

F. E. MARCY.
HYDRAULIC CONCENTRATOR.
APPLICATION FILED JUNE 12, 1912.

1,056,923.

Patented Mar. 25, 1913.

3 SHEETS-SHEET 1.

FIG. 1.

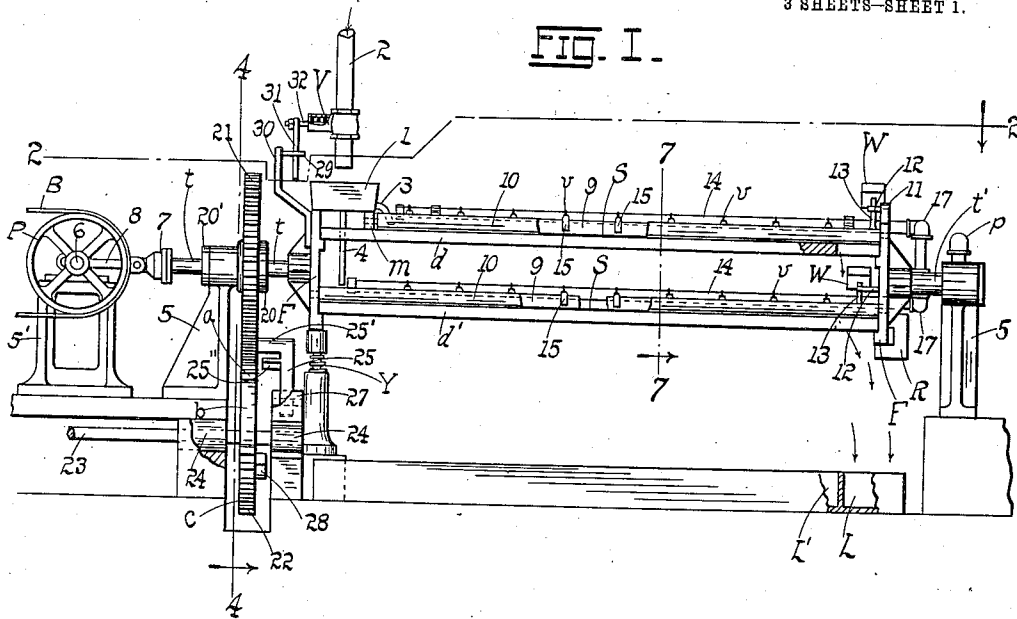


FIG. 2.

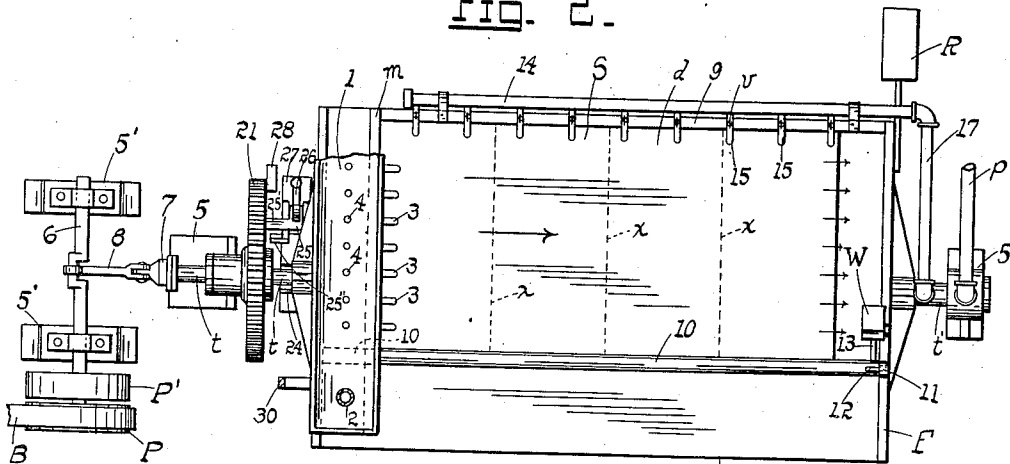
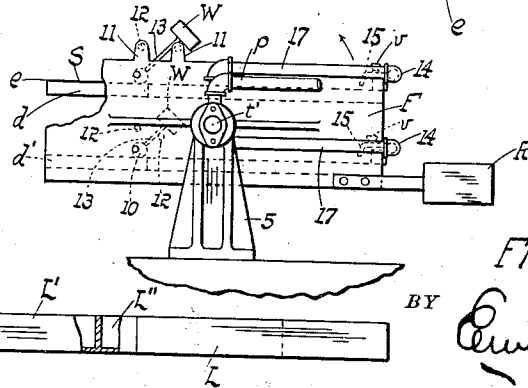


FIG. 3.



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3 SHEETS-SHEET 2.

FIG. 4.

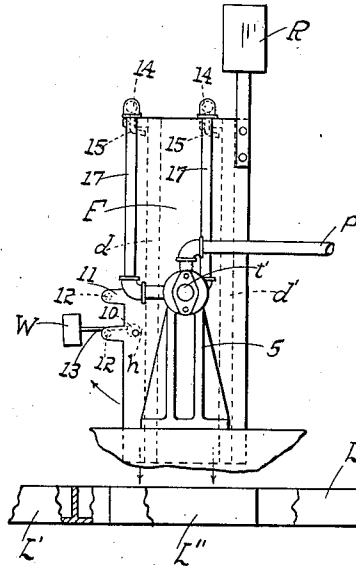
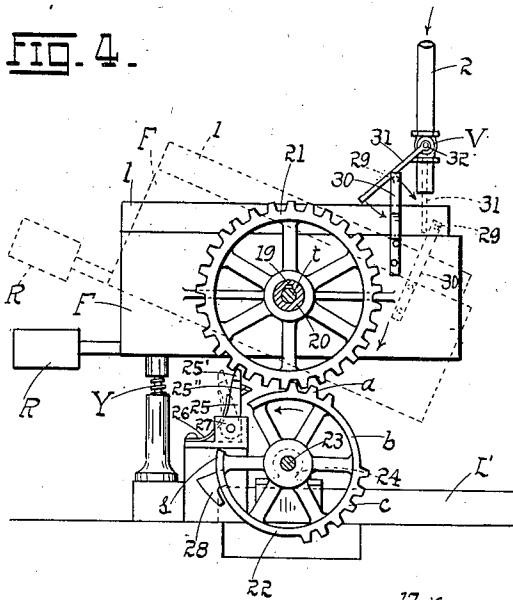


FIG. 6.

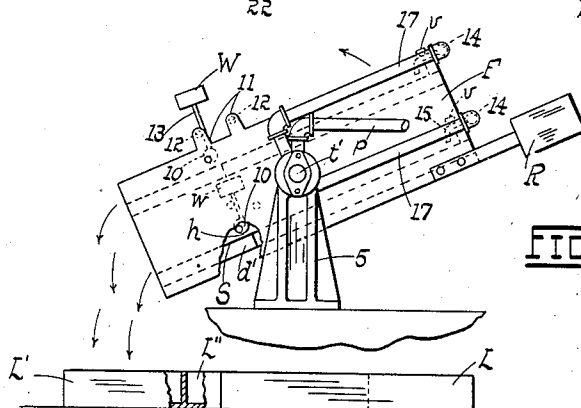
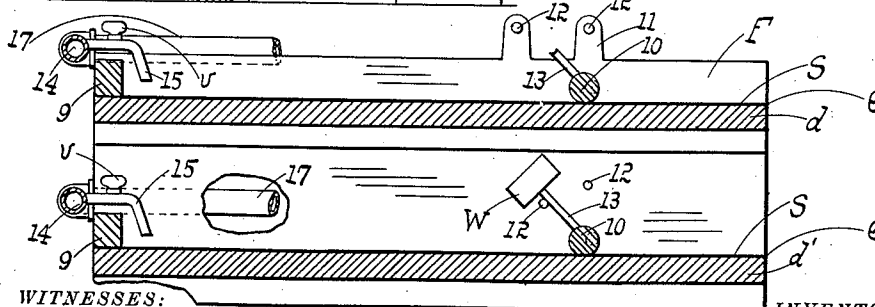


FIG. 5.



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FIG. 7.

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3 SHEETS—SHEET 3.

FIG. 8.

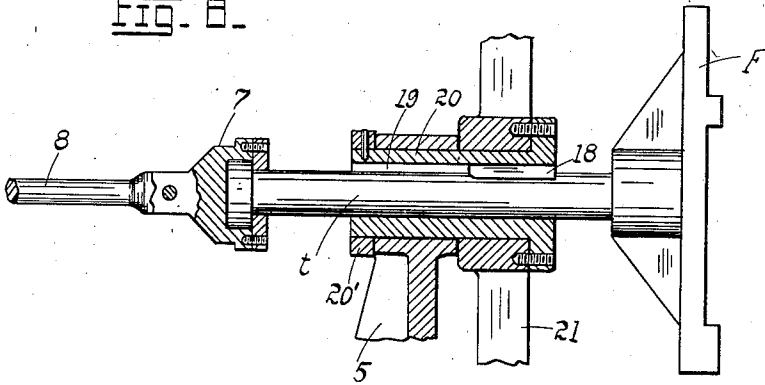


FIG. 9.

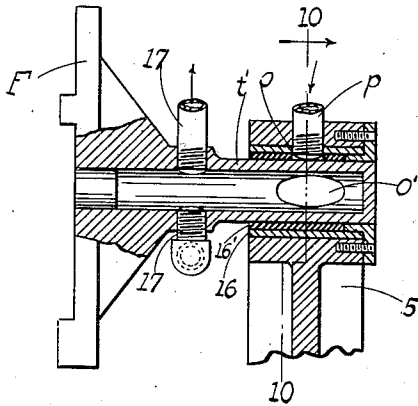


FIG. 10.

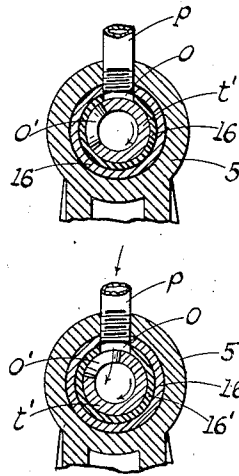


FIG. 11.

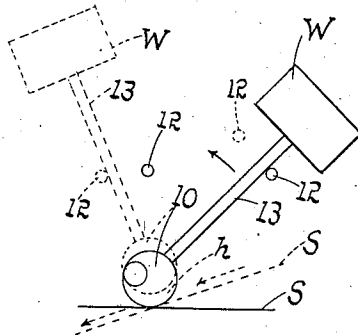


FIG. 12.

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HYDRAULIC CONCENTRATOR.

1,056,923.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, FRANK E. MARCY, citizen of the United States, residing at Salt Lake City, in the county of Salt Lake and State of Utah, have invented certain new and useful Improvements in Hydraulic Concentrators, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part hereof.

My invention has relation to improvements in hydraulic concentrators; and it consists in the novel details of construction more fully set forth in the specification and pointed out in the claims.

In the drawings, Figure 1 is a side elevation of the machine in feeding position; Fig. 2 is a top plan thereof with parts in section on the line 2—2 of Fig. 1, and with parts broken away; Fig. 3 is a rear end view of the concentrator in feeding position with parts broken away; Fig. 4 is a vertical cross-section on the line 4—4 of Fig. 1; Fig. 5 is a rear end view of the concentrator in its dressing position, parts being broken away; Fig. 6 is a rear end view thereof in its washing position; Fig. 7 is an enlarged vertical cross-section on the line 7—7 of Fig. 1; Fig. 8 is a longitudinal sectional view taken through the bearing of the trunnion adjacent the crank-shaft, showing the manner of mounting said trunnion; Fig. 9 is a similar sectional view of the bearing of the opposite or hollow trunnion showing the manner of feeding the dressing and wash water to the tables, the position of the parts corresponding to the pulp-feeding position of the tables; Fig. 10 is a cross-section on line 10—10 of Fig. 9; Fig. 11 is a similar section showing the trunnion turned however to dressing position; and Fig. 12 is a digrammatic view showing the manner of operation of the guide or bar by which the feed-area of the deck or table is restricted, and how said area is enlarged for the dressing and washing operations.

The object of my invention is to construct a hydraulic concentrator to the separating surface of which is preferably imparted a horizontally reciprocating movement whereby a complete stratification between the concentrates and lighter gangue and sands may be effected, the concentrates adhering to the separating surface and the lighter materials resting upon the heavier.

A further object is to construct a machine wherein the stratified material automatically classifies itself according to the gravity of its components, the classification having the effect of grading the materials in an order conforming to the general direction of flow of the pulp sheet over the deck or separating surface of the concentrator. Since in such flow the lighter particles are carried farthest from the supply source of the pulp, it follows that ordinarily larger deposits of such lighter particles will be farthest from such source. By my invention, the stratified and classified materials are dressed and washed by streams of water directed transversely to the normal flow of the pulp, such transverse flow being eminently desirable since the dressing, and washing of the concentrates is attended with a minimum waste of water. By the classification the separating surface is divided into distinct transverse zones of deposit, from each of which zones the gangue may be washed off or dressed, by carefully regulating the intensity and quantity of the stream of water necessary to accomplish the purpose. By reason of the classification less water would be necessary for example to dress the concentrates at a point removed from the pulp feed, than at a point near the pulp-feed, because at the farthest points the finer and lighter gangue would accumulate, the heavier particles tending to drop out and separate at points near the feed.

The advantages of the invention will be apparent from a detailed description thereof which is as follows:—

Referring to the drawings, 1 represents a trough receiving the pulp from the pulp-supply pipe 2. The pulp is distributed from the trough 1 by means of tubes or nozzles 3, 4, respectively, onto the separating surfaces S of the tables or decks d , d' , entering in the construction and forming part of, the tilting frame F, the trunnions t , t' , of which are loosely supported in the standards 5, 5. The separating or catching surfaces S may be of rubber (as shown) or of canvas, wood, cement, or other suitable material well known in the art. The present frame while specifically showing two superposed decks d , d' , may be equipped with one, two or more decks, any single deck constituting a concentrator in itself, and being independent of

the other decks. A description of one deck or table will therefore answer for all. Opposite one end of the frame F are standards 5', 5', between which is mounted a crank-shaft 6, a swivel joint or coupling 7 of any approved design at the outer end of the trunnion *t* being connected to the crank of the crank-shaft by a connecting rod 8, so that with a rotation of the crank-shaft a horizontal reciprocating or shaking motion is imparted to the frame F, and hence to the decks or tables *d*, *d'*, the separating surfaces of which preferably (though not necessarily) have a slight dip from the source of pulp supply or trough 1 (Fig. 1). The reciprocating movement here referred to is not however indispensable, and its presence in all cases is not necessary because with a "silent" or non-reciprocating table, stratification would take place at the dressing period to be presently described. The pulp flows as indicated by the arrow in Fig. 2, over a prescribed section of the total area of the deck, said section being included between the side marginal flange 9 of the deck and a longitudinally disposed guide or cylindrical bar 10 parallel thereto and removed a suitable distance from the adjacent longitudinal free edge *e* of the deck. The guide 10 is mounted to rock about an eccentric axis and operates on the principle of a cam, the ends of the guide being supported in the terminal walls of the frame F below the lugs or brackets 11, 11, (Fig. 3), the lugs and said frame walls being provided with pins 12 against which is adapted to impinge the weighted arm 13 secured to each guide, the weight W at the end of the arm oscillating the arm first in one direction and then the other, depending on the degree of lateral oscillation or tilt imparted to the frame F about its trunnions *t*, *t'*, the pins 12 arresting the arm and confining its oscillations (and hence the rotations of the guide 10) to certain limits. Being thus eccentrically mounted, the periphery of the guide 10, which for a horizontal position of the frame F engages the separating surface of its corresponding deck (Fig. 12) will rock away or be disengaged from, said separating surface, thereby leaving a free passage-way *h* between it and the guide, when the frame has been sufficiently tilted to cause the lever arm 13 to swing in proper direction to rock the guide to such disengaging position (Fig. 5). The tilting of the frame F about the axis of the trunnions *t*, *t'*, will be more fully hereinafter entered into.

Disposed contiguous to the side flange 9 of each deck or table is a spray-pipe 14 provided with valve-controlled nozzles 15 for discharging dressing water and water for washing off the concentrates at the conclusion of the operation of stratification and classification. The pipes 14 are supplied

with water (at the proper time) from a supply pipe *p* connected to the standard 5, the trunnion *t'* being hollow (Fig. 9) and operating in a bushing 16 (provided with a packing ring 16') with the peripheral port *o* of which the discharge terminal of the pipe *p* is in constant communication. The peripheral wall of the trunnion *t'* is provided with a port *o'* which, when the frame F is tilted to a proper angle (the dressing angle) from its normally horizontal position (Fig. 11), is brought into register with the port *o* and the water from the pipe *p* rushes into the trunnion, whence it flows through the branches 17 to the pipes 14 and their nozzles 15. Until the frame has been tilted through a sufficient angle, the ports *o*, *o'* remain out of register (Figs. 9 and 10) so that the reciprocation of the frame may go on without the possibility of water discharging over the decks from the nozzles 15, and interfering with the pulp sheet directed thereover, or with the stratification and classification of the pulp while pursuing the course of its normal flow. The ports *o*, *o'*, are so proportioned that no matter at what portion of a stroke (of its reciprocation) the frame F may be stopped preparatory to the tilting thereof to secure a register between said ports, the port *o* will always come well within the port *o'* to secure the full volume of water therethrough not only for an inclination of the frame which corresponds to the dressing period, but for an inclination which corresponds to the concentrate washing period, as will more fully hereinafter appear.

The tilting of the frame F (with its decks *d*, *d'*) for purposes of dressing and washing may be accomplished by suitable gearing, rotation of the crank-shaft 6 being stopped for the time being by shifting the driving belt B from the fast pulley P to the loose pulley P' thereof as well understood in the art. One form of the tilting gear is shown in the drawings, and is substantially as follows:—The trunnion *t* is provided with a key 18 (Fig. 8) operating freely through a key-way or groove 19 in a bushing 20 secured to a gear wheel 21 and passing loosely through the standard 5, a terminal ring 20' secured to the bushing preventing displacement of the latter (in one direction) as shown in Fig. 8. By this arrangement the trunnion *t* is free to reciprocate within the bushing and through the gear-wheel 21 during the reciprocations of the frame F, and when the frame is stopped, rotation of the gear 21 will obviously impart rotation to the trunnion *t* (being keyed thereto) and hence to the frame. The gear wheel 21 is advanced by the toothed sections *a*, *c*, (Fig. 4) of the partially toothed wheel 22 mounted on the shaft 23 supported in bearings 24, and driven from any suitable source of

power (not shown), and at any predetermined speed. The plain section *b* of the wheel 22 has no action on the gear 21 and the frame remains at rest while said section *b* is opposite the gear. The action of the section *a* is to turn the wheel 21 sufficiently to cause the frame F to rock to dressing position, the tables assuming an angle of about twenty-five degrees (more or less) to the horizontal, as shown in Fig. 5, the section *c* rocking the frame to cause the tables to assume substantially a vertical position (Fig. 6), at which they remain until the frame is released and allowed to resume its horizontal position. The frame (whatever be the angle to which it is tilted) is locked against a return movement by a spring-controlled pawl 25 (yielding in one direction by the bending of the flexed spring 26, but limited in the opposite direction by an abutment 27) the terminal laterally deflected finger 25' of which engages the teeth of the gear wheel 21; but when the pawl is oscillated out of engagement with the said gear wheel, (see dotted position of the pawl in Fig. 4) the frame returns automatically to its horizontal position under the action of the counterweight R. This return to horizontal position is accomplished while the pawl is displaced (forced from engagement with the gear 21) by the cam or dog 28 carried by the wheel 22 at an appropriate distance beyond the end of the toothed section *c* of said wheel. When the dog 28 has passed off the bevel face of the lug 25'' of the pawl (which it traverses in effecting displacement of the pawl) the latter reengages the gear wheel 21, by which time the frame has resumed its horizontal position. In rotating back to such horizontal position under the action of the weight R, the frame settles down on a spring-buffer Y of any approved construction, such buffer eliminating any jars, and serving in a measure to support the frame and thus relieve the locking pawl 25 of a portion of the weight of the frame. In resuming its horizontal position under the action of the weight R, the rotation of the frame causes the weighted arm 13 to oscillate back to its original position (from which it had swung with the tilting of the frame and in which it rocked the guide 10 out of contact with the separating surface) thereby rotating the guide 10 back into contact with the separating surface, destroying the passage *h*, and confining the flow of the next lot of pulp between the guide and the side flange 9 as described.

During the tilting of the frame to bring its decks to dressing and washing positions, the pulp-feed is automatically cut off by the closing of a spring-controlled self-closing rock-valve V of any conventional type mounted on the pipe 2, and held open during the feeding period by a tappet or pin 29

at the free end of an arm 30 carried by the frame, said tappet engaging or bearing against, the lever arm 31 of the valve-spindle 32 during said feeding period. So long as the frame remains in its horizontal position, the tappet 29 will bear against the lever arm 31 and hold the valve open; as the arm 30 recedes from the member 31 with the tilting of the frame to dressing position, the release of the member 31 will permit the valve to close automatically as clearly obvious from the drawings. As the frame tilts to its washing or vertical position the valve still remains open (the lever-arm 31 having a certain limit of oscillation). As the frame returns to its original horizontal position the tappet 29 will strike or reengage the lever-arm 31 and thus rock the valve V back to open or feed position.

L represents a launder for the tailings flowing over the free transverse edges of the decks *d*, *d'*; L' a launder compartment for the gangue or middlings resulting from the dressing operation and flowing over the side edges *e* of the decks; and L'' a launder compartment for the concentrates washed off during the washing period.

The operation of the concentrator will now be clearly obvious and is substantially as follows:—Let us assume that rotation has been imparted to the crank-shaft 6 so that a horizontal reciprocation is imparted to the frame F and hence to the separating surfaces of the decks *d*, *d'*, thereof, the pulp being allowed to discharge from the pipe 2 into the trough 1 whence it flows or feeds onto the decks through the nozzles 3, 4, as described. Stratification and classification of the material will now take place over the surfaces S, the heavy concentrates being at the bottom and the lighter gangue and sands on top, the two superposed layers grading or classifying themselves progressively along the surfaces S into distinct zones separated by dividing lines *x* disposed across the decks (Fig. 2) as previously pointed out. We can assume that a constant rotation is imparted to the tilting gearing 21, 22, and that the period of reciprocation of the frame is confined to the period of inaction of the said gears (21, 22), that is to say, to the period that the plain portion *s* of the periphery of the wheel 22 between the dog 28 and the toothed section *a* is rotating opposite the gear 21, this being the period during which the frame F remains in its horizontal position after being allowed to return to said position by the dog 28 releasing the pawl 25 from the gear 21. The moment the section *a* of the wheel however, engages the teeth of the wheel 21, the reciprocating movement of the frame is stopped by stopping rotation of the crank-shaft. As illustrated, the stopping of the crank-shaft at this juncture must be done

by hand, though it is within the purview of the skilled mechanic to cause the belt B to shift from the tight pulley P to the loose pulley P' automatically, and thus stop the crank-shaft's rotation. The section *a* now tilts the frame and hence the decks *d*, *d'*, to dressing position (Fig. 5), the gear 21 being keyed to the trunnion *t* as previously described, and hence permitting such action, in which rotation of the frame the pin or tappet 29 leaves the valve lever 31, the valve V automatically rocking to its closed or cut off position (see dotted position of parts in Fig. 4). At the same time the port *o'* will be rocked into register with the port *o* (Fig. 11) and dressing water will immediately rush into the spray pipes 14 and nozzles 15 onto the decks *d*, *d'*, the streams flowing over the stratified and classified material being regulated by the cocks or valves *v* with which the nozzles 15 are provided. In thus tilting to the dressing angle the frame F causes the eccentric or guide 10 to rock away from the surface S leaving between it and said surface a clear passage-way *h* (see dotted position Fig. 12) for the washed material which thus flows over the edge *e* into the launder L'. The provision of the guide 10 is important, as it prevents any loss of concentrates during the dressing operation, the said concentrates adhering to that section of the area of the surface S included between the guide and overflow edge *e* of the deck, while the light gangue is carried over said edge. Were it not for the guide, which restricts the original pulp-flow to a prescribed section of the entire area of the deck, the concentrates would be in danger of being washed off the deck in the dressing operation, whereas they are now caught by that section of the deck surface between the guide and edge *e*. The dressing continues, and the frame is locked by the pawl 25 to the dressing angle, while the plain section *b* of the gear 22 is advancing opposite the gear 21. As the gear 22 continues to revolve the section *c* next advances the gear 21 causing it to turn sufficiently to rock the frame to bring the decks *d*, *d'*, thereof to vertical position (Fig. 6) the ports *o*, *o'*, still however remaining sufficiently in register as not to interfere with the free delivery of water to the nozzles 15. The transverse streams of water now wash the concentrates adhering to the separating surfaces, into the launder compartment L'', the washing continuing until the dog 28 has tripped the pawl 25 and released the gear 21, the weight R restoring the frame F, and the decks thereof to horizontal position while the dog is passing over the bevel edge of the lug 25'' of the pawl. The frame having resumed its horizontal position, rotation is restored to the crank-shaft which

will again impart a horizontal reciprocation to the frame during the period that the plain portion *s* of the gear 22 between the dog and the toothed section *a* is passing the gear wheel 21. Thus a complete cycle has taken place, and this cycle is repeated as often as necessary. As the frame F rocks from the dressing to washing position, the tappet 29 leaves the valve-arm 31 which has reached the limit of its sweep by the closing of the valve V, but on the return of the frame to its horizontal feed or stratifying position, the said tappet will strike or reengage said valve arm and oscillate and restore it to its first position, thus again opening the valve V and releasing the pulp into the trough 1. At the same time the ports *o*, *o'*, are brought out of register and the dressing and wash water is automatically cut off. The tailings from the pulp during the stratifying and classifying operation are caught in the launder L; the middlings are caught in the launder L'; and the concentrates in the launder L'' as already described.

Owing to the presence of the trough one end of the guide 10 identified with the upper deck *d* has its spindle mounted preferably in the strip *m* which forms the support for the inner edge of the bottom of the trough (Fig. 1). The lower guide 10 however, extends the full length of the frame F having its eccentric spindles mounted between the end walls of said frame.

The specific arrangement of superposed decks here shown need not of course be adhered to, a complete duplicate machine, that is to say two decks in substantially the same plane fastened to a single frame, or in fact any combination of decks, falling within the spirit of my invention.

Having described my invention, what I claim is:—

1. In combination with a member having a substantially plane reciprocating separating surface for the distribution of the concentrates in sheet form, means for feeding pulp over said surface in a direction substantially parallel to the plane of reciprocation thereof whereby the material is graded in the line of flow of the pulp, means for directing streams of water transversely to the line of pulp flow for dressing, and subsequently washing off the concentrates in their graded distribution, and means for cutting off the flow of pulp during the dressing and washing operations.

2. In an ore concentrator, a member presenting a substantially plane surface to the flow of pulp thereover in a given direction and adapted to grade the material in sheet form in the general line of flow, means for tilting said surface about an axis substantially parallel to the line of flow, means for directing dressing streams across the

graded material transversely to said axis, and means for cutting off the pulp flow during the dressing operation.

3. In an ore concentrator, a member presenting a separating surface for the flow of pulp thereover in a given direction and the grading of said pulp in sheet form in the general line of flow, means for tilting said surface about an axis substantially parallel to the line of flow and bringing the same into a plane disposed at an angle to the plane of pulp-flow, means for directing across said surface streams for purposes of dressing at one angle, and streams for washing the concentrates at a higher angle and discharging the same in their graded distribution, and means for cutting off the pulp flow during the dressing and washing periods.

4. In a concentrator, a member provided with a guide resting on the surface thereof during the flow of pulp thereover, and disposed parallel to the general direction of the pulp-flow, means for tilting said member, and means for raising said guide off said surface with the tilting of the latter to a dressing plane.

5. In a concentrator, a member having a separating surface traversable by a pulp-flow in a given direction in a given plane whereby the material is graded in the general line of flow, means for cutting off the pulp-flow, means for tilting the member to bring its surface in a plane inclined to the plane of pulp-flow, and discharging dressing water across the graded material during the period of cut-off of the pulp, means for regulating the force of the dressing currents over different portions of the separating surface according to the grades thereon, and means for discharging the material in graded distribution.

6. An ore concentrator provided with a separating surface disposed in a plane permitting the flow of pulp thereover in a given direction, means for cutting off the pulp-flow and tilting the surface at an angle to the original plane of flow for purposes of dressing, and at a higher angle for purposes of removing concentrates, the material grading itself in its flow over the surface into zones progressing in the general line of flow, and means for directing streams of water for dressing and washing across the several zones and discharging the concentrates in their graded distribution during the period of cut-off of the pulp-flow.

7. A concentrator having a member tiltable about an axis and having a substantially plane separating surface adapted to be brought into distinct planes for concentration, dressing and washing of concentrates, means for feeding the pulp over said surface in a direction substantially parallel to said axis whereby the material becomes

graded on said surface in the general line of flow, means for cutting off the flow during the dressing and washing operation, and means for directing the dressing and wash water in proper direction over the material to preserve the graded condition thereof.

8. In combination with a member having a separating surface for concentrates, means for feeding pulp in a given direction over said surface whereby the same becomes graded in the general line of flow, means for cutting off said flow, means for tilting said member in a plane transverse to the normal direction of flow of the pulp, and means for directing streams of dressing water during said period of cut-off over said tilted surface transversely to the normal direction of pulp flow for preserving the graded condition of the material preparatory to washing.

9. In an ore concentrator, a member provided with a separating surface for the flow of pulp thereover in a given direction whereby the same becomes graded in the general line of flow, means for cutting off the flow, means for tilting said surface transversely to the direction of the pulp-flow and at an angle to the plane of pulp-flow and means for directing across the same, during the period of cut-off, streams of water for purposes of dressing at one angle, and streams for washing the concentrates at a higher angle and discharging the same in their graded distribution.

10. In a concentrator, a tilting member provided with a separating surface for the concentrates, means for causing a flow of pulp in a given direction over said surface, means disposed along the pulp stream and engaging the separating surface for restricting the aforesaid flow to a certain portion of said surface, means for cutting off the pulp flow, means for directing streams of water over the surface transversely to the normal direction of flow of the pulp during the period of pulp cut-off, and means for removing said area-restricting member from the concentrating surface to expose the entire area of said surface to said transversely directed water currents.

11. In a concentrator, a member provided with a substantially plane separating surface, means for directing a flow of pulp in a given direction over a portion of said surface whereby the material becomes graded on said portion in the general line of flow, means for cutting off the pulp-flow, and means for directing currents of water over the entire separating surface in a direction transverse to the normal direction of pulp flow during the period of cut-off of the pulp for dressing, and means for discharging the concentrates in their graded distribution.

12. In combination with a member having a substantially plane separating surface

over which the pulp is free to flow in a given direction and be graded in the general line of flow, said member being rotatable about an axis parallel to the general direction of the pulp-flow, means for cutting 5 off the pulp, and directing streams of water over said surface across the path of pulp-flow for a tilted position of the member during the period of cut-off, for dressing 10 at one angle, and washing and discharging the concentrates in their graded distribution at a higher angle.

13. In combination with a member having a separating surface over which the 15 pulp is caused to flow in a given direction whereby the same is caused to stratify, and grade into zones separated by lines of division transverse to the direction of pulp 20 flow, means for cutting off said pulp, means for tilting the member about an axis parallel to the general direction of pulp-flow and bringing its separating surface into a plane disposed at an angle to the plane of 25 pulp flow, and means for directing streams of water across the zones of classification in paths substantially transverse to the axis of rotation of the member during the period of cut-off of the pulp, and discharging the concentrates in their graded distribution.

14. In combination with a substantially 30 plane separating surface having material deposited and graded thereover in distinct zones, means for directing streams of water across the zones in paths substantially 35 parallel to the lines of separation between the zones and discharging the concentrates in their graded distribution, and means for regulating the force of the water currents according to the character of the graded 40 material.

15. In combination with a suitable source of pulp supply, a rotatable member having a substantially plane separating surface over which the pulp is free to flow and become 45 graded in a general direction parallel to the rotation axis of said member, means for tilting the member about said axis to bring the separating surface in a plane inclined to the plane of flow of the pulp, 50 means for cutting off the pulp, means for directing streams of dressing water over the material deposited on the separating surface during the period of cut-off of the pulp in a direction transverse to the rotation axis 55 of the member, and means for discharging the concentrates in their graded distribution.

16. In combination with a suitable source of pulp supply, a rotatable member having 60 a separating surface over which the pulp is free to flow and become graded in a general direction parallel to the rotation axis of said member, means for tilting the member about said axis to bring the plane of the 65 separating surface to a predetermined in-

cline to the plane of flow of the pulp, means for cutting off the pulp to said surface, means for directing during the period of cut-off of the pulp, streams of water over the material deposited on the separating 70 surface in a direction transverse to the rotation axis of the member, means for tilting the member to bring the plane of its separating surface to a greater incline to the plane of flow of the pulp, and continuing 75 the transverse streams of water aforesaid over the surface to wash and discharge the concentrates in their graded distribution.

17. In combination with a suitable source 80 of pulp supply, a rotatable member having a substantially plane separating surface over which the pulp is free to flow and become graded in a general direction parallel to the rotation axis of said member, means 85 for tilting the member about said axis to bring the separating surface in a plane inclined transversely to the plane of flow of the pulp, means for automatically cutting the pulp, means for directing streams of 90 dressing water over the material deposited on the surface in a direction transverse to the rotation axis of the member during the period of cut-off of the pulp, and means for discharging the concentrates in their graded 95 distribution.

18. In combination with a suitable source of pulp supply, a rotatable member having a substantially plane separating surface over which the pulp is free to flow and become 100 graded in a general direction parallel to said axis, means for reciprocating said member parallel to said axis, means for tilting the member about said axis to bring the separating surface in a plane inclined transversely to the plane of flow of the pulp, means for cutting off the pulp to said surface, means for directing streams of dressing water over the surface across said axis after the pulp flow has been cut off, and means for 110 discharging the gangue and sands and concentrates in their graded distribution.

19. In combination with a tilting member having a substantially plane separating surface for concentrates, means for feeding 115 pulp thereover in a given direction whereby the same becomes graded over said surface, means for cutting off the pulp-flow, means for directing streams of dressing water over the graded material in paths substantially parallel to the lines of division between the grades, and means for washing 120 and discharging the concentrates in their graded distribution.

20. In an ore concentrator, a member presenting a substantially horizontal surface 125 to the flow of pulp in a given direction whereby the material becomes graded on said surface, means for cutting off the pulp supply, means for tilting said surface in a 130

plane transverse to said pulp-flow and to distinct angles, and means for directing streams of water across said surface while at said angles for respectively washing and 5 discharging the sands and concentrates in their graded distribution.

21. In an ore concentrator, a member presenting a substantially plane separating surface for the flow of pulp thereover in a given 10 direction whereby the pulp becomes graded thereover in the general line of flow, means for cutting off the flow, means for tilting said surface during the period of cut-off of the pulp in a plane transverse to the direction 15 of pulp-flow and at an angle to the plane of pulp-flow, means for directing across the tilted surface at an angle to the line of flow of the pulp thereover, streams for dressing the graded material, and means 20 for washing and discharging the concentrates in their graded distribution.

22. In combination with a tiltable member provided with a substantially plane separating surface, means for producing a flow of 25 pulp thereover in a given direction whereby the material is graded in the line of flow, means for tilting the member, means for washing the material transversely of said flow on said member while tilted, and means 30 for discharging the concentrates in their graded distribution.

23. In combination with a member tiltable about a fixed axis and provided with a substantially plane separating surface, means 35 for producing a flow or pulp thereover in a direction substantially parallel to said axis whereby the material is graded in the line

of flow, means for cutting off the flow and washing the material transversely of said flow for a tilted position of the member and 40 maintaining the separation between the grades, and means for discharging the concentrates in their graded distribution.

24. In an ore concentrator, a member presenting a substantially plane separating surface 45 for the flow or pulp thereover in a given direction and the grading of said pulp in sheet form in the general line of flow, means for tilting said surface, about an axis substantially parallel to the line of flow, into 50 a plane disposed at an angle to the plane of pulp-flow, and means for directing across the same dressing streams for the purpose of dressing the pulp, and means for washing 55 away the concentrates from said surface.

25. In combination with a tiltable member provided with a substantially plane separating surface, means for producing a flow 60 of pulp thereover in a given direction whereby the material is graded in sheet form in the general line of flow, means for tilting said member about an axis substantially parallel to the line of flow, and means 65 for washing the material transversely of said axis while said member is tilted, and directing the streams thereover to preserve the concentrates in their graded distribution.

In testimony whereof I affix my signature, in presence of two witnesses.

FRANK E. MARCY.

Witnesses:

H. I. GOODSPEED,
O. H. JOHNSON.