arranged to scrape along the bottom and sides of said extension to remove material therein over said lip, said blades having resilient sealing strips secured to the tips and side edges thereof, making medium-tight contact with the said bottom and sides, means for rotating said shaft at desired variable speeds, means for continuously admitting heavy medium to said vessel below the top of the body of medium therein, and means for withdrawing medium continuously from the bottom of said vessel and for establishing and varying as desired, the surface level of medium in said vessel and extension below the level of said lip.

4. Apparatus for separating materials of different specific gravities, comprising a separating vessel having a trough-like extension from one upper end thereof having an upwardly inclined bottom terminating in a discharge lip, means for admitting heavy medium into said vessel below said extension, means for establishing and maintaining the surface level of medium in said vessel and extension below the level of said lip, means for feeding material to be separated on to the surface of the medium at the end of the vessel opposite to said extension, a plurality of rotary means positioned above the surface of the medium, spaced apart in the lengthwise direction of said vessel and adapted to dip below said surface for propelling the floating part of the fed material towards said extension, and rotary means mounted above said extension, arranged to scrape along the bottom and sides thereof to remove medium and float therein over said lip, said means having resilient sealing strips secured to the scraping edges thereof, said propelling and removing rotary means being separated to leave a portion of the surface of the medium between the same not directly disturbed.

5. Apparatus for separating materials of different specific gravities, comprising a separating vessel having means for admitting heavy medium thereto, means for feeding material to be separated to the top region of the medium at one end of the vessel, said vessel having a discharge lip at the end opposite to said material feeding means, means for establishing the surface level of the medium in said vessel below said lip, and a plurality of rotary means comprising shafts with radially extending blades thereon mounted above said vessel at spaced intervals and arranged to propel float material on the medium towards said lip and for discharging the same together with some medium over said lip, each of said shafts having continuous web members thereon at right angles thereto attached to said blades to stiffen the latter and of sufficient diameter to enable them to dip below the surface of the medium parallel to the direction of flow thereof, to divide the surface into parallel parts.

6. Apparatus for separating materials of different specific gravities, comprising a separating vessel having a trough-like extension from one upper end thereof having an upwardly inclined bottom terminating in a discharge lip, means for admitting heavy medium into said vessel below said extension, means for establishing and maintaining the surface level of medium in said vessel and extension below the level of said lip, means for feeding material to be separated on to the surface of the medium at the end of the vessel opposite to said extension, a plurality of rotary means positioned above the surface of the medium spaced apart in the lengthwise direction of said vessel and adapted to dip below said surface for propelling the floating portion of the fed material towards said extension, means for rotating said rotary means, a rotary member mounted above said extension arranged to scrape along the bottom and sides thereof to remove medium and "float" therein over said lip, and independent variable speed means for rotating said rotary member, said rotary member and the one of said rotary means nearest thereto being separated to leave a portion of the surface of the medium between the same not directly disturbed.

7. In a sink-and-float process of separating materials of different specific gravities by the use of a body of heavy medium comprising a suspen-

sion of insoluble particles in liquid, the steps of continuously removing float material, and medium, from the top of said body at independently adjustable rates, which consists in pushing accurately measured amounts of medium with float material thereon from the upper portion thereof successively during determined time intervals, varying the rate of float and medium removal as required by operating conditions by varying the length of said time intervals, and independently varying the rate of removal of medium by varying the measured amount thereof pushed from the upper portion of said body during each of said time intervals.

8. Apparatus for separating materials of different specific gravities, comprising a separating vessel having a trough-like extension from one upper end thereof, having an upwardly curved bottom terminating in a discharge lip, a shaft above said extension at the centre of curvature of the bottom thereof, blades on said shaft arranged to scrape along the bottom and sides of said extension to remove material therein over said lip, said blades having resilient sealing strips secured to the tips and side edges thereof, making medium-tight contact with the said bottom and sides, means for rotating said shaft, means for continuously admitting heavy medium to said vessel, below the top of the body of medium therein, and means for withdrawing medium continuously from the bottom of said vessel and for establishing and varying as desired the surface level of medium in said vessel and extension below the level of said lip.

9. In apparatus for separating materials of different specific gravities, the combination of a separating vessel, means for admitting heavy medium thereto at a determined constant rate below the top of the body of medium therein, an upwardly extending casing connected with the lower portion of said vessel, an overflow weir of adjustable height in said casing, providing for continuous withdrawal of medium from the bottom of said vessel and for establishing and varying at will the surface level of medium in said vessel, and means for removing medium and float material from the top of said vessel, consisting exclusively of means movable above said vessel and positioned to dip below the surface of medium therein to a fixed level relative to the structure of the vessel constructed to remove accurately predetermined quantities of medium and float material thereon during determined time intervals.

10. In apparatus for separating materials of different specific gravities, the combination of a separating vessel having an upwardly extending trough at one upper end thereof terminating in a discharge lip, means for admitting heavy medium to said vessel at a determined constant rate below the top of the body of medium therein, an upwardly extending casing connected with the lower portion of said vessel, an overflow weir of adjustable height in said casing, providing for continuous withdrawal of medium from the bottom of said vessel and for establishing and varying at will the surface level of medium in said vessel and trough, and means for removing medium and float material from the top of said vessel, consisting exclusively of means movable above and in said trough and coacting with the sides and bottom of said trough for enclosing and removing accurately predetermined quantities of medium and float material thereon during each of determined successive time intervals.

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