No. 668,746. Patented Feb. 26, 1901.

P. H. ADAMS.

CENTRIFUGAL SEPARATOR.

(Application filed Feb. 21, 1900.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

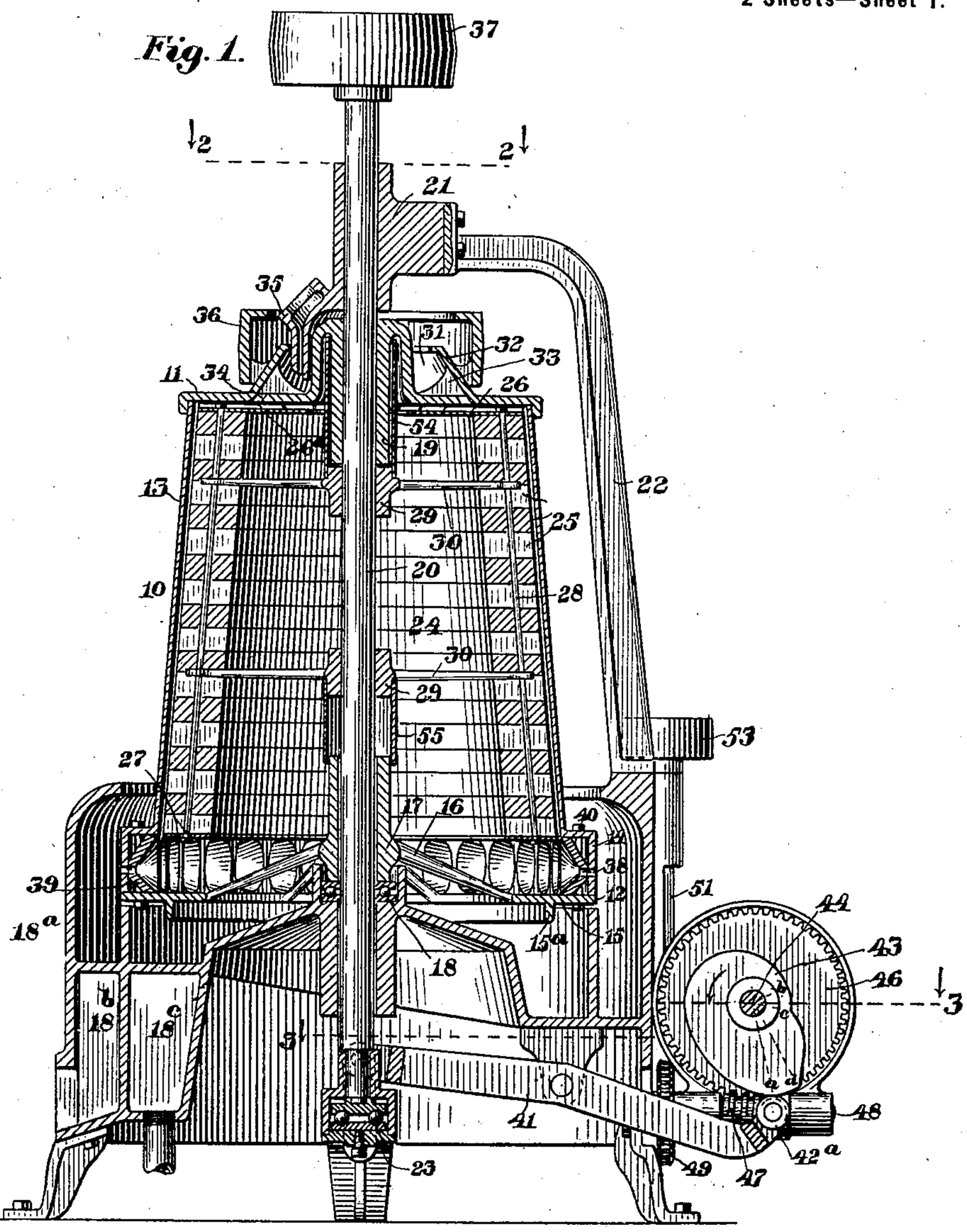

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Fig. 2.

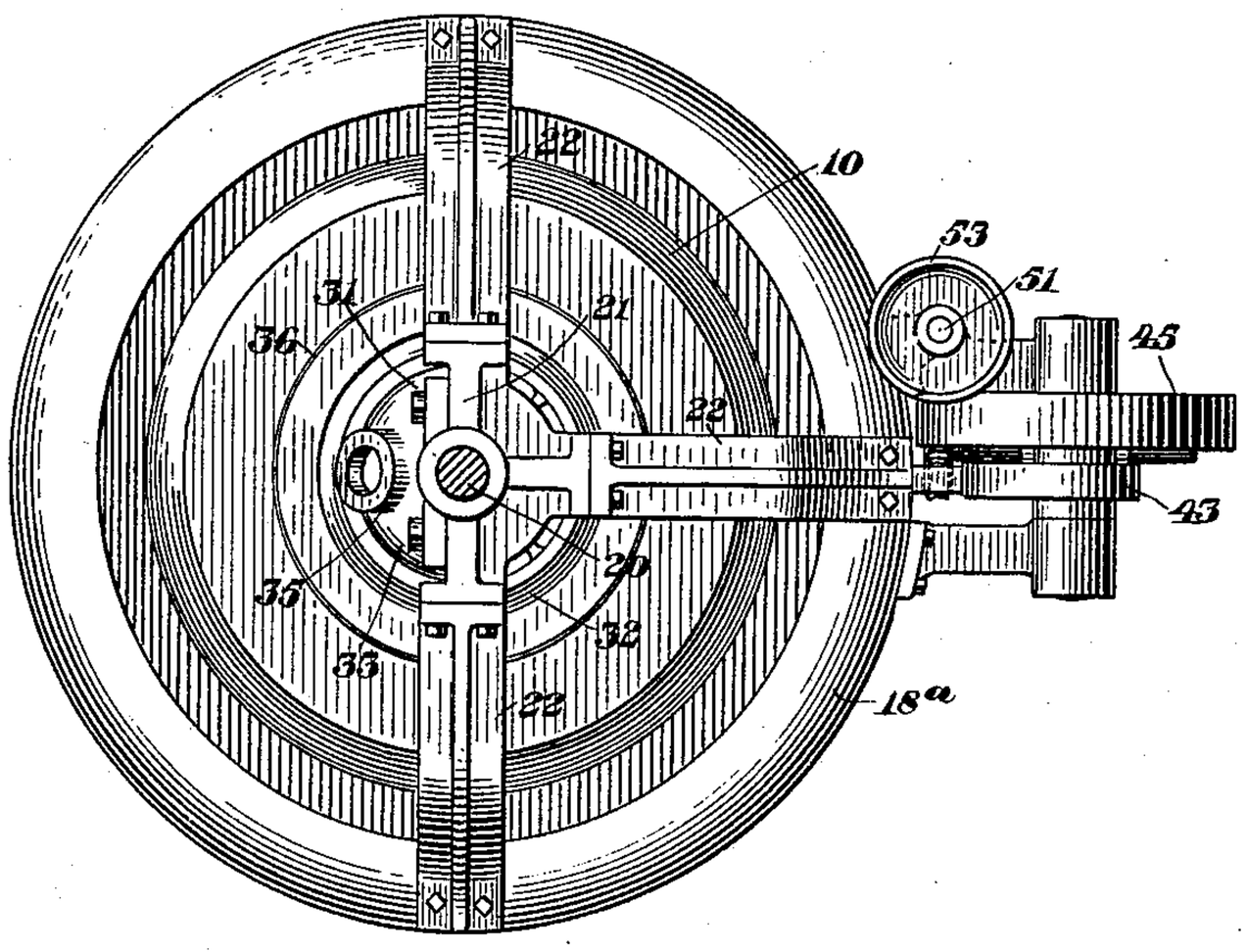

Fig. 4.

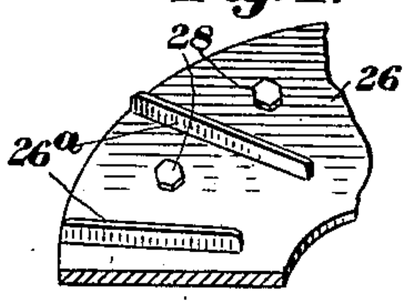

Fig. 3.

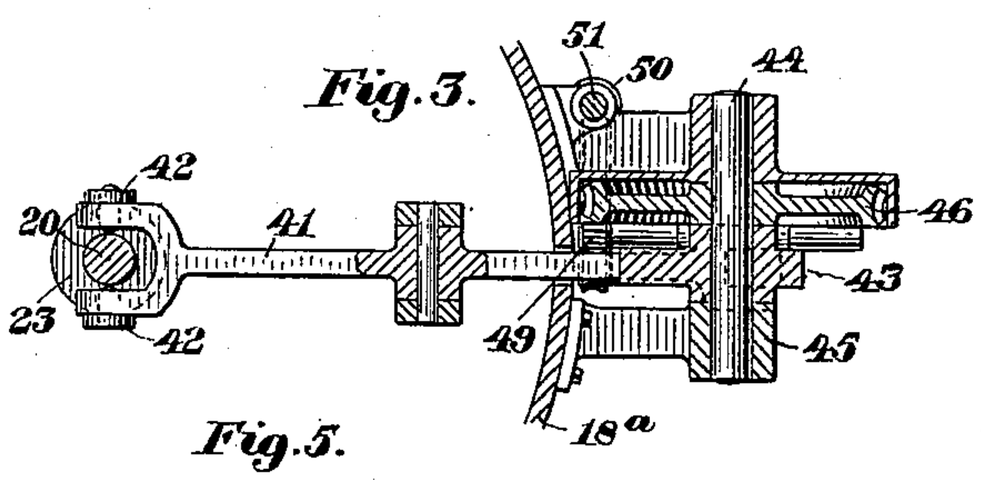

Fig. 5.

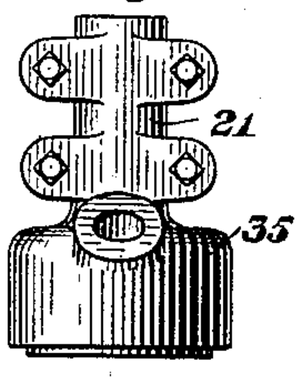

Fig. 6.

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UNITED STATES PATENT OFFICE.

PHINEAS H. ADAMS, OF CHICAGO, ILLINOIS, ASSIGNOR TO EDMOND C. PECK, OF SAME PLACE.

CENTRIFUGAL SEPARATOR.

SPECIFICATION forming part of Letters Patent No. 668,746, dated February 26, 1901.

Application filed February 21, 1900. Serial No. 6,065. (No model.)

To all whom it may concern:

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

My invention relates more particularly to improvements in the art of centrifugal separation or concentration of materials while in a finely-divided state and in the presence of or mixed with water; and it consists in the various details of construction of a machine for use in this art, as hereinafter described and claimed.

In the drawings, Figure 1 is a central vertical longitudinal section of my improved separator. Fig. 2 is a horizontal transverse section on the line 2 2 of Fig. 1. Fig. 3 is a sectional detail on the line 3 3 of Fig. 1. Fig. 4 is a detail in perspective of a portion of the plate at the upper end of the deflector. Fig. 5 is a side elevation of the feed-spout, and Fig. 6 is a bottom plan view thereon. All sections are taken in a direction indicated by the arrows.

Similar numerals designate like parts throughout the several figures of the drawings.

10 designates a treatment vessel or cylinder consisting of two heads 11 and 12 and an intermediate cylindrical or frusto-conical portion 13, preferably of thin metal and having at its lower end an enlargement 14. The lower head 12 is composed of an outer portion formed as a flat ring 15, corresponding in diameter to the end of the enlargement and secured thereto, and radial spokes 16, connecting the inner edge of the ring to a hub 17. This hub projects downwardly for a short distance below the spokes and is stepped upon an antifriction-bearing 18, which is carried upon the center of a casing or trough 18^a, surrounding the lower portion of the treatment vessel and serving as a base therefor, being provided with legs to raise it a short distance above the floor on which it stands. The upper head 11 is provided with a cylindrical extension or hub 19, encircling and having a bearing upon a vertical shaft 20, which is journaled near its upper end in a bearing 21, preferably supported by three standands 22 22 22, extending upward from the top of the casing. The lower end of the shaft is journaled in an antifriction step-bearing 23, to be hereinafter more fully described. The hub 17 at the lower end of the treatment vessel preferably also has a bearing upon the shaft.

Within the treatment vessel is a deflector or cylinder 24 of substantially the same taper or inclination, preferably hollow, with more or less open ends, and consisting of rings 25, which may be made of wood and in sections. Upon the upper and lower end of the deflector are annular plates 26 and 27, respectively, and bolts 28 pass longitudinally through the sections of the deflector and the rings and serve to clamp the parts together. The deflector is secured to the shaft 20 by spiders, consisting of hubs 29 and arms 30, the latter extending into recesses in the rings and being provided with holes through which the bolts 28 pass, securing the cylindrical portion to the spiders.

Upon the upper head of the vessel is situated a feed-receptacle 31, preferably formed integrally with the head and concentric to the axis, consisting of an inwardly-inclined flange 32, forming the wall of the receptacle, from the inside of which vertical webs 33 extend to the head. Between these webs are peripheral feed-openings 34, preferably extending about the entire circumference of the receptacle between the webs. The webs 33 serve not only to support and strengthen the wall of the receptacle, but also as wings to quickly start into rotation the material delivered to it. Into the annular opening at the top of the receptacle 31 extends a feed-spout 35, which may consist of a lower hollow portion of about the width of the opening into the receptacle and extending around the same one-half the circumference. Near the center of the top of this portion is an opening to which a feed pipe or conduit may be attached. The spout is preferably cast integrally with a part of the bearing 21 and is thus maintained securely in place. Upon the plate 26 at the upper end of the deflector are provided vertical wings 26^a, reaching from near the outer surface of the deflector to a point beyond the openings 34. These serve

to maintain the mixture in rapid rotation in its passage from the feed-receptacle to the separating-channel between the inner wall of the cylinder and the outer wall of the deflector. The plate 26 extends some distance toward the axis under the openings 34 to receive the feed and direct it into the channel.

The upper head of the vessel carries a pulley 36, which may be conveniently cast with the wall of the feed-receptacle, being joined thereto by a suitable number of webs. By this pulley the treatment vessel is rotated at the desired speed. Rotation is imparted to the deflector by a pulley 37 at or near the upper end of the shaft 20.

In the outer wall of the enlargement 14 is a series of peripheral discharge-orifices 38, and in the recess formed by this enlargement is fitted a hollow ring 39, consisting of a series of sections having inner openings filling the width of the recess and tapering to outer openings registering with those at 38 in the cylinder. Bolts 40 extend through the upper wall of the enlargement and the lower head of the vessel between the sections, retaining said head and the ring in place. The spaces between the spokes 16 also form openings from the vessel and serve to permit a free discharge of any pulp which may be forced back from the separating-channel by obstructions therein or which may pass inward over the upper head of the deflector, as there is sometimes a tendency to do when the separator is being rotated at a reduced speed for unloading the concentrates. In either case this excess or overflow will pass toward the axis and instead of backing through the feed-openings and splashing out of the feed-receptacle will fall through the inside of the deflector and out of the vessel through the openings between the spokes. These openings will also take care of any backflow at the lower end which might be caused by obstructions in the discharge-orifices 38 or by a reduction in speed, and under normal conditions of operation during the separating period a slight discharge through them shows that the separating-channel is full, as is necessary to the proper working of the machine. This last-named discharge is of comparatively clear water.

The casing 18^a forms a double trough, an outer section 18^b of which surrounds the discharge-orifices 38 to receive the separated substances, and an inner section 18^c extends under the openings through the head of the vessel between the spokes and serves to conduct away the overflow. An annular flange 15^a, depending from the lower head of the vessel within the section 18^c of the trough, directs the discharge through the head into this section, preventing its being thrown by centrifugal force to the outside of the vessel. Suitable pipes or conduits leading from the two sections carry off their contents.

The deflector is shorter than the treatment vessel. Its shaft is mounted to slide freely in its bearings and the step 23 is provided with a means to secure its periodic vertical reciprocation. The reciprocating mechanism preferably consists of a lever 41, pivotally fulcrumed near its center to the bottom of the trough and connected to the step at its forked inner end, which embraces the shaft, by links 42 42, pivoted to the lever and to the bottom of the step. The opposite end of the lever is provided with a roller 42^a, contacting with the edge of a cam 43. This cam is mounted upon a shaft 44, journaled in a bracket 45, secured to the side of the trough, and is continuously rotated by a slow-down gearing consisting of a worm-wheel 46 upon the shaft 44, which meshes with a worm 47 upon a short shaft 48, journaled in the lower portion of the bracket, said bracket forming a casing to cover the outside of the worm-wheel 46 and worm 47. Upon the inner end of the shaft 48 is a worm-wheel 49, meshing with a worm 50 upon a short-vertical shaft 51, journaled in a portion of the bracket and casing 45 and rotated at the desired speed by means of a pulley 53. This gearing causes the continuous rotation of the cam in the direction shown by the arrow in Fig. 1, which by its irregular contour causes the tilting of the lever 41 and the automatic longitudinal movement of the deflector at the desired times, the lever being held constantly against the cam by the weight of the deflector upon the other end. The cam is also so designed that while the lever-roller is in contact with its face from a point *a* to a point *b* upon a curve of gradually-increasing radius the deflector, starting from a position in proximity to the head of the vessel, will be slowly moved to the other end. Then during the motion of the cam from the point *b* to the point *c* there will be a suspension of longitudinal movement, the deflector being maintained at that position for a time, as that portion of the cam is on an arc of a circle struck from the axis. From *c* to *d* the diameter of the cam rapidly increases, causing the deflector to be quickly returned to its highest position. Then from *d* to *a* the surface of the cam is again formed upon the circumference of a circle concentric to that at *b c*, but of less length, permitting a briefer period of rest before it is again moved downward.

To prevent the material within the cylinder from reaching the upper bearing of the vessel upon the deflector-shaft, the head at that end is provided with an annular groove formed between the hub 19 and an upwardly-extending portion of the head, and into this groove projects a sleeve 54, carried by the hub of the upper spider. This groove and sleeve are of such dimension that the latter will remain within the former during the entire longitudinal movement of the deflector, being thus always interposed between the feed-openings and the bearings.

To protect the journal within the lower hub 17, it is encircled by a sleeve 55, secured to

the under side of the lower deflector-spider, this also being of sufficient length to be always about the hub in any position of the deflector.

In operation the deflector being at its extreme upper position in the vessel, the cam contacting with the roller at the point *a*, the period of separation is about to begin. Ore or other material more or less finely pulverized and mingled with water to form a pulp is fed through the spout 35 into the feed-receptacle and passes into the vessel, which is being rotated at a speed sufficient to develop the desired degree of centrifugal force. The mixture is supplied in sufficient quantities to fill the channel or passage between the inner or separating surface and the deflector and is forced therethrough by the centrifugal force acting in the body of water between the head of the cylinder and the deflector in the feed end and along the inclined surface and also to some extent by gravity, producing a current downward through the vessel. Here centrifugal force causes the material to move toward a position around the circumference of the vessel and the heavier to lodge upon the separating-surface. The differential rotation of the deflector causes an agitation in the mixture within the channel, permitting the precipitation of the heavier portion, while it maintains the lighter partially or wholly in suspension of the liquid, with which it is moved along toward the discharge-orifices by the downward flow. As the separation progresses and heavier material accumulates on the separating-surface the diminishing circumference of the cam gradually lowers the deflector, thus carrying its exterior away from the separating-surface and widening the channel between them. The distance between said deflector and the surface of the accumulating material is thus kept approximately constant, maintaining the flow through the channel constant and of such intensity as to carry along only the lighter substances. These will be delivered to the outer section of the trough and carried away for further treatment or permitted to go to waste. When the point *b* on the cam has reached the roll of the lever, the desired amount of heavier substances or concentrates is supposed to have accumulated on the separating-surface. The deflector is then maintained without longitudinal movement for a short time during the progress of the cam from *b* to *c*, during which the last traces of the lighter material are allowed to flow off. The concentrates are now discharged by the increasing diameter of the cam causing the deflector to move rapidly upward, contracting the channel, and resulting in the washing away of the deposit from the separating-surface by the increased velocity of flow thereover. If desired, the speed of rotation of the treatment vessel may be simultaneously decreased to cause the material to be held less firmly to the separating-surface and the speed of rotation of the deflector increased to produce greater agitation. During the period of discharge of the concentrates the feed of material to the treatment vessel is preferably stopped and water introduced to assist in the removal. At this time the discharge-pipes of the outer trough will be so connected as to convey the concentrates to a suitable receptacle. Prior to the recommencement of the separating period the deflector is held by the circular portion *d a* of the cam at the upper end of the vessel without longitudinal travel, while the last of the concentrates are being washed out.

It will be noticed that the length of the separating-surface is substantially the same as that of the deflector and that the longitudinal movement of the latter is permitted by the space which the discharge-openings occupy in the enlargement at the end of the vessel, these openings converging to the orifices 38. It has been found when there is an extension of the separating-surface beyond the deflector when at its inmost position that during the separating period the lighter material which is being discharged has a tendency to accumulate at this point and that though a portion of this is removed by the downward or outward travel of the deflector yet a layer remains, which must be discharged with the concentrates and lessens their value. By the arrangement herein described this objectionable feature is eliminated, the lighter substances at all times during the separating period passing down the inclined sides of the openings and the entire separating-surface receiving a deposit of heavier material.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In a centrifugal separator, the combination of a treatment vessel rotatable about a vertical axis, a step-bearing at the lower end thereof, a longitudinally-movable deflector within said vessel, and a supporting-shaft therefor journaled in a bearing above the vessel and in a reciprocating step below the step of the vessel, the upper end of said vessel having a bearing upon the deflector-shaft which retains it against lateral movement while sliding freely therethrough, substantially as described.

2. In a centrifugal separator, the combination of a rotatable treatment vessel, a deflector therein having alternate periods of longitudinal movement and rest, and automatic means for effecting this periodic movement, substantially as described.

3. In a centrifugal separator, the combination of a rotatable treatment vessel, a deflector therein having alternate periods of longitudinal movement and rest, and a continuously-rotating cam for effecting this periodic movement, substantially as described.

4. In a centrifugal separator, the combination of a rotatable treatment vessel, a reciprocating deflector therein having during the separation of material a longitudinal move-

ment from the feed end of the vessel toward the discharge end, and then a suspension of longitudinal movement previous to the discharge of accumulated substances, and automatic means to effect this periodic movement, substantially as described.

5. In a centrifugal separator, the combination of a rotatable treatment vessel, a reciprocating deflector therein having during the discharge of accumulated substances a longitudinal movement from the discharge end of the vessel toward the feed end, and then a suspension of longitudinal movement previous to the beginning of the separation of material, and automatic means to effect this periodic movement, substantially as described.

6. In a centrifugal separator, the combination of a rotatable treatment vessel, an independently-rotatable deflector, and an annular sleeve carried by the deflector extending into an annular groove in the head of the cylinder at the feed end, substantially as described.

7. In a centrifugal separator, the combination of a rotatable treatment vessel, a longitudinally-movable deflector therein, and an annular sleeve carried by the deflector extending into an annular groove in the head of the cylinder at the feed end, said sleeve and groove being of such dimensions that the former will remain in the latter during the entire movement of the deflector, substantially as described.

8. In a centrifugal separator, the combination of a rotatable treatment vessel, inwardly-extending hubs upon the heads thereof, an independently-rotatable deflector within said vessel, and annular sleeves carried by the deflector surrounding the hubs of the vessel, substantially as described.

9. In a centrifugal separator, the combination of a rotatable treatment vessel, inwardly-extending hubs upon the heads thereof, a longitudinally-movable deflector within said vessel, annular sleeves carried by the deflector surrounding the hubs of the vessel, said sleeves and hubs being of such dimensions that the former will overlap the latter during the entire movement of the deflector, substantially as described.

10. In a centrifugal separator, the combination of a rotatable treatment vessel provided with a separating-surface, feed-orifices at one end thereof, discharge-orifices near the opposite end, and an independently-rotatable deflector within the vessel covering substantially the entire separating-surface from the feed-orifices to the opening of the discharge-orifices, substantially as described.

11. In a centrifugal separator, the combination of a rotatable treatment vessel provided with a separating-surface, feed-orifices at one end thereof, discharge-orifices near the opposite end, and a longitudinally-movable deflector within the vessel covering substantially the entire separating-surface from the feed to the discharge openings and having the extent of its path approximately equal to the length of the inner openings of the discharge-orifices, substantially as described.

12. In a centrifugal separator, the combination of a rotatable treatment vessel, feed-openings at one end thereof, peripheral discharge-openings near the opposite end, and a head for partially closing the discharge end of the vessel consisting of an outer ring connected by spokes to a central hub, substantially as described.

13. In a centrifugal separator, the combination of a rotatable treatment vessel, feed-openings at one end thereof, peripheral discharge-openings near the opposite end, a head for partially closing the discharge end of the vessel consisting of an outer ring connected by spokes to a central hub, and a trough surrounding the discharge-openings between the spokes, substantially as described.

14. In a centrifugal separator, the combination of a rotatable treatment vessel, feed-openings at one end thereof, peripheral discharge-openings near the opposite end, a head for partially closing the discharge end of the vessel consisting of an outer ring connected by spokes to a central hub, and a double trough having one section surrounding the discharge-openings and the other extending under the openings between the spokes, substantially as described.

15. In a centrifugal separator, the combination of a rotatable treatment vessel, feed-openings at one end thereof, peripheral discharge-openings near the opposite end, a head for partially closing the discharge end of the vessel consisting of an outer ring connected by spokes to a central hub, a double trough having one section surrounding the discharge-openings and the other extending under the openings between the spokes, and a flange upon the head to deflect any discharge from the openings between the spokes into the second section of the trough, substantially as described.

16. In a centrifugal separator, the combination of a rotatable treatment vessel, feed-openings at one end thereof, peripheral discharge-openings near the opposite end, a deflector in said vessel forming therewith a separating-channel, and openings in the ends of the deflector whereby any substances fed which fail to traverse the channel may pass freely through the interior of the deflector, substantially as described.

17. In a centrifugal separator, the combination of a treatment vessel rotatable about a vertical axis, feed-openings at the upper end thereof, peripheral discharge-openings near the opposite end, openings through the lower head of the vessel, a deflector within said vessel forming therewith a separating-channel, and openings in the ends of the deflector whereby any substances fed which fail to traverse the channel may fall freely through the interior of the deflector and out through the head of the vessel, substantially as described.

18. In a centrifugal separator, the combination of a treatment vessel, an enlargement at one end thereof, discharge-orifices therein, a head covering the end of the enlargement and forming a recess, and a hollow ring consisting of tapering sections having their outer openings registering with the discharge-orifices and their inner filling the width of the recess, substantially as described.

19. In a centrifugal separator, the combination of a treatment vessel, an enlargement at one end thereof, discharge-orifices therein, a head covering the end of the enlargement and forming a recess, a hollow ring consisting of tapering sections having their outer openings registering with the discharge-orifices and their inner filling the width of the recess, and bolts passing between the tapering sections to secure the head to the vessel, substantially as described.

20. In a centrifugal separator, the combination of a rotatable treatment vessel, an independently-rotatable deflector therein, bearings for the two rotatable parts, and a feed-spout for the vessel formed integrally with a portion of one of the bearings, substantially as described.

21. In a centrifugal separator, the combination of a rotatable treatment vessel, an independently-rotatable and longitudinally-movable deflector therein, and a trough surrounding the vessel furnishing a bearing for both the vessel and deflector and a support for the reciprocating mechanism of the deflector, substantially as described.

22. A cylinder, consisting of a series of rings, recesses in said rings, spiders for supporting the cylinder provided with arms projecting into the recesses, and bolts passing through the rings and the ends of the arms and serving to clamp the parts together, substantially as described.

23. A cylinder consisting of a series of wooden rings, recesses in said rings, spiders for supporting the cylinder provided with arms projecting into the recesses, metal rings at the ends of the cylinder, and bolts passing through the rings and the ends of the arms and serving to clamp the parts together, substantially as described.

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