P. F. PECK.

CENTRIFUGAL ORE SEPARATOR.

APPLICATION FILED JULY 22, 1908.

917,120.

Patented Apr. 6, 1909.

3 SHEETS—SHEET 1.

Fig 1

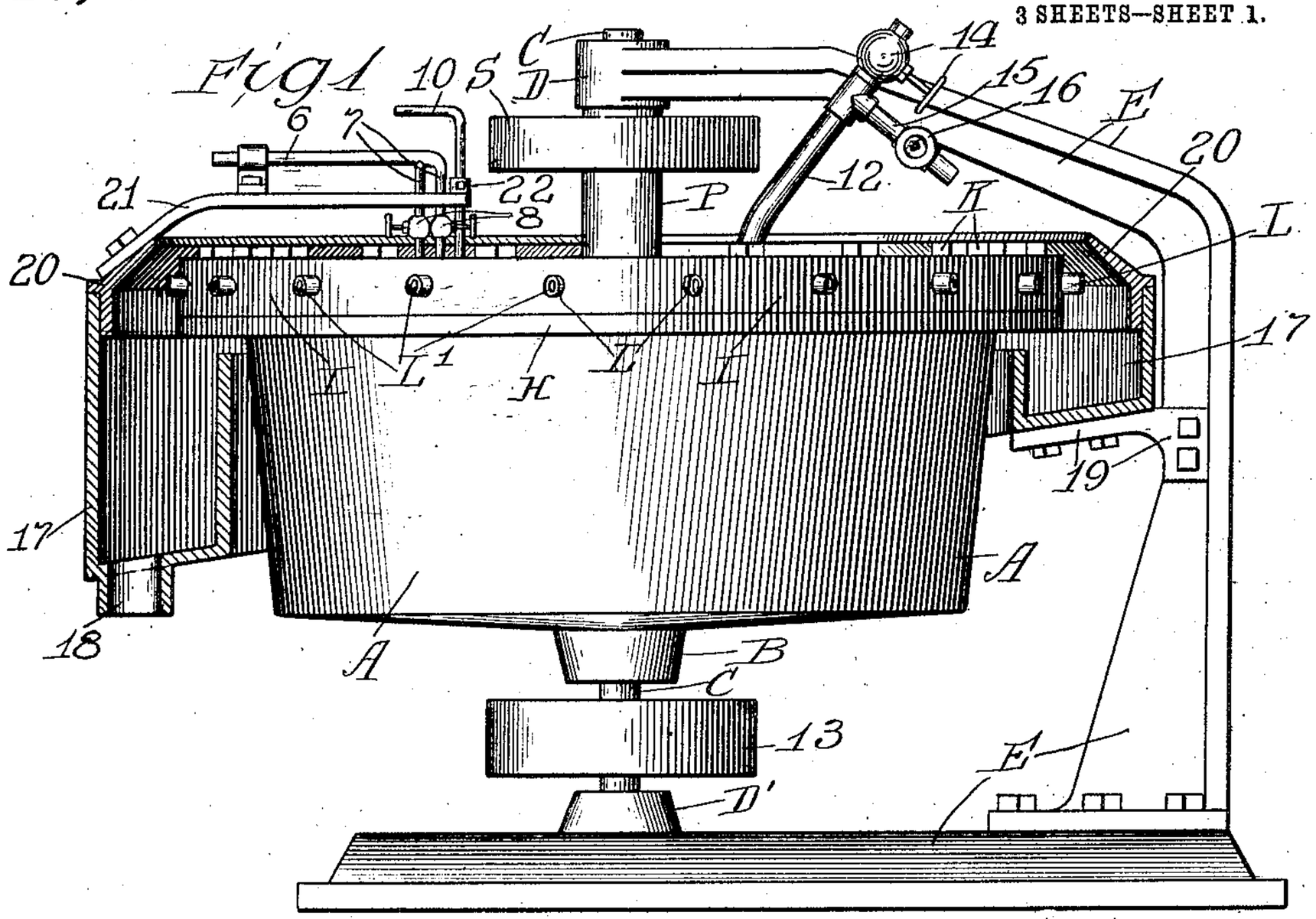
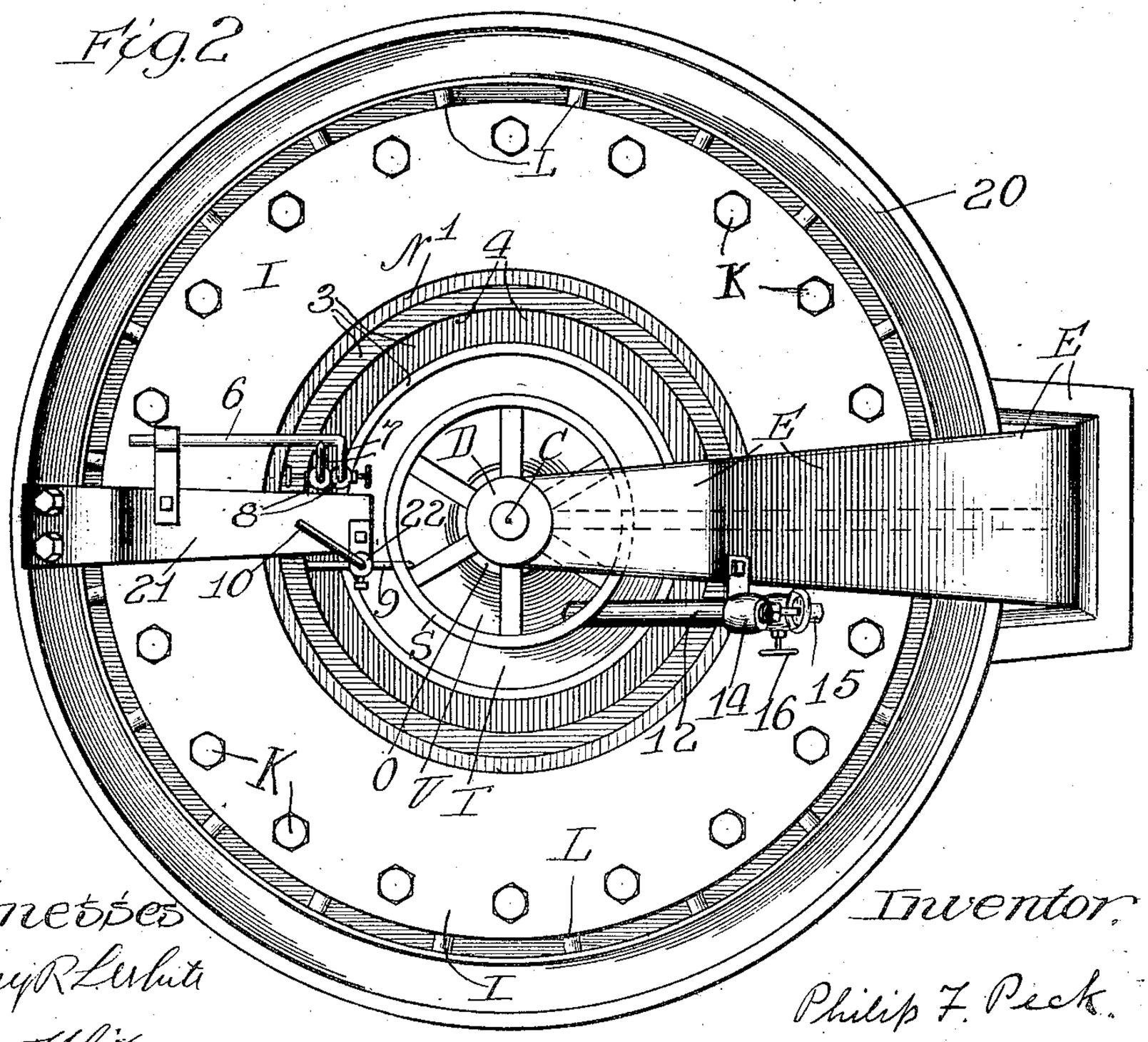


Fig. 2



Witnesses
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3 SHEETS—SHEET 2.

Fig. 3.

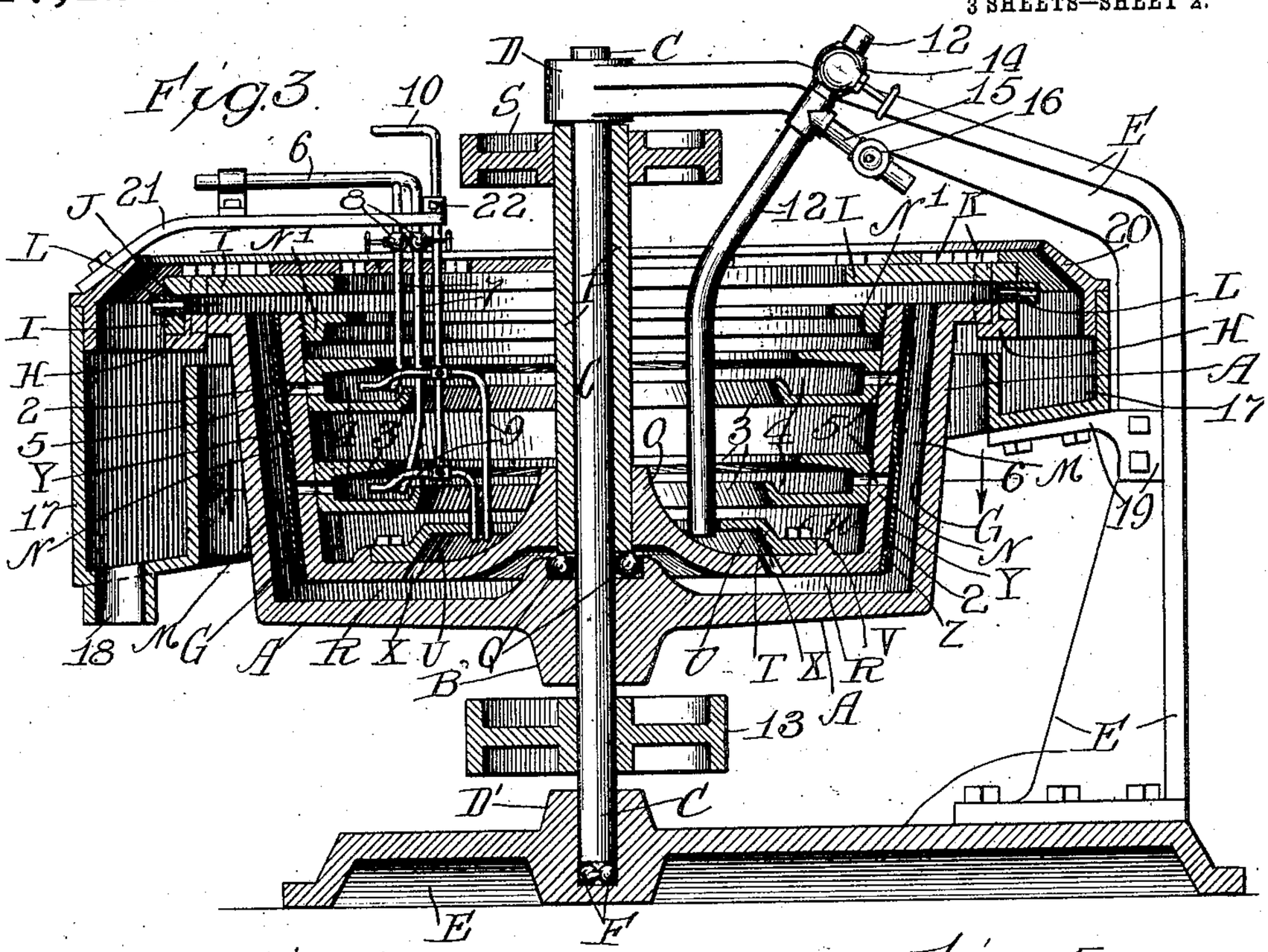


Fig. 4

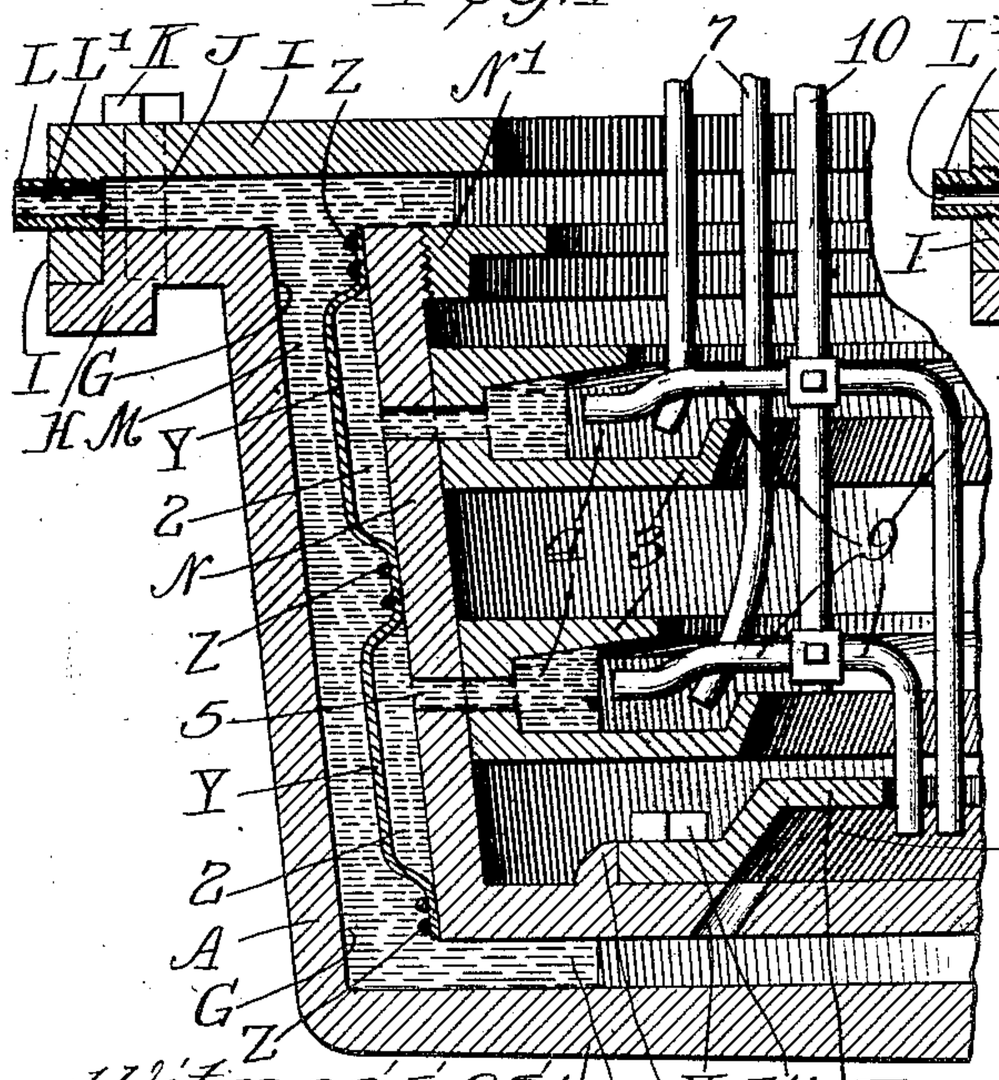
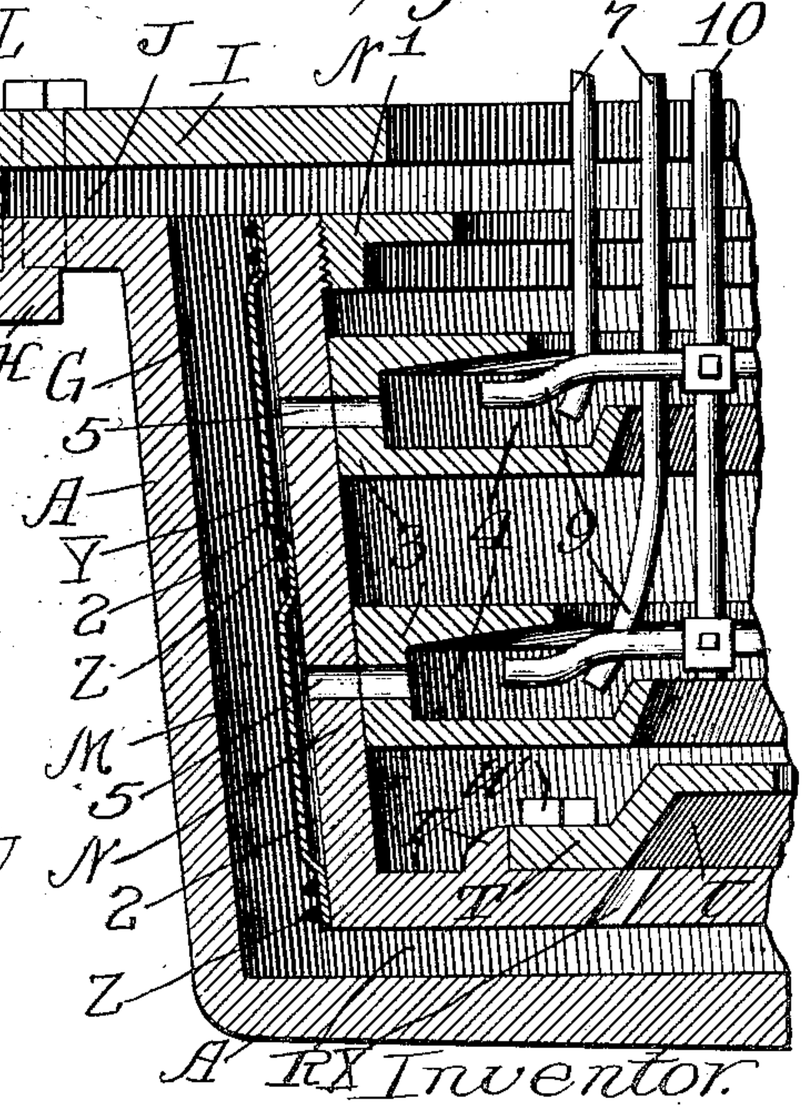


Fig. 5



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3 SHEETS—SHEET 3.

Fig 6

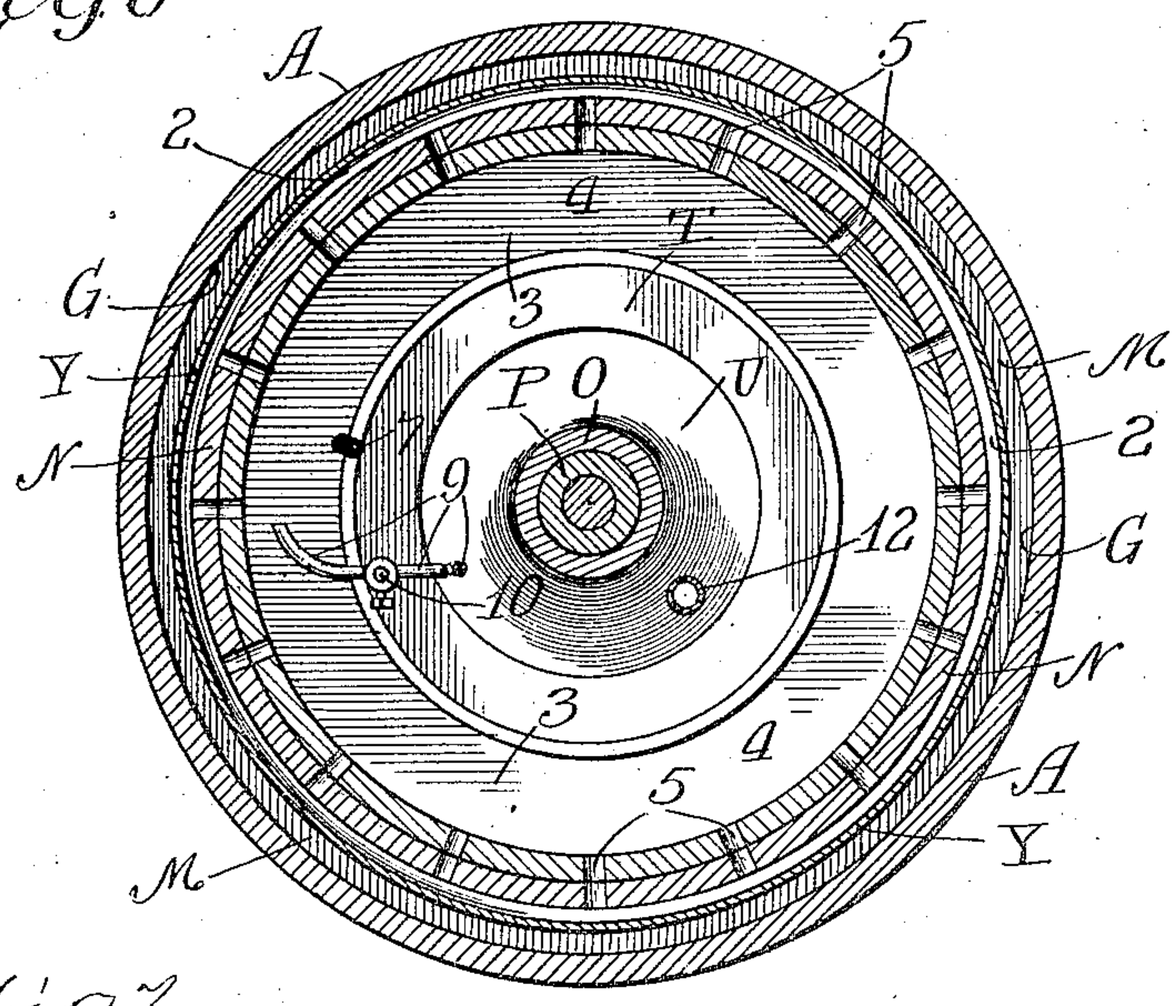


Fig 7

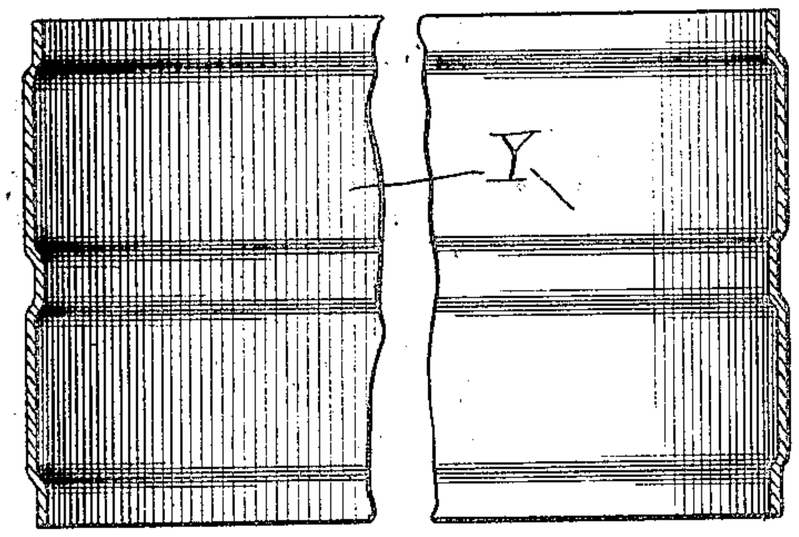


Fig 8

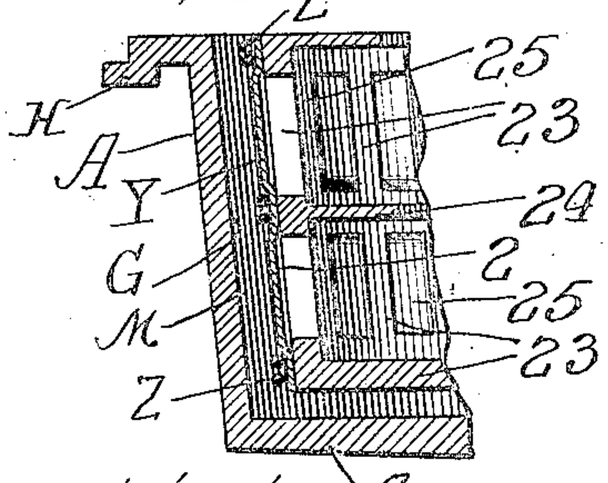
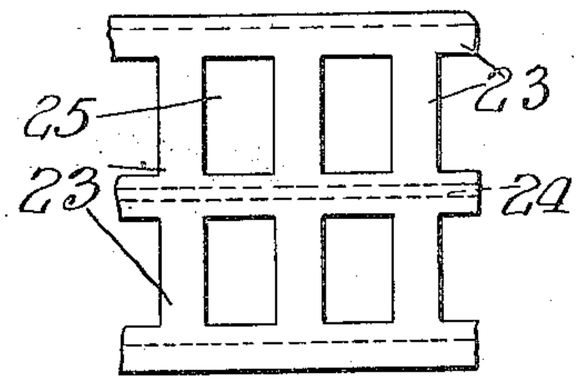


Fig 9



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UNITED STATES PATENT OFFICE.

PHILIP F. PECK, OF CHICAGO, ILLINOIS.

CENTRIFUGAL ORE-SEPARATOR.

No. 917,120. Specification of Letters Patent. Patented April 6, 1909.

Application filed July 22, 1908. Serial No. 444,787.

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 objects of my invention are to construct a separator employing centrifugal force and assisting agencies for separation of particles of waste and value in pulverized ores while mixed with liquid, in the most complete manner, with as slight a loss as possible, as hereinafter more fully set forth, and of the same general character or class as those illustrated in my applications Serial Nos. 453,526 and 453,527, both filed September 17, 1908, and application Serial No. 456,060, filed October 3, 1908.

In the accompanying drawing Figure 1 is a side elevation of the rotatable portions and the frame of my separator, as well as showing the launder in transverse central section. Fig. 2 is a top plan view of my separator. Fig. 3 is a transverse vertical central section of my separator, excepting the frame, which is shown in side elevation. Fig. 4 is principally an enlarged transverse section of the left side of the main rotating parts, similar to that illustrated in Fig. 3, but with the flexible portion shown partly expanded and with liquid shown present as it occurs during operation. Fig. 5 is similar to Fig. 4 except that the liquid is not illustrated present, and the flexible portion is shown as contracted to substantially its minimum size. Fig. 6 is a transverse section of my separator, on line 6—6, of Fig. 3, looking in the direction of the arrows, showing a distended state of the flexible portion, as in Fig. 4. Fig. 7, is a vertical cross section of the flexible covering element to the deflector, removed and broken near its center to reduce the size of this figure. Fig. 8, is a transverse sectional view similar to Fig. 4 of the separator, showing a modified deflector supporting part. Fig. 9, is an outside elevation of a fragmentary segmental part of the deflector supporting structure, illustrating the modification presented in Fig. 8.

In making my improved centrifugal separator, I provide a member having a separating surface, which member I prefer to be in the form of a vessel A, with a closed bottom and substantially open top. The bottom of the vessel has a central hub B, that engages rigidly a shaft C, that is mounted in journal boxes D and D′, respectively, to support it vertically; the journal boxes are attached to a suitable general supporting frame E of the separator, and the lower end of the shaft is stepped on an anti-friction bearing F, (Fig. 3) to carry its weight. The vessel A is turned smoothly on its inner wall, which affords the separating surface G, over which the substances to be separated pass, as hereinafter described, and the rim of the open or upper edge of the vessel is flanged outward as shown and indicated by H, which flange has an annular recess at its outer top edge, around into which the depending part of the ring I, is seated. The ring I, from its depending part extends inward some distance toward the axis of the vessel, thereby partly closing the opening in the top of the vessel. The depending part on this ring is some greater in width than the depth of the annular recess in the flange H, so there is left between the ring and the flange, when the two are seated together, an annular space J. The vessel is preferably made larger at its open end than at its closed, thereby inclining its walls and the separating surface outward from the bottom of the vessel as illustrated toward its top. The ring I, extends a greater distance toward the axis than the extent of outward slant or inclination of the walls of the vessel, so that the bore or opening of the ring is less in diameter than the diameter of the bottom of the vessel, resulting, when desired during operation, in a sufficient body of the liquid, supplied to the vessel, being retained in the vessel to fill the separating passage and submerge its inner walls and the separating surface. The ring I is held in place on the flange of the vessel by the screws K, which pass through the ring and are threaded into the flange as shown. This ring around its outer diameter, through its depending part is provided with a row of screw threaded holes communicating with the space J, into which are placed plugs L, that are provided with small holes L′ shown in Figs. 4 and 5, of suitable size to permit of discharge of liquid and material from the vessel, yet to retain a sufficient quantity in the vessel to fill the separating channel and submerge the separating surface, as above stated.

Located inside of the vessel A, and together with said vessel forming a separating

passage M, I provide a member to serve as a deflector which preferably embodies a substantially non-elastic supporting element or portion N which I have illustrated in form of a vessel, although this part may be any other design of supporting structure that will subserve the purposes required, I will in most places in the specification refer to it as the "deflector vessel." This deflector vessel has a closed bottom and an open top, except that at its top is a ring N′ in threaded engagement with it. The deflector vessel is also somewhat smaller in diameter than the inside of the vessel A, thereby leaving the separating passage M, adjacent to the separating surface, it is also somewhat shorter than the inside of the vessel A, and has a central hub O, which securely and rigidly engages the lower portion of the sleeve P, that is mounted in a rotatable manner around the central shaft C.

Between the upper end of the hub B, and the lower end of the sleeve P, I provide a bearing Q, (Fig. 3), which is preferably of an anti-friction type; this bearing is of sufficient thickness to hold the bottoms of the vessels A and N apart, and leave a comparatively small space R between them as shown.

On the upper end of the sleeve P, I provide a pulley S, by which the sleeve with the deflector may be revolved differentially to the vessel A, by means of any suitable belt (not shown) from an appropriate source of power.

Around the hub O of the deflector vessel, I provide a ring T, which rises above the bottom of the vessel and forms a feed chamber U. The ring has a central opening at its top, considerably larger than the outer diameter of the hub O, leaving an annular space around the hub through which liquid and material may be introduced into the feed chamber U. This ring T has an outwardly extended flange at its lower edge, that fits in the recess inside of the raised boss V on the bottom of the deflector vessel, and is tightly secured to the vessel by the screws W. Near the outer diameter of this feed chamber, I provide a number of holes X, through the bottom of the deflector vessel, which serve as material and liquid passages from the feed chamber down into the space R, whence such material and liquid actuated by centrifugal force may be driven into the separating passage as hereinafter described.

The deflector member, in addition to the supporting part or element N, which is illustrated as a vessel, embodies a flexible part which I prefer to form by surrounding the circumference of the supporting part with an expansible element Y that may be in the nature of a suitable piece of rubber fabric, jacket or tubing securely and appropriately fastened to the supporting part. The fastening of this expansible element to the supporting vessel or element N, is preferably effected by tightly winding several strands of wire Z around over the desired places and twisting or otherwise suitably securing the ends of the wire together. In this way the larger part of the circumferential area of the deflector vessel and the expansible jacket element are unattached, and form facility for expansion chambers 2, which are adapted to receive liquid under pressure for expanding the jacket element to enlarge the deflector and proportionately decrease the depth of the separating passage as hereinafter described. The strands of wire wrapped around this expansible element establishes a complete substantially liquid tight partition or division between these expansion chambers, making them closed or practically so with respect to each other, and cause the expansible member to be revolved with the deflector vessel during operation. The number of these expansion chambers may be varied if desired, and while I prefer to have them substantially continuous circumferentially, and have so illustrated them, they may be made otherwise if desired.

On the inside of the deflector vessel I have provided facility for supplying liquid to the expansion chambers, by means of annular groove or trough shaped rings 3, adapted to receive liquids in their channels 4, while they are in a state of rotation. The outer circumferences of these rings are of size to tightly fit within the inner wall of the deflector vessel,—one of which is located preferably in transverse axillar alinement with each of the expansion chambers. Around the bottoms of these ring shaped troughs are several holes 5, extending from the channels 4 in the troughs through the wall of the deflector vessel, and communicating with their respective expansion chambers. During operation of the separator, liquid introduced into the channels 4 is in part driven by the action of centrifugal force through the holes 5, into the expansion chambers 2, becoming expanding liquid, and by liquid pressure distending or expanding the jacket element Y outward, enlarging the diameter of the deflector and proportionately diminishing the size or depth of the space M, which is the separating passage. The degree of expansion of this jacket element depends largely on the quantity of liquid introduced and maintained in the channels 4, as hereinafter more fully explained. As means for introducing liquid into these channels 4, to effect expansion, there is provided a pipe 6, having branches 7 with their delivery ends in position to flow the liquid into the respective channels, and in each of these branches is a valve 8, which affords facility for independently regulating the supply of liquid flowed into the different channels 4, resulting in the degree of disten-

tion of the expansible element over the area of the different expansion chambers and separating surface, being regulated and governed independently of each other.

The accumulation or quantity of liquid for effecting expansion, which it is desired and permitted in the separator is not only regulated by the valves 8, but any excess of such liquid that may be introduced is scooped out and removed by pipes or conduits 9, of shape to permit their open ends to operate on and against the surface of the revolving body of liquid in the respective channels 4. Scooping the liquid out of the channels at a greater distance from the axis, lessens the liquid pressure in the expansion chambers and permits a proportionate contraction of the jacket element or portion N and consequently enlarges the separating passage as desired, thereby the conduits form means for limiting the quantity of liquid exerting expanding pressure on the jacket or expansible element, independently of the rotating speed of the deflector member, and together with the movably supporting rods 10, hereinafter described, form variable and adjustable means for regulating and limiting such expanding pressure. The amount of expanding liquid removed from either of the channels 4, and their associate expansion chambers, will depend on how far the operating end of the conduit 9 affecting it, is moved out toward the bottom of that channel 4.

The conduits 9 are supported by the rod 10 through the swiveled clamps 11 and may be independently adjusted to bring their scoop ends in or out in position to remove the expansion liquid from a greater or less depth in the channels 4, and the delivery ends of these conduits may terminate at any suitable place to dispose of the removed liquid but I have illustrated them in position to deliver it into the feed chamber U, of the separator, whence it passes through the separating passage.

Water or other liquid with material to be separated is fed to the separator from any suitable source of supply, through a conduit, which I have shown as a pipe 12, with its end entering the space leading into the feed chamber U. From the feed chamber, during operation, the liquid and material pass through the holes X, down into the space R, and, actuated by centrifugal force, are driven up into the separating passage M with pressure resulting from said force on the liquid in the separating passage as well as by the force on progressively following liquid flowing in the space R. The pressure of the liquid in the separating passage exerts a resisting force on the outer surface or wall of the expansible element Y, to the latter's expansion and at the same time, and thereby exerts a liquid compression force thereon, so that it follows that during operation, while liquid is in the separating passage, being actuated by centrifugal force, and liquid is also in the expansion chambers, being actuated by centrifugal force, the expansible element Y is operating between two bodies of liquid under pressure and will yield in expansion or contraction as the case may be, to the body of liquid which exerts a sufficiently greater or excess pressure to effect such result. Thus, while operating between yieldable expansion and compression forces, it will automatically vary the size of the separating passage in conformity with the variation of the expansion and compression forces operating against its respective sides. If it is desired during operation to procure a greater degree of expansion and greater size of the deflector, which will decrease the depth of the separating passage, the operating ends of the conduits 9, may be adjusted nearer to the separator axis and permit a greater accumulation of liquid in the channels 4, resulting in a deeper column of liquid accumulating in the said channels being actuated by centrifugal energy and exerting a consequent greater expanding liquid pressure against the inner wall of the expansible element. This condition may be developed sufficiently to over-balance the compression pressure of the liquid in the separating passage and effect expansion to the extent wished. If it is desired to produce greater expansion in one of the expansion chambers than in another, the position of the conduit 9 which operates with respect to that particular chamber may be adjusted independently to permit a deeper accumulation of actuating expansion liquid for that chamber, and vice versa. During operation of the separator the vessel or member carrying the separating surface is revolved at a desired rate of speed by a belt (not shown) passing around the pulley 13, from any suitable source of motive power, and the deflector is revolved at a sufficient speed differential to the separating surface to effect purposes desired. During this time, as has been hereinabove explained, the expansible element or portion of the deflector is operating between the expanding pressure of the liquid in the expansion chambers and the compression pressure of liquid in the separating passage, and from the fact that this expansible element or portion is secured to its supporting part N, it is rotated therewith, and differentially to the vessel A, the separating surface and the liquid and material in the separating passage, and through the instrumentality of the liquid in the separating passage transmits a liquid scouring or washing friction on the separating surface, or material that may be thereon. The effectiveness of this scouring friction and its practical results in aiding separation depend largely on the nearness of operating

proximity of the flexible element to the surface where separation is being effected, and to obtain the desired nearness of operating position of these differentially moving surfaces, and consequent intensity of frictional wash, a sufficient quantity of liquid may be introduced and maintained in the channels 4 as above explained, to create requisite expansion pressure to effect this purpose, and as separated material lodges and beds on the separating surface, contracting the separating channel, liquid may be removed by the conduits 9 from the channels 4 to permit of a corresponding compression or contraction of the flexible element, to proportionately increase the depth of the separating passage.

The compression force on the flexible element Y depends partly on the nearness of approach to it of the accumulating concentrates on the separating surface, and as a result, even though liquid is not removed from the channels 4, as such accumulation occurs, the expansible element will be automatically forced backward, but not in so satisfactory manner as when part of the liquid is gradually removed from the channels 4.

In operation the liquid, which I prefer to be water, with finely pulverized material to be separated, in a state to flow freely, is introduced into the separator through the pipe 12 hereinabove described, and is driven into the separating passage, the liquid accumulating in a sufficient body to fill the separating passage, the lighter portion of the material with the liquid then passes up over the separating surface and over its top edge into the space J and to discharge through small holes L′ in the plugs L, while the heavier parts of the material lodge on the separating surface. At the beginning of the operation the member Y is expanded to approach within a short distance of the separating surface in order that its washing friction for assisting in separation may be sufficiently effective, as well as to prevent irregularities or unevenness in the bedding of separated material. As the operation proceeds and the separated material accumulates in a bed on the separating surface, filling the separating passage to that extent, the flexible element Y is progressively contracted until there has been a sufficient quantity of separated material or concentrates bedded in the separating channel to practically fill it, then the flow of water with the material for separation is discontinued by closing the valve 14, and the speed of the vessel having the separating surface is decreased to a comparatively slow velocity, which lessens the degree of centrifugal force by which the bedded material is held on the separating surface, and clean water is introduced by means of the branch pipe 15, which connects with a suitable source of preferably clean water supply, the volume of which is regulated by the valve 16. The high speed of rotation of the deflector is maintained during this time, which greatly increases the differential velocity, and automatically the intensity of the scouring force in the separating channel. The intensity of the scouring force is automatically increased because the pressure in the expansion chambers remains constant, actuated under constant rotation of the deflector, while the compression or resisting force of liquid in the separating passage is much reduced under the decreased rotary velocity of the vessel A. The greater friction then operating against the bedded material, which is being held with reduced security, causes this material to quickly yield and be carried out and discharged with the water or other liquid through the holes in the plugs L where it is caught in the launder 17, and as discharged from said launder through the opening 18, may then be diverted to any place desired. The launder is supported by the bracket 19, and has a removable cover or top 20. While the bedded accumulation of separated concentrates is being removed, the pressure of the liquid in the expansion chambers forces the flexible element outward, keeping its outside surface in close operating proximity for effecting that purpose, and if desired during this time, expansion may be further augmented by permitting a greater accumulation of liquid in the channels 4. After the accumulation of separated material has been discharged, the greater speed of rotation of the vessel A is restored, the clean water valve 16 closed and the material valve 14 opened and the operation is repeated. If there is then a more excessive expansion pressure being exerted on the flexible element than required to best facilitate separation it may be reduced to the desired extent by removing part of the liquid from the channels 4 by means of the pipes 9. The pipes 6, it will be seen, are suitably supported by the arm 21, and the rod 10 is also adjustably supported to this arm by the bracket 22, through which it passes. The pipe 12 is secured to the general frame of the separator as illustrated.

In the modification shown in Figs. 8 and 9, I have employed a supporting element for the flexible member 23 more in the form of frame work than is the deflector vessel 11, shown in other figures, and I have also omitted the channeled rings 3, employing instead a partition ring 24, Fig. 8, which, together with the element 23, forms annular liquid channels or receptacles 25, from which the liquid passes readily into contact with the flexible member Y, through the openings in the supporting element 23.

By the term "separating surface" in the specification and claims I mean it in a broad sense and not necessarily to imply a continuous smooth even surface, and of course it will be understood that the various rota-

table parts of the separator will be finished true and concentric, or otherwise made in a manner to permit them to subserve the purposes desired and to be revolved at a sufficiently high speed without serious vibration. I prefer that all parts where practicable be turned smooth and even. I desire to further state that in the specification and claims where I have used the expression that the vessel or member having the separating surface and the member having the expansible element together form the separating passage, I do not mean to necessarily imply that they wholly form such passage, as they may only in part form it and still come within the scope of my meaning, claims and invention.

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

1. In a centrifugal separator, the combination of a rotatable member having a separating surface, a member differentially rotatable thereto in part forming with said first member a separating passage, the second member embodying an element in proximity to the separating surface adapted to be expanded by liquid pressure, and means adapted to supply liquid for effecting said expanding pressure, substantially as described.

2. In a centrifugal separator, the combination of a rotatable member forming one wall of a separating passage, and a member differentially rotatable thereto in part forming the separating passage which is adapted to contain a body of liquid while in operation, the second member embodying an element adapted to be expanded by liquid pressure and to be periodically contracted by pressure of liquid in the separating passage, substantially as described.

3. In a centrifugal separator, the combination of a rotatable member having a separating surface, a member differentially rotatable thereto, forming in part with said first member a separating passage which is adapted to contain a body of liquid while in operation, the said second member embodying an exterior element adapted to hold liquid while in operation and to be expanded and contracted by liquid pressure actuated by centrifugal force, substantially as described.

4. In a centrifugal separator, the combination of a rotatable member, forming one wall of a separating passage, a member differentially rotatable thereto, in part forming said separating passage which is adapted to contain a body of liquid while in operation, the second member embodying a substantially non-expansible supporting element and an expansible element adapted to hold liquid while in operation and to be periodically expanded and contracted by liquid pressure actuated by centrifugal force, and means for supplying liquid for effecting said pressure, substantially as described.

5. In a centrifugal separator, the combination of a rotatable member having a separating surface, a deflector differentially rotatable thereto, forming, with said member, a separating passage which is adapted to contain a body of liquid while in operation, said deflector embodying expansible and contractible means adapted through the instrumentality of liquid pressure to be periodically expanded and contracted thereby effecting contraction and enlargement of the separating passage, substantially as described.

6. In a centrifugal separator, the combination of a rotatable vessel having a separating surface, a member differentially rotatable to said vessel, forming therewith a separating passage, said member embodying a yieldable portion adjacent to the separating passage adapted to be subjected to liquid pressure on both of its sides while in operation and to yield toward or from the axis of rotation forced by the liquid on its side which exerts the greater pressure thereon and adapted to generate liquid frictional force within the separating passage, substantially as described.

7. In a centrifugal separator, the combination of a rotatable member having a separating surface, a member differentially rotatable thereto forming with said first member a separating passage which is adapted to contain a body of liquid while in operation, means for subjecting said liquid to the action of centrifugal force, the second member embodying a flexible element adjacent to the separating passage, which element is adapted to contain a body of liquid and to yield in expansion or contraction to the liquid on its side exerting relatively excess pressure thereon and means for subjecting the liquid in the expansible element to the action of centrifugal force, substantially as described.

8. In a centrifugal separator, the combination of a rotatable member having a separating surface, a member differentially rotatable thereto forming with said first member a separating passage, the second member embodying a yieldable element adapted to be expanded by liquid pressure in relatively varying degrees throughout parts of its area, and means for supplying liquid expansion pressure in relatively varying degrees throughout different parts of the area of said element, substantially as described.

9. In a centrifugal separator, the combination of a rotatable member having a separating surface, and a member differentially rotatable thereto forming with said first member a separating passage which is adapted to contain a body of water while in operation, the second member embodying an element adapted to be expanded by liquid pressure throughout part of its area, irrespective of other parts of its area, substantially as described.

10. In a centrifugal separator, the combination of a rotatable member having a separating surface, a member differentially rotatable thereto forming with said first member a separating passage, the second member embodying an element in part forming liquid containing chambers and adapted to be expanded by liquid pressure relatively to a greater degree throughout one part of its area than another part, and means adapted to supply liquid to said chamber, substantially as described.

11. In a centrifugal separator, the combination of a rotatable member, having a separating surface, a deflector differentially rotatable thereto forming with said member a separating passage which is adapted to contain a body of water while in operation, the deflector embodying an exterior portion adapted to be expanded by liquid pressure throughout parts of its area and means adapted to regulate expanding pressure over parts of said area of said exterior portion irrespective of other parts thereof, substantially as described.

12. In a centrifugal separator, the combination of a rotatable member having a separating surface, a differentially rotatable deflector forming together with said member a separating passage and embodying a substantially non-expansible part and on the circumference thereof an expansible part adapted to be expanded by liquid pressure, said two parts forming a liquid chamber within the deflector and means for introducing liquid in said chamber, whereby expansion is effected, substantially as described.

13. In a centrifugal separator, the combination of a rotatable member having a separating surface, a differentially rotatable deflector forming with said member a separating passage, and embodying a non-expansible part and on the circumference thereof an expansible part, said two parts forming multiple liquid chambers substantially closed with respect to each other, and means for supplying liquid in relatively varying quantities to the separate chambers, substantially as described.

14. In a centrifugal separator, the combination of a rotatable member having a separating surface, a differentially rotatable deflector forming with said member a separating passage and embodying a substantially non-expansible supporting part and on the circumference thereof an expansible part, said two parts forming a substantially continuous liquid chamber around the circumference of the non-expansible part, and means for introducing liquid to said chambers, substantially as described.

15. In a centrifugal separator, the combination of a rotatable vessel having a separating surface, a differentially rotatable deflector forming with said vessel a separating passage and embodying a non-expansible element with a sleeve shaped expansible element secured on its circumference, said elements forming multiple substantially circumferentially continuous liquid chambers around the non-expansible element and means adapted to supply liquid to the respective chambers, substantially as described.

16. In a centrifugal separator, the combination of a rotatable member having a separating surface, a differentially rotatable deflector forming in part with said member, a separating passage and embodying a non-expansible element and on the circumference thereof an expansible element, said two elements in part forming multiple substantially circumferentially continuous liquid chambers around the non-expansible element, means adapted to supply liquid to the respective chambers and means for regulating the quantity of liquid in said chambers substantially irrespective of each other, substantially as described.

17. In a centrifugal separator, the combination of a rotatable member having a separating surface, a differentially rotatable deflector forming with said member a separating passage and embodying a non-expansible element, and on the circumference thereof an expansible element, the two elements in part forming multiple substantially circumferentially continuous liquid chambers around the non-expansible element, means adapted to supply liquid to the respective chambers and adjustable means adapted to automatically limit the quantity of liquid contained in said chambers, substantially as described.

18. In a centrifugal separator, the combination of a rotatable element having a separating surface, a differentially rotatable deflector forming with said element a separating passage and embodying a non-expansible element and on the circumference thereof an expansible element, said t o elements forming multiple substantially circumferentially continuous liquid chambers around the non-expansible element, and an adjustable conduit with an opening adapted to operate against the surface of the expansion liquid affecting said chambers for removal thereof, substantially as described.

19. In a centrifugal separator, the combination of a rotatable member having a separating surface, a differentially rotatable deflector forming with said member a separating passage, the outer circumference of said deflector embodying an expansible element in part forming multiple liquid chambers, elements having liquid channels within the deflector communicating with said liquid chambers and means for introducing liquid into said liquid channels, substantially as described.

20. In a centrifugal separator, the combi-

nation of a rotatable member having a separating surface, a differentially rotatable deflector forming with said member a separating passage, said deflector embodying a yieldable frictional scouring element adapted to operate between two bodies of liquid under pressure, and to be expanded or contracted by the relatively varying pressures of the two bodies of liquid, and means for supplying liquid on both sides of said element, substantially as described.

21. In a centrifugal separator, the combination of a rotatable member having a separating surface, a differentially rotatable deflector, forming with said member a separating passage and embodying a supporting part and a yieldable frictional part secured to the supporting part forming a liquid chamber and adapted to operate between two bodies of liquid under pressure and to be expanded and contracted by the body of liquid exerting the greater pressure thereon, means having annular liquid channels within the deflector, means for introducing liquid into said channels and means for introducing liquid into a separating channel, substantially as described.

22. In a centrifugal separator, the combination of a rotatable member mounted on a supporting shaft and having a separating surface, a differentially rotatable deflector within said member secured to an element journaled around said shaft, the deflector embodying a yieldable element adapted to be expanded and contracted by liquid pressure, a supporting element to said yieldable element, and means for rotating the supporting element around the shaft, substantially as described.

23. In a centrifugal separator, the combination of a rotatable vessel mounted on a supporting shaft and having a separating surface, journal boxes engaging said shaft, a differentially rotatable deflector within the vessel forming therewith a separating passage adapted to hold water while in operation, the deflector embodying a supporting element engaging a sleeve journaled around the vessel shaft and a yieldable element secured to said supporting element, adapted to operate between two bodies of liquid in the separator and to be expanded or contracted by the body of liquid exerting the greatest pressure thereon, means for introducing liquid to both sides of said yieldable element. and means for effecting rotation of the vessel and deflector, substantially as described.

24. In a centrifugal separator, the combination of a rotatable member having a separating surface, a deflector differentially rotatable thereto forming with said member a separating passage, which is adapted to contain a body of liquid while in operation, said deflector embodying expansible and contractible means adapted through the instrumentality of liquid pressure to be periodically expanded and contracted thereby effecting contraction and enlargement of the separating passage, and means for limiting the quantity of expansion liquid within the deflector, substantially as described.

25. In a centrifugal ore separator, the combination of a rotatable member having a separating surface, a member differentially rotatable thereto in part forming with the first member a separating passage, the second member embodying an element in proximity to the separating surface adapted to be expanded during operation and to be automatically contracted by pressure of liquid in the separating passage and means adapted to supply liquid to the separating passage, substantially as described.

26. In a centrifugal ore separator, the combination of a rotatable member having a separating surface, a member differentially rotatable thereto in part forming with the first member a separating passage which is adapted to contain a body of liquid while in operation, a yieldably expansible element adapted to be automatically contracted by pressure of liquid in the separating passage, means adapted to effect yieldable expansion of said expansible element and means for introducing liquid into the separating passage, substantially as described.

27. In a centrifugal ore separator, the combination of a rotatable member, having a separating surface, a member differentially rotatable thereto in part forming with the first member a separating passage, the second member-embodying an element in proximity to the separating surface, adapted to automatically yield to the relatively varying expansion and compression forces operating on its respective sides, effecting substantial contraction or enlargement of the separating passage and means for limiting said expansion force independently of the rotating speed of said second member, substantially as described.

28. In a centrifugal ore separator, the combination of a rotatable member having a separating surface, a member differentially rotatable thereto in part forming with the first member a separating passage, the second member embodying an element in proximity to the separating surface, adapted to be expanded during operation and to be contracted by pressure of liquid in the separating passage, means adapted to limit expansion pressure on said flexible element variable independently of variation of the rotating speed of said element, and means adapted to supply liquid to the separating passage, substantially as described.

29. In a centrifugal ore separator, the combination of a rotatable member having a separating surface, a member differentially rotatable thereto in part forming with the

first member a separating passage, the second member embodying an element in proximity to the separating surface adapted to be expanded during operation, relatively to a greater degree throughout one part of its area than another part thereof and to be contracted by pressure of liquid in the separating passage, and means adapted to supply liquid to the separating passage, substantially as described.

PHILIP F. PECK.

Witnesses:
JOHN G. CAMPBELL,
JESSE E. PECK.