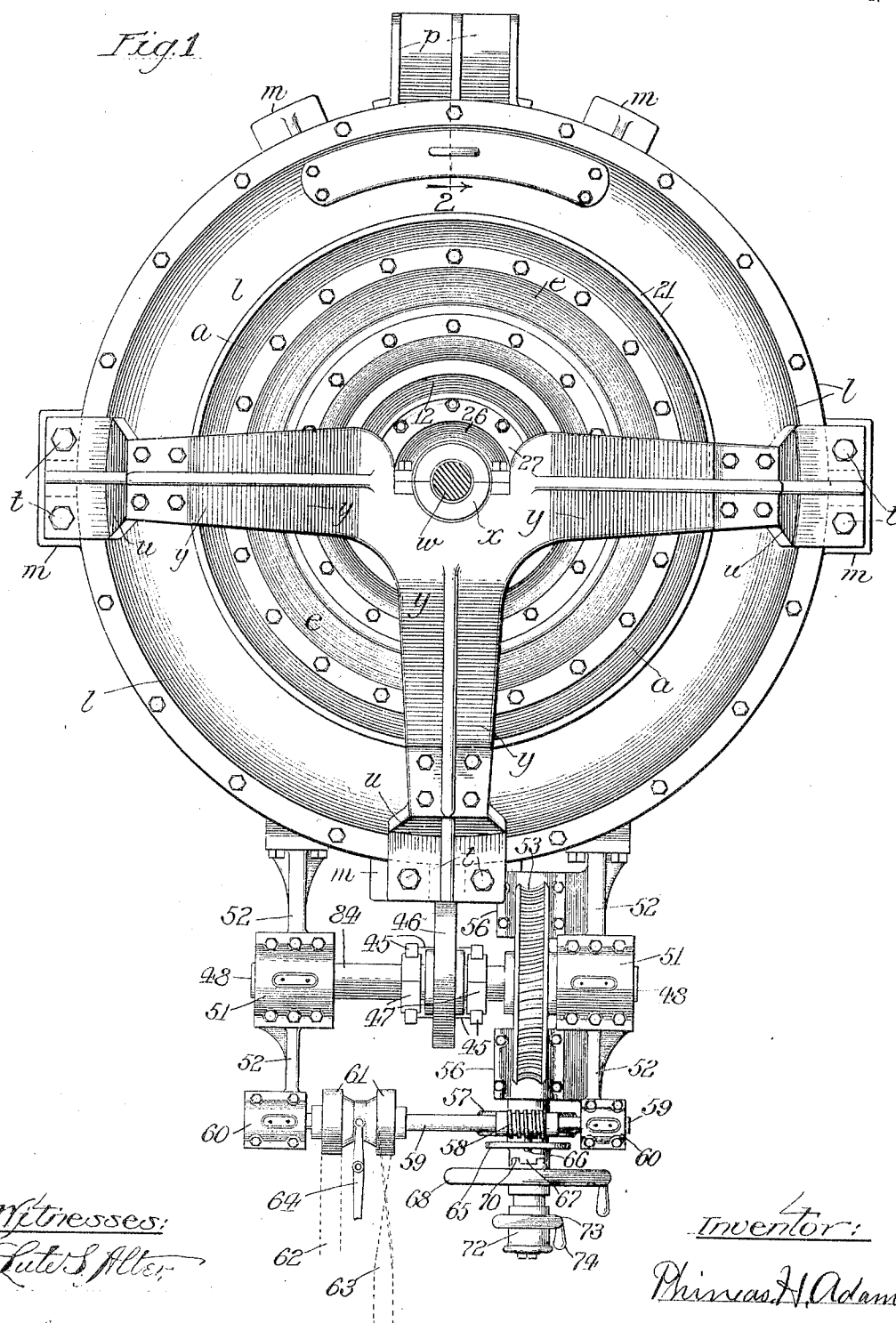


P. H. ADAMS.
CENTRIFUGAL CONCENTRATOR.
APPLICATION FILED MAY 6, 1903.

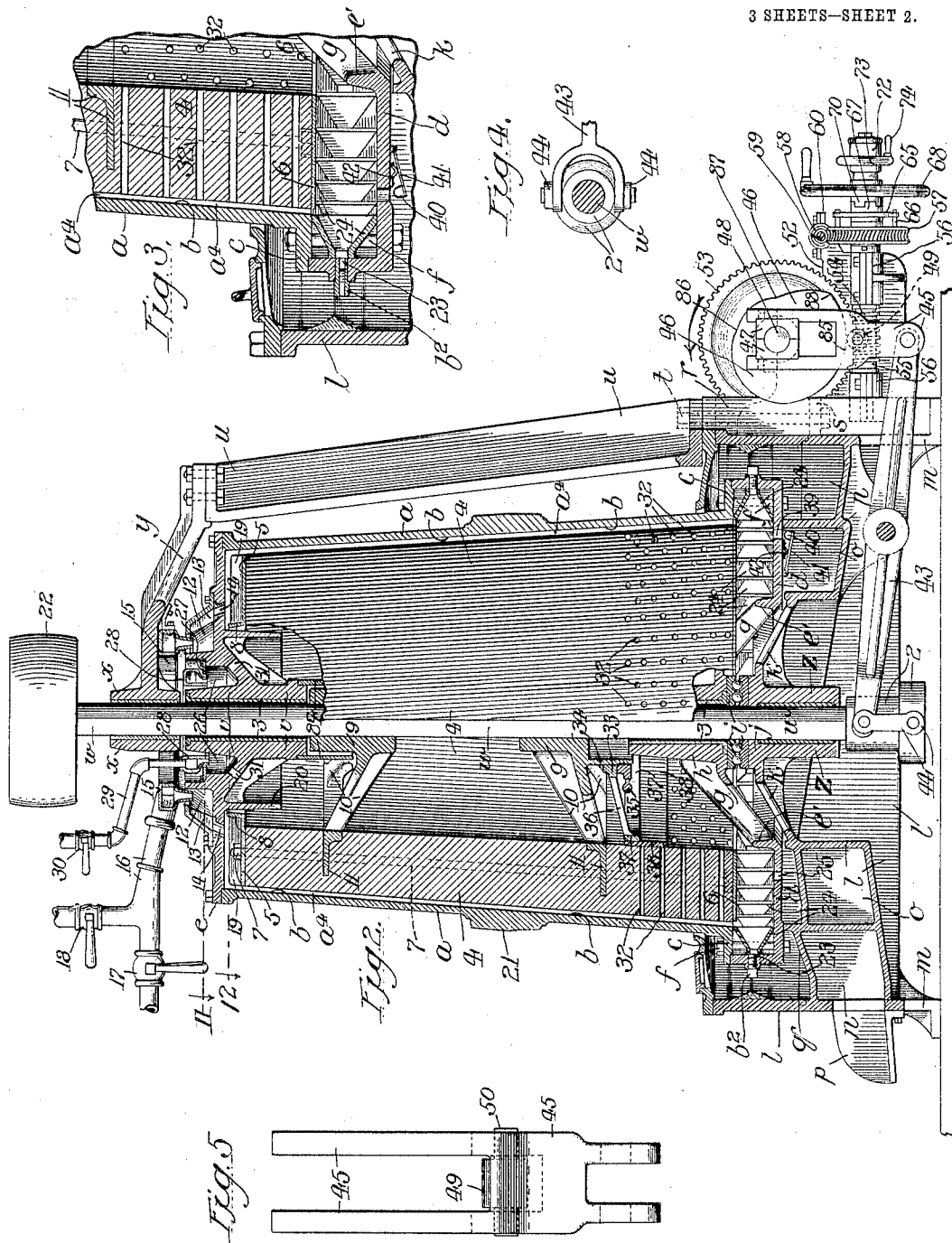
3 SHEETS—SHEET 1.



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3 SHEETS—SHEET 2.

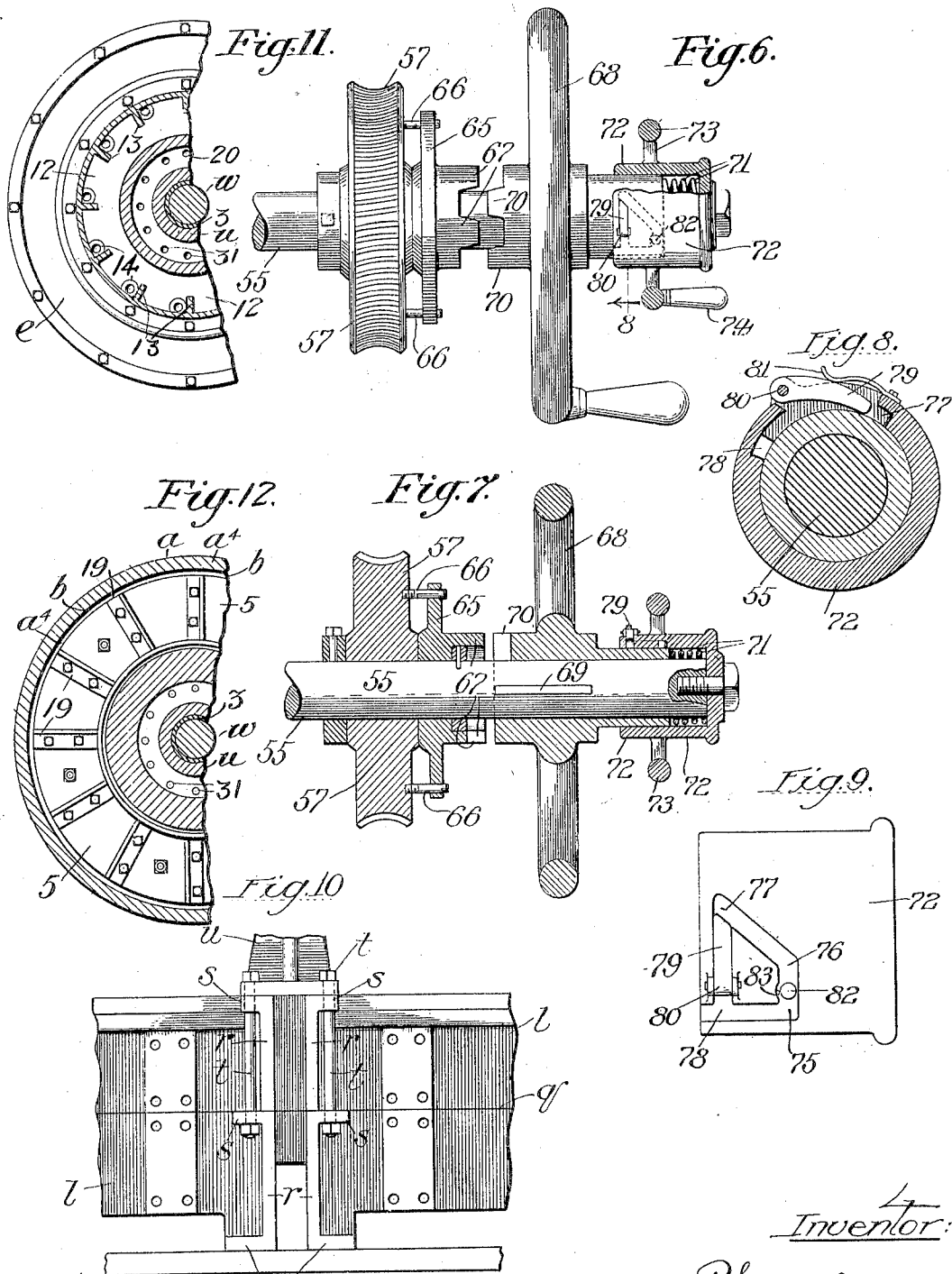


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Inventor:
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3 SHEETS—SHEET 3.



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Lute S. Alter,
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UNITED STATES PATENT OFFICE.

PHINEAS H. ADAMS, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO TITLE OWNERS COMPANY, A CORPORATION OF MAINE.

CENTRIFUGAL CONCENTRATOR.

No. 802,724.

Specification of Letters Patent.

Patented Oct. 24, 1905.

Application filed May 6, 1903. Serial No. 155,959.

To all whom it may concern:

Be it known that I, PHINEAS H. ADAMS, a citizen of the United States, residing at Chicago, Cook county, State of Illinois, have invented certain new and useful Improvements in Centrifugal Concentrators, of which the following is a specification.

My invention relates more particularly to improvements in the art of centrifugal concentration or separation of materials of different degrees of specific gravity while in a finely-divided state and in the presence of or mixed with water; and it consists in the various combinations, features, and details of construction and mechanism or machinery and the movements and effect of its parts for use in said art, which are hereinafter described and claimed.

To enable a better understanding of my invention, I will state that in operation it ordinarily occurs that the separation of the lighter particles of the heavier or value parts of material is not accomplished with the same ease and distinctness as the heaviest particles of this portion and that some of the heaviest portions of the lighter or waste part of the material lodges or deposits with these lighter-value particles on a greater or less area of the separating-surface near the discharge end of the vessel, thereby forming a mixed or blended imperfectly-separated accumulation or layer increasing in percentage of waste particles as the discharge end of the separating-surface of the vessel is approached, which mixed material in practice is known as "middlings." Through this depositing or accumulating of waste particles the efficiency and utility of the centrifugal concentrator as ordinarily built are materially reduced, partly from the fact that heretofore when the accumulated mass or layer of more cleanly separated, and hence more valuable, concentrates is periodically discharged from the other portions of the separating-surface, this imperfectly-separated or middlings portion is also at the same time discharged or removed and commingles with the better part, thereby substantially reducing the richness of the entire mass, as well as increasing its volume, and consequently increasing the cost of subsequent smelting or further reduction, because of the increased quantity to be smelted, and also from the fact that the waste particles, as a rule, are highly silicious and more difficult to smelt.

In the drawings, Figure 1 is a top plan of my concentrator with the upper driving-pulley and feed casings and pipes removed. Fig. 2 is a central vertical section of Fig. 1 partly on line 2, somewhat reduced in size, looking in the direction of the arrow, also showing, however, part of the deflector and some other parts in elevation. Fig. 3 is an enlarged detailed central view of a portion of the lower outer diameter or wall of the treatment vessel and its lower head, a part of the corresponding wall of the deflector and some other parts showing their relation, arrangement, and position. Fig. 4 is a detail showing a cross-section of the deflector-shaft, a top plan of its lower end step-box, and the forked end portion of the oscillatory lever. Fig. 5 is an enlarged detail of the forked casting shown at the cam in Fig. 2, but in position turned one-quarter around. Fig. 6 is an enlarged detail, mostly in elevation, of the hand-wheel, clutch-jaws, and safety device in the reciprocating mechanism, with, however, parts shown by dotted lines and parts broken away. Fig. 7 is principally a central horizontal section of Fig. 6, but, however, with the shaft and some small parts in elevation and the grasping-piece to the hand-wheel omitted. Fig. 8 is an enlarged detail cross-section of Fig. 6 on line 8 looking in the direction of the arrow, showing more clearly some parts and showing the part broken away in Fig. 6 restored. Fig. 9 is an enlarged outline of the end or cup-shaped casting shown in Figs. 6 and 7, illustrating more clearly certain features. Fig. 10 is an elevation of that side of the base castings or housing where the reciprocating-mechanism parts are connected. Fig. 11 is a detail plan, partly in section, of part of Fig. 2 on line 11 looking in the direction of the arrow; and Fig. 12 is a detail plan section of part of Fig. 2 on line 12 of Fig. 2 looking in the direction of the arrow.

Similar letters and figures designate similar parts throughout the several figures of the drawings.

In the construction of my concentrator I provide a concentrating or treatment vessel consisting, principally, of a tapering tubular or frustum portion *a*, affording on its inner circumferential wall a separating-surface *b*. The circumferential wall of the treatment vessel is preferably of comparatively thin metal, having at its lower or larger end a

flanged part C, which helps to form an enlargement at the discharge end of the treatment vessel. To the vessel is provided two heads *d* and *e*. The lower head *d* is preferably composed of an outer portion in the nature of a flat ring with an upward-turned portion or flange *e'* at its inner edge and also one with an upwardly-turned flange part at its outer or peripheral edge corresponding in diameter to the flange C. This head is secured to the flange C by bolts *f* and, with said flange, forms the enlargement at the discharge end of the vessel, as shown in Figs. 1 and 3. Connected to the inner edge of the ring portion of the head are radial spokes *g*, secured to a hub or central portion *h*. This hub is seated upon an antifriction-bearing *i*, which is carried by a casting *j*, and thus vertically supports the treatment vessel. This casting is connected by arms *k* to the inner diameter or wall of the base casting or housing *l*, which surrounds the lower portion of the treatment vessel and serves as a base for the concentrator, being provided with legs *m* to raise it a short distance above the floor or foundation on which it stands. It also contains compartments serving as curved spirally-inclined troughs or launders *n* and *o* for receiving the material and water discharged from the treatment vessel and has attached to it a delivery-spout *p* for such material and water. The outer wall of this trough or base housing is preferably for convenience of manufacture made in an upper and lower part or section, being divided through a horizontal plane at *q*. It is provided with reinforcing-ribs *r* (best shown in detail Fig. 10) and with lugs or extended parts or flange portions *s*, through which the bolts *t* pass to hold the two sections together, and some of said bolts also preferably pass through the base or foot of the columns *u*, as especially shown in detail in Fig. 10, and serve to help hold these columns and the several parts rigidly together.

The upper head *e* of the cylinder or treatment vessel is provided with a central cylindrical extension or hub *v*, encircling and having a bearing upon a vertical shaft *w*, which is journaled near its upper end in a bearing *x*, preferably supported through connecting parts or arms *y*, by the three columns *u*, Fig. 1, which extend upward from the top of the base-casting. The lower end of the shaft is journaled in the box *z*, which is an extension of the part *j*, and is seated in a reciprocatory antifriction-bearing 2, to be hereinafter more fully described.

The hub *h* of the lower end or head of the treatment vessel also has a bearing upon the shaft, and both the hubs *h* and *v* are provided with suitable internal removable metal sleeves or bushings 3, having linings of Babbitt or other suitable antifriction metal and having outwardly-extended portions at one end through which bolts or screws may be passed

to assist in holding them to place. The central opening in these hubs are of proper size to receive the sleeves or bushings so they will be held well in place, yet so when the babbitt is worn too much for satisfactory service the bushings may be removed for repair and return, or others may be substituted in their places.

Within the treatment vessel is a tapering, preferably tubular, core 4, which serves as a deflector and which, together with the wall of the vessel, forms a covered separating channel or passage *a'* and deflects and guides material along near the separating-surface, as well as for other important purposes, as hereinafter more fully described. This core, which I will term a "deflector," is hollow, with more or less open ends. It may be made of sections of wood or in any other desired way. It is preferably made of a length to extend over or cover substantially all of the separating-surface while it is in position nearest the feed end of the treatment vessel and then also to extend a short distance beyond the opposite end of such surface, yet leaving room for its longitudinal movement or reciprocation a distance substantially equivalent to the width of the enlargement or chamber therein at the discharge end of the vessel.

Upon the upper and lower ends of the deflector are plates or rings 5 and 6, respectively, and bolts 7 pass longitudinally through the wall of the deflector and the plates, serving to clamp and assist in holding these parts securely together. The upper plate has on its inner edge an annular upwardly-extended flange 8, Fig. 2, to prevent material and water from flowing into the central opening of the deflector, at this point.

The deflector is rigidly secured to its shaft *w* by spiders consisting of hubs or central portions 9, arms 10, and rings 11, the latter extending into the wood of which the wall of the deflector is made and is provided with holes through which the bolts 7 pass, thus assisting to secure the wall of the deflector and spiders together.

Upon the upper head of the treatment vessel is situated a material feed receptacle or chamber 12, and within this feed-chamber are provided suitably-located vertical webs 13, and between these webs are feed openings or channels 14 through the head *e* to the interior of the treatment vessel. These parts are shown in Figs. 2 and 11. The web serves not only to support and strengthen the wall of the feed-chamber, but also as means to quickly start into rotation the material delivered to it.

The feed-chamber is provided with an annular opening at its top, into which extends a feed-casting 15, which may consist of an annular hollow portion of proper diameter and size, having, preferably, a narrow annular opening or channel between two downwardly-extended walls of size and shape to register

with and enter the opening into the feed-chamber. This feed-casting is connected to a branched pipe 16, having suitable valves 17 and 18, located in the respective branches.

One of these branches is adapted to be connected with an agitating-tank or other suitable source of supply of material, pulp, or pulverized ore properly mixed with water for concentration and serves to supply the concentrator with material for concentration or separation at the desired time. Its flow is governed by the valve in that particular branch. The other branch is connected to a proper source of supply of preferably clean water for use at the desired time in discharging or removing accumulated concentrates or middlings. Its flow is governed by the valve in this branch.

Upon the plate 5 at the upper end of the deflector are provided radial wings 19, (shown in Figs. 1 and 12,) reaching from near the outer circumference of the deflector to a point beyond the feed-channels 14. These serve to maintain the mixture in rapid rotation in its passage from the feed-chamber to the treatment vessel and into the separating-channel.

The plate 5 extends some distance in toward the axis under the feed-opening 14 to receive the feed of material from the feed-chamber and divert it into the separating-channel and is here provided, as before stated, with the annular upturned flange 8 around its inner border to prevent flow of material over this edge.

The upper head of the treatment vessel is preferably provided with a depending ring or flange 20 of size and in position so it will with small diametrical clearance enter the central opening of the plate 5 and telescope therein and down into the deflector as the latter is reciprocated and to extend at least slightly within the deflector when it is in its lowest position. This flange serves to assist in preventing the material and water from splashing from the top of the deflector down into its central opening and when desired for delivering water into the deflector, as herein-after described.

The outer circumference of the treatment vessel carries a pulley or belt surface 21, Fig. 2, which may be conveniently formed thereon and by which, through the use of a belt, the treatment vessel is rotated at a desired rate of speed. This surface may, however, be properly grooved, if desired, for receiving a rope for transmission of motion to the vessel instead of by a flat belt. Rotation is imparted to the deflector through a pulley 22, Fig. 2, at or near the upper end of its shaft *u*.

In the circumferential wall of the enlargement at the discharge end of the treatment vessel there are a number of radial discharge-orifices 23, (most clearly shown in detail in Fig. 3,) which are contracted to the desired size by removable pipes or hollow plugs 2,

and in the recess or chamber formed in this enlargement is fitted a ring 24, having a series of tapering chambers leading to the discharge-orifices 23.

The bolts *f* extend through the flange C, which forms the upper wall of the enlargement, and through the lower side or the head of the vessel between the chambers in the ring, securely retaining the head and the cylindrical part of the vessel together, as well as holding the ring 24 in place.

There are preferably through the larger or lower head, and best located approximately a somewhat less radial distance from the axis than the interior diameter of the small end of the treatment vessel, several holes or channels 25 for the discharge of excess material or water in this end of the vessel, especially during the concentrating period under normal conditions of operation, at which time it is desirable and advantageous to feed a sufficient quantity to the treatment vessel to constantly produce at least a slight discharge from these holes, thereby insuring that the separating-channel is well and completely filled and giving visible evidence to the operator of such fact, it being caught by the inner trough *o* in the base-casting and separately flowed out for observance.

Preferably nearer to the axis than the material-feed chamber 12 and concentric to such axis is located a chamber 26 for the reception of water alone. This water-feed chamber is preferably formed by an annular depression in the upper head adjacent to its hub *v*, as shown well in Fig. 2, and a suitable plate 27, which is properly located and secured to the head, extending toward the axis, thereby largely covering the depression, but leaving a suitable annular opening for introduction of water, when desired, by sufficient and proper means, as a curved pipe or casting 28, provided with depending lips, with an annular opening between them, of size and form to register with the opening in the chamber. To this casting is connected a water-supply pipe or conduit 29, connected to a suitable source of water-supply and is governed by a valve 30, located in the pipe. It is much preferable, although not absolutely necessary, that the water here introduced should be comparatively clean. From this water-feed chamber are provided means for conveying water into the hollow of the deflector, which are openings 31, communicating with the depending ring or flange 20, hereinbefore described, which is in position to receive the water and deliver it down within the upper end of the hollow deflector, as illustrated in Fig. 2, a sufficient distance even when the latter has been drawn down to its fullest extent. The width of this flange is somewhat greater than the extent of reciprocation of the deflector. It then follows that inasmuch as the inner wall of the deflector diverges

outward toward its lower or opposite end and, further, from the fact that it is in a vertical position, the water after passing from the flange and being thrown by centrifugal force against the deflector-wall, quickly flows down toward the lower end of the deflector and with violence into the lower part of the separating-channel through preferably a number of holes, perforations, or channels 32, which I provide through the wall of the deflector more or less thickly over its area up for a desired distance from its lower or discharge end.

It will be seen that the agencies above described operating as a part of the concentrator to supply, carry, and deliver water within the lower portion of the separating-channel and on that part of the separating-surface without delivering water into the upper part of such channel, form means for the employment of water whereby prior to the removal of the most highly concentrated and richer part of the material or concentrate, which may be known as "finished" concentrates, that are accumulated on the upper portion of the separating-surface near or toward the feed end, the mixed or imperfectly-separated or middlings part accumulated on the lower portion or toward the discharge end, over which these holes 32 range, can first and be separately removed and discharged from the separating surface and vessel without disturbing or removing the other or finished portions.

While I have described with considerable exactness the several parts which in this instance operate conjointly to serve as means for employment of water whereby middlings can be first and separately removed in this class of a concentrator without removing the better concentrates, I do not intend thereby to confine myself to the close details of construction or the close detail association of parts described for this purpose.

It will be understood that by reason of the differential rotation of the separating-surface and the deflector all portions of the separating-surface throughout the longitudinal extent to which the perforations reach and are left uncovered will be circumferentially swept or brought under the radial influence or washing action of the water passing through such perforations or channels, and, further, from the fact that the deflector is reciprocatory the perforations or channels may be more or less reciprocated at the same time they are differentially rotated, thereby serving to more completely cover, sweep, or clean the lower portion of the separating-surface. This reciprocation, however, during the time of unloading middlings can be but slight without removing material from the upper part of the separating surface or channel, as the concentrating-channel will be nearly full of concentrates and will not permit of much upward travel of the deflector without removing concentrates,

so that the middlings, if removed separately, are necessarily removed while the deflector is in a down or drawn-out position.

As means for more completely governing the extent or longitudinal distance from the discharge end of the separating-surface from which the mixed material or middlings may be separately removed and for nicely adjusting or changing this limit of effectiveness I supply the perforations or channels 32 up longitudinally in the deflector, the maximum distance from which in any case it will likely be desirable to first remove the middlings. I then provide an adjustable means for covering or closing a desired portion or number of these perforations or channels from their upper line, preferably composed of a central or hub part 33, Fig. 2, loosely surrounding the sleeve 34, which depends from the lower one of the hubs 9, and resting on the internally-threaded hand-wheel 35, which engages threads on the outside of said sleeve 34. From the central part 33 are extended arms 36, carrying a ring or hoop 37 near the inner surface of the deflector in position to properly support an elastic part 38 in the nature of a sheet-rubber covering and to permit it to rest or lie closely against this portion of the inner surface of the deflector. The arms 36, as well as the arms or spokes 10 of the hub 12, are far enough apart to afford ample space between them for the flow of water within the deflector. The elastic portion is preferably made of comparatively thin sheet-rubber to enable it to be expanded by centrifugal force and to conform to the shape of and rest close against the surface of the deflector. It is of sufficient width so even when it is moved fully downward it will cover the holes lying above it, in this way effectually and completely covering such portion of the perforations or channels as may be desired, preventing water from flowing through them, and consequently the removal of material or middlings radially under them. Of course it will be understood that the water will flow over this elastic portion and down to and through the perforations that are not covered by it. The supporting parts of the elastic portion may be moved up or down by turning the hand-wheel 35, and thereby such number of the perforations or channels covered or uncovered as may be desired, and consequently the extent of the separating-surface, from which materials are first removed, governed as wished.

As means for preventing the water from accumulating in too great a quantity in the lower end of the treatment vessel during the period of removing the middlings and from backing up in the separating-channel too far above the upper perforations through the deflector-walls, and thus disturbing the deposit of finished concentrates above the area from which it is desired to first effect removal of the middlings, I provide, preferably, several open-

ings 39 through the lower head of the vessel at a proper radial distance from the axis, so the excess amount of water will be discharged at these points. The water therefore will not

back up in the separating-channel and on the separating-surface to an extent substantially nearer the axis than the radial position occupied by these openings, which I will term for convenience "secondary overflow-channels."

During concentration it is necessary to keep the separating channel or passage full of water to enable effective concentration, and during that period if these secondary overflow-channels were open they would permit the water to then flow out so rapidly as to abstract it from the separating-channel and defeat the results sought. It is necessary, therefore, to provide means to close these channels during the concentrating period, and I prefer to do this by supplying a suitable plug or stopper 40, Figs. 2 and 3, for each secondary overflow-channel, which may be of comparatively soft rubber, each secured to a separate hinged piece 41 in proper position, so the plug will register with and cover its respective channel when it is swung up to place. The part 41 is preferably provided with a spring 42, secured in position on the lower head of the vessel to contact with the part 41 in a manner to resist the swinging up of this part and stopper to close the channel.

It will be understood that during the concentrating period the vessel is rotated at a greater speed than during the unloading or discharging period, and the strength of the spring 42 and weight of the part 41 are proportioned with relation to the speed of the vessel at the respective times, so that at the unloading period and speed the spring will overcome the centrifugal force being developed on the stopper and its carrying parts and force them down, thus opening the secondary overflow-channels; but, on the other hand, the spring is sufficiently weak to permit the increased centrifugal force developed during the concentrating period to carry the part 41 and the stopper up and retain the latter firmly over their respective secondary channels, effectively stopping any discharge thereat during this period. In this way means rotatable with the vessel are provided for preventing water during this period of separately removing middlings from flowing up into the separating-channel and on the concentrating-surface beyond the desired distance, consequently preventing removal of material at that time from other portions of the concentrating-surface. Of course other means may be employed for opening and closing the secondary channel 39; but I prefer to employ this automatic arrangement as being effective and convenient. The radial distance or position of location of these secondary overflow-channels from the axis of rotation establish or predetermine the extent to which the water can back or

flow up in the separating-channel while they are open, and therefore in locating these passages the extent of such upward flow of water is thereby predetermined.

As before stated, the deflector is shorter than the treatment vessel, and its shaft is mounted to slide freely in all but its lower or combined step and lateral bearing. These last are connected with means to secure to them alternate periods of longitudinal reciprocation or movement and rest.

The reciprocating mechanism preferably consists of a lever 43, forked at its inner end, pivotally fulcrumed near its center to the bottom or the trough or base-housing and connected to the step-bearing at its forked end by links 44, Figs. 2 and 4. The opposite end of the lever is hinged or pivotally connected by a reciprocatory upwardly-extending casting 45, which diverges upward into two pairs of forks or yokes, the separate pairs of which pass on the opposite sides of the cam-wheel 46 and are in engagement in a sliding manner with the boxes or bearings 47 around the cam-shaft 48, which here holds the forked casting in position, as illustrated in the drawings. One view of this casting is shown in detail Fig. 5. This forked casting has in its lower portion or body, properly located to contact with the circumferential surface of the cam-wheel, a roller 49, which is of suitable size and rotatably mounted on a pin 50, so the cam maintains this end of the lever, and when the cam revolves the roller travels against the circumferential surface of the cam and is thus forced downward or is permitted to rise, carried by the weight on the opposite end of the lever, with the irregular contour of the cam, accordingly carrying the forked casting, rocking or reciprocating the lever, and producing a reciprocating or longitudinal movement of the step-bearing, the shaft, and its deflector. It will be understood that the cam 46 has a peripheral surface with an irregular contour adapted to produce the movements or oscillations of the lever which are desired, as well as its periods of rest, and in turn such movements and rest of the deflector. This cam is securely mounted and maintained on its shaft 48, which is journaled in boxes 51, Fig. 1, carried by brackets 52, secured to the base casting or housing of the concentrator. The shaft and cam are rotated by slow-down gearing or mechanism, consisting of a worm-wheel 53, rigidly mounted upon the cam-shaft and meshing with a worm 54 upon a shaft 55 passing through it (the shaft is indicated in Figs. 5 and 6) and journaled in boxes 56, which are properly connected to and carried by one of the brackets 52. The worm 54 has its ends or hubs extended sufficiently to contact with the boxes 56 to prevent the worm from being moved endwise. Upon the shaft 55 is also located, but in a loose or rotatable manner, a worm-wheel 57, meshing with a worm 58 upon

a shaft 59, journaled in boxes 60 in suitable position for this purpose. The parts above stated, which are mounted on the shaft 55, as shown assembled in Figs. 1 and 2, so completely cover it as to entirely obscure the said shaft from view in these figures. For receiving the motive power for this mechanism and imparting rotation thereto a pair of clutch-pulleys 61, Fig. 1, are preferably mounted on the shaft 59 and are driven in reverse directions by straight and crossed belts 62 and 63 (shown in dotted lines, Fig. 1) and may be thrown in or out of engagement by a proper lever 64, and the shaft 59, with its rigidly-mounted worm 58 and the loosely-mounted worm-wheel 57, be thereby revolved in either direction desired, depending on which of the pulleys are brought into engagement for this purpose. As means by which to transmit rotation from the worm-wheel 57 to the cam 46 and also when desired to enable stopping the movement of the cam and parts actuated by it while the other parts of the cam-driving mechanism continue to operate and also to enable manual operation at the cam and reciprocation of the deflector the worm-wheel 57, as above stated, is rotatably mounted upon its shaft 55, held longitudinally to place thereon at one side by a collar and at the other by contacting with one end of the hub of a disk 65, which is also loosely mounted on the shaft 55. This arrangement is best shown in Figs. 6 and 7.

To connect the worm-wheel 57 and disk 65 together, so when the former is revolved the latter will be carried with it. I provide pins 66, extended into the walls of both parts. These pins or studs are of sufficient strength to force or carry the worm-wheel around with the disk under or doing any normal duty in reciprocation of the deflector, but are intended to be sufficiently frail to break under largely undue stress in reciprocation of the deflector, thereby forming a safety measure, points, or device in their driving mechanism. In this way accident is prevented that might otherwise occur caused by possible clogging in the separating-channel. The pins may be renewed, if broken. The outer hub of the disk is extended and provided with clutch-jaw 67, adapted to engage with clutch-jaws on the hub of the hand-wheel 68, which wheel is mounted and splined in a manner to be moved longitudinally on the shaft 55, but not rotated thereon, so when the hand-wheel revolves the shaft is also forced around by the spline 69 (shown in Fig. 7) and through which when the clutch-jaws 70 of the hand-wheel and disk are in engagement the worm-wheel 57 will be rotated and the shaft 48 revolved with its cam. If, however, it is desired to stop the rotation of the cam and the reciprocation of the deflector while the worm-wheel 57 is revolving, the hand-wheel may be drawn back

on its shaft until the clutch-jaws are out of engagement, thus permitting the worm-wheel and disk to loosely revolve on their shaft. In this position the hand-wheel 68 and its shaft, as well as the parts driven by it, will remain at rest until it is desired to operate them manually through the agency of the hand-wheel or until the clutch-jaws are again brought into engagement.

As means for forcing the jaws on the hand-wheel and disk into engagement, as well as to assist in holding them in such position when desired, there is a coiled spring 71 (shown in Figs. 6 and 7) around their shaft properly located to contact at one end against the outer end of the hub of the hand-wheel and at its other end against the bottom of the cup-shaped casting 72.

As means with which to readily withdraw the clutch-jaws of the disk and hand-wheel from engagement when desired and again permit them to become engaged I provide a secondary hand-wheel 73, fixedly mounted on and employing the cup-shaped casting 72 as its hub portion, and for convenience of manipulation it may be provided with a handle or grasping-piece 74.

Preferably in the inner wall of the cup-shaped casting opening to its interior circumference, as is best shown in Figs. 6, 8, and 9, the latter of which shows it in diagrammatical outline, I provide a groove, channel, or groove of suitable width and depth to enable it to subserve the purposes for which it is intended. This groove preferably starts at the open end of the casting, thus leaving it with an open end, and first extends approximately parallel to the axis of the casting at least a distance in length somewhat greater than the length of the clutch-jaws to the point 75, thence preferably extending at right angles a comparatively short distance to a point 76, thence in an oblique diagonal or spiral direction for a desired distance back toward the open end of the casting to a point 77, thence in a direction preferably at right angles to its first course, intersecting the same at a point 78. To operate in the last-described portion of this groove, part of which portion preferably extends clear through the wall of the casting, is located a metal piece 79, loose at one end and hinged at its other end at a point 80, with its inner side preferably slightly extending into the groove and its opposite end extending or lying deeply into the groove, terminating in position to come flush with the wall of the diagonal or oblique portion of the groove nearest to the hinged end, as most clearly shown in Figs. 6 and 9. Thus in its normal position the loose end will fill the point of intersection of the groove in which it lies and the diagonal portion of the groove and serve to here complete the wall of this latter portion, and its lower or inner side will form an in-

clined plane in the groove, with its loose end yieldingly held down in place in the groove by a spring 81, only showing in Fig. 8.

At a proper point on the hub of the hand-wheel 68, which carries the clutch-jaws, is located a protruding pin 82 of size and shape to quite loosely fit and travel in the groove, the two being located relatively, so that when the clutch-jaws are in engagement with those on the hub of the disk the position of the pin will be in the slot at the point 78, and then to disengage the clutch-jaws the secondary hand-wheel is revolved first to the right, turning with it the cup-shaped casting or hub and passing the pin through the part of the groove to the point 77. During this time the piece 79 is pushed or swung outward by the pin to permit its passage; but when the pin has passed beyond the end of this piece and fully entered the diagonal part of the groove, the pushed-out end being relieved, is carried in again to its normal position by the spring 81, Fig. 8, and completes that portion of the wall of the diagonal part of the groove at 77, thus preventing the pin from again entering the part of the groove through which it has just passed. The secondary hand-wheel is now turned to the right, and the contact of the pin against the side of the wall of the diagonal portion of the groove in its revolution forces the pin along the groove in a backward direction, drawing with it the hand-wheel and its clutch-jaws, thus disengaging the latter. By the time 76 in the groove is reached by the pin the clutch-jaws will be fully withdrawn out of engagement, and by some further rotation of the hand-wheel the pin will pass into the portion of the groove between the points 76 and 75 and may there rest, holding the clutch-jaws out of engagement and permitting the worm-wheel 53 and cam-wheel 46 and the parts they operate to remain at rest while the clutch-pulleys 61, the worm 58, the worm-wheel 57, and disk continue to rotate. When it is desired to again bring the clutch-jaws into engagement, the secondary hand-wheel may be turned sufficiently farther to the right to bring the pin fully into the part or points 75, Fig. 9, of the groove, and then with the pin unobstructed the hand-wheel will be forced along its shaft by the coiled spring and the clutch-jaws again brought into engagement, at the same time moving the pin into its initial position in the groove ready to again perform its service when desired. Of course if the clutch-jaws of the two parts are not in proper relative position to engage when the pin first reaches the point 75 it will remain there at rest until the rotation of the disk brings its clutch-jaws in proper relative longitudinal position, when engagement will quickly take place, effected by the pressure of the spring. When the clutch-jaws are being held out of engagement by this described mechanism, the worm-wheel 53, the cam-

wheel, and their driven parts may be manually operated through application to the hand-wheel, and the deflector may thus be manually reciprocated.

I prefer to form a comparatively shallow, more or less, curved depression or recess 83, Fig. 9, in the wall in the portion of the groove between the points 75 and 76, in which the pin may at least partly recess and rest in its passage through this portion of the groove. The presence of this depression will enable the operator during the time he is turning the secondary hand-wheel through this part of its revolution to readily distinguish when the pin has safely reached that position in the groove intended for holding the clutch-jaws out of engagement, as well as to maintain it in such position with more security and yet readily yield when a comparatively moderate additional amount of rotary pressure is applied to the secondary hand-wheel. If desired, two of these grooves or channels and pins may be employed to advantage, preferably to operate in unison on diametrically opposite sides of the casting in which they are located. In this way a more even application of operating force to those parts may be had.

To prevent the material within the concentrator from splashing on or reaching the upper bearing of the treatment vessel, the lower end of its hub is provided with a depending sleeve 84 of size and form to at all times extend somewhat over the hub of the upper spider of the deflector, as illustrated, Fig. 2, and during reciprocating operation to telescope over such hub, thus always covering this portion of the shaft. To protect the journal of the lower hub $\frac{1}{2}$, it is also encircled by the sleeve 34, secured to the lower side of the hub of the lower spider of the deflector, this also being of proper and sufficient dimensions to be always about the hub in any position of the deflector and to telescope over the same during reciprocation.

In operation the deflector being at its extreme upper position in the vessel—that is, nearest to the feed end—the roller 49 contacting with the cam at the point 85 the period of separation or concentration is about to begin. Ore or other suitable material more or less finely pulverized and properly mixed or commingled with the water to form a pulp is fed through the feed-pipe 16 and through the feed-casting, feed-chamber, and feed-orifices into the treatment vessel, which is being rotated at a sufficient speed to develop the desired degree of centrifugal force. The mixture is supplied in sufficient quantities to quickly fill the separating channel or passage and is forced therethrough by the centrifugal force acting on the greater or less body of water that accumulates between the head of the vessel and that of the deflector in the feed end and along the inclined surface in the separating-channel, and also to some extent

by gravity, producing a current downward through the separating-channel and the vessel. In the separating-channel centrifugal force causes the material to move toward a position around the circumference of the vessel and the heavier portion to lodge on the separating-surface, the heaviest assuming this position first and maintaining it with great tenacity, therefore filling that portion of the separating-channel nearest the feed end with a more distinctly and cleanly separated deposit than farther down in the channel nearer the discharge end, where the lighter parts of the heavier ore values are driven for fixed lodgment, while the waste is mostly driven on to discharge out of the vessel. The differential rotation of the deflector causes an agitation in the mixture within the separating-channel and a frictional wash over the separating-surface of requisite intensity to permit practically fixed precipitation of the heavier or value portions, while it maintains the lighter or waste particles partially or wholly in suspension in the liquid or in traveling contact on the separating-surface, with which liquid it is moved along toward the discharge-orifices by the said friction and downward flow. As separation progresses and the heavier materials accumulate on the separating-surface the diminishing radius of the cam in its rotation gradually lowers the deflector through the agency of their connecting parts, thus carrying the exterior of the deflector away from the separator-surface and widening the separating-channel between them. The volume of feed to the concentrator is gaged so that by the gradual lowering of the deflector the distance between its outer surface and the surface of the accumulating concentrates is kept approximately constant, maintaining the velocity of flow of water through the channel approximately constant, and of such intensity, together with the frictional wash, as to carry along to discharge the lighter substances, which will be caught by the troughs or launders in the base casting or housing and be delivered from the concentrator by the spout *p*. This spout connects with an adequate arrangement of shifting troughs (not shown) to enable the various products discharged from the separator at the different times to be diverted to different desired points. During this time or period of separation there is always some waste particles lodged in the separating-channel, especially on or near the lower portion of the separating-surface near the discharge end, thus by accumulating with the lighter value particles forming a mixed or blended deposit thereon. This deposit gradually decreases in percentage of value particles and weight as the discharge end is more nearly approached and forms what is generally known in practice as "middlings." There are as well during this period some of the lighter value particles pass or flow from the discharge or lower end of

this deposit out to discharge and are lost. This latter making up largely the percentage of value losses in concentration, and this percentage of loss depends largely on the distance in length of the separating-surface that can practically be allotted or given over for the deposit of this imperfectly-separated part and that in turn largely depends on the facility for removing these middlings or imperfectly separated parts by themselves for retreatment. To insure that there shall be practically none or at most the smallest amount of value possible flowed or moved over to discharge and loss, there is a sufficiently small quantity of material for separation fed to the concentrator, so that its cleanly separated or finished value contents will not well fill the space within the separating-channel throughout its entire length, but will leave a considerable room or extent for the mixed and blended or middlings portion of the deposit to lengthen out or extend well up on the separating-surface some distance from the discharge end under the path of circumferential travel of the perforations or channels in the deflector-wall, thereby affording greater space on the separating-surface in which this blended mixture part may lodge and a greater distance in which this percentage of value particles that would otherwise be washed to discharge may be saved, resulting in a higher percentage of saving in values from the material being treated. This allotment of greater length or space is rendered practical for the middlings material because of the devising and employment of means for separately removing and discharging it for retreatment without removing the more valuable parts at the same time, and thereby keeping the two separate. During the concentrating period the deflector has gradually been lowered or drawn out toward the discharge end; but when the point 86 on the cam has been reached by the roller contacting with it the desired amount of heavier substances, materials, or concentrates to form a charge or lode have accumulated on the separating-surface, the feed of material to the concentrator is stopped and the deflector is maintained by the cam without longitudinal movement, or in a state of longitudinal rest for a short period, during the progress of the cam from 86 to 87, during the first part of which time practically all of the last portions of the lighter material and water from the upper part of the separating-channel then in progress of treatment are discharged. Water is then introduced by opening the valve 30, thus flowing it into the water-feed chamber, from which it passes down into the hollow of the deflector and down and out through the perforations or channels 32 in the deflector-wall, being thrown out of the same with considerable violence by the action of centrifugal force against the mixed portion or middlings deposit on the

separating-surface, thereby affecting their removal and discharge without disturbing or removing the other or more highly concentrated or finished portions of the deposit on the upper part of the separating-surface. This removal is preferably wholly or largely secured during the period of longitudinal rest of the deflector at this point, which is preferably its longer period of rest. The roller contacting with the cam, through the latter's progressive rotation, having reached the point 87, the deflector thereafter is, by the then diverging contour of the cam, soon forced or carried upward and to its initial position, thereby contracting the size of the separating-channel to its starting or smallest size and resulting in washing and forcing off from the separating-surface the deposit on the upper portion thereof, which is that part lying nearer the feed end than the portion occupied by the middlings, which were previously removed. During this latter movement of the deflector, which occurs during the cams rotating contact with the roller 49 from the point 87 to 88, water is introduced into the treatment vessel and through the separating-channel by opening the valve 18 in the branch of the feed-pipe, and, further, if desired during this period, water may also be introduced into the deflector and through the channels in its wall to assist in removing this latter material. During the unloading period of both the middlings and better or finished concentrates it is desirable to decrease the speed of rotation of the treatment vessel, thereby decreasing the centrifugal force and the consequent tenacity with which materials are held on the separating-surface, thus rendering them more easily removed or discharged. It is intended that by the time the point 88 of the cam-surface is reached and the deflector thereby forced to its highest or initial position practically all or at least most of the concentrates will have been discharged from the vessel, and during the rotation of the cam from the point 88 to the point 85, during which time the deflector undergoes a state or period of vertical rest, all of any remaining portion of the concentrates will be washed out and discharged and the treatment vessel will again be ready for loading. Before the material is started to flow into the treatment vessel for concentration its speed of rotation should again be increased to the desired point.

It will of course be understood that during the period of removing the concentrates and middlings the flow of material for treatment into the vessel should be discontinued and that it is desirable, although not absolutely necessary, that the water used in the removal of both the middlings and the concentrates should be practically clean to maintain them in as high a state of purity as possible.

In using the term "near the discharge end" or "near the feed end" I do not necessarily

mean just at or closely adjacent to these ends, but mean to designate desired portions of the separating-surface in the direction of either one end or the other. Usually, however, in practice there will be approximately one-third of the longitudinal distance on the separating-surface nearest to the discharge end employed for deposit of mixed material or middlings and approximately two-thirds of such surface nearest the feed end for better or finished concentrates; but as these proportions are not at all fixed I do not desire to be confined to them.

What I regard as new, and desire to secure by Letters Patent, is—

1. In a centrifugal concentrator the combination of a rotatable treatment vessel having a separating-surface therein; a core therein forming a covered separating channel or passage for the flow of material over said surface; means for employment of water whereby material can be removed from a desired portion of such surface around near its discharge end, and means in part rotatable with said vessel, for preventing water from flowing up into said channel beyond a predetermined distance during said removal.

2. In a centrifugal concentrator, the combination of a rotatable tapering treatment vessel, having a separating-surface thereon with a core forming a separating-passage for the flow of material over said surface, means for supplying water to the inner portion of said vessel and to said passage whereby material can be removed from a desired portion of the separating-surface near its discharge end without moving that on the other portions thereof; and means in part rotatable with said vessel for preventing water from flowing up into said channel beyond a predetermined desired distance during such removal, said means automatically openable at a comparatively slow speed of rotation and closable at a comparatively high speed of rotation of the vessel.

3. In a centrifugal concentrator, the combination of a rotatable tapering treatment vessel with a differentially-rotatable hollow tapering deflector therein the two with a channel or passage between them, and a separating-surface forming one wall of the channel or passage, said hollow deflector adapted to convey water internally over said separating-surface without such water disturbing material on said surface above the area from which it is intended to first remove material, and automatic means in part rotatable with the vessel, for preventing water from flowing up into said channel beyond a desired distance during removal of said material.

4. In a centrifugal concentrator, the combination of a rotatable treatment vessel, having a separating-surface, and with a rotatable water-receiving chamber on its feed end; a rotatable hollow deflector together with the

vessel forming a concentrating channel or passage between them; means for delivering water from said water-receiving chamber into the deflector, the deflector being adapted to receive said water and deposit it on middlings accumulated on the separating-surface near the discharge end of the vessel whereby said middlings can be removed without removing the material from other portions of the separating-surface, and automatic means for preventing water from flowing up into the separating-channel beyond a desired predetermined distance during such removal, openable at a comparatively slow speed of rotation and closable at a comparatively high speed of rotation of the vessel.

5. In a centrifugal concentrator, the combination of a rotatable treatment vessel having a separating-surface and a covered separating channel or passage therein, a deflector within the vessel, having alternate periods of longitudinal movement and rest; means for producing such period of movement and rest, and means connected to and rotatable with for opening water-passages from the vessel while it is at a comparatively slow speed of rotation, and closing them at a comparatively high speed thereof.

6. In a centrifugal concentrator, the combination of a rotatable treatment vessel having a separating-surface therein, a deflector within the vessel having alternate periods of longitudinal movements and rest, means for effecting such periods of movements and rest, said vessel having passages for preventing water from flowing up on the separating-surface beyond a predetermined distance, openable at a comparatively slow speed of rotation of the vessel, and closable at a comparatively high speed thereof, the said deflector being provided with water-channels through its wall near its lower end and means for introducing water into the deflector.

7. In a centrifugal concentrator, the combination of a rotatable treatment vessel having a separating-surface, and a hollow differentially-rotatable reciprocatory deflector therein, and with one or more feed-channels at one end and one or more discharge-orifices at the other end and having an enlargement at its discharge end of width approximately as great as the reciprocating movement of the deflector, a ring or similar portion in such enlargement having chambers or recesses leading from its inner side to said discharge-orifices, means for employment of water whereby material can be removed from a desired portion of the separating-surface near the discharge end without removing material from near the feed end, such means embodying said deflector, the latter having water-passages through the lower portion of its wall and adapted to alternate periods of longitudinal reciprocation and rest and means

for producing such periods of reciprocation and rest.

8. In a centrifugal concentrator, the combination of a rotatable treatment vessel having a separating-surface therein, and a hollow deflector within the vessel forming together with the vessel, a separating channel or passage, said vessel having a chamber formed on one of its ends adapted to receive feed of material for delivery into the vessel, and having a rotatable chamber on said end nearer the axis of rotation, said latter chamber adapted to receive water for delivery into said hollow deflector, the said deflector having imperforate walls near its feed end, and provided with water-passages through its wall near the discharge end of the vessel, and means for preventing water from flowing up on the separating-surface beyond a predetermined distance, such means in part rotatable with the vessel.

9. In a centrifugal concentrator, the combination of a rotatable treatment vessel having a separating-surface, a hollow deflector therein forming together with the vessel a separating channel or passage, one end of said vessel having a chamber formed thereon adapted to receive material for delivery into the vessel, and a rotatable chamber on said end nearer the axis of rotation, adapted to receive water for delivery into said hollow deflector, said rotatable chamber provided with a water-passage communicating with the deflector, an extended flange or ring portion telescoping into the hollow feed end of the deflector having a width approximately as great as the distance of reciprocation of the deflector, and the deflector provided through its walls with perforations or channels for delivery of water in position for removing material from a desired portion of the separating-surface near the discharge end, without removing that from near the feed end.

10. In a centrifugal concentrator, the combination of a rotatable treatment vessel having a separating-surface, and a covered separating channel or passage therein, with means for employment of water whereby material can be removed from a desired portion of such surface near its discharge end without removing material from other portions thereof, and means for regulating the longitudinal extent on the separating-surface from which such material is removed.

11. In a centrifugal concentrator the combination of a rotatable treatment vessel, having a separating-surface and a covered separating channel or passage therein, with means for employment of water, whereby material can be removed from a desired portion of such surface near its discharge end, without removing material from other portions thereof, embodying parts having perforations or channels for the flow of water opening radi-

ally over the separating-surface, and means for covering a desired portion of such perforations or channels.

12. In a centrifugal concentrator, the combination of a rotatable treatment vessel having a separating-surface, and a covered separating channel or passage therein, with means for employment of water whereby material can be removed from a desired portion of such surface near its discharge end without removing material from other portions thereof, and means in part rotatable with the vessel for preventing water from backing or flowing up into such channel beyond a predetermined distance.

13. In a centrifugal concentrator, the combination of a rotatable treatment vessel having a separating-surface, and a covered separating channel or passage therein, with means for employment of water whereby material can be removed from a desired portion of such surface near its discharge end without removing material from other portions thereof, and automatic means openable at a comparatively slow rotation of the vessel, for preventing water from backing or flowing up into such channel beyond a predetermined distance.

14. In the centrifugal concentrator, the combination of a rotatable treatment vessel having a separating-surface, and a covered separating channel or passage therein, with means for employment of water whereby material can be removed from a desired portion of such surface near its discharge end without removing material from other portions thereof, said vessel having an overflow-passage openable at a comparatively slow speed of rotation of the vessel and closable at a higher speed of rotation.

15. In a centrifugal concentrator, the combination of a rotatable treatment vessel having a separating-surface, and a separating channel or passage therein, means for employment of water whereby material can be removed from a desired portion of such vessel near its discharge end without removing material from other portions thereof, said vessel having an overflow-passage, and automatic means for effecting opening and closing thereof.

16. In a centrifugal concentrator, the combination of a rotatable treatment vessel having a separating-surface, and a covered separating channel or passage therein, means for employment of water whereby material can be removed from a desired portion of such surface near its discharge end without removing material from other portions thereof, an overflow-passage, and a hinged portion carrying a stopper adapted to register with such overflow-passage and effect closure thereof, said hinged portion operating to permit closure of said overflow-passages at a comparatively high speed of rotation of said ves-

sel, and to open said passages at a comparatively slow speed of the vessel.

17. In a centrifugal concentrator, the combination of a rotatable treatment vessel, a longitudinally movable or reciprocatory deflector therein partly supported on one end of an oscillatory lever, and reciprocated thereby, a cam for maintaining the other end of the lever, and imparting oscillation thereto; mechanism for revolving said cam, provided with a yieldable relatively readily disconnecting portion therein, serving as a safety device whereby the rotation of the cam and reciprocation of the deflector will be stopped by yielding of said portion under undue stress in effecting longitudinal movement of the deflector.

18. In a centrifugal concentrator, the combination of a rotatable treatment vessel, a longitudinally movable or reciprocatory deflector therein at least partially supported on one end of an oscillatory lever, and reciprocated thereby, a cam for maintaining the other end of the lever and imparting oscillation thereto, mechanism for revolving such cam, having a worm and a worm-wheel therein and provided with a yieldable relatively readily disengaging portion therein serving as a safety device whereby the rotation of the cam and reciprocation of the deflector will be stopped by the yielding of said portion under undue stress in effecting longitudinal movement of the deflector.

19. In a centrifugal concentrator the combination of a rotatable treatment vessel; a longitudinally movable or reciprocatory deflector therein at least partly supported by one end of an oscillatory lever, and reciprocated thereby, a cam for maintaining the other end of the lever and imparting oscillation thereto, mechanism for revolving such cam having a worm and a worm-wheel therein, and provided with a yieldable relatively readily disengaging portion serving as a safety device, whereby the rotation of the cam and reciprocation of the deflector will be stopped by the yielding of said portion under undue stress in effecting longitudinal movement of the deflector, and means for disengaging parts of such mechanism thereby stopping the rotation of the cam, while permitting other parts of such mechanism to revolve.

20. In a centrifugal concentrator, the combination of a rotatable treatment vessel, a longitudinally movable or reciprocatory deflector therein at least partly supported on one end of an oscillatory lever, and reciprocated thereby, a cam for maintaining the other end of the lever and imparting oscillation thereto, mechanism for revolving such cam, having a worm and a worm-wheel therein, and a safety device interposed in said mechanism, whereby the rotation of the cam and reciprocation of the deflector will be

stopped by undue stress in effecting such movement of the deflector and a hand-wheel for disengaging parts of said mechanism, thereby stopping the rotation of the cam while permitting other parts of such mechanism to revolve.

21. In a centrifugal concentrator, the combination of a rotatable treatment vessel, a longitudinally movable or reciprocatory deflector therein at least partly supported on one end of an oscillatory lever, and reciprocated thereby, a cam for maintaining the other end of the lever and imparting oscillation thereto, mechanism for revolving such cam having a worm and a worm-wheel therein, and provided with a yieldable portion forming a safety device interposed in said mechanism, whereby the rotation of the cam and reciprocation of the deflector will be stopped by undue stress in effecting the longitudinal movement of the latter, a hand-wheel for disengaging parts of such mechanism, thereby stopping the rotation of the cam while permitting other parts of the mechanism to revolve, and a hand-wheel whereby the cam can then be manually revolved.

22. In a centrifugal concentrator, the combination of a rotatable treatment vessel, having a separating-surface, a hollow reciprocatory deflector therein means for alternately reciprocating the deflector, the said deflector forming together with the vessel a separating channel or passage, one end of said vessel having a chamber thereon adapted to receive feed of material for delivery into the vessel, and with a chamber on said end nearer the axis of rotation, adapted to receive water for delivery to said hollow deflector, an extended flange or ring portion telescoping into the hollow feed end of the deflector having a width approximately as great as the distance of reciprocation of the deflector, and the deflector provided through its walls with channels for delivery of water in position for removing material from a desired portion of the separating-surface near the discharge end, without removing that from near the feed end.

23. In a centrifugal concentrator the combination of a rotatable tapering treatment vessel, having a separating-surface and a hollow deflector therein, said deflector adapted to alternate periods of longitudinal reciprocation or movements and rest, the rest periods occurring substantially at the extremities of the reciprocating movements, said deflector adapted to carry water to effect removal of a large portion of material from near the discharge end of the separating-surface and at the same time prevent the radial deposit of water on said surface near its discharge end, means for effecting such periods of movement and rest, means for preventing water from flowing onto said surface beyond

a predetermined point, and means for introducing water into the vessel and into said deflector.

24. In a centrifugal concentrator, the combination of a rotatable treatment vessel having a separating-surface, a hollow deflector therein, having alternate periods of longitudinal reciprocations or movements and rest, means for preventing removal of material from near the feed end of the separating-surface during such rest periods while material is being removed from near the discharge end, and automatic means for effecting such periods of movement and rest.

25. In a centrifugal concentrator, the combination of a rotatable treatment vessel, having a separating-surface, a hollow deflector therein, having alternate periods of longitudinal reciprocations or movements and rest, the period of rest being longer which occurs at the out, or withdrawn position of the deflector; means for preventing removal of material from near the feed end of the separating-surface, while material is being removed from near the discharge end of said separating-surface during such longer rest period of the deflector, automatic means for producing such reciprocations and periods of rest and means for actuating said automatic mechanism.

26. In a centrifugal concentrator, the combination of a rotatable treatment vessel having a separating-surface, a hollow deflector therein, having alternate periods of longitudinal reciprocations or movements and rest, means for actuating said deflector so as to produce such periods of longitudinal reciprocations or movements and rest the deflector forming together with the vessel a separating channel or passage, one end of said vessel having a chamber thereon adapted to receive feed of material for delivery into the vessel, and with a chamber on said end nearer the axis of rotation, adapted to receive water for delivery to said hollow deflector, an extended flange or ring portion telescoping into the hollow feed end of the deflector, having a width approximately as great as the distance of reciprocation of the deflector, and the deflector provided through its walls with channels for delivery of water in position for removing material from a desired portion of the separating-surface near the discharge end, without removing that from near the feed end, and means for preventing water from backing up in the separating-channel beyond a predetermined distance during the time of revolving the treatment vessel at a comparatively slow speed for removal of middlings.

27. In a centrifugal concentrator the combination of a rotatable treatment vessel having a separating-surface, a reciprocatory deflector therein having, during concentration of material, a longitudinal movement from

the feed end of the vessel toward the discharge end, and then a temporary suspension of longitudinal movement, means partly rotatable with the treatment vessel for preventing water from flowing up on the separating-surface beyond a predetermined distance, such means operatable at a comparatively slow speed of rotation, and means for effecting such movements and periods of rest.

28. In a centrifugal concentrator, the combination of a rotatable treatment vessel, having a separating-surface a reciprocatory deflector therein having, during concentration of material a longitudinal movement from the feed end of the vessel toward the discharge end, and then a temporary suspension of longitudinal movement, means partly rotatable with the treatment vessel for preventing water from flowing up on the separating-surface beyond a predetermined distance such means operable at comparatively slow speed of the vessel, thereby enabling removal of a large portion of accumulated material from a desired part of the separating-surface near the discharge end during such suspension of longitudinal movement previous to the removal of accumulated material from near the feed end, said deflector then having during the removal of a large portion of the accumulated material from near the feed end a longitudinal movement toward said feed

end, and means for effecting such movements and periods of rest.

29. In a centrifugal concentrator, the combination of a rotatable treatment vessel, having a separating-surface, a reciprocatory deflector therein having, during concentration of material a longitudinal movement from the feed end of the vessel toward the discharge end, and then a temporary suspension of longitudinal movement, and means for preventing water from flowing up on the separating-surface beyond a predetermined extent, thereby enabling removal of a large portion of accumulated material from a desired part of the separating-surface near the discharge end during such suspension of longitudinal movement previous to the removal of accumulated material from near the feed end, said deflector then having during the removal of a large portion of the accumulated material from near the feed end a longitudinal movement toward said feed end, and a period of rest near the feed end previous to again commencing concentration and automatic means for effecting such movements and periods of rest.

PHINEAS H. ADAMS. [L. s.]

Witnesses:

EUGENE COOK,
O. T. X. ADAMS.