Feb. 8, 1949. E. C. BITZER 2,460,801

METHOD AND MEANS FOR HINDERED SETTLING CLASSIFICATION

Filed April 21, 1944 2 Sheets-Sheet 1

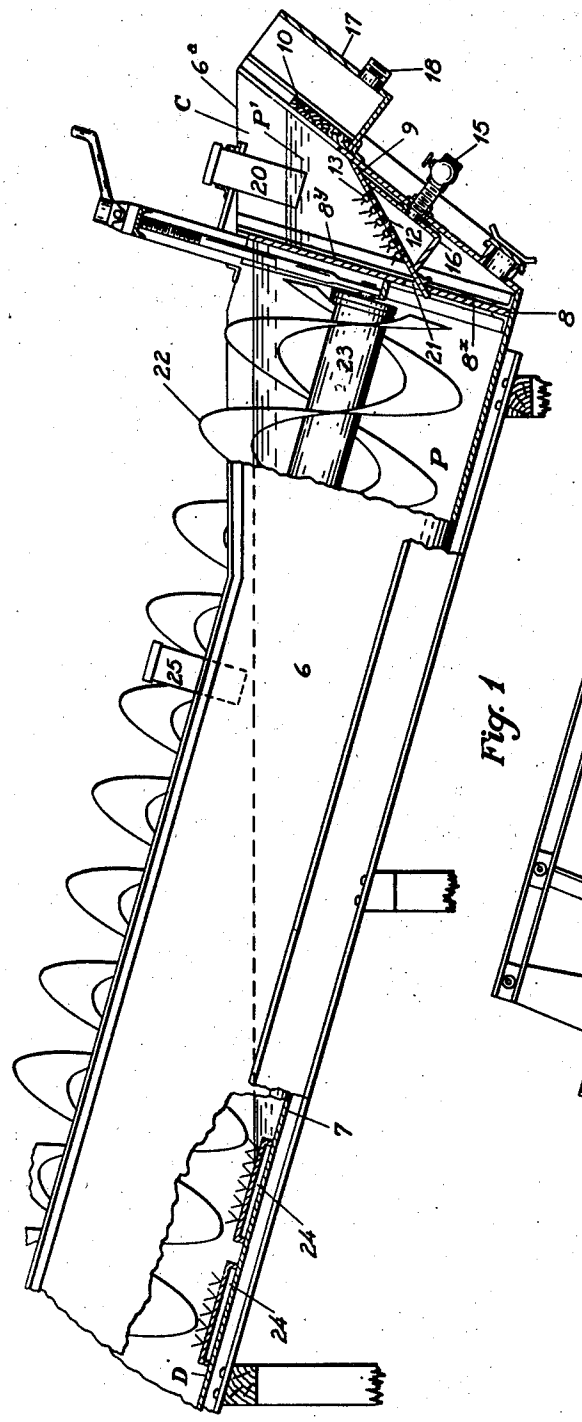


Fig. 1

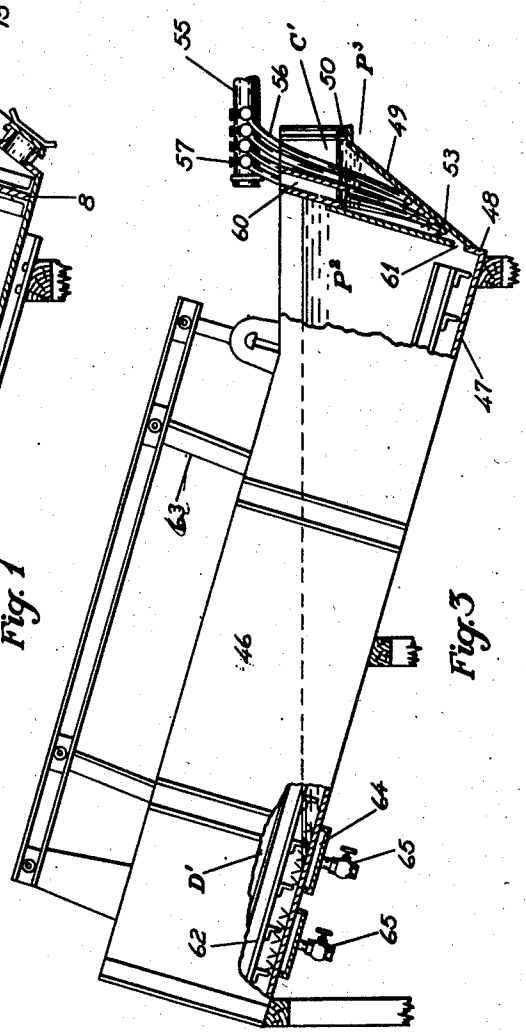


Fig. 3

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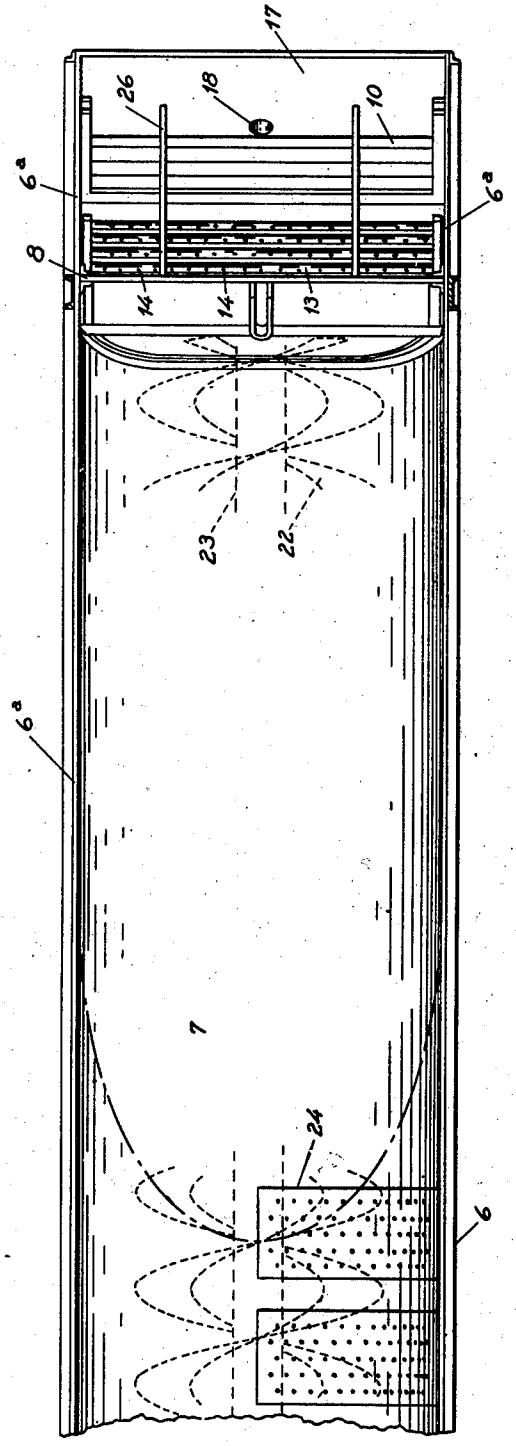


Fig.2

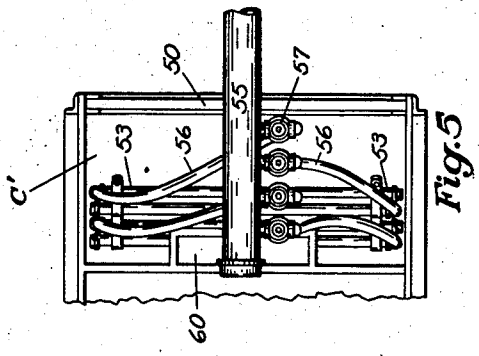


Fig.5

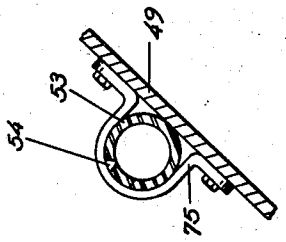


Fig.4

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UNITED STATES PATENT OFFICE

2,460,801

METHOD AND MEANS FOR HINDERED SETTLING CLASSIFICATION

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Application April 21, 1944, Serial No. 532,180

17 Claims. (Cl. 209—18)

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This invention relates to hydraulic classification means and methods, and more particularly relates to a novel type of hindered settling classification applicable to various types of conventional mechanical classifying apparatus.

Most wet classification of ores or similarly finely divided solids such as sand, cement mix etc. is practiced in mechanical classifiers. This type of machine comprises an inclined tank or trough which when substantially filled with a pulp comprising a mixture of water and material to be classified forms a pool at the lower end of the tank. Classification is accomplished by inducing the larger and heavier particles of the feed to settle while the lighter and finer particles of the feed are maintained in suspension and removed from the tank by overflow. The settled solids, commonly called the sand product, are removed from the tank by conveying them up the sloping bottom under the action of the mechanical means which may consist of revolving helical blades or spiral assembly, reciprocating rakes or a continuous chain drag.

As the settled material passes the upper limit of the pool, the fine solids and water begin to drain out on the sloping bottom and flow back into the pool. In this way, the elevating mechanism acts both as a conveyor and a dewatering device. Most classification treatments are directed toward control of the size distribution of particles in the overflow, with the object of maintaining a set minimum amount of what is classed as oversize material. The amount and size range of this so-called oversize varies within wide limits depending upon the requirements of a given operation.

In most apparatus the entering feed is delivered to the classifier near the upper limits of the pool. The larger particles of oversize plus a proportion of what could be accepted as overflow material settle out as soon as they enter the pool and thereafter are conveyed up the sloping bottom. Smaller particles of oversize settle out of suspension as the pulp flows back from the feed inlet to the overflow weir, and the object of the conventional operation is to control the settling rate of the oversize in such manner as to settle everything coarser than a certain predetermined size before the pulp stream reaches the overflow point.

By operating in this manner, a varying but substantial amount of acceptable overflow material settles or is entrained with the larger oversize material and in conventional practice, little, if anything, can be done to prevent the

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settling of this acceptable material without causing an undesirable amount of large particles to pass out with the overflow. As a result, such operations are inefficient in varying degrees, depending upon the amount of acceptable material that settles or is carried into the oversize sands.

In present practice, the principal method of controlling the size of the classifier overflow product is to regulate the specific gravity of the mixture of solids in liquid, usually water, by controlling the addition of fresh liquid to the pool. In general, fine overflows are made by the addition of fresh liquid in large quantity or volume and maintaining low pulp gravities, while coarse overflows are made by reducing the fresh liquid introduction and allowing the specific gravity of the pulp to increase. Another important factor in the control is the amount of extremely fine material, generally designated slimes, in the classifier feed.

When the slimes content is slight or entirely lacking, the operation is much more difficult to control because the settling rate of solids is so high that far too much acceptable overflow material settles with the oversize. Control by means of fresh liquid introduction in such cases is not effective, and particularly when the object is to make a coarse overflow, the present type mechanical classifiers fail to perform satisfactorily.

It will be noted from the foregoing that in their conventional methods of operation, the mechanical classifiers heretofore in use are required to convey, dewater and classify in a single tank under conditions which cause the conveying and dewatering functions to interfere with the primary treatment, namely, that of classifying solids.

It is an object of the present invention to provide a novel method of classification in which the conveying and dewatering steps are physically separated from the primary classification treatment but are in communicating relation therewith.

Another object of the invention is to provide a hydraulic classification treatment in which it is possible to reject in the overflow coarse sizes beyond the size range of the overflow product of the present type mechanical classifiers.

A further object of the invention is to provide a method of classification which may be utilized in the concentration of an ore constituent rather than providing the usual size classification of ore constituents.

Still another object of the invention is to provide a novel type of treatment zone which may be added to or incorporated in conventional type classifier apparatus to adapt same for the performance of the treatment of the present invention.

Other objects reside in novel steps and treatments, and in novel combinations and arrangements of parts, all of which will be described more fully in the course of the following description.

Briefly stated, the present invention involves the treatment of a body of solids in liquids in two physically separated but intercommunicating pools, with the pool in which the solids and liquids are initially fed being maintained free from the influences of the conveying and dewatering mechanism, and utilizing the second pool in which the conveying and dewatering steps are performed to provide a resistance factor exerted against the first said pool to impede the settling of solids therein.

The invention will be best understood by reference to the accompanying drawings which illustrate typical structural embodiments for practicing the novel treatment. In the drawings in the several views of which like parts have been designated similarly,

Fig. 1 is a fragmentary side elevation partially broken to show essential features of the various treatment stages;

Fig. 2 is a fragmentary top plan view of the classifier tank shown in Fig. 1, with the spiral conveyor and feed box removed to better illustrate the relation of the treatment stages;

Fig. 3 is a fragmentary side elevation of another form of treatment tank embodying features of the present invention and partially broken to show details of the treatment stages;

Fig. 4 is an enlarged section through one of the liquid injecting nozzles; and

Fig. 5 is an enlarged top plan view of the classification compartment of the tank shown in Fig. 3.

Referring first to the form of the invention shown in Figs. 1 and 2, a classifier of the "Akins" or spiral conveyor type has been illustrated with features of the present invention applied thereto. This classifier comprises an elongated tank 6 suitably supported with its bottom 7 in an inclined position. At the lower end the interior of tank 6 is divided by a partition member designated generally by the numeral 8 into two pools P and P'. The pool P' is enclosed by a sloping bottom member 9, an adjustable overflow weir 10 and side walls 6a of tank 6. The bottom member 9 is suitably apertured as indicated at 12 and supports at spaced intervals a plurality of pipes or conduits 13 suitably apertured as indicated at 14 in Fig. 2, to function as injection nozzles. Liquid is delivered to the nozzles 13 through a valve-controlled supply line 15 and a hutch box 16 mounted on the under surface of sloping bottom 9. Preferably, an overflow box 17 adjoins the adjustable weir 10 and is provided with a suitable outlet nipple 18 for attachment of any suitable conduit member.

This unit comprises the primary classification zone or compartment C, while the portion of the tank interior on the opposite side of partition 8 together with its associated mechanism constitutes the conveying and dewatering zone or compartment D.

Feed to pool P' preferably is delivered through an adjustable feed box 20, the outlet of which is submerged in pool P'. The partition member

8 in the preferred form comprises a lower section 8x, which is fixedly held in tank 6 in supporting relation to the sloping bottom member 9. The upper section 8y is mounted for up and down movement in spaced relation to section 8x to provide an outlet passage 21 of restricted character but of variable dimension. The restriction of opening 21 and the extension of the member 8y to a point substantially higher than the overflow level determined by the top surface of weir 10 results in the creation and maintenance of a liquid level for pool P which is substantially higher than the level of pool P' whenever additional liquid is supplied to the pool, as clearly shown in Fig. 1.

This superelevation is utilized in the operation of the apparatus to cause a back flow through opening 21 from pool P to pool P' against which particles fed to pool P' are required to settle in a countercurrent travel before they can enter pool P. The portion of the apparatus containing pool P operates as a conveying and dewatering zone with a spiral blade assembly 22 mounted on a rotary shaft 23 providing the necessary conveying action for moving solids settling in pool P to an elevated point of discharge (not shown) in a manner well known in the art.

Preferably, there is provided on the bottom of tank 7 one or more wash boxes 24 positioned to act on the solids being elevated by conveyor 22 and wash therefrom fine particles which have been entrained in or otherwise intermingled with the coarse particles. Also in the preferred construction, a liquid inlet in the form of a pipe 25 is supported in overhanging relation to pool P and preferably has its discharge outlet in close proximity thereto to avoid undue turbulence in the discharge of liquid into the pool.

With this understanding of the construction required in adapting classifiers of the spiral conveyor type to the practice of the present invention, the operations performed in such apparatus will now be described. Pulp is introduced through inlet 20 and initially fills the tank to the effective level of weir 10 as established by the number of slat members forming the weir. In this operation a portion of the pulp passes through the opening 21 and the spiral assembly 22 is rotated by shaft 23 to move settled sands upwardly along the tank bottom to the point of discharge.

Prior to or as soon as the levels on opposite sides of partition 8 are uniform, liquid under pressure is admitted to hutch box 16 through the valve-controlled conduit 15 and thence is discharged in jets or fine streams through the nozzle members 13 to keep the mass of pulp constituting pool P' in teeter, and at the same time to induce an upward movement of fine particles through the downwardly descending mass of coarse particles.

At the same time the pulp in pool P is diluted by the introduction of additional liquid through wash boxes 24 or inlet 25, or both, and so long as the amount of liquid so introduced is in a volume in excess of the volume that will pass through the restricted opening 21 and rise through the dense liquid body forming pool P' to pass across overflow weir 10, the level of pool P will rise progressively. Whenever the desired super-elevation has been attained, the liquid introduction into pool P through wash boxes 24 and feed inlet 25 is reduced to balance the outflow through passage 21 and thereafter a substantially static level differential is maintained.

While this condition maintains, there is a continuous flow of fluid from pool P into pool P' which is countercurrent to the travel of coarse particles settling through pool P' under gravitational influence.

When the spray action of wash boxes 24 is utilized, entrained fines are separated from the coarse solids being raked upwardly by the spiral conveyor, which fines and the injected liquid drain back into pool P as a liquid suspension of greater density than the liquid suspension medium of the pool. The resulting increase in density of the pulp forming pool P provides additional resistance to the settling particles approaching opening 21, with the result that only particles of relatively coarse size are able to overcome the combined resistance factors in pool P' and pass out of such pool into pool P, while other particles of relatively coarse but lesser size are impelled to the surface by the combined resistance factors and pass from the pool P' by overflow. The ultimate result of this action is that in this classifying treatment a much coarser overflow product is obtained than has heretofore been possible by using the conventional methods of mechanical type classifiers.

In certain treatments the settling area provided by compartment C may be too large to permit the operation to overflow a product of the desired coarseness. An effective method for attaining the desired result is to treat the same volume of feed in a smaller settling area, which changed condition tends to increase the density of the pulp and thereby impede the settling of larger sized particles to increase the size of the overflow product. Such a change is readily effected by inserting one or more partitions 26 as shown in Fig. 2, which reduce the size of the settling area in compartment C.

From the foregoing it will be apparent that a classifier of the type illustrated in Fig. 1 provides two physically separated but intercommunicating pools lying generally in the same horizontal plane, with the pool into which the initial feed is delivered being maintained substantially free from the conveying and dewatering influences of the other pool, but subject to a hydrostatic head therein exerted through the communicating passage. Also in said second pool the conveying and dewatering steps preferably are performed in conjunction with liquid introduction which serves to create an increased density factor in the pool, which in turn becomes a resistance factor at the passage to the other pool because of the hydrostatic differentials maintained.

In the classification pool the pulp, in addition to being subjected to the aforementioned resistance factors initiated by the other pool, is also subjected to hindered settling influences preferably through the introduction of liquid under pressure, which is subject to changes both in velocity and direction. The accumulative effect of these several resistance factors is to provide a selective control of the coarseness of the overflow product which is subject to precise variation and which may be operated to overflow a product much coarser than has heretofore been possible in the operation of conventional type mechanical classifiers.

In Figs. 3, 4 and 5, the features of the present invention have been shown as applied to a classifier of a reciprocating rake type. This apparatus comprises a rectangular tank 46 suitably supported to dispose its bottom 47 at a substantial inclination and having its interior divided by a

partition member 48 into a classification compartment C' and a conveying and dewatering compartment D'.

The end wall 49 of tank 46 acts as the sloping bottom of compartment C' and terminates at its upper end in a slat weir 50 or similar regulating means for varying the overflow level. A plurality of nozzle members 53 are mounted at intervals along sloping bottom 49, each of which is provided with a series of apertures 54 for the discharge of liquid.

The nozzles 53 are loosely held in U-clamps 75 and may be turned, as from the full line position of opening 54 to the dotted line position, for example, to direct the discharge through said openings in different directions in compartment C'. A header 55 carries a supply of liquid under pressure and a flexible conduit 56 connects each individual nozzle member 53 with said header and has a valve 57 to permit selective control of the discharge velocity.

Pulp is fed into compartment C' through a feed box 60 and upon discharge is subjected to the elevating influence of the jets issuing from nozzles 53, which are individually regulated for pressure and direction. Solids settling in this compartment pass through an opening 61 in partition 48 and enter compartment D'. In the latter compartment, the settled solids are moved upwardly along sloping bottom 47 by reciprocating rakes 62 actuated by mechanism 63.

Preferably the raked solids are subjected to the action of one or more wash boxes 64, which are subject to individual valve regulation as indicated at 65 in Fig. 3. Again in this form the addition of water through wash boxes 64 and the restriction to discharge provided by opening 61 serve to create a superelevation of the pulp body P^2 in compartment D' relative to the pool P^3 in compartment C'. The size of the opening and the height of superelevation determine the velocity of liquid passing through the slot and as the sinking particles must pass counter to this stream to enter pool P^2, a classification according to size, shape or specific gravity takes place.

In the classification compartment C', an increase of jet pressure will result in the removal of coarser particles from the mass of pulp and their overflow from the compartment, whereas a decrease in jet pressure results in the removal and overflow of finer particles. In addition to the control provided by jet pressure, the direction of the jets affects the rising currents and surface movements and thus is another factor in the control of particle size in the overflow.

From the foregoing description of the construction and operation of the classifiers illustrated in Figs. 1 and 3, it will be apparent that such features are generally applicable to various types of mechanical type classifiers such as chain drag classifiers (not illustrated) or various reciprocating rake type such as the form shown in Fig. 3, or to various spiral or "Akins" type as shown in Fig. 1. Similarly, the novel features of Fig. 1 may be incorporated in the classifier of Fig. 3 and conversely the novel features of Fig. 3 may be incorporated in the classifier of Fig. 1. This applies particularly to the liquid injecting nozzles of the classification compartment, which may be either a fixed type of an adjustable type and which may be regulated by only one valve or by having each nozzle individually regulated by its own valve.

The wash boxes may be located with their

upper surfaces above the tank bottom as shown in Fig. 1, or may be beneath the tank bottom which, in such case, is suitably apertured to admit the liquid from such wash boxes.

The partition dividing the classification compartment from the conveying and dewatering compartment may be a single wall suitably slotted to provide the connecting passages, in which case a sliding gate or other equivalent adjusting means will be mounted for movement relative to such opening to vary the effective area thereof.

The present design not only provides for the construction of a novel type of classifier apparatus, but also permits conversion of existing machines to embody such features. Referring to Fig. 1 for example, the partition member 8 may be the end wall of the standard type spiral classifier to which the compartment structure C is attached by welding to convert such standard classifier to the practice of the present invention. In such conversion the wash boxes 24 also may be installed in conventional tank designs. The wash box per se has been shown and described in the co-pending application of Thomas A. Dickson, Serial No. 471,989, now Patent No. 2,428,789, Oct. 14, 1947, and features described but not claimed herein have been made the subjects matter of claims in said application.

Another feature of the operation performed in the various forms of classifiers described and claimed herein is that the resistance factors to the settling of particles in the classification compartment may be maintained to effect a separation according to specific gravity rather than according to size or shape. As an example, if a given ore contains one or more minerals of high specific gravity and associated rock or gangue matter of relatively low specific gravity, the impedance to settling in the classification compartment may be established to cause substantially all the gangue matter regardless of its size or shape, to pass out across the overflow while the mineral through the various size ranges, because of its high specific gravity, will settle through the resistance zone and pass into the conveying and dewatering compartment where it is collected and removed as a concentrate.

From the foregoing it will be apparent that the present invention provides a simple, economical and efficient method of hydraulic classification, which also may be utilized as a concentrating medium in the treatment of certain materials. Changes and modifications may be availed of within the spirit and scope of the invention as defined in the hereunto appended claims.

What I claim and desire to secure by Letters Patent is:

1. A hydraulic classification method, which comprises the treatment of a body of solids in mixed sizes in two pools which lie within a common horizontal plane and in adjoining vertical planes maintained in physically separated relation with a countercurrent restricted flow from the bottom of one said pool into the bottom of the other pool, one of said pools having its surface at a substantially higher elevation than the surface of the other pool, feeding a pulp containing solids in mixed sizes into one said pool at a point horizontally distant and at a higher elevation than the restricted flow, maintaining a hindered settling action in the pool in which the pulp is fed by directing upward flowing currents across substantially the entire area of the pool between the point of feed introduction and said restricted flow, passing solids in the larger size ranges countercurrent to said upward currents in a horizontally ranging course into and through the restricted flow to the other said pool, feeding wash water into the conveying pool at a rate sufficient to maintain the level of the conveying pool above the level of the first mentioned pool, flowing the wash water containing fine particles from the conveying pool to the first mentioned pool for further impeding said countercurrent settling conveying settled solids through said last-mentioned pool to an elevated point of discharge, and overflowing solids in the finer size ranges from the first said pool.

2. A hydraulic classification method, which comprises the treatment of a body of solids in mixed sizes in two pools which lie within a common horizontal plane and in adjoining vertical planes maintained in physically separated relation with a countercurrent restricted flow from the bottom of one said pool into the bottom of the other pool, one of said pools having its surface at a substantially higher elevation than the surface of the other pool, feeding a pulp containing solids in mixed sizes into one said pool at a point horizontally distant and at a higher elevation than the restricted flow, maintaining a hindered settling action in the pool in which the pulp is fed by directing upward flowing currents across substantially the entire area of the pool between the point of feed introduction and said restricted flow, moving said currents through the pool at a velocity sufficient to maintain the contents of the pool in constant teeter, passing solids in the larger size ranges countercurrent to said upward currents in a horizontally ranging course into and through the restricted flow to the other said pool, feeding wash water into the conveying pool at a rate sufficient to maintain the level of the conveying pool above the level of the first mentioned pool, flowing the wash water containing fine particles from the conveying pool to the first mentioned pool for further impeding said countercurrent settling conveying settled solids through said last-mentioned pool to an elevated point of discharge, and overflowing solids in the finer size ranges from the first said pool.

3. A hydraulic classification method, which comprises the treatment of two physically separated pools confined in end-to-end relation, one of which has its surface at a substantially higher elevation than the surface of the other pool, feeding a pulp containing solids in mixed sizes into the pool of lower surface elevation, flowing settled solids from the bottom of the pool in which the pulp is fed through a zone of restricted volume into the lower portion of the other said pool, directing upward flowing currents substantially across the bottom of the pool in which pulp is fed to hinder settling of fine sizes in the feed, feeding wash water into said other pool at a rate sufficient to maintain the level of said pool above the level of the pool into which the pulp is fed, said wash water forming a high density fluid with solids of the finer size ranges flowing the high density fluid from the pool of higher surface elevation into the zone of restricted volume so as to further impede the settling of particles in fine sizes in the other pool, overflowing solids in the finer size ranges from the last-mentioned pool, and conveying settled solids through the pool of higher surface elevation to an elevated point of discharge from the treatment.

4. A hydraulic classification method, which comprises the treatment of two physically separated pools confined in end-to-end relation, one of which has its surface at a substantially higher elevation than the surface of the other pool, feeding a pulp containing solids in mixed sizes into the pool of lower surface elevation, flowing settled solids from the bottom of the pool in which the pulp if fed through a zone of restricted volume into the lower portion of the other said pool, directing upward flowing currents substantially across the bottom of the pool in which pulp is fed to hinder settling of fine sizes in the feed by introducing a pressure fluid in a plurality of streams therein, feeding wash water into said other pool at a rate sufficient to maintain the level of said pool above the level of the pool into which the pulp is fed, said wash water forming a high density fluid with solids of the finer size ranges flowing the high density fluid from the pool of higher surface elevation into the zone of restricted volume so as to further impede the settling of particles in fine sizes in the other pool, overflowing solids in the finer size ranges from the last-mentioned pool, and conveying settled solids through the pool of higher surface elevation to an elevated point of discharge from the treatment.

5. A hydraulic classification method, which comprises the treatment of two physically separated pools confined in end-to-end relation, one of which has its surface at a substantially higher elevation than the surface of the other pool, feeding a pulp containing solids in mixed sizes into the pool of lower surface elevation, flowing settled solids from the bottom of the pool in which the pulp is fed through a zone of restricted volume into the lower portion of the other said pool, directing upward flowing currents substantially across the bottom of the pool in which pulp is fed to hinder settling of fine sizes in the feed by introducing water under pressure in a plurality of streams therein, feeding wash water into said other pool at a rate sufficient to maintain the level of said pool above the level of the pool into which the pulp is fed, said wash water forming a high density fluid with solids of the finer size ranges flowing the high density fluid from the pool of higher surface elevation into the zone of restricted volume so as to further impede the settling of particles in fine sizes in the other pool, overflowing solids in the finer size ranges from the last-mentioned pool, and conveying settled solids through the pool of higher surface elevation to an elevated point of discharge from the treatment.

6. A hydraulic classification method, which comprises the treatment of two physically separated pools confined in end-to-end relation, one of which has its surface at a substantially higher elevation than the surface of the other pool, feeding a pulp containing solids in mixed sizes into the pool of lower surface elevation, flowing settled solids from the bottom of the pool in which the pulp is fed through a zone of restricted volume into the lower portion of the other said pool, directing upward flowing currents substantially across the bottom of the pool in which pulp is fed to hinder settling of fine sizes in the feed, feeding wash water into said other pool at a rate sufficient to maintain the level of said pool above the level of the pool into which the pulp is fed, said wash water forming a high density fluid with solids of the finer size ranges flowing the high density fluid from the pool of higher surface elevation into the zone of restricted volume so as

to further impede the settling of particles in fine sizes in the other pool, overflowing solids in the finer size ranges from the last-mentioned pool, conveying settled solids through the pool of higher surface elevation to an elevated point of discharge from the treatment, and subjecting solids being conveyed out of said pool to a washing action to remove entrained fines and thereby increase the density of the pool into which they drain.

7. A hydraulic classification method, which comprises the treatment of two physically separated pools confined in end-to-end relation, one of which has its surface at a substantially higher elevation than the surface of the other pool, feeding a pulp containing solids in mixed sizes into the pool of lower surface elevation, flowing settled solids from the bottom of the pool in which the pulp is fed through a zone of restricted volume into the lower portion of the other said pool, directing upward flowing currents in different directions substantially across the bottom of the pool in which pulp is fed to hinder settling of fine sizes in the feed, feeding wash water into said other pool at a rate sufficient to maintain the level of said pool above the level of the pool into which the pulp is fed, said wash water forming a high density fluid with solids of the finer size ranges flowing the high density fluid from the pool of higher surface elevation into the zone of restricted volume so as to further impede the settling of particles in fine sizes in the other pool, overflowing solids in the finer size ranges from the last-mentioned pool, and conveying settled solids through the pool of higher surface elevation to an elevated point of discharge from the treatment.

8. A hydraulic classification method, which comprises the treatment of two physically separated pools confined in end-to-end relation, one of which has its surface at a substantially higher elevation than the surface of the other pool, feeding a pulp containing solids in mixed sizes into the pool of lower surface elevation, flowing settled solids from the bottom of the pool in which the pulp is fed through a zone of restricted volume into the lower portion of the other said pool, directing upward flowing currents substantially across the bottom of the pool in which pulp is fed to hinder settling of fine sizes in the feed, feeding wash water into said other pool at a rate sufficient to maintain the level of said pool above the level of the pool into which the pulp is fed, said wash water forming a high density fluid with solids of the finer size ranges flowing the high density fluid from the pool of higher surface elevation into the zone of restricted volume so as to further impede the settling of particles in fine sizes in the other pool, overflowing solids in the finer size ranges from the last-mentioned pool, conveying settled solids through the pool of higher surface elevation to an elevated point of discharge from the treatment, and increasing the density of the pulp in the last-mentioned pool to provide additional resistance to the passage of solids from the other pool.

9. A hydraulic classification method, which comprises the treatment of two physically separated pools confined in end-to-end relation, one of which has its surface at a substantially higher elevation than the surface of the other pool, feeding a pulp containing solids in mixed sizes into the pool of lower surface elevation, flowing settled solids from the bottom of the pool in which the pulp is fed through a zone of restricted volume

into the lower portion of the other said pool, directing upward flowing currents substantially across the bottom of the pool in which pulp is fed to hinder settling of fine sizes in the feed, varying the velocity of said currents in accordance with changes in the pulp, feeding wash water into said other pool at a rate sufficient to maintain the level of said pool above the level of the pool into which the pulp is fed, said wash water forming a high density fluid with solids of the finer size ranges flowing the high density fluid from the pool of higher surface elevation into the zone of restricted volume so as to further impede the settling of particles in fine sizes in the other pool, overflowing solids in the finer size ranges from the last-mentioned pool, and conveying settled solids through the pool of higher surface elevation to an elevated point of discharge from the treatment.

10. Apparatus of the character described, comprising a tank for pulp having an inclined bottom, a solids discharge outlet at the upper end of said inclined bottom, an overflow weir at the lower end of said tank, a partition dividing said tank into two compartments for maintaining pulp-containing pools in end-to-end relation, there being a restricted opening in said partition for the countercurrent passage of pulp from the bottom of one pool to the bottom of the other, means for feeding pulp into the compartment adjoining said overflow weir, said compartment having its bottom disposed in converging relation to the partition at the restricted opening so as to crowd and direct settling solids through said opening, means for injecting liquid under pressure in a plurality of streams distributed over substantially the entire bottom of the feed-receiving pool, and conveyor means for moving settled solids in the other said compartment to the solids discharge outlet.

11. Apparatus of the character described, comprising a tank for pulp having an inclined bottom, a solids discharge outlet at the upper end of said inclined bottom, an overflow weir at the lower end of said tank, a partition dividing said tank into two compartments for maintaining pulp-containing pools in end-to-end relation, there being a restricted opening in said partition for the countercurrent passage of pulp from the bottom of one pool to the bottom of the other, means for feeding pulp into the compartment adjoining said overflow weir, said compartment having its bottom disposed in converging relation to the partition at the restricted opening so as to crowd and direct settling solids through said opening, means for injecting liquid under pressure in a plurality of streams distributed over substantially the entire bottom of the feed-receiving pool, said means being mounted for movement to different liquid injecting positions, and conveyor means for moving settled solids in the other said compartment to the solids discharge outlet.

12. Apparatus of the character described, comprising a tank for pulp having an inclined bottom, a solids discharge outlet at the upper end of said inclined bottom, an overflow weir at the lower end of said tank, a partition dividing said tank into two compartments for maintaining pulp-containing pools in end-to-end relation, there being a restricted opening in said partition for the countercurrent passage of pulp from the bottom of one pool to the bottom of the other, means for feeding pulp into the compartment adjoining said overflow weir, said compartment having its bottom disposed in converging relation to the partition at the restricted opening so as to crowd and direct settling solids through said opening, means for injecting liquid under pressure in a plurality of streams distributed over substantially the entire bottom of the feed-receiving pool, means comprising at least one partition arranged to vary the width of the feed-receiving pool, and conveyor means for moving settled solids in the other said compartment to the solids discharge outlet.

13. Apparatus of the character described, comprising a tank for pulp having an inclined bottom, a solids discharge outlet at the upper end of said inclined bottom, an overflow weir at the lower end of said tank, a partition dividing said tank into two compartments for maintaining pulp-containing pools in end-to-end relation, there being a restricted opening in said partition for the countercurrent passage of pulp from the bottom of one pool to the bottom of the other, means for feeding pulp into the compartment adjoining said overflow weir, said compartment having its bottom disposed in converging relation to the partition at the restricted opening so as to crowd and direct settling solids through said opening, means for injecting liquid under pressure in a plurality of streams distributed over substantially the entire bottom of the feed-receiving pool, including a plurality of valve-controlled nozzles disposed along said sloping bottom at intervals above the opening, and conveyor means for moving settled solids in the said other compartment to the solids discharge outlet.

14. Apparatus of the character described, comprising a tank for pulp having an inclined bottom, a solids discharge outlet at the upper end of said inclined bottom, an overflow weir at the lower end of said tank, a partition dividing said tank into two compartments for maintaining pulp-containing pools in end-to-end relation, there being a restricted opening in said partition for the countercurrent passage of pulp from the bottom of one pool to the bottom of the other, means for feeding pulp into the compartment adjoining said overflow weir, said compartment having its bottom disposed in converging relation to the partition at the restricted opening so as to crowd and direct settling solids through said opening, means for injecting liquid under pressure in a plurality of streams distributed over substantially the entire bottom of the feed-receiving pool, including a plurality of nozzles disposed along said sloping bottom at intervals above the opening and an individual valve-controlled conduit connected to each said nozzle, and conveyor means for moving settled solids in the other said compartment to the solids discharge outlet.

15. Apparatus of the character described, comprising a tank for pulp having an inclined bottom, a solids discharge outlet at the upper end of said inclined bottom, an overflow weir at the lower end of said tank, a partition dividing said tank into two compartments for maintaining pulp-containing pools in end-to-end relation, said partition comprising a lower portion fixedly held within the tank and an upper portion mounted to provide a restricted passage of variable area for the countercurrent passage of pulp from the bottom of one pool to the bottom of the other, means for feeding pulp into the compartment adjoining said overflow weir, said compartment having its bottom disposed in converging relation to the partition at the restricted opening so as to crowd and direct settling solids through said opening,

means for injecting liquid under pressure in a plurality of streams distributed over substantially the entire bottom of the feed-receiving pool, conveyor means for moving settled solids in the other said compartment to the solids discharge outlet, and means for supplying additional liquid to the pulp body in the last-mentioned compartment.

16. Apparatus of the character described, comprising a tank for pulp having an inclined bottom, a solids discharge outlet at the upper end of said inclined bottom, an overflow weir at the lower end of said tank, a partition dividing said tank into two compartments for maintaining pulp-containing pools in end-to-end relation, said partition comprising a lower portion fixedly held within the tank and an upper portion mounted for up and down movement to provide a restricted passage of variable area for the countercurrent passage of pulp from the bottom of one pool to the bottom of the other and extending above the elevation of the overflow weir to provide a superelevation of the pool adjoining the solids discharge end of the tank, means for feeding pulp into the compartment adjoining said overflow weir, said compartment having its bottom disposed in converging relation to the partition at the restricted opening so as to crowd and direct settling solids through said opening, means for injecting liquid under pressure in a plurality of streams distributed over substantially the entire bottom of the feed-receiving pool, conveyor means for moving settled solids in the other said compartment to the solids discharge outlet, and means for supplying additional liquid to the pulp body in the last-mentioned compartment.

17. Apparatus of the character described, comprising a tank for pulp having an inclined bottom, a solids discharge outlet at the upper end of said inclined bottom, an overflow weir at the lower end of said tank, a partition dividing said tank into two compartments for maintaining pulp-containing pools in end-to-end relation, there being a restricted opening in said partition for the countercurrent passage of pulp from the bottom of one pool to the bottom of the other, means for varying the restriction of said opening, means for feeding pulp into the compartment adjoining said overflow weir, said compartment having its bottom disposed in converging relation to the partition at the restricted opening so as to crowd and direct settling solids through said opening, means for injecting liquid under pressure in a plurality of streams distributed over substantially the entire bottom of the feed-receiving pool, and conveyor means for moving settled solids in the other said compartment to the solids discharge outlet.

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