May 26, 1936. C. E. CARSTENS ET AL 2,042,444

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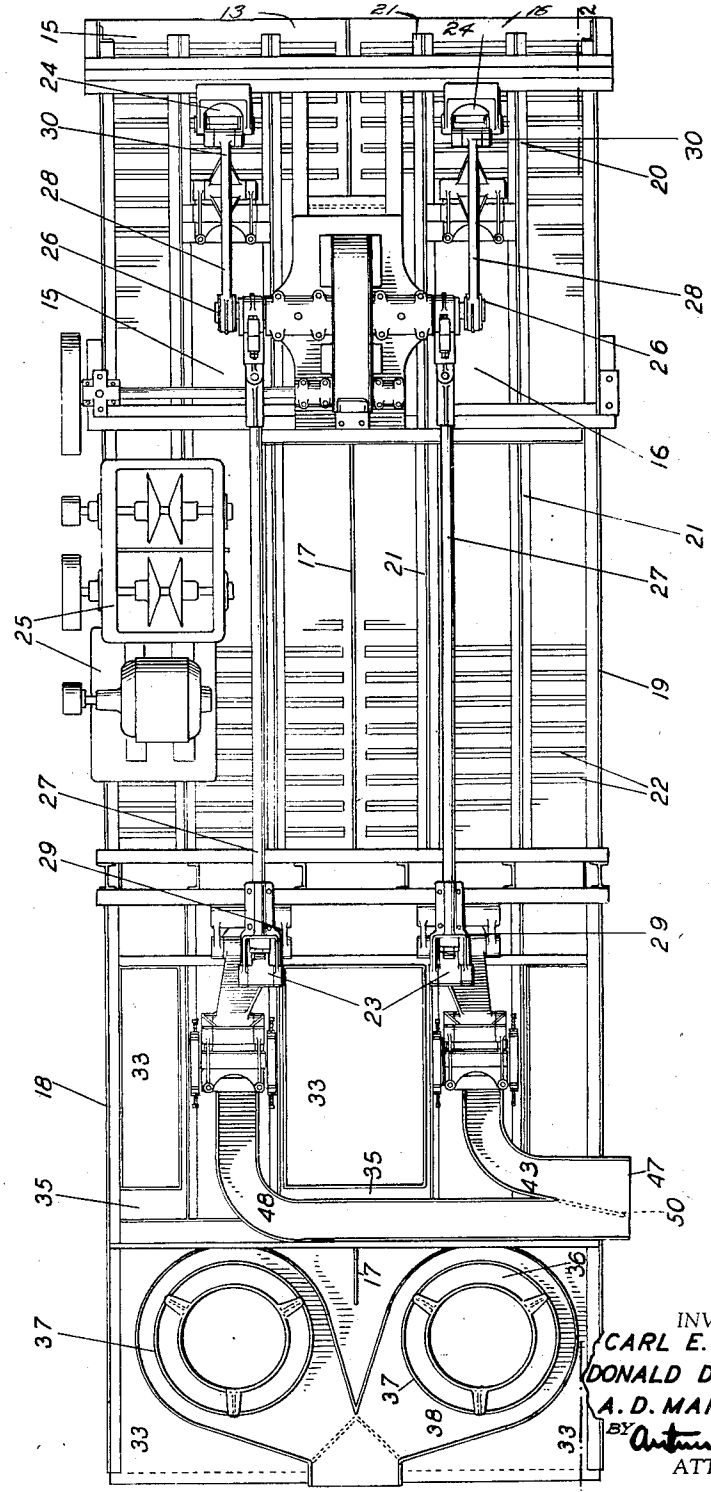


Fig. 1.

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CLASSIFIER

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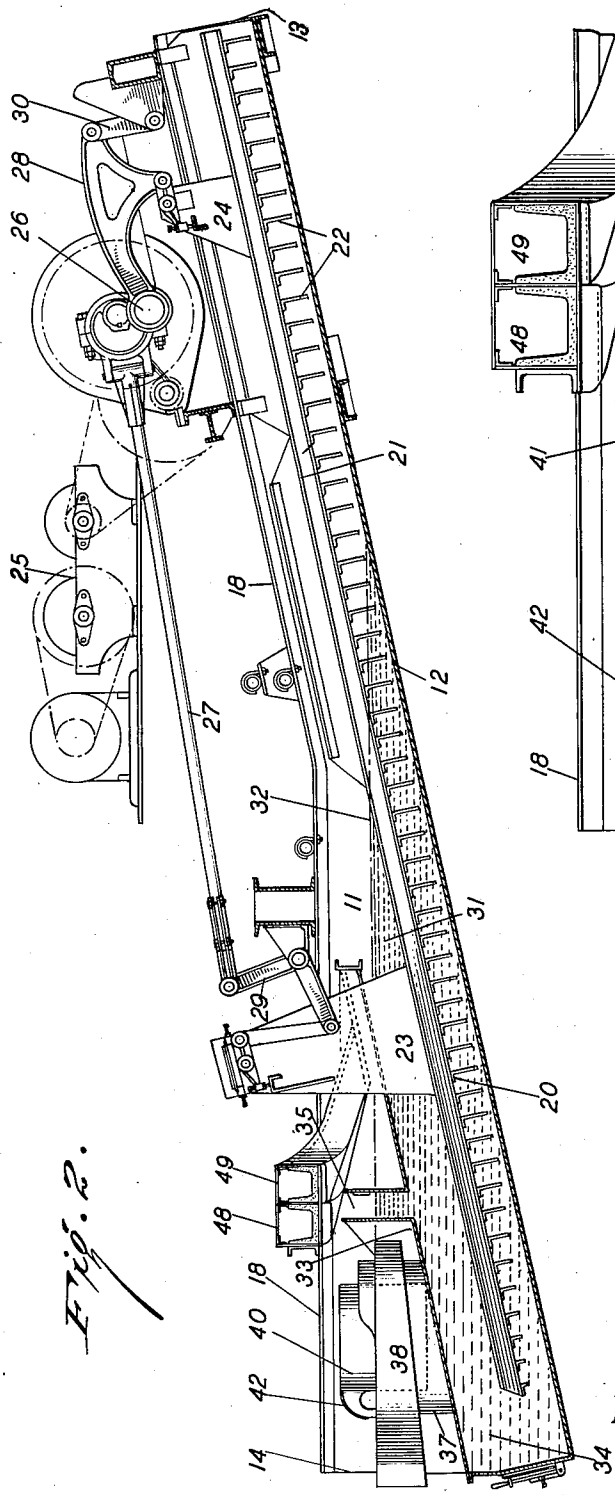


Fig. 2.

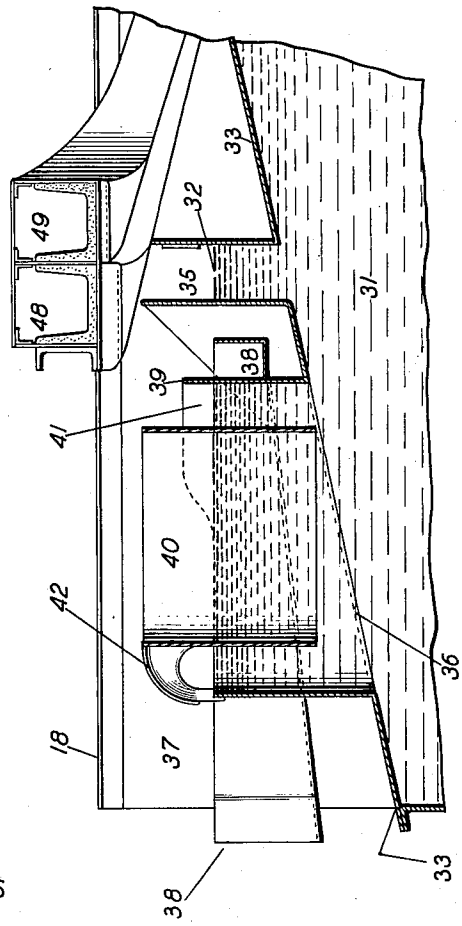


Fig. 3.

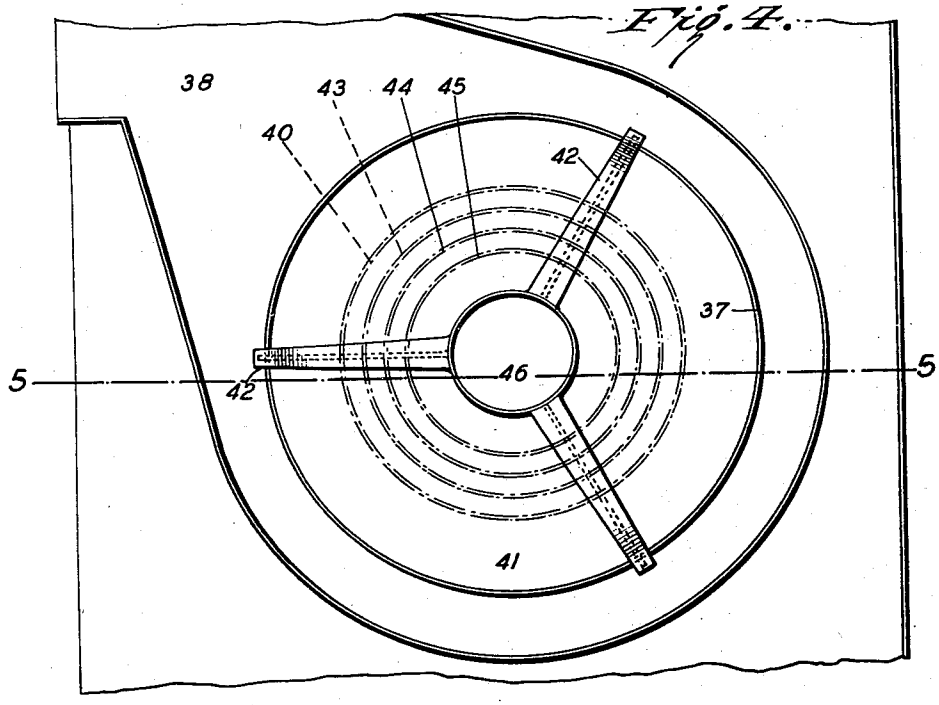
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Fig. 4.



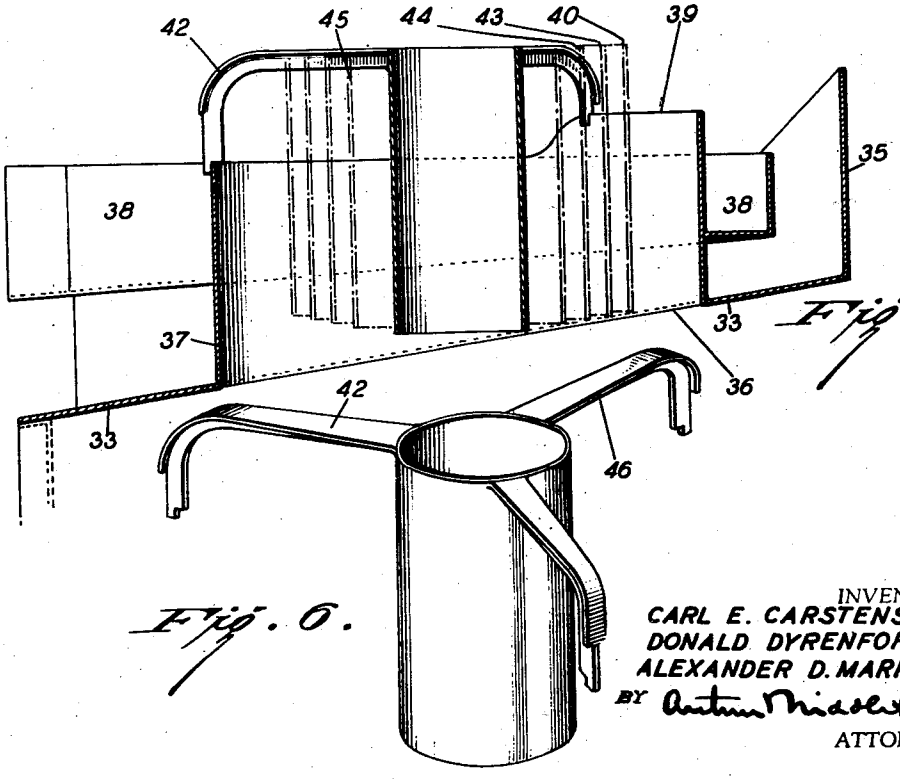


Fig. 5.

Fig. 6.

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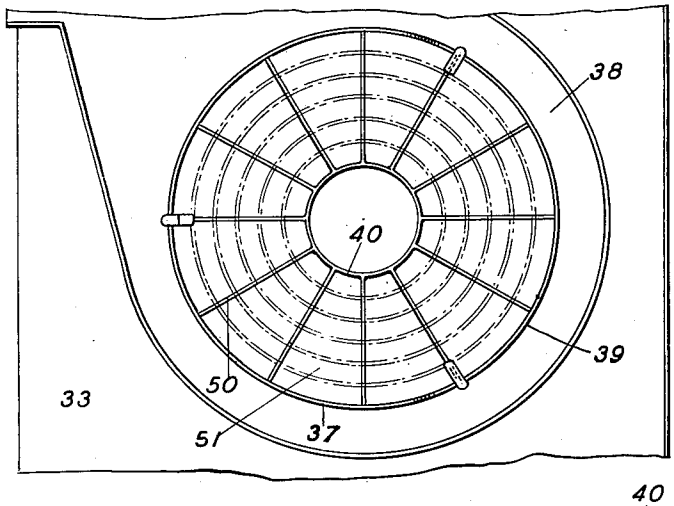


Fig. 7.

Fig. 8.

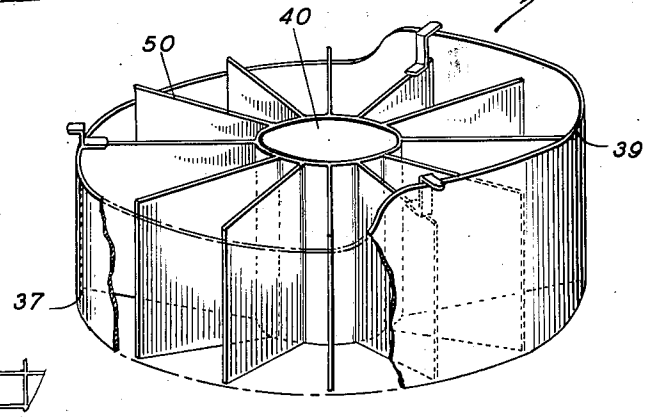
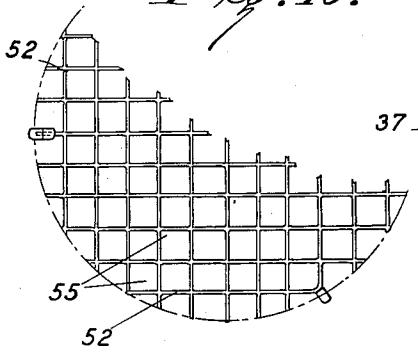


Fig. 10.



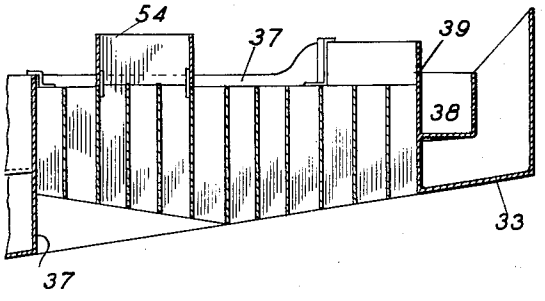
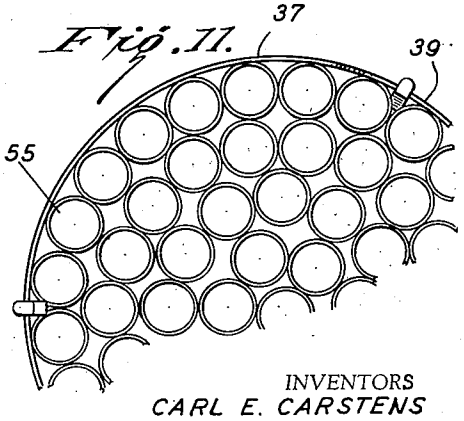


Fig. 9.

Fig. 11.



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Patented May 26, 1936 2,042,444

UNITED STATES PATENT OFFICE

2,042,444

CLASSIFIER

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Application October 19, 1933, Serial No. 694,216

5 Claims. (Cl. 209—462)

This invention relates to improvements in classifiers such as are used in the treatment of ores and the like, in which the agitation of a conveying rake partly submerged in a sloping tank causes the separation of a mixed pulp into a coarse rake product and an overflowing suspension of fines.

One difficulty in the operation of such machines lies in the fact that the agitation produced by the rake is not sufficiently curved to prevent undesirable disturbing effects upon the uniformity and character of the separation desired in the overflow. While a certain degree of control in that respect can be exercised by regulating the amount of wash water supplied to these machines, this invention contemplates structural improvements which make possible a more positive control of the quality of separation. In other words, it is intended that the functioning of the classifier be divided more distinctly into a zone of agitation surrounding the rakes in which the agitation is produced by rake movement and a relatively non-agitative zone superposed upon the agitation zone, with the latter characterized by the association therewith of a controllable sorting column of liquid.

That is, by this invention, a classifier is provided with two zones of classification, namely, one zone of extreme agitation and scrubbing running parallel to the bottom of the classifier tank, and another free-settling classification sorting zone in which the size of overflow is dependent upon pulp velocity and not upon agitation due to the movement of the classifier rakes. By separating these two zones there are provided optimum conditions for complete liberation of the fines from the coarse sand in the raking zone and likewise optimum conditions for controlling the overflow product.

Thus one aim of this invention is to render the function of each zone more completely independent of the other for causing a cleaner and more efficient separation of desired sizes in the machine and reducing to a minimum the disturbance in the overflow by stray currents resulting from rake motion and by what is known in classifiers as surging ordinarily due to the building up of an excess of an intermediate size in suspension above the rake.

Another difficulty is encountered when the operation of a classifier is interrupted by the sands contained in the volume of pulp in the tank settling down upon the rake resulting in the burying of a portion thereof. The rake thus loaded down makes restarting difficult and requires freeing by washing out the sands thereabout or else the aid of an additional rake lifting mechanism. To overcome this difficulty, this invention contemplates the restriction of the pulp depth over the rakes in the tank to effect a reduction in the amount of solids which are liable to settle upon the classifier rakes, in case of a shutdown, and to enable the operation to be resumed without washing out or rake lifting.

Still another difficulty is experienced when the attempt is made to determine the proper slope of the tank in setting up classifiers. This procedure often includes laborious trials in the field. A gentler slope may be required in some cases in order to make available a larger or longer bath in the classifier tank to insure the desired degree of cleanliness of separation, whereas in other cases a steeper grade may suffice. In terms of structure this means further that in some cases a longer classifier tank is required than in others. Consequently, this invention has as one of its aims the elimination of this factor of uncertainty, and the making possible of the use of a suitable standard grade, say 2½ inches per foot, by arranging for a more positive control of separation by means such as those outlined herein.

Thus the objects of this invention may be said to include the provision of means of positive control, enabling the machine to make a cleaner, that is to say, closer size separation, and to increase the flexibility of operation; the discouragement if not avoidance of irregularities by surging or eddying in the overflow, and thus to reduce the amount of stray oversize in the overflow; the making possible of a sharper separation when the classifier is used in connection with a grinding mill as in a grinding cycle, with resulting higher mill capacity and less over-grinding; to produce a higher percentage of solids in the overflow for a given mesh size of separation; coordination of the partial functions of the machine so as to enable it to work under normal capacity and at the same time at highest efficiency of separation; the production of a machine whose principle of operation is correct for the great majority of operations; to permit the machine to be started up after shutdown without necessity of rake lifting or washing out the settled sands; and finally to permit the use of a standard slope for the classifier trough.

Referring more specifically to the divergent functions in the classifier, if it be desired to change the raking capacity by changing the rake speed, such change will have immediate effect upon the character of separation in the over-

flow, while a change in the latter may be entirely undesired. Accordingly such changes cannot be made in ordinary classifiers without losses in the efficiency of separation. The effect of such overlapping or interrelated conditions can be recognized in the phenomenon of the so-called intermediate fines. These particles are thrown into suspension by the rakes but are on the average too heavy to make their way through the overflow, so they form a suspension or screen or agglomeration in the liquid body above the rakes more specifically in the lower and deeper portion of the tank where flow conditions are not readily controlled. There they form an obstruction to proper separation, causing the periodical disturbance in the overflow known as surging whenever that suspension has acquired a sufficient weight or density to break down in bulk as it does from time to time.

However, it is to be remembered that irregularities in the overflow of the character of surging or eddying may also be due in part to the reciprocating movement of the rake structure itself, in that such movement causes some kind of an impact or increased water-pressure against the lower end wall of the tank, which impact or pressure manifests itself in some surging in the overflow.

It is furthermore realized that in such classifiers a means is provided to keep the working conditions in the classifier under control to a certain extent, by the regulation of the wash water introduced into the tank. However, such means is limited in its use and effect, whereas the improvements contemplated by this invention offer a greater possibility and working range of separation control and greater accuracy.

It is due to the very character of the classification performed in this type of machine that the effects of intermediate size and surging upon the separation cannot be entirely eradicated, however, it can be said that as a result of this invention these effects are reduced to an almost imperceptible minimum.

To these ends the invention may be said to reside in the feature of providing a cover or baffle at the lower or overflow end thereof extending from the end wall of the classifier below the normal liquid level thereof inwardly toward the sand discharge end of the classifier and terminating above the normal liquid level to form a sloping water filled pocket or toe on the classifier into which the submerged portion of the classifier rake structure extends in operative position. Further the invention comprises the provision of one or more stacks, pipes or conduits rising from the cover or baffle substantially aligned with an aperture therein whereby a column of liquid will rise from the bath or pool in the classifier upwardly through the pipe or pipes, and overflow. The rising column of liquid in its pipe forms in effect a hydroseparator and as such it it is important to control the velocity or other flow conditions therein so to that end the invention also comprises means for adjustably controlling the effective cross-sectional area of the pipe or overflow passage.

One feature of the invention lies in the establishment of clear-cut zones of different types of hydraulic action in the tank. An agitating zone has superposed thereon a hydroseparation or free settling zone or passage for relatively quiescent upward liquid flow effective to cause a suspension of solids of desired character escaping therethrough from the agitation zone to the overflow at the top of the liquid column in that upward passage. The arrangement provides that the desired flow conditions, such as flow velocity with optimum homogeneity thereof can be induced and controlled in the liquid column in the upward passage, and that such induced conditions are shielded or baffled so as not to be appreciably affected by the condition of violent stirring which prevails in the rake compartment below. Provision is made to compensate for any changes in the operation by means which allow for variable control of the flow velocity in the upward passage. Such control permits the realization of flow conditions for giving the necessary impulse to the particles which it is desired to carry to the overflow.

Another feature of this invention is that the overflow passage, stack or pipe rising from the cover plate or baffle should be set back thereon a suitable distance from the lower end and the side walls of the classifier. This creates a dead corner in the lower end or toe of the classifier tank, which has the effect of deadening or absorbing the hydraulic impacts or localized disturbances such as eddies set up between the end wall and side walls of the classifier and those ends or extremity portions of the raking blades adjacent thereto caused by reciprocation of the rake structure. This arrangement tends to prevent the effects of such impacts from making themselves felt by disturbances of surging or eddying in the overflow.

According to another feature the sloping cover plate or baffle has air venting means located ahead of the overflow passages. This is to allow the escape of air bubbles or entrained air which may have entered the bath together with the pulp feed. Entrapped air which may get caught underneath the cover plate is thus prevented from reaching the overflow column and upsetting the uniformity of the sensitive overflow.

Another feature lies in the fact that the volume or depth of the classifier bath is considerably reduced particularly above the classifier rakes in comparison with ordinary classifiers by the baffling or covering over the lower end of the tank. This means that in a case of shutdown such a relatively small amount of sands will be present to settle out that it will not appreciably impede the restarting of the machine even without extraneous aids. For example, the usual rake lifting device for larger classifiers can thus be dispensed with.

Still another feature is seen in the fact that improvements in the way of positive separation control make possible the adoption of a standard and convenient classifier slope. From a practical viewpoint, this means that laborious field tests to ascertain the optimum degree of slope are avoided.

This invention possesses other objects and features or advantages some of which, with the foregoing, will be set forth in the following description. In the accompanying drawings, there has been illustrated the best embodiment of the invention known to us, but such embodiment is to be regarded as typical only of many possible embodiments and this invention is not to be limited thereto.

Figure 1 shows a plan view of a classifier embodying this invention. Figure 2 shows a vertical sectional view taken along the line 2—2 in Figure 1. Figure 3 shows an enlarged detailed sectional view of the baffle and sorting column of this invention. Figure 4 shows a detailed plan

view of the sorting column and adjusting cylinder. Figure 5 shows a vertical sectional view taken along the lines 5—5 in Figure 4, while Figure 6 is a perspective view of one of the adjusting cylinders for varying the velocity of flow through the sorting column. Figures 7 to 11 show a baffle arrangement in the sorting column and modifications thereof.

Referring to the accompanying drawings, it will be seen that the invention has been shown embodied in a classifier of the well-known Dorr type and in a duplex or double compartment model thereof wherein 11 indicates the classifier tank having a sloping or slanting bottom 12, a sand discharge end 13 and a lower or overflow end 14. 15 indicates generally one compartment of the classifier while 16 indicates the other and these compartments are separated by divisional wall 17. 18 indicates one side wall of the classifier tank and 19 the other. In each compartment is a rake structure 20 formed of stringers 21 from which depend raking blades 22, mounted for reciprocation in a substantially D-path on pairs of hangers 23 and 24 respectively, with suitable motivating devices such as by motor and speed reducer mechanisms 25, crank shaft 26, connecting rods 27 and 28 and linkages 29 and 30, 31 represents the pulp of liquid and solids forming the classifier bath and which the classifier is to operate. 32 represents the normal liquid level in the classifier. So far the construction described is standard.

The invention is embodied in the addition to a raking classifier broadly represented by the classifier above described, of a cover or baffle section 33 extending inwardly from the lower end 14 of the classifier toward the discharge end 13 thereof from a point below the normal liquid level 32 of the classifier to a point thereabove. This cover or baffle 33 forms a water filled compartment pocket section or toe 34 of the classifier when the classifier has a bath of pulp therein, into which the rake structure 20 extends in normal operating position. The cover or baffle 33 may be provided with an air vent 35 extending upwardly therefrom above the liquid level 32. Any chips entrained in the classifier feed tend to accumulate therein from whence they are readily removable. The cover or baffle 33 is provided with an opening or aperture 36 therethrough for each classifier compartment 15 and 16, although under certain conditions more than one aperture may be provided for each compartment. From each aperture 36 a hollow element such as a stack, pipe or conduit 37 rises from the cover 33 to a point substantially level with the liquid level 32 of the classifier. The stack does not necessarily have to be cylindrical or round although such a shape is preferred. One requirement of the stack, however, being that no section thereof should have an effective horizontal cross-sectional liquid flow area which is less than that of the top portion of the stack or conduit. Surrounding the stack 37 is a launder or trough 38 for catching the overflow therefrom. The stack 37 is provided with an upper extension 39 which is in the nature of a splash plate for the purpose of directing the overflow therefrom into the launder 38, in the direction of the discharge overflow end of the launder. The extent or circumferential length of this extension 39 determines the weir capacity or length of the overflow lip or edge of stack 37.

In order to control the current flow conditions in the stack whose purpose is to have formed therein a non-agitative free settling zone or sorting liquid column, means are provided for varying the effective cross-sectional flow area of the stack 37. It is found that this can be done satisfactorily by placing in the stack 37 an open ended cylinder or cylindrical baffle member, or core member 40 which seems to create a dead or motionless body of liquid in the stack or pipe 37 whereby the only effective area of upward flow is in the annular space 41 between the cylinder 40 and the stack 37. The cylinder 40 and other similar ones may be maintained in position to extend above the liquid level in the classifier by providing it with legs 42 adapted to rest upon the upper edge of the stack 37 and therefore support it. In order to be able to control the current flow conditions or velocity to produce the right degree of desired hydroseparation or free settling separation in the stack 37, it is necessary to get by experimentation the right cross sectional area of effective flowing liquid. To that end a plurality of cylinders are provided such as 43 to 46 of different diameters, and with legs 42 for supporting any one of the cylinders in the stack 37, the only requirement being that none of the cylinders shall project below the cover plate of baffle 33. Figure 5 shows how these cylinders are successively shortened as their diameter increases so that they do not project below the baffle plate into the classifier rake compartment. It is to be understood that only one cylinder is used at a time until the correct cross-sectional area is produced in the space 41 for the desired velocity of overflow from the stack 37. However, other means may be used for varying or adjusting this velocity.

In order to produce optimum conditions of non-agitation in the vertical column or stack 37 this invention also proposes the subdivision of the cross-sectional area thereof by vertical baffles, or other flow directing arrangements in association with that column. Various modifications of baffle arrangements are shown in the detail Figures 7 to 11.

Figures 7 and 8 show radial vertical baffles 50 which subdivide the annular overflow passage between the stack 39 and a cylinder 40 into passages 51. In the perspective Figure 8 the baffles are shown to be attached to the cylinder to form a unit therewith, the upper edges of the baffles being made flush with the upper edge of the cylinder and thus rising somewhat above the elevation of the overflow. In this disclosure, therefore, each vertical passage or baffle compartment 51 occupies its individual portion of the circumferential overflow.

The modification of Figures 9 and 10 shows vertical dividing baffles arranged in the way of a grid system 52 forming a multitude of vertical channels 53. This baffle grid is shown to terminate somewhat below the overflow edge of the stack 37 so as to allow the particles emerging from the various passages to cross over other passages on their way to the overflow. A collar or crown member 54 is shown to be applied to this grid in order to illustrate the manner in which any suitable portion of the cross area can be curbed for the purpose of adjusting the hydraulic conditions in the passages.

Figure 11 is a modification of Figures 9 and 10, in which tubes 55 are arranged in the way of a honeycomb within the stack to take the place of the grid.

It should be understood that within the scope of this invention, other modifications and varia-

tions of baffle arrangements are possible. Thus it is possible to place any suitable grid or vane or baffle arrangement in the lower portion of the stack and to superpose thereon a cylinder to restrict the effective cross-sectional area. In this way any desirable type of grid or baffle arrangement can be combined with any desirable flow restricting element such as the cylinder **40**.

The classifier is provided with a pulp feed launder **47**, which in the case of a duplex classifier is formed into two branches **48** and **49** each of which may be controlled by a feed splitter **50** but the important point of the feed is that the feed launders shall deliver the feed to the classifier bath **31** through the baffle plate toward its upper edge or at a point beyond the baffle plate **33**. Wash water may be fed to the classifier as is usual in bowl classifier operation.

Operation.—The rake structure **20** of the classifier is reciprocated in its usual D-path by means of the motivating devices, connecting rods and linkages indicated generally by reference numerals **25** to **30**, through the medium of hangers **23** and **24** from which the rake structure depends. The raking blades **22** convey the sands upwardly along the sloping bottom **12** of the classifier to discharge at the upper end **13** thereof. Reciprocation or motion of the rake structure **20** sets up a zone of agitation in the classifier bath **31** for the usual purpose of washing and scrubbing the sands but it is desired to confine or restrict this zone of agitation to barely surround the reciprocating rakes, to which end the baffle cover **33** is provided to close in more or less as the toe of a shoe, the lower end **14** of the classifier over the extremities of the submerged blades of the rake structure. By setting the outlet from the zone of agitation in the pipe or stack **37** spaced inwardly from the overflow end **14** and from the side walls of the classifier, a baffle section or cover is thus provided to take up or absorb some of the agitation or surging produced by the reciprocation of the rakes so that the disturbances set up by the extremities of the rakes are shielded in a manner whereby they will not unduly interfere with the non-agitative free-settling zone in the stack or pipe **37**.

It is to be noted that the feed for the classifier bath is introduced through launders **48** or **49** somewhat ahead of the point at which it would be introduced in a standard classifier because it should be introduced near the uncovered part of the classifier bath. From the point of introduction, the feed passes back beneath the baffle cover **33** through the somewhat restricted space occupied by the rakes **22**.

Within the pipe or stack **37** there is formed a zone of substantially non-agitated liquid since it is above the cover baffle **33** and consequently does not seem to be disturbed by the agitation in the classifier bath **31**. The liquid of this zone flows quietly upwardly through the stack **37** due to the hydraulic head thereon of the classifier bath and overflows around the upper edge of the stack **37** into the launder **38** from which it discharges the fines from the classifier bath. The upflowing liquid in the stack **37** acts as a free-settling sorting column for selecting out the fines and rejecting from overflow any solids of a size which will settle against instead of rising with, the upward flowing stream of the sorting column in the stack **37**. The selectivity of the sorting column accordingly can be maintained by controlling the velocity of the liquid flowing upwardly out of stack **37**. And the velocity can be controlled by inserting into the stack **37**, cylinders for varying the cross-sectional area of the space in the stack through which the sorting column of liquid can flow. This cross-sectional area may be varied in a number of ways, such as by putting solid objects in the stack or other obstructions but our preferred form is shown in the use of the open ended cylinders which seem to have the same effect in decreasing the effective area of the stack and consequently the velocity of the liquid flowing therethrough as if they were solid objects. At the same time the quiescent body of liquid in the hollow cylinders apparently acts as a shock absorber for dampening the surging from the classifier. The preferred sorting column thus established has an effective cross sectional area of annular shape.

An arrangement of vertical baffles to subdivide the active cross-sectional area of the passage such as indicated in the Figures 7 to 11 is designed to further insure quiescence on the upward passage and to subdue whatever reactions might make themselves felt from the agitating zone below.

Through this arrangement of removable cylinders, it is possible to adjust or vary the cross-section area of the sorting column over comparatively wide limits and thus control the size of overflow particles for any optimum pulp density. Stray oversize in the overflow is thus eliminated.

A reason for the unusual selectivity of separation in this preferred embodiment can be seen in the fact that the annular overflow provides a fair chance for all particles which are to pass therethrough to reach the overflow column along a relatively short path from any point in the agitating chamber. Moreover, it is to be noted that the reciprocating movement of the rakes sets up a corresponding transversely reciprocating flow in the lower part of the tank which helps to sweep the more remote particles into the range of the overflow column, thus helping the selectivity of separation and the elimination of disturbances through intermediate size by directing the particles in the shortest possible time and along the shortest possible path to their destination.

In order for this liquid sorting column to maintain its proper sorting effectiveness with respect to the velocity therein for accomplishing the desired solids separation, a requirement thereof is that there should be maintained in the column a substantially non-diminishing upflow velocity condition in an upper horizontal section thereof as compared with the velocity condition in a lower horizontal section thereof.

We claim:

1. A classifier having a tank with a sloping bottom adapted to contain a bath of pulp to be classified, a rake structure operative to produce a zone of agitation in the bath and to convey to discharge solids settling on said bottom, and a feed for the classifier tank, characterized by a cover for the lower end of the classifier extending to a point below the normal liquid level therein for restricting the zone of rake-produced agitation, said cover having an opening therethrough and a rising conduit associated with said opening to allow for solely upward passage therethrough and overflow therefrom of a sorting column of liquid from the classifier bath, the elevation of overflow from said conduit determining the normal liquid level in the tank, a submerged grid system extending transversely of said sorting column, and a core member adapted to rest upon said grid system and to rise from a selected por-

tion thereof to a point above said overflow level, said core member effective to block out a predetemined volume from, or render ineffective a predetermined cross sectional area of the effective volume of the said sorting column.

2. A classifier having a tank with a sloping bottom adapted to contain a bath of pulp to be classified, a rake structure operative to produce a zone of agitation in the bath and to convey to discharge solids settling on said bottom, and a feed for the classifier tank, characterized by a cover for the lower end of the classifier extending to a point below the normal liquid level therein for restricting the zone of rake produced agitation provided with an opening therethrough and means for selectively overflowing fines from the classifier associated with the opening and rising from said cover containing a sorting column of liquid flowing solely upwardly therethrough from the classifier bath and from the feed thereto in substantially one-way direction to form a substantially quiescent free-settling zone, and in which the feed for the classifier enters the classifier bath at an uncovered part thereof.

3. A classifier having a tank with a sloping bottom adapted to contain a bath of pulp to be classified, a rake structure operative to produce a zone of agitation in the bath and to convey to discharge solids settling on said bottom, and a feed for the classifier tank, characterized by a cover for the lower end of the classifier extending to a point below the normal liquid level therein for restricting the zone of rake produced agitation provided with an opening therethrough and means for selectively overflowing fines from the classifier associated with the opening and rising from said cover containing a sorting column of liquid flowing solely upwardly therethrough from the classifier bath and from the feed thereto in substantially one-way direction to form a substantially quiescent free settling zone, and in which air venting means are provided in said cover.

4. A classifier apparatus having a tank formed with a slanting bottom with sides and an end wall, means for feeding pulp thereto, and mechanical agitating and solids conveying means therein; a cover extending inwardly from said end and side walls forming therewith a covered liquid containable pocket section into which said mechanical element functionally extends; characterized by a conduit structure rising from said pocket section in substantially unrestricted communication therewith through the cover thereof having an overflow defining the liquid level in said tank and adapted to house a column of upwardly flowing liquid and so constructed that no section thereof has a horizontal effective cross-sectional liquid flow area which is substantially less than that of the top portion of said conduit structure, said feeding means arranged to deliver pulp into a section of the tank that is spaced from the lower end of said conduit structure whereby pulp thus fed is compelled to come under the operative influence of said mechanical agitating means and whereby liquid of the pulp is forced by the incoming feed upwardly through said conduit structure carrying therewith to overflow the classified fines in suspension.

5. A classifier apparatus having a tank formed with a slanting bottom with sides and an end wall, means for feeding suspended solids to the tank to form a bath therein, a partially submergible bladed raking structure in said tank which agitates the bath of suspended solids to be classified and discharges to emergence the classified larger solids while there is a concurrent overflow from the tank in suspension of the classified finer solids, a cover overlying the lower end of the tank and extending substantially parallel to the slanting bottom from below the liquid level to a point thereabove, and a conduit upstanding from said cover having a substantially uniform liquid flow area the conduit constituting an overflow for the suspension of classified finer solids and said feed means delivering suspended solids at a point remote from said conduit whereby there is a one-way flow of liquid from the bath upwardly through the conduit thus forming a sorting column whose sorting effectiveness depends upon the maintaining of a substantially non-diminishing upflow velocity condition in the flow area thereof in an upper horizontal section thereof, as compared with a lower horizontal section with a minimum of localized disturbances such as eddies, and by virtue of which overlying cover the local disturbances set up between the extremities of the submerged bladed raking structure and the tank walls and end adjacent thereto are dampened and discouraged from affecting adversely said uniform velocity condition.

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