

April 6, 1943.

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2,315,536

CLASSIFICATION METHOD AND APPARATUS

Filed Aug. 10, 1939

4 Sheets-Sheet 1

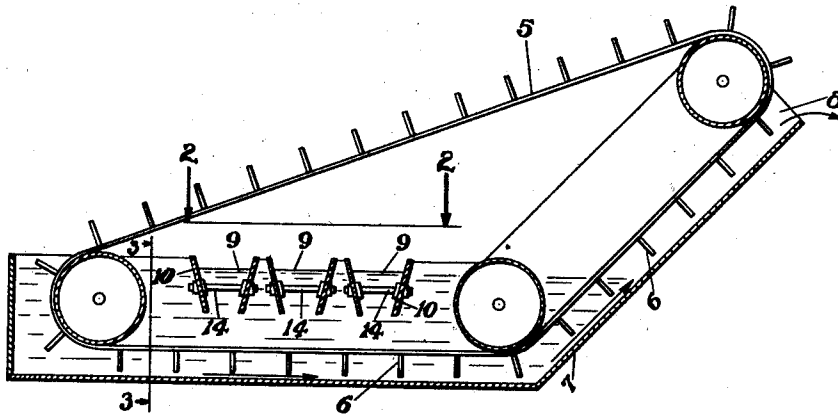


Fig. 1

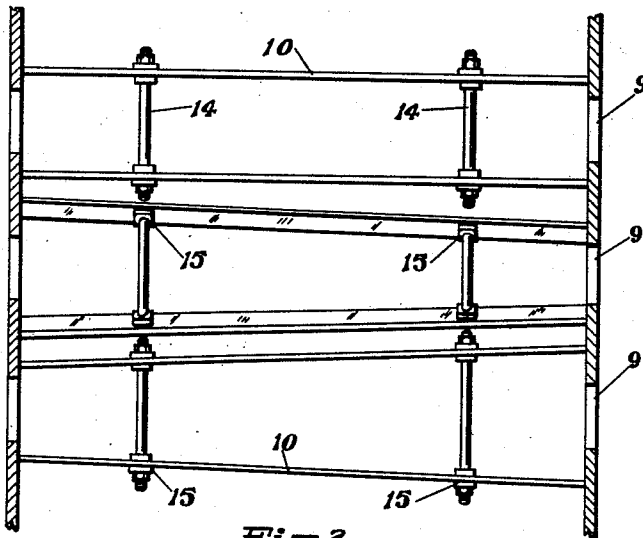


Fig. 2

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4 Sheets-Sheet 2

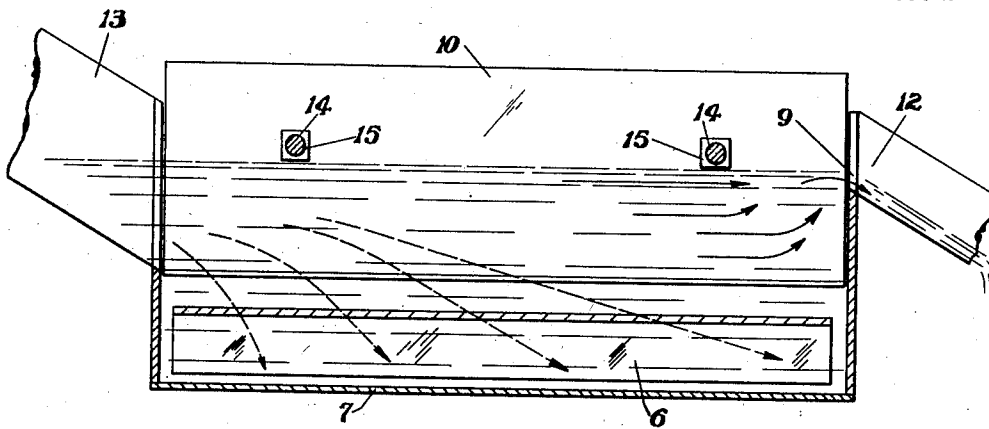


Fig. 3

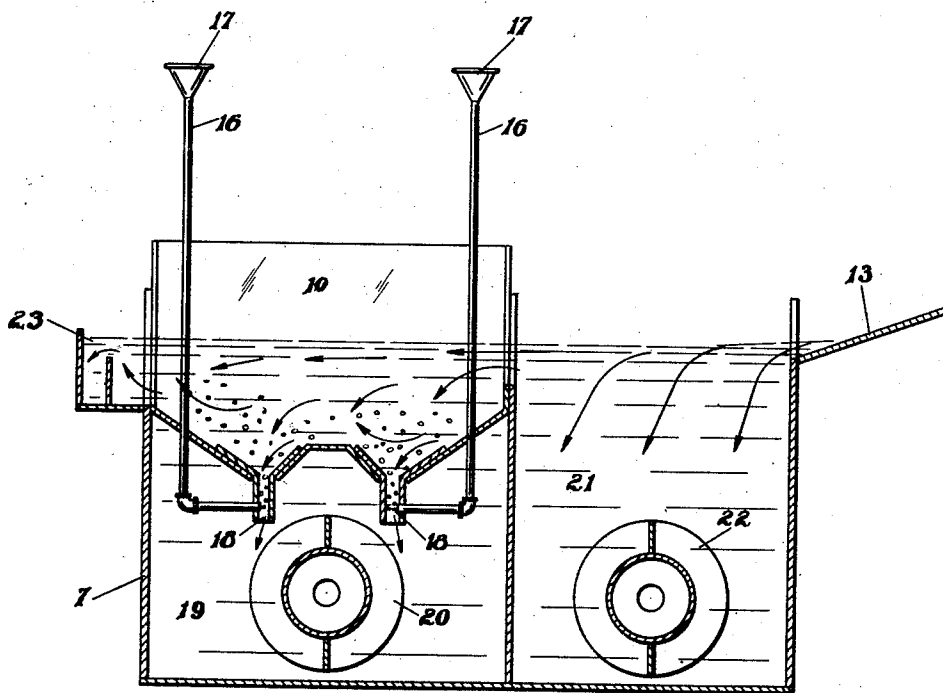


Fig. 4

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4 Sheets-Sheet 3

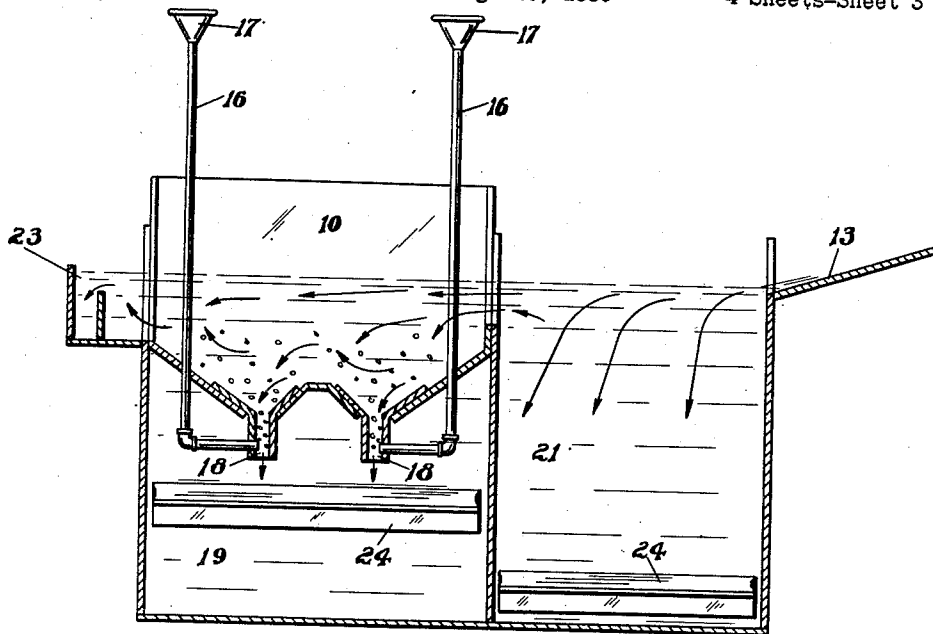


Fig. 5

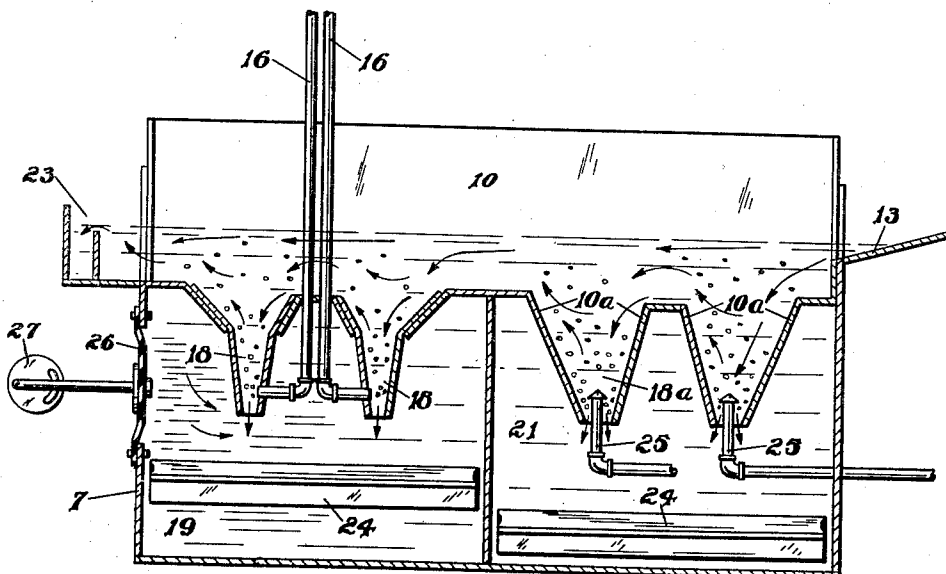


Fig. 6

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4 Sheets-Sheet 4

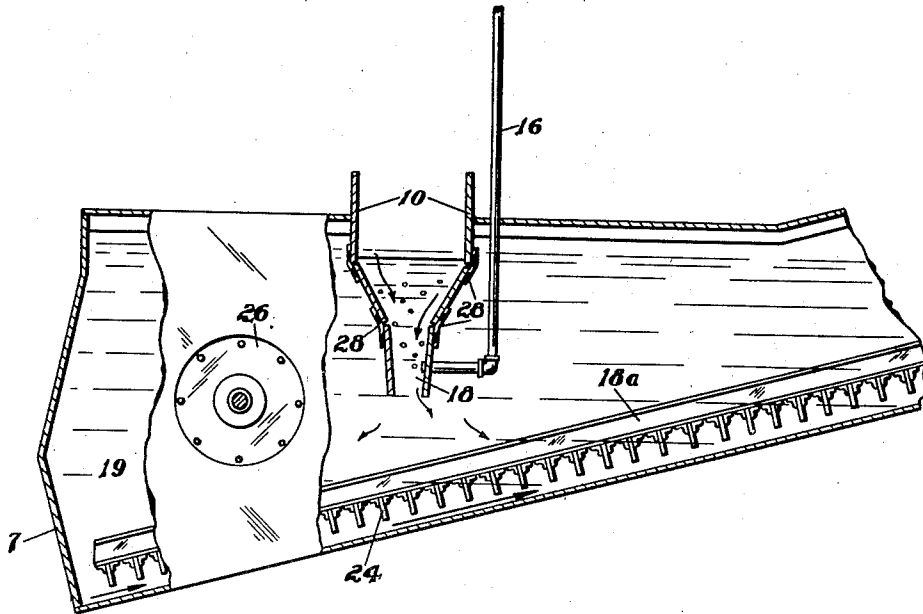


Fig. 7

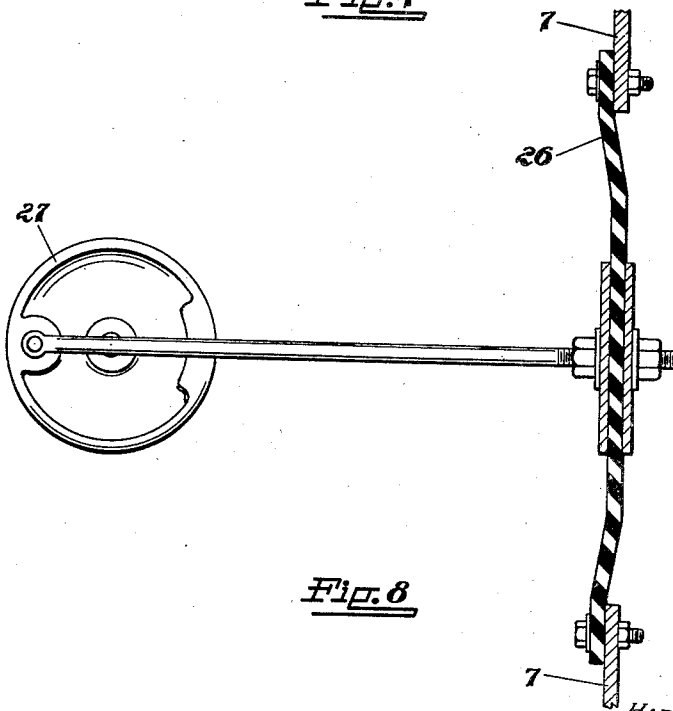


Fig. 8

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2,315,536

CLASSIFICATION METHOD AND APPARATUS

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Application August 10, 1939, Serial No. 289,466

15 Claims. (Cl. 209-157)

This invention relates to classification methods and apparatus for the practice of such methods and more particularly relates to an improved method and means for the elimination of undersize from classification treatments.

Heretofore in the art of classification, particularly as it has been applied to the treatment of ores in closed circuit grinding operations, deleterious results have occurred from the retention of undersize material in the classification treatment for periods longer than necessary to attain the desired degree of separation.

In classification treatments and particularly metallurgical operations, it frequently happens that relatively large amounts of freed mineral of relatively heavy specific gravity will be ready for treatment after a single pass through the grinding mill. Because of the high specific gravity, such material, upon reaching the classification stage, immediately descends into the raked material with which it is returned to the grinding circuit and subsequently broken down into finer sizes. It is a well known fact that the major metallurgical loss of most operations occurs in the finer sizes (minus 300 mesh) and the present invention has for one of its objects, the diminution of such loss in metallurgical treatments.

It is a principal object of the present invention to promptly eliminate from the classification treatment a relatively large percentage of the fines of the separation before the main body of material under treatment has been subjected to the agitative influences of the elevating means.

A further object of the invention is the control of feed introduction into a classification stage to determine the movement of constituents of material differentially according to the ratio of sizes and specific gravities thereof.

Another object of the invention is the provision of a selective control of the separative action of classification treatment to regulate the products of the respective discharges within predetermined limits.

Still another object of the invention resides in the provision of an impellent action to regulate the settling rate of different constituents in the material under treatment.

A still further object of the invention is the provision of novel means of velocity control of constituents of the material under treatment to thereby produce a precision control of the separative action.

Other objects reside in novel details of construction, in novel steps and treatments, and novel combinations and arrangements of parts, 55

all of which will appear more fully in the course of the following description.

To afford a better understanding of the invention, reference will be made to the accompanying drawings illustrating structure and operation in accordance with the invention. In the drawings, in the several views of which like parts have been designated similarly,

Figure 1 is a side elevation partially in section illustrating the application of the invention to a classifier of the endless drag type;

Figure 2 is a fragmentary plan view taken along the line 2-2, Figure 1 and drawn to an enlarged scale;

Figure 3 is a section taken along the line 3-3, Figure 1, also drawn to an enlarged scale;

Figure 4 is an end elevation partially in section of a modified form of the invention applied to a classifier of the spiral or "Akins" type;

Figure 5 is an end elevation partially in section of another modification of the invention applied to a classifier of the reciprocating rake type;

Figure 6 is an end elevation of another modification of the invention applied to a classifier of the reciprocating rake type;

Figure 7 is a fragmentary side elevation partially in section, of the classifier tank of Figure 6; and

Figure 8 is an enlarged fragmentary section of the reciprocating diaphragm shown in Figure 6.

Referring now to Figures 1, 2 and 3, the classifier illustrated comprises a tank 7 having a sands discharge 8 to which material is moved by a scraper 6 of an endless drag member 5. Mounted within the tank 7 in a submerged or at least partially submerged condition, are a series of lateral open bottom troughs 10 defined by cooperatively adjustable members mounted on shafts 14 with a fines overflow opening 9 provided in a side wall of the tank 7 at an end of each of the troughs 10. A suitable receptacle for such discharge, such as a launder 12, is provided adjacent each of the openings 9.

In order to provide the proper adjustment of the members of the trough 10, an adjusting nut 15 is mounted on each of the shafts 14 in engagement with a side of each member 10 and actuation of the nuts 15 will serve to vary the inclination of the members of the trough and by so doing, provide a means for regulation of the velocity of the material passing therethrough. Feed to the tank is provided by an inclined chute or launder 13 suitably partitioned to distribute the feed uniformly into the plurality of troughs 10.

In the operation of this mechanism, the pulp

fed through launder 13 into the plurality of passages 10 distributes itself substantially in the manner indicated diagrammatically by the arrows in Figure 3. The constituents of greater specific gravity or size will settle quickly in the tank adjacent the feed inlet and due to the lateral impetus imparted by the impelling influences at the feed inlet, the materials of progressively lesser specific gravity and size will settle in order in the progress of the charge across the tank, while the finest sizes constituting the finished product of the classification treatment, travel in a substantially straight line movement to the overflow and pass from the tank into launder 12 without being subjected to settling tendencies.

Due to entrapment and other causes, some fines normally tending to remain in suspension will be carried down by the settling action of the heavier materials, but as the zone for settling within the troughs 10 is of a restricted character, and the velocity of the material therein is adequate for the movement of the finer sizes to overflow the discharge, only relatively small amounts of fines will settle from the troughs and reach the bed of sands being impelled out of the tank by the conveyor, in this case the endless drag.

In treatments where there is a relatively large quantity of constituents coming within the class of undersize, substantial quantities of which would normally settle with the sands and be removed at the sands discharge, the troughs 10 are adjusted to restrict the free settling of material therefrom to a substantial degree and by so doing, the velocity of material passing through the troughs is appreciably increased.

This control of velocity serves to maintain the finer sizes in suspension and permit only the settling of those constituents requiring removal with the sands.

In other treatments where the close control of the settling rate of the finer sizes is not so important, the velocity of material in the trough can be decreased by adjustment of the trough defining members and thus promote a more rapid settling of the coarser constituents.

From the foregoing, it will be seen that the provision for feeding material into the tank in a direction transverse to the impelling movement of the conveyor mechanism, effectively serves to reduce the duration of retention of the undersize in the tank and thus restricts the principal treatment of the operation to material from which the finished product has been substantially eliminated.

A further advantage from the velocity control and the resulting prompt removal of the finished product, resides in the relation of the volume of the material under treatment to the velocity control. Where the entering feed diminishes appreciably, obviously a variation in the passage to maintain uniformity of velocity will be required to induce the proper separation of the finished product; whereas, with a feed approaching maximum capacity, a different volume will be required to induce the movement of the proper quantity of the finished product to the overflow. Therefore, initial testing for a given operation will determine the proper velocity regulation and subsequently feed changes or variations in other factors tending to alter the result, will require additional velocity regulation.

Referring next to Figure 4, the tank illustrated is of a duplex type, divided into two separation zones 19 and 21 respectively. Feed from

a launder 13 enters the zone or compartment 21 near the overflow level of the tank determined by a weir overflow 23 and passes into compartment 19 through troughs 10. Due to the velocity imparted to the entering feed by its gravitational movement into the tank only the materials of greatest specific gravity and size will settle in compartment 21, as in this compartment the dilution and agitation will be such that practically no finished product can settle.

A spiral 22 mounted in the tank, moves the settled material to the elevated sands discharge (not shown). In the second zone or compartment 19, the trough members 10 are provided with hindered settling cones or members of conic section in place of the open bottom arrangement of Figure 1. These cones terminate in spigots 18, into each of which a conduit 16 extends from an elevated funnel member 17 (or other source of supply).

Small quantities of water are continuously entered into the spigots 18 from a supply in the funnel 17 and exert a countercurrent influence on the settling solids passing into the spigots 18, which serves to elevate therefrom any adhering fines which are thereby returned to a state of suspension and subsequently pass to the discharge across overflow weir 23. The settled solids descending through the spigots 18 are thereupon acted upon by a second spiral 20 which moves the same to the elevated sands discharge (not shown).

In Figure 5 a similar arrangement has been shown, with the exception that the reciprocating rakes 24 in each of the compartments 19 and 21 have been substituted as the elevating conveyor in place of the spirals 20 and 22.

In each form of the invention illustrated in Figures 4 and 5, the finished product is maintained in suspension during its movement through compartment 21 by reason of the dilution and agitation therein, and upon entering into compartment 19, is readily maintained in suspension by the velocity, coupled with certain elevating influences hereinafter described.

Thus, relatively small quantities of dilution fluid are required to produce a given overflow because this dilution is concentrated upon washing the sands before they leave the hindered settling cones and discharge into the raking zone. Likewise, the disturbing effect of the raking or conveying movements are divorced from the separative action in this form of classification.

In this connection, it is to be observed that only relatively small quantities of fluid are required to be introduced through the conduit 16 to provide the necessary degree of countercurrent action, and consequently, the effects of the dilution are not appreciable, and little, if any, of the finished product is able to descend through the opposition of the countercurrent flow.

Unlike other forms of countercurrent chambers heretofore used in the art, the discharge of the spigot is not open to atmospheric pressure. The quantity of water discharging from the bottom of the spigot is not controlled by the size of the opening, but by the amount of water entrained by the dewatered rake product as it emerges from the body of liquid at the sands discharge.

In Figure 6, still another form of construction has been illustrated and has been exemplified in connection with a classifier of the reciprocating rake type. In this form of invention, the tank is divided into two compartments 19 and 21, and

feed is again introduced into the compartment 21 through a feed chute or launder 13.

In this compartment, to the troughs 10, hereinafter described, funnel-shaped trough members 10a have been added, which provide a restricted opening for the passage of settling material to the reciprocating rake 24. Extending into the members 10a from the bottom thereof are conduits 25 suitably connected with a source of gas under pressure (not shown). These conduits terminate within the members 10a in a discharge outlet or nozzle suitably capped to prevent the descent of solids into the conduit.

Material tending to separate from the impelling pulp stream in the upper portion of the trough is subjected to impelling influences by the action of the conduits 25, and in this way, the fines of the treatment, particularly those coming within the size range of finished product, are separated from the coarser solids and maintained in suspension; the discharge of spigots 10a comprising almost entirely of unfinished material.

Due to the impelling action imparted by the launders 13 and the velocity control exercised by the troughs 10, the main body of lighter material passes through compartment 21 at the upper surface of trough 10 and enters into compartment 19 which is similar to the corresponding compartment of Figure 5.

However, to aid the elevating tendency of the countercurrent flow, there is also provided a reciprocating diaphragm 26 in a wall of the tank 7, which is actuated by any suitable prime mover 27, usually an eccentric as here illustrated (Figure 8).

The reciprocating diaphragm 26, in reality, varies the volumetric capacity of the tank, thereby pulsating the body of liquid in the tank without vibrating or pulsating the tank or its associated mechanism. This vibrating movement of the body of liquid within the tank aids in holding up the fine or finished particles in the pulp, while at the same time facilitating the breaking up of flocs of particles which may tend to accumulate in the pulp. This breaking-up of the flocs facilitates separating the coarse particles from the fine or finished particles and as the flocs are broken up, the heavy particles or sands are free to settle away from the lighter particles.

While the various trough arrangements providing the control means for the separation action have been illustrated in connection with specific types of classifiers, it will be appreciated that any of the arrangements illustrated in Figures 2, 4, 5 and 6 can be incorporated into any type of classifier, such as the endless drag type, the reciprocating rake type, or the spiral type and such classifiers may be either of the single-compartment or plural-compartment construction.

It will be understood that the various troughs utilizing spigot discharges are adjustable for the regulation of velocity, as for example, by hinges 28, Figure 7, and in any of the trough structures herein described, the surfaces may be warped instead of straight as a further factor of velocity control when desired.

In the usual classification treatment, there will be a relatively large amount of freed mineral in heavy sizes which is in proper condition for treatment. Because of its weight, such mineral descends into the raked product of classification and subsequently is again returned to grinding where it is broken up further, although such re-

sult is undesirable from a metallurgical standpoint.

To avoid such deleterious action, the air can be discharged through nozzle 25 in a violent manner, which serves to establish a hindered settling condition in the cones without any dilution.

Then, by entering a suitable flotation reagent into the pulp fed to the first compartment 21, as by feeding reagent into launder 13, these heavier mineral particles will be elevated by the aeration and carried to the surface, or held at the surface. Due to the velocity of the streams traveling through troughs 10, such collected mineral immediately passes to the overflow 23 for discharge to subsequent treatment.

In connection with the foregoing operation, it should be noted that the air is not introduced in close proximity to the overflow, but distantly therefrom, as it is used primarily for hindered settling, and therefore does not interfere with the final critical separation in the compartment 19.

Likewise, with a classifier such as the form illustrated in Figure 4, it is possible to return the raked product from compartment 21 to the mill for regrinding while the slimes overflow from the troughs 10 and the sands discharge from compartment 19 are removed from the circuit as final products; the graded settling being effective for keeping undesirable quantities of oversize out of the finished sands.

Having thus described the operating procedure and structural forms utilized, a comparison of some of the features of the present invention with common practice may provide a better understanding of the practice of the present invention.

As an example, with conventional equipment, high conveying speeds with the rakes or screws produce such violent agitation that the separation is reduced appreciably, unless an excessive amount of water is added to dilute the bath and overcome the violence of the conveying influences. In most plants, the use of excess water increases first cost and operating cost.

In the present invention, the classifying or separative action is separated from the conveying or raking movements, and violent agitation induced by high speed movement does not extend into the zone of separation. As a consequence, higher circulating loads can be carried in less floor space than with other classifiers.

Further, by using a continuous conveyor, much steeper slopes can be employed, making it possible to operate mills in closed circuit which at present need auxiliary equipment. Also by so doing, it is possible to treat the raked product of the classifier and still return the sand to the mill scoop box by gravity.

Preferably, this treatment will comprise a gravity separation operation such as jigging, in which the freed mineral too coarse to float is recovered and removed from the circuit as a concentrate product. The remainder inclusive of the middlings product so separated, then returns to the mill as indicated, for regrinding.

The product so treated may be the entire rake discharge of the classifier. However, in classifiers of the type illustrated in Figures 4, 5 and 6, freed mineral capable of floating will be maintained at or near the surface by reason of the hindered settling treatment, and consequently passes from the classifier at the overflow 23. Due to this separation, the rake product of compartment 19 contains such a small amount of

freed mineral that treatment of this product is economically unimportant.

In contradistinction, the rake product of compartment 21, particularly in the forms illustrated in Figures 4 and 5, will contain substantial amounts of freed mineral in the unfloatable sizes, due to the provision of rapid settling of materials of high specific gravity in said compartment.

As a consequence, the product selected for the gravity separation treatment is one in which substantially all finished product has been eliminated and the freed mineral of high specific gravity is graded in size by reason of the separation occurring in compartment 21 so it is appreciably smaller than the size of the gangue particles with which it is associated.

By reason of this condition, the product responds readily to gravity separation methods such as jigging, to provide an efficient recovery of the freed mineral.

Conventional classifiers act as thickeners to a large extent, with respect to the finished product. Such material is detained too long in tanks which are too large, with the result that much of such product settles into the raked product and needlessly returns to the grinding mill.

With the present invention, the removal of substantial quantities of finished product across the overflow in the first pass through the classifier serves to produce a better product at each extreme of the grinding range, due to finer grinding of coarse sizes and coarser grinding of finer sizes, and thus, fewer grains of mineral are produced in unlocking the mineral in a given quantity of ore under treatment.

This condition has a beneficial effect on the entire milling operation, particularly at the gravity concentration, flotation, thickening, filtering and leaching stages. Likewise, it will be understood that every ton of granular finished product eliminated from the raked product of the classifier, leaves room in the grinding mill for a ton of unfinished material on which useful work can be done.

A further advantage of the present invention resides in its flocculation control. Thus, in conventional practice, the difference in degree of flocculation in two pulps may make it necessary to use twice the size of classifier on the one that is necessary to give the same overflow on the other. Flocs can form more readily if given time and relative quiescence, and both functions are present in conventional classifier operation.

However, with the present invention, the velocity control permits regulation of the time element, which can be reduced to a minimum when conditions require. And where the countercurrent treatment is utilized, the upward current of diluting fluid will act as a dispersant as its influence is concentrated at the points where classification occurs.

With this understanding of the invention, it will be apparent that while in the preferred form of construction the troughs 10 are disposed transversely to the movement of the raked product through the tank, such troughs may extend in any direction, and so long as velocity control is exercised to obtain quick elimination of the finished product, the essentials of the present invention will be utilized.

Further, with reference to the use of the reciprocating mechanism, the purpose is to prevent a segregation of ascending and descending streams in the cones. Consequently, any mechanism pro-

ducing a similar pulsating movement, such as the "Richards rotary plug cock" may be used as a substitute for the reciprocating diaphragm.

From the foregoing, it will be apparent that the present invention in its various embodiments provides means for a close control of the separative action of the classification treatment and particularly in the speedy elimination of finished product.

Changes and modifications may be availed of within the spirit and scope of the invention as defined in the hereunto appended claims.

Having thus fully described my invention what I claim as new and desire to secure by Letters Patent is:

1. A classifier comprising a tank divided into a plurality of classifying zones for the reception of solids settled from pulp comprising a mixture of solids suspended in liquid, conveyor means positioned to move settled solids from each of said zones, open bottom trough-like means extending across said tank in a position transverse to the direction of removal of solids from said tank, there being an inlet for fluid pulp at one end of said trough-like means and a discharge overflow at the other end thereof, a cone positioned beneath said trough-like means in conductive communication therewith and terminating in a spigot positioned within said tank and substantially above one of said conveyors, and means for introducing a flow of fluid into said cone in a direction counter to the normal direction of gravitational settling of solids in the cone.

2. A classifier comprising a tank divided into a plurality of classifying zones for the reception of solids settled from pulp comprising a mixture of solids suspended in liquid, conveyor means positioned to move settled solids from each of said zones, trough-like means extending across said tank in a position transverse to the direction of removal of solids from said tank, there being an inlet for fluid pulp at one end of said trough-like means and a discharge overflow at the other end thereof, cones positioned beneath said trough-like means in conductive communication therewith and each terminating within the respective zones of said tank and substantially above said conveyors, and means for introducing a flow of fluid into said cones in a direction counter to the normal direction of gravitational settling of solids in the cones.

3. A classifier comprising a tank divided into a plurality of classifying zones for the reception of solids settled from pulp comprising a mixture of solids suspended in liquid, conveyor means positioned to move settled solids from each of said zones, trough-like means extending across said tank in a position transverse to the direction of removal of solids from said tank, there being an inlet for fluid pulp at one end of said trough-like means and a discharge overflow at the other end thereof, cones positioned beneath said trough-like means in conductive communication therewith and each terminating within the respective zones of said tank and substantially above said conveyors, means for introducing a flow of liquid into one of said cones in a direction counter to the normal direction of gravitational settling of solids in the cone, and means for introducing a flow of gas under pressure in a direction counter to the normal direction of gravitational settling of solids in the cone.

4. A classifier comprising a tank divided into a plurality of classifying zones for the reception of solids settled from pulp comprising a mixture

of solids suspended in liquid, conveyor means positioned to move settled solids from each of said zones, open bottom trough-like means extending across said tank in a position transverse to the direction of removal of solids from said tank, there being an inlet for fluid pulp at one end of said trough-like means and a discharge overflow at the other end thereof, a cone positioned beneath said trough-like means in conductive communication therewith and terminating within said tank and substantially above one of said conveyors, means for introducing a flow of fluid into said cone in a direction counter to the normal direction of gravitational settling of solids in the cone, and a diaphragm in a wall of the tank for rhythmically changing the volumetric capacity of said tank.

5. Apparatus for classification, comprising a tank containing solids in liquid, having an inlet in one wall and an overflow in an opposite wall, means including said inlet constructed and arranged to deliver feed into the tank in a substantially horizontal stream at the surface of the liquid therein, means disposed to impart an upward flow to liquid beneath said horizontal stream, a pair of downwardly converging members in said tank and extending between said inlet and outlet and constituting a partially submerged trough for guiding said horizontal stream directly from the inlet to the overflow, said overflow being disposed in sufficiently close proximity to the top of the trough to maintain a progressive movement of material therethrough and said converging members being constructed and arranged to provide a restricted bottom opening through which substantially less than the entire solids content of said trough may pass under the hindered settling influences within the tank and said converging members defining a passage through which said upward flow of liquid moves, means for changing the angular relationship of said trough members to control the velocity of material passing therethrough, and mechanism for discharging settled matter from the bottom of said tank.

6. Apparatus for classification, comprising a tank containing solids in liquid, having an inlet in one wall and an overflow in an opposite wall, means including said inlet constructed and arranged to deliver feed into the tank in a substantially horizontal stream at the surface of the liquid therein, means disposed to impart an upward flow to liquid beneath said horizontal stream, a pair of downwardly converging members in said tank and extending between said inlet and outlet and constituting a partially submerged trough for guiding said horizontal stream directly from the inlet to the overflow, said overflow being disposed in sufficiently close proximity to the top of the trough to maintain a progressive movement of material therethrough and said converging members being constructed and arranged to provide a restricted bottom opening through which substantially less than the entire solids content of said trough may pass under the hindered settling influences within the tank and said converging members defining a passage through which said upward flow of liquid moves and mechanism for discharging settled matter from the bottom of said tank.

7. In a classifier, inclusive of a tank for pulp, the improvement which comprises a trough in the tank partially submerged in the pulp and extending from one wall to an opposite wall and between an inlet and an outlet determining the pulp level

therein, means inclusive of said inlet for delivering feed into the tank in a substantially horizontal stream at the surface of said pulp body, means disposed to impart an upward flow to liquid beneath said horizontal stream, a pair of downwardly converging walls defining said trough, said outlet being disposed in sufficiently close proximity to the top of the trough to maintain a progressive movement of material therethrough and said walls being constructed and arranged to provide a restricted bottom opening through which substantially less than the entire solids content of said trough may pass under the hindered settling influences within the tank and said converging members defining a passage through which said upward flow of liquid moves, and means for changing the angular relation of said walls.

8. In a classifier, inclusive of a tank for pulp, the improvement which comprises a trough in the tank partially submerged in the pulp and extending from one wall to an opposite wall and between an inlet and an outlet determining the pulp level therein, means inclusive of said inlet for delivering feed into the tank in a substantially horizontal stream at the surface of said pulp body, means disposed to impart an upward flow to liquid beneath said horizontal stream, a pair of downwardly converging walls defining said trough, said outlet being disposed in sufficiently close proximity to the top of the trough to maintain a progressive movement of material therethrough and said walls being constructed and arranged to provide a restricted bottom opening through which substantially less than the entire solids content of said trough may pass under the hindered settling influences within the tank and said converging members defining a passage through which said upward flow of liquid moves, and means for varying the spacing between said walls.

9. Apparatus for classification, comprising a tank containing solids in liquid, having an inlet in one wall and an overflow in an opposite wall, means including said inlet constructed and arranged to deliver feed into the tank in a substantially horizontal stream at the surface of the liquid therein, means disposed to impart an upward flow to liquid beneath said horizontal stream, a pair of downwardly converging members in said tank and extending between said inlet and outlet and constituting a partially submerged trough for guiding said horizontal stream directly from the inlet to the overflow, said overflow being disposed in sufficiently close proximity to the top of the trough to maintain a progressive movement of material therethrough and said converging members being constructed and arranged to provide a restricted bottom opening through which substantially less than the entire solids content of said trough may pass under the hindered settling influences within the tank and said converging members defining a passage through which said upward flow of liquid moves, a pulsating diaphragm in a wall of the tank for changing the volumetric capacity of said tank, and mechanism for discharging settled matter from the bottom of said tank.

10. In a method of classification in which settled solids are mechanically elevated to a point of discharge above a confined liquid body under treatment, the improvement which comprises directing feed, inclusive of a finished product, into such a liquid body in a substantially horizontal stream, confining said stream at the surface of said body in a zone extending from one side of the body directly across to another side thereof, re-

stricting the stream at its lower portion to a greater degree than it is restricted at the surface to attain an expanding classifying effect, subjecting matter in said expanding zone to hindered settling by introducing a fluid in an elevating stream into the same, discharging settled solids from the lower portion of said stream, maintaining the surface of the horizontal stream in close proximity to the top of said expanding zone, maintaining substantially all finished product of the feed at the surface of said horizontal stream during its passage across the body by its movement at a predetermined velocity, and discharging liquid inclusive of said finished product from the treatment at the completion of its movement in said horizontal stream.

11. In a method of classification in which settled solids are mechanically elevated to a point of discharge above a confined liquid body under treatment, the improvement which comprises directing feed, inclusive of a finished product, into such a liquid body in a substantially horizontal stream, confining said stream at the surface of said body in a zone extending from one side of the body directly across to another side thereof, restricting the stream at its lower portion to a greater degree than it is restricted at the surface to attain an expanding classifying effect, subjecting matter in said expanding zone to hindered settling by introducing a gas in an elevating stream into the same, discharging settled solids from the lower portion of said stream, maintaining the surface of the horizontal stream in close proximity to the top of said expanding zone, maintaining substantially all finished product of the feed at the surface of said horizontal stream during its passage across the body by its movement at a predetermined velocity, and discharging liquid inclusive of said finished product from the treatment at the completion of its movement in said horizontal stream.

12. In a method of classification in which settled solids are mechanically elevated to a point of discharge above a confined liquid body under treatment, the improvement which comprises directing feed, inclusive of a finished product, into such a liquid body in a substantially horizontal stream, confining said stream at the surface of said body in a zone extending from one side of the body directly across to another side thereof, restricting the stream at its lower portion to a greater degree than it is restricted at the surface to attain an expanding classifying effect, subjecting matter in said expanding zone to hindered settling by introducing a liquid in an elevating stream into the same, discharging settled solids from the lower portion of said stream, maintaining the surface of the horizontal stream in close proximity to the top of said expanding zone, maintaining substantially all finished product of the feed at the surface of said horizontal stream during its passage across the body by its movement at a predetermined velocity, and discharging liquid inclusive of said finished product from the treatment at the completion of its movement in said horizontal stream.

13. The method of classification which comprises the treatment of a body of solids in liquid within a pool, directing feed inclusive of a finished product and oversize into the pool at its surface in a substantially horizontal stream, confining said stream at the surface of said body in a zone extending from one side of the body directly across to another side thereof, restrict-

ing said stream at its lower portion to a greater degree than it is restricted at the surface to attain an expanding classifying effect, restricting the discharge of settled oversize from said horizontal stream, dividing the settled oversize in graded sizes upon discharge from said stream, subjecting matter in said expanding zone to hindered settling by introducing a fluid into the same, maintaining the surface of the horizontal stream in close proximity to the top of the expanding zone, maintaining substantially all finished product of the feed at the surface of the confined stream during its passage across the body by its movement at controlled velocity, removing liquid inclusive of said finished product from the treatment at the completion of its movement across said liquid body, and separately discharging each graded oversize product from the treatment.

14. In a method of classification in which settled solids are mechanically elevated to a point of discharge above a confined liquid body under treatment, the improvement which comprises directing feed, inclusive of a finished product, into such a liquid body in a substantially horizontal stream, confining said stream at the surface of said body in a zone extending from one side of the body directly across to another side thereof, restricting the stream at its lower portion to a greater degree than it is restricted at the surface to attain an expanding classifying effect, subjecting matter in said expanding zone to hindered settling by introducing a fluid in an elevating stream into the same, discharging settled solids from the lower portion of said stream, maintaining the surface of the horizontal stream in close proximity to the top of said expanding zone, maintaining substantially all finished product of the feed at the surface of said horizontal stream during its passage across the body by its movement at a predetermined velocity, preventing the formation of flocs by pulsation of the liquid body, and discharging liquid inclusive of said finished product from the treatment at the completion of its movement in said horizontal stream.

15. In a method of classification in which settled solids are mechanically elevated to a point of discharge above a confined liquid body under treatment, the improvement which comprises directing feed, inclusive of a finished product, into such a liquid body in a substantially horizontal stream, confining said stream at the surface of said body in a zone extending from one side of the body directly across to another side thereof, restricting the stream at its lower portion to a greater degree than it is restricted at the surface to attain an expanding classifying effect, temporarily diluting matter in said expanding zone in a hindered settling action by introducing gas therein, maintaining material in other portions of said body free from dilution by passing the gas directly to the surface of said horizontal stream following its introduction into the expanding zone, maintaining the surface of the horizontal stream in close proximity to the top of the expanding zone, maintaining substantially all finished product of the feed at the surface of the horizontal stream during its passage across the body, and removing liquid inclusive of said finished product from the treatment at the completion of its movement in said horizontal stream.

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