P. F. PECK.

CENTRIFUGAL ORE SEPARATOR.

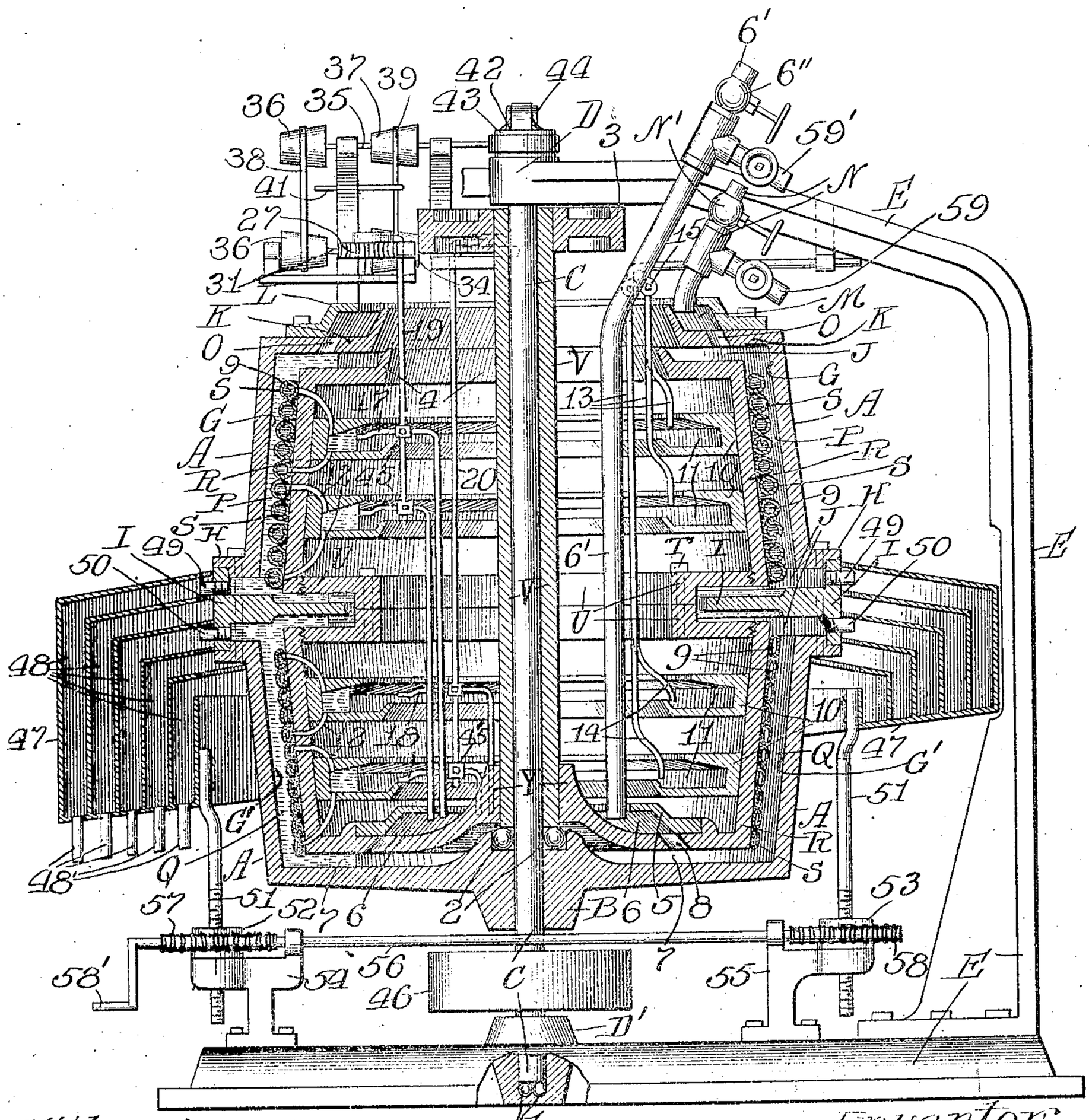
APPLICATION FILED SEPT. 17, 1908.

917,122.

Patented Apr. 6, 1909.

4 SHEETS—SHEET 1.

Fig. 1.



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4 SHEETS—SHEET 2.

Fig. 2.

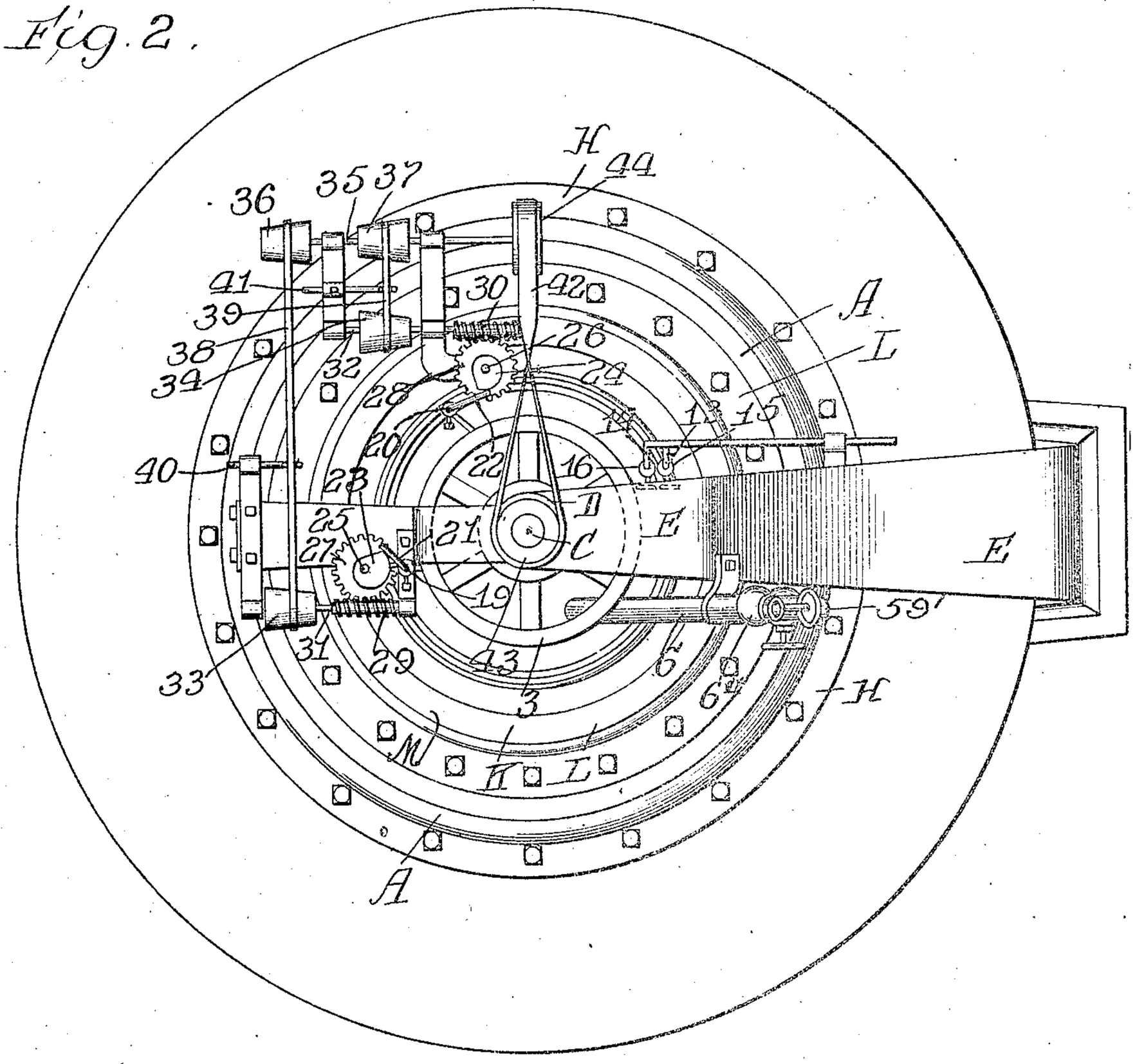
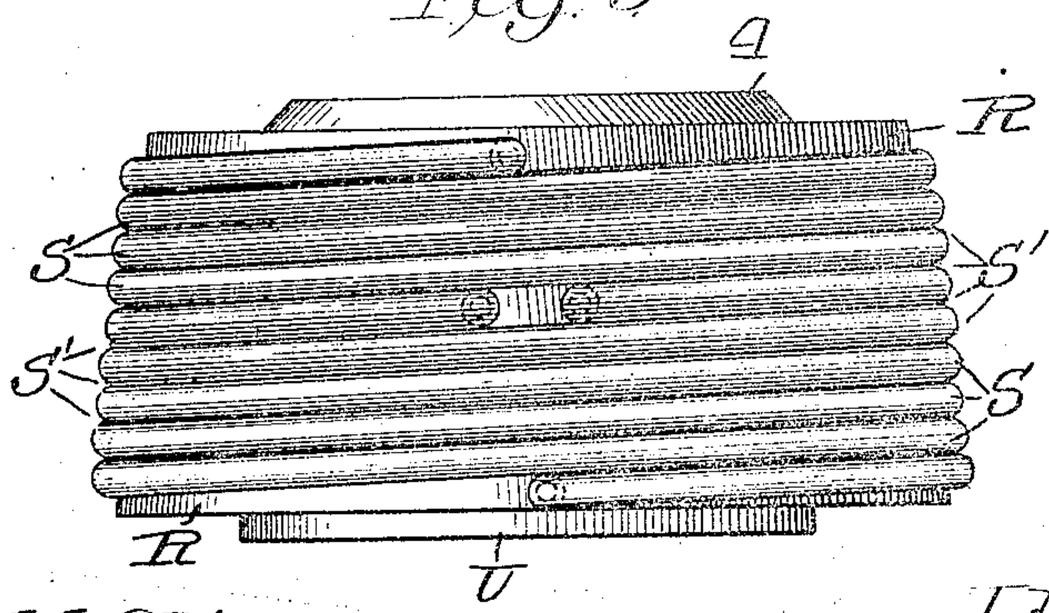


Fig. 3



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4 SHEETS—SHEET 3.

Fig. 4.

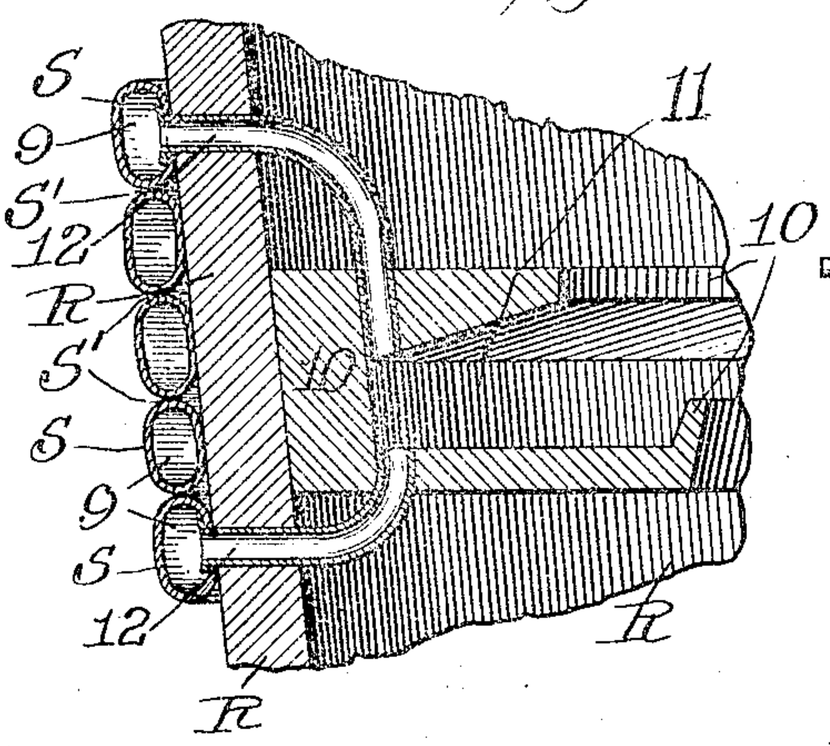


Fig. 5

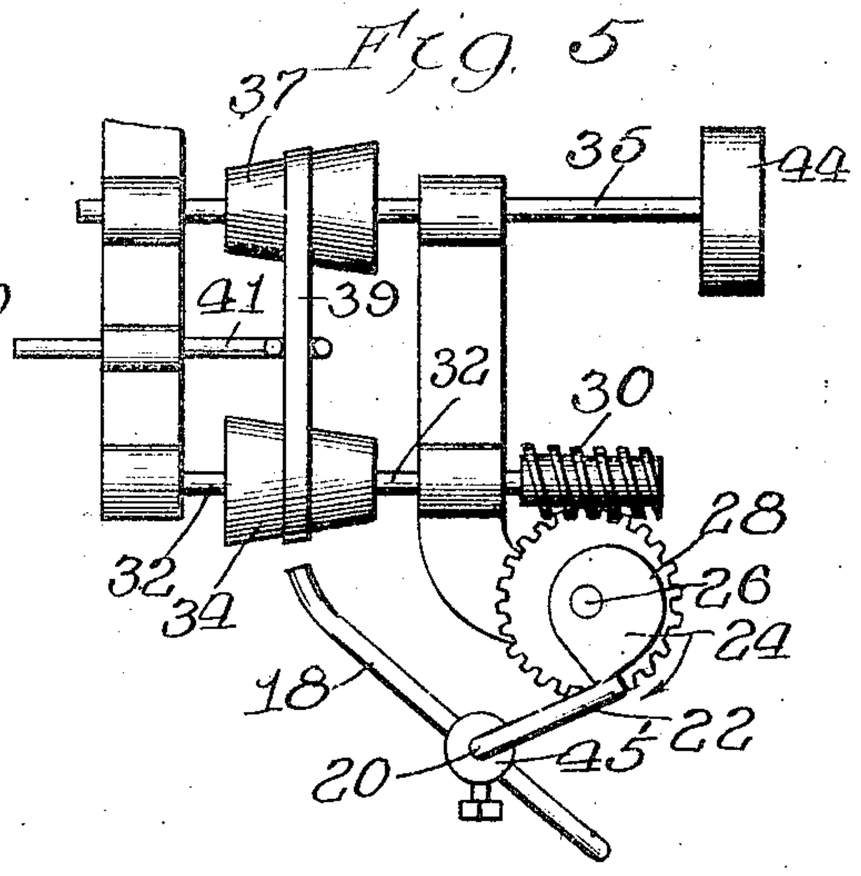


Fig. 6

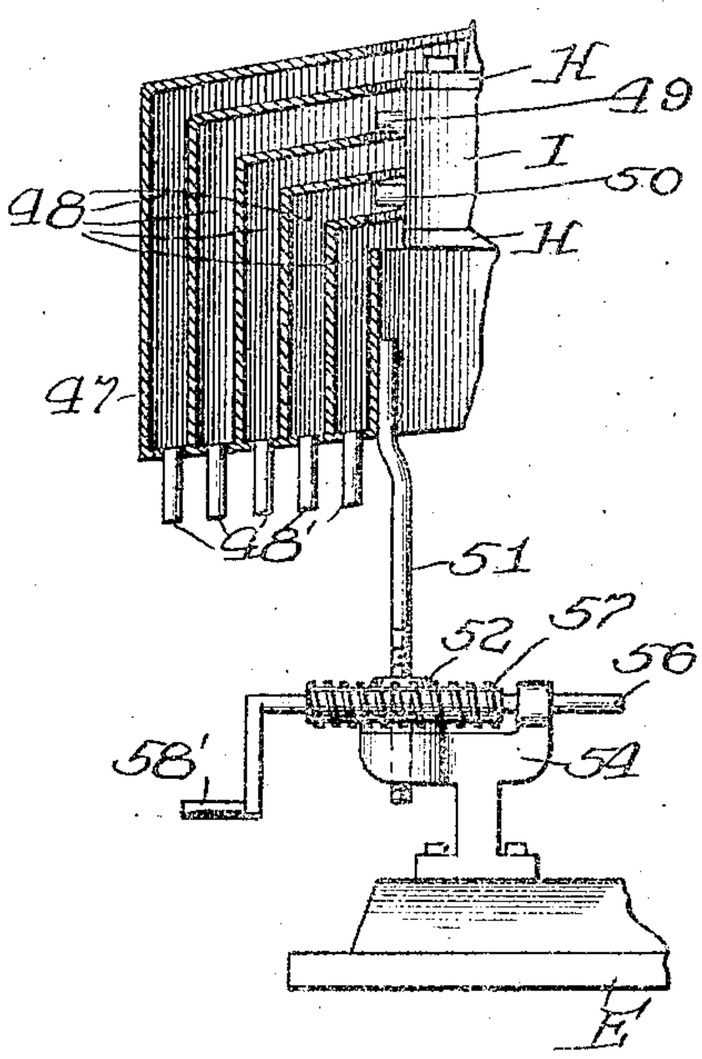
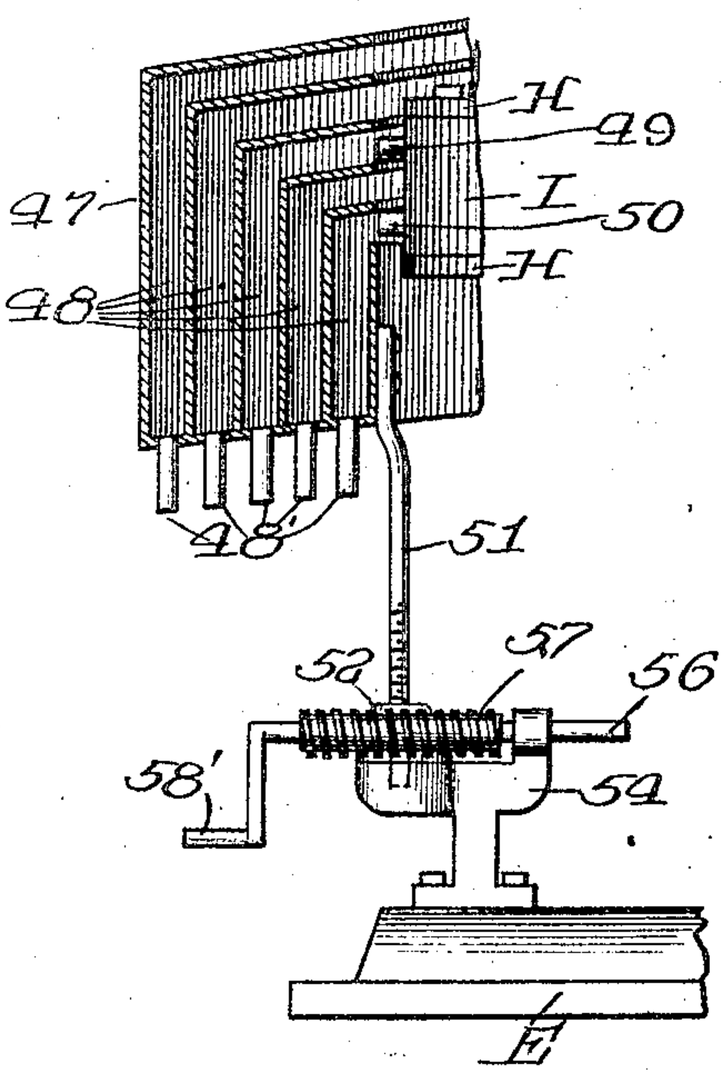


Fig. 7.



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4 SHEETS—SHEET 4.

Fig. 8

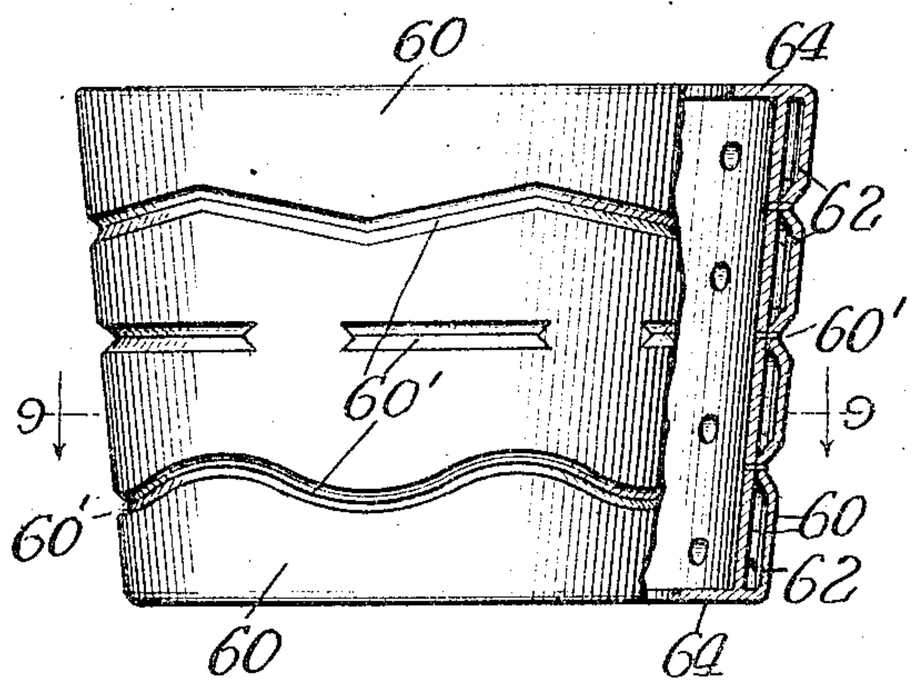


Fig. 10

Fig. 9

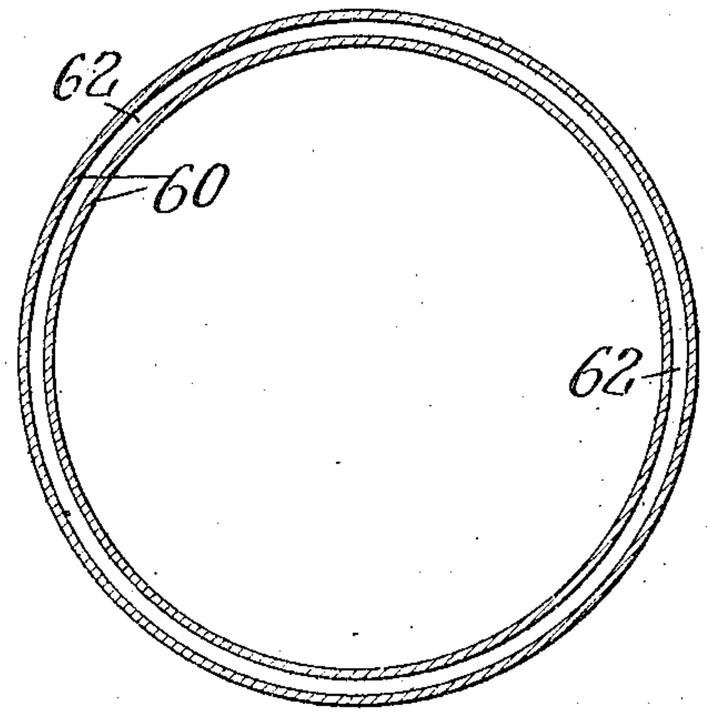
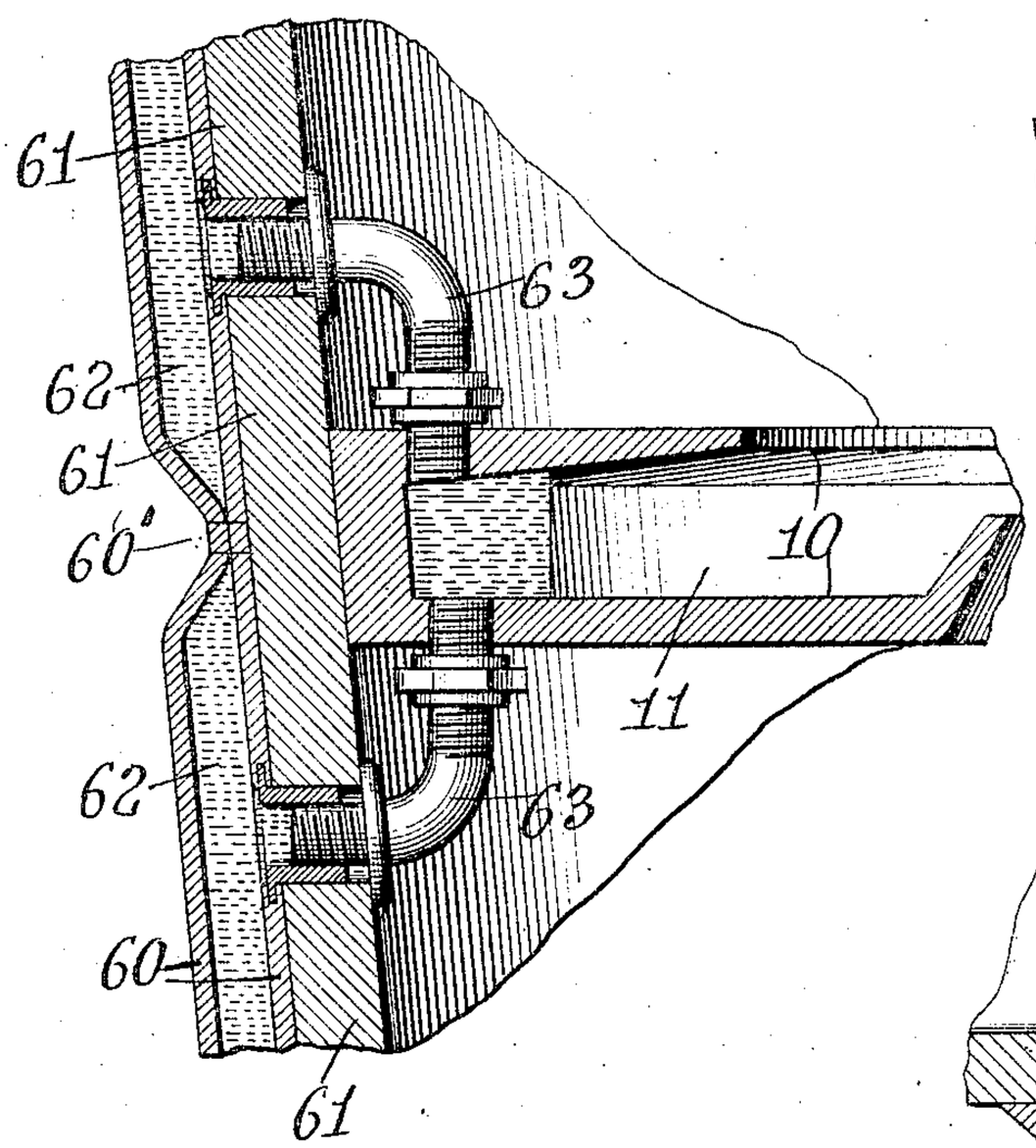
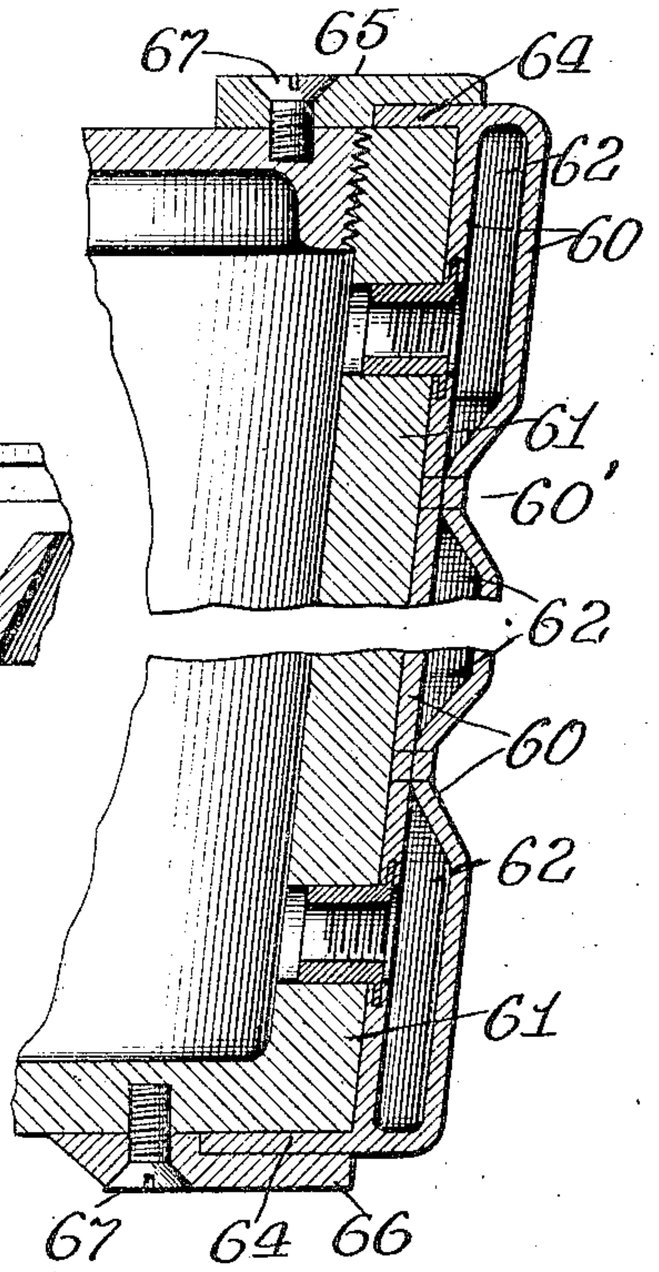


Fig. 11





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UNITED STATES PATENT OFFICE.

PHILIP F. PECK, OF CHICAGO, ILLINOIS.

CENTRIFUGAL ORE-SEPARATOR.

No. 917,122. Specification of Letters Patent. Patented April 6, 1909.

Application filed September 17, 1908. Serial No. 453,527.

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 an improved separator employing centrifugal force in separation of particles of waste and value in pulverized ores while mixed with liquid, of the general type illustrated and described in my application for United States patent Serial No. 444,787, filed July 22, 1908; application Serial No. 453,526, filed September 17, 1908, and application Serial No. 456,060, filed October 3, 1908.

In the accompanying drawing Figure 1 is mainly a transverse vertical central section of my separator. Fig. 2 is a top plan view of my separator. Fig. 3 is an outside elevation of the upper half or the deflector member, removed from the separator. Fig. 4 is principally an enlarged transverse section of the left side of a fragmentary part of the deflector vessel wall, the expansion element, one of the channel rings and their connecting conduits as shown in Fig. 1. Fig. 5 is principally an enlarged top plan of the cam and its driving mechanism detached from the separator. Fig. 6 is mainly a cross sectional detail of the left side of the launder and a part of the left side of the discharge enlargement of the separator vessel, both as illustrated in Fig. 1, showing the launder in a central position of elevation to catch the middlings product as it is discharged from the vessel. Fig. 7 is similar to Fig. 6 except that the launder is illustrated as elevated to its maximum position to catch concentrate as it is discharged from the separator vessel. Fig. 8 is partly a side elevation and partly a vertical cross section of a modified form of an expansible element, in a state of expansion. Fig. 9 is a cross section of Fig. 8 on line 9—9 of Fig. 8, looking in the direction of the arrows. Fig. 10 is an enlarged transverse vertical sectional detail of the central part of the wall of the deflector vessel and some of its internal parts with a portion of the expansible element at this point shown in operating position; expansion liquid also being shown present. Fig. 11 is an enlarged transverse vertical section of the upper and lower portions of a side of the deflector vessel and some attached parts, with the expansible element in place in a state of expansion.

In making my improved centrifugal ore separator, I provide a member having a separating surface, which member I have illustrated in the form of a vessel A, with a closed bottom and substantially open top, and may be termed a treatment vessel. This vessel is preferably of a double or composite nature made of substantially upper and lower halves, and the two halves being fastened together near the center as hereinafter described.

The bottom of the treatment vessel has a central hub B, that rigidly engages a shaft C, which 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 in an anti-friction bearing F to carry its weight.

The vessel A is turned smooth and concentric to the shaft C, and the inner walls of both the upper and lower halves afford independent separating surfaces G and G′ respectively, over which the substances to be separated pass, as hereinafter described.

The rim or edge of both halves of the vessel around its largest diameter is flanged outward as shown, and indicated by H which flanges have an annular recess at their outer edges around into which the respective flanged parts of the ring I, are seated. These flanges on the ring I being greater in width than the depth of the annular recesses in the flange H, there is left between the ring and the flange when these parts are in place an annular space J.

The main part of the ring I is made wide enough to extend inward toward the center of the vessel, some distance, thereby partly closing the two halves of the treatment vessel with respect to each other which prevents water or other liquid and material to be separated from flowing from one half of the vessel into the other while in operation.

The vessel is preferably made of greatest diameter at its central portion longitudinally, the walls of the two halves which form the separating surfaces, being inclined outward from their respective feed ends toward the middle. The upper end of the top half of the vessel is provided with a ring or flange K

extending a considerable distance toward its axis, forming a partial closure to this end of the vessel and having its inner edge turned upward as shown. On the upper side of this flange portion is provided a ring L of shape to form an annular feed chamber M into which material for separations with water may be introduced by a suitable pipe N for passage over the separating surface of the upper half of the vessel. The pipe N is provided with a valve N'.

Through the partial closing flange or ring K is a series of openings O extending from the feed chamber M down into the space J' as hereinafter more fully described.

Located within the vessel A, and with it forming separating passages P and Q I provide a member or deflector embodying a non-elastic comparatively rigid supporting element R, and an elastic or expansible element S. The supporting element R, I have made in the form of a vessel and have termed it a deflector vessel. This deflector vessel is preferably made in two halves secured together by bolts T through its inwardly extended ring flanges U, which are threaded into the walls of the vessel as illustrated. These flanges are of form to permit of the placing of the ring I, as especially illustrated in Fig. 1. The upper end of the deflector vessel is partly closed by an inwardly extended ring 4.

I have mounted the deflector rigidly on a sleeve V which is rotatably journaled around the central shaft C, and its fastening to this sleeve is facilitated by means of the hub Y at the lower part of the deflector. The sleeve rests on an anti-friction bearing 2 which is seated on the bottom of the treatment vessel A and the sleeve is rotated differentially to the treatment vessel, and with it the deflector by the drive pulley 3. The expansible element in this instance is composed of a flexible tube preferably in the nature of a hose of rubber, coiled or wrapped closely around the outer diameter of the deflector vessel as illustrated, so that substantially all of the circumferential part of the deflector, which is located in proximity to the separating surface, is composed of an element which may, by internal pressure of liquid be expanded outward thereby enlarging the diameter and circumference of the deflector.

In placing the expansible or elastic tubing around the deflector vessel I prefer to wrap it spirally so that the crack, or lines of depression S', between the different coils will not be circumferentially in a constant plane transverse to the axis of rotation, and so that during differential travel of the deflector and treatment vessel A, all parts of the separating surface will be crossed or swept by parts of the expansible element lying between the depression lines therein.

The deflector is made sufficiently smaller in diameter than the treatment vessel A, to leave the desired separating passages P and Q around between its outer wall and the walls of the vessel. The deflector is also sufficiently shorter to leave the desired space J' between its top ring 4 and the flange K of the upper half of the vessel. Where the separating passages occur on the left side of Fig. 1, I have illustrated liquid in operating position, but have not shown it in the passages at the right side.

Around the hub Y in the bottom of the deflector I provide a ring 5 of shape to form a feed chamber 6 into which material for separation with water is introduced by a pipe 6', and governed by a valve 6'', so as to pass over the lower end of the separating surface, which is initialed G'.

Extending from the feed chamber 6 through the bottom of the deflector into the space 7 are holes or passages 8 for flow of material from said chambers on its way to the lower of the separating passages.

On the inside of the deflector vessel I have provided facility for supplying liquid to the expansion chambers or channels 9, inside of the tubes forming the expansible element. I accomplish this by means of annular groove or trough shaped rings 10 adapted to receive liquid in their channels 11. The outer circumferences of these rings are of size to tightly fit at the places desired inside of the deflector vessel as illustrated. I have illustrated four of these rings in the deflector—two in the upper part and two in the lower, but as many may be employed as will best serve the purposes desired.

The tubing forming the expansible element on each half of the deflector vessel is preferably in at least two pieces as illustrated in Fig. 4, and both ends of each piece are suitably connected to an appropriate one of the rings 10 by conduits 12 as illustrated, so there is a passage from the channels 11, into the expansion chamber of the tube forming the expansion element through which liquid may be introduced into or expelled from, or circulated through the expansion chamber 9, thereby forming means by which liquid may be circulated annularly through the spiral tubes.

The tubing which constitutes the expansible element forms a wall for the expansion chambers not only on the side adjacent to the separating passage, but also adjacent to the supporting element or deflector vessel, the latter wall preferably lying in contact with the outer circumference of the deflector vessel as illustrated. The expansion chambers therefore, being within the tube, are interposed between the double or multiple walls of the expansible element.

The expansible element may be removable after disconnecting its fastenings to the supporting element after the deflector has been

removed from the vessel A, by uncoiling the tubing, constituting such element.

During operation of the separator, liquid introduced into the channel 11 is in part driven by the action of centrifugal force through the conduit 12 into the expansion chambers 9 becoming expansion liquid, and by liquid pressure distends or expands the elements S outward, enlarging the diameter of the deflector and proportionately diminishing the size or depth of the spaces P and Q which are the separating passages. As means for introducing liquid into these channels 11 to effect expansion, I provide pipes 13 and 14 with their delivery ends in position to flow the liquid into the respective channels, and in these pipes is a valve 15 and 16 respectively, which afford facility for independently regulating the supply of liquid flowed into the channels in the rings of the different halves of the deflector so that the liquid supplied to the parts of the expansible element, which operates in conjunction with the different separating surfaces, may be regulated independently.

The degree of expansion of the element S depends largely on the quantity of liquid permitted to accumulate in the channels 11, and this accumulation is governed or limited by the position of the scoop conduits or pipes 17 and 18 which are of shape to bring their outer open ends to operate on, and against the surface of the revolving body of liquid in the respective channels 11, thereby lessening the expanding pressure on the element S and consequently enabling enlargement of the separating passage as desired.

It is advantageous that the expanding pressure on the element S of the deflector be diminished gradually as concentrates accumulate and bed in the separating passage, permitting gradual contraction of the expansible element, and proportionate gradual enlargement of the separating passage to accommodate the bedding concentrates. I, therefore, support the scoop conduits 17 and 18 that operate with respect to the different separating surfaces, on independent or different rotatably mounted rods 19 and 20 which have their upper ends 21 and 22 crooked at approximately right angles to their main body, and the crooked ends 21 and 22 respectively contact with the surfaces of the different cams 23 and 24 which are mounted on different rotatably journaled shafts 25 and 26, so when the cams are revolved the crooked ends 21 and 22 will be moved to conform to the surface contour of the cams, and thereby gradually and independently rotatably move the rods 19 and 20 and swing the outer or scooping ends of the conduits 17 and 18 out or in with respect to the axis of the separator, which gradually scoops out and removes the liquid from the corresponding channels 11 to a greater or less distance from the axis, thus automatically limiting and regulating the expanding pressure on the expansible elements.

The surfaces of the cams are made of suitable contour, and the scoop pipes and cams are adjusted with respect to the rods 19 and 20 and the channels 11, in position to accomplish the removal of the quantity of liquid desired.

As means for effecting rotation of the cams I have placed worm wheels 27 and 28, on the shafts 25 and 26, which with worms 29 and 30, mounted on suitably journaled shafts 31 and 32, on which latter shafts I also provide cone shaped belt pulleys 33 and 34.

On a suitably mounted shaft I have placed cone shaped pulleys 36 and 37 in proper belt alinement with the pulleys 33 and 34 respectively, and have provided drive belts 38 and 39 appropriately connecting these two pairs of cone pulleys by which rotation is transmitted from the cones 36 and 37 to those 33 and 34 and through the worms and worm wheels to the cams.

The belts 38 and 39 can be moved along the cones as desired by the guides 40 and 41 to obtain variation of revolution. The twisted drive belt 42 from a pulley 43 on the upper end of the shaft C to a pulley 44 as shown in Fig. 2, drives the cone pulleys and other mechanism to move the scoop pipes as just above described.

By means of the swiveled clamps 45 and 45′ respectively the scooping conduits 17 and 18 may be independently adjusted on their rods to bring their scooping ends in or out into position to relatively move the expanding liquids to a greater or less depth from the channels 11, 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 6 of the separator, whence it passes through the separating passage.

The pressure of the liquid in the separating passages exerts a resisting force on the outer surface or wall of the expansible element S, 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 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.

If it is desired to produce greater expansion in one of the expansion chambers than in another, the position of the scoop conduit

17 which operates with respect to that particular chamber may be adjusted on its rod independently to permit a deeper accumulation of expansion liquid for that chamber, and vice versa.

During operation of the separator the vessel or member carrying the separating surfaces is revolved at a desired rate of speed by a suitable belt (not shown) passing around the pulley 46, from any suitable source of motive power, and the deflector is revolved at a sufficient speed differential to the separating surface, to transmit through the instrumentality of the liquid in the separating passage a liquid scouring or washing friction on the separating surface, or material that may be thereon to facilitate separation desired. As the operation of the separator proceeds, and the separated material accumulates in a bed on the separating surface, filling the separating passage to that extent, the outer or scooping ends of the conduits 17 being gradually moved outward by the cams and associated mechanism hereinabove described, and gradually lessening the accumulation of expanding liquid from the channels 11 permitting the flexible element S to be gradually contracted until a desired quantity or load has bedded in the separator. By this time the cams have revolved a sufficient distance to bring the crooked part 21 and 22 of the rods into position on the cams to be quickly moved and swing the outer ends of the scoop conduits inward, and again permit the maximum desired accumulation of expanding liquid in the channels 11.

As means for separately catching the several products discharged from the separator, I have supplied an annular launder or trough 47 provided with several compartments 48, having independent annular openings, around their upper parts, which are of proper size and spacing with relation to the two rows of hollow discharge nipples 49 and 50 so that at the same time there will be one of the openings in radial alinement with each of the rows of discharge nipples to catch the separate products therefrom, and there will also be one of the several annular openings interposed between these two rows, and so when the launder is properly shifted up or down the same relative conditions will prevail to catch separately the different products discharged at different periods from the rows of discharge nipples. From the several compartments 48, are discharge pipes 48′, as illustrated.

The launder is supported by rods 51 secured to it as illustrated, which have their lower ends threaded and passed through the internally threaded worm wheels 52 and 53, which are suitably maintained in the stands 54 and 55.

There is provided a suitably journaled shaft 56 having worms 57 and 58 meshing with the worm wheels by which said wheels are revolved when desired, to raise or lower the launder; the shaft is provided with a suitable crank 58′ serving as a handle by which to turn it, although any other suitable means may be employed to revolve the shaft.

While operating, if it is desired that one half of the separator be in process of loading or effecting separation while the other half is unloading or discharging accumulated concentrates and vice versa, the feed pipe delivery into the feed chamber for the separating surface on which separation is progressing, is at this time supplying material for separation, and the water in the expansible members operating with respect to this surface is then being governed to secure desired intensity of washing friction for separation; while at this time clean water is being introduced into the feed chamber of the separating surface where unloading is progressing, and the water to the expansible member for this separating surface is regulated to produce a sufficiently greater or more intense washing friction to effect the removal and unloading of the concentrates that have previously been bedded on this separating surface and in its separating passage.

It will be understood that the branch pipes 59 and 59′ are adapted to supply clean water into their respective pipes N and 6, as desired for uses hereinabove explained.

In Fig. 1 the expansible element on the upper half of the deflector is illustrated in a state of expansion, while in the lower half it is in a contracted state.

When the concentrates have been removed from this latter passage and the other separating surface has been sufficiently loaded or bedded with concentrates, the flow of material for separation to the latter passage is stopped and clean water is supplied instead, and also greater expansion pressure is obtained for effecting removal as hereinabove described, the launder 47 having been properly relatively adjusted. At the same time material may be introduced for separation on the surface from which the concentrates have just been discharged, the proper expansion conditions for separation being automatically established as has been hereinabove described.

In Fig. 1 I have illustrated the launder in its lowest operating position. In Fig. 6 it is in its medium position, and in Fig. 7 in its highest or maximum operating position.

In Figs. 8, 9, 10 and 11 I have illustrated a modification wherein I make the expansion element of my separator in the form or nature of a tube, the walls being formed with double or multiple layers relatively unadhered throughout part of their area, which I have here initialed 60, the tube being of suf-

ficient diameter and of shape to slide over the outer diameter of the supporting element or deflector vessel 61, instead of a tube wrapped around the supporting element 61. This form is illustrated removed from the deflector vessel in Fig. 8.

When the deflector vessel is made in two parts joined together as is illustrated in the main figures of the drawings and the different parts are intended to operate with respect to different separating surfaces, there is preferably an expansion element provided of suitable size and shape for each of the two parts of the deflector. This expansible element is preferably formed having walls with double or multiple parts in the nature of unadhered layers, walls as above stated of preferably substantial water-tight material as suitable rubber cloth, or of any other material that is sufficiently yieldable and will otherwise subserve the purposes required. The layers of the walls are secured together at their ends and at intervals as desired, preferably to form circumferential expansion chambers 62, between them, and in a manner so that the resultant depressions that occur in the outer surface of the expansible element will course irregularly around the deflector with respect to a constant plane transverse to the axis of rotation. These depressions may also occur in shorter lengths with an undepressed space between them. Both of these forms of depression are shown in Fig. 8 of the drawing.

The importance of having the depression occur in a broken or irregular course is in order to bring all parts of the separating surface with respect to which the expansible element operates under or in operating frictional proximity to those parts of the expansion element which are expanded, lying between the depressions. The fastening together of these double or multiple layers of the walls may be effected in any suitable way desired, but I have employed stitching or sewing for this purpose and prefer to coat the stitching over with some substance as rubber to prevent leakage. The inner layer of the wall of this expansible element when in place on the deflector vessel, rests closely against the exterior of the vessel and the outer layer is then expansible outward by liquid that is introduced during operation from the channels 11, through the connections as illustrated.

The rings containing the channels 11 may be located properly with respect to the expansion chambers so that two or more of said chambers may be connected by suitable conduits 63 to the channels in the same ring 10 if desired, as shown in Fig. 10. The expanding liquid is illustrated in operating position in Fig. 10.

To assist in holding the expansible element in place on the outside of the deflector vessel in the modification, I have provided the expansible element with extended yieldable ends 64 adapted to be folded over on the top and bottom ends of the part of the deflector vessel on which these elements are respectively carried as shown in Fig. 11, and I secure rings 65 and 66 over these respective folded ends to tightly hold them in place. These rings may be secured when in place in any suitable desired way as by screws 67, and if it is desired to remove the expansible element these rings must first be removed.

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

1. 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 a comparatively rigid supporting element and an expansible element in proximity to the separating surface, which expansible element has walls comprising multiple yieldable layers forming an expansion chamber interposed between them, one of said layers being 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 ore 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 a comparatively rigid supporting element and an element with walls having multiple yieldable layers forming an expansion chamber interposed between them and being adapted to be expanded by liquid pressure and to be periodically compressed by pressure of liquid in the separating passage, substantially as described.

3. 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 a comparatively rigid supporting element and an element in proximity to the separating surface the second element having walls with multiple yieldable layers secured together at intervals and forming liquid holding chambers between said yieldable layers, one of said layers adapted to be expanded by liquid pressure and means adapted to supply liquid to said chamber, substantially as described.

4. 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 sec-

ond member embodying an expansible element in proximity to the separating surface, said element having walls with multiple layers with an expansion chamber between them, said layers being secured together in a course circumferentially irregular with respect to a constant plane transverse to the axis of rotation and means adapted to supply liquid to the expansion chamber, substantially as described.

5. 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 a yieldable frictional washing element having multiple walls with an expansion chamber interposed between them, said walls being fastened together forming an exterior depression extending circumferentially in an irregular course with respect to a constant plane transverse to the axis of rotation, one of said walls being adapted to operate between two bodies of liquid under pressure and to be expanded or contracted by the relatively varying pressure of the two bodies of liquid and means adapted to supply liquid to both sides of said yieldable wall, substantially as described.

6. In a centrifugal ore 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 a supporting element and an element in proximity to the separating surface, the second element having walls with multiple yieldable layers with an expansion chamber interposed between said layers, the layers being secured together forming depressions on its outer surface, one of said layers adapted to be expanded by liquid pressure and means adapted to supply liquid to said chamber, substantially as described.

7. In a centrifugal ore separator, the combination of a rotatable member forming one wall of a separating passage, a member differentially rotatable thereto, in part forming the separating passage which passage is adapted to contain a body of liquid while in operation, the second member embodying a supporting element and an element having walls with multiple yieldable layers with an expansion chamber interposed between said layers and being adapted to be expanded by liquid pressure, and to be periodically compressed by pressure of the liquid in the separating channel and adjustable automatic means adapted to limit the expanding pressure on said second element, substantially as described.

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Witnesses:
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W. H. PECK.