P. F. PECK.

CENTRIFUGAL ORE SEPARATOR.

APPLICATION FILED SEPT. 17, 1908.

917,121. Patented Apr. 6, 1909.

4 SHEETS—SHEET 1.

Fig. 1

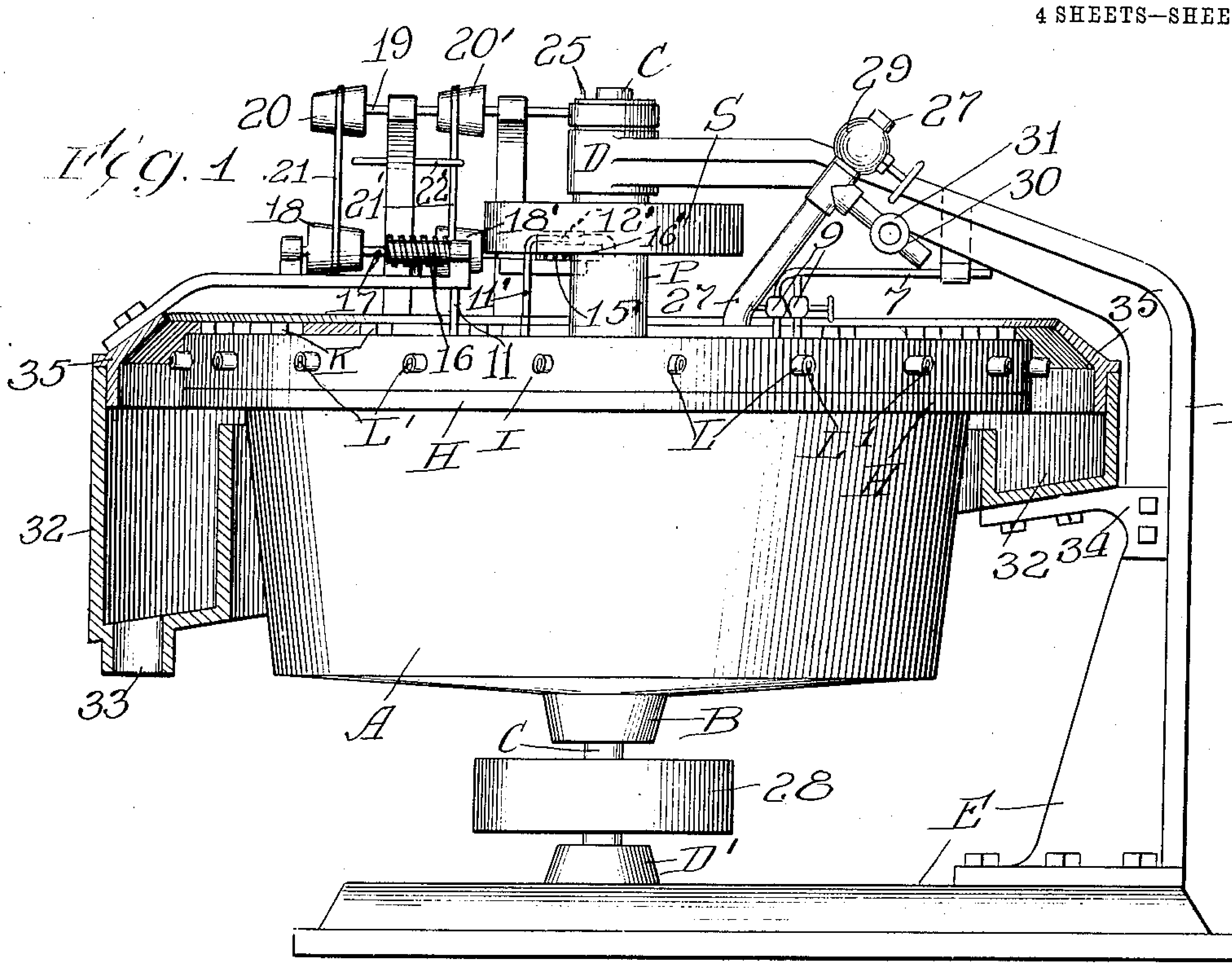
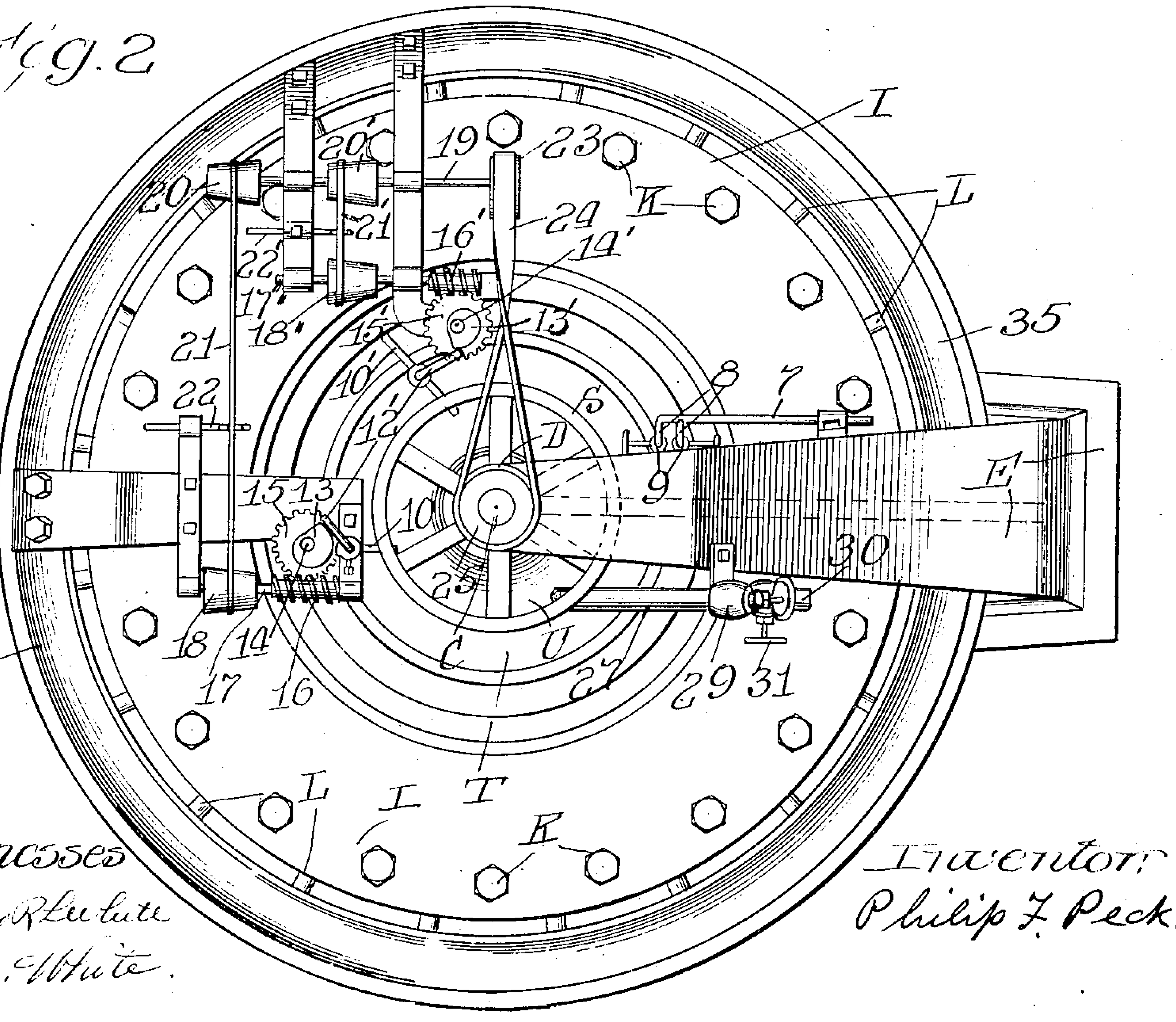


Fig. 2



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4 SHEETS—SHEET 2.

Fig. 3

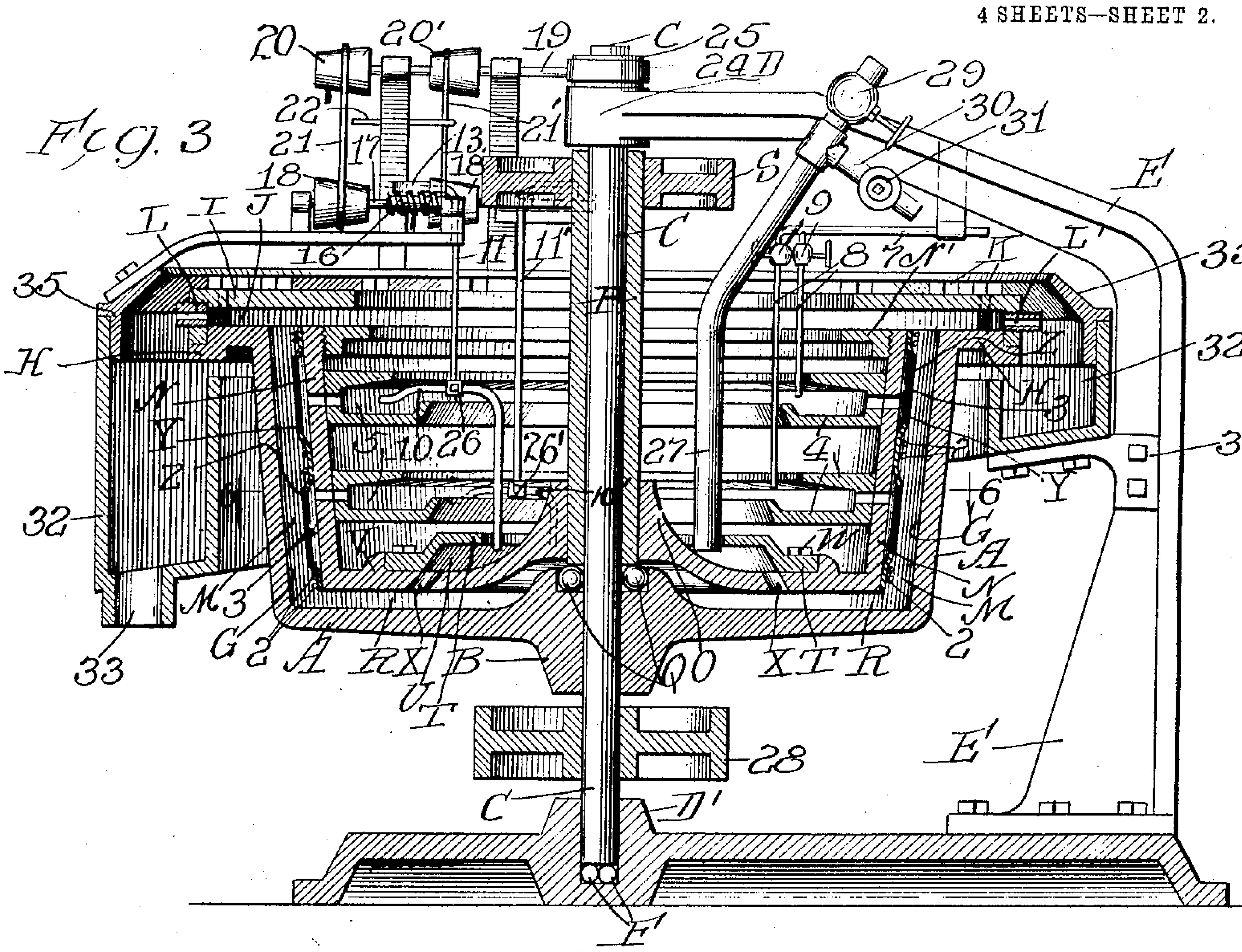


Fig 4

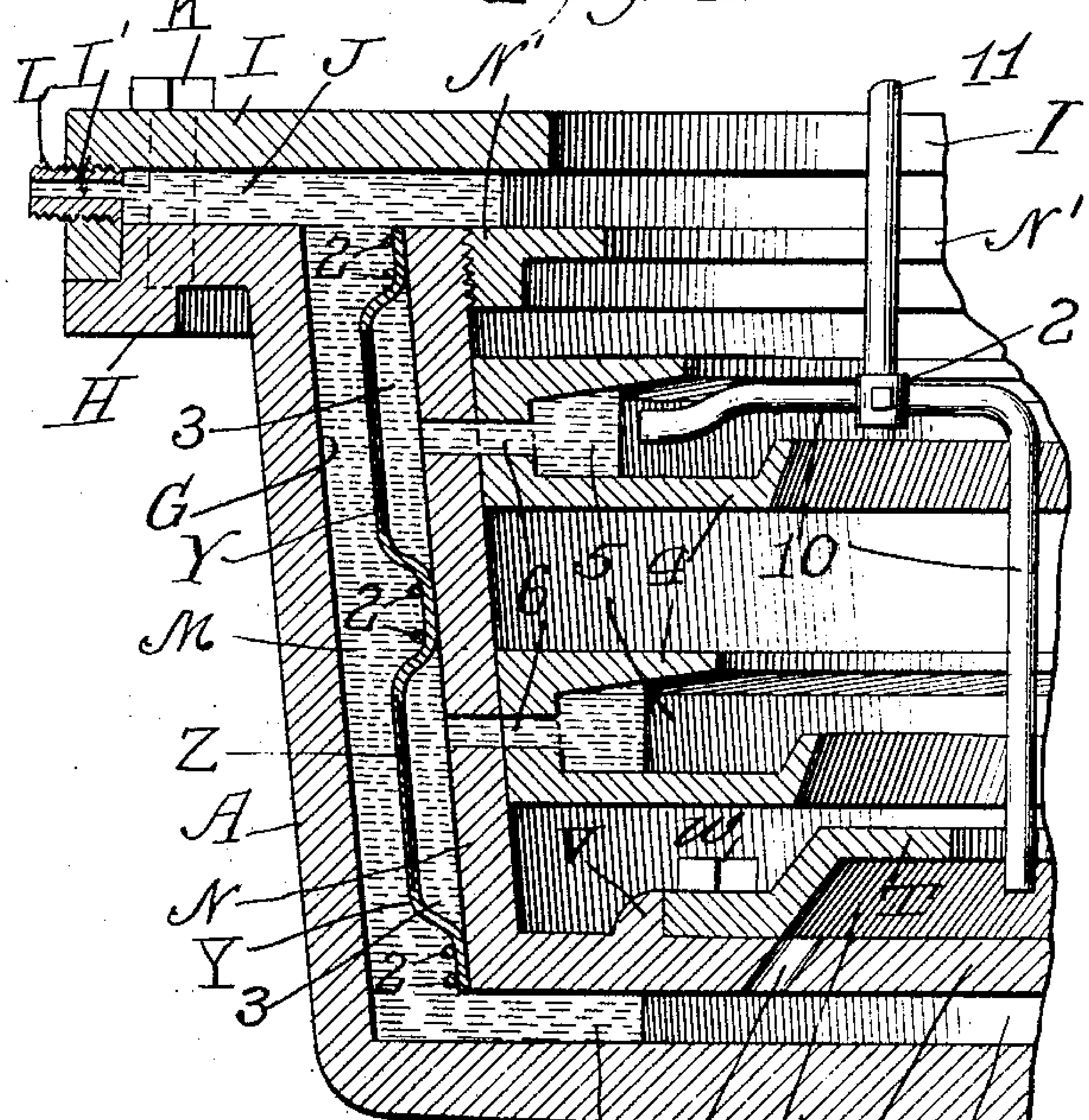
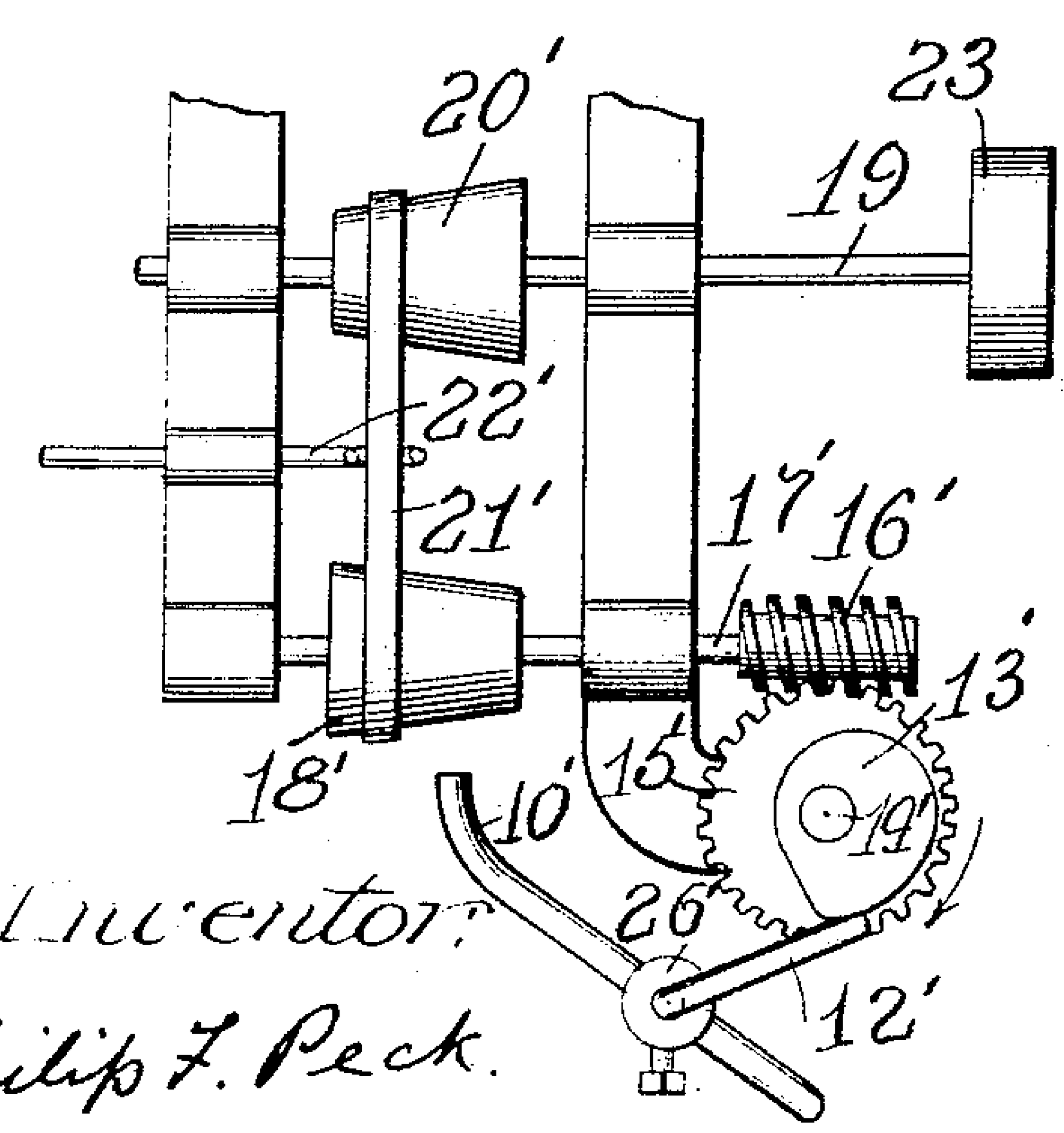


Fig 5



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4 SHEETS—SHEET 3.

Fig. 6.

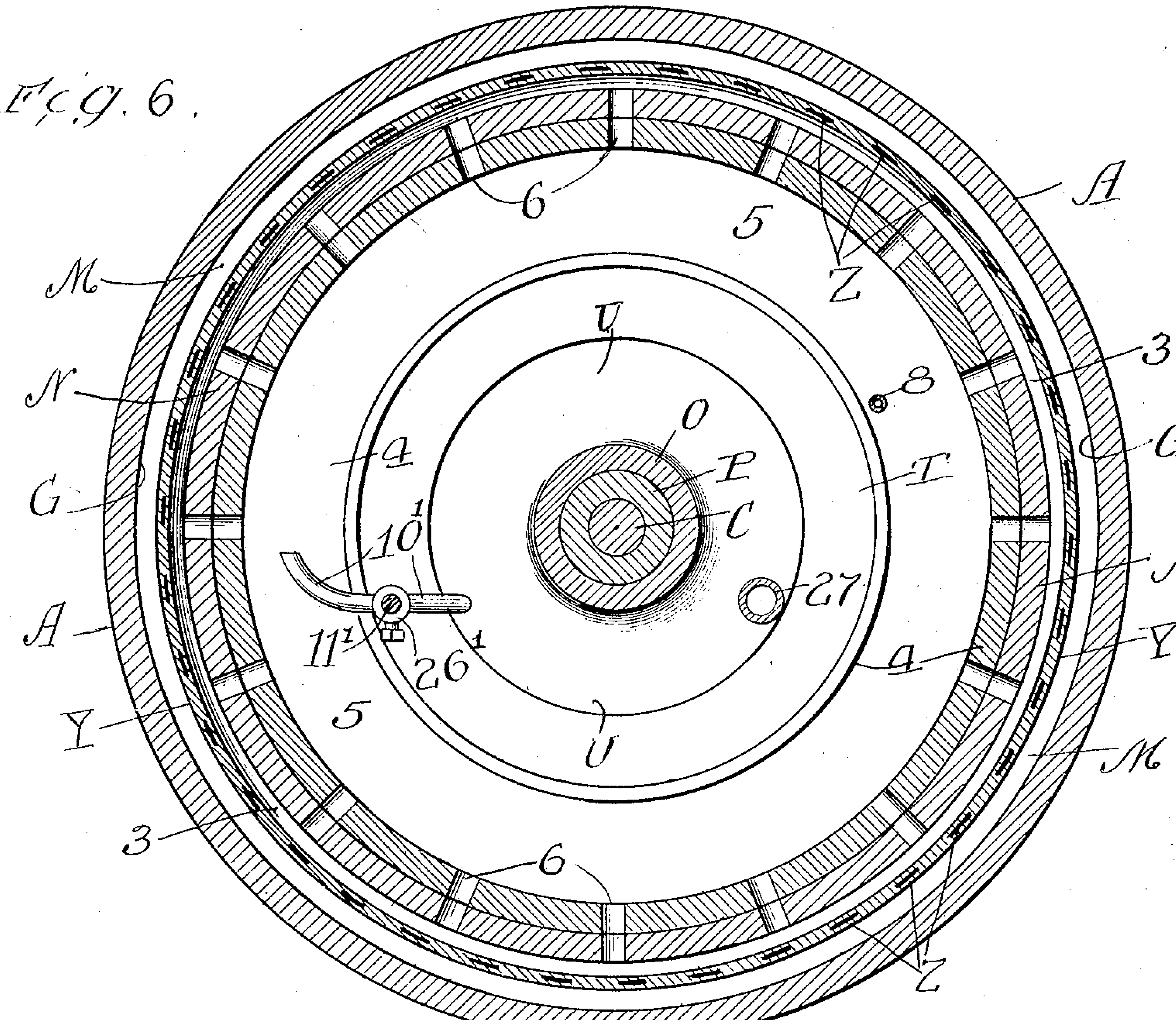


Fig. 7

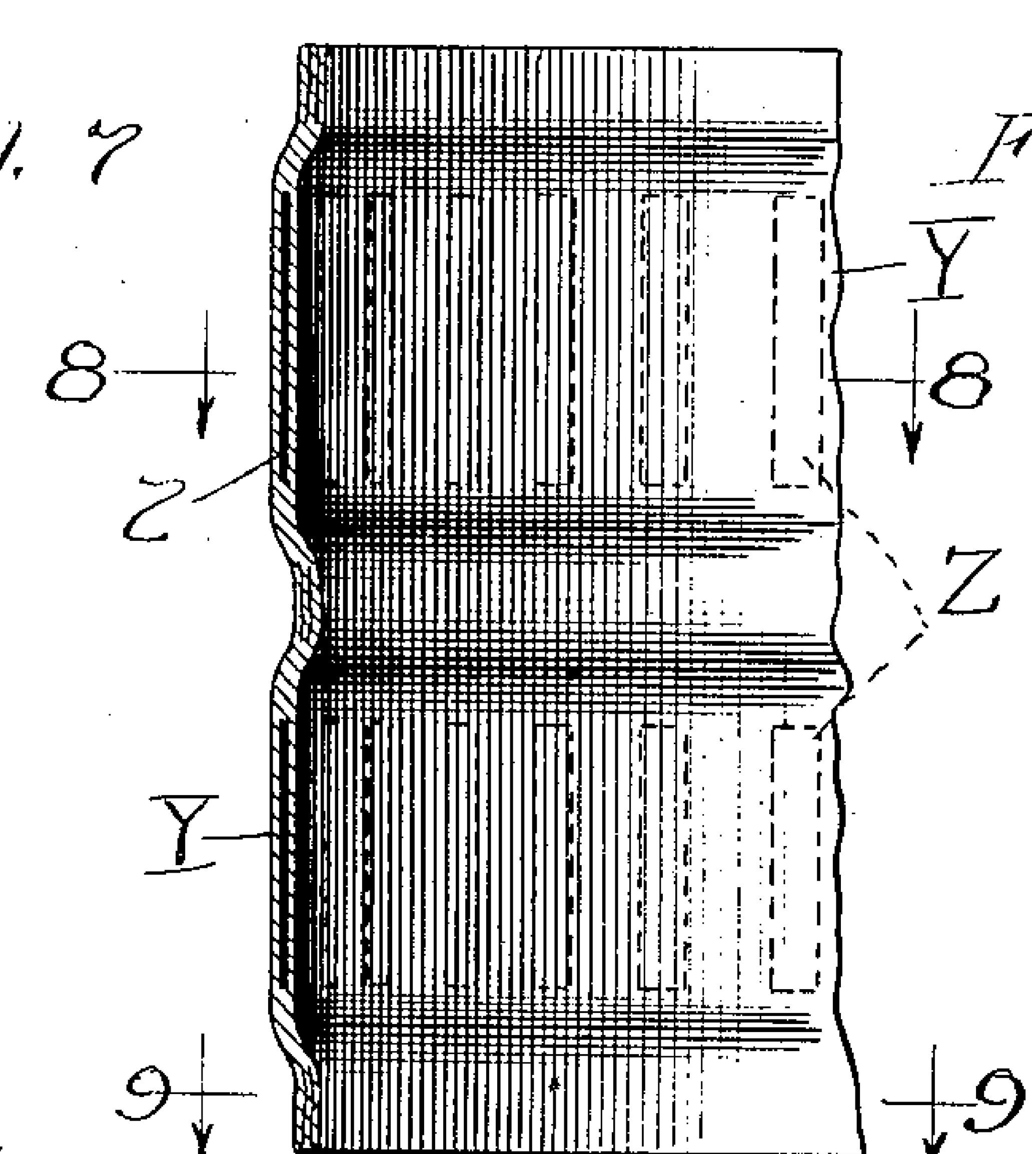


Fig. 8

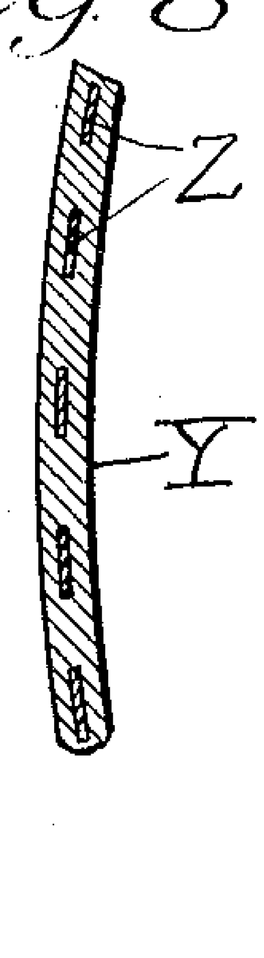
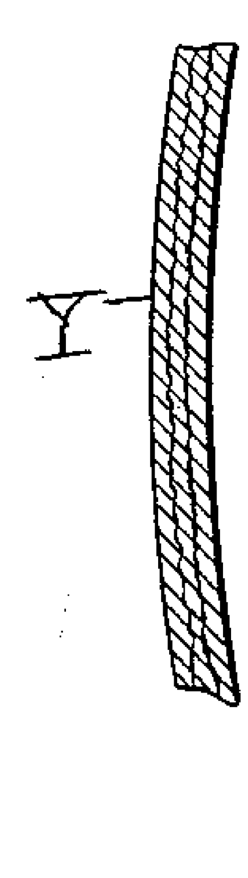


Fig. 9



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4 SHEETS—SHEET 4.

Fig. 10

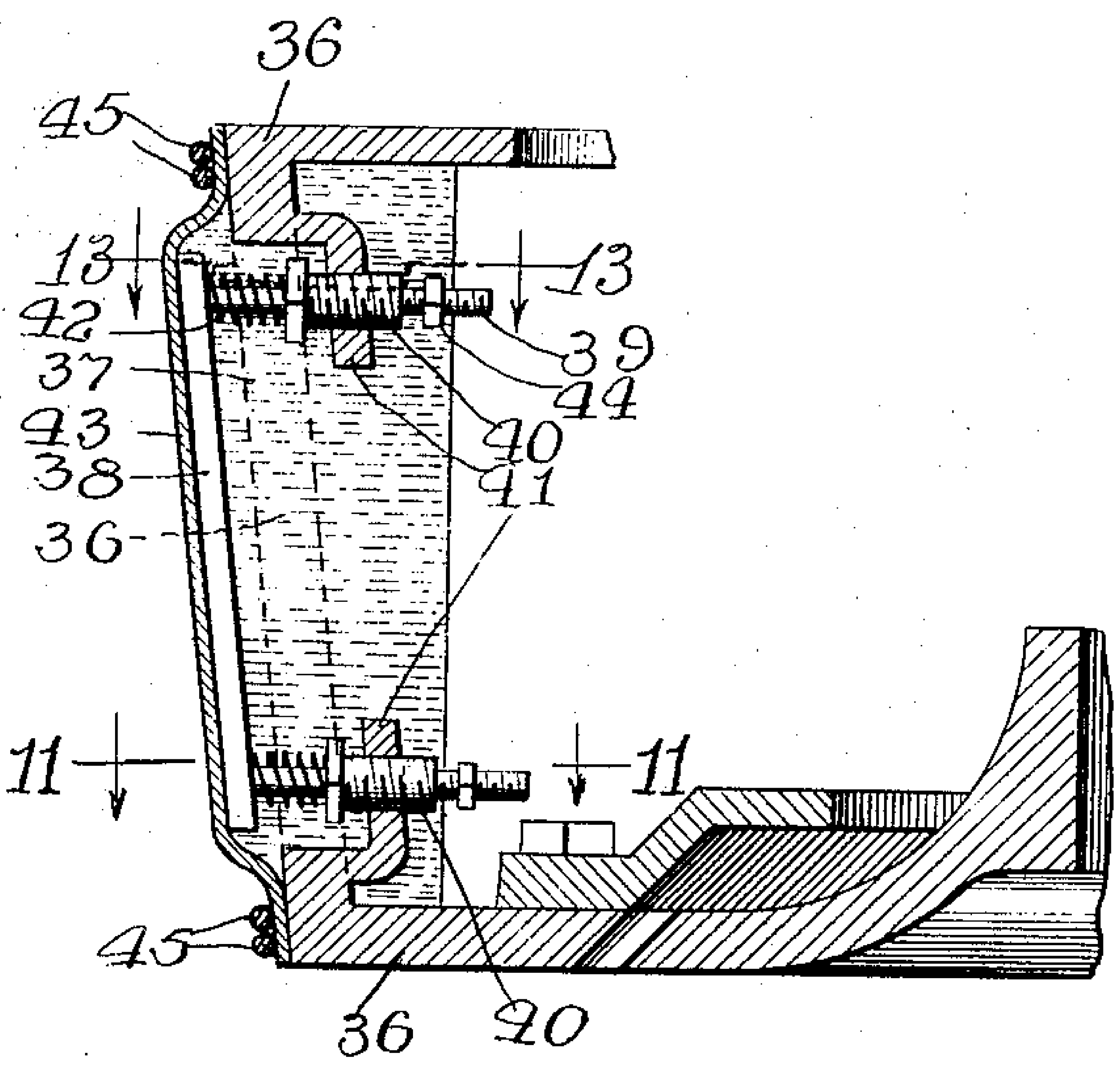


Fig. 11

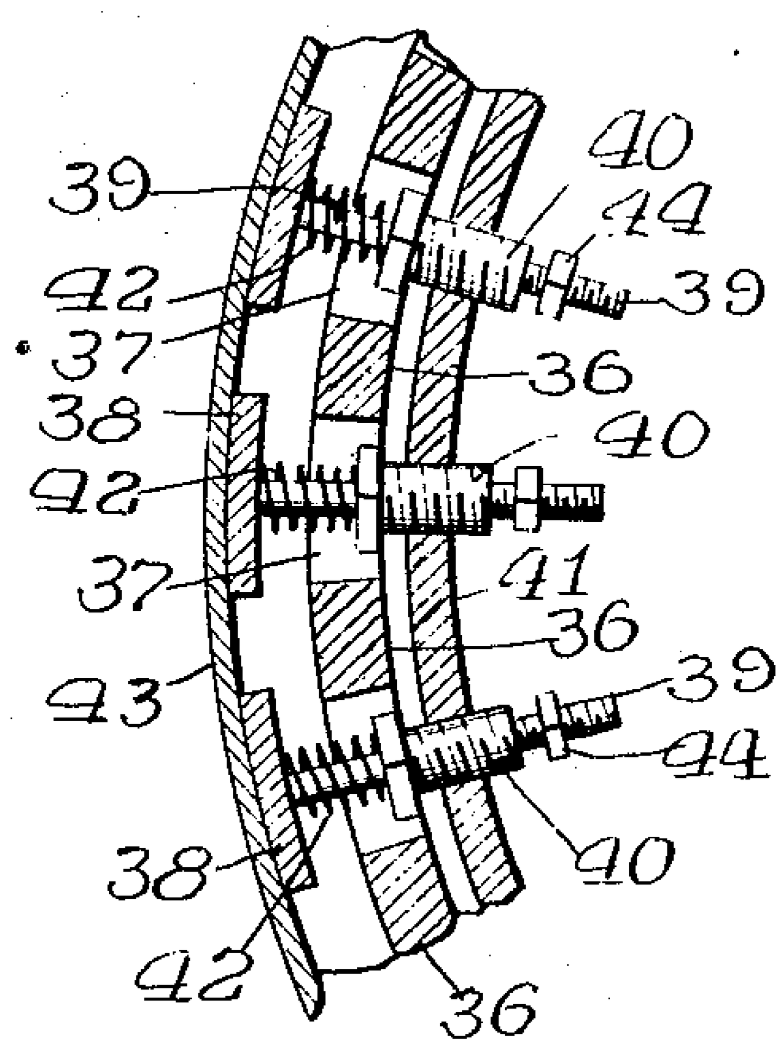


Fig. 12

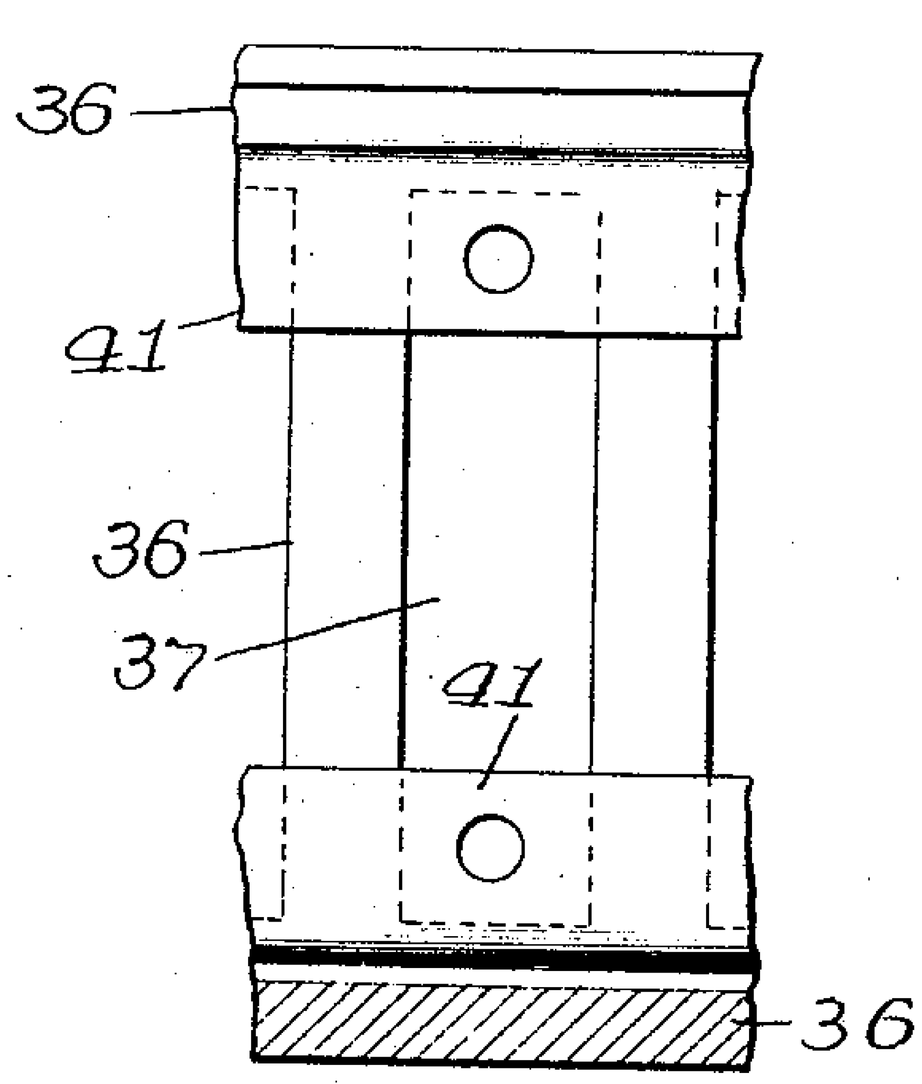
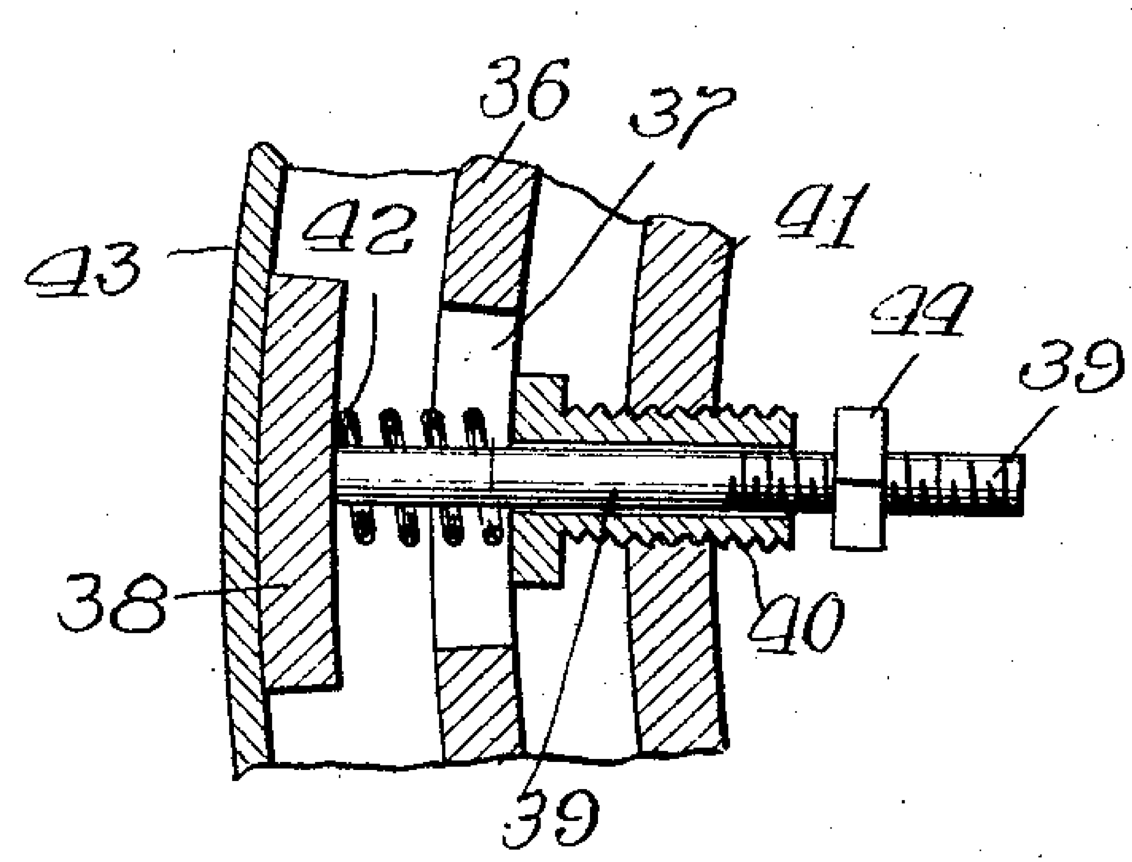


Fig. 13.



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UNITED STATES PATENT OFFICE.

PHILIP F. PECK, OF CHICAGO, ILLINOIS.

CENTRIFUGAL ORE-SEPARATOR.

No. 917,121. **Specification of Letters Patent.** **Patented April 6, 1909.**

Application filed September 17, 1908. Serial No. 453,526.

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 and assisting agencies for separation of particles of waste and value in pulverized ores while mixed with liquid, of the general type illustrated and described in my applications for United States Patents, Serial No. 444787, filed July 22, 1908; Serial No. 453,527, filed September 17, 1908, and Serial No. 456,060, filed October 3, 1908.

In the accompanying drawing Figure 1 is a side elevation of the rotatable portions and 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 principally a plan of a detached part showing one of the cams and its drive mechanism, enlarged. Fig. 6 is an enlarged 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 part of the flexible covering element to the deflector enlarged and removed. Fig. 8 is a transverse section of Fig. 7 enlarged, on line 8—8 of Fig. 7, looking in the direction of the arrows. Fig. 9 is a transverse section of Fig. 7 enlarged, on line 9—9 of Fig. 7, looking in the direction of the arrows. Fig. 10 is mainly an enlarged vertical central cross section of one side of the deflector member, modified. Fig. 11 is mainly a cross section of Fig. 10, on line 11—11, of Fig. 10, looking in the direction of the arrows. Fig. 12 is an inside elevation of a fragmentary part of the wall of the supporting element or deflector vessel. Fig. 13 is mostly an enlarged fragmentary cross section of the parts for effecting yieldable expansion, taken on line 13—13 of Fig. 10.

In making my improved centrifugal 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. The bottom of the vessel has a central hub B, that engages rigidly 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 on an anti-friction bearing F, (Fig. 3) to carry its weight. The vessel A is turned smooth and concentric to the shaft C, and on its inner wall is a separating surface G, over which the substances to be separated pass, as hereinafter described.

The rim of the open end of the vessel is flanged outward as shown and indicated by H, which flange has an annular recess at its outer top edge, into which the depending part of the ring I, is seated; this depending part being some greater in width than the depth of the annular recess in the flange H, there is left between the ring and the flange, when the two are seated together, an annular space J. The main part of the ring is also made wide enough so it extends inward some distance toward the axis of the vessel, thereby partly closing the opening in the top of the vessel.

The vessel is preferably made with its walls and the separating surface inclining outward from its bottom to its top or open end, and 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, enabling when desired a sufficient body of the liquid, supplied to the vessel, being retained therein to fill the separating passage and submerge 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 best in Fig. 4, of suitable size to permit of discharge of liquid and material, 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 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 that I have illustrated in form of a vessel, although this part may be any other suitable form of supporting structure, and 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. This vessel is 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. This 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 the feed chamber U, 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 is driven into the separating passage as hereinafter described.

The deflector member, in addition to the supporting part or element N, embodies a flexible part which I prefer to form by surrounding the circumference of the supporting part with a yieldably 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, bringing it into proximity to the separating surface and in part forming the separating channel. It is important that the expansion of this expansible element should be effected by means that will permit of its properly yielding to and being compressed or contracted by an excess pressure of liquid in the separating passage, which excess pressure may be caused during operation by the bedding of concentrates in the separating passage, it therefore following that the separating passage automatically becomes enlarged to provide space for lodgment and accumulation of a bed of concentrates on the separating surface, and to facilitate this end I have provided means for effecting this yieldable expansion mainly by liquid pressure hereinafter more fully described. I have provided the expansible element in this case with substantially non-elastic reinforcing means or strips Z (shown best in the enlarged Figs. 6, 7 and 8,) of metal or other suitable material, to reinforce the jacket against distortion caused by its circumferential friction in the separating passage. These reinforcing means are arranged in a manner to serve the office intended, and yet permit of diametrical expansion of the jacket element. They are illustrated as lying substantially parallel with the axis of rotation, and do not in this application extend into the zones where the fastening of the jacket to the deflector vessel is effected. Within these zones there are provided reinforcements of canvas, or similar material as especially shown in Figs. 7 and 9. The non-elastic reinforcing strips or means Z, are held together and to place principally by the rubber or equivalent substance which serves as binder means for them. The fastening of this expansible element to the supporting vessel or element N, is preferably effected by tightly winding several strands of wire 2 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 expansion chambers 3 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 substantially liquid tight partition or division between these expansion chambers, making them closed or practically so with respect to each other, and causes 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 4, adapted to receive liquid in their channels 5, 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 rings is located preferably in transverse axillar alinement with each of the expansion chambers. Around through the bottoms of these ring shaped troughs are several holes 6, extending from the channels 5 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 5 is in part driven by the action of centrifugal force through the holes 6, into the expansion chambers 3, thereby becoming expansion liquid, and by liquid pressure distends or expands in a yieldable manner 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; this expansion is augmented to the maximum degree at or before the commencement of the loading period of the separator. As means for introducing liquid into these channels 5, to effect expansion, there is provided a pipe 7, having branches 8 with their delivery ends in position to flow the liquid into the respective channels, and in each of these branches is a valve 9, which affords facility for independently regulating the supply of liquid flowed into the different channels 5. The degree of expansion of the jacket or expansible element depends largely on the quantity of liquid permitted to accumulate in the channels 5, and this accumulation is governed and limited by the position of the outer ends of the scoop conduits 10 and 10′ which are of shape to bring these outer open ends to operate on and against the surface of the revolving body of liquid in the respective channels 5, thereby removing liquid and lessening the expanding pressure on the jacket element and consequently enabling enlargement of the separating passage as desired. It is advantageous that the expanding pressure on this element Y 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 10 and 10′ respectively, that operate in the different channels 5, on separate rods 11 and 11′ which are suitably mounted to be susceptible of partial rotation and have their respective upper ends 12 and 12′ crooked at approximately right angles to their main body. The crooked ends respectively contact with the peripheral surfaces of different cams 13 and 13′ that are mounted on rotatably journaled appropriate shafts 14 and 14′, so when the cams are revolved the crooked ends of the rods are moved to conform to the surface contour of the cams, and thereby gradually rotatably move the rods 11 and 11′ swinging the scooping ends of the pipes or conduits 10 and 10′ out or in with respect to the axis of the separator, which gradually removes the liquid from the channels 5 to a greater or less distance from the axis, thus automatically and gradually regulating, varying, and limiting the expanding pressure on the expansible element, independently of variation of the rotating speed of the deflector member or expansible element.

The surfaces of the cams are made of suitable contour and the scoop pipes 10 and 10′, and the cams are adjusted with respect to the rods 11 and 11′, and the channel rings 4 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 15 and 15′ respectively on the shafts 14 and 14′, meshing with worms 16 and 16′, mounted on suitably journaled shafts 17 and 17′, on which latter shafts I also provide cone shaped belt pulleys 18 and 18′, as illustrated.

On a suitably mounted shaft 19, I have placed cone shaped pulleys 20 and 20′ in proper relative belt alinement with the pulleys 18 and 18′, and have provided drive belts 21 and 21′, respectively connecting these two pairs of cone pulleys, by which rotation is transmitted from the cones 20 and 20′ to those 18 and 18′ and to the worms and worm wheels 16 and 16′ and 15 and 15′ respectively, and to the cams 13 and 13′.

The belts 21 and 21′ can be moved along the cones as desired by the guides 22 and 22′ to obtain greater or less speed of rotation of the cams 13 and 13′, or either of them. The shaft 19 is provided with a pulley 23 connected by a quarter twist drive belt 24 from a pulley 25 on the upper end of the shaft C, so that the cams and their associated mechanism are revolved while the separator is in operation.

By means of the swiveled clamps 26 and 26′ the conduits 10 and 10′ may be independently adjusted on their rods 11 and 11′ 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 5, and the delivery ends of these conduits may terminate at any suitable place to dispose of the removed liquid.

I have illustrated them in position to deliver 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 27, with its end entering the space leading into the feed chamber U. From the feed chamber, the liquid and material pass through the 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.

If it is desired to produce greater expansion in one of the expansion chambers than in another, the position of the scoop conduit which operates with respect to that particular chamber may be adjusted on its rod 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 28, 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. 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 pipes 27 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 part of the material lodges or beds 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 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 outer or scooping ends of the conduits 10 to 10′ are being gradually moved outward by the cam mechanism gradually lessening the accumulation of expanding liquid in the channels 5, and permitting the flexible element Y to be gradually contracted. This continues 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 stopped by closing the valve 29, and the speed of the vessel having the separating surface is decreased to a comparatively slow velocity, and clean water is introduced by means of the branch pipe 30, which connects with a suitable source of preferably clean water supply, the volume of which is regulated by the valve 31. By this time the cams have revolved a sufficient distance to bring the crooked part 12 and 12′ of the rods 11 into position on the cam to be quickly moved and swing the outer ends of the scoops 10 and 10′ inward, and again permit the maximum desired accumulation of expanding liquid in the channels 5.

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 of the movement of the scoops to a position permitting a greater accumulation of expansion liquid and also because the expansion liquid is 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 32, and as discharged from said launder through the opening 33, may then be diverted to any place desired. The launder is supported by the bracket 34, and has a removable cover or top 35. After the accumulation of separated material has been discharged, the greater speed of rotation of the vessel A is restored, the clean water valve 31 closed and the material valve 29 opened and the operation is repeated.

In Figs. 10, 11, 12 and 13, I have illustrated a modification of means for effecting yieldable expansion of the expansible element. In this modification I have made the deflector vessel or supporting element, which I have herein indicated by numeral 36, with its diametrical walls largely cut away leaving elongated spaces 37, best shown in detail Fig. 12. Spaced around the circumference of the supporting element 36 I have provided bars 38 extending longitudinally of the axis, which are movably connected to the supporting element by means of rods 39 located at each end of and attached to the respective bars as shown. The rods 39 extend toward the axis of rotation, passing through appropriate externally threaded sleeves 40, best shown in Fig. 13, which sleeves are in threaded engagement with the suitably shaped and located internal flange rings 41, of the supporting element. The sleeves 40 are of sufficient length to permit of desired adjustment in or out, by means of their screw threads, and are provided with a head or flange on their outer ends adapted to rest against the inner ends of the spiral springs 42, which are coiled around the rods or pins 39. The outer end of the springs 42 rest against the bars 38 and exert an outward pressure on the bars, forming yieldable expansion means for the expansion element 43 which surrounds the outer surface of the collective bars as hereinafter more fully explained. The outward or expanding pressure on the bars may be increased or diminished by screwing the sleeves 40 in or out, thereby increasing or decreasing the compression of the springs 42. The rods 39 extend through the sleeves in a slidable manner so as to permit the bars to move out or in while yielding to relative variation of the expanding and compression forces exerted on the respective sides of the expansible element, and the rods are threaded to the extent desired and engage nuts 44 adjacent to the ends of the sleeves nearest the axis of rotation, which nuts may be adjusted in or out to contact with the ends of the sleeves, as may be desired, to limit the movement or extent of the expansion force of the bars.

Around over the circumference of the deflector vessel or supporting element and over the collective outside area of the bars 38, I locate the expansible element 43, which serves to create a washing or liquid scouring friction in aid of separation of material during operation as has been before explained. This element 43 may be secured to the supporting element in any suitable way, as by tightly wrapping strands of wire 45 around it. The bars being held out by the springs 42 expand the element 43 in a yieldable manner, so that by an excess pressure of the liquid in the separating channel, the springs 42 will yield and permit the element 43 to be compressed accordingly. The degree of expansion force and resistance to compression of the element 43 may be regulated by adjustment of the sleeves 40, out or in, thereby increasing or decreasing the pressure on the springs 41. To assist in effecting yieldable expansion, liquid may also be employed inside of the expansible element as illustrated in Fig. 10, and the quantity may be regulated or limited by any suitable means, as has been explained in the main figures of the drawing.

I desire to here explain that where in the specification and claims I have used the expression that the vessel or member having the separating surface and the member having the expansible element form the separating passage, I do not mean that they necessarily wholly form such passage, as they may only in part form it and still come within the scope of my meaning, claims and invention. I also desire to state that in the use of the word "element" I do not mean to necessarily imply a basic or noncomposite factor.

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 an element in proximity to the separating surface which element contains comparatively non-elastic reinforcing means and is 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.

2. 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, which element contains comparatively non-elastic reinforcing means, and is adapted to automatically yield to the relatively varying expansion and compression forces on its respective sides, effecting substantial contraction or enlargement of the separating passage and automatic means adapted, during operation, to vary said expansion force independently of the rotating speed of said second member, 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 an element in proximity to the separating surface adapted to yield to relatively varying expansion and compression forces operating on its respective sides, effecting substantial contraction and enlargement of the separating passage and means adapted to gradually and automatically during operation, vary said expansion force independently of the rotating speed of the said second element, substantially as described.

4. In the combination of a centrifugal ore separator, having a rotatable treatment member with a separating surface, a differentially rotatable member in part forming with the treatment member a separating passage and embodying an expansible and contractible element, comprising comparatively non-elastic reinforcing means, and yieldable binder means,—the two combined and coöperating in formation of said element adapted to operate between yieldably expanding and compressing forces and to automatically yield to relatively varying pressure of said forces, while generating a liquid washing force in the separating passage, substantially as described.

5. In the combination of a centrifugal ore separator, having a rotatable treatment member with a separating surface, a differentially rotatable member in part forming with the treatment member a separating passage and embodying an expansible and contractible element, comprising comparatively non-elastic reinforcing means, and yieldable fibrous material,—the two combined and coöperating in formation of said element adapted to operate between yieldably expanding and compressing forces and to automatically yield to relatively varying pressure of said forces, while generating a liquid washing force in the separating passage, substantially as described.

6. In the combination of a centrifugal ore separator, having a rotatable treatment member with a separating surface, a differentially rotatable member in part forming with the treatment member a separating passage and embodying an expansible and contractible element comprising comparatively non-elastic reinforcing means, being multiple strips or bars disposed substantially parallel to the axis of rotation, and yieldable fibrous material,—the two combined and coöperating in formation of said element, adapted to operate between yieldably expanding and compressing forces, and to automatically yield to relatively varying pressure of said forces while generating a liquid washing force in the separating passage, substantially as described.

7. In the combination of a centrifugal ore separator, having a rotatable treatment member with a separating surface, a differentially rotatable member in part forming with the treatment member, a separating passage and embodying an expansible and contractible element comprising comparatively non-elastic reinforcing means, yieldable fibrous material and elastic substance,—the three combined and coöperating in formation of said element adapted to operate between yieldably expanding and compressing forces, and to automatically yield to the relatively varying pressure of said forces, while generating a liquid washing force in the separating passage, substantially as described.

8. In the combination of a centrifugal ore separator, having a rotatable treatment member with a separating surface, a differentially rotatable member in part forming with the treatment member a separating passage and embodying an expansible and contractible removable tube shaped element comprising comparatively non-elastic reinforcing means, yieldable fibrous material and elastic substance,—the three combined and coöperating in formation of the said element, adapted to operate between yieldably expanding and compressing forces and to automatically yield to relatively varying pressure of said forces, substantially as described.

9. 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 an element in proximity to the separating surface having comparatively non-elastic reinforcement means and adapted to be expanded by liquid pressure, and means adapted to supply liquid for effecting said expanding pressure, substantially as described.

10. 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 adapted to contain a body of liquid while in operation, the second member embodying an element adapted to be expanded by liquid pressure and means adapted to gradually decrease the liquid operating to effect expansion during the loading period, substantially as described.

11. In a centrifugal ore separator, the combination of a rotatable member having a separating surface, a differentially rotatable deflector forming with said member a separating passage, said deflector embodying a yieldable liquid actuating frictional scouring element adapted to operate between two bodies of liquid under pressure, and to be expanded or contracted by the liquid exerting the greater pressure thereon, means for supplying liquid on both sides of said ele-

ment and means adapted to gradually and automatically decrease the liquid operating to effect expansion during the loading period, substantially as described.

12. In a centrifugal ore 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 adapted to contain a body of liquid while in operation, the said second member embodying an exterior element having comparatively non-elastic reinforcing means and adapted to hold liquid while in operation and to be expanded and contracted by liquid pressure actuated by centrifugal force, substantially as described.

13. 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 said separating passage 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, means for supplying liquid for effecting said pressure and automatic means for varying the effective quantity of the last named liquid, substantially as described.

14. In a centrifugal ore separator, the combination of a rotatable member having a separating surface, a deflector differentially rotatable thereto, forming with said member, a separating passage adapted to contain a body of liquid while in operation, said deflector embodying expansible and contractible means having comparatively non-elastic reinforcing elements and 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.

15. In a centrifugal ore 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 provided with substantially non-elastic reinforcing means and adapted to be subjected to liquid perssure 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 while generating liquid frictional force within the separating passage, and means adapted to gradually automatically decrease the liquid operating to effect expansion during the loading period, substantially as described.

16. In a centrifugal ore 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 yieldable elements forming areas adapted to be expanded by liquid pressure, having substantially non-elastic reinforcing elements, and means whereby liquid expansible pressure may be gradually and automatically varied on parts of said elements to a greater degree than on other parts thereof, substantially as described.

PHILIP F. PECK.

Witnesses:
M. PECK,
W. H. PECK.