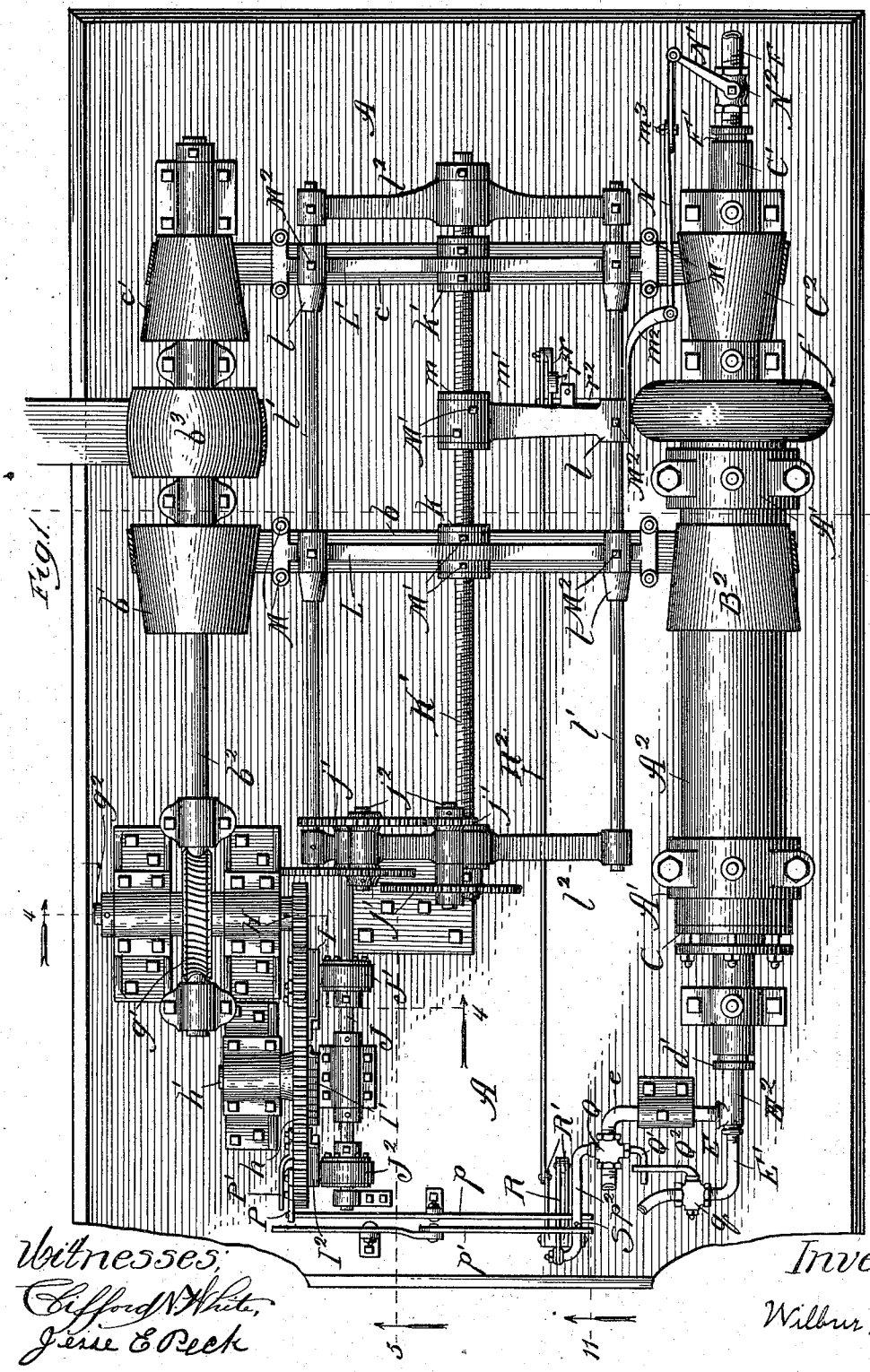
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W. H. PECK.

ART OF CENTRIFUGAL SEPARATION.

No. 560,640. Patented May 19, 1896.



Witnesses,
Clifford N. White,
Jesse E. Peck

Inventor,
Wilbur H. Peck

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ART OF CENTRIFUGAL SEPARATION.

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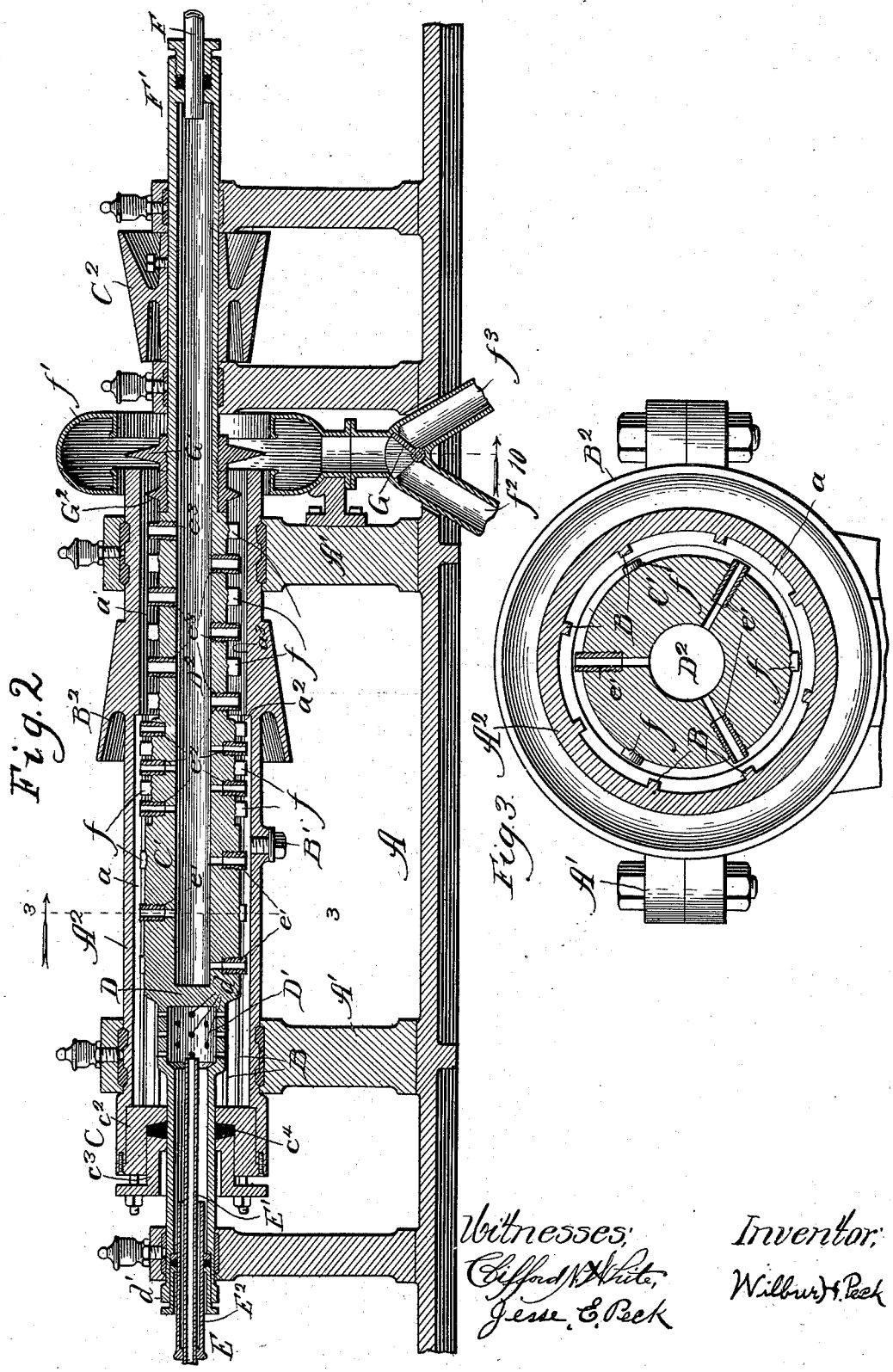


Fig. 2

Fig. 3.

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ART OF CENTRIFUGAL SEPARATION.

No. 560,640. Patented May 19, 1896.

Fig. 4.

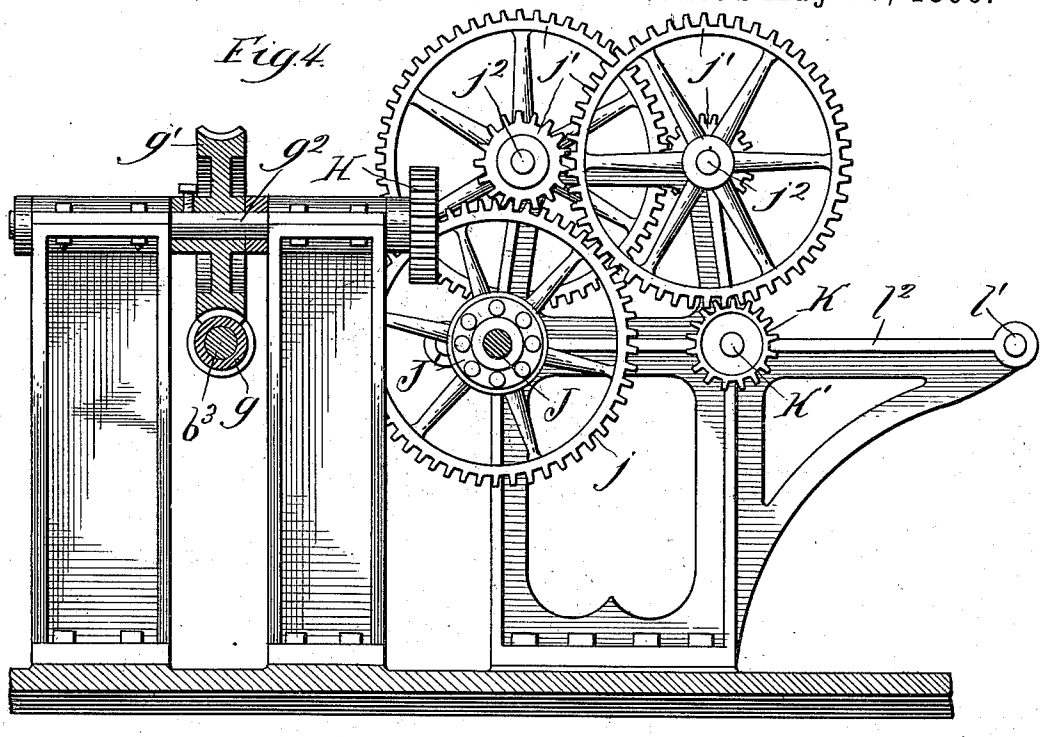


Fig. 5.

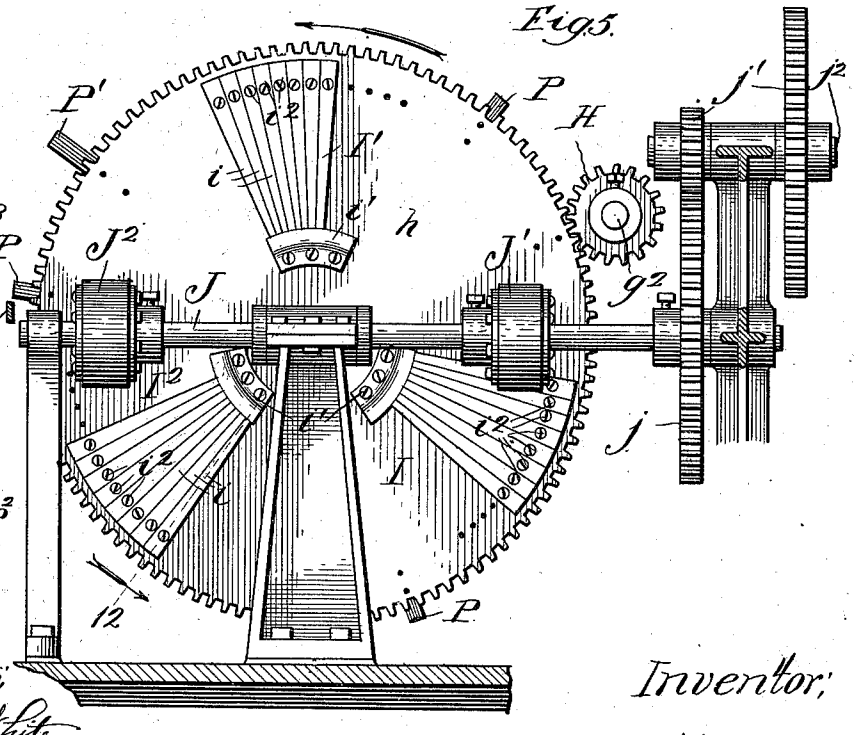


Fig. 7.

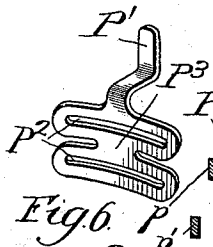
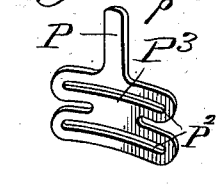


Fig. 6.



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ART OF CENTRIFUGAL SEPARATION.

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Fig. 8.

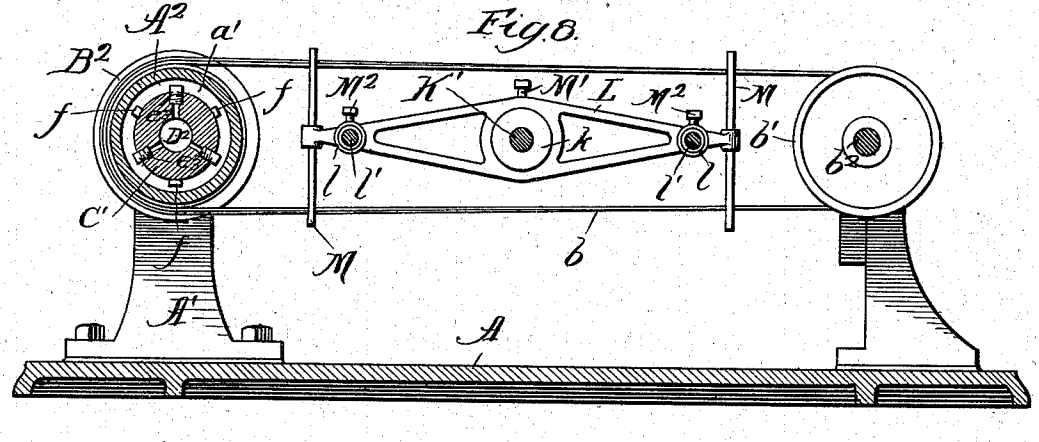


Fig. 12.

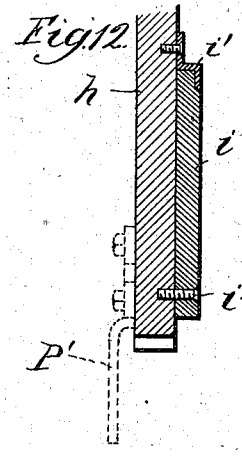


Fig. 9.

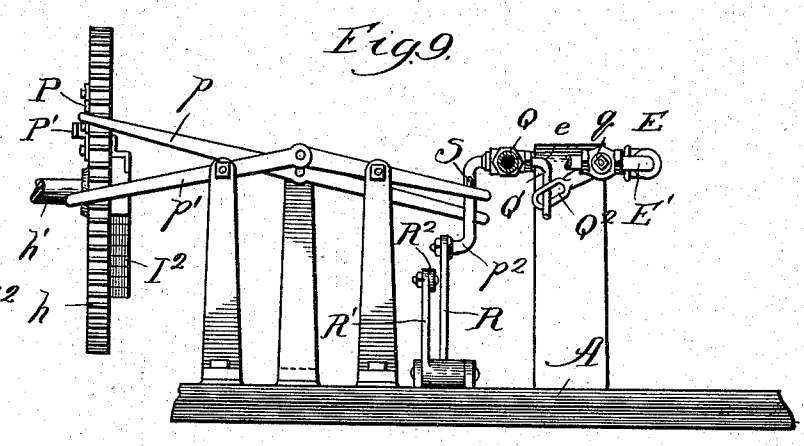


Fig. 13.

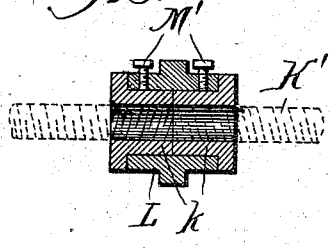


Fig. 10.

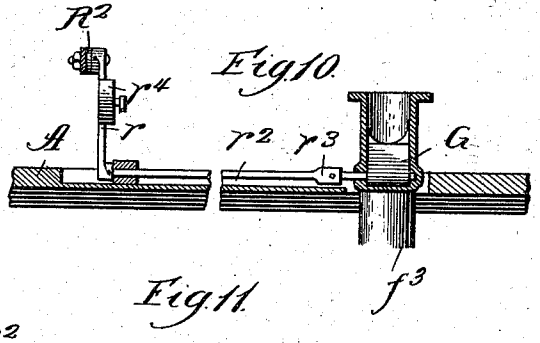
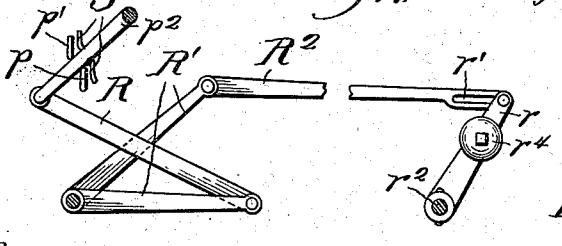


Fig. 11.



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UNITED STATES PATENT OFFICE.

WILBUR H. PECK, OF CHICAGO, ILLINOIS.

ART OF CENTRIFUGAL SEPARATION.

SPECIFICATION forming part of Letters Patent No. 560,640, dated May 19, 1896.

Application filed April 21, 1894. Serial No. 508,452. (No model.)

To all whom it may concern:

Be it known that I, WILBUR H. 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 the Art of Centrifugal Separation, of which the following is a specification.

My invention relates to improvements in a process of and apparatus for separating ore by subjecting it while under the influence of centrifugal force to the action of mercury to effect amalgamation of certain metallic portions, and to various forces to assist the separation of heavier and lighter substances. I attain these objects 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. 2. Fig. 4 is a transverse section on the line 4 of Fig. 1. Fig. 5 is a longitudinal section on the line 5 of Fig. 1. Figs. 6 and 7 are perspective views of the two striking-fingers. Fig. 8 is a transverse section on the line 8 of Fig. 1. Fig. 9 is an elevation of the mechanism for actuating the material and liquid feeding valves. Fig. 10 is a vertical section on the line 10 of Fig. 2. Fig. 11 is a longitudinal sectional detail on the line 11 of Fig. 1. Fig. 12 is a sectional detail on the line 12 of Fig. 5, and Fig. 13 is a longitudinal detail through the center of one of the belt-shifting bars. All sections are taken in the direction indicated by the arrows.

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

A designates a base-plate upon which is supported by standards A′ A′, in which it is journaled, the treatment vessel A^2, preferably of cylindrical form and divided into two transverse portions or sections $a\,a'$, the former or amalgamating portion nearest the feed end of the vessel being of largest diameter, separated from the section a' by a shoulder a^2 and adapted to contain a body of mercury while rotating in the recess thus formed. It is provided over its surface with a series of longitudinally-extending ribs B, which serve to maintain the mercury in rotation at practically the same speed as the vessel. These ribs do not extend quite to the top of the shoulder a^2, so that their upper sides may be somewhat below the surface of the mercury, leaving it unbroken. A perforation through the wall of section a between two of the ribs, closed by a screw-plug B′, enables the charge of mercury or amalgam to be drawn off when desired. The concentrating-section a' is provided with a separating-surface a^3, over which heavier and lighter material are separated and separately discharged. The treatment vessel has upon its exterior a conical belt surface or pulley B^2, by which it is rotated by a belt b from the cone-pulley b' on the counter-shaft b^2, preferably journaled in standards on the base-plate and driven from any suitable source of power by a belt passing over a pulley b^3.

The treatment vessel is preferably closed at the feed end by a stuffing-box C, through which passes an inner, preferably hollow, agitating and deflecting shaft or cylinder C′, journaled in standards on the base-plate and rotated by a cone-pulley C^2, driven by a belt c from a cone-pulley c' on the counter-shaft. The rotation of this inner cylinder is at a different rate of speed from the outer cylinder, preferably faster, causing the agitating means carried thereby to travel circumferentially with respect to the amalgamating and separating surface. This cylinder forms with the separating-cylinder an intermediate channel or passage, and serves to bring the material into proximity to the surface of the mercury and to deflect or guide said material along near the separating-surface a^3.

The stuffing-box C is formed by a sleeve c^2 secured in the end of the treatment vessel and having an inwardly-extending flange embracing the inner cylinder, and into this sleeve projects a gland c^3 secured thereto by bolts, by the adjustment of which the elastic packing c^4 may be compressed, insuring a practically water-tight joint. The inner cylinder is divided by a partition D into two sections D′ D^2. The former is supplied with orifices d, through which material in a finely-divided state and mingled with a liquid, preferably water, introduced by a conduit E passing through an adjustable stuffing-box d', is fed to the treatment vessel at or near the head end. The portion of the cylinder

C′ through which are the orifices d is of less diameter than the remainder of the cylinder within the treatment vessel, forming a chamber or enlargement in the channel over the surface of the mercury into which the material is fed.

The conduit E is compound, being composed of a central pipe E′, extending in proximity to the orifices d, and through which material mingled with a liquid is fed. Surrounding the pipe E′ is a shorter pipe E^2, extending for a portion of the distance between the stuffing-box d' and the end of pipe E′, and forming with said pipe a passage into which a clear liquid, preferably water, is introduced by a pipe e. The flow of liquid from this passage serves, in addition to the other functions hereinafter described, to keep the material from passing back through the section D′ and getting into the stuffing-box, where the wear would cause leakage. The pipe E^2 may be removed if desired and another of different length substituted, to secure the proper action for the particular pressure which may be applied to the material and clear-liquid pipes. Section D^2 is provided with orifices or perforations throughout the length of the separating vessel, in which are preferably screwed or otherwise secured three sets of hollow projections or tubes e' e^2 e^3, the first two being over the amalgamating-section and the last over the separating-surface. Through these tubes are forced jets of a liquid, preferably water, supplied by a pipe F passing through an adjustable stuffing-box F′. The inner cylinder also carries over its surface, alternating with the tubes, projections or pins f. The impact of the liquid jets and the contact of the moving tubes and pins serve to agitate the material for the purpose hereinafter described. The portion of the inner cylinder which is supplied with these projections is preferably of three different diameters. That over a portion of the amalgamating-section in which are the tubes e' is largest, extending close to the surface of the mercury to bring the material into intimate contact therewith. It has comparatively few agitating projections over its surface, which serve to maintain only the lightest portions of the material in suspension in the liquid within the channel, and permit the heavier substances which may contain metal capable of amalgamation to be passed over the surface of the mercury. Over a smaller part of the amalgamating-section, toward the discharge end of the vessel, the inner cylinder is of somewhat less diameter, leaving a wider channel, and is thickly provided with tubes e^2 and pins f, which produce a sufficiently violent agitation to maintain almost all the material in suspension in the increased body of liquid, but which allow particles of finely-divided or "shotted" mercury, which may have been present in the material or formed and mingled therewith by effects incident to the operation, to be separated therefrom, precipitated, and caught by the main body. The cylinder is of least diameter over the separating-surface and is provided with the tubes e^3 and pins at more frequent intervals than in the amalgamating-section, but less than the intermediate section, producing an agitation sufficient to wholly or partially effect and maintain the suspension of the lighter substances in the liquid, or assisting in moving them toward the point of discharge, and allow the heavier to be precipitated and accumulate on the separating-surface, and later by their increased agitating effect in dislodging said accumulated heavier substances. The tubes over the amalgamating-section are of less internal diameter than those in the wider channel to give less agitating effect and to keep the velocity of flow throughout the vessel approximately uniform.

The treatment vessel discharges into a hood f', which communicates with branch pipes f^2 f^3, conducting lighter and heavier substances, respectively, to suitable receptacles, the passage from the hood to the pipes being controlled by a valve G, which is automatically operated as hereinafter described. Within the hood, secured to the cylinder, is preferably placed a circular plate G′, which deflects the material discharged from the treatment vessel into the hood. At one side of the plate G′ and just inside the end of the vessel is a similar smaller plate G^2, which partially closes the exit therefrom so that sufficient resistance is offered to the discharge of material and liquid to maintain the channel or passage practically full, and keep the material therein in a state of submergence, allowing the suspension of the lighter portion.

To accomplish the separation of material in the treatment vessel and the separate discharge of lighter and heavier substances, the speed of rotation of the separating and agitating cylinders, the period of introduction of material and clear liquid through conduit E and impact liquid through the pipe F, and the operation of the discharge-valve are preferably automatically controlled and periodically or intermittently operated by the mechanism which will now be described. These actions might, however, be otherwise effected—manually, if desired.

On the counter-shaft b^2 is fixed a worm g, engaging a worm-wheel g', mounted on a shaft g^2, which also carries a small spur-gear H, engaging teeth upon the periphery of a large wheel h, rotating it at a comparatively slow rate of speed. One face of the wheel h serves as a friction surface or disk and carries three sets I I′ I^2 of small movable friction-plates i, which are secured to the face of the gear at their inner ends by flanged brackets i', and at their outer by screws i^2, engaging a series of holes. By changing the number and position of these plates the surface of frictional contact may be varied both in length and position. On a shaft J, suitably journaled in a position parallel with the face

of the wheel h, are mounted two friction wheels or rolls J' J², adjustably secured thereon by set-screws and alternately engaging with the friction-plates during the rotation of the wheel. On the end of the shaft J is a gear j, which communicates through a train of speed-up gears j' on the short longitudinal shafts j^2 with a gear K, mounted near the end of a longitudinally-extending threaded rod K'. This rod is supported for rotation in standards, preferably mounted on the base-plate, and carries internally-threaded sleeves k k', upon which are mounted the transversely-extending belt-shifting bars L L', which are supported at their outer ends by sleeves l, sliding freely upon rods l', supported by cross-bars l^2. Upon the ends of the bars L L' are vertical pins M, engaging the opposite sides of the belts b c, which communicate rotation to the treatment vessel and inner cylinder, respectively.

As the wheel h is rotated by the intermediate gearing, the sets of friction-plates on its surface engage the friction-wheels J' J², and through the speed-up gearing cause the threaded rod to be rapidly rotated alternately in opposite directions with greater or less intermediate periods of rest, thus causing the belt-shifting bars to travel along the rod in accordance with this rotation and move the belts from one end of the cone-pulleys B² C² to the other, increasing and decreasing the speed of rotation with intermediate periods of constant speed. These pulleys are so arranged on their respective cylinders that for an increase of speed of B² that of C², which is tapered in the opposite direction, is decreased for the reason hereinafter stated. The threaded sleeves k k' are preferably made in two parts, as shown in Fig. 13, and upon each of these bears a set-screw M', passing through the belt-shifting bar.

If it be desired that either of the belts shall remain stationary in its movement along the surface of the cone-pulleys, maintaining the speed of rotation of one or more parts constant while the others are varied, the set-screws are loosened, thus allowing the sleeves to turn freely in the bars and preventing their travel along the threaded rod. At the same time set-screws M² in the sleeves l are tightened to engage the rods l', thus insuring the belt-shifting bar remaining stationary. The rod K' also carries another threaded sleeve m, upon which is mounted a bar m', extending in one direction only and supported at its outer end by a sleeve l, similar to the others. To this bar is secured a rod m^2, to which is pivoted a connecting-rod N, pivotally connected at its opposite end to a lever N' on the stem of the impact-liquid valve N² in the pipe F. The rod N is of adjustable length, being made in two parts secured together by a bolt m^3 passing through slots in their adjacent ends. The bar m' being caused to travel back and forth by the rotation of the rod K' within its threaded sleeve, the valve N² is alternately opened and closed by the interposed rods and levers with intermediate periods during which it is stationary. It may be thrown out of action, if desired, by an arrangement precisely similar to that employed with the belt-shifting bar. Upon the opposite surface of the wheel h from that which carries the friction-plates are preferably three sets of two adjustable contact portions or fingers P P', which are secured to the face of the wheel by screws passing through slots P² in an enlarged portion P³, the slots permitting an adjustment of the fingers circumferentially of the wheel. The finger P lies in the same plane as its enlarged portion and projects close to the face of the wheel, while the finger P' is bent twice nearly at right angles, which causes it to project in a plane at a slight distance from the surface. It also has a greater radial length. These fingers respectively engage the ends of levers p p', the former being a simple lever pivoted at its center upon a standard mounted on the base-plate, while the lever p' is compound, its two sections being mounted on two similar standards. The opposite ends of these levers contact with the lower and upper sides, respectively, of a lever p^2, extending at right angles from the end of the stem of the liquid-feeding valve Q in the pipe e. The opposite extremity of the valve-stem carries a lever Q', the lower end of which projects through a slot in the end of a lever Q², fixed to the stem of the material-valve q in the pipe E.

To the outer extremity of the lever p^2 is pivoted a rod R, connected to one member of a bell-crank lever R', pivoted to the base-plate, to the other arm of which is pivotally attached a long connecting-rod R², leading to the upper extremity of a lever r, to which it is attached by a bolt passing through a slot r'. The lower end of the lever r is secured to a rod r^2, having a socket r^3 at its opposite end, in which is secured by means of a set-screw the stem of the discharge-valve G. By changing the point of attachment of the lever r to the rod R² and by turning the valve-stem in its socket the extent of movement of the valve G may be adjusted and its relative time of action to the other elements varied. A weight r^4 near the upper end of the lever r assists in throwing it in one direction or the other.

As the levers p p' are moved downward by the contact of the fingers P P' they respectively raise and lower the lever p^2, thus opening and closing the valve Q with intermediate periods during which it is stationary. The lever p^2 carries upon its upper and lower surfaces small pins S, which serve to prevent the slippage of the levers p p' as they engage it. As the valve Q is actuated it also in turn opens and closes the material-valve q through the intervention of the levers Q' and Q² at the same time the discharge-valve G is operated

by the bell-crank lever and its connecting-rods and levers.

The pipes E', *e*, and F are preferably connected to elevated reservoirs, pumps, or other sources of supply for securing a suitable pressure of material and liquid to obtain the proper flow through the cylinder and the impact force from the tubes e' e^2 e^3. Manually-operated valves might be arranged between these sources and the separator to govern the pressure irrespective of the position of the automatic valves.

The operation of the device is as follows: The valve *q* being open to its fullest extent and the valve Q partially open, ore in a finely-divided state and mingled with water is fed into the treatment vessel, which is being rotated at a speed sufficient to develop the desired degree of centrifugal force, in sufficient quantities to fill the channel or passage between the inner cylinder and the surface of the mercury. Here the centrifugal force carries the heavier material toward the surface of the mercury, over which it is passed by the flow through the vessel and the portions capable of amalgamation retained thereby. At the same time the agitation produced by the impact of the jets of liquid from the tubes e' and by the movement of the tubes themselves and the pins *f* causes the lighter and non-metallic portions to be suspended in the liquid out of contact with the mercury. The material then passes into the field of action of the tubes e^2 and their companion pins, where the increased agitation maintains practically all of the material in suspension in the liquid, but allows the particles of mercury which may have become mingled therewith to be precipitated and caught by the main body. The material is then carried by the flow of liquid into the concentrating-section a', where the agitation is only of a sufficient degree to maintain the lighter substances in suspension while the heavier portion is precipitated upon the separating-surface by the centrifugal force and lodges and accumulates. The separation being accomplished in the concentrating portion and a proper amount of heavier substances having accumulated upon the separating-surface, the valves and gearing are in the position shown in the drawings and the heavier material is now to be automatically discharged. The group I of friction-plates in its upward movement, as shown in Fig. 5, engages the friction-wheel J' and causes it to rotate, through the intermediate gearing, the longitudinal threaded rod, thus moving the threaded sleeves and the bars they support, shifting the belts to the opposite ends of the cone-pulleys, and opening wide the impact-valve N^2. At the same time the finger P strikes the end of lever *p*, which, by means of the system of levers already described, closes the material-valve *q*, opens wide the clear-liquid valve Q, and shifts the position of the discharge-valve. As a result of these changes the supply of material is shut off from the treatment vessel, the speed of rotation of said vessel decreased, causing the heavier substances to be held less forcibly against the separating-surface and permitting them to be dislodged by the increased agitation produced by the more rapidly revolving projections and greater impact force of liquid from the jet-tubes. At the same time the flow of liquid is so intensified by the maximum supply through the pipes *e* and F that the heavier substances are washed from the separating-surfaces out of the treatment vessel and discharged into the pipe f^3, which conveys them to a separate receptacle. This position of parts and constant degree of forces for discharge are maintained until the group I' of friction-plates in its downward movement engages the friction-roll J^2, causing the opposite rotation of the rod K', which, with the striking of the finger P' against the lever p', restores the elements to their former condition, and the period of separation follows.

When the mercury has taken up the desired amount of metal, it may be drawn off by removing the screw-plug B' and a fresh charge inserted.

By means of adjustments and changes in the various parts of the mechanism the length and frequency of the periods of operation of the elements, the intensity of the applied forces, and their relation one to the other may be varied within the desired limits. The relative length of the periods during which material and liquid are fed may be controlled by the circumferential movements of the fingers on the face of the disk, while the adjustment of the contact-surfaces I, I', and I^2 and the friction-wheels engaging therewith furnish a means for varying the intensity and time of application of the centrifugal force and agitation to vary the periods of separation and removal by changing the time and extent of movement of the belts on the cone-pulleys. By setting either of the belt-shifting bars along the threaded rod the timing of the movements of the parts it actuates will be charged with respect to its fellows. The speed of rotation of either of the pairs of pulleys may be maintained constant by throwing out of action and fixing its belt-shifting bar. The setting of the bar m' on the rod K' and the variation in the length of the rod N adjust the periods of action of the impact-valve, while the time and extent of movement of the discharge-valve may be independently adjusted by the point at which its lever is attached to the connecting-rod and the movement of its valve-stem in the connecting-socket.

Although the treatment vessel and inner shaft have been shown and described as cylindrical this form is not absolutely essential to the operation of the machine, and any other might be employed by which the desired result would be obtained.

Obviously many changes in the details of

construction of the various parts of the mechanism herein described may be made without departing from the spirit of the invention.

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

1. The process of amalgamation, which consists in subjecting the material in a flowing liquid to the action of centrifugal force to bring it into contact with mercury, and simultaneously to an agitation produced by liquid jets sufficient to keep the lighter substances in suspension, and thereafter to an increased agitation to allow only the precipitation of particles of mercury which may have been carried along, substantially as described.

2. The process of amalgamation, which consists in subjecting the material in a flowing liquid to the action of centrifugal force to bring it into contact with mercury, and simultaneously to an agitation sufficient to keep lighter substances in suspension, thereafter to an increased agitation to allow only the precipitation of particles of mercury which may have been carried along, and finally to an intermediate degree of agitation upon a separating-surface to maintain all but the heavier, unamalgamated substances in suspension, substantially as described.

3. In a centrifugal amalgamator, the combination of a rotatable vessel adapted to contain mercury, and means for obtaining jets of liquid to effect suspension of material through the vessel, placed at more frequent intervals over a portion of the mercury toward the point of discharge, substantially as described.

4. In a centrifugal separator, the combination of a rotatable vessel adapted in one portion to contain mercury and provided in another portion with a separating-surface, and agitating means to effect suspension of material throughout the vessel placed at more frequent intervals over the separating-surface, substantially as described.

5. In a centrifugal separator, the combination of a rotatable vessel adapted in one portion to contain mercury and provided in another portion with a separating-surface, means for effecting the suspension of different grades or quantities of material by producing different degrees of agitation in the two portions, means for conveying material over the surface of the mercury and the separating-surface by securing a flow of liquid through the vessel, and means for removing accumulated heavier substances from the separating-surface by increasing the flow, substantially as described.

6. In a centrifugal separator, the combination of a rotatable vessel adapted in one portion to contain mercury and provided in another portion with a separating-surface, means for effecting the suspension of different grades or quantities of material by producing different degrees of agitation in the two portions, means for conveying material over the surface of the mercury and the separating-surface by securing a flow of liquid through the vessel, and automatic means for removing accumulated heavier substances from the separating-surface by increasing the flow, substantially as described.

7. In a centrifugal separator, the combination of a rotatable vessel adapted in one portion to contain mercury and provided in another portion with a separating-surface, means for effecting the suspension of different grades or quantities of material by producing different degrees of agitation in the two portions, and means for removing the accumulated heavier substances from the separating-surface by increasing the agitation, substantially as described.

8. In a centrifugal separator, the combination of a rotatable vessel adapted in one portion to contain mercury and provided in another portion with a separating-surface, means for effecting the suspension of different grades or quantities of material by producing different degrees of agitation in the two portions, and automatic means for removing accumulated heavier substances from the separating-surface by increasing the agitation, substantially as described.

9. In a centrifugal separator, the combination of a rotatable vessel adapted in one portion to contain mercury and provided in another portion with a separating-surface, means for effecting the suspension of different grades or quantities of material by producing different degrees of agitation in the two portions, and means for permitting the removal of accumulated heavier substances from the separating-surface by varying the speed of rotation of the vessel, substantially as described.

10. In a centrifugal separator, the combination of a rotatable vessel adapted in one portion to contain mercury and provided in another portion with a separating-surface, means for effecting the suspension of different grades or quantities of material by producing different degrees of agitation in the two portions, and automatic means for permitting the removal of accumulated heavier substances from the separating-surface by varying the speed of rotation of the vessel, substantially as described.

11. In a centrifugal separator, the combination of a rotatable vessel adapted to contain mercury in one portion and provided in another portion with a separating-surface, and an interposed agitator which effects the suspension of the material and permits only the precipitation of particles of mercury, substantially as described.

12. In a centrifugal separator, the combination of a rotatable vessel adapted to contain mercury in one portion and provided in another portion with a separating-surface, interposed means for separating and retaining

particles of mercury, and means for causing the suspension of different grades or quantities of material by effecting different degrees of agitation in each of the three portions, substantially as described.

13. In a centrifugal separator, the combination of a rotatable vessel or cylinder recessed in one portion to adapt it to contain mercury and also provided in another portion with a separating-surface over which fluids may pass freely, and on which heavy material will be retained by the action of centrifugal force for periodic discharge, and a differentially-rotatable cylinder or deflector within said vessel extending over both the surface of the mercury and the separating-surface, substantially as described.

14. In a centrifugal separator, the combination of a rotatable vessel or cylinder recessed in one portion to adapt it to contain mercury and also provided in another portion with a separating-surface over which fluids may pass freely, and on which heavy material will be retained by the action of centrifugal force for periodic discharge and a differentially-rotatable cylinder or deflector within said vessel provided with agitating means arranged at different distances apart over the two portions, substantially as described.

15. In a centrifugal separator, the combination of a rotatable vessel or cylinder adapted to contain mercury and also provided in another portion with a separating-surface, over which fluids may pass freely and on which heavy material will be retained by the action of centrifugal force for periodic discharge and a hollow shaft or cylinder therein provided with orifices over said mercury and separating-surfaces to deliver agitating-jets thereon, substantially as described.

16. In a centrifugal separator, the combination of a rotatable vessel or cylinder adapted to contain mercury and also provided in another portion with a separating-surface, over which fluids may pass freely and on which heavy material will be retained by the action of centrifugal force for periodic discharge and a hollow deflector or cylinder having separate sections for material and liquid, substantially as described.

WILBUR H. PECK.

Witnesses:
JESSE E. PECK,
EDMOND C. PECK.