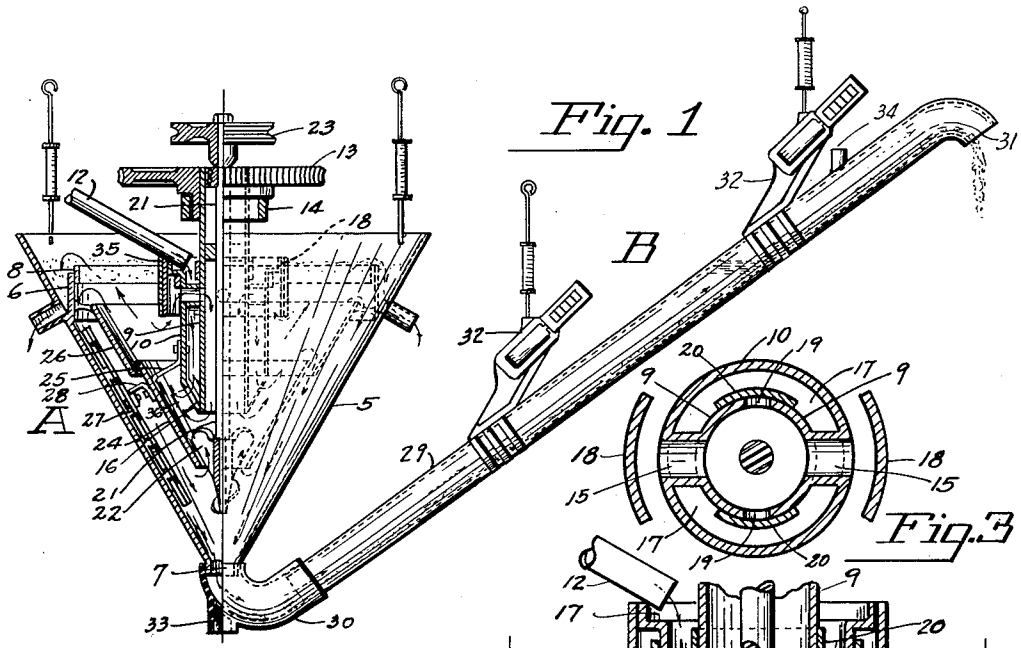
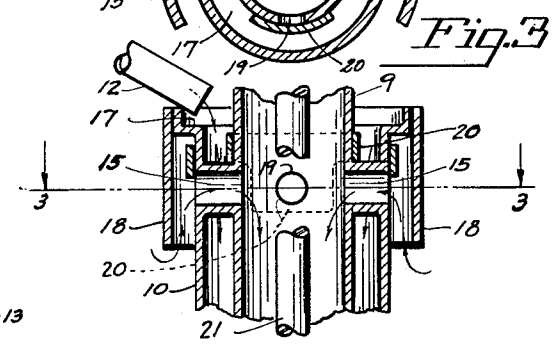
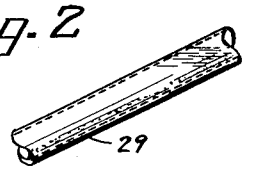
Feb. 23, 1937. A. C. DAMAN 2,071,617

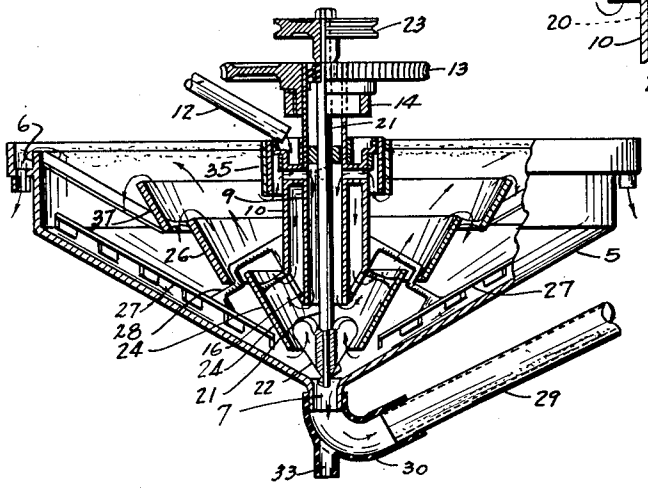
CLASSIFIER

Filed Dec. 15, 1931 3 Sheets-Sheet 1









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CLASSIFIER

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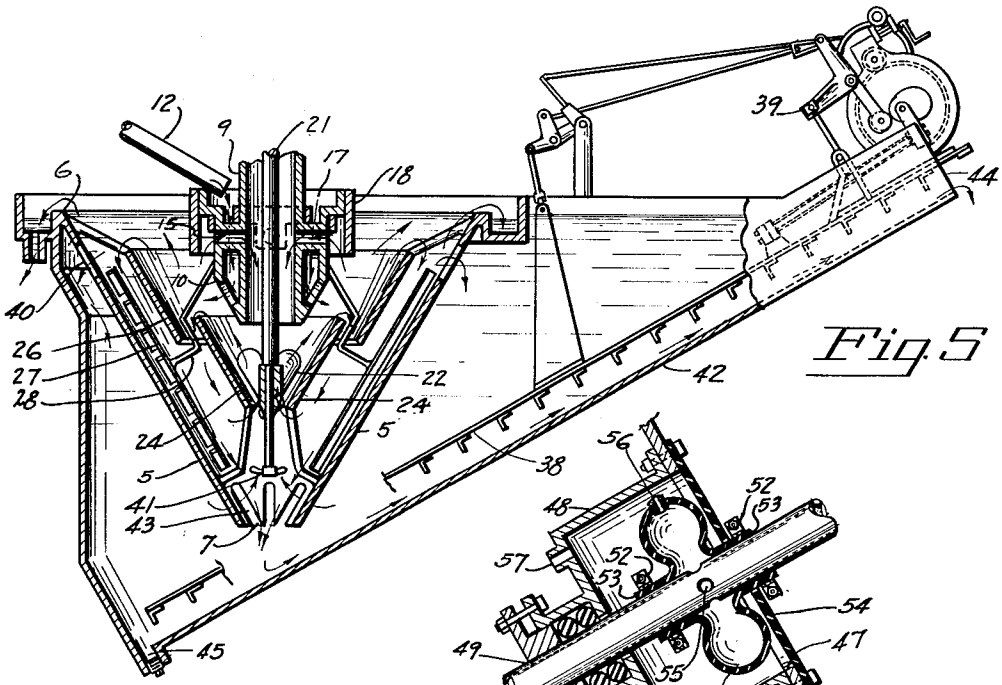

Fig. 5

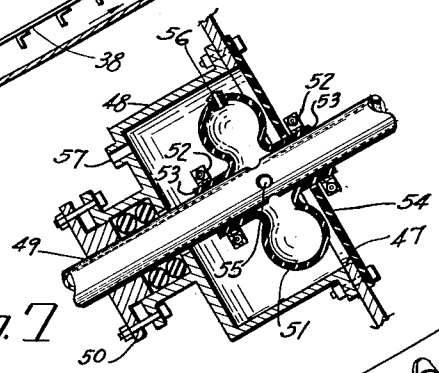

Fig. 7

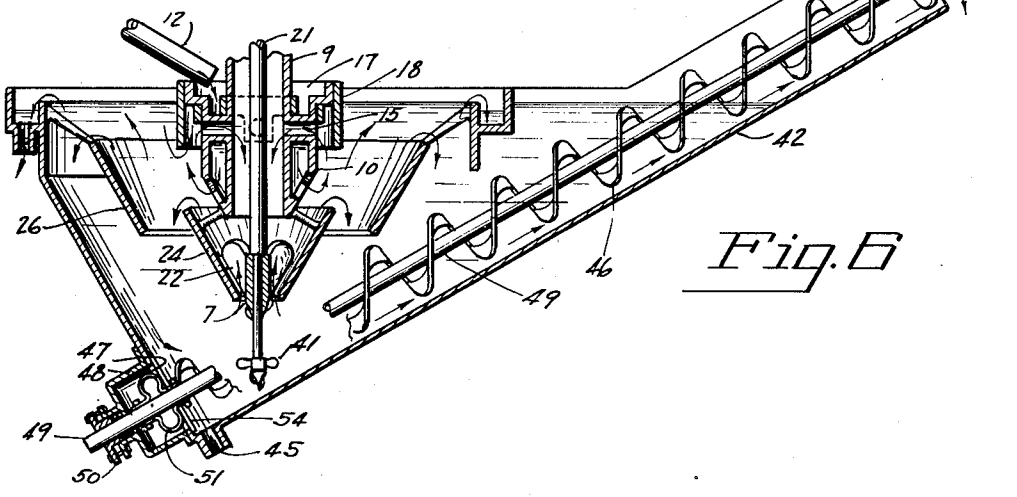

Fig. 6

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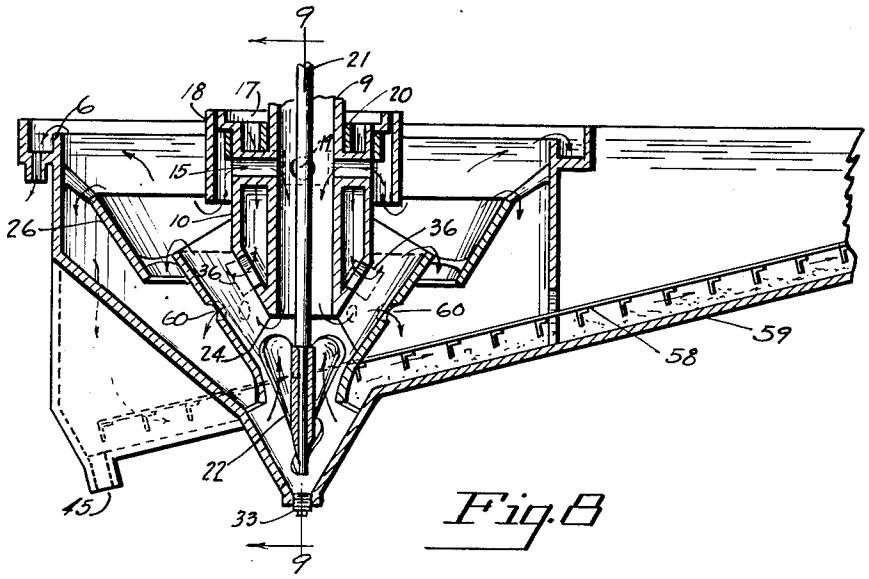

Fig. 8

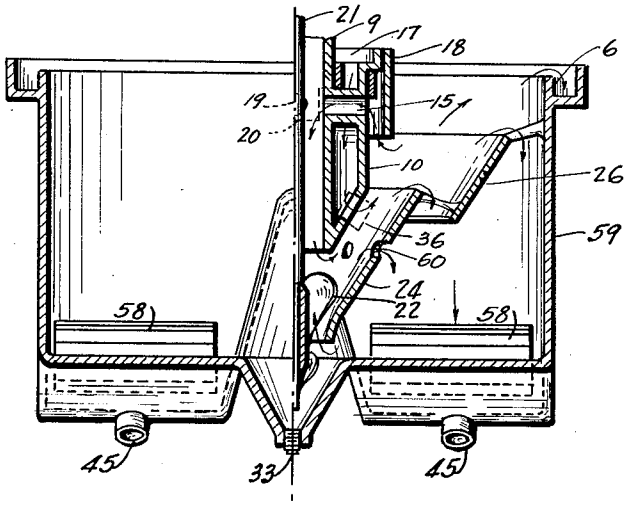

Fig 9

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UNITED STATES PATENT OFFICE

2,071,617

CLASSIFIER

Arthur C. Daman, Denver, Colo.

Application December 15, 1931, Serial No. 581,129

23 Claims. (Cl. 209—18)

This invention relates to ore-classifiers in which the ore is subjected to a separating action in a primary classifying element providing an overflow for slimes or fine material in liquid-suspension, and in which coarse material settling in the primary element, is subjected to a de-watering action in a conveying element by which they are moved to a point of ultimate discharge.

A settling element similar to that of the present invention has been disclosed in United States Letters Patent No. 1,953,672, granted to me April 3, 1934, and it is an object of the invention to provide certain new and useful improvements which promote and expedite the clean classification of fine and coarse constituents in the material under treatment by progressive separation and by circulation of part of the material in a closed circuit, whereby exposing it to repeated separative influences.

Another object of the invention resides in the provision of a de-watering and conveying element, in combination with the primary classifier, and in the provision of a de-watering and conveying element of novel character and construction.

Further objects of the invention, relating to novel features of construction and novel arrangements and combinations of parts, will appear in the course of the following description, made with reference to the accompanying drawings.

In the drawings in the several views of which like parts have been designated by similar reference characters,

Figure 1 represents a sectional elevation of the invention in its preferred form,

Figure 2, an enlarged sectional view of the upper portion of the feed and circulating parts of the same,

Figure 3, a section on the line 3—3, Figure 2,

Figure 4, a sectional elevation showing a modified form of the classifying element of the apparatus,

Figure 5, a sectional elevation of a modified construction, with particular reference to the conveying element of the same,

Figure 6, a sectional elevation showing still another form of the conveying element,

Figure 7, an enlarged sectional view of a means to provide a water-tight closure around a rotary part of the construction illustrated in Figure 6,

Figure 8, a fragmentary section showing a modification of the form illustrated in Figure 5, and

Figure 9, a section taken along the line 9—9 in Figure 8.

Referring first to Figures 1 to 3 of the drawings, the primary classifying element A comprises an inverted cone-shaped vessel 5 having a circular weir 6 for the overflow of slimes, and having at its lower end, an outlet 7 for the delivery of coarse settling products of the classifying operation, to the de-watering and conveying element B.

The weir has a loose rim 8 which may be adjusted to raise or lower the line of the overflow which determines the liquid level in the vessel. Two concentric tubes 9 and 10 in the vessel 5 have their common axis coincident with the vertical axis of the cone-shaped vessel, and conjointly provide an element for conveying material fed into the space between the tubes through a launder 12, to the lower portion of the vessel.

A rotary movement is imparted to the inner tube by means of a worm-wheel 13 supported on a bearing 14 above the vessel and the two tubes are rigidly connected by cross-tubes 15 adjacent their upper ends and by an apertured flange 16 at their lower ends. The outer tube has at its upper end a bell-shaped enlargement 17 into which the material is fed from the launder 12 and exteriorly of the rim of this enlargement are two opposite shields 18 for directing upwardly moving material to the connections 15 at the upper ends of the tubes.

The central tube 9 has, adjacent the connections 15, one or more openings 19 through which material fed into the mouth 17 of the outer tube air may enter the inner tube, and a sliding valve 20 around the inner tube, normally resting on the cross-connections 15, is adjustable to control the passage of material through the openings 19.

A shaft 21 coaxial with the vessel, extends through the inner tube and carries at its end below the same, an impeller 22 adapted to impart an upward thrust to the material discharged from the tubes.

The impeller is rotated through the medium of a sheave 23 supported above the worm-wheel 13. A conical baffle 24, is fastened as by arms 25 to rotate with the concentric tubes, and its lower end houses a part of the impeller in spaced relation thereto.

Another similar baffle-ring 26 laps at its lower end over the upper portion of the baffle 24 in spaced relation thereto and is held stationary by connection with the wall of the vessel.

Scrapers 27 provided with slanting blades, are connected with the rotary parts of the classifier, as by means of arms 28, to compel settling material to move along the inner surface of the vessel to the discharge opening 7. The arms 28 of the

scrapers may be attached to a vertically adjustable ring 35 around the mouth 17 of the feed tube. By adjustment of this ring, the position of the scrapers may be varied, and the edge of the mouth of the feed tube, may, if necessary, be elevated to a plane above the liquid level in the vessel.

The element B comprises a preferably rigid tube 29 connected with the outlet 7 of the classifier, by a flexible elbow 30.

The tube slants upwardly from the opening with its sand-discharging upper end 31 above the plane of the liquid level in the vessel.

A vibratory longitudinal motion is imparted to the tube 29 by means of electrical vibrators 32, in order to convey the sands upwardly through the tube to its discharge opening. The vibratory movement may be differential to accelerate the upward movement of the sands by alternate slow and rapid strokes imparted to the tube by the vibratory devices. It is apparent that these devices may be of any desired character within the scope of the invention. The vibratory motion of the tube 29 may be communicated to the vessel 5 in order to expedite the separation of the coarse matter from the fines in the material under treatment. The vessel and the tube are, in such case, supported for conjoint vibration. Any suitable structure may be employed to thus support the apparatus and inasmuch as such structure must necessarily be varied according to the construction of the mill in which the classifier is erected, detailed illustration of the same has been omitted from the drawings.

In order to maintain the material under treatment at the proper density for the separation of its fine and coarse constituents in a settling action, water may be supplied to the classifier at any desired point as, for example, at the bend of the elbow below the discharge opening 7, as shown at 33.

Water may also be supplied to the conveyor as by means of a tube 34, to accelerate the upward movement of de-watered sands, in case the density of the material in the conveyor tube exceeds a predetermined normal. By extending the conveyor above the plane of the liquid level in the classifier, a hydrostatic balance is established and the coarse matter moved above said plane by the vibratory movement, is delivered through the end of the conveyor in a comparatively dry condition and substantially free of fines and slimes. The oversize discharged from the conveyor may be conducted to a ball mill or other grinding mill, from which it may be returned to the classifier in a closed circuit, as in ordinary practice.

In the operation of the classifier, the pulp fed into the feed tube from the launder 12 moves downwardly through the apertures at the lower end of the tube 10 into the zone immediately above the impeller. The upward thrust imparted to the material causes it to move in an upward current through the conical baffle 24 and thence through the upper stationary baffle 26, as indicated by the arrows.

During the upward movement of the material, coarse particles thereof settle out of the liquid current to move to the lower part of the settling vessel over the upper edges of the baffles.

The finer matter in suspension is divided into fine slimes which rise to the liquid level to be discharged across the overflow, and middlings which enter the space between the shields 18 and the feed tube 10 and pass through the cross connections 15 into the inner tube 9 for re-classification upon its return into the zone above the impeller.

By thus moving a part of the material in a closed circuit, it is by repeated separative actions, cleanly divided into the slimes which pass across the overflow and the coarse sands which pass through the outlet 7 of the vessel into the conveying and de-watering element B, the operation of which has been described hereinbefore.

The scraping action of the rakes 27 moving over the inner surface of the conical vessel, insures a constant movement of all of the gravitating sands to and through the outlet. During the upward movement of the material under the influence of the impeller its velocity gradually decreases in ratio to the increasing cross-sectional area of the vessel, thereby promoting gravitation of the oversize according to the sizes of its particles, it being apparent that the coarsest particles will settle out of the liquid mass during the early part of its upward motion, while particles of lesser coarseness will not be separated until they are carried further upwardly into a zone of greater quietude.

The circulatory movement of the pulp in the classifier aids in maintaining its proper density. Water introduced under pressure through the opening 33, aids in producing the same result and, moreover, washes the settling sands into the conveyor element B, and thereby replaces slimes that moved downwardly with the sands, and are subsequently returned to the primary classifier by the vibratory motion and by suction of the impeller.

The water supplied to the conveyor through the pipe 34 also functions to force and wash the slimes carried upwardly with the sands, downwardly for their return to the primary classifier.

Owing to the circulatory movement of the pulp in the classifier, but little water is required to maintain the pulp density. The vibratory movement of the apparatus keeps the slimes in suspension and thus accelerates their movement to the level of the liquid in the vessel.

The impeller may function as an aerator and in that capacity further aids the separation of the material.

In case it is desired to deliver the feed into the central zone above the impeller, together with the circulating slimes, the openings 19 of the inner tube may be opened by adjustment of the valve 20, in which case the discharge openings of the outer tube are plugged as indicated in broken lines at 36 in Figure 1, and by regulating the feed and the effective size of the openings 19, any desired amount of air can be introduced to effect the aeration referred to in the above paragraph.

In the form of the invention, illustrated in Figure 4, the vessel is comparatively shallow and its conical wall is of less inclination to retard the movement of the settling sands to the outlet. A third conical baffle 37 is added above the others, in spaced relation to the same, it being obvious that the plurality of baffles will function to separate the coarse particles from the slimes, progressively in accordance with their varying sizes. Otherwise the construction of Figure 4 is substantially similar to that of Figure 1 hereinbefore described.

In the modified construction illustrated in Figure 5, the upward movement of the sands discharged from the primary classifier is effected by means of one or more reciprocating rakes 38 moving over the sloping bottom of a tank 42, in which the primary settling vessel is disposed. A suit-

able mechanism for longitudinal reciprocation of the rakes combined with alternate upward and downward movements, is shown at **39**. This mechanism is old in the art and no detailed description will be given.

The construction of the primary classifying element differs from that of Figure 1, mainly in that the conical vessel has in the upper portion of its wall, outlets **40** for the return flow of middlings exteriorly of the vessel to the outlet **7** at the lower end of the same.

A second smaller impeller **41** connected with the other rotates in the lower zone of the vessel to effect or accelerate the upward movement of the middlings through the outlet, together with the slimes that were carried upwardly with the sands into the conveying element. The rakes move below the outlet of the classifier and the outlet has been slotted as at **43**, to prevent possible clogging of the sands and facilitate their movement to the conveyor.

The outlet **44** of the tank, is as in the before described construction above the liquid level in the vessel, and the tank has below the vessel an opening **45** which may be used for the supply of additional water, as before, or for the purpose of clearing the tank, if necessary.

The entire apparatus of this form of the invention, like that of Figure 1, may be supported for vibration and this also applies to other modified constructions hereinafter to be described.

The baffle **24** has been shown as fixed to the wall of the baffle **5**.

The main difference between the construction illustrated in Figure 6 and that shown in Figure 5, resides in the replacement of a helical screw conveyor **46** for the reciprocating rake or rakes. The rotary shaft projects through an opening **47** at the lower end of the sloping bottom of the tank and in order to close this opening against leakage of water from the tank, a device is employed which on an enlarged scale, is illustrated in Figure 7, which forms the subject matter of my copending application, Serial No. 738,709, filed August 6, 1934.

A box **48** fastened exteriorly of the wall of the vessel around the opening **47** through which the shaft **49** of the screw **46** extends, has a stuffing box **50** for the shaft which prevents possible leakage of liquid contained in the box. Inside the box is a circular tube **51** of flexible material which surrounds the shaft and is securely clamped upon the same, by suitable clamping devices **52** applied to oppositely extending sleeves **53** that are fitted upon the shaft. The tube engages with a flexible sheet **54** which covers the opening in the wall of the tank.

The shaft is hollow and it has openings **55** within the tube through which air or liquid under pressure may enter the same.

The tube has a small opening **56** for the escape of air or liquid into the box **48**. The escaping fluid moves to the point of contact of the tube with the flexible sheet for the removal of sand or other matter which might impair or destroy the contact.

The box has, furthermore, an inlet **57** for air or water, it being preferable that the box be filled with a suitable fluid; provided, of course, that the pressure within the tube remains greater than that outside the same.

The sheet **54** may be flexible or rigid, and any pressure fluid may be supplied to the hollow shaft and thence to the flexible tube, by any suitable means. It will be apparent that the pressure within the tube keeps it in an inflated condition and in water-tight contact with the sheet **54**, thus preventing leakage of liquid from the tank, around the shaft extending through the opening of the same.

In Figures 8 and 9, a construction has been shown in which two rakes **58** of the character of that of Figure 5, move at opposite sides of the primary classifying element. The impeller in this form of the invention projects through the outlet of the primary classifier, and the matter passing downwardly across the baffles, is discharged into the tank **59** of the rakes, to be returned in part to the classifying vessel by the action of the impeller. By the provision of openings **60** in the lower conical baffle, through which the coarser particles may settle, one or more of the plurality of baffles may be omitted. Otherwise, the primary classifying element is substantially the same as those hereinbefore described.

The method disclosed but not claimed herein is claimed in application Serial No. 44,915, filed October 14, 1935.

The impeller is partially below the level of the rakes in the conveying element. It will be understood that the impeller may be entirely below the rakes as is the impeller **41** of Figure 6, which is of particular value in re-fitting old classifiers of the rake type now in use.

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

1. In classifying apparatus, a classifier comprising a settling vessel having an overflow for slimes and a bottom outlet for settling matter, a rotary open impeller in the lower portion of the vessel to impart an upward thrust to gravitating material, a feed tube in the upper portion of the vessel, having a discharge in a zone of the vessel immediately above the impeller, and a baffle-element providing a path for material moved upwardly by action of the impeller, and having outlets for gravitating constituents of the same.

2. In classifying apparatus, a classifier comprising a settling vessel having an overflow for slimes and a bottom outlet for settling matter, a rotary impeller in the lower portion of the vessel to impart an upward thrust to gravitating material, and a feed element including inner and outer tubes having discharges in a zone of the vessel immediately above the impeller, and cross connections for the passage of material from the vessel exteriorly of the outer tube, into the inner tube.

3. In classifying apparatus, a classifier comprising a settling vessel having an overflow for slimes and a bottom outlet for settling matter, a rotary impeller in the lower portion of the vessel to impart an upward thrust to gravitating material and a feed element including inner and outer tubes having discharges in a zone of the vessel immediately above the impeller, cross connections for the passage of material from the vessel exteriorly of the outer tube, into the inner tube, and a baffle element defining a path for material moved upwardly by action of the impeller, and having outlets for coarse matter in the material.

4. In classifying apparatus, a classifier comprising a settling vessel having an overflow for slimes and a bottom outlet for settling matter, a rotary impeller in the lower portion of the vessel to impart an upward thrust to gravitating material and a feed element including inner and outer tubes having discharges in a zone of the vessel immediately above the impeller, cross connections for the passage of material from the

vessel exteriorly of the outer tube, into the inner tube, and means for directing material to the cross connections.

5. In classifying apparatus, a classifier comprising a settling vessel having an overflow for slimes and a bottom outlet for settling matter, a rotary impeller in the lower portion of the vessel to impart an upward thrust to gravitating material and a rotary feed element including inner and outer tubes having discharges in a zone of the vessel immediately above the impeller, cross connections for the passage of material from the vessel exteriorly of the outer tube, into the inner tube, means for directing material to the cross-connections, and a scraper element for moving settling matter to the outlet of the vessel, connected with said rotary feed element.

6. In classifying apparatus, a classifier comprising a settling vessel having an overflow for slimes and a bottom outlet for settling matter, a rotary impeller in the lower portion of the vessel to impart an upward thrust to gravitating material and a rotary feed element including inner and outer tubes having discharges in a zone of the vessel immediately above the impeller, and cross connections for the passage of material from the vessel exteriorly of the outer tube, into the inner tube.

7. In classifying apparatus, a classifier comprising a settling vessel having an overflow for slimes and a bottom outlet for settling matter, a rotary impeller in the lower portion of the vessel to impart an upward thrust to gravitating material, and a rotary feed element including inner and outer tubes having discharges in a zone of the vessel immediately above the impeller, cross connections for the passage of material from the vessel exteriorly of the outer tube, into the inner tube, and an annular baffle partially extending around and upwardly from the impeller.

8. In classifying apparatus, a classifier comprising a settling vessel having an overflow for slimes and a bottom outlet for settling matter, a rotary impeller in the lower portion of the vessel to impart an upward thrust to gravitating material, and a rotary feed element including inner and outer tubes having discharges in a zone of the vessel immediately above the impeller, cross connections for the passage of material from the vessel exteriorly of the outer tube, into the inner tube, an annular baffle partially extending around and upwardly from the impeller, and a stationary annular baffle lapping over the rotary baffle in spaced relation thereto.

9. In classifying apparatus, a classifier comprising a settling vessel having an overflow for slimes and a bottom outlet for settling matter, a rotary impeller in the lower portion of the vessel to impart an upward thrust to gravitating material, and a feed element including inner and outer tubes, having an apertured connection at their lower ends, and having cross connections nearer their upper ends for the passage of material moved upwardly by the thrust of the impeller, from exteriorly of the outer tube into the inner tube.

10. In classifying apparatus, a classifier comprising a settling vessel having an overflow for slimes and a bottom outlet for settling matter, a rotary impeller in the lower portion of the vessel to impart an upward thrust to gravitating material, and a feed element including inner and outer tubes having discharges in the zone above the impeller, the inner tube having an opening nearer its upper end, and a valve controlling said opening, means for feeding material into the outer tube, and means for obstructing the discharge of the outer tube, whereby the feed is compelled to pass through the inner tube.

11. In classifying apparatus, a classifier comprising a settling vessel having an overflow for slimes and a bottom outlet for settling matter, a rotary open impeller in the lower portion of the vessel to impart an upward thrust to gravitating material, a rotary feed element in the upper portion of the vessel having a discharge in the zone immediately above the impeller, means for movement of material moved upwardly by the thrust of the impeller, in a closed circuit including a settling space outside the feed element, and including the zone immediately above the impeller, and a scraper element connected with the rotary feed element for moving settled matter to the outlet of the vessel.

12. Classifying apparatus comprising a settling element having an overflow for slimes, and a discharge opening at its bottom for settling matter, a circumferentially closed element adapted to move matter from the discharge opening to an elevated point of delivery, a flexible connection between the discharge opening and the lower end of the conduit, and means for imparting a differential reciprocating movement to the conduit.

13. Classifying apparatus comprising a settling element having an overflow for slimes, and a discharge opening for settling matter, a slanting tube to convey matter from the discharge opening to an elevated point of delivery, a flexible connection between the discharge opening and the lower end of the tube, and means for imparting a longitudinal reciprocating motion to the tube.

14. In classifying apparatus, a classifying element including a settling vessel having an overflow for slimes and an opening for the discharge of settling matter, a rotary impeller in the lower portion of the vessel to impart an upward thrust to the material, means providing a path for the upwardly moving material with outlets for settling matter, a conveying element connected with the discharge opening, for moving the settled matter to a delivery point of higher elevation, and a rotary impeller below the discharge opening, to impart for movement through the discharge opening and upward thrust to matter moving opposite to the operative movement of the conveying element.

15. In classifying apparatus, a classifying element, including a settling vessel having an overflow for slimes and an opening for the discharge of settling matter, a classifying element including a conveyor for moving settled matter from the discharge opening to a point of delivery of higher elevation, and an impelling element imparting an upward thrust to matter in the vessel and imparting to matter moving in a direction opposite to the operative movement of the conveyor, an upward thrust through the discharge opening.

16. Classifying apparatus comprising a settling element having an overflow for slimes and a discharge-opening for settling matter, a classifying element, connected with the opening to move the material to an elevated point of delivery above the liquid level determined by the overflow, and means for imparting a vibratory movement to either element independent of the other.

17. Classifying apparatus comprising in combination a settling vessel having a peripheral overflow for slimes and a discharge-opening in its bottom, a classifying element including a con-

veyor for moving material passing through the discharge-opening to a point of higher elevation above the liquid level determined by the overflow, and an impeller to counteract by an upward thrust, the downward movement of material through the discharge-opening.

18. Classifying apparatus comprising in combination a settling vessel having a peripheral overflow for slimes and a discharge-opening in its bottom, a conveying element for moving material passing through the discharge-opening to a point of higher elevation above the liquid level determined by the overflow, and an impeller to move to the discharge-opening, material moving in a direction opposite to the operative movement of the conveyor.

19. Classifying apparatus comprising a classifying element including a settling vessel having an overflow for slimes and an opening for the discharge of settling matter, a classifying element including a conveyor connected with the discharge-opening for conveying settled matter to a delivery point of higher elevation, and suction means comprising an impeller for moving material under classification in the classifying element; upwardly into the settling vessel through its discharge-opening.

20. In classifying apparatus, a classifier comprising a settling vessel having an overflow for slimes and a bottom outlet for settling matter, a rotary impeller in the lower portion of the vessel to impart an upward thrust to gravitating material, means for feeding material into a zone in the upper portion of the vessel immediately above the impeller, and a baffle-element providing a path for material moved upwardly by action of the impeller, and having outlets for gravitating constituents of the same.

21. Classifying apparatus comprising a classifying element including a settling vessel having an overflow for slimes, and an opening for the discharge of settling matter, a classifying element including a conveyor connected with the discharge-opening for conveying settled matter to a delivery point above the slime overflow, and means for directing intermixed streams of water and air upwardly into the settling vessel for reducing the density of the material under treatment.

22. Classifying apparatus comprising a settling element having an overflow for slimes, and a discharge opening at its bottom for settling matter, an upwardly ranging tubular classifying element having its lower end in communication with the discharge opening, for moving matter upwardly from the discharge opening, to a point above the slime discharge, and means for imparting a conjoint differential reciprocating movement to the tubular element and the settling element to accelerate movement of material therein.

23. Classifying apparatus comprising a settling element having an overflow for slimes and a discharge opening for settling matter, a classifying element communicating with the opening to move the material to an elevated point of delivery, means for imparting a vibratory movement to said classifying elements and means for connecting the classifying element to the discharge opening of the settling element and serving to impart a modified vibration to the settling element.

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