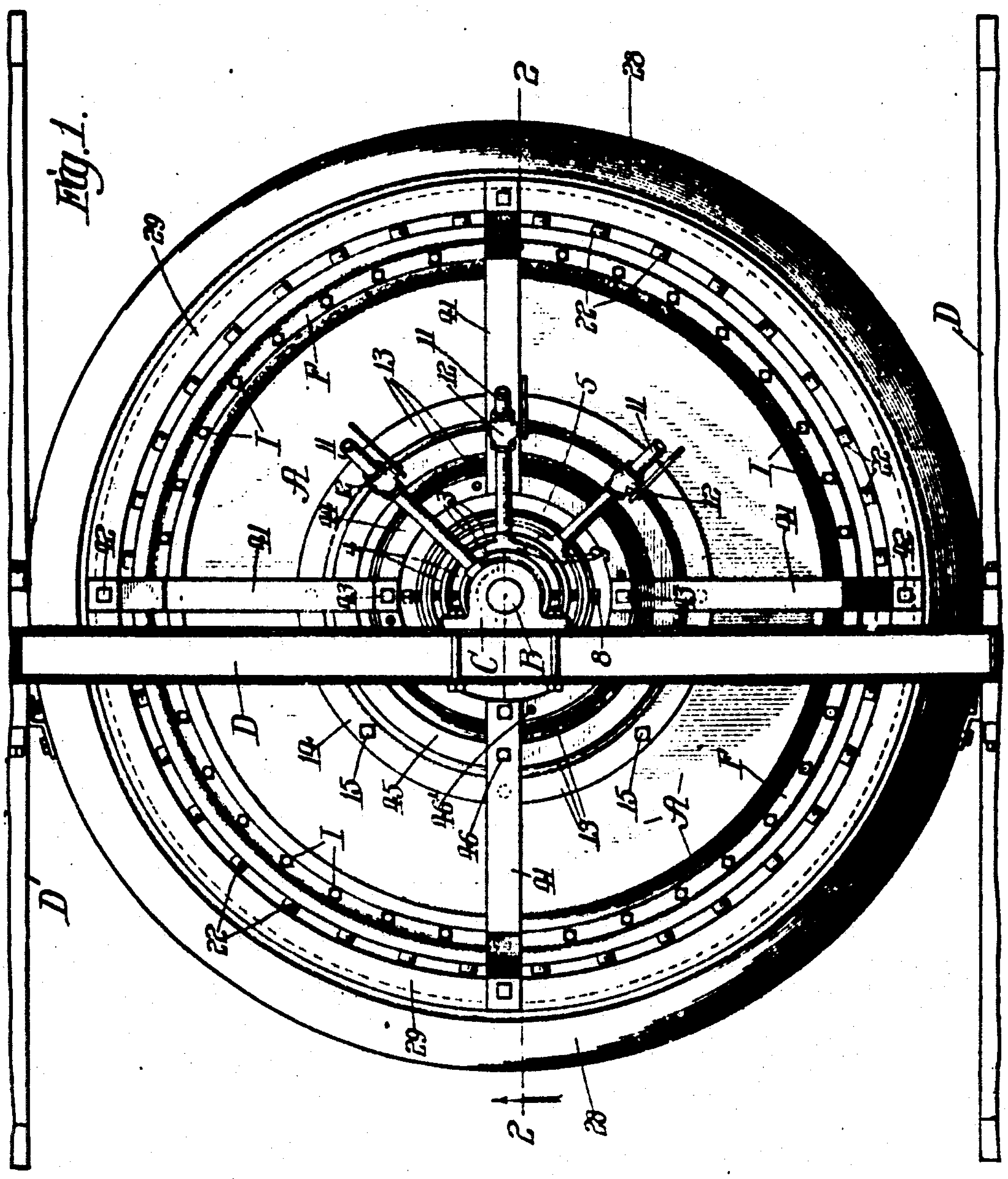
No. 879,893. PATENTED FEB. 25, 1908.

P. F. PECK.

CENTRIFUGAL ORE SEPARATOR.

APPLICATION FILED JAN. 25, 1907.

4 SHEETS—SHEET 1.



Witnesses:
Harold G. Barrett
W. H. Peck

Inventor:
Philip F. Peck

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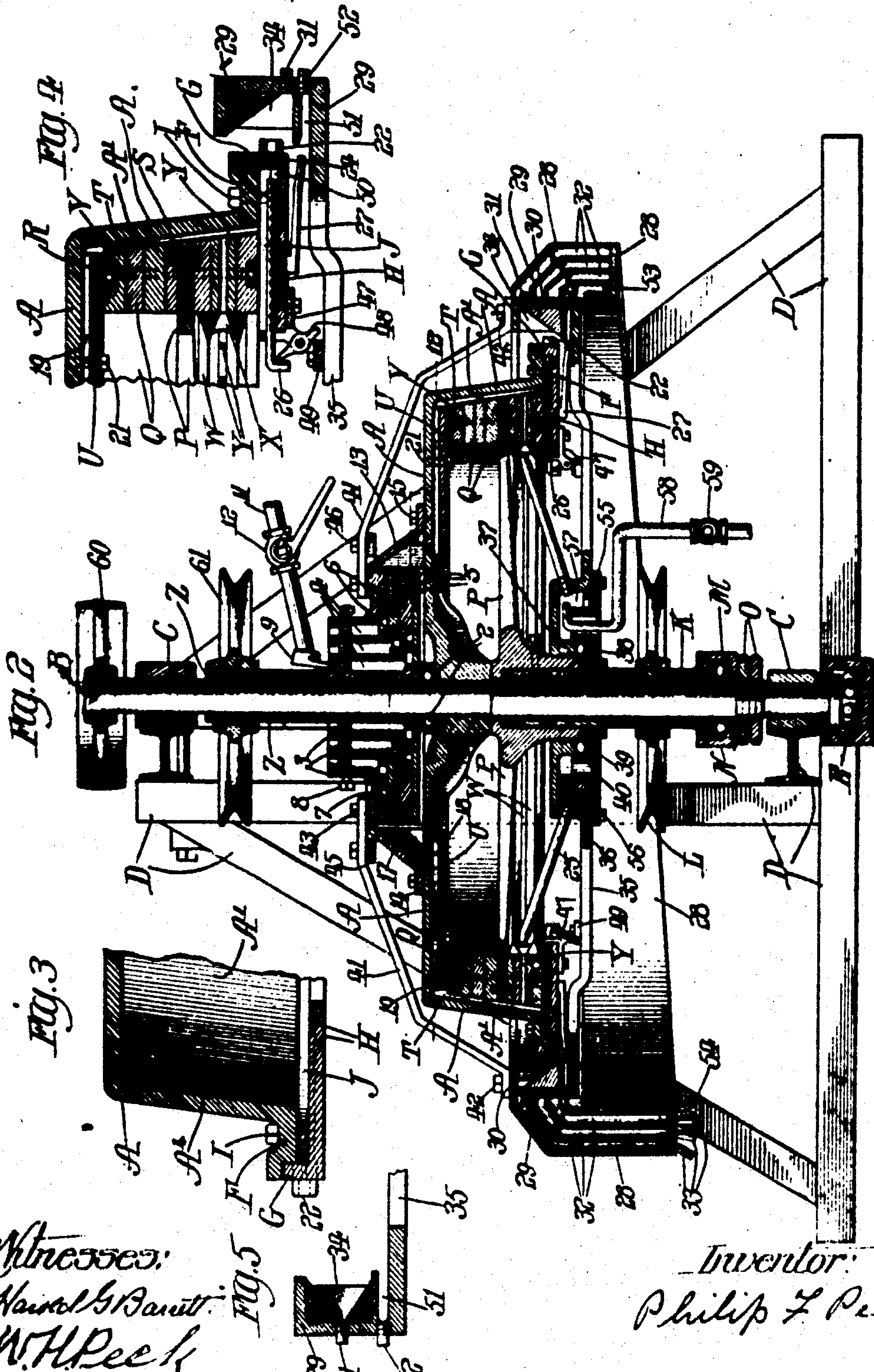
4 SHEETS—SHEET 2.



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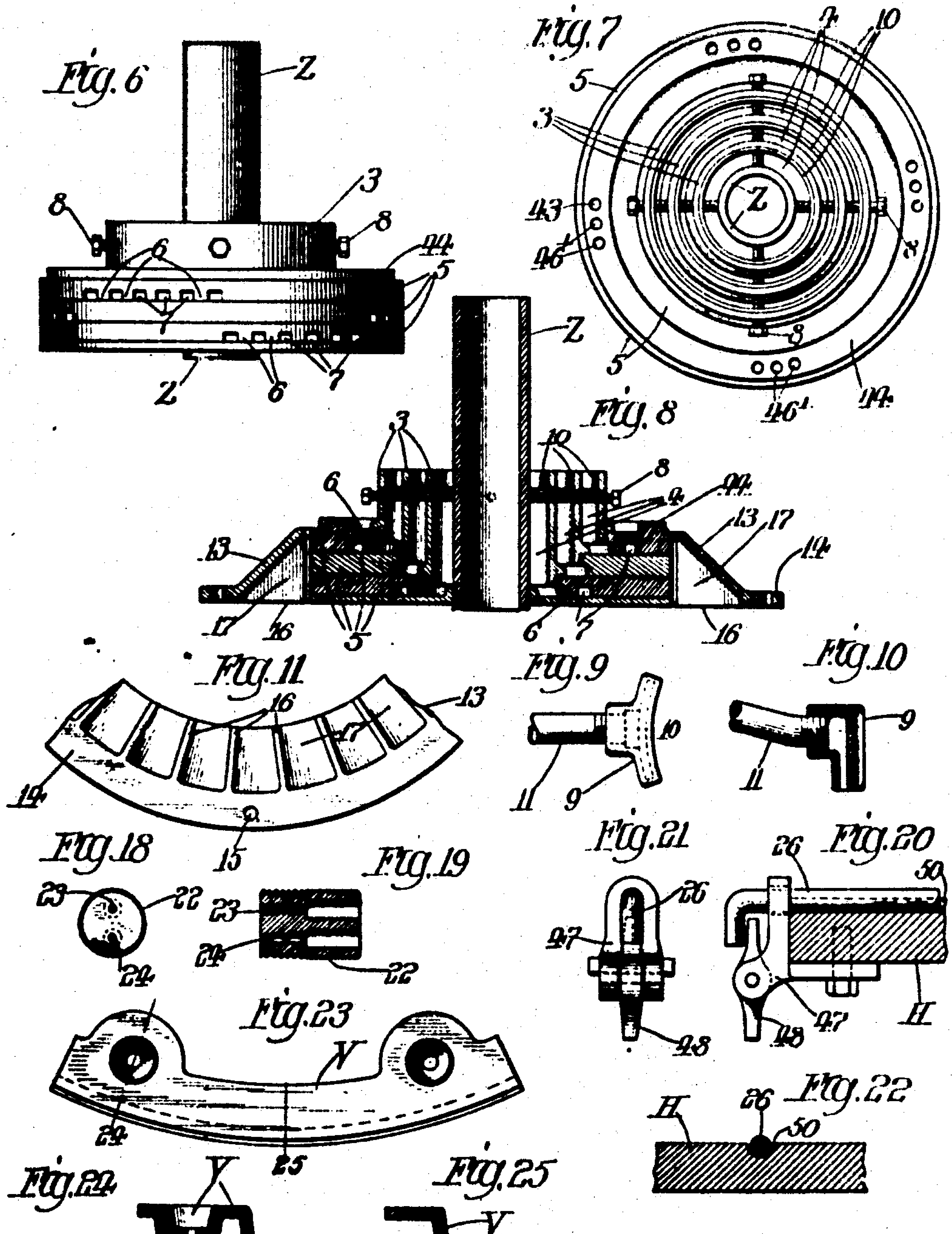

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W. H. Peck

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4 SHEETS—SHEET 4.

Fig. 12

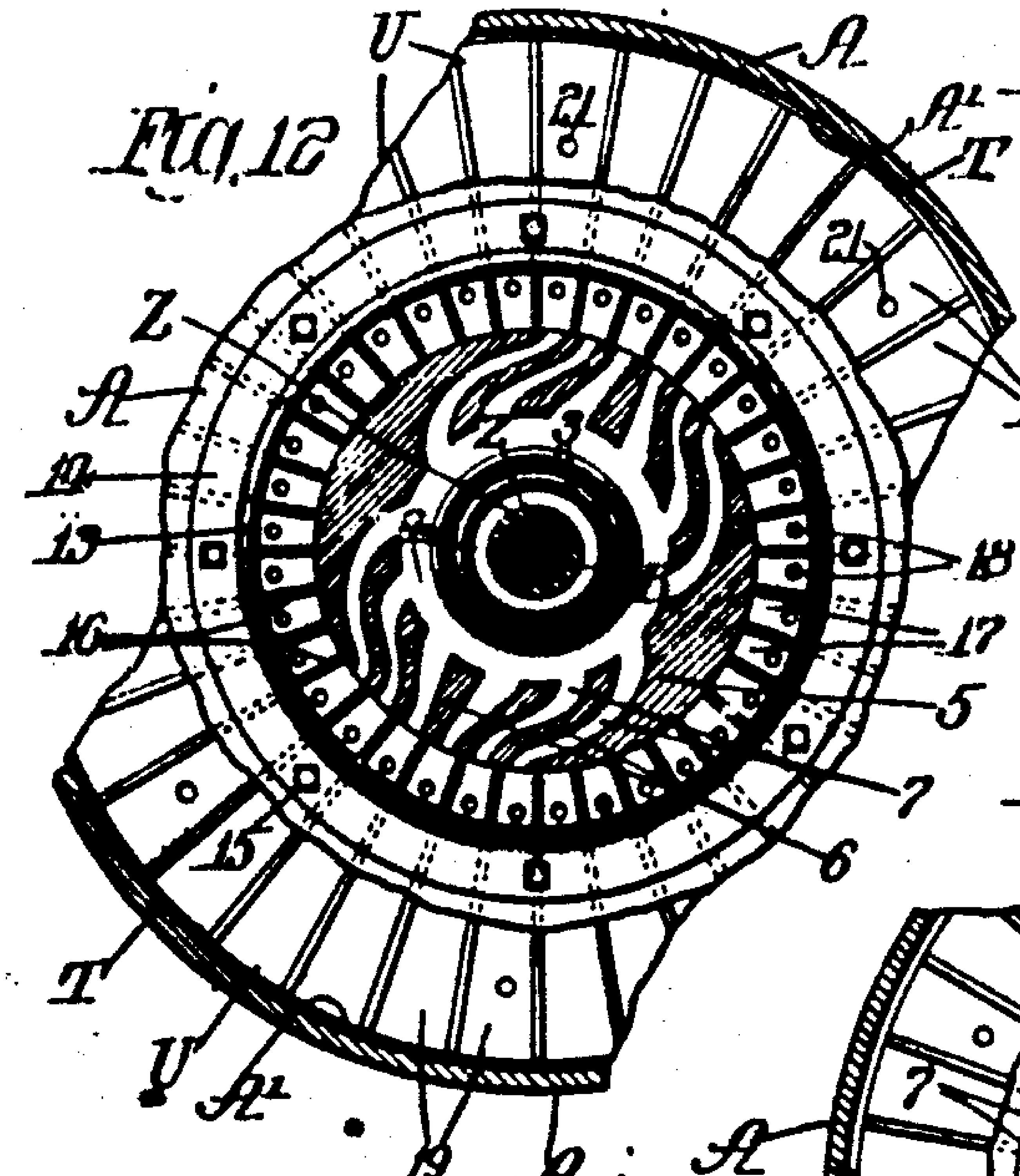


Fig. 15

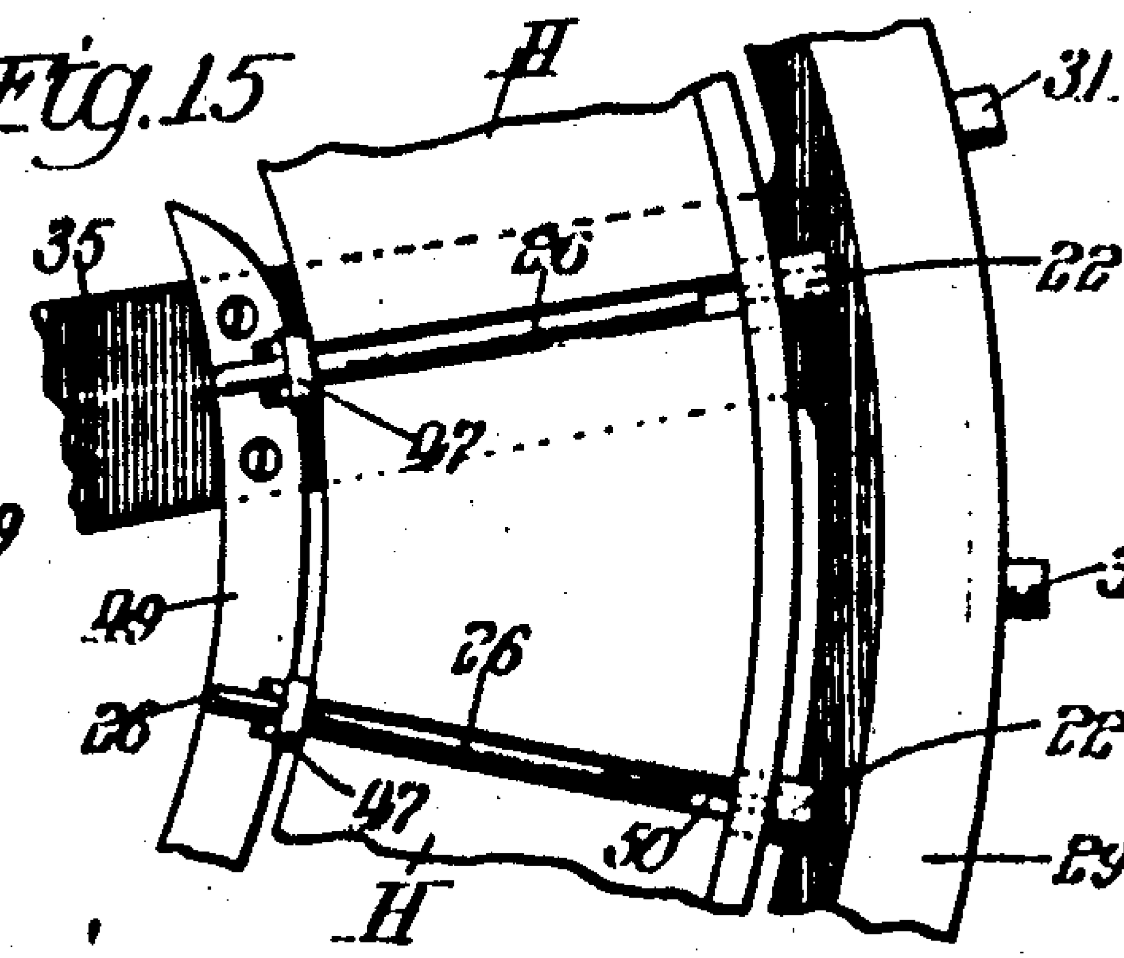


Fig. 13

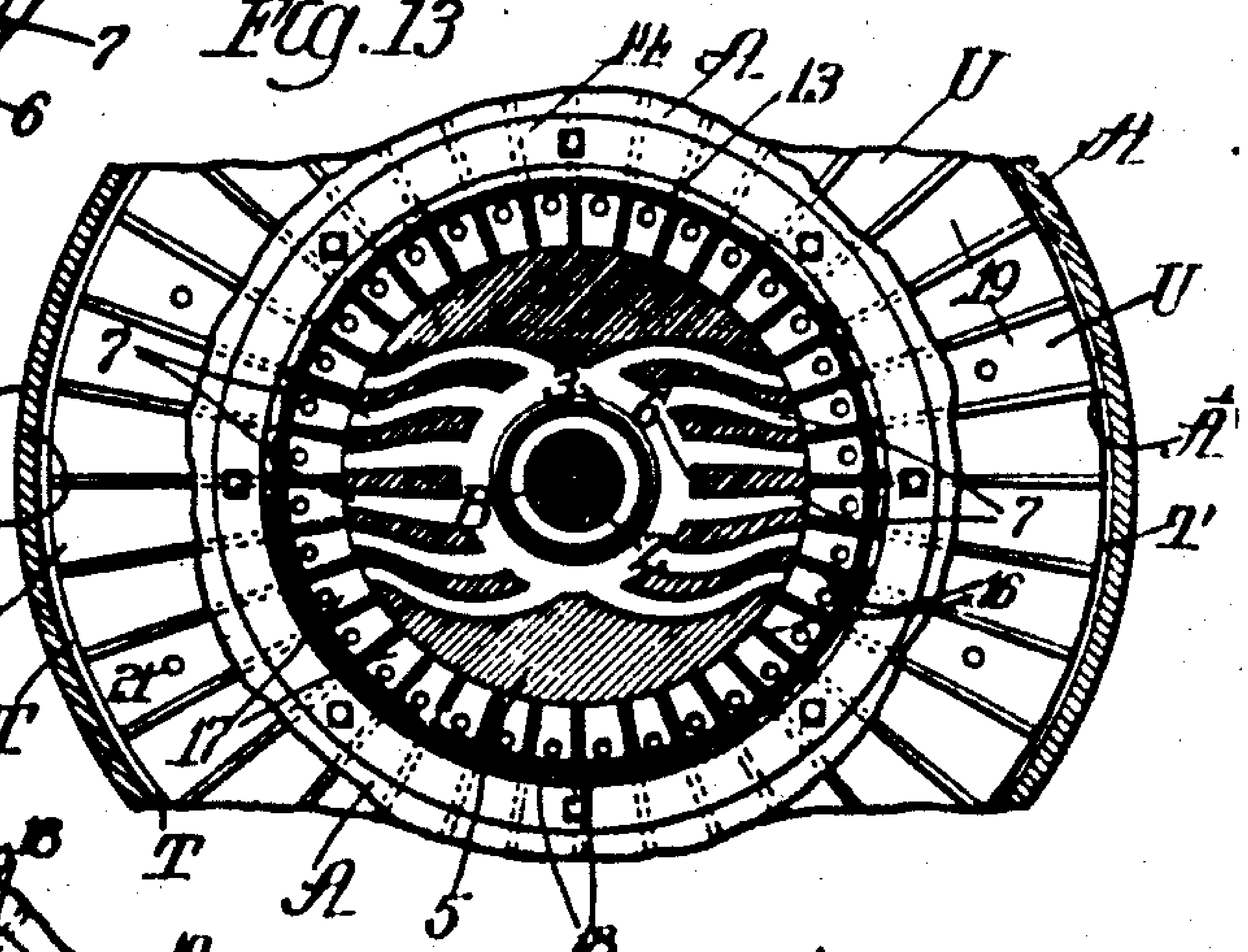


Fig. 14

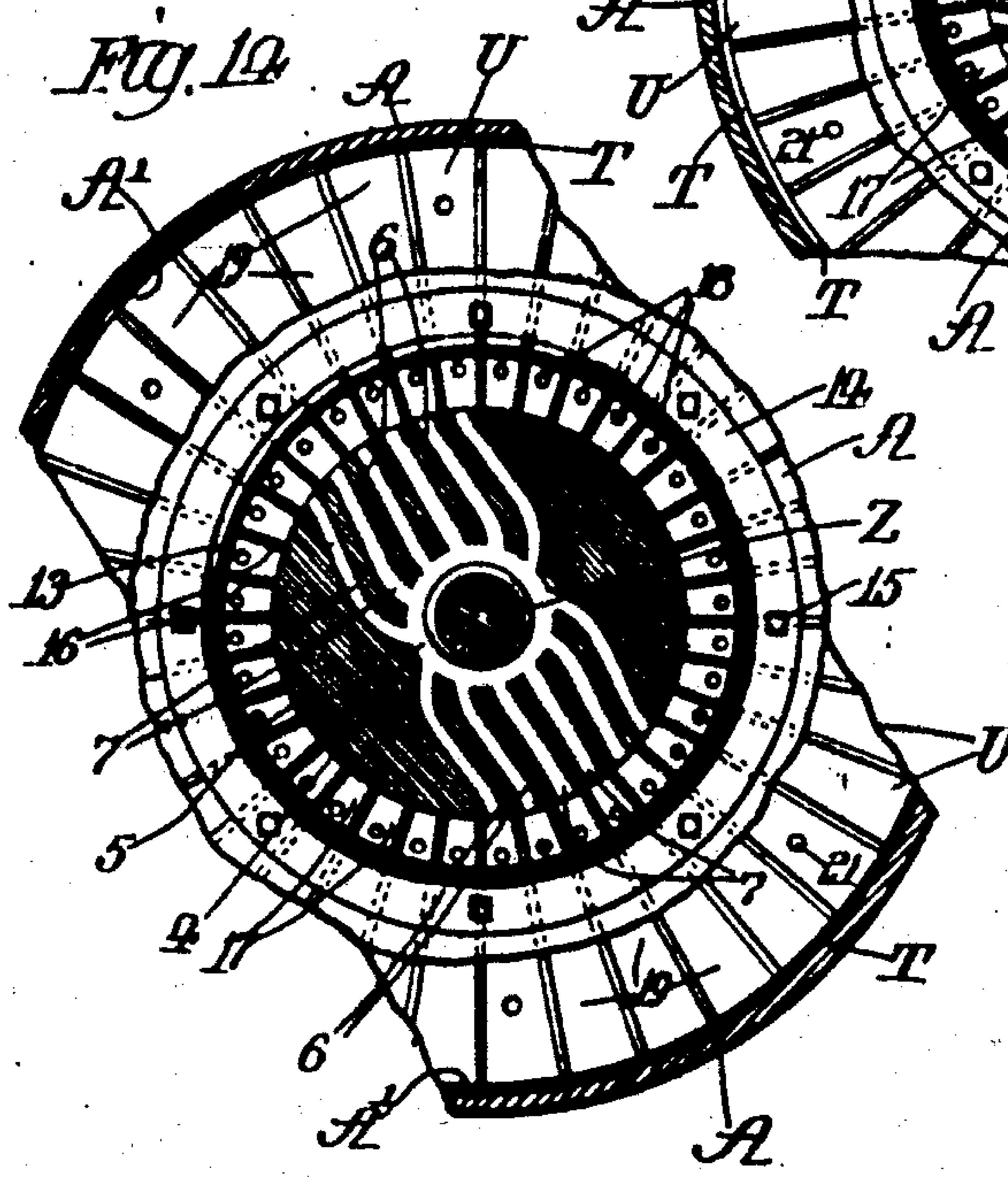


Fig. 16

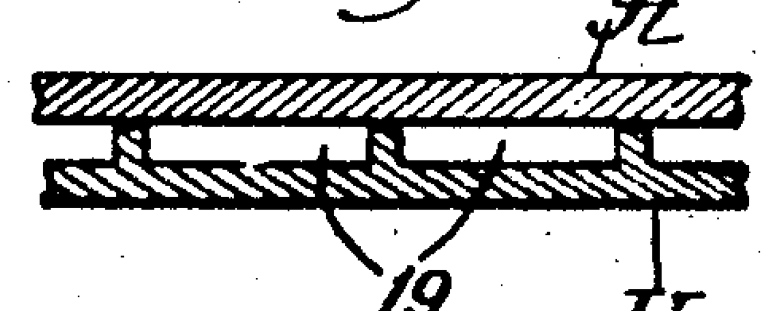
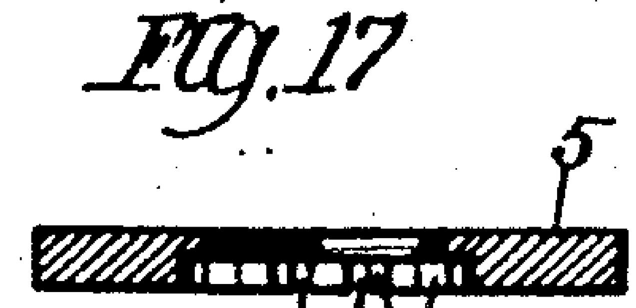


Fig. 17



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UNITED STATES PATENT OFFICE.

PHILIP F. PECK, OF CHICAGO, ILLINOIS.

CENTRIFUGAL ORE-SEPARATOR.

No. 879,893. Specification of Letters Patent. Patented Feb. 25, 1908.

Application filed January 25, 1907. Serial No. 354,078.

To all whom it may concern:

Be it known that I, PHILIP F. PECK, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Centrifugal Ore-Separators, of which the following is a specification.

The object of my invention is, mainly, to make a centrifugal ore separator which in its operation will employ centrifugal force with coöperating forces to best advantage for separation of finely pulverized ores and similar materials, while at the same time continuously receiving such material for that purpose and uninterruptedly discharging separately the several separated products; and my invention consists in the means to this end, including the features and details of construction, as well as the association and relative operations of parts which are hereinafter described and claimed.

In the drawings—Figure 1 is a top plan of my ore separator with the upper driving pulley and sheave removed, and the side portions of the framework partly broken away. Fig. 2 is a vertical central section of Fig. 1, taken on line 2—2 and looking in the direction of the arrow, except that only one feed supply pipe and casting is shown, and the upper drive pulley and sheave are illustrated; and further that, in order to facilitate clearness of this figure, the portion of the retaining plate and some other parts that would appear in elevation are omitted. Fig. 3 is an enlarged vertical cross sectional detail of one side wall of the treatment vessel with its separating surface, and an adjacent part of its closed end; also a cross section of the water-retaining ring or plate, the parts together forming the annular treatment vessel or water chamber, with its open side towards the axis. Fig. 4 is an enlarged vertical cross sectional detail of a portion of one side of the vessel and retaining ring or plate, similar to that shown in Fig. 3, with also a like section of the deflector in operating position, and of the rotatable trough at a point internally formed to make delivery in a plane below its center, and further showing some attached parts in elevation. Fig. 5 is an enlarged detail cross section of the rotatable trough at a point where it is internally formed to deliver from an approximately central radial plane. Fig. 6 is an enlarged detail side elevation of the feed device or means, which serves also for distributing as well as receiving the supply of water and material, showing some channel terminal groups. Fig. 7 is a top plan view of Fig. 6. Fig. 8 is an enlarged vertical central section of Fig. 6, showing also a cross section of the receiving chamber ring, which I will term a "distributing ring". Fig. 9 is a top plan of one of the supply castings with a small piece of supply pipe in elevation. Fig. 10 is a cross section of Fig. 9, taken on line 10 thereof, but showing the attached piece of pipe in elevation. Fig. 11 is an enlarged bottom plan of a part of the distributing ring. Fig. 12 is a detail of part of Fig. 2—reduced in scale, taken on line 12 thereof and passing through the lower part of the upper feed distributing disk, showing the peripheral wall of the treatment vessel with its separating surface in horizontal section and a portion of the closed top of the treatment vessel nearer the center in top plan, having a broken border line; a part of the feed distributing plate with its ribs and channels in top plan, and part in dotted lines a part of the receiving chamber ring in horizontal section and a part of it in top plan, and also the ribs of the upper disk of the feed device in horizontal section, showing the feed channels that radiate from the outer feed passage to diametrically opposite terminal groups for supply to diametrically opposite zones of like action on the separating surface, and also illustrating some other parts. Fig. 13 is mostly similar to Fig. 12, but the section line—where it crosses the feed device—passes through the lower part of the disk next below that of Fig. 12, showing the feed channels extending from the feed passage next nearest the axis and their terminal groups relatively located in a circumferential position to supply material or water to adjacent zones of action to those supplied by Fig. 12. Fig. 14 is mostly similar to Figs. 12 and 13, but the section line passes through the lower part of the disk next below that of Fig. 13, and the feed channels are shown radiating from the feed passage nearest to the axis and with their terminal groups in circumferential positions to supply material or water for different zones of action to those supplied by Figs. 12 and 13, so that the terminal groups of channels illustrated in the three figures will, when the several disks are properly assembled, constitute a continuous zone circumferentially on the feed device, to supply separately the commingled water and material and the clear water for their respective zones of different action, as desired. Fig. 15 is an enlarged detail plan of a part of the retaining ring or plate detached, showing the relative position of some of its associated parts, and also a portion of the rotatable trough in top plan. Fig. 16 is an enlarged detail elevation of the edge of a part of the distributing plate in place on a sectional part of the closed top of the treatment vessel, showing the ribs and channels on the plate. Fig. 17 is a detached central cross section of one of the feed distributing disks, showing the inner ends of the feed ribs and channels, where they enter the feed passage. Fig. 18 is an enlarged elevation of the outside end of one of the treatment vessel discharge plugs. Fig. 19 is a vertical central longitudinal section of Fig. 18. Fig. 20 is an enlarged detail cross section of a part of the retaining ring or plate, showing some connected parts in side elevation. Fig. 21 is a front elevation of some parts shown in Fig. 20. Fig. 22 is a vertical section of a part of the retaining plate, showing a valve rod in cross section in place in its groove. Fig. 23 is a top plan of one of the metal segments, detached, that are used around the upper outer corner of the deflector. Fig. 24 is a cross section of Fig. 23, taken on line 24 thereof; and Fig. 25 is a cross section of Fig. 23, taken on line 25 thereof.

In making my improved centrifugal ore separator, I provide a part or portion adapted to be rotated at a desired rate of speed, and to afford a surface sufficiently smooth and suitable to serve as a separating surface. In the drawings I have illustrated this part as a comparatively deep frusto cone-shaped, short metal treatment vessel A with a closed top and substantially open bottom, having its circumferential walls turned smoothly and even, so the inner side of them forms a separating surface A' inclined outward from the closed end of the vessel towards its open end as illustrated, but this vessel may be made of any desired size and suitable shape as conditions of operation and the material to be separated may demand. I further provide a suitable shaft B, which I will term the vessel shaft, rotatably mounted in journal boxes C, which are secured to the supporting frame D of the separator. These journal boxes maintain the shaft in a vertical position, but the weight of the shaft and its attached parts are supported by an anti-friction bearing E, on which the lower end of the shaft is stepped.

I mount the vessel, preferably, in position with its closed end upward, fixing it rigidly on the shaft as shown, so that the vessel will be supported by the shaft, and rotated by it when the shaft is revolved. Around the open edge of the vessel I provide an outwardly extended flange F, formed with an annular peripheral recess and shoulder, to receive and telescope with the flange G on the preferably flat water-retaining ring plate H—shown best in Fig. 2 and in enlarged detail in Figs. 3 and 4, and which, for convenience, I will hereinafter designate as a retaining-plate. I strongly secure this retaining-plate to the flange of the vessel by bolts I, passing through the flange and threaded into the plate. The depth of the annular recess on the flange of the vessel and the height of the flange on the retaining plate H are so proportioned that when the latter is in position, there will be a comparatively small annular radial space J between the lower surface of the flange F and the adjacent surface of the retaining-plate, as shown.

The retaining-plate is made of sufficient width to extend inward toward the axis of rotation a somewhat greater distance than the extent of outward slant or deflection of the separating surface, as clearly shown in enlarged detail in Figs. 3 and 4, so that in operation the plate and the vessel together constitute a treatment or water-retaining vessel, of which the plate serves to retain a body of water therein while under the influence of centrifugal force,—holding the water around over the separating surface and back towards the axis of rotation to a position somewhat nearer to said axis than the smallest diameter of the separating surface, as hereinafter more fully described, and thereby at all times during operation insuring that the separating channel will be completely filled and the separating surface in a fully submerged state.

Around the vessel shaft, located below the hub of the vessel, I provide an adequate sleeve K, relatively rotatable to the vessel, and some other parts. The upper end of this sleeve extends up into the vessel, while its lower portion extends down below the vessel a sufficient distance to receive a driving pulley or sheave wheel L, in position—as shown—to allow a drive belt or rope to pass with required clearance below the treatment vessel. The lower end of this sleeve is stepped on a roller bearing M, located within an oil-retaining housing N, which is mounted on and supported by suitable located nuts O, on the vessel shaft. To the upper portion of the sleeve K, located within the vessel, I securely mount a deflector-supporting part P—Figs. 2 and 4—which is preferably a casting in the nature of a pulley, having its rim portion made as a flat ring parallel with the spokes, instead of transversely to them. To this flat ring portion I secure a deflector Q—Fig. 2 and in enlarged detail Fig. 4—which may be made of any suitable material desired, but I have illustrated it in the drawings as made of segments of wood, secured on the upper and lower sides of the flat ring and solidly held in place by bolts R. The wooden segments may also be nailed together to insure greater stability. To assist in holding these segments in place on the flat ring, I have provided an annular raised rib S, on each side of the ring as shown, and have channeled the adjacent wooden segments suitably to receive these ribs, which help to prevent the segments from slipping outward.

The outer circumferential area or surface of the deflector, preferably corresponds in shape to the contour of the separating surface A', and is of diameter to leave only a comparatively small preferably circumferentially continuous space T between the separating surface and deflector, which space forms the separating channel. The deflector is located in position between the closed end of the treatment vessel and the retaining-plate, and largely fills the space between these parts, leaving between the bottom side of the deflector and the retaining-plate, preferably, only a sufficient space for clearance of the parts here located to enable differential rotation without contact; and where the upper surface of the deflector approaches nearest to the closed end of the vessel it is desirable to make the space large enough to accommodate the outer portion of the distributing plates U—hereinafter more fully described—and to permit of differential rotation without contact. The upper peripheral corner of the deflector nearest to the closed end of the vessel is, preferably, channeled suitably to receive metal segments V, shown in Fig. 2,—in detail Fig. 4, and detached in Figs. 23, 24 and 25, which are of shape to form this annular corner or edge with desired uniformity, and serve as means for protecting the wood of the deflector around this portion. These metal segments are held in place by bolts R, which pass through depressed holes in the metal segments, and down through the wood constituting part of the deflector, and through the flat supporting rim to which the wood is secured. These bolts may have their nuts either at one side or the other of the deflector, but I prefer to have them on the upper side, and it is desirable to have both the nuts and heads countersunk below their respective surfaces of the deflector, as shown, so as not to form an obstruction in securing close operating positions between these surfaces and other parts.

Around on the internal bore of the deflector, in position approximately one-third of the distance upward from the lower side of the deflector, I provide an annular groove-shaped trough or channel W, of wood, as shown in Figs. 2 and 4, with cross partitions X at quite close intervals, and in the bottom of this trough, extending radially through the deflector to its outside surface, I provide a circumferential row of perforations Y—Fig. 4—for the passage of water from sid trough to appropriate portions of the separating surface, to assist in removal of middlings, as hereinafter explained.

The deflector is rotated differentially to the treatment vessel and separating surface, as well as to the feed or feed distributing device or means and distributing channels or means, the revolving trough, and some other parts, which are hereinafter more fully described, through the use of a rope belt that may be supplied and operated around the sheave L. The deflector in its differential rotation serves to assist in the even distribution of material over the separating surface, and also, because of its differential rotation to the separating surface and to the material being deposited on such surface, frictionally generates and transmits through the instrumentality of the body of water in the separating channel an aqueous scouring force to assist in separation of said material, as well as in the removal of its various products.

To support and rotate the material and water feed or feed distributing means or device, I provided an ample sleeve Z, located around the vessel shaft, above where the vessel is secured to the shaft. I prefer that the closed end of the vessel around its central position be depressed, as shown in Fig. 2. In this depression, and resting on the vessel, I locate a roller bearing 2, surrounding the shaft, for supporting the sleeve Z and its connected parts, and I extend the lower end of the sleeve down and rest it on this bearing, as shown. I construct and provide the said feed or feed distributing device for receiving and feeding or distributing separately the materials for separation commingled with water, and the clean water for different purposes within the separator, in a way to deliver these elements for the different purposes severally from predetermined segmental portions of the circumference of said feed distributing device or its field of rotation, in position, actuated by its momentum and centrifugal force to pass into the proper channels for passage to and deposit on their respective progressively changing segmental areas on the separating surface thereby predetermining the several places of feed for distribution within the separator, of the said elements for different purposes, and in that way assisting in establishing or in part establishing the several segmental zones of different action and their relative location in the separator. These zones comprise different segmental portions of the field of rotation of the treatment vessel, and embrace respective segmental areas on the separating surface. This feed device embodies several comparatively short pipes or tube-shaped pieces 3, located preferably circumferentially to the sleeve Z, as illustrated especially in Figs. 2 7 and 8. The tubes successively increase sufficiently in diameter from the sleeve outward to leave a suitable annular feed passage between each of them, which passage I have initialed 4.

The sleeve Z and each of the short tubes are threaded at their lower ends, and each enters into and engages with the screw threads in the central bore of a corresponding disk—the sleeve engaging the lower disk. The several disks are indicated by the numeral 5, and are assembled one above the other in close contact, as shown, and at right angles with the tubes: They extend out diametrically a considerable distance, and all, except the bottom one, are provided with ribs 6, on their lower sides, as illustrated. The ribs of each disk at their inner ends are preferably spaced at substantially equal distances apart throughout the circumference of the central bore of their disk, and extend therefrom in deflected radial courses at substantially right angles to the axis,—as also especially shown in detail in Figs. 12, 13, 14 and 17—preferably to the outer diameter of said disk, terminating in two preferably diametrically opposite groups, each group embracing a desired portion or zone of the circumference of the disk.

Between the ribs are located channels, 7, for the flow of water and material, so that the channels for each disk radiate from the inner circumference of its central bore, which is substantially the outer circumference of the bottom of the respective feed receiving passages, and terminate preferably in the two diametrically opposite groups at the outside portion of the disk,—each group embracing a multiplicity of channels covering preferably, about one-sixth of the total circumference of the disk or field of rotation of the feed device, and serving as means for receiving clean water, or material for separation commingled with water, that is fed into the separate feed passages 4, and delivering it with practically uniform distribution throughout the particular segmental zones embraced by the channels from the respective feed passages. These groups of terminals of said channels substantially determine the location and extent of the several zones of different and of like action in the separator, because said groups of channels feed or distribute the appropriate elements in or for said zones, thereby initially establishing these different zones within predetermined different circumferentially travelable segmental portions of the field of rotation of the treatment vessel, embracing corresponding, and therefore predetermined circumferentially travelable segmental parts or areas on the separating surface. As shown, these ribs and channels are located on the under side of the disks, and I have placed one disk above the other in contact, as above stated, and have secured them together so that the top side of one disk serves as the bottom of the channels directly above it, and also as the bottom of the corresponding one of the feed passages 4. To assist in holding the short tubes and the central sleeve strongly together and relatively in place, I have provided several stud bolts 8—shown most clearly in Figs. 2, 6, 7 and 8—threaded through the walls of the several tubes, transversely to said walls, and have extended them to, and engaged them with the central sleeve.

In assembling the disks I have done so with reference to the groups of outer terminals of their feed channels 7, as shown especially in Fig. 6, so that the several segmental groups or zones of channels will collectively form a continuous zone or field of these channels throughout the circumference of the collective disks, into their respective feed passages 4, for different purposes in the separator, will be delivered out within their zones corresponding segmental or parts of the field of rotation of the feed device at the circumference of the collective disks, and from there, by additional agencies hereinafter described, will be carried out through the several corresponding segmental zones within the field of rotation of the treatment vessel to and deposited on the corresponding segmental areas of the separating surface included within said zone, which zones are embraced between substantially radial lines transversely to the axis from their respective segmental feed zones at the circumference of the feed disks. It therefore follows that during operation, the volume or quantity of flow into any of the said feed passages, and consequent delivery on the respective parts or areas of the separating surface within the several segmental zones and the flow through the corresponding parts of the separating channel while the separator is at a constant speed of rotation, may be varied and regulated irrespective of the flow within other zones, there being facility through secondary discharge holes hereinafter described, for increasing the discharge capacity from desired segmental portions of said channel while said portions are within zones of action requiring such increased flow.

I have placed Figs. 12, 13 and 14 on their sheet of the drawings in relative circumferential positions, each illustrating the feed channels of a separate disk, so that collectively they embrace the entire circumferential field of action within the separator, and if the several disks were assembled one on top of the other (as shown in Fig. 6) in the relative circumferential positions illustrated, the terminals of their channels would collectively embrace the entire circumference of the assembled disks and that of their entire field of rotation.

As means for supplying water and material into the central feed passages 4, I provide suitably shaped hollow supply castings 9—shown in Figs. 1 and 2, and in detail in Figs. 9 and 10—with openings in their depending extensions which are of form and size to enter the upper end of their respective annular feed passages, as shown, so that the flow from these castings will be directed and delivered down into the feed passages. In the upper end of each of the tubes forming these feed passages I have fixed a suitable ring 10, to form an internal shoulder at this point, which serves to prevent water introduced from flowing out over the top of the respective tubes.

The supply castings are each provided with internally threaded openings, suitably located to receive the screw threaded end of a supply pipe 11, which several pipes are provided with suitable valves 12, for stopping or controlling the flow of material for separation, commingled with water, and also clear water, as these products are flowed through their respective pipes to the separator. The supply pipes used for clean water connect with any suitable source of supply of water, and the one used for the commingled material and water supply preferably connects with a suitable sufficiently elevated agitator tank—not shown—for its source of supply. The agitator should be adequate to keep the material well mixed with water, and sufficiently elevated to secure flow into the feed passages of the separator by means of gravity. The feed castings are held in place by means of their connected pipes or otherwise, if desired.

Located on the outside of the closed end of the vessel in position around the outer circumference of the collective feed disks—which largely constitute the feed device or means—and extending with its upper edge somewhat above the top of the collective feed disks, I provide a ring 13, with the top of its outer wall having a bore of size to leave but comparatively small clearance between said wall and the feed disks, and having its circumferential wall inclined considerably outward in its downward course, as shown, to its lower outward flange 14, which is secured by bolts 15 to the closed end of the vessel. On the interior of said ring, which I will term a "distributing ring", and extending from the inside surface of its inclined circumferential wall to a position nearly as close to the axis as the bore of the top of the ring, I provide wings, 16, cast integral with and transversely to the ring. These wings have chambers 17 between them, which I will term "receiving chambers", and which preferably correspond in number and spacing to the terminals of the channels 7, which collectively form a continuous zone of such terminals throughout the circumference of the assembled feed or feed distributing disks. These chambers, 17, receive the commingled material and water, and the water alone, as the same are delivered separately from their respective zones around the circumference of said disks, and conduct such products separately down through the holes, 18, in the closed end of the treatment vessel. One of these holes extends from each of the receiving chambers, and delivers the elements or products from said chamber separately, down into a radial distributing channel 19, located on the upper side of the distributing plate U.

I have provided the distributing plate with as many radial channels as there are holes 18, and there is preferably one of the channels, 19, extending radially from each of the holes to a position near the upper edge of the separating surface, close to the closed end of the vessel, so that each channel will deliver the materials and water, or the water alone, as the case may be, flowed into it through its hole 18, without commingling, and deposit it on the appropriate segmental area of separating surface A' embraced within its respective and proper segmental zone: These receiving chambers, the holes 18 and the distributing channels 19 together serve as the means for delivering the materials and the water from the rotatable feed or feed distributing device means to the separating surface, and are differentially rotatable to said device. They are wholly or partly illustrated in section in Figs. 2 and 4, and in plan in detail in Figs. 12, 13 and 14, and in outside end elevation in detail in Fig. 16. It will, therefore, be seen that in operation material for separation commingled with water may be flowed into one of the central feed passages 4 of the separator and through the instrumentality of its feed channels 7, such material will be fed delivered or distributed from the certain and predetermined circumferential portions of the feed device, which are embraced by the terminal groups of the particular ones of the channels 7, emanating from said feed passage, and passes into the initial end of the two diametrically opposite separating zones, the circumferential location, extent and scope of which zones in the separator are thereby predetermined and mainly or in part established by this feed device. The said zones are then maintained and proper passage of material and water insured through them from the feed device, by the corresponding receiving chambers 17, and holes or passages 18, and the corresponding distributing channel 19, which delivers the same for deposit within the predetermined diametrically opposite circumferential portions of the separating surface then located within said zones near the top or initial edge of said surface, which portion of the separating surface at that time corresponds to the circumferential portion of the feed device embraced by the terminals of the feed channels 7, said material is then ready to be flowed within the segmental separating zone, transversely across said surface for concentration in the accomplishment of the progressive steps of the operation.

As the feed device, embodying the disks with their feed channels 7, is slowly revolving differentially to the vessel and its attached parts, the terminals of the feed channels will be slowly differentially traveled and changed with respect to the several receiving chambers 17, and consequently will progressively and continuously change the individual ones of these chambers, and their allied holes 18 and distributing channels 19, into which the material is delivered, resulting in progressive and constant change of the segmental portions or zones within the field of rotation of the separating vessel and corresponding segmental portions or areas of the separating surface on which material is fed for separation. There will also be a like changing of the other zones of action on said surface. It will therefore be seen that the said feed device or means becomes of the nature of a feed distributing device or means and its differential rotation to the vessel is very important or necessary to effect slow relative circumferential movement of the segmental zones with their respective segmental areas, and the separating surface, and it will further be seen that its differential and independent rotation to the deflector is also necessary, to permit of a much greater differential velocity between said deflector and the vessel than that of the feed device and the vessel. This differential velocity between the deflector and separating surface or vessel is required to produce the necessary aqueous scouring force on the separating surface to sufficiently assist in separation, and in removal of separated concentrates and other products. This constant and progressive changing or traveling of the several zones with respect to the separating surface will be in direct proportion as, synchronously with, and governed by the rate of differential rotary speed between the feed means, and the treatment vessel with its connected parts, and the separating surface. I prefer that the feed means be revolved slower than the vessel, causing the separating surface to travel faster than the several zones of different action.

The distributing plate, U, is secured solidly to the inside of the closed end of the vessel by bolts 21, as shown in Figs. 2 and 4, so that said closed end serves as one side of the distributing channels. The distributing plate is large enough in diameter to leave only a comparatively small annular space between its circumference and the upper edge of the separating surface, so that the distributing channels, 19, will make delivery as near as practicable directly in contact with the separating surface.

Around the flange G, of the plate H, I have provided a sufficient number of radial discharge plugs 22, threaded into suitable holes through the flange for the discharge of material, and water, as more fully hereinafter described. The plugs which serve as discharge means have primary and secondary discharge holes, 23 and 24, as particularly shown in the enlarged detail views of Figs. 18 and 19,—the holes being small enough to enable a sufficient body of water to be retained in the separator during operation, and, therefore, proportionately too small to be clearly illustrated in the main figures of the drawings.

Material from the distributing channels deposited on the segmental separating surface within the separating portions or areas embraced within their respective segmental zones will be passed or washed, principally actuated by the flow of water accompanying its deposit, down from the top or initial edge of said surface in a somewhat spirally inclined course, through the separating channel over their segmental areas, transversely to the circumference of the separating surface, towards its discharge edge; and the tailings or lighter parts will mostly be separated during such travel, and be carried over the discharge edge of the separating surface and discharged with its accompanying water through the particular primary holes 23, which are within and progressively traveling through these segmental zones, and the heavier parts, constituting the concentrates and middlings of said material will lodge or in part move slowly on the separating surface. These zones of deposit and separation, as has been heretofore explained, are situated in position within approximately radial lines from the groups or zones of terminals of their feed channels in the differentially rotatable feed means and embrace respective segmental separating areas on the separating surface. Through the differential rotation of the feed means and the separating surface, the said concentrates and middlings will be carried on around out of the separating zones, by the particular portions of the separating surface merging from said zones, and into following adjacent wash water zones, which are receiving clean water distributed by the feed device.

The parts for supplying material and water to the separator, and the rotatable feed or feed distributing device embodied in the separator are arranged relatively, so that, as above stated, the segmental wash water zones follow and are adjacent to the segmental material receiving and separating zones, and after materials deposited within the latter zones have been separated, so far as it is practicable to do so within such zones, feed device embraced by the terminals of the feed channels 7, said material is then ready to be flowed within the segmental separating zone, transversely across said surface for concentration in the accomplishment of the progressive steps of the operation.

As the feed device, embodying the disks with their feed channels 7, is slowly revolving differentially to the vessel and its attached parts, the terminals of the feed channels will be slowly differentially traveled and changed with respect to the several receiving chambers 17, and consequently will progressively and continuously change the individual ones of these chambers, and their allied holes 18 and distributing channels 19, into which the material is delivered, resulting in progressive and constant change of the segmental portions or zones within the field of rotation of the separating vessel and corresponding segmental portions or areas of the separating surface on which material is fed for separation. There will also be a like changing of the other zones of action on said surface. It will therefore be seen that the said feed device or means becomes of the nature of a feed distributing device or means and its differential rotation to the vessel is very important or necessary to effect slow relative circumferential movement of the segmental zones with their respective segmental areas, and the separating surface, and it will further be seen that its differential and independent rotation to the deflector is also necessary, to permit of a much greater differential velocity between said deflector and the vessel than that of the feed device and the vessel. This differential velocity between the deflector and separating surface or vessel is required to produce the necessary aqueous scouring force on the separating surface to sufficiently assist in separation, and in removal of separated concentrates and other products. This constant and progressive changing or traveling of the several zones with respect to the separating surface will be in direct proportion as, synchronously with, and governed by the rate of differential rotary speed between the feed means, and the treatment vessel with its connected parts, and the separating surface. I prefer that the feed means be revolved slower than the vessel, causing the separating surface to travel faster than the several zones of different action.

The distributing plate, U, is secured solidly to the inside of the closed end of the vessel by bolts 21, as shown in Figs. 2 and 4, so that said closed end serves as one side of the distributing channels. The distributing plate is large enough in diameter to leave only a comparatively small annular space between its circumference and the upper edge of the separating surface, so that the distributing channels, 19, will make delivery as near as practicable directly in contact with the separating surface.

Around the flange G, of the plate H, I have provided a sufficient number of radial discharge plugs 22, threaded into suitable holes through the flange for the discharge of material, and water, as more fully hereinafter described. The plugs which serve as discharge means have primary and secondary discharge holes, 23 and 24, as particularly shown in the enlarged detail views of Figs. 18 and 19,—the holes being small enough to enable a sufficient body of water to be retained in the separator during operation, and, therefore, proportionately too small to be clearly illustrated in the main figures of the drawings.

Material from the distributing channels deposited on the segmental separating surface within the separating portions or areas embraced within their respective segmental zones will be passed or washed, principally actuated by the flow of water accompanying its deposit, down from the top or initial edge of said surface in a somewhat spirally inclined course, through the separating channel over their segmental areas, transversely to the circumference of the separating surface, towards its discharge edge; and the tailings or lighter parts will mostly be separated during such travel, and be carried over the discharge edge of the separating surface and discharged with its accompanying water through the particular primary holes 23, which are within and progressively traveling through these segmental zones, and the heavier parts, constituting the concentrates and middlings of said material will lodge or in part move slowly on the separating surface. These zones of deposit and separation, as has been heretofore explained, are situated in position within approximately radial lines from the groups or zones of terminals of their feed channels in the differentially rotatable feed means and embrace respective segmental separating areas on the separating surface. Through the differential rotation of the feed means and the separating surface, the said concentrates and middlings will be carried on around out of the separating zones, by the particular portions of the separating surface merging from said zones, and into following adjacent wash water zones, which are receiving clean water distributed by the feed device.

The parts for supplying material and water to the separator, and the rotatable feed or feed distributing device embodied in the separator are arranged relatively, so that, as above stated, the segmental wash water zones follow and are adjacent to the segmental material receiving and separating zones, and after materials deposited within the latter zones have been separated, so far as it is practicable to do so within such zones, while additional unseparated material is constantly being deposited on it, the parts of the material remaining, including the concentrates and middlings, are progressively carried by reason of said differential rotation into the wash water zones, and are subjected to further cleansing, aqueous scouring, and more complete separation. This more complete action is enabled because the wash water zones are out of the scope of deposit of unseparated materials, and within the action of clean and independent wash water supply. Within these wash water zones there is a sufficient quantity of water supplied from their groups of feed channels in the feed means to produce a washing current of desired strength to satisfactorily complete or finish separation and cleansing, and to largely move to a position near the discharge edge of the separating surface middlings that may be lodged on the upper portion of the separating surface. This water is fed by one of the pipes 11 that supplies the particular central feed passage appropriate to make delivery to these zones.

Following the wash water zones, and adjacent to them, I provide segmental middlings removing zones, and to these zones, through suitable pipes 25, and thence through the particular ones of the perforations Y in the deflector that are passing in radial alinement with these zones, I supply the requisite amount of water, which is actuated by centrifugal force, to procure sufficient flow over the lower portion of the separating surface within these zones to wash and remove the middlings product over the edge of the separating surface and discharge it through the plugs 22.

In addition to the water supplied to the middlings removing zones through the perforations Y, water is supplied at the upper edge of these zones through the feed channel, located in the latter circumferential parts of the groups of channels that supplies the wash water zones; and this water in its downward flow is effective in further removing any remaining middlings from the upper part of these zones, as well as in assisting in the removal of middlings to discharge off from the lower edge of the separating surface. There will then only remain on these portions of the separating surface, after they progressively emerge or travel from the middlings remaining zones, finished, clean concentrates, ready for removal and discharge.

Adjacent to the middlings removing zones, and following them in their relative travel circumferentially to the separating surface, is a segmental concentrates removing zone, in which a sufficiently strong current of clean water is supplied from its corresponding water feed passages and channels to remove concentrates from the segmental separating area of the relatively circumferentially traveling separating surface and carry them to discharge, through the particular discharge holes then substantially radially within said zones.

In the removal of concentrates while the separator is being rotated at substantially constant speed it is necessary to supply a stronger flow of water, and it is important to confine the required increased flow and volume of water through the separating channel and transversely over the separating surface, principally within the limits of the concentrates removing zones, so that the concentrates will not be washed around and recommingled. To accomplish this purpose, I provide the secondary discharge holes 24, as above stated, which are most clearly shown in detail in Figs. 4, 18 and 19, in addition to the primary discharge holes: in operation the secondary discharge holes, except when opened within desired zone of action are closed by contacting ends of suitable small rods 26, which I have designated as valve rods, and which are located and operated in radial alinement with their respective secondary holes—see Figs. 2, 4 and 15. Through means hereinafter described these rods are drawn inward toward the axis of rotation, in the position in which they are illustrated in part of the figures, in the drawings and thereby open the secondary discharge holes as they come within, and while they are progressively passing through, the concentrate removing zones. As the rods and secondary hole progressively pass out of said zones, the rods are successively permitted to travel outward sufficiently to again close over their respective secondary holes, remaining there until they again enter a zone of the discharge of concentrates, or middlings, if desired.

It will be seen that while several of the secondary discharge holes are within the limits of the concentrates removing zones and are progressively passing through the same, and are at that time open, they will afford greatly increased facility for discharge of the increased volume of clean concentrates removing water applied and flowed within these zones, and insure that the increased flow through the separating channel and transversely over the separating surface will be substantially confined within the limits of these zones, with the result that the concentrates will be removed and discharged substantially within their limits. The feed of water for these zones and the size of the secondary discharge openings should be proportioned, so that there will be a sufficiently strong flow of water over the separating surface within them to effect desired removal of concentrates and to prevent objectionable flow of water and material circumferentially into or from the zones. To facilitate the removal of middlings within the middlings-removing zone by providing for discharge of the water here added through the perforations Y—I prefer that the secondary holes should also be open within these zones.

It will be understood that the volume of water supplied within the various segmental zones, and the resultant different velocity and intensity of flow through different segmental parts of the separating channel and across corresponding segmental areas on the separating surface within said zones, to effect the several and different purposes herein described and intended, together with any frictional wash or aqueous scouring effect which is partly across the various zones of action within the channel that is obtained from differential rotation of the deflector—as will be hereinafter described—should be properly adjusted and proportioned to effect the most desirable results.

The various products and accompanying water discharged from the several zones of the separating surface will be discharged in substantially the same plane transversely to the axis through the discharge plugs 22, except such moderate quantity of water as may be discharged through passages in overflow pipes 27, hereinafter described; and as means for receiving the several products separately as they are discharged through the plugs 22, and separately delivering them in different planes in a direction transversely to the axis so they can be caught separately by a fixed annular launder 28—or equivalent means—and flowed for desired dispositions, I provide an annular rotatable diverting trough or receptacle 29, which in this specification I will term a rotatable trough. This rotatable trough is located around the flange of the treatment vessel, passing fully around its circumference, and in position radial to the discharge plugs, as shown. It is of sufficient internal diameter to afford necessary clearance between its internal bore and the ends of the discharge plugs to permit of relative differential rotation. Its width is preferably, several times as great as the thickness of the discharge plugs, and is of sufficient depth to subserve the purpose for which it is intended.

The outer wall or bottom of the trough, throughout the part of its circumference which is radially adjacent to the zones from which one kind of product is being discharged, is inclined to the upper edge of the trough, as indicated at 30 Fig. 2, so as to divert the products and water from these zones to a higher plane than the discharge plugs 22; and from there it is thrown off from the revolving trough through discharge nipples 31 in that part of the revolving trough. In another portion of the inner circumference of the revolving trough, adjacent to the zones of discharge of another class of products and in position to catch such discharge, the bottom of the trough is inclined from both sides to its center, as shown in detail in Fig. 5, to divert such products to the center, which are then discharged in that plane through the appropriately located discharge nipples 31 in the revolving trough; and, further, such portion of the inner circumference of the revolving trough as catches the third class of material discharged from its zones is inclined towards the lower edge—as illustrated in Fig. 4—to a plane below the discharge plugs 22, and thereby diverts this material to the lower plane, from whence it is discharged through its appropriately located nipples at a lower plane than the said discharging plugs.

The difference between the planes of delivery of the three classes of materials discharged from the revolving trough, as well as that of the overflow 27, is sufficient to enable them to be caught separately in annular openings of the several compartments 32—Fig. 2—in the fixed launder 28, so as to be flowed separately from these compartments through their respective delivery pipes 33, for desired disposition. The fixed launder is provided with an inclined bottom towards its pipes 33, as shown, to facilitate flow of water and material from it.

The parts of the circumference of the revolving trough having different inclinations are divided by suitable partitions 34, to prevent possible annular flow in the trough from one part to another, and the trough is partly supported and laterally held in place by the spokes 35—Fig. 2—connected to its lower side, which spokes from there extend inward to and are connected with the central web 36, which is provided with a central hub 37, journaled around the extended end of the hub 38 of the deflector support. The hub 37 rests upon a roller bearing 39, contained in a housing 40, which is secured to and supported by the hub 38. The rotatable trough is further supported and is rotated by spokes or suitably shaped bars 41—Figs. 1 and 2—secured by bolts 42 to the revolving trough. These spokes extend upward and inward over the upper side of the vessel and connect, by bolts 43, to a raised annular boss or ring on the rotatable feed device or means. The boss 44 is raised, to afford better facility and greater strength for securing the ends of the spokes. The end portions of the spokes are further held together by the ring 45, secured to them by bolts 46, so that the ring holds this end portion of the spokes relatively in place at times, when the bolts 43 are removed to enable the trough, 29, to be circumferentially shifted or adjusted with relation to the feed device. There are several screw holes, 46′, located in suitable positions in the boss to register with the bolts in the ends of the spokes 41, so that if it should be desired the bolts 43 may be removed and the trough swung or shifted somewhat around, and the said bolts then replaced, entering different screw holes, thereby holding the spokes, and, consequently, the revolving trough in shifted position.

Through the connection of the revolving trough with the feed device, by means of the spokes 41, the trough is rotated by and with the feed device, and the several portions of its bottom differentially and appropriately inclined to collect the materials discharged from the several zones of different action in the separator are maintained in the same radial position to the respective zones of action and discharge. If desired, the relative position of the revolving trough to the feed device and the several zones of action may be changed or adjusted after removing the bolts 43, as just above explained.

The secondary discharge holes 24, as has been explained are normally closed by contact of the outer ends of the valve rods 26, which are drawn inward when it is desired to open their respective secondary discharge holes while within the appropriate zones of action in the separator. To accomplish the inward movement of these rods, I provide a casting 47—see Figs. 2, 4, 15, 20 and 21—for each of the rods, and secure it in alinement with the rod on the inside bore of the retaining-plate H, as especially shown in the enlarged detail in Fig. 15, and to the casting I provide a small fulcrumed lever 48, one end of which is in position in contact with the inner side of the bent outer end of the rod. The opposite end of this lever depends in position to contact with and be deflected or swung outward by the suitably shaped and located shoe 49,—especially shown in Fig. 15—which shoe is secured in desired position to the spokes 35, and deflects or rocks the levers 48 while these levers are differentially traveling by the shoes, with the result, through the outward movement of the other end of the lever, of drawing the rod towards the axis of the separator sufficiently to open its secondary discharge hole, permitting water and material to flow to discharge through it.

The length of the shoes 49 is intended to be as great as the zones or circumferential extent of the zones on the separating surface, from which it is desired to secure the increased flow of water by means of the secondary discharge holes, and as the levers are severally traveled beyond the shoes in their relative differential rotation, they are released from deflecting contact with the shoe, and will then permit their associated valve rods, actuated by centrifugal force to travel outward and again cover their secondary discharge holes until another shoe—preferably diametrically opposite to the one just passed—is encountered. The valve rods in their said outward travel will rock or move the levers 48, to their former position.

The rods 26 are partly depressed in radial channels 50, formed transversely to the plate H, which channels are in alinement with the respective secondary discharge holes and serve to assist in holding the rods in alinement, as well as partly depressing them from position above the surface of the plate H. This state is well shown in detail cross section in Fig. 22.

As means for affording ocular evidence during operation of the fact that the separator has a sufficient body of water accumulated in it to completely fill the separating channel and fully submerge the separating surface, which is necessary to enable the procuring of satisfactory results, and to enable transmission of an aqueous scouring or washing force from the differential, rotatable deflector to the separating surface, I provide a number of overflow pipes 27, which pass through the retaining-plate H at points somewhat nearer the axis of rotation than the smallest diameter of the separating surface. In this position, during the operation of the separator, water will not pass through these overflow pipes until a sufficient body has accumulated over the separating surface and within the separating channel to fully submerge and fill these parts and approach as near the axis as the location of the overflow passages in these pipes. These overflow pipes deliver their product into an annular compartment 51 of the revolving trough, as illustrated, and from there it is conducted through the discharge nipples 52 from the trough and delivered into a compartment 53 of the fixed launder, from which it flows by itself through a comparatively short discharge pipe 54, so that it may be observed by the operator and affords evidence that the separating surface and separating channel are in a satisfactory state of submergence.

From their respective compartments 32 of the fixed launder, tailings, concentrates and middlings are separately and uninterruptedly flowed through the appropriate discharge pipes 33, for any desired disposition.

As illustrated in Fig. 2, the central or web portion 36, connected to the revolving trough, is of shape, together with the ring 55 which is secured to the web by screw bolts 56, to form an annular water-receiving chamber 57, into which clear water can be introduced by a pipe 58 from any suitable source of supply. The pipe 58 has a valve 59 located in it, to govern the flow of water to the chamber.

Communicating with the chamber 57, by engaging with screw-threaded openings through the circumferential wall of said chamber, are the two or more suitably located pipes 25, which extend outward with their ends terminating in position to deliver water into the annular groove-shaped trough

W, to pass through the perforations Y in the deflector and assist in removing middlings within certain zones of the separating surface, as has been hereinbefore explained. The positions of the ends of these pipes are such, with relation to the zones in which middlings are removed, as to effect suitable delivery of water for such purposes.

In operation, the treatment vessel carrying the separating surface is revolved at a desired rate of speed by power transmitted to the pulley 60, which drives the vessel shaft; and at the same time the feed device or means is revolved by power transmitted to the rope drive sheave 61, but at a sufficiently differential rate to that of the vessel to produce the velocity of differential travel between the feed means and several zones of different action and the separating surface that will best enable satisfactory accomplishment of the various steps of treatment of the particular material being operated upon—usually this differential rate of velocity would be approximately between one and two revolutions per minute in a separator having approximately 200 tons treatment capacity per 24 hours.

Material for separation, commingled with a sufficient amount of water to dilute it, so as to flow very freely as liquid and perform its part in separation, is supplied through its supply pipe casting in a desired volume, into one of the feed passages of the differentially rotatable feed and distributing device embodied in the separator—preferably the passage nearest to the axis, and is carried by means of the various agencies already herein described and deposited on the predetermined corresponding separating areas of separating surface within the two diametrically opposite segmental separating zones in which separation is mainly accomplished. At the same time water—preferably clean—is introduced in comparatively moderate quantities through one of the water supply pipes and castings into the feed passage of the separator that furnishes water to be delivered on the separating surface within the wash water zones, which are following and adjacent to separating zones. Following and adjacent to these wash water zones are the middlings removing zones, and in addition to the water supplied to their upper parts through some of the channels in the groups that supply to the wash water zones, water is at this time introduced through the perforations Y in the deflector as they pass radially through these middlings removing zones. The flow of water through these perforations is regulated by the valve in the water pipe 58.

I have shown the discharge from the wash water zones and the middlings removing zones as being delivered in the same portions of the revolving trough and in the same compartment of the fixed launder, thereby becoming commingled. This course is permissible, as they are intended to be re-treated; but, if desired, the circumference of the revolving trough may be provided with portions adapted to collect and discharge these separately, and the fixed launder may be provided with another compartment, so as to receive and deliver them separately. During this time there is also preferably clean water in larger quantities flowed by the water supply pipe and casting that delivers into the feed passage which supplies the concentrates-removing zones, to effect concentrates removal. The water introduced within the several segmental zones should be sufficient in quantity to at all times keep this separating channel full, and consequently the separating surface submerged, and to back up or accumulate sufficiently to produce some flow through the overflow pipes for observance by the operator as it flows from the fixed launder, and it should also be sufficient and the flow adjusted to accomplish the various purposes in the cycles of operation and movements desired.

To assist in the separation and removal of the various products within the separating channel and on the separating surface, by creating or generating a somewhat spiral washing or aqueous scouring current, I rotate the deflector at a desired speed differential to the vessel and separating surface, which at the same time is also differential—but necessarily in a different degree—to the feed device or means and the revolving trough. I also regulate the extent of this spirally created scouring current by the amount of differential rotation of the deflector.

While material is on the separating surface under the influence of centrifugal force, it has a tendency to be strongly thrown down and held on said surface, the resultant frictional contact therewith preventing such material from being traveled in so great a spirally inclined course, or to the same extent as the water will be traveled,—and, further, the spiral deflection of material across the separating surface, throughout the circumference of such surface, will be substantially the same in the several segmental zones of operation, so that said several zones will be carried or spirally deflected in substantially the same degree, and their relative uniformity and positions will be sufficiently maintained.

It will be understood that within the separating zone unseparated material is uninterruptedly being deposited, and the steps in separation are also here progressing, so that while separation is progressing here, unseparated material is also being added, which condition, to some extent, interferes with complete and finished separation and the cleansing of concentrates within these zones;

but in the operation of my separator during this time, and uninterruptedly, the separating surface, as has been explained, is traveling forward with relation to the several segmental areas of different action located on it and the several zones which embrace such areas, and thereby carrying the concentrates and middlings that have been treated and mostly separated and lodged within the separating zones, together with any unseparated tailings that may remain, into the adjacent wash water zones. The water supply of these wash water zones is preferably clean, and is adjusted to produce a flow sufficient to separate and carry to discharge the remaining lighter material, and move most of the remaining commingled middlings from the upper part of the separating surface down towards the lower part of such surface, thereby cleansing the concentrates and more completely separating and depositing the middlings along the lower portion of the separating surface.

After the middlings have been removed within the middlings removing zones, and discharged, as has been hereinabove explained, there will only remain concentrates on the separating surface as it progressively emerges forward from these zones into the adjacent concentrates-removing zones, where they are subjected to a sufficiently strong flow of water to wash and remove them from the separating surface and carry them to discharge into their appropriate circumferential portion of the revolving trough, from whence they will be thrown through the appropriate nipples in said trough into their compartments in the fixed launder, and flowed from there separately with their water for disposition to any desired place.

As the vessel carrying the separating surface and the retaining plate H, with the valve rods and their fulcrumed levers, rotates differentially with relation to the revolving trough, and as the spokes of said trough carry the shoes 40—which latter are located within the scope of the segmental middlings and concentrates-removing zones in operation, it follows that the valve rods as they enter these zones are drawn inward and the secondary discharge passages within these zones are opened, as has been described, to enable the proper discharge of the greater volume of water required for renewal of these products. After portions of the separating surface have passed through the several zones, as explained,—the concentrates having been removed—such portions are ready to again progressively enter the material-receiving and separating zones and again perform their purposes in the cycle of operation, with the result that separation in its incipient, progressive, and finishing stages, and the removal and separate discharge of the various products, is constantly and uninterruptedly being accomplished.

While I have shown two of each of the different zones of action within my separator, a greater or less number of each may be employed, provided the separator is of size to allot circumferentially a sufficient space to each in which to accomplish the required results.

By the term, field of rotation I mean to designate and include the field, scope of area embraced within the circumferential boundaries described by the respective rotating parts to which reference is made.

The details of my separator may be varied and changed somewhat, and still come within the scope of my invention, so I do not want to be confined closely to these, but desire latitude in construction and arrangement for the embodiment of the broader principles herein described and illustrated.

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

1. In a centrifugal ore separator, rotatable supply means provided with material and water distributing members adapted to supply material from a predetermined segmental part of its field of rotation in position for delivery on a predetermined segmental separating area and at the same time to supply water alone from a different predetermined segmental part of its field of rotation in position for delivery on a predetermined segmental concentrates removing area, in combination with rotatable means having a separating surface within a separating channel adapted to be submerged during operation, said separating surface embracing the said areas and being relatively circumferentially travelable thereto, a rotatable deflector adapted to frictionally generate an aqueous scouring or washing force over the separating surface and across said areas, said supply means and said means having the separating surface and said deflector all being differentially rotatable with respect to each other, substantially as described.

2. In a centrifugal ore separator, rotatable supply means provided with material and water distributing members adapted to supply material from a predetermined segmental part of its field of rotation in position for delivery on a predetermined segmental separating area, and at the same time to supply water alone within a different predetermined segmental part of its field of rotation in position for delivery on a predetermined segmental concentrates removing area, in combination with rotatable means having a separating surface within a separating channel adapted to be submerged during operation, said separating surface embracing the said areas and being relatively circumferentially travelable thereto, a rotatable deflector adapted to frictionally generate an aqueous scouring or

washing force over the separating surface and across said areas, said supply means and said means having a separating surface, and said deflector, all being differentially rotatable with respect to each other and means differentially rotatable to said rotatable distributing device, means adapted to conduct said material and said clean water alone separately from said distributing device to their respective segmental areas on the separating surface, substantially as described.

3. In a centrifugal ore separator, the combination of a rotatable element having a separating surface within a covered separating channel adapted to be submerged while in operation, a deflector differentially rotatable to said separating surface forming one wall of said separating channel and adapted to generate an aqueous scouring force within said channel, feed distributing means having material and water passages and being differentially rotatable to said element with the separating surface and to said deflector and establishing in part a segmental separating zone and a segmental concentrates removing zone of form embracing different substantially transverse segmental areas of the separating surface, which areas are travelable circumferentially with respect to said separating surface and said deflector, said distributing means adapted to deliver material for separation within said separating zone, and for delivery of water within said concentrates removing zone, and means for feeding material for separation, and water alone in their respective passages in said feed distributing means, substantially as described.

4. In a centrifugal ore separator, the combination of a rotatable distributing device adapted to deliver material for separation, from a predetermined part of its circumferential portion and to deliver clean water from another predetermined part of its circumferential portion, a differentially rotatable vessel portion having a separating surface and forming the outer wall of a covered separating channel which is adapted to be filled with water during operation, a deflector portion differentially rotatable to the distributing device and the vessel portion, forming the inner wall of the separating channel, said distributing device and said vessel and said deflector portion all differentially rotatable to each other, establishing a segmental separating zone and a segmental concentrates removing zone which embrace different substantially transverse segmental areas of the separating surface, said areas being relatively circumferentially travelable to said separating surface and deflector portions and synchronously traveling during operation with the feed distributing device, said separating surface adapted to receive material for separation within the separating zone and to carry concentrates for removal into the concentrates removing zone, substantially as described.

5. In a centrifugal ore separator, the combination of rotatable means forming the outer wall of a separating channel and having a separating surface within said channel, a differentially rotatable deflector forming the inner wall of said channel and adapted to generate an aqueous scouring force in said channel, a feed distributing device differentially rotatable to said separating surface and deflector and provided with distributing channels, and adapted at the same time to deliver material for separation, middlings removing water and concentrates removing water respectively within separate predetermined travelable substantially transverse segmental areas on the separating surface, and rotatable means for delivering separately at the same time the several separated products discharged from the separating surface, substantially as described.

6. In a centrifugal ore separator, the combination of rotatable means forming the outer wall of a separating channel and having a separating surface within said channel, a differentially rotatable deflector forming the inner wall of said channel, and adapted to generate an aqueous scouring force within said channel, and a feed distributing device differentially rotatable to said separating surface and deflector, and adapted to deliver material for deposit and separation within a segmental separating zone and water alone in a segmental concentrates removing zone which zones embrace separate segmental areas of the separating surface and are travelable with respect to said surface and the deflector and means for increasing the water discharge capacity from portions of said separating channel while within said concentrates removing zone, substantially as described.

7. In a centrifugal ore separator, the combination of rotatable means forming the outer wall of a separating channel and having a separating surface within said channel, a differentially rotatable deflector forming the inner wall of said channel, and adapted to generate an aqueous scouring force within said channel, a feed distributing device differentially rotatable to said separating surface and deflector, and adapted to deliver material for deposit and separation within a segmental separating zone and water alone in segmental concentrates removing zone which zones are travelable with respect to the separating surface and deflector and means for increasing the water discharge capacity from portions of said separating channel while within said concentrates removing zone, said means embodying reciprocatory mechanism, substantially as described.

8. In a centrifugal ore separator having a rotatable feed distributing device adapted to

feed material for separation and water alone from separate predetermined segmental portions of its circumference, a rotatable deflector, and a rotatable member having a separating surface, the deflector and said member together forming a comparatively shallow circumferentially continuous separating channel adapted to be submerged during operation, and means adapted to increase during substantially constant rotation of the separator, the flow of water through predetermined segmental portions of said separating channel, said feed distributing device, said deflector and said member having the separating surface all being differentially rotatable with respect to each other, substantially as described.

9. In a centrifugal ore separator, the combination of a rotatable vessel having a separating surface adapted to be submerged while in operation, differentially rotatable means for supplying material for deposit and separation within particular segmental separating zones on said separating surface, rotatable means for supplying concentrates removing water within particulan segmental concentrates removing zones on said separating surface, said vessel provided with primary and secondary discharge holes and mechanism for closing said secondary holes while passing through desired zones of action and opening them within other desired zones of action, and means differentially rotatable to the separating surface and said rotatable material supply means for frictionally generating an aqueous washing force on said surface, substantially as described.

10. In a centrifugal ore separator, the combination of rotatable means forming one wall of a separating channel and having a separating surface within said channel embodying a separating area and a concentrates removing area relatively circumferentially travelable to said surface, a differentially rotatable deflector forming one wall of said channel and adapted to frictionally generate an aqueous scouring force in said channel, a feed distributing device differentially rotatable to said separating surface and deflector, and adapted to deliver material for deposit and separation within said separating area, and discharge means from said separating channel provided with primary and secondary discharge holes and means for closing said secondary holes while passing through particular zones, substantially as described.

11. In a centrifugal ore separator, the combination of rotatable means having a separating surface, a differentially rotatable deflector adapted to frictionally generate an aqueous scouring force on said surface, differentially rotatable feed means embodying a feed passage and having multiple channels extending from the circumference of said passage and terminating in groups circumferentially, adapted for delivery of material or water throughout a desired portion of the circumference of said feed means, and means differentially rotatable to said feed means having multiple channels for delivery of material water from said feed means and conducting it to the separating surface and rotatable means adapted to deliver separately the several separated products from the separating surface, substantially as described.

12. In a centrifugal ore separator, the combination of a rotatable element having a separating surface, a differentially rotatable deflector adapted to frictionally generate an aqueous scouring force on said separating surface, differentially rotatable feed means embodying several feed passages and having multiple channels extending from the respective circumferences of said feed passages and terminating in groups in positions adapted for the delivery of material or water within desired separate portions of the circumference of the feed means, means differentially rotatable to said feed means for conducting material and water from said feed means to the separating surface and rotatable means adapted to deliver separately the separated products discharged from the separating surface, substantially as described.

13. In a centrifugal ore separator, the combination of a rotatable element having a separating surface, a differentially rotatable deflector adapted to frictionally generate an aqueous scouring force on said separating surface, differentially rotatable feed means embodying several feed passages and having multiple channels extending from the respective circumferences of said feed passages and terminating in groups in positions adapted for the delivery of material or water within desired separate portions of the circumference of the feed means, means differentially rotatable to said feed means for conducting material and water from said feed means to the separating surface terminating substantially in alinement with the separating channel between the deflector and element having the separating surface, and rotatable means adapted to deliver separately the several separated products discharged from the separating surface, substantially as described.

14. In a centrifugal ore separator, the combination of a rotatable element having a separating surface, means adapted to distribute material for deposit and separation on said surface within particular separating areas, a deflector adapted to frictionally generate a circumferential aqueous washing current on said surface, means adapted to catch separately the several separated products discharged from the separating surface, said distributing means and said means for catching material being differentially ro-

tatable in reverse directions with respect to the separating surface, substantially as described.

15. In a centrifugal ore separator having a rotatable separating surface and a separating channel adjacent thereto, the combination of means for distributing material for deposit and separation on said surface within particular separating areas, means for generating a circumferential aqueous washing current in the separating channel and on said surface, said means for generating a washing current and said distributing means being rotatable relatively in reverse directions with respect to the separating surface, substantially as described.

16. In a centrifugal ore separator, the combination of a rotatable feed distributing device provided with a feed receiving passage for material and having multiple channels extending therefrom, terminating in groups adapted to deliver material for separation within a predetermined part of the circumference of said device, and provided with a feed receiving passage for water alone having multiple channels terminating in groups within other predetermined portions of the circumference of said device, a differentially rotatable vessel portion forming the outer wall of a separating channel which is adapted to be filled with water during operation, a deflector portion differentially rotatable to the distributing device and the vessel portion forming the inner wall of said separating channel and adapted to frictionally generate an aqueous scouring force within said channel, the distributing device establishing in part a separating zone and a concentrates removing zone within the separator, said separating surface relatively travelable to said respective zones and adapted to receive material for separation within the separating zone and to carry concentrates for removal onto the concentrates removing zone, substantially as described.

17. In a centrifugal ore separator, the combination of a rotatable vessel forming one wall of a separating channel and having a separating surface within said channel, a differentially rotatable deflector forming the outer wall of said channel, a feed distributing device differentially rotatable to said vessel and deflector and provided with feed receiving passages, and passages for water alone, and having channels from said passages adapted to deliver the said material from predetermined portions of the circumference of said distributing device and water alone from other predetermined positions of said distributing device, a member surrounding said feed distributing device differentially rotatable thereto and provided with multiple chambers adapted to receive separately the elements delivered from the different circumferential portions of said distributing device, and means provided with multiple channels communicating with said multiple chambers, adapted to deliver separately the elements from said chambers to the desired circumferential portions of the separating surface, substantially as described.

18. In a centrifugal ore separator, the combination of a rotatable vessel having a substantially closed top and open bottom, and having a separating surface on its inner wall, a feed distributing device differentially rotatable to said vessel with multiple channels adapted to deliver material for separation from predetermined portions of its circumference and water alone from other predetermined portions of its circumference, means surrounding said feed distributing device and differentially rotatable thereto provided with multiple chambers, means adjacent to the closed top of said vessel provided with multiple channels communicating with said chambers, and adapted to deliver material and water to desired portions of said separating surface, substantially as described.

19. In a centrifugal ore separator, the combination of a rotatable vessel centrally mounted on a supporting shaft and forming one wall of a separating channel and having a separating surface within said channel, a differentially rotatable deflector mounted on a sleeve journaled around said shaft below the engagement of said vessel with the shaft, and forming the other wall of said channel, a feed distributing device mounted on a sleeve journaled around the shaft above the engagement of the vessel with the shaft, and differentially rotatable to said vessel and deflector and provided with a feed receiving passage for material for separation, and for water alone, and having multiple channels from said passages adapted to deliver material for separation from predetermined portions of the circumference of said distributing device and water alone from other predetermined portions of said distributing device, means surrounding said feed distributing device differentially rotatable thereto and provided with multiple chambers adapted to receive separately the elements delivered from the different circumferential portions of said distributing device, means provided with multiple chambers and adapted to deliver separately the elements from said chambers to desired circumferential portions of the separating surface and means for independently rotating said vessel said deflector and said feed distributing device, substantially as described.

PHILIP F. PECK,

Witnesses:
W. H. PECK,
HAROLD G. BARRETT.