

Jan. 25, 1938.

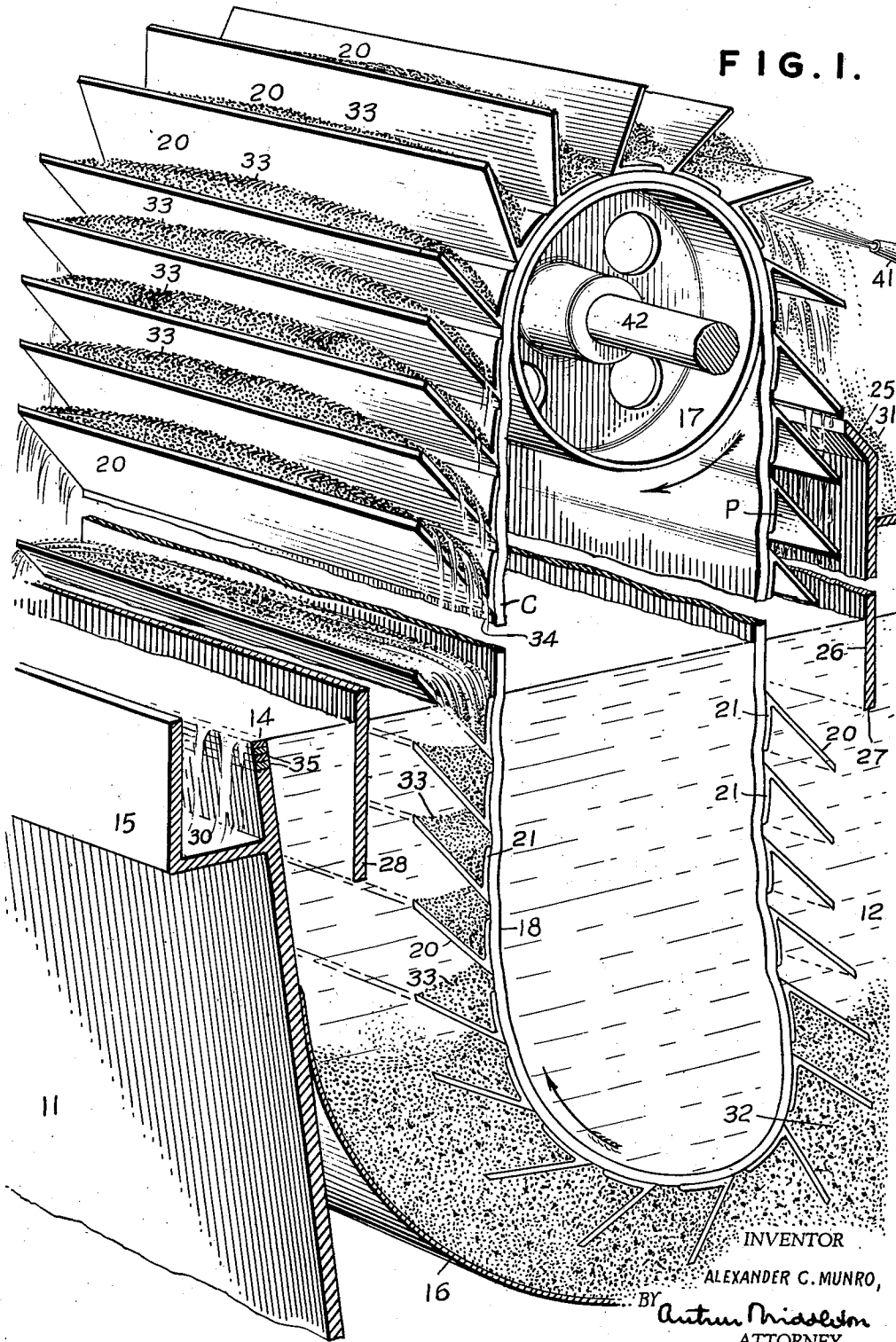
A. C. MUNRO

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CLASSIFICATION

Filed April 19, 1937

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Jan. 25, 1938.

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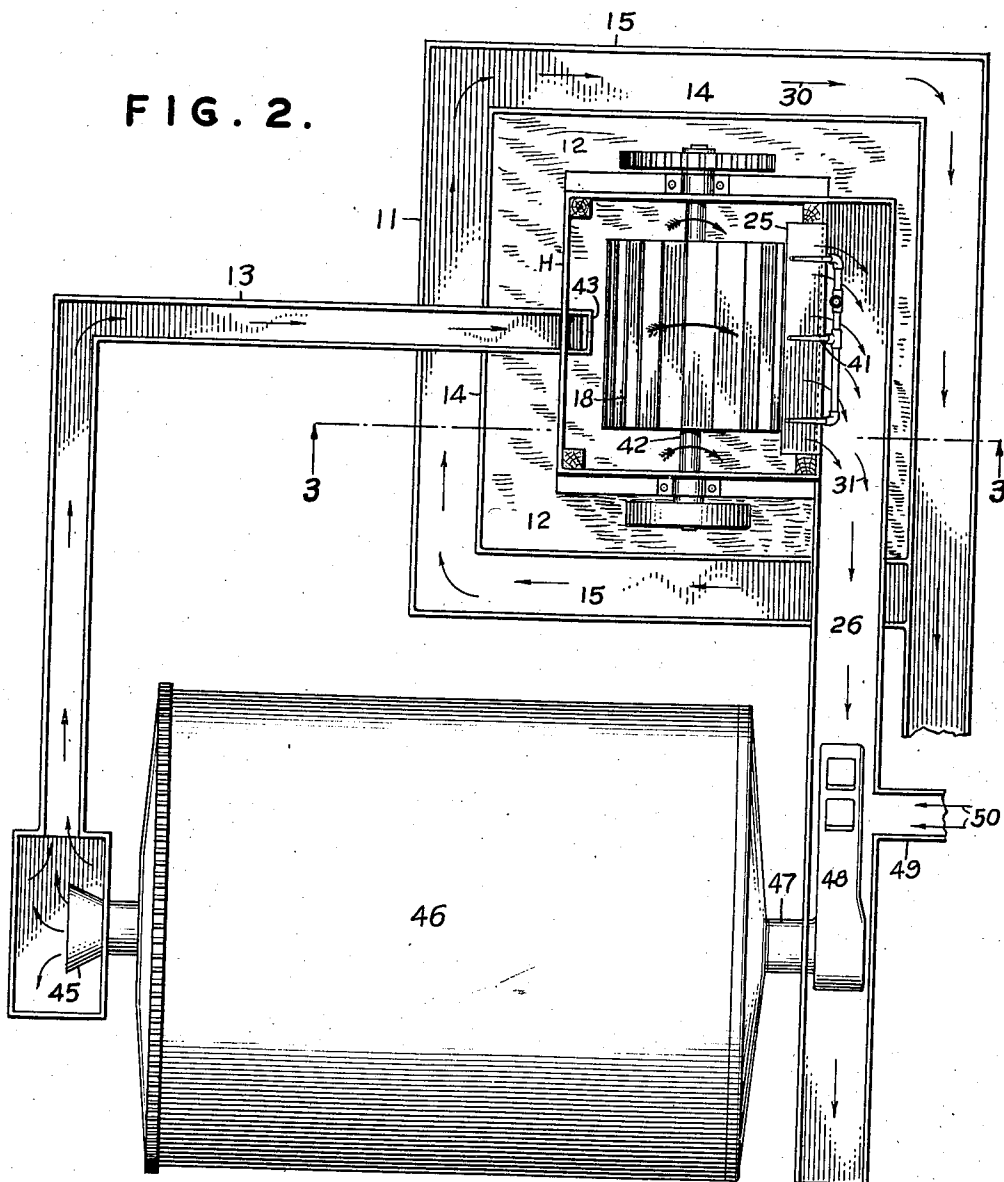
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CLASSIFICATION

Filed April 19, 1937

5 Sheets-Sheet 2

FIG. 2.



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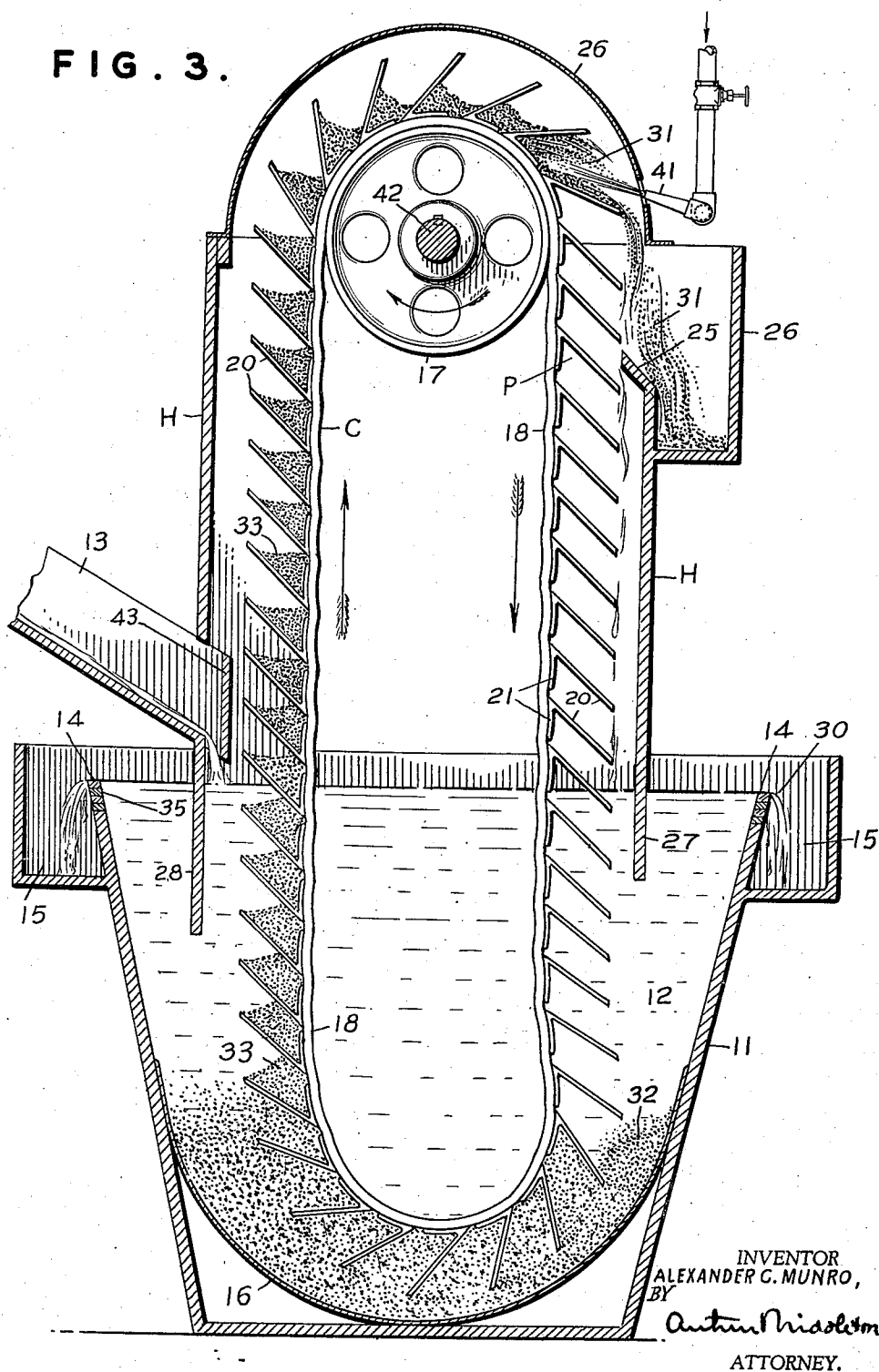
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CLASSIFICATION

Filed April 19, 1937

5 Sheets-Sheet 3

FIG. 3.



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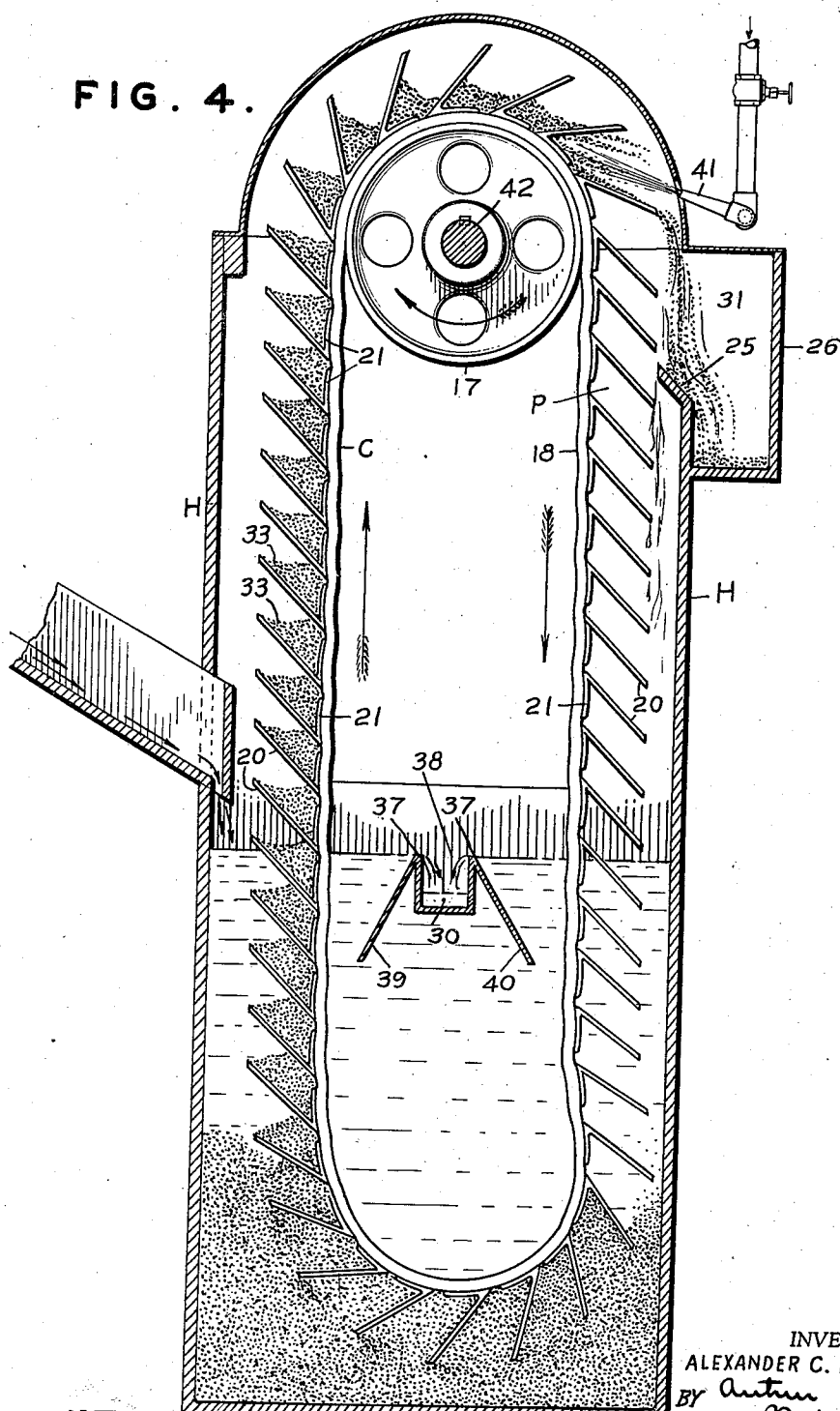
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CLASSIFICATION

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5 Sheets-Sheet 4

FIG. 4.



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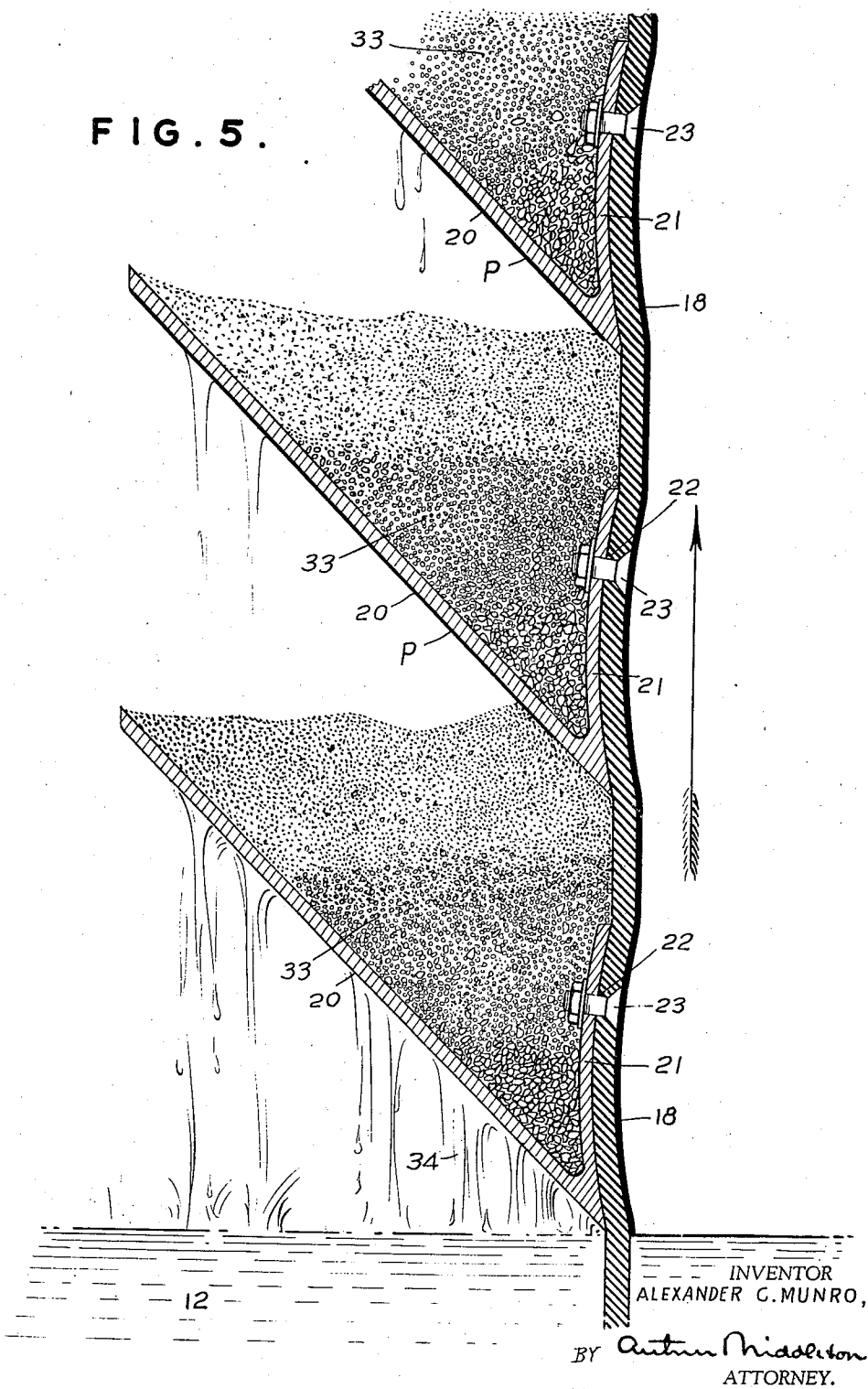
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CLASSIFICATION

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FIG. 5.



UNITED STATES PATENT OFFICE

2,106,156

CLASSIFICATION

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Application April 19, 1937, Serial No. 137,883

12 Claims. (Cl. 209—461)

This invention relates to the art of classification, whereby solids in suspension are separated into at least two groups, with those of one group exhibiting different characteristics from those of the other group. These characteristics may be different in size, or they may be different in type.

More particularly this invention relates to classifiers that are used in metallurgical processes, wherein similar solids in suspension are separated into two groups according to size, wherein solids of one group below a specified size are removed from the classifier in suspension and are called "fines"; whereas solids of the other group removed from the classifier having a size above that specified, or oversize solids, are called "sands". Sands are discharged accompanied by water, but they are not in suspension, as are the fines. Classifiers of this type may also be used in other industries where different size solids are to be selectively separated into groups and such classifiers may also be used where the selectivity depends upon the type of solids rather than their size, such as is occasionally done in the treatment of sewage, where organic solids are separated from inorganic solids, irrespective of the size of solids.

The object of the invention is to devise a classifier or stratifier of extreme simplicity with a minimum of wearing parts, and yet efficient as to selectivity.

Another object of this invention is to devise an effective classifier which will take a minimum of floor space.

Another object is to devise a classifier which will elevate the oversize solids well above the liquid level of the classifier bath, since such a function is desirable in closed-circuit grinding systems where the oversize is to be returned to the grinding mill.

Another object is to produce an efficient classifier embodying the principle of an endless flexible belt with blades angularly extending from the belt, capable of conveying settled submerged solids or sediment, from submergence to emergence under requisite conditions as hereinafter explained.

A further object is to design a classifier of the above-mentioned characteristics with no submerged bearings or contacting parts that move relative to each other.

A still further object is to design such a classifier so that even though mounted on a flexible belt its blades are capable of digging into settled solids or sediment in the basin section or sump of the classifier.

Another object is to design such a classifier with

the weight of the blades having such a relation to the weight of the load they carry, that the load will not interfere with the dependable operation of the blades.

A still further object is to design such a classifier which can be started up readily after a shut-down, namely, one in which the submerged blades will not become imbedded in the settled sands, or at least not so much but that they may be freed by a loosening up of the settled material after a temporary shut-down.

One manner in which this invention may be carried out is to supply the liquid having the solids in suspension therein to be classified—sometimes called "pulp"—to a tank, basin or sump. When the liquid with its solids is in its basin or sump, it is frequently referred to as a bath. Extending into this bath and partly submerged therein, is the elevator-classifier construction, the dual function of which is to cause agitation in one zone of the bath in the tank for bringing about controlled selective separation of fines, which are solids of a desired size or smaller, from sands which are solids of larger than the desired size.

The fines are discharged or outflowed from the tank in suspension, while the coarser solids or sands are discharged from the tank in emerged condition. The agitative disturbance in the agitation zone or true classification zone is such that the fines or smaller solids are kept in suspension, while the coarser solids or sands settle in that zone in spite of the disturbance therein. There is also provided a zone of relative quiescence, functionally connected to, but shielded from, the zone of agitation, because as the fines in suspension pass from the agitation zone into the zone of quiescence for overflow or outflow therefrom it is desired to have gravitation function actively to eliminate in the zone of quiescence any substantial quantity of oversize solids or sands.

The elevator-classifier construction preferably comprises a flexible endless belt, having a smooth surface taking around a head pulley from which the belt is supported, so disposed that the belt hangs from the pulley with the lower section and loop of the belt entering the bath. The belt carries a multiplicity of blades, preferably V-shaped in cross-section with one leg of the V extending at an acute angle therefrom, all similarly directed and mounted on the belt in succession.

A feed of liquid to be treated is provided for the tank and a weir or liquid level controlling outflow is also provided past which the fines, classified or selected out according to the degree of

disturbance in the agitation zone, are discharged while in suspension and pass into an outflow launder. The weir and overflow launder or other outflow is associated with a zone of liquid quiescence in the tank and care should be exercised in the design of the classifier so that disturbance or agitation in the liquid bath, caused by the moving belt with its blades, does not disturb or adversely affect the quiescence in the region of the outflow. The quiescence must be relative to the disturbance to the extent that sands or oversize solids are substantially absented therefrom due to sedimentation. The bath in the tank should be deep enough to permit sedimentation or settling of the larger solids into a stratified condition as sediment in the bottom of the sump, while the fines or undersize remain in suspension.

Taking now the action of a single blade on the endless belt as illustrative of what happens with all of the blades, when a blade descends from emergence into submergence in the bath, it ultimately encounters the stratified larger or oversize solids in the bottom section of the bath, selectively settled due to their size in spite of the agitation of the bath, whereupon it digs into the sediment and scrapes or scoops therefrom a load of settled solids which the blade is adapted to elevate or hoist from submergence to emergence and then to discharge. During its travel from the low point of its descent, to the liquid level of the bath in its ascent, a time interval preferably is arranged for so that the solids of its load tend to stratify in the crotch of the V formed between the angularly-extending blade and the belt. As soon as the blade starts to pass from submergence to emergence, water entrained by the load of sand on the blade quickly drains off from the load running out of each open end of the blade in the preferred embodiment. The flow of water from the load is unobstructed and is permitted quick release, because it is found that if unobstructed, the water carried up by the blade and its load to emergence, will drain off from the load while washing a minimum of the load from the blade. If this water be obstructed and its release delayed, the entrapped water tends to stir up or roll the sands on the blade with the result that, due to their mobility, too much sand is ultimately washed from the blade by the escaping water.

As the blade with its load continues to ascend, it passes over the head pulley until the blade is reversed as to direction, or upside-down, whereupon its load is discharged, and by means of a deflector plate, caused to flow away or to be diverted from the classifier. This load constitutes the coarse sands or oversize. The overflow launder or outflow may be disposed in different relationships with respect to the endless belt and its blades. If rather fine separation or selectivity is required of the classifier and where, because thereof, overflow length of weir is desired, the overflow weir can be spaced outside of and surrounding the endless belt and its blades so long as a baffle system is provided between the belt and its blades to confine the agitative influence thereof and keep that influence from affecting the necessary quiescence in the overflow zone. If lesser selectivity is good enough, then the overflow weir can be in the shape of a launder or trough, substantially U-shaped in cross-section, located within the loop of the endless belt and disposed parallel thereto, since the inside faces of the loop of the belt are purposely made smooth so that they produce a minimum of disturbance in the bath, but in such an arrangement the head

pulley should be of substantial diameter in order to separate the ascending part of the belt from the descending part sufficiently wide enough to assure a quiescent zone in the bath on each side of the overflow launder, and adjacent portions of the belt.

With these objects and features of advantage and operation, as well as others, the invention is shown in the accompanying drawings, which illustrate the best embodiment of the invention now known to me. But the showings in the drawings and in the following specification should be taken as illustrative, and not limiting, for obviously the invention is capable of being practiced in other embodiments.

Figure 1 is a partial perspective view of the classifier with parts broken away for the purpose of illustrating the action of the classifier;

Figure 2 is a plan view of a classifier embodying this invention, in closed-circuit with a grinding mill, such as a ball mill;

Figure 3 is a vertical sectional view of the classifier taken along the lines 3—3 of Figure 2; the form of classifier shown in this figure having the overflow weir located at the periphery of the classifier tank;

Figure 4 is a view similar to Figure 3, except that it shows a slightly different embodiment of the overflow weir. In this embodiment, the overflow launder with its weirs is located within the loop of the classifier belt, instead of around the periphery of the tank, as in Figure 3;

Figure 5 is an enlarged sectional view of details of construction and operation of the classifier blades.

In the drawings, 11 represents a tank or basin adapted to contain a bath 12 of the liquid-solids mixture or pulp to be treated. The tank is equipped with a feed launder 13 and an overflow weir or other outlet or outflow 14, past which suspended fines are adapted to flow into an overflow launder 15. The basin 11 is tapered inwardly or rounded in its bottom section 16. In the bath 12 of the tank 11, there is arranged to operate an elevator-classifier mechanism, indicated collectively by the letter C, made up of a head pulley 17 around which takes a flexible endless belt 18 that is supported and impelled by the head pulley 17. The flexible belt 18 extends from above to below the normal liquid level of the bath 12 in the tank 11, so that a part of the belt is in submergence when in operation.

On the belt is secured a multiplicity of pocket elements indicated collectively by the letter P, made up of blades 20 extending angularly from the belt 18 at an angle of the order of 45°. The pocket P is V-shaped in cross-section in that the blade 20 forms one leg of the V and the back leg 21 forms the other leg of the V. The back leg 21 is secured to the belt by such means as bolts or rivets 22, although it is desired to counter-sink in the belt any heads 23 thereof, to present a smooth surface. The leg 21 forms a rather sharp apex 24 with the blade 20. In the preferred embodiment these pockets are open at each end. The blades are adapted to collect sediment in the tank 11 and carry it up, or hoist it, to discharge as they take around and over head pulley 17.

25 indicates a deflector for diverting from the classifier loads discharged from the blades 20 when they are upset in passing over the head pulley 17. 26 indicates the launder for conveying the discharged emerged solids away from the classifier to a place of further treatment or dis-

posals. H indicates a housing for the elevator-classifier, which preferably extends down into the classifier bath 12, to provide baffles for dividing the bath 12 of the tank 11 into two zones, namely, the zone adjacent the travelling blades comprising a zone of agitation, and the zone adjacent the overflow 14 comprising a zone of quiescence. 30 indicates the overflowed and classified fines discharging from the classifier in suspension over the weir 14 through the launder 15. 31 indicates the emerged classified sands or larger solids discharged from the classifier through the launder 26. 32 indicates the sediment or settled solids in the bottom region of the bath 12, which have been settled due to sedimentation. 33 indicates the load carried by the blades 20. 34 indicates entrained water escaping from the loads on the blades 20 after they emerge from the bath 12. 35 indicates adjustable or removable strips applicable to the classifier of Figure 3, for raising and lowering the effective liquid level of the bath in the tank 11 and the height of the overflow weir 14.

In the embodiment shown in Figure 3, the overflow weir 14 surrounds the elevator-classifier, so that there can be obtained the effect of maximum weir length. In this embodiment the quiescent zone is between the elevator-classifier C and the side walls of the tank 11, with the zone of agitation being between the baffles 27 and 28. Due to the resulting carefully controlled quiescence, this arrangement lends itself admirably where fineness of overflow is desired.

The modification shown in Figure 4 differs principally from the modification shown in Figure 3 by the reversal of relative positions of the zones of agitation and quiescence in the bath 12. Here the zone of agitation extends from the blades 20 to the side walls of the tank while the zone of quiescence is divided between the smooth inner sides of the faces of the belt 18 and its bottom loop. In this embodiment the feed comes in through a launder 36 and the suspended classified fines overflow weirs 37 on each side of an overflow launder 38, disposed between the inner sides of the belt 18. The liquid in the region of launder 38 may be protected or quieted by inclined baffles 39 and 40. Since here the quiescence is not so carefully controllable, this type of arrangement is more suitable where high circulating loads are encountered such as in a primary classifier in a closed-circuit grinding system.

41 indicates, in all figures, valve-controlled water jet or jets for directing water into the pockets P at the moment or just after the moment of discharge of their loads due to their being upset taking over the head pulley 17, in order to assure their emptying.

The endless-belt construction can be used as a unit in one classifier or a plurality of the belts may be used, located either edge to edge, or concentrically. The belts can be made satisfactorily of a combination of rubber and fabric or duck, since for the best operation of the device it is important to maintain the zone of quiescence in the bath 12, which, in the embodiment of Figure 4, will be disturbed if the endless belt is articulated such as in the form of a chain, instead of presenting as it now does a surface smooth enough so that during the travel of the belt the zone of quiescence, adjacent the overflow launder 38, is not harmfully disturbed. In the modification of Figure 3, the smoothness of the construction of the belt is not so important, because the belt is in the midst of the zone of agitation, and

to this extent quite unlike the embodiment of Figure 4. In the arrangement of Figure 4, should it be desired to assure greater quiescence, this can be done by increasing the diameter of the head pulley 17, thus increasing the distance apart between the ascending and descending sections of the endless belt 18. Since the selectivity of classification is governed by the degree of quiescence in the quiescent zone adjacent the overflow, it is important to control this, if greater selectivity is desired, and this can be controlled as above described by spacing apart the ascending and descending parts of the belt, or by lowering the speed of travel of the belt, or both. Deepening the bath also contributes to increased selectivity.

In the arrangement of Figure 3, should it be desired to increase the degree of agitation in the zone of agitation, it can be done by using a smaller-diameter head pulley to bring the ascending and descending sections of the belt 18 closer together and thus intensify the agitation, because of the travel of the belt and its blades. In both types shown in Figures 3 and 4, the intensity of agitation can also be controlled by the speed of rotation of the head pulley, so that to that end there is usually provided for the head-pulley shaft 42 a speed-reduction mechanism and a prime mover. 43 in Figure 3 indicates a baffle on the feed launder 13 for directing the incoming feed downwardly to avoid a washing action on the adjacent loads on the ascending blades.

It has been said that the angle between the blades 20 and the belt is of the order of 45°. This will give acceptable all-around classification where the classifier is used in closed-circuit grinding; but this angle may be changed to 50° or to 40°, depending upon the degree of selectivity desired. Nevertheless, in changing the angle of these blades, it should be remembered that the smaller the angle, the greater quantity of the load carried to emergence by the blade is likely to stick to the blade and into the pocket formed by it and its leg 21, when the pocket is upset. The greater the tendency of the load to stick in the pocket, the more water must be used through the jet device or nozzles 41 to empty the pocket. In closed-circuit grinding the presence of this excess water in the discharged sands 31 is unimportant. The classifiers can be used for the separation of solids under conditions where the discharge sands or larger solids must be relatively dry to such an extent that it would be harmful to have too much water in the discharged sands. Under such circumstances, the need for the water jets can be obviated by increasing the angle between the blades 20 and the belt 18.

The blades work satisfactorily if made of cast steel, but if they are made of a material which is less strong, such as cast iron, then it may be necessary to provide tie braces from one leg of the V to the other. The blades should be of rather heavy metal so that their total weight bearing upon the head pulley prevents slippage between the pulley and the belt. Again, they had best be heavy enough so that the weight of the loads on the ascending blades does not cause a degree of unbalance to affect adversely the belt-driving function of the head pulley. And further, the blades should be disposed on the belt close enough together, say from 3 to 5 inches apart, to add rigidity to the submerged loop of the belt when the submerged blades dig into and scrape up sediment in the tank. The inside leg 21 of the crotch of the blade is crowned to a curvature correspond-

ing to the curvature of the periphery of the pulley so that it will lie against or hug closely the belt as it takes around the pulley. This permits the belt to lie smooth and tight against the pulley and serves to keep the belt running true over the head pulley without lateral play. Further, it facilitates the discharge of the load from the blade when it starts to descend from the high point it reaches in taking round or over the head pulley. And as discharge begins at the high point, the load runs downwardly onto the shorter leg of the blade. Unless that leg fits tightly against the belt, sand would flow between the leg and belt and soon badly abrade both. Again the outside of the longer leg of the blade must extend well to a point or apex so that as a blade is reaching an inverted and discharging position the back portion of the blade below serves as a chute or bridge from the belt toward the deflector plate 25, and at the same time prevents as far as possible any sand from getting between the short leg and the belt. The bolted leg 21 of the pocket P can be heightened for coarse separation but for finer separation the reverse is desirable.

Another factor that needs careful attention is the depth of the bath 12 in the tank 11. It must be deep enough to permit the deposit and collection in the bottom section of the tank as sediment of larger settled solids, and also be deep enough so that the blades 20, in passing upwardly in submergence with their load of sediment, have a time interval long enough so that stratification of the grains or other component parts of the load shall have a chance to take place with the larger on the bottom and the smaller on the top, as indicated in somewhat exaggerated degree in Figure 5. 12 inches of submergence of the blades is usually enough for this purpose and about two inches clearance between edge of blade and tank bottom is sufficient. One reason for this is that if it is done prior to emergence of the load, a large percentage of the water held in the interstices between the grains of the load is squeezed out, or rather, it may be said that the interstices existing between the grains of the load have been lessened in average size. Therefore when the blade emerges from the bath with its load, most of the water of the load is carried by the top surface of the load, so that immediately upon emergence, it drains off the load quickly. The prompt escape of the water from the load on the blade 20 is important, so that the entrained water, in leaving the load, carries with it a minimum of the solids of the load. If the escape of the entrained water is obstructed, it tends to roll up the solids of the load, whereupon, when it does escape, it carries too many of these solids with it. Another way to express this idea may be to say that it is desired to discourage the eroding effect of the entrained water when it runs from the load. This effect can be accomplished as above described by causing stratification of the load on a blade during its passage upwardly through submergence to emergence, if a long enough time interval is provided for, and the pockets P are open at each end. But when they are thus open, in the zone of emergence, the entrained water of the load quickly flows from the mid-length of the load toward each end of the pocket or blade, and falls or cascades into the bath. Open-ended pockets give the best results, but it is not to be understood that this patent is limited to that construction, for it is possible with less satisfactory results, to permit the water to escape from some other location of the pockets than the ends.

An attractive feature of this elevator-classifier is that by increasing the length of the belt 18 and raising the head pulley 17 a greater distance above the tank 11, the height of the discharge of the sands 31 can be raised above the tank. In closed-circuit grinding, for instance, this is a decided advantage, because this height can be so far above the mill inlet trunnion that the discharged sands can be fed by gravity back to the mill.

The incorporation of a classifier embodying this invention in a closed-circuit grinding system, is shown in Figure 2, wherein the classifier is shown in plan view and reference numerals are applied thereto corresponding to those used in the other figures. The feed launder 13 of the classifier conveys solids in suspension to be classified that are discharged from a trunnion 45 of a ball or other grinding mill 46. The sands or oversize, classified and emerged out of the pulp by the classifier, which pass over deflector plate 25 into discharge launder 26, are conducted in closed circuit back to the mill 46 through its intake trunnion 47 by means of a usual scoop 48, which picks up the sands from the launder 26 and conveys them into the mill. New raw feed 50 is supplied to the mill circuit through the launder 49, which joins the recirculated sands launder 26, as shown.

From what has preceded it is clear that:—The apparatus is for separating out coarse solids from a liquid-solids mixture containing solid particles of sizes ranging from desirable fines through intermediate sized particles to non-desired coarse sizes. The apparatus comprises a tank having means functioning in effect as a partial partition whereby there are provided an agitation zone and a zone of relative quiescence sufficiently separated from each other so as to prevent undue extension of the agitative effect from the agitation zone to and into the quiescent zone, but which partial partition leaves a direct free-flow passageway for liquid containing fines and intermediates in suspension therein to pass from the agitation zone to the quiescent zone. This passageway leading from the agitation zone to and into the quiescent zone extends to an elevation or locality substantially above the body or bed of sedimented coarse solids. The bed of sediment comes into existence incident to the functioning of the apparatus and comprises a substantially constant depth body of an everchanging mass of sedimented solids. The passageway or passageways, if there are more than one, may be viewed as providing for constant hydraulic communication between the aforesaid zones for thus assuring the same level for the liquid in both zones. The means that provides the partial partition may be viewed as a baffle means that functions to baffle or restrict the scope of agitative effects so that they will not be transmitted from the body of liquid in the agitation zone to and into the body of liquid in the zone of relative quiescence.

The liquid-solids mixture is fed initially into the agitation zone. The agitative effects in said zone are produced by a continually moving endless belt carrying a series of bladed members extending outwardly therefrom and forwardly in the direction of belt travel. The bladed members function as agitating blades and also as lifting blades. They may be considered as members which, incident to their movement, effect violent mechanical induced agitation within that portion of the liquid-solids mixture lying within the agitation zone of the tank.

An overflow means is provided whereby liquid

with the selected out desirable finer solids in suspension therein, can pass from the relatively quiescent zone of the apparatus. The overflow means, sometimes referred to as the slimes overflow, determines the normal level of the liquid-solids mixture or bath in both zones of the tank. The depth of the quiescent zone is such that only finer particles in suspension and certain unsettled smaller intermediate sized particles will pass the overflow. In other words the depth of the quiescent zone is sufficient to insure that the larger intermediate and the coarse sizes shall not rise to an elevation high enough to reach the slimes overflow thus insuring that the larger intermediates, if there are such, shall stay in the tank until they reach a locality at which they can settle ultimately with the coarse solids and be withdrawn therewith by the blades on the endless belt. Such larger intermediate sizes constitute what may be defined as the smaller limits for the coarse particles emerged to discharge as the result of the functioning of the classifying apparatus.

The operation of the device is as follows: The liquid-solids mixture to be classified is fed to the tank 11 through the launder 13 in the device of Figure 3, or the launder 36 in the device of Figure 4. The feed forms the bath 12 in the tank. Rotation of the head pulley 17 impels the flexible belt 18 with its pockets P. The usual speed is 24 ft. per minute. As a blade descends into submergence, it encounters the sediment of solids settled in spite of the agitation in the bath onto the bottom section of tank 11, as shown in Figure 1. Continued movement of the belt with the blade, causes the blade to dig into and bury itself in the sediment and scoop up a load thereof, so that when the blade begins to ascend, it has a full load of solids thereon, as indicated in that figure. Ascent of the blade in submergence is long enough to stratify the solids of its load, as above described, so that by the time the blade emerges, the solids of its load have become fairly well stratified so that the coarser solids tend to displace from the blade load smaller solids which may have found their way therinto, as shown in Figure 2. On emergence the water entrained by the load quickly flows or drains off, so that the load, in further ascending, is substantially dewatered. As the blade with its load takes over the head pulley 17, the load is discharged from the blade as the blade is upset. The discharging load encounters a deflector blade 25, which diverts it into the feed launder 26, adapted to carry it away from the classifier to a place of disposal or further treatment. The travelling blades set up enough disturbance in the zone of agitation in the bath, extending substantially between the baffles 27 and 28 in Figure 3, to cause a selective and controllable separation of solids, the coarser solids settling by sedimentation in spite of the disturbance, while the finer solids are kept in suspension, in which condition they travel or drift to the zone of quiescence that is functionally connected to, but shielded from, the zone of agitation, and located adjacent the overflow weir or outflow 14. Due to the continuous feed of new material to the bath 12 through the launder 13, the drifting fines are caused to flow past the weir or other level controlling device 14, from which they are conveyed through the launder 15 to the place of use.

In the embodiment shown in Figure 4, the elevator conveyor C operates the same as that of Figure 3, the difference being that in this embodiment the overflow launder 38 is

located between the inner surfaces or faces of the belt, so that the zone of quiescence, which must be adjacent the overflow weir or suspended fines outflow 37, lies within the lower loop section of the belt; but otherwise the operation is the same. The bottom section of the tank is preferably tapered or moved inwardly to prevent the accumulation of sediment in corners out of reach of the blades 20, and to prevent banking of solids or slimes on the tank sides. This taper also discourages the upward sweep of oversize solids.

In general, therefore, the mode of operating the classification apparatus herein described, involves the introduction of the liquid with its variously sized suspended solids into the agitation zone wherein relatively powerful agitative effects are established and maintained incident to the operation of the bladed members on the moving endless belt and more particularly incident to the several bladed members successively digging into the body of sedimented coarse solids effected by sedimentation in the bottom of the tank. While one function of each bladed member is to lift out a quantity of coarse solid particles, nevertheless an important function thereof is to effect such a degree of agitation that the desirable fines and smaller intermediate sized particles will remain in suspension while only the coarse particles and the larger intermediates will settle whereby the bed of settled solids will comprise substantially only the coarse and larger intermediate sized solids, forming a bed of undesirable large sizes relatively free of fines or desirably sized solids because the agitation is so violent that the desirable fines do not settle. Thus is selective size separation brought about.

Reference has heretofore been made to the fact that the zone of relative quiescence is provided with a slimes overflow to permit an outflow of the liquid and suspended fines selectively recovered as the result of the classification operation and that an essential feature of this quiescent zone is that it have sufficient depth to discourage the passing of the larger intermediates up to and out with the slimes overflow.

A theory of the operation is that the intermediate sizes settle less readily than the larger solids since they have more of a tendency to remain unsettled or in suspension, but they have sufficient tendency to settle whereby should they travel toward the region of the slimes overflow they will not reach an elevation as high as that, with the result that as the apparatus functions there would appear to exist an intermediate layer or stratum of only partially settled intermediate sizes. The downward movement of the angularly disposed bladed members within the agitation zone effects eddy currents that serve to maintain the intermediate sizes more or less in suspended or non-settled condition in the liquid, whereby they are intermixed with the finer particles that continue in suspension with the result that the sedimented body of coarse solids is relatively free of fine and intermediate sized particles.

As a bladed member enters the body of sedimented coarser solids, it picks up and removes from the sedimented material a load or quantity corresponding to the size of the holding space provided between the carrying belt and the particular bladed member involved. As the bladed member with its load thereon ascends, it effects a further agitation within the agitation zone and there is permitted a relatively free and unobstructed surface flow, approaching a horizontal

flow, from off the load of those intermediates and finer sized particles that are in the bath section immediately overlying the particular load. The result is that during the emerging from the bath of a particular blade with its load of solids, the surface of the load is left relatively free of other than the coarse solids sought to be obtained by the lifting operation that is, as soon as each blade with its load of sedimented larger solids, starts to leave the bath, it is automatically ridded of water, fines, and certain intermediate sizes because the blade is constructed so as to permit a surface drainage or horizontal flow therefrom to take place as the load emerges from the bath. By the series of operations herein described, there is obtained a load of emerged larger solids that are relatively free from smaller solids whose sizes are substantially those that it is desired to recover in suspension by the classification process.

Therefore the degree of agitation and the amount of large settleable solids obtained as sediment in the lower portion of the classifier tank becomes in effect a function of the speed of movement of the endless belt carrier with the blade elements thereon and also of the size and specific gravity of the larger particles.

The zone having the fines or slime overflow is referred to herein as a relatively quiescent zone. But such zone is not necessarily a strictly quiescent zone. It is a zone that is substantially more quiescent than is the agitation zone and for the proper functioning thereof reliance is placed upon the depth of the zone being sufficient to prevent the larger size particles from passing therefrom to and over the slimes overflow. An important function of the apparatus resides in having the bladed or bucket construction of such shape that there is assured a free flow of liquid from the top surface or load in the bucket whereby the top surface upon emerging from the bath is forthwith freed or ridded of liquid previously thereover and of the fines in suspension in said liquid. This end is attained by making the bladed members so that they have open ends but it also may be attained at least to a fair extent, by making the bladed member so that any other section thereof is left sufficiently low to provide for the free flow from the surface of the load or burden on the blade.

This application is in part a continuation of my Application 15,041 filed April 6, 1935, and renewed April 19, 1937, and which has been abandoned after allowance.

I claim:—

1. A classifier having a tank, adapted to contain a bath of a solids-liquid mixture to be treated provided with a feed therefor and an outflow for the discharge of classified finer solids in suspension, an endless flexible belt extending from above to below the normal liquid level of said bath, a head pulley for supporting and impelling

said belt, a plurality of blades on the outside of said belt extending therefrom at an angle of the order of 45° adapted to be carried by travel of said belt into submergence in said bath and then to emergence, said bath being divided into a zone wherein agitation is caused by travel of said blades and a zone of relative quiescence adjacent said outflow wherein there can be realized concurrently sedimentation and a relatively quiet outflow, each of said blades adapted to carry to emergence without harmful disturbance of said outflow a load of settled solids picked up from the bottom zone of said tank from which loads liquid entrained thereby escapes freely, and means for diverting from the classifier the emerged loads discharged by the blades upon their being upset after taking around said head pulley.

2. Apparatus according to claim 1 in which load-carrying pockets are formed between the blades and the belt having an opening for the quick release, upon emergence of a load on a blade, of liquid entrained thereby.

3. Apparatus according to claim 1 in which load-carrying pockets are formed between the blades and the belt having open ends for the quick release, upon emergence of a load on a blade, of liquid entrained thereby.

4. Apparatus according to claim 1 in which the bath is divided into its two zones by means of the belt itself.

5. Apparatus according to claim 1 in which the bath is divided into its two zones by means of baffle devices.

6. Apparatus according to claim 1 in which the blades are V-shaped in cross-section with one leg thereof secured to the belt.

7. Apparatus according to claim 1 in which the blades are V-shaped in cross-section with one leg thereof secured to the belt and said leg curved to the curvature of the head pulley.

8. Apparatus according to claim 1 in which the blades are V-shaped in cross-section with one leg thereof secured to the belt, with said blades mounted sufficiently close together on the belt to give it rigidity for enabling the blades when in submergence to dig into and scoop up settled solids from the bottom region of said bath.

9. Apparatus according to claim 1 in which the overflow weir is disposed between the sides of said endless belt.

10. Apparatus according to claim 1 in which the overflow weir is embodied in an overflow launder disposed between the sides of said endless belt.

11. Apparatus according to claim 1 in which the overflow weir surrounds said endless belt.

12. Apparatus according to claim 1 in which the overflow weir is supported from the margin of said tank.

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