Nov. 21, 1939. C. E. WOOD 2,180,574

CONCENTRATING APPARATUS

Filed March 28, 1934 5 Sheets-Sheet 1

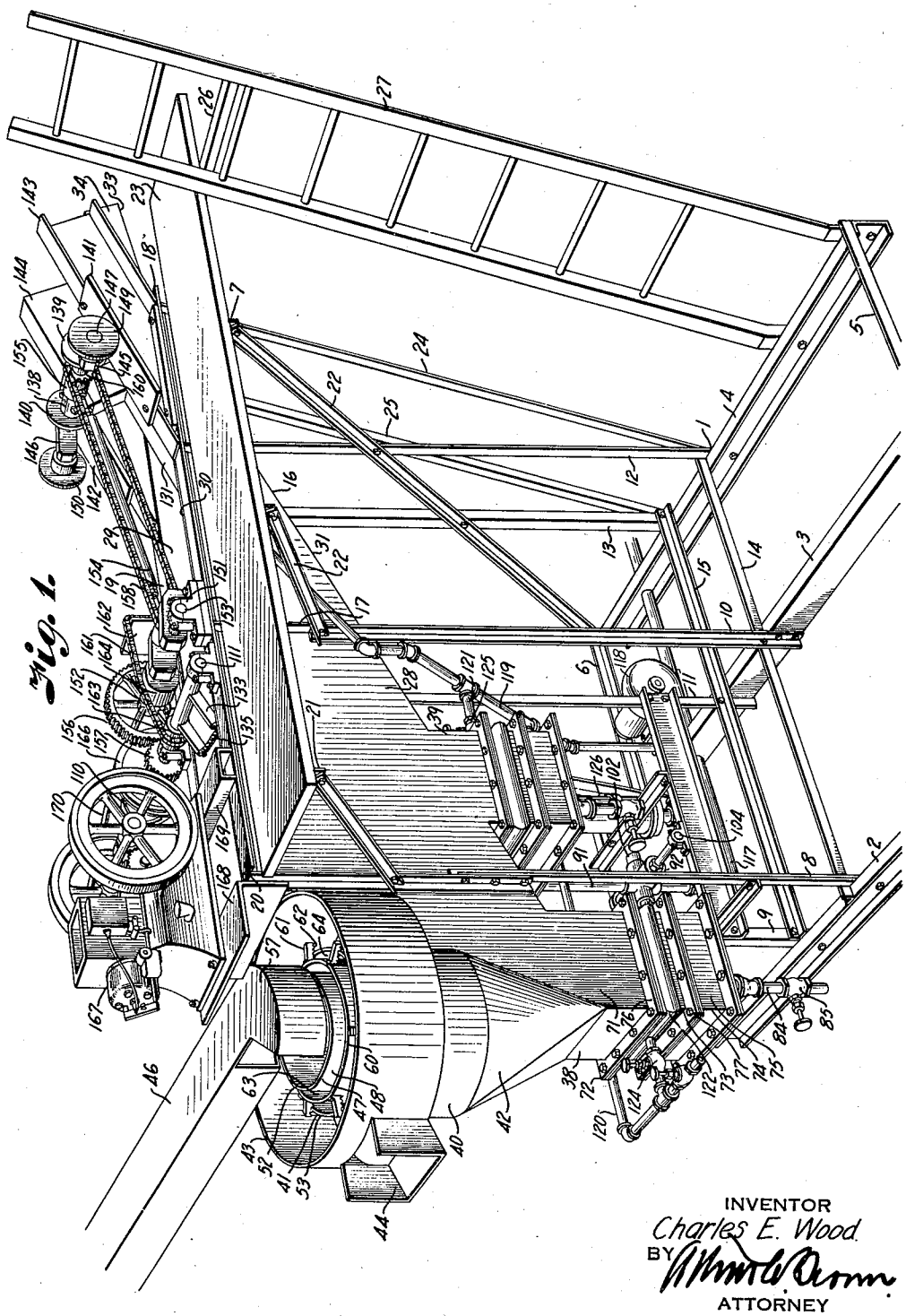


Fig. 1.

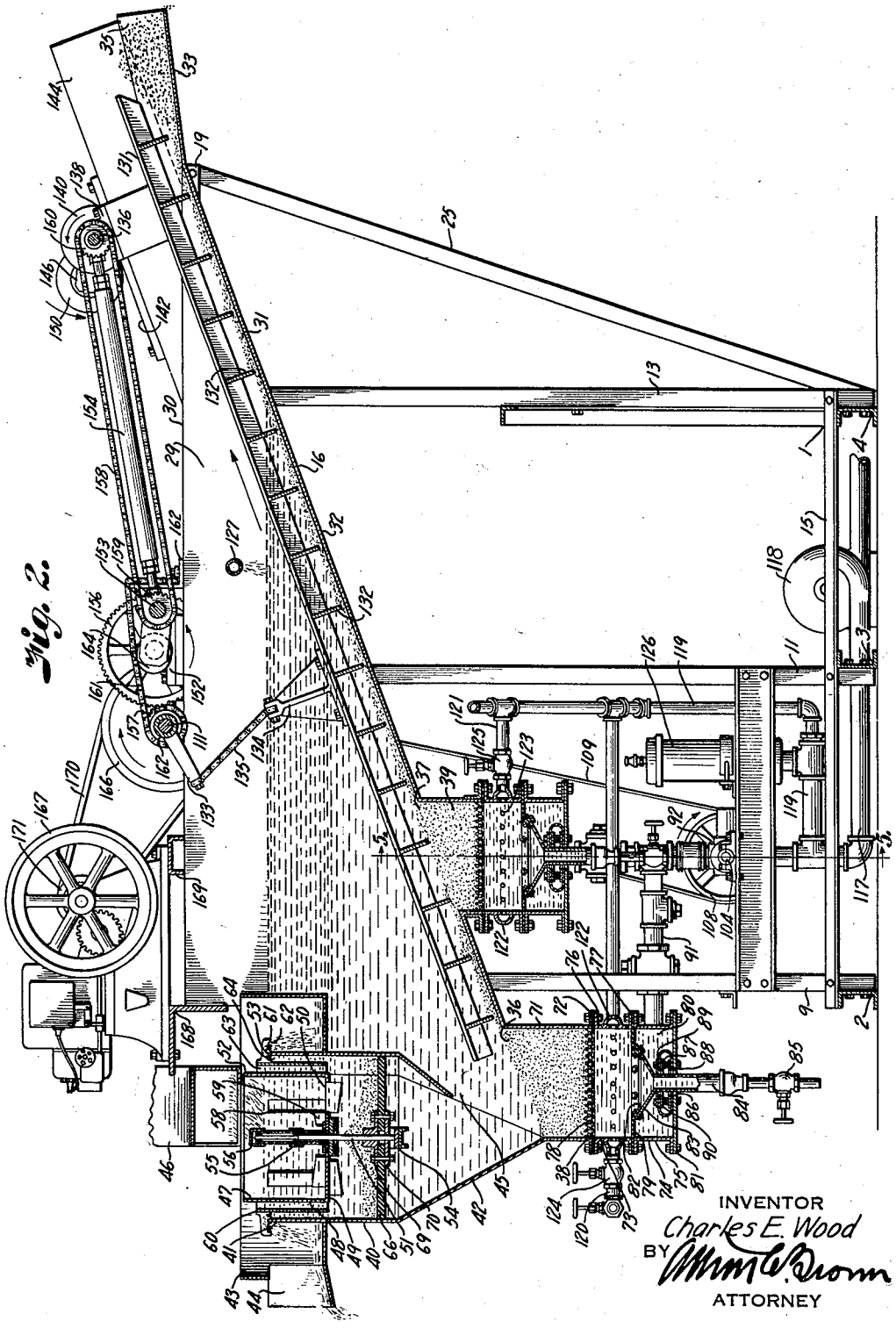
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CONCENTRATING APPARATUS

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Fig. 2.



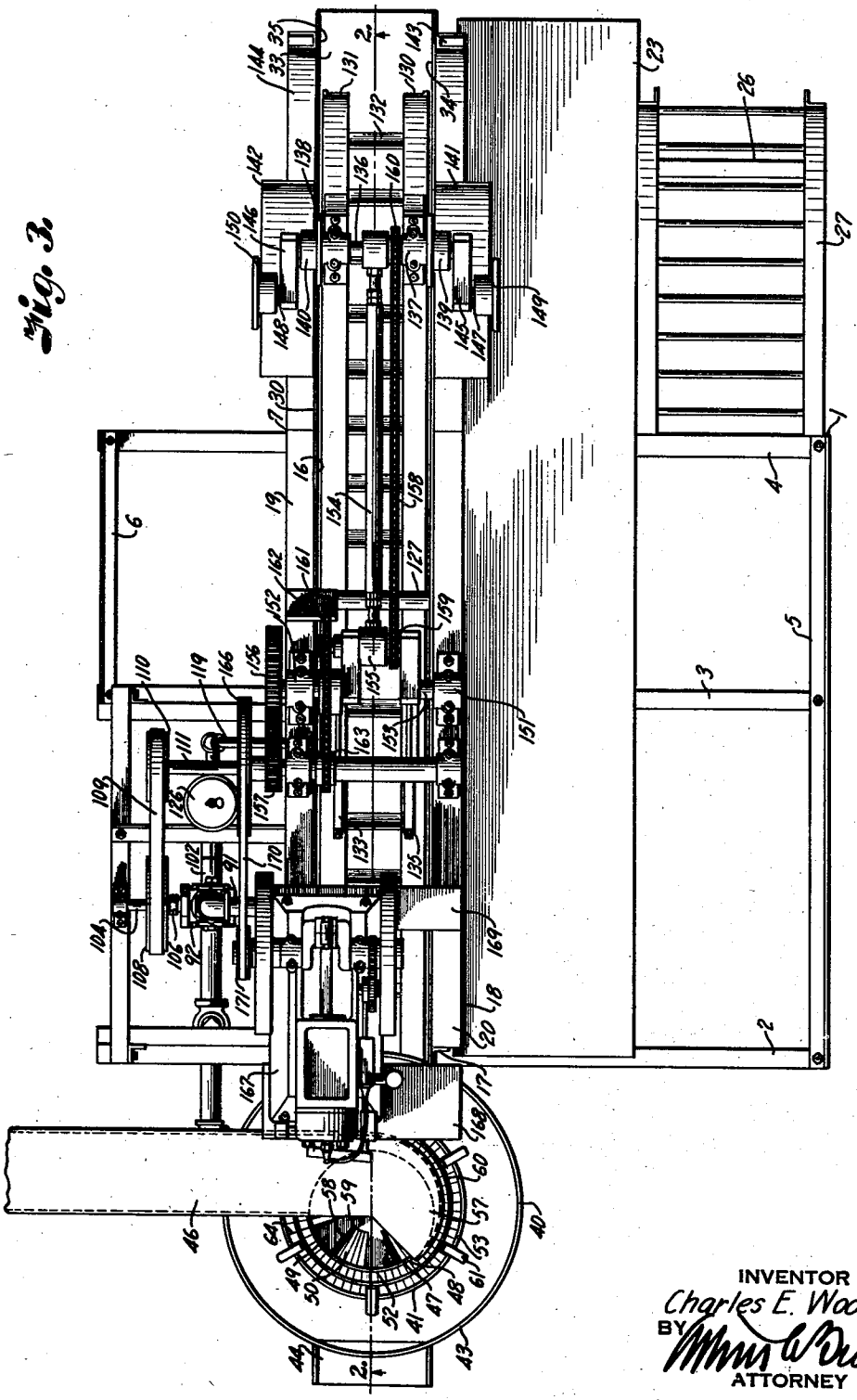
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Fig. 3.



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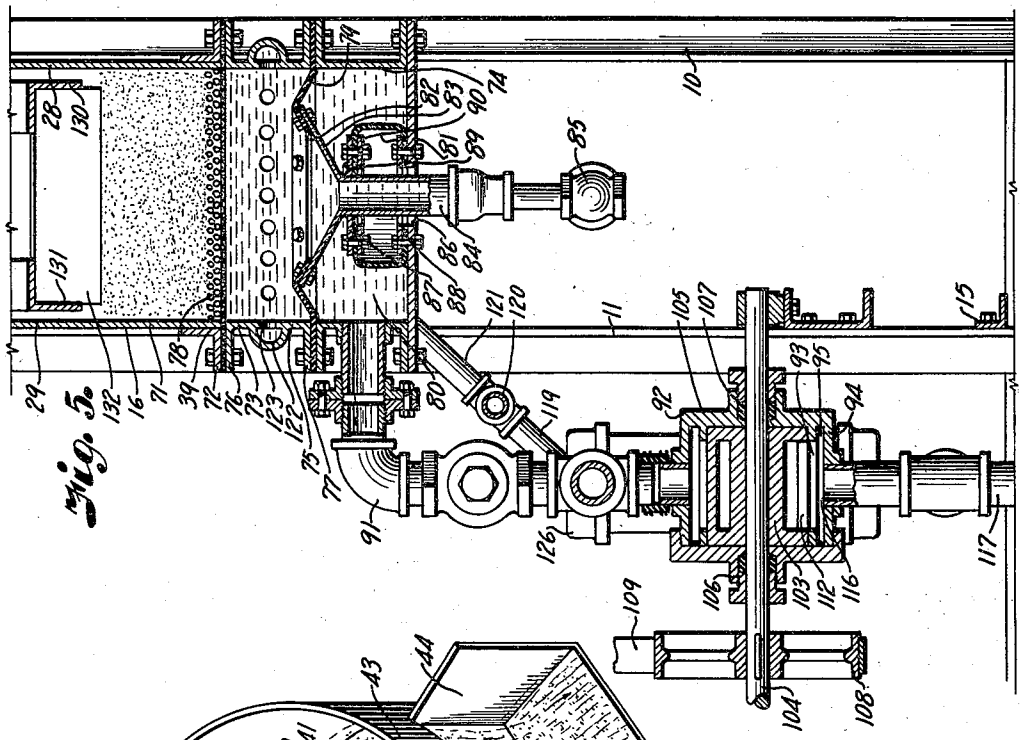


Fig. 5.

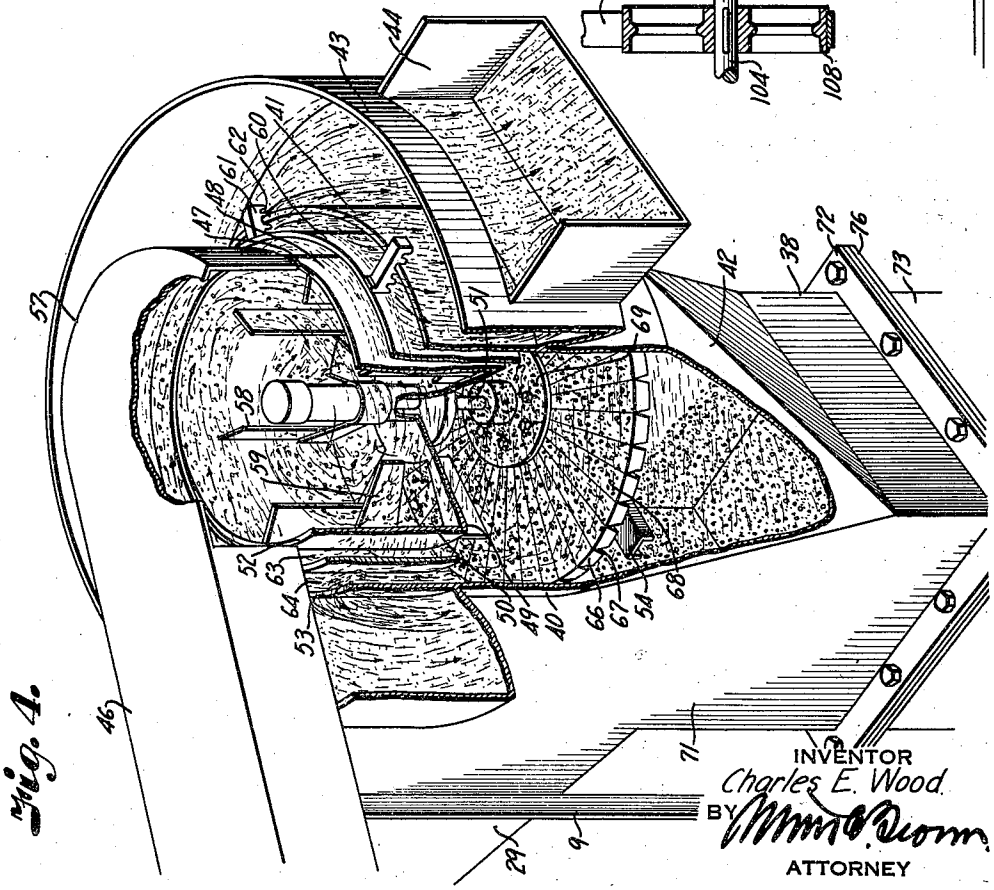


Fig. 4.

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Fig. 7.

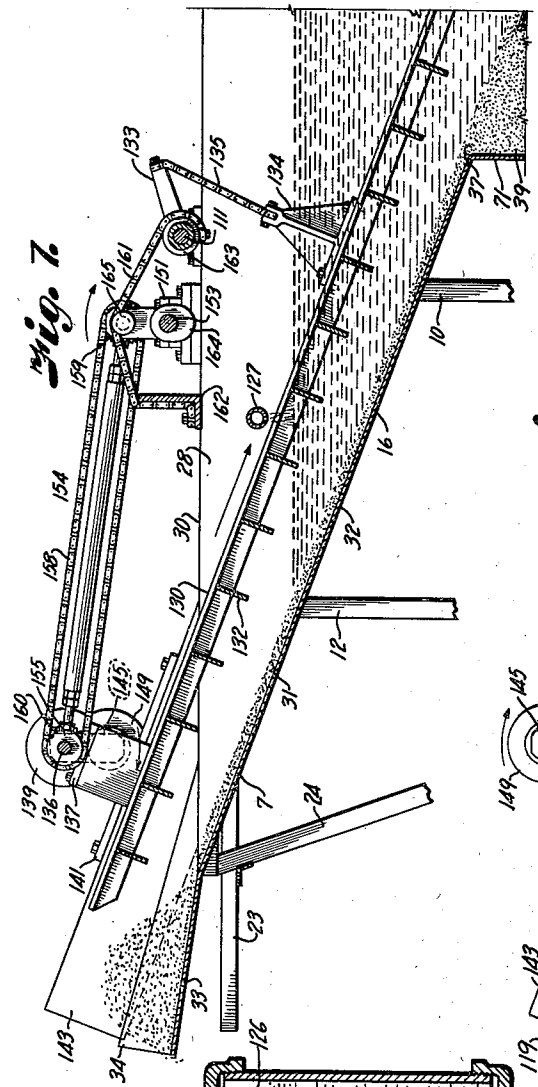


Fig. 8.

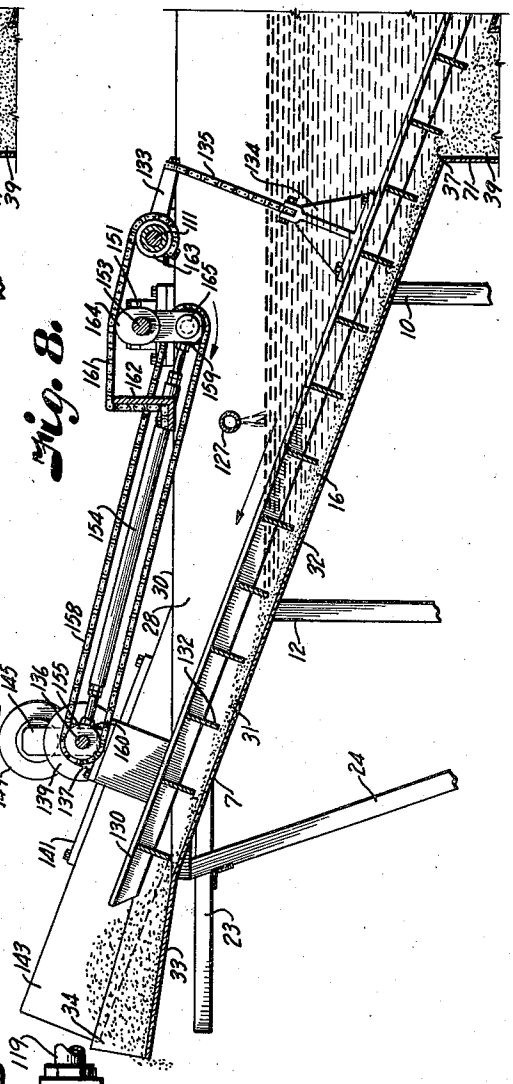
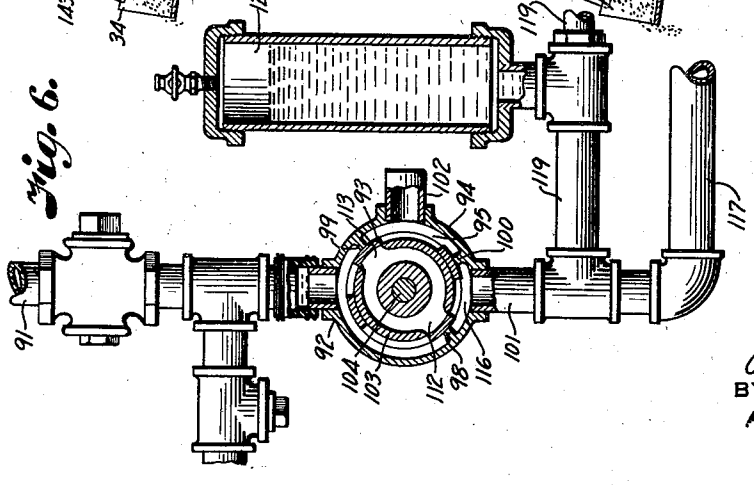


Fig. 6.



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UNITED STATES PATENT OFFICE

2,180,574

CONCENTRATING APPARATUS

Charles E. Wood, Baxter Springs, Kans.

Application March 28, 1934, Serial No. 717,739

8 Claims. (Cl. 209—158)

This invention relates to concentrating apparatuses and more particularly to an apparatus of that character for the separation and gravity concentration of mineral bearing ores from waste materials with which the minerals are associated.

In the usual run of ore pulp, as it is prepared for gravity concentration, the valuable minerals are carried with, and in, solid waste materials, grading in size from minute particles to the mesh of the screen over which the ore was prepared and these valuable materials are intermingled with a much greater volume of silt and similar size particles of completely waste material which hinder concentration of the valuable material.

It is, therefore, desirable to effect separation of the silt and like fine material from the heavy materials which carry the minerals and to maintain the valuable materials free of such waste or fine material detrimental to concentration during processing of the pulp. Owing to the fact that in most pulps minute particles of valuable minerals are so closely associated with the fine material, it has been difficult to effect separation of the fine material from the coarse material which is generally considered detrimental to gravity concentration.

Likewise, when the concentration steps were carried out without removal of the fine material, it interfered with the concentration of the valuable minerals.

Consequently, such methods are not efficient and with many ore bearing materials, the ratio of recovery is so small that they are not commercially practical.

It is, therefore, the principal object of the present invention to provide an apparatus wherein the fine materials are efficiently removed, and to maintain the material being concentrated free from such materials that hinder successful concentration of the valuable minerals.

In accomplishing this and other objects of the invention, as hereinafter set forth, I employ an improved apparatus illustrated in the accompanying drawings, wherein:

Fig. 1 is a perspective view of a concentrating apparatus constructed in accordance with the present invention.

Fig. 2 is a longitudinal vertical section through the apparatus on the line 2—2, Fig. 3.

Fig. 3 is a plan view of the apparatus.

Fig. 4 is an enlarged detail perspective view partly in section of that portion of the apparatus employed in separating the fine material from the coarser materials carried in the pulp.

Fig. 5 is an enlarged vertical cross section through one of the pulsating ore cells of the apparatus on the line 5—5, Fig. 2, particularly illustrating the method of pulsating water through the ore bed carried in the cell.

Fig. 6 is a detail view partly in section of the valve and pipe connections controlling flow of the liquid for effecting actuation of the diaphragms which pulsate water through the ore beds.

Fig. 7 is a detail longitudinal sectional view of the rake for removing the waste material from the apparatus showing the rake in one position of its movement.

Fig. 8 is a similar view showing the rake in the act of removing the waste material.

Referring more in detail to the drawings:

1 designates a supporting frame preferably constructed of structural shapes and including spaced channel cross sills 2, 3 and 4 connected at their ends by longitudinal angles 5 and 6 to form a base carrying a super-structure 7 including spaced pairs of vertical legs 8—9, 10—11, and 12—13, connected to the cross sills 2, 3 and 4, respectively, at points intermediate the ends thereof.

The lower ends of the legs are connected by longitudinal angles 14 and 15 extending across the cross sills 2, 3 and 4 and having their flanges secured to the legs and to the sills, as shown in Fig. 1, whereby the pairs of legs are retained in perpendicular position to support a tank 16 which is connected to the upper ends thereof by angles 17 fixed to the face of the tank and forming extensions of the legs.

The upper ends of the leg extensions are connected by longitudinal angles 18 and 19 having laterally directed horizontal flanges 20 forming a support for the bearings and operating machinery, as hereinafter described.

Extending laterally from the extensions of the legs 8, 10 and 12 are horizontal angles 21 having their outer ends anchored to the extensions by braces 22 for supporting a horizontal walk-way 23 extending longitudinally of the side of the tank.

The brace 22 connected with the leg 12 preferably extends across to the leg 13 and is connected to the outer end of the sill 4 to brace the super-structure in a direction laterally of the tank. The super-structure is also braced in a longitudinal direction by angles 24 and 25 having their lower ends connected with the sill 4 and their upper ends connected to the rear ends of the hor-

izontal angles 18 and 19, as best shown in Figs. 1 and 2.

Extending from the rear end of the walk-way is a lateral angle 26 which cooperates with the sill 4 in supporting a ladder 27 whereby the operator of the machine can climb to the walk-way for inspection and repair of the various operating parts.

The tank 16 includes triangular shaped side walls 28 and 29 having their upper edges 30 extending longitudinally of the lateral flanges of the angles 18 and 19 and their lower inclined edges 31 connected by an inclined bottom wall 32 having its upper end terminating in an inclined platform 33 provided with side walls 34 and 35 forming upward extensions of the side walls 28 and 29 of the tank, as best shown in Fig. 2.

Provided in the inclined bottom wall is a plurality of rectangular openings 36 and 37 into which are connected substantially rectangular shaped ore cells 38 and 39, later described in detail.

The forward ends of the side walls 28 and 29 of the tank are joined with the cylindrical wall 40 of a separating chamber 41 having a cone shaped lower portion 42 extending into contiguity with the sides of the tank housing, as clearly shown in Fig. 1. The upper edges of the side walls of the tank 16 are cut away in line with the legs 8 and 9 to provide space for accommodating a launder 43 encircling the separating chamber 41 and having an overflow spout 44.

The lower end of the cone shaped bottom 42 is cut away within the tank to form a passageway 45 through which coarse materials from the separating chamber are discharged into the tank 16 where the valuable materials are separated from the waste materials as later described.

In carrying out the present invention, the separating chamber 40 is utilized for the gravity separation of silt and like waste material carried in the ore pulp which is admitted under pressure through a suitable discharge conduit 46.

As is well known, gravity separation of solids is effected through the relative rates at which the solid particles settle in liquids, the rate being governed by their size and shape, specific gravity, and the density of the pulp.

In processing ore pulps for gravity concentration, there is a certain settling rate at which it is desired to divide the respective materials and the closer that this separation can be effected, the more efficient is the apparatus.

The ideal condition in gravity separation would be that each grain of material and each drop of water should have the same distance to travel at exactly the same rate before reaching the overflow and the feed should enter the separating chamber at the same velocity as the flow therethrough, and that there are no eddy or counter currents.

Under operating conditions, the stream of pulp must be maintained at relatively high velocity in order for it to carry the solid materials in suspension, and under ordinary conditions when such a stream is directed into a tank, it immediately sets up counter currents and eddies that are irregular and largely uncontrolled. The average velocity of the material through the separation chamber is made up of some very high velocity currents, some very low velocity currents, and even some back flow.

Consequently, there is no defined line of separation between the fine and coarser materials, with the result that some of the coarse material is carried away with the overflow from the chamber and much of the fine material remains and gravitates with the coarse material to the bottom of the chamber.

Since high entering velocity of the pulp cannot be dispensed with, I have provided means for dissipating this velocity in such a way that it will no disrupt the uniformity of the actual classifying currents whereby the coarse materials are separated from the finer due to the inability of the currents to carry the coarser materials. I am, therefore, enabled to provide a definite line of separation between the respective materials by definitely controlling the velocity and direction of the stream as it moves through the separating chamber.

This is accomplished by discharging the pulp into the separating chamber in a tangential direction with as little downward pitch as is possible so that the stream of the pulp is caused to move in close spiral circumvolution in a downward direction and then upwardly in uniform overflow and velocity into the launder, as now to be described.

Supported concentrically within the cylindrical separating chamber is an inner cylinder 47 including a cylindrical wall 48 having a horizontal bottom 49 provided with a series of radial ports 50 through which pulp may flow into the separating chamber.

The inner cylinder is rotatably supported on a shaft 51 so that the upper rim 52 thereof extends above the upper edge of the wier 53 of the outer cylindrical wall 40. The supporting shaft 51 is carried by a bar 54 extending diametrically across the separating chamber at a point adjacent the lower edge of the wall 40.

The upper end of the shaft projects through the bottom of the revolving cylinder and carries anti-friction bearings 55 and 56 which are retained in a tubular post sleeved over the shaft and having its lower end connected with the bottom of the cylinder whereby the cylinder rotates freely under impelling influence of the pulp stream admitted through the spout 46.

In order to spread the flow of the pulp stream through as great a distance around the periphery of the inner cylinder as possible, the end of the spout is provided with an arcuate shaped hood 57, as shown in Fig. 4.

The inner wall of the revolving cylinder and the bottom thereof adjacent the port openings are provided with vanes 58 and 59 for increasing the rotational effect of the cylinder by the flow of pulp thereagainst.

Due to the fact that the feed of pulp is checked in downward movement by the bottom of the cylinder and aided by centrifugal forces, the water or pulp level in the inner cylinder rises above the level in the outer cylinder, as controlled by the height of the wier 53, thereby providing a fixed static head in the inner cylinder which governs flow through the separator.

It is this difference in head and not in the momentum in the feed stream that causes circulation downwardly through the feed ports and then upwardly around the outer cylinder for overflow across the wier. As long as this head is constant, I am therefore enabled to maintain constant velocity of flow upwardly between the cylinders and over the wier.

Since the current assumes the form of a spiral moving downwardly in the inner cylinder and upwardly between the inner and outer cylinder,

it will be noted that the horizontal component does not affect the classifying action as that depends upon the ratio of the vertical velocity to the settling rate of the particles of solid material.

Particles which have a settling rate greater than the vertical velocity of the uprising column of fluid between the respective cylinders will settle downwardly into the separating chamber, while other particles which have a lower settling rate than the velocity of the fluid will be carried up and out with the overflow.

Since the specific gravity of the particles carried out in the overflow depends upon the vertical velocity of the current moving through the space between the cylinders, I term it a sorting column, and since the velocity is determined by the volume of water and the cross sectional area of the sorting column, it is apparent that a change in area of this column will produce an inverse proportional change in the vertical velocity of the fluid.

I, therefore, provide for blocking out or filling a part of this space by means of a split circular band 60 encircling the revolving cylinder and supported in spaced relation therewith by bracket arms 61 having a series of notches 62 for selective engagement with the wier 53. The lower end of the band terminates substantially at the bottom of the revolving cylinder, while its upper end projects slightly above the wier 53.

The annular space 63 thus provided between the revolving cylinder and the band 60 becomes dead, as the water therein cannot overflow because the band projects above the level of the wier. The uprising velocity in the sorting column, which now is the annular space 64 located between the wall of the separating chamber and the band, is increased in proportion to the decrease in the cross sectional area as filled by the dead space 63.

Therefore, by regulating the cross sectional area of the annular space 64, I am enabled to effect selective gravitation of any predetermined material according to its settling rate.

With the proper head of fluid in the inner cylinder, I am enabled to cause gravitation of all of the predetermined materials into the bottom of the separating chamber, while the other material in the stream will be carried off with the water overflow into the launder.

In order to support a bed of gravitated material in the separating chamber below the revolving cylinder, so that the pulp, upon passing through the ports 50, will be directed outwardly for passage through the sorting column, the separating chamber is provided with a flexible diaphragm 66. The diaphragm 66 includes a disk preferably formed of rubber and having a plurality of radial slits 67 to form a series of flexible segments or arms 68 having sufficient rigidity to support a definite depth, for example several inches, of gravitated material under water, but which will yield under a predetermined weight of the material to allow gravitational discharge of the material through the slits 67 into the tank 16.

The upper edges of the segments normally touch each other, but they are beveled away from each other on the under side to effect clearance of the slits by any material that may tend to lodge therebetween. The diaphragm is supported on the cross bar 54 and is clamped between the plates 69 and 70 encircling the lower end of the post 51, as clearly shown in Fig. 2.

The disk thus provides a support for a bed of the material which forms an effective seal to prevent free circulation of the dirty liquid into the tank 16.

The heavy materials, upon passing the diaphragm, will drop into the tank 16 through the opening 45 and onto the first of the cells 36, now to be described.

The cells 36 and 37 each include rectangular walls 71 depending from the inclined bottom of the tank and terminating in outwardly extending flanges 72 to which are bolted rectangular cell sections 73 and 74. Each section includes vertical walls 75 aligning with the walls 71 and having flanges 76 and 77 extending outwardly therefrom. The flanges 76 of the upper section cooperate with the flanges 72 to clamp a screen diaphragm 78 extending across the cells. The lower flanges 77 of the upper sections cooperate with the upper flange on the lower sections 74 to clamp a flexible diaphragm 79 to form a collecting and pulsating chamber.

The screens 78 provide supports or grates over which the heavy materials are passed and through which water is caused to pulsate to effect stratification of the materials according to their specific gravities, that is, the heavier materials collect on the screens where they are drawn off from above, or they pass through the screens into the chamber formed by the upper section.

In order to vibrate the diaphragm to effect pulsation through the screen, the lower sections are provided with fluid piston chambers 80, the bottoms of which are closed by plates 81 fixed to the lower flanges.

The diaphragms 79 are provided with a central opening 82 in which is secured a funnel shaped mouth 83 of a concentrate discharge conduit 84 having a valve 85 closing its lower end. The discharge conduits 84 extend loosely through openings 86 in the end plates 81, which openings are closed by flexible packing elements.

The packing elements are preferably formed of rubberized fabric or the like and are of U-shaped cross section to provide upper and lower attaching portions 87 and 88 adapted to be connected to the heads 81 and to flanges 89 on the conduits 84 respectively by means of clamping rings 90.

Water is intermittently admitted to the piston chambers through conduits 91 connected with a valve housing 92.

The valve housing is best illustrated in Figs. 5 and 6 and comprises a cylindrical valve chamber 93 spaced from the outer wall 94 of the housing to provide an annular space 95, the space 95 being divided by partitions 98 and 99 and 100 communicating respectively with the conduits 9, an inlet conduit 101 and a fluid outlet 102.

Rotatably mounted in the valve chamber is a valve core 103 that is fixed to a shaft 104 extending through the end walls 105 of the casing, as shown in Fig. 5, the shaft being rotatably mounted in bearings in the end walls and sealed by the ordinary packing glands 106 and 107. The shaft is provided with a pulley 108 operated by a belt 109 running over a pulley 110 fixed to a countershaft 111 that is carried by the longitudinal angles 18 and 19, previously described.

The valve core has diametrically opposed ports 112 and 113 which successively communicate with the inlet, outlet and discharge ports in the valve housing to direct the liquid to and from the piston chambers to effect vibrations of the diaphragms 79.

The water is supplied to the inlet connection of the valve through a conduit 117 that is connected with the discharge side of a pump 118.

Water for the pulsating chambers of the cells is supplied from a conduit 119 connected with the conduits 91 through branch conduits 120 and 121 that connect with manifolds 122 extending about the periphery of the upper sections 73.

The manifolds preferably are formed as a part of the sections and communicate with the interior thereof through a series of ports 123. The branch conduits may be provided with valves 124 and 125 respectively whereby the water may be regulated to control the condition of the bed.

In order to prevent a water hammer effect incident to actuation of the rotary valve, the conduit 119 is provided with an air compression chamber 126, as best shown in Fig. 6.

To provide for free gravity movement of the concentrates and pulsation of wash water through the screens 78, the screens are preferably covered with a layer of pellets of slightly larger diameter than the meshes of the screen, as shown in Fig. 2, to support the bed of material from direct contact therewith and provide for keeping the screen free of material which will wedge in and clog the openings therein.

Upon actuation of the flexible diaphragm, the water in the pulsating chamber is pulsated through the bed and into the tank 16 to cause similar pulsation in the body of the water carried in the tank and effect slight vibrations of the diaphragm 66 to assist in the discharge of the bed as it accumulates in the separating chamber.

Clean water is supplied to the tank 16, through a perforate pipe 127 located adjacent the upper end thereof and which discharges the water onto the inclined bottom 32 for counterflow to the movement of the solid materials.

The fresh water collects in the tank up to the level of the wier 53 passing through the diaphragm 66 into the separating chamber so that the movement of fresh water will tend to prevent entrance of the sludge into the tank 16.

This constant movement of fresh water also washes the heavy materials of any sludge that may be carried therein so that when the particles are delivered to the bottom of the tank they are substantially free of the light materials that are supposed to be delivered into the launder 43.

Constant pulsation through the beds of material that are carried in the cells maintains the material in a constant state of agitation to effect scouring action of the particles and removal of the silt adhering thereto, which silt rises to the upper strata of the beds along with the light materials where it is picked up by the current of water moving through the tank 16 and carried therewith into the separating cylinder for overflow along with the dirty water into the launder.

The light material accumulating in the upper stratum of the lower bed is caused to be moved up the inclined bottom 32 of the tank 16 and across the surface of the bed in the next upper cell 39, where the particles again come into contact with a pulsating current to cause the heavier of the lighter materials to separate out while the light materials are caused to continue movement up the inclined bottom of the tank for discharge onto the platform 33 upon actuation of a rake, now to be described.

The rake includes a pair of spaced angle bars 130 and 131 having substantially the same length as the inclined bottom of the tank and which are connected by a series of vertically arranged cross bars or cleats 132, arranged for moving the material up the inclined bottom when the rake is moved in an upward direction.

In order to reciprocate the rake in raking relation to the bottom 32 and to lift it therefrom for reverse movement, I provide a crank mechanism, now to be described.

Loosely mounted on the shaft 111 previously described is a crank arm 133 which is connected to a bracket 134 fixed to the lower end of the rake by a flexible connection 135. The forward end of the rake carries a shaft 136 rotatably mounted in bearings 137 and 138 carried by the spaced angles 130 and 131 and having flanged rollers 139 and 140 intermittently operable on tracks 141 and 142 carried by the channels 143 and 144 secured to the angles 18 and 19 and to the side walls of the tank as shown in Fig. 1. The outer ends of the shaft 136 carry crank arms 145 and 146 having stub axles 147 and 148 mounting flanged rollers 149 and 150 which also operate upon the tracks 141 and 142 at the times the other rollers 139 and 140 are raised from the tracks, whereby the forward end of the rake is alternately suspended from the respective sets of rollers during reciprocation of the rake.

Rotatably mounted in bearings 151 and 152 adjacent the shaft 111 is a crank shaft 153 which is connected to the shaft 136 by a connecting rod 154.

The connecting rod 154 is operably connected with the respective shafts by wrist bearings 155 adjustably mounted on the opposite ends of the rod whereby the spacing between the shafts adjusts the relative position of the rake to the tank.

The crank shaft 153 is rotated from the shaft 111 by a gear 156 fixed to the end thereof and meshing with a pinion gear 157 on the shaft 111. Rotation of the crank shaft effects similar rotation of the shaft 136 through a chain 158 operating over sprockets 159 and 160 on the shafts 153 and 136 respectively to effect vertical movement of the forward end of the rake simultaneously with reciprocation thereof through the connecting rod 154. The rear end of the rake is also raised and lowered during reciprocation by a chain 161 having one end connected to a bracket 162 on the angle member 19 and its opposite end operating over and connected to a roller 163 having fixed connection with the arm 133 previously described. The intermediate portion of the chain is alternately engaged by a cam 164 on the crank shaft 153 and a roller 165 so that the arm 133 is intermittently oscillated thereby to raise and lower the rear end of the rake.

The shaft 111 is provided with a pulley 166 which is operably connected with a prime mover 167, such as an internal combustion engine that is mounted upon cross members 168 and 169 carried by the angle members 18 and 19, the pulley 166 being operated by a belt 170 running over the pulley 166 and over a pulley 171 on the power shaft of the engine.

When the rake moves on its upward stroke, the light material is advanced along the bottom of the tank toward the platform 33. Upon return movement, the rake is raised from the bottom to prevent back raking of the light materials.

The light material advanced by the rake will collect upon the platform 33 until it is finally pushed off by the forward end of the rake. Detention of tailings on the platform is important because it permits the water to drain therefrom back into the tank.

In operating an apparatus constructed and assembled as described, the ore pulp is admitted through the spout 46 into the inner cylinder 47 where the momentum thereof causes rotation of the cylinder upon its shaft 51.

Due to the centrifugal forces acting on the pulp as well as the retarded movement of the pulp by the bottom of the cylinder, a head of pulp will be established in the rotating cylinder to effect movement of the pulp through the sorting column at constant velocity, which velocity has been determined by adjustment of the band 60.

Since the velocity of the water moving through the sorting column is not sufficient to retain the coarse materials in suspension, they will gravitate out and be collected on the diaphragm 66, while the fine material will be carried with the water over the wier into the launder for discharge from the machine.

As soon as a sufficient amount of material collects on the flexible diaphragm, the segments or arms thereof will yield to allow passage of the material through the slits and into the first of the concentrating cells.

Rotation of the valve 92, which controls flow to and from the piston chambers, will cause pulsation of the water through the bed of material collecting in the cells for effecting stratification of the materials, the heavy materials collecting on the screen or passing therethrough, while the light materials collect in the upper portion of the bed and in position to be engaged by the rake which starts them upon their travel up the inclined bottom of the tank and across the next upper concentrating cell where the next lighter concentrates are separated from the materials.

Attention is here directed to the fact that a time differential may be established between the input and relief of water through the valve by varying the relative spacing of the valve ports or by an irregular timing of the valve between its movements to and from registry of the respective ports.

The light materials will be collected in the top of the second bed and be gradually moved up the inclined bottom upon continued actuation of the rake to finally accumulate upon the platform 33 where the water drains therefrom back into the tank.

As soon as the pile of light material reaches a certain height, the rake will begin to effect discharge of a portion thereof upon each forward reciprocation thereof.

Simultaneously with the feed of the material up the inclined bottom of the tank, fresh water is admitted to the tank through the pipe 127 which fills the tank to the level of the wier so that there is a constant movement of fresh water in counter flow to the flow of the material discharged from the separating chamber.

This water carries away silt and the like which has been scoured from the larger materials by the pulsating action in the respective cells.

Reciprocation of the rake also causes a similar scouring and pulsating action of the water within the tank 16 which assures substantially clean products when they are discharged from the machine.

The amount of water admitted through the valves 124 and 125 influences fluidity or density of the beds carried in the cells which are preferably maintained so that the materials being concentrated are in relatively loose condition whereby the heavier concentrates move freely toward the bottom and low side of the cell and in reverse direction to movement of the light materials. It is thus obvious that the heavier materials move to one side of the cells and the lighter toward the opposite side so that there is little likelihood of any of the heavier materials being discharged by the rake.

The concentrates may be continuously drawn from the pulsating chamber if the valves 85 are left open, or they may be drawn off from time to time upon opening of the valves, while the larger concentrates collecting above the screens may be drawn off from time to time, as in conventional practice.

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

1. In an apparatus of the character described, a tank, a separating chamber having communication with the tank, a cylinder rotatably supported in the separating chamber with its upper end extending above the level of water in the chamber and having an apertured bottom, means for discharging a stream of pulp tangentially into the cylinder to maintain a fixed static head in the cylinder for effecting flow through the apertured bottom thereof at uniform velocity, and regulating means in the separating chamber for regulating the velocity through said chamber to effect gravity separation of selected particles carried in said stream.

2. In an apparatus of the character described, an elongated tank, a separating chamber having communication with the tank, a cylinder rotatably supported in the separating chamber and having an apertured bottom, means for discharging a stream of pulp tangentially into the cylinder to maintain a fixed static head in the cylinder for effecting flow through the bottom thereof at uniform velocity, regulating means in the separating chamber for regulating the velocity through said chamber to effect gravity separation of selected particles carried in said stream, means in the tank for separating the lighter gravitated material from the heavier material, and means for respectively removing the materials at opposite ends of the tank.

3. In an apparatus of the character described, a separating chamber having an outlet, a cylinder rotatably supported in the separating chamber and having an apertured bottom, means for discharging a stream of pulp tangentially into the cylinder to provide a static head in the cylinder for effecting flow through the bottom thereof at uniform velocity, regulating means in the separating chamber for regulating the upward velocity through said chamber to effect gravity separation of selected particles in said stream, a tank having connection with said outlet for containing a liquid adapted to balance the liquid of the pulp stream, and means acted upon by said balancing liquid for deflecting liquid of said pulp stream and for supporting a bed of said selected particles in the separating chamber, said last named means being adapted to yield under a predetermined load and to allow settlement of the selected particles into the tank.

4. In an apparatus of the character described, a separating chamber having an outlet in the bottom thereof, means for establishing a head of liquid to act against flow through said outlet, means for discharging a stream of pulp into the separating chamber, means in the separating

chamber for effecting gravity separation of the coarser particles carried in said stream, and a flexible diaphragm in the separating chamber to separate said head of liquid from the pulp stream and having yieldable portions for passing the gravitated material through said outlet.

5. In an apparatus of the character described, a separating chamber having an outlet in the bottom thereof, means for establishing a head of liquid to act against flow through said outlet, means for discharging a stream of pulp into the separating chamber, means in the separating chamber controlling velocity of the pulp stream to effect separation of the coarse material from the fine material carried in said stream, and a flexible diaphragm supported in the separating chamber for carrying a bed of coarse material and arranged to cooperate with said head of liquid to divert the pulp stream for overflow from the separating chamber, said flexible diaphragm having portions yieldable under weight of the bed of material to pass the coarse material through said outlet.

6. In an apparatus of the character described, a separating chamber having an outlet in the bottom thereof, means for establishing a head of liquid to act against a flow through said outlet, means for discharging a stream of pulp into the separating chamber, means in the separating chamber controlling velocity of the pulp stream to effect gravity separation of the coarse material carried in said stream, and a flexible diaphragm in the separating chamber cooperating with said head of liquid for diverting the pulp stream for overflow into the separating chamber, said diaphragm having normally closed slits which open under weight of the coarse material for passing the material through said outlet.

7. In an apparatus of the character described, a separating chamber having an outlet in the bottom thereof, means for establishing a head of liquid to act against a flow through said outlet, a cylinder rotatably supported in the separating chamber and having an apertured bottom, means for discharging a stream of pulp tangentially into the cylinder to effect rotation thereof and provide a static head in the cylinder for effecting flow through the bottom thereof at uniform velocity, regulating means in the separating chamber for regulating the velocity through said chamber to effect gravity separation of selected particles in said stream, and means supporting a bed of said selected particles in the separating chamber and cooperating with said head of liquid to prevent flow of pulp through said outlet, said supporting means being yieldable to allow settlement of the selected particles through said outlet.

8. In an apparatus of the character described, a separating chamber having an outlet in the bottom thereof, means for discharging a stream of pulp into the separating chamber, means in the separating chamber for effecting gravity separation of the coarser material carried in said stream, yieldable means normally closing said outlet and yieldable under a predetermined load of said coarser material to pass the coarser material through said outlet, and a tank having connection with said outlet for containing a head of liquid to counterbalance the liquid of said pulp stream and maintain substantially equal liquid pressures on the respective sides of said yieldable means.

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