(No Model.) 3 Sheets—Sheet 1.

O. B. PECK.

CENTRIFUGAL SEPARATOR.

No. 560,627. Patented May 19, 1896.

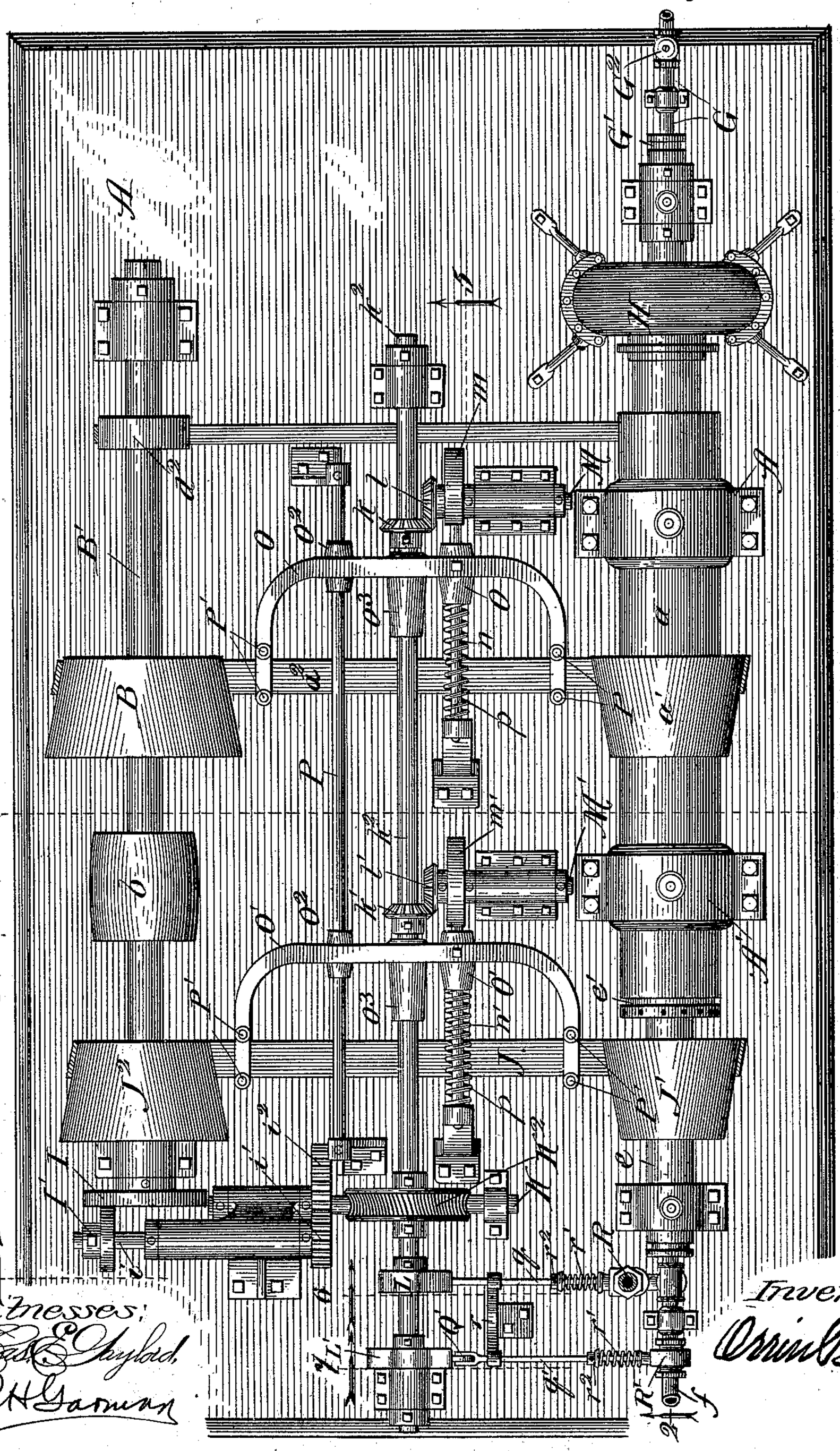

Fig. 1.

Witnesses:
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O. B. PECK.

CENTRIFUGAL SEPARATOR.

No. 560,627. Patented May 19, 1896.

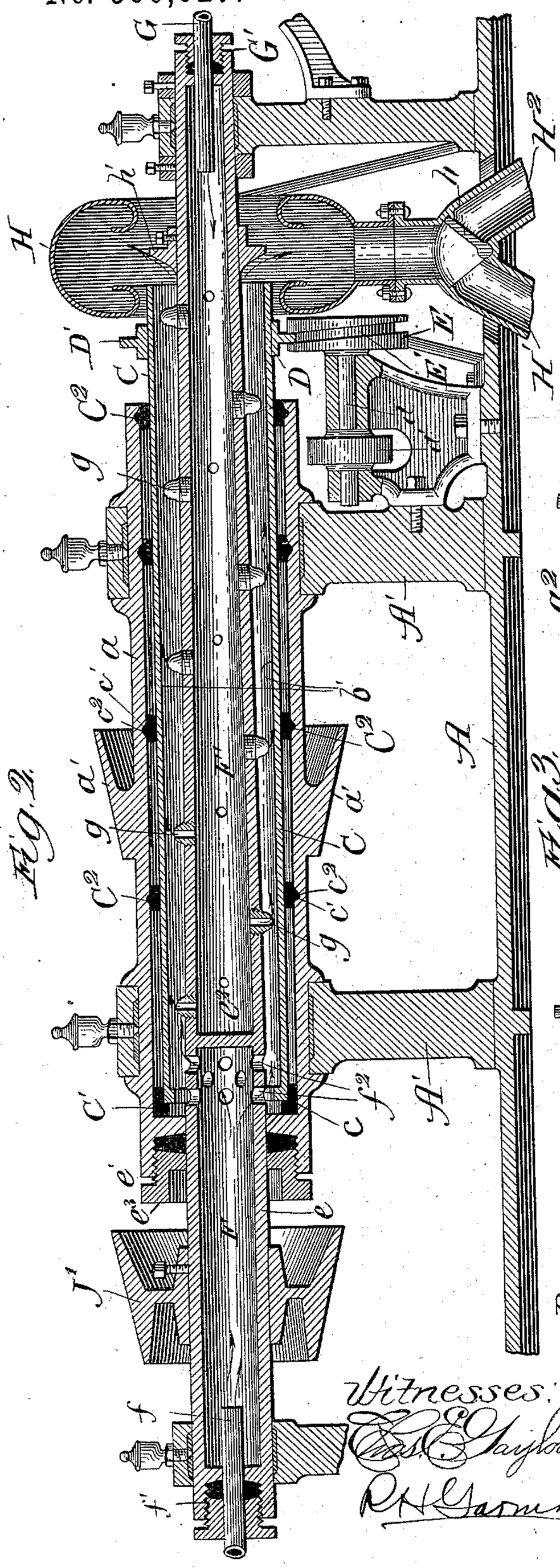

FIG. 2.

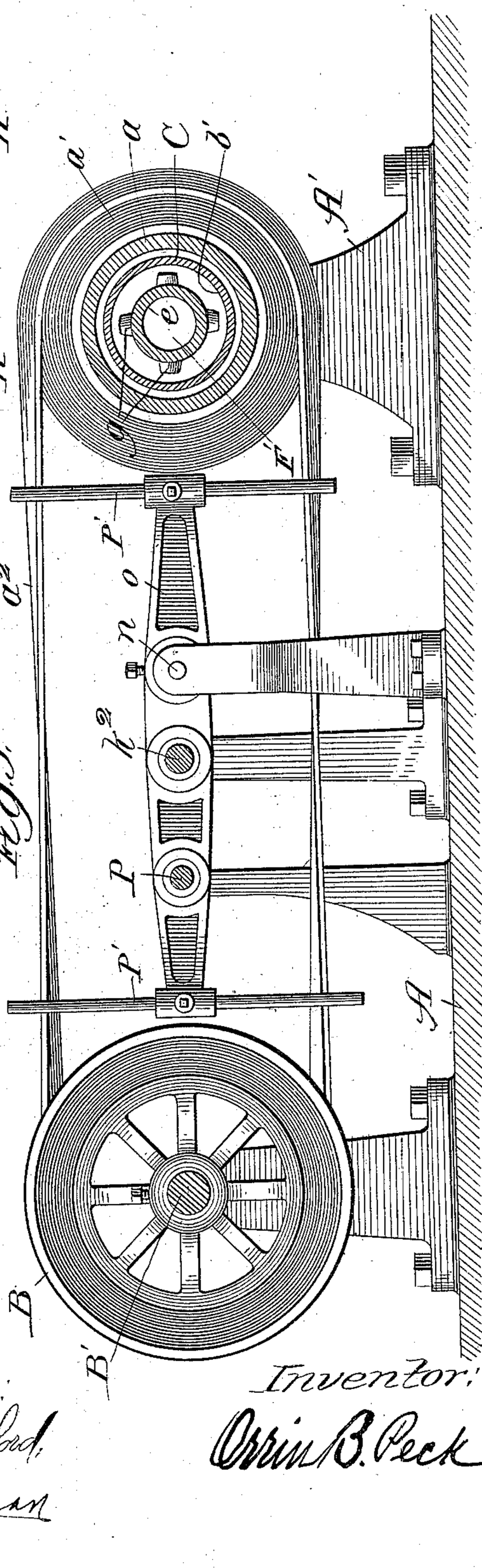

FIG. 3.

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(No Model.) 3 Sheets—Sheet 3.

O. B. PECK.

CENTRIFUGAL SEPARATOR.

No. 560,627. Patented May 19, 1896.

Fig. 4.

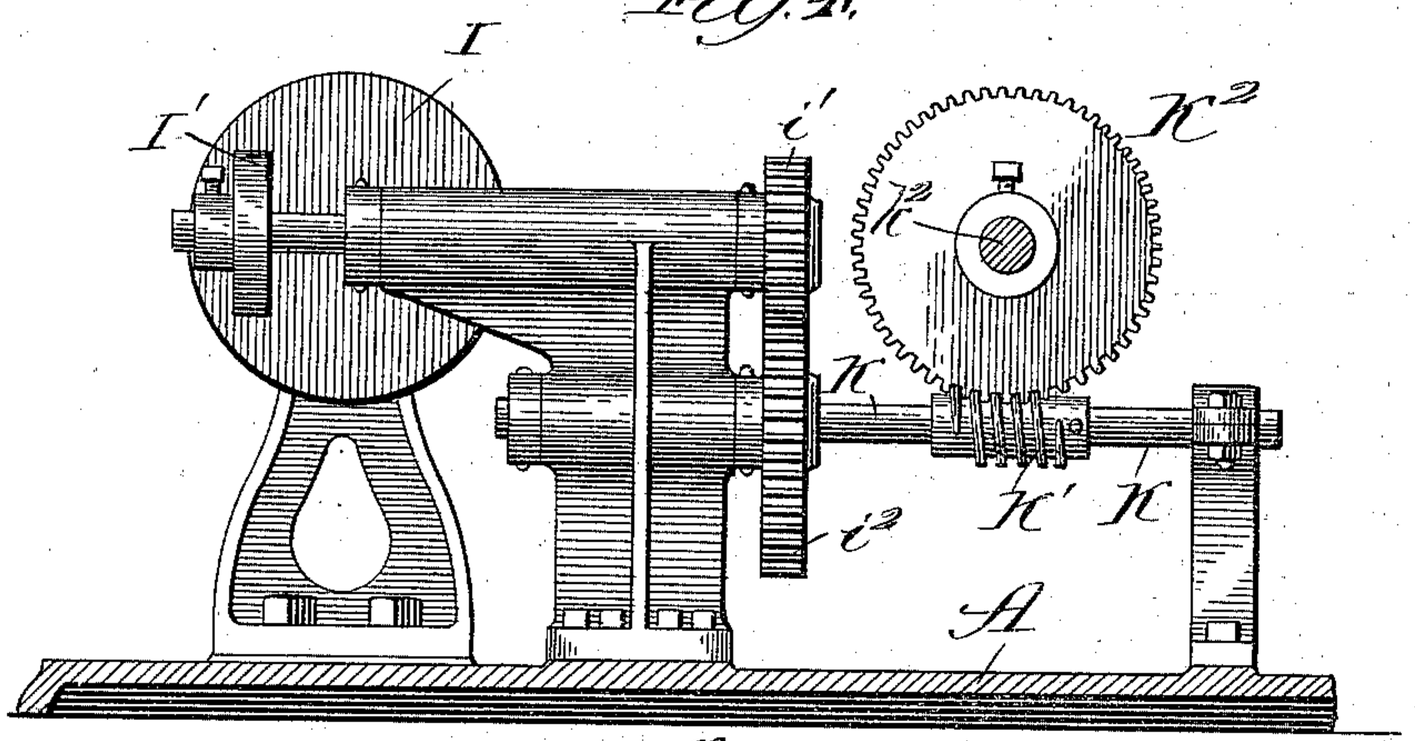


Fig. 5.

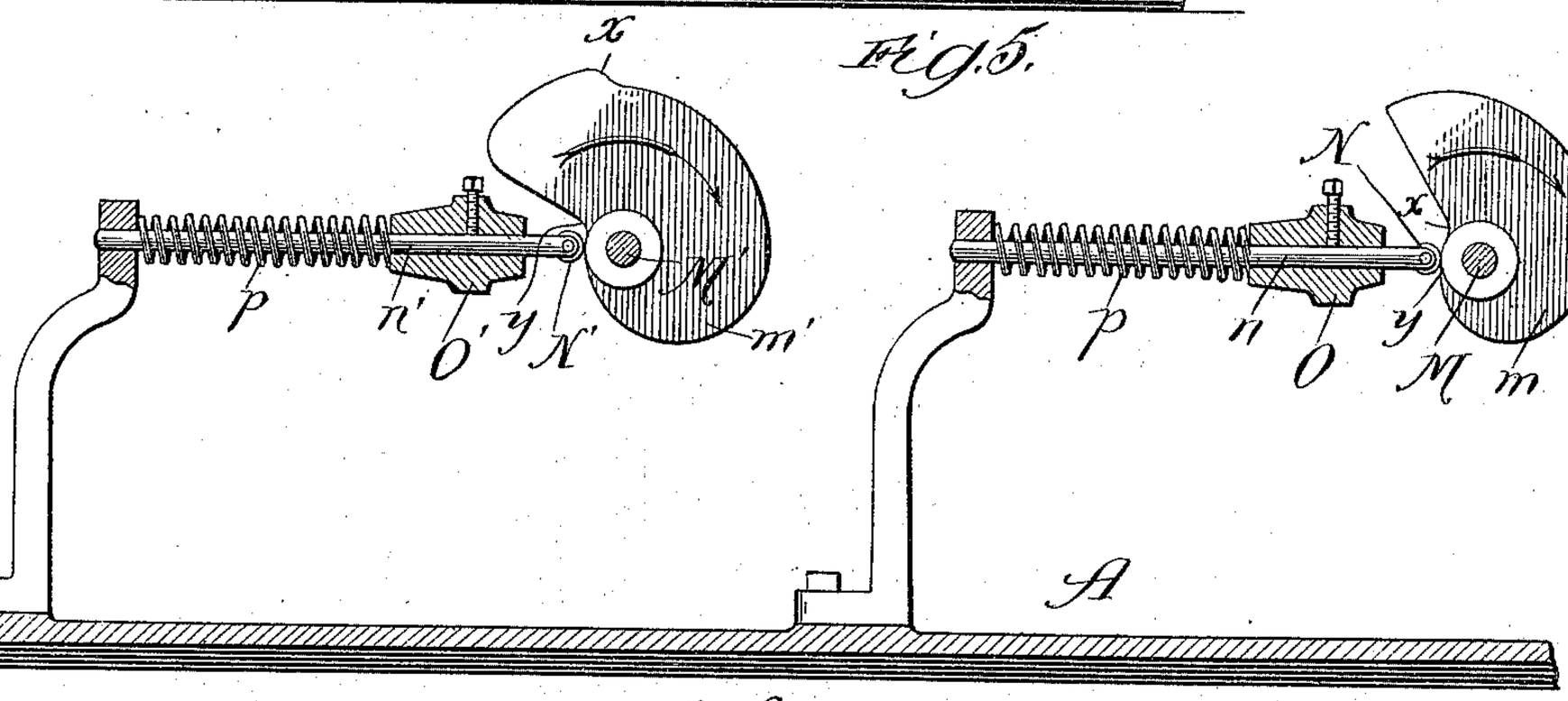


Fig. 6.

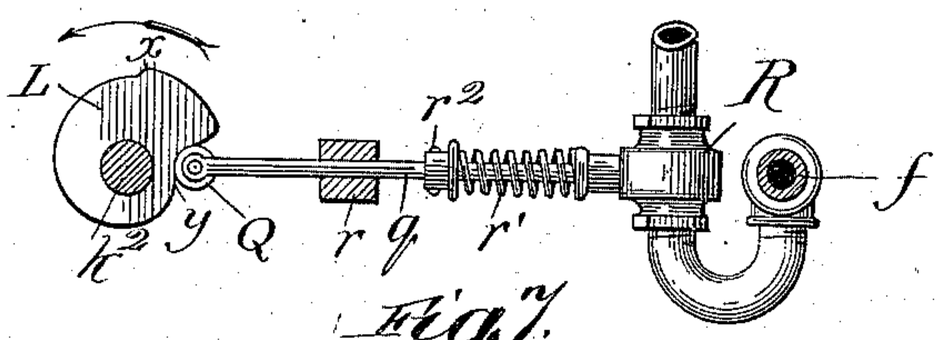
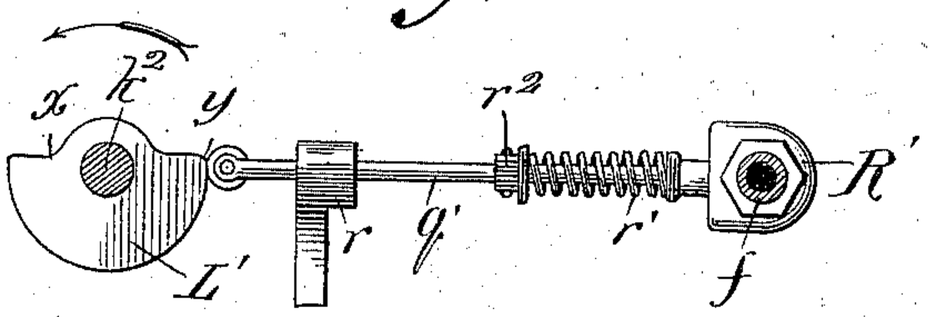


Fig. 7.



Witnesses:
Chas. E. Gaylord,
R. H. Garman

Inventor:
Orrin B. Peck

UNITED STATES PATENT OFFICE.

ORRIN B. PECK, OF CHICAGO, ILLINOIS, ASSIGNOR TO MELINDA PECK, OF SAME PLACE.

CENTRIFUGAL SEPARATOR.

SPECIFICATION forming part of Letters Patent No. 560,627, dated May 19, 1896.

Application filed March 28, 1894. Serial No. 505,417. (No model.)

To all whom it may concern:

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

My invention relates more particularly to centrifugal ore-separators, and has for its principal object the provision of a machine for obtaining a more perfect separation of lighter from heavier material while in a finely-divided state by subjecting it to centrifugal force, liquid flow, and other forces, and varying the intensity of the centrifugal force approximately as the intensity of the liquid forces are varied during separation.

As is well known, in the passage of a constant quantity of water through a channel or passage whose sectional area is varied, the velocity of the flow will vary inversely as the area of the channel, and its kinetic energy will consequently be varied as the square of its velocity. Therefore if a separating vessel having its separating-surface forming one wall of a channel or passage is rotated with sufficient rapidity to develop a minimum desired intensity of centrifugal force, and as the material under treatment accumulates on the separating-surface a constant quantity of water or other liquid is introduced therewith, which at the beginning of the operation developed by its velocity of flow the impulse necessary to carry away lighter material and allow the heavier to be precipitated and accumulated, the latter will decrease the area of the channel, resulting in an increased velocity of flow and largely-increased impulse of the liquid, thus destroying the ratio of intensity of the liquid and centrifugal forces, and in consequence causing some of the heavier material to be carried off with the lighter. Now the centrifugal force developed varies directly as the square of the speed of rotation, and to overcome the above difficulty the speed of rotation of the treatment vessel is increased approximately as the velocity of flow of liquid in the channel or passage, thus maintaining the ratio between or the relative degree or proportion of the forces approximately constant throughout the operation. The heavier material is held against the separating-surface with gradually-increasing force to resist the tendency of the increased impulse of the liquid to wash it away with the lighter, while at the same time the material is subjected to other varying forces to insure its more perfect separation. I attain these results by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is a top plan view of the entire machine. Fig. 2 is a central vertical longitudinal section through the treatment vessel. Fig. 3 is a transverse section on the line 3 of Fig. 1. Fig. 4 is a transverse section on the line 4 of Fig. 1. Fig. 5 is a sectional detail on the line 5 of Fig. 1, showing the belt-shifting cams. Fig. 6 is a sectional detail on the line 6 of Fig. 1, showing the mechanism for operating the material-feeding valve; and Fig. 7 is a similar view on the line 7 of Fig. 1 of the liquid-feeding valve. All sections are taken in the direction indicated by the arrows.

Similar letters of reference refer to like parts throughout the several views.

A designates a base-plate upon which, in standards A′ A′, is journaled a supporting-frame *a*, preferably of cylindrical form, and having upon its exterior a conical belt surface or pulley *a′*, by which it is rotated by means of a belt a^2, passing over a cone-pulley B on the counter-shaft B′, preferably supported in standards on the base-plate. This shaft is driven by a pulley *b*, belted to any source of power.

Within the outer cylinder or frame is preferably supported a light vibratable intermediate or separating cylinder C, provided with a separating-surface *b′* and yieldingly supported by means of elastic rings C′ C^2 C^2, preferably of rubber, interposed between the exterior of the separating-cylinder and the inner surface of the supporting-cylinder. The ring C′ at the feed end has an annular inside groove *c*, into which the end of the separating-cylinder projects, forming a practically water-tight joint, thus preventing material and liquid from passing between the cylinders. The rings C^2 C^2 have upon their outer surface an annular projection *c′*, which engages an annular groove c^2 in the interior of the supporting-cylinder, thus preventing the longi-

tudinal displacement of the rings during the vibration of the separating-cylinder, which is permitted by the elasticity of the supporting means. These rings are compressed between the cylinders to a sufficient degree to insure their rotating together at approximately the same speed, yet allowing the longitudinal vibratory movement of the separating-cylinder.

At the discharge end of the treatment vessel the separating-cylinder projects beyond the supporting-cylinder, and has secured upon its exterior a ring D, on which is an annular projection D′. Below the treatment vessel is a short shaft *d*, supported in a bracket bolted to the base-plate. This shaft has a pulley *d*′, by which it is rotated by a belt from a pulley d^2 on a counter-shaft B′. Upon the other end of the shaft is a wheel E, having upon its surface a cam-groove E′, which engages the projection D′ during its rotation, causing the separating-cylinder to be rapidly slightly reciprocated and imparting thereto shocks or vibrations, thus assisting in the separation of the material.

Within the separating-cylinder extends the inner, preferably hollow, agitating cylinder or shaft *e*, supported in standards on the base-plate and extending through an adjustable stuffing-box *e*′ at the feed end of the supporting-cylinder, the packing of which may be compressed by a threaded gland or plug e^3, thus insuring a practically water-tight joint. This inner cylinder is rotated at a different speed from the separating-surface, preferably faster, by a cone-pulley J′, over which passes a belt J from a cone-pulley J^2 on the counter-shaft B′. The cylinder *e* is divided by a partition e^2 into two sections F and F′. Into the section F extends a non-rotatable pipe *f* through a stuffing-box *f*′, by means of which material in a finely-divided state and mingled with a liquid, preferably water, is introduced into the section, and from there by the orifices f^2 into the separating-cylinder at or near the feed end, as indicated by the arrows in Fig. 2.

At the opposite end of the inner cylinder, into the section F′, extends a non-rotatable pipe G through a similar stuffing-box G′. Through this pipe a liquid, preferably water, is introduced, which passes preferably through the hollow projections or tubes *g*, screwed or otherwise secured in the holes arranged along the inner cylinder, and flows in jets against the material accumulated on the separating-surface, as indicated by the arrows in Fig. 2, the longitudinal movement of the cylinder C bringing a greater area under their action. The impact of these jets aids in separating lighter from heavier material and causes it to become wholly or partially suspended in the liquid for the purpose of discharge, this action being assisted by the agitation imparted to the material by the direct contact of the tubes as they pass through it. The flow of liquid in the pipe G is controlled and regulated as desired by means of a valve G^2. The inner cylinder is slightly tapered from the feed to the discharge end of the treatment vessel, being smallest at the latter point, thus maintaining a practically constant velocity of flow through the entire length thereof by increasing the area of the channel or passage in approximately the same ratio as the quantity of liquid is increased by the added number of jets. It also permits the lighter material to expand or move more freely in this portion of the channel at which it is about to be discharged, and also decreases the agitation produced by the impact of the jets of liquid and the action of the tubes upon the accumulated heavy substances by removing them farther from the surface upon which it rests, thus insuring more perfect separation by preventing the remingling of the material.

About the discharge end of the separating-cylinder is a hood H to receive the material flowing therefrom, and to this are connected branch pipes H′ H^2 for receiving the lighter and heavier material respectively, the entrance thereto being controlled by a valve *h*, which may be operated as desired. Within this hood upon the inner cylinder is preferably placed a circular plate *h*′, secured thereto by a set-screw, and being so arranged in proximity to the end of the separating-cylinder that the material discharged therefrom is deflected into the hood, and at the same time the flow from said cylinder is so checked as to allow the material to be submerged in the liquid to attain the suspension of the lighter portion.

For the purpose of varying the intensity of the centrifugal force, the degree of agitation, and the feed of material and liquid to the separating-surface the automatic mechanism is preferably used which will now be described. These actions might, however, be otherwise effected—manually, if desired.

Upon the extremity of the counter-shaft B′ is secured a friction-disk I, against which bears a friction wheel or roll I′, adjustably bolted to a short shaft *i*, supported in a standard bolted to the base-plate, carrying upon its opposite extremity a gear *i*′, which meshes with a gear i^2 upon the shaft K, suitably supported. Upon this shaft K is a worm K′, which engages a worm-wheel K^2 upon a longitudinally-extending shaft k^2. To this shaft are secured two bevel-gears *k k*′ and two cams L L′. The bevel-gears *k k*′ engage bevel-gears *l l*′ upon the ends of stub-shafts M M′, supported on the base-plate. These shafts also carry the cams *m m*′, against the surface of which bear rollers N N′ upon the ends of rods *n n*′, passing through brackets bolted to the base-plate. Upon these rods sleeves O O′ are secured by set-screws and carry belt-shifting bars *o o*′, the latter being further supported by sleeves o^2 o^2, sliding on a rod P, and sleeves o^3 o^3, sliding freely on the shaft k^2. The belt-shifting bars have at their extremities vertically-extending rods P′, which engage the

opposite sides of the belts a^2 J, causing them to be shifted from one end of the cone-pulleys to the other, thus varying the speed of rotation of the separating-surface, and agitating means, as the rods n n', are moved back and forth by the rotation of the cams. The rollers N N′ are held constantly against the faces of the cams by spiral springs p p, encircling the rods n n' and bearing against the sleeves o o' and the supporting-brackets. The cams L L′ have bearing against their surface rollers Q Q′ upon the ends of the stems q q' of the material and liquid feeding valves R R′, respectively. The valve-stems are supported by the intermediate bracket r, and have embracing them spiral springs r' r', which bear against the valves and adjustable collars r^2 r^2, secured thereon by set-screws for the purpose of adjusting the tension of the springs, maintaining the rollers in constant contact with the face of the cams, and permitting the valves to be periodically opened and closed as they rotate. To vary the rate at which these parts are actuated, the friction-wheel I′ may be adjusted toward and from the center of the friction-disk I, thus varying its speed of rotation, and consequently the length and frequency of the periods during which material and liquid are fed, and the rate of change in the speed of rotation of the separating-surface and agitating-cylinder.

When a separating vessel or cylinder is used of sufficiently large diameter to permit an accumulation or head of liquid at the receiving end to secure, by the centrifugal force generated therein, the desired force of flow through the same, the packing-boxes are preferably dispensed with.

The operation of the machine is as follows: In the position in which the elements are shown in the drawings the period of separation has just begun. The valve R is open to its fullest extent, allowing a proper amount of material to be introduced into the treatment vessel, which is being rotated at a speed sufficient to develop the desired centrifugal force, causing the material to move toward a position about the outer diameter of said vessel and to be there separated, while the valve R′ is opened sufficiently to allow liquid enough to flow in to submerge the material and allow the lighter portion to be held in suspension for the purpose of discharge. At the same time the driving-belts are at the largest diameter of cone-pulleys a' J′, which are thus being rotated at their slowest speed. As the separation proceeds and the cams rotate, the material-valve is preferably gradually closed, while the liquid-valve is held in a constant position by the uniform portion of its cam, there preferably being but a small amount of liquid introduced with the material. If desired, the rate of feed of material might be maintained constant during separation by making the actuating portion of its cam for this period of uniform diameter, similarly to that of the liquid-valve. The belt a^2 is gradually shifted to the smaller diameter of pulley a', increasing the speed of rotation of the treatment vessel in the same ratio as the increase of the velocity of flow of the liquid by the accumulation of material or the centrifugal force, as the momentum, and belt J is simultaneously moved in the same direction, gradually increasing the rotation of the inner cylinder in the same relative degree or proportion as that of the treatment vessel, and therefore the agitation produced by the motion of the tubes and the impact of the jets of liquid, by which means the lighter is partially or wholly separated from the heavier material, suspended in the liquid, and passed through the treatment vessel, for the most part without frictional contact with the separating-surface, and discharged without carrying heavier substances with it. When the points x on each of the cams have come under the rollers on the belt-shifting bars and valve-stems, this occurring simultaneously, the separation and discharge of lighter material will have been accomplished and the material-valve is abruptly closed, the liquid-valve opened wide, the speed of rotation of the vessel suddenly decreased, and the rapidity of rotation of the agitating means slightly increased. This results in decreased centrifugal force and increased agitation and the impellent force of the flow of liquid dislodging the heavier material, which is thus discharged into pipe H², the valve h being properly adjusted to receive it. This condition and operation of elements continue uniform until the points y on the cams come under the rollers, when the initial condition in the vessel is restored and the period of separation recommences.

Although the term "cylindrical" has been applied throughout to the three portions of the treatment vessel for the sake of brevity, this form is not absolutely essential to the operation of the machine and any other might be employed by which the desired results would be obtained. It is to be understood in this generic sense in both description and claims.

It is obvious that many changes and modifications in the details of construction of the various parts of the mechanism herein described may be made as desired by the constructor, or to best suit the varied conditions under which the machine is operated, without departing from my invention.

In my applications Serial Nos. 505,410, 505,413, 505,416, and 505,418 I claim certain features shown and described but not claimed herein.

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

1. In a centrifugal separator, the combination of a rotatable cylinder, rotatable agitating means supported therein to aid separation and discharge of material, means for preventing the discharge of heavier substances with the lighter by varying the speed of rotation

of the cylinder approximately as the force of flow over the separating-surface is varied during separation, and means for effecting the removal of heavier substances by decreasing the speed of the cylinder and increasing that of the agitator, substantially as described.

2. In a centrifugal separator, the combination of a rotatable cylinder, rotatable agitating means supported therein to aid the separation and discharge of material, means for preventing the discharge of heavier substances with the lighter by varying the speed of rotation of the cylinder approximately as the force of flow over the separating-surface is varied during separation, and automatic means for decreasing the speed of the cylinder and increasing that of the agitator to effect the removal of heavier substances, substantially as described.

3. In a centrifugal separator, the combination of a rotatable cylinder, pipes for supplying material and a liquid thereto, cams for controlling the supply of material and liquid and speed of rotation of the cylinder, and a common adjustable speed-gearing for actuating all the cams, substantially as described.

4. In a centrifugal separator, the combination of a rotatable cylinder, pipes for supplying material and a liquid thereto, an agitating-shaft therein, cams for controlling the supply of material and liquid and speed of rotation of the cylinder and agitating-shaft, and a common adjustable speed-gearing for actuating all the cams, substantially as described.

ORRIN B. PECK.

Witnesses:
M. L. ALLEN,
R. H. GARMAN.

Correction in Letters Patent No. 560,627.

It is hereby certified that Letters Patent No. 560,627, granted May 19, 1896, upon the application of Orrin B. Peck, of Chicago, Illinois, for an improvement in "Centrifugal Separators," were erroneously issued to Melinda Peck as sole owner of the invention; whereas said Letters Patent should have been issued to *The Patent Title Company, of same place*, said The Patent Title Company being assignee, by mesne assignments, of the entire interest in said invention, as shown by the assignments of record in this Office; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed, countersigned, and sealed this 23d day of June, A. D. 1896.

[SEAL.]

JNO. M. REYNOLDS,
Assistant Secretary of the Interior.

Countersigned:

S. T. FISHER,
Acting Commissioner of Patents.