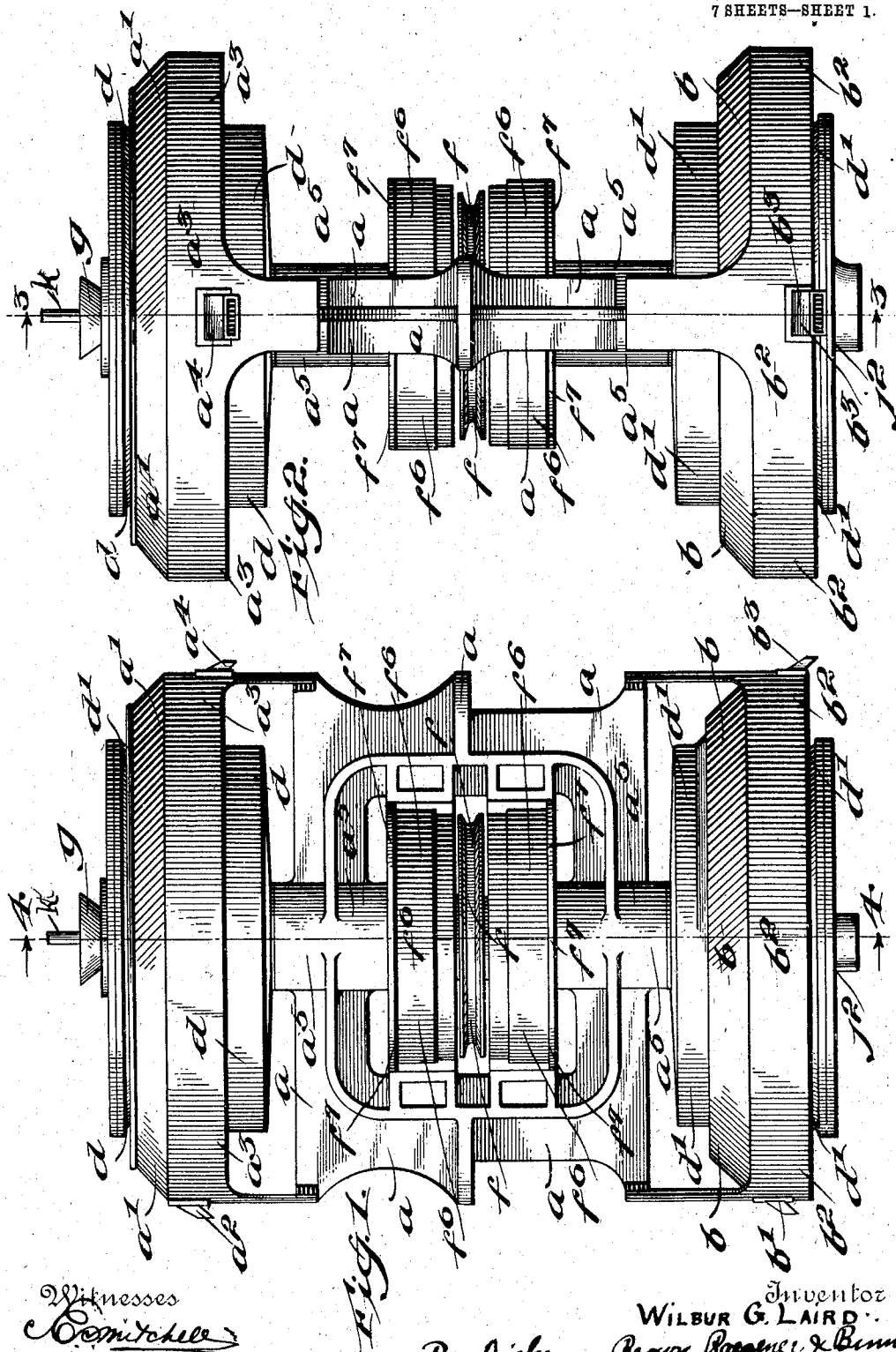


No. 791,703.

PATENTED JUNE 6, 1905.

W. G. LAIRD.
CENTRIFUGAL SEPARATOR.
APPLICATION FILED MAR. 26, 1904.

7 SHEETS—SHEET 1.



Witnesses
Comitchee
J. W. Ashless

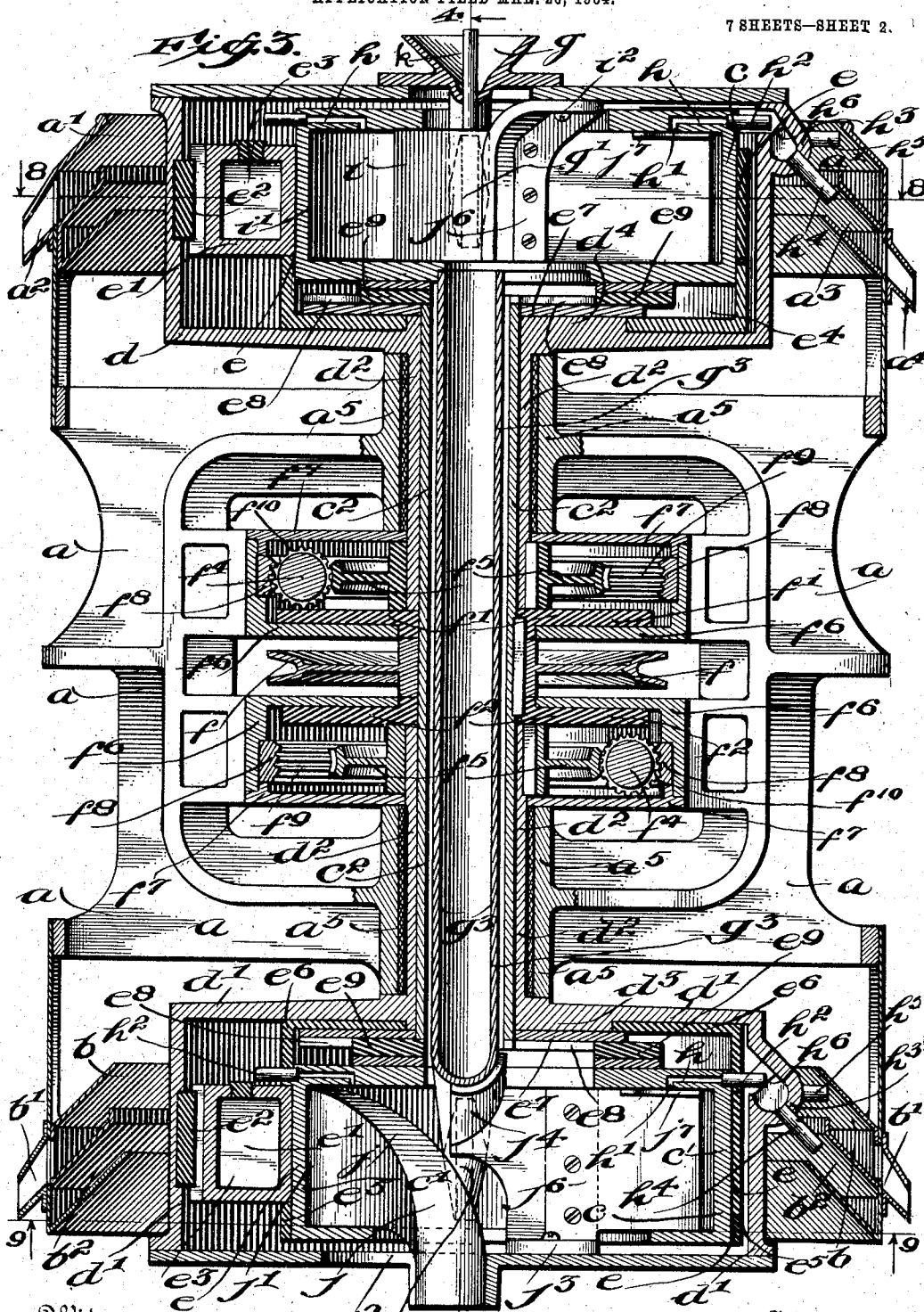
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7 SHEETS—SHEET 2.

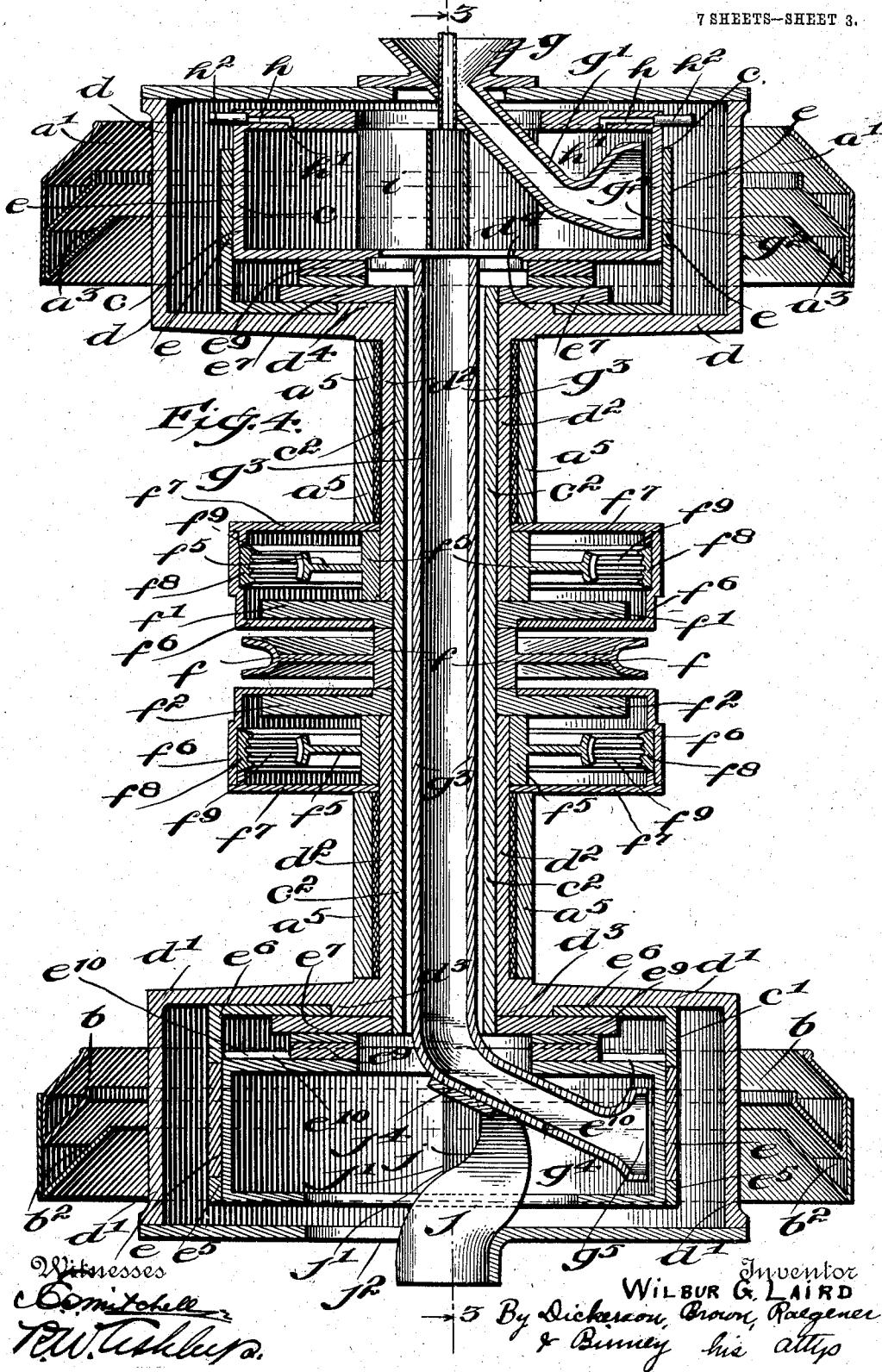


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7 SHEETS—SHEET 3.

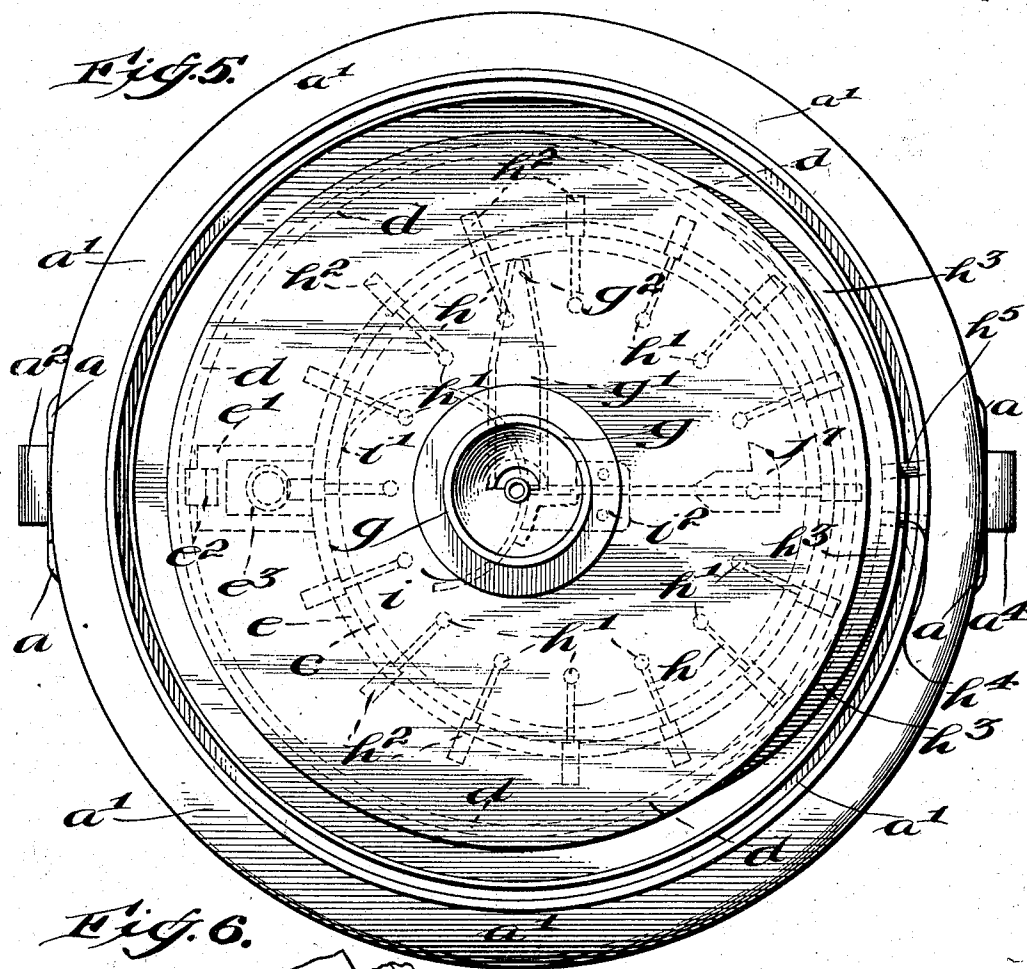
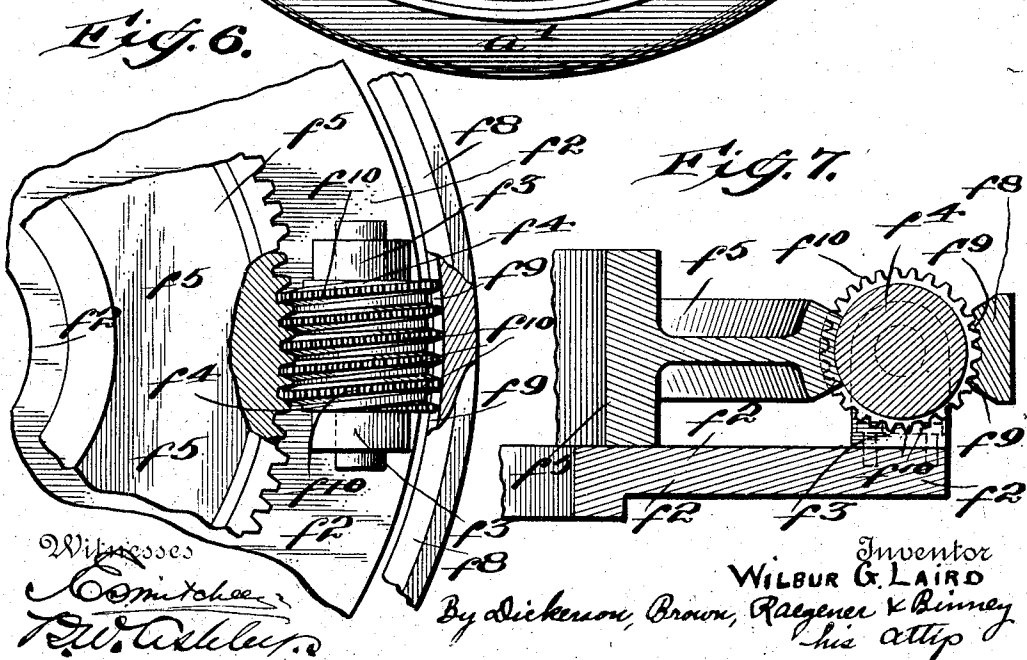


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7 SHEETS—SHEET 4.

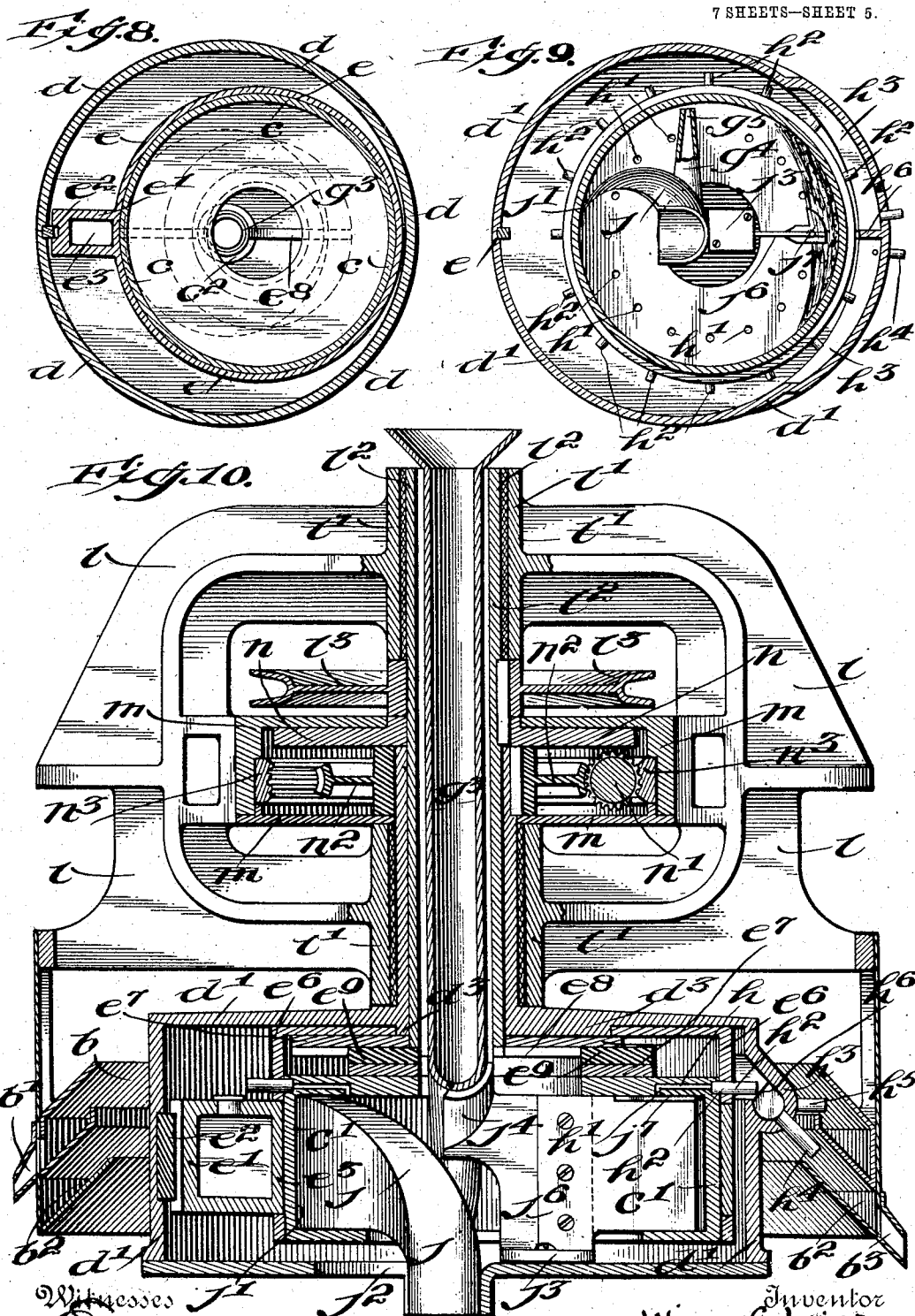


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7 SHEETS--SHEET 5.



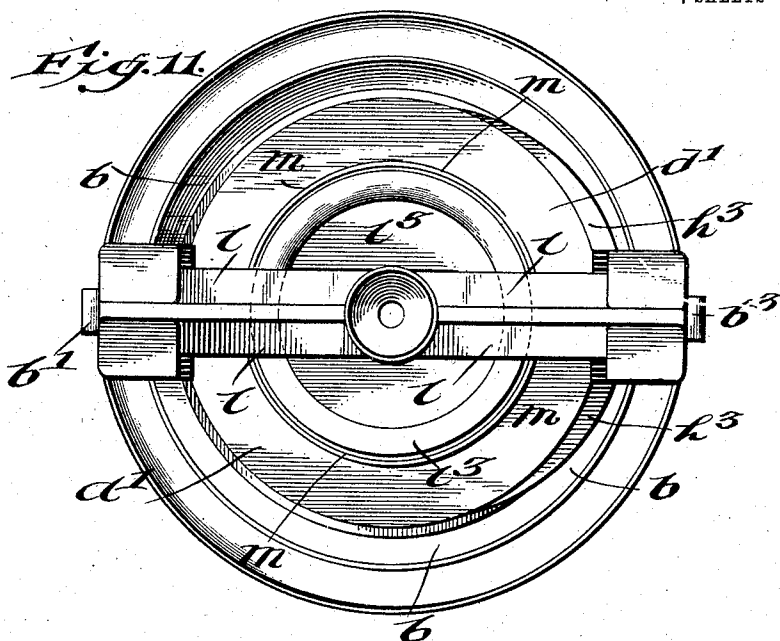
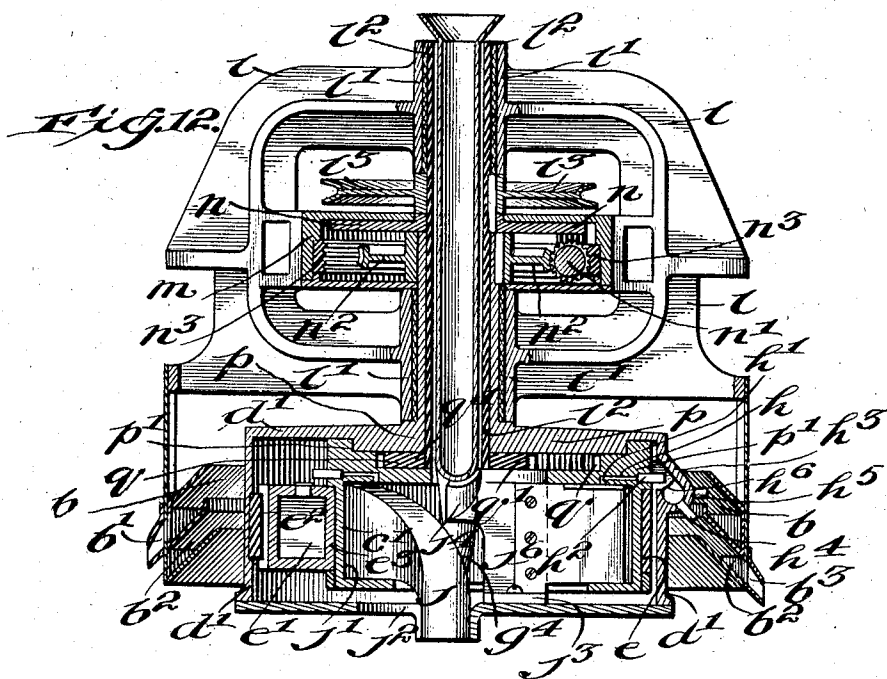
Witnesses J. H.
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APPLICATION FILED MAR. 26, 1904.

7 SHEETS—SHEET 6.



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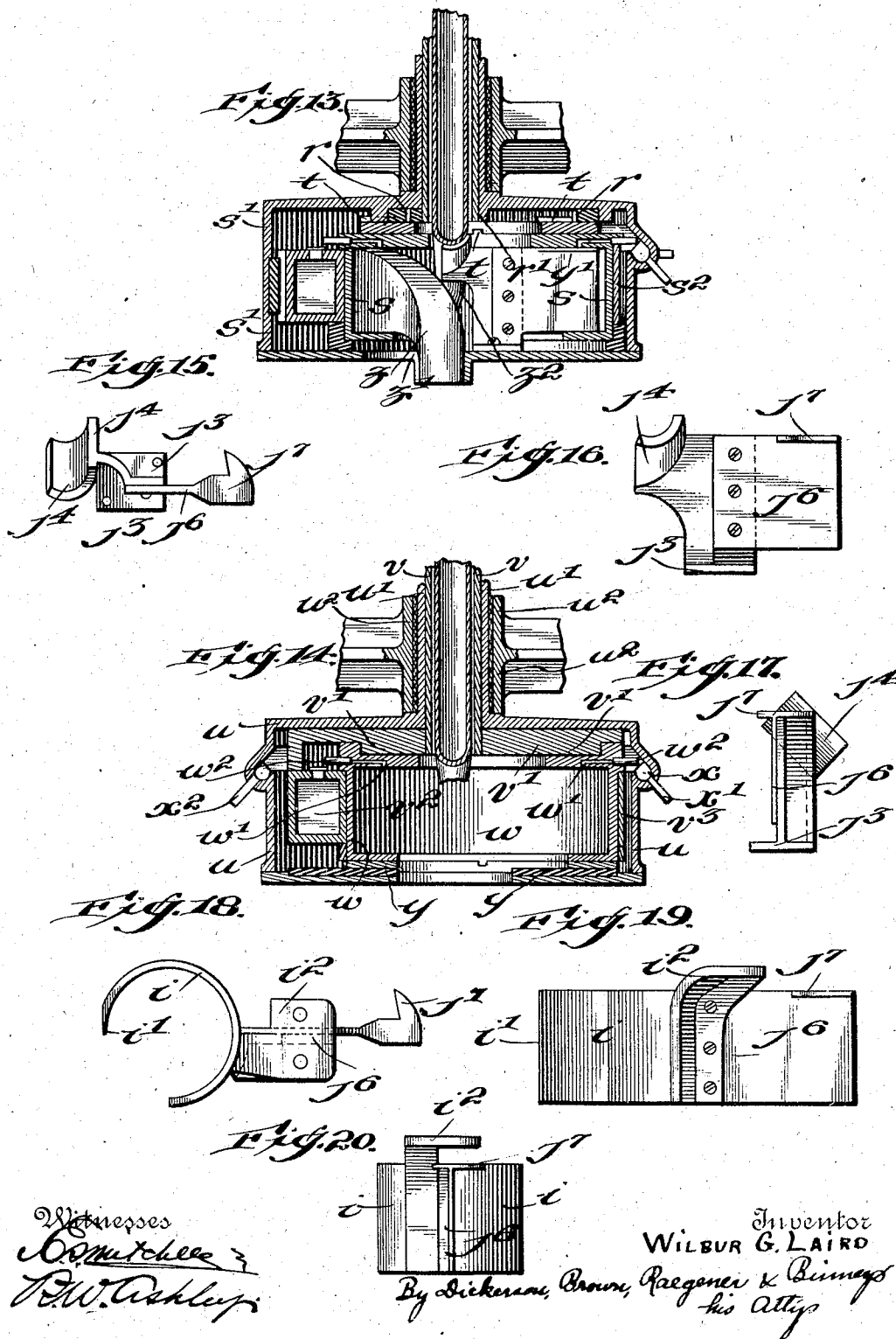
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APPLICATION FILED MAR. 26, 1904.

7 SHEETS—SHEET 7.



UNITED STATES PATENT OFFICE.

WILBUR G. LAIRD, OF DENVER, COLORADO.

CENTRIFUGAL SEPARATOR.

SPECIFICATION forming part of Letters Patent No. 791,703, dated June 6, 1905.

Application filed March 26, 1904. Serial No. 200,098.

To all whom it may concern:

Be it known that I, WILBUR G. LAIRD, a citizen of the United States, residing at No. 728 East Tenth avenue, in the city and county of Denver and State of Colorado, have invented certain new and useful Improvements in Centrifugal Separators, of which the following is a specification.

This invention relates to centrifugal separators for the purpose of separating solids from liquids, the invention being applicable for the purpose of separating sugar, salt, ores, wood-pulp, and materials of like characteristics into their constituents—namely, liquids and solids.

The object of the invention is primarily to design a separator for the separation of ores from cyanid solution, concentrates from water, tailings from water, &c.

The principle made use of in the present invention is that of a separating-bowl mounted eccentrically and so moving or shifting that the solid material is carried out of the presence of the liquid, thus facilitating the separation of the two portions. Heretofore centrifugal separators of this type have been suggested in which there is a crescent of liquid formed on the inner surface of the separating-bowl and in which scrapers are employed for the purpose of removing the deposited solids, the solids being carried around the bowl to the discharge-opening. The scrapers in the said construction, however, do not touch the inner surface of the bowl. A machine of this type is also known in which no scrapers are employed. The solid matter is ejected upwardly and the liquid matter downwardly from the bowl. As compared with machines of these general descriptions, my invention possesses a number of advantages which will appear to those skilled in the art.

It may be mentioned that the present invention is peculiarly adapted for the treatment of slimes or ores, as the moving parts move at high speed and as scrapers are preferably employed for removing the solid matter, which packs in a tough hard sheet in such a manner that the sheet is peeled away and not cut by the scrapers, which otherwise would

not stand the ever-grinding action of the particles of mineral.

My invention consists of certain features of construction and combinations of parts to be hereinafter described and then particularly claimed with reference to the accompanying drawings, showing some desirable constructions embodying the invention, and in which—

Figure 1 is an elevation of a double separator which is adapted for separation, washing, and reseparator. Fig. 2 is a side elevation of Fig. 1. Fig. 3 is an enlarged vertical central section on the line 3 3 of Fig. 2 and on the line 3 3 of Fig. 4. Fig. 4 is an enlarged vertical central section of the double separator on the line 4 4 of Fig. 1 and 4 4 of Fig. 3. Fig. 5 is a plan view. Figs. 6 and 7 are respectively a broken plan view and a transverse section of the differential gear which is preferably used in connection with all forms of the separator. Fig. 8 is a transverse section on the line 8 8 of Fig. 3, the scraper, feed-nozzle, and seal being removed. Fig. 9 is a section on the line 9 9 of Fig. 3, illustrating the bottom bowls of the double separator and also the bowls of the single separator. Fig. 10 is a vertical central section of a single separator. Fig. 11 is a plan view of the same. Fig. 12 is a vertical central section of a single separator in which the separating-bowl is mounted on a fixed eccentric and is gear-driven. Fig. 13 illustrates a further form of single separator in section in which the separating-bowl is driven by internal and external gears. Fig. 14 illustrates a still further modification of a single separator in which the separating-bowl is driven by an outer bowl through the medium of a flexible connection, but in which the two bowls revolve at the same speed. Figs. 15, 16, and 17 are elevations of the feed-tube support with the seal attached and which may be used in connection with the lower bowl of the double separator or with the single separator; and Figs. 18, 19, and 20 are detail views of the support for the scraper and seal of the upper bowl of the double separator.

Referring to the drawings, Figs. 2 to 9, inclusive, the main frame *a* of the separator or

machine is of any suitable construction and is supported in any desired manner, it being provided at its upper part with a double pan, of which the upper portion d' is provided with a discharge spout or spouts d^2 , while its lower portion d^3 is provided with a spout or spouts d^4 . At the lower part of the frame a is another double pan, the upper portion b of which is provided with a spout or spouts b' , while its lower portion b^2 is provided with a spout or spouts b^3 . These pans receive the liquids which are separated from the solids, and the said spouts discharge the liquids into convenient receptacles. In this double separator there is an upper separating-bowl c and a lower separating-bowl c' , said bowls and the supports therefor, here in the form of outer bowls $d d'$, being mounted to rotate at suitable speed. The outer bowls $d d'$ are provided with hubs or hollow shafts d^2 , which turn in bearings a^5 of the frame a . These hubs or hollow shafts d^2 in turn furnish bearings for a shaft c^2 , which operates the separating-bowls relatively to the outer bowls. The separating-bowls $c c'$ are mounted within and eccentrically to the bowls $d d'$, they being held in eccentric position by means of the collars e , each collar inclosing its respective separating-bowl and provided at one side with a counterbalance e' , said counterbalance having a tongue-and-groove connection at e^2 with the outer bowl d or d' , as the case may be, and rotatable therein. The counterbalance e' is hollow, and its cavity e^3 may receive a suitable number of weights for the purpose of increasing or decreasing the counterbalancing effect. It is evident that other means may be employed for counterbalancing the eccentric separating bowl or bowls and for setting them eccentrically, as, in fact, the counterbalancing part e constitutes a device which sets or locates the separating-bowl eccentrically with respect to the inclosing bowl. The collar around the upper separating-bowl is supported by a flanged disk e^4 , which is suitably fixed to and turns with the separating-bowl, while the lower collar is supported around the separating-bowl by a ring support e^5 , fixed to the said separating-bowl. A flanged disk e^6 , similar to that e^4 , is applied to the upper part of the lower separating-bowl, as shown. These disks practically constitute parts of the separating-bowls and are provided with central openings which receive eccentric hubs $d^3 d^4$ on the bottom and top, respectively, of the upper and lower bowls $d d'$. The shaft c^2 is suitably operated, as hereinafter described, so as to impart a differential rotation to the separating-bowls relatively to the bowls $d d'$, and the connection between the shaft and each eccentric separating-bowl is what might be termed a "flexible" one, as some such connection is necessary, due to the eccentric location of the separating-bowls and the different rates of speed. Attached to each end of the hollow shaft c^2 is a driving-plate e^7 , which has a

diametrical tongue-and-groove connection at e^8 with a shifting ring e^9 , the tongue-and-groove connection being a sliding one, and there is another tongue-and-groove connection e^{10} , which is also a sliding connection, between the shifting ring e^9 and the respective eccentric bowls c or c' . The tongue-and-groove connection e^{10} is arranged at right angles to the tongue-and-groove connection e^8 , and the combination of these tongues and grooves between the driving-plates e^7 and the eccentric bowls allows the relative shifting on their axes of said eccentric bowls, the latter shifting in one direction by sliding the rings e^9 on the driving-plates e^7 and in the other direction at right angles thereto by sliding on the said rings alone. The described flexible connection is applied to the lower part of the upper separating-bowl and to the upper part of the lower separating-bowl. Before describing the separating-bowls in greater particularity and the manner in which the solids and liquids are separated and discharged the mechanism for acting on the shafts of the said parts will first be described.

The driving sheave or pulley f is mounted at about the mid-length of the hollow shaft c^2 between two disks f' f^2 , and as the parts which are operated from the disks f' f^2 are of the same construction either above or below the said disks the same reference-letters will be used for each differential gear whether for the upper bowls or for the lower bowls. The said disks f' or f^2 are each, as shown more clearly in detail in Figs. 6 and 7, provided with a bracket or brackets f^3 , in which turns a worm-wheel f^4 , the thread of which meshes between the teeth of a worm-wheel f^5 , having its hub applied to the hollow shaft d^2 of the bowl inclosing the separating-bowl. The said gearing is boxed in by means of a suitable casing comprising two sections f^6 f^7 , said casing, however, being supported by the stationary frame a . The sections f^6 f^7 of the casing are so constructed and connected as that they fix within them a ring f^8 , which is provided on its inner periphery with threads f^9 . The threads f^9 extend in helical paths around the inner periphery of the said ring f^8 , and into spaces between the said threads f^9 mesh gear-teeth f^{10} , which are formed on the thread of the worm f^4 . The described construction of gearing will be seen to be peculiar in that by the travel of the worm f^4 around the inner periphery of the ring f^8 and the meshing of the gear-teeth f^{10} on the worm with the inclined threads f^9 on the ring a slow rotation is imparted to the worm-wheel, which rotation is communicated to the worm-wheel f^5 at a differential rate, which, as shown, is faster than the rotation of the disk f' . In other words, the rotation of the outer bowl is faster than that of the eccentric bowl, and the ratio may be two thousand and five to two thousand, for instance. If the ratio be the

reverse, then it will be evident to skilled mechanics that slight changes in the apparatus will have to be made. The said casing f^6 f^7 can be used as an oil-reservoir, and the worm as it revolves around the center or main axis of the separator will pick up the oil and throw it against the inner periphery of the outer ring directly in front of the worm, thus insuring good lubrication, and as the worm revolves around said center it also turns on its own axis, thus continually bringing around a new and cool surface in contact with the threads in the outer ring.

A feed-hopper g is mounted at the center of the top of the upper bowl d , which hopper is provided with a feed-nozzle g' , that extends through top openings in the upper bowl d and its confined eccentric bowl c , said nozzle being inclined or turned so that its mouth g^2 will be located adjacent and in close proximity to the inner wall of the eccentric bowl c . The discharge for the matter to be further separated from the eccentric separating-bowl c is by means of a pipe g^3 , which is located inside the hollow shaft c^2 and extends through the same, being provided at its lower end with a feed-nozzle g^4 , the mouth g^5 of which is arranged the same as the mouth g^2 .

As is well understood, the particles of greatest specific gravity are thrown against the inner surface of the separating-bowl, while those of less specific gravity are nearer the center. Therefore for conducting away the liquid portion separated radial ducts h are formed in the outer portion of the top of each separating-bowl c or c' , these ducts being provided at their inner ends with inlets h' , opening into the separating-bowl, while the outer ends of the ducts at the periphery of the bowl are terminated by discharge-nozzles h^2 . These discharge-nozzles h^2 pass by and over a trough or pocket h^3 , formed in the upper part of the outer bowl d or d' , which trough is provided with discharge-nozzles h^4 h^5 , the discharge-nozzle h^4 emitting a portion of the liquid into the pan a^3 or b^3 and the nozzle h^5 emitting another portion of the liquid into the pan a' or b' . The respective portions of the liquid are discharged through the pan-nozzles a^2 a' b' b^3 into suitable receptacles provided therefor. The trough or pocket h^3 is provided with a partition h^6 for the purpose of keeping one portion of the liquid separate from another portion, so that the nozzles h^4 h^5 will discharge the respective portions of the liquid separately.

To remove the solid portions of the mass being separated in the separating-bowls, a scraper i (see Figs. 18, 19, and 20 more particularly) for the upper separating-bowl is provided, the knife-edge i' of said scraper acting upon the inner wall of the separating-bowl to remove the solid matter which clings to said wall. It may be well to state here that due to the arrangement and operation of the described parts the liquid of the mass is

disposed in crescent shape on an area of the inner surface of the separating-bowl which is remote from the main center of the separator, the heavier portions of the mass clinging to the bowl-surface and the liquid crescent remaining *in situ*. The scraper i is of broken cylindric form and is mounted upon a bracket i^2 , the base of which is riveted or otherwise secured to the top of the outer bowl d , as shown in Fig. 3. This scraper causes the solid or semisolid matter to fall into the pipe or conduit g^3 . A scraper j is located in the lower separating-bowl and is formed with a twist, its knife-edge j' acting upon the inner wall of the separating-bowl to scrape off the solid matter and remove it through the bottom discharge-opening j^2 , said scraper being supported by the means more particularly shown in Figs. 15, 16, and 17. The support consists of a bracket j^3 , which is riveted or otherwise secured to the bottom of the outer bowl d' and is provided with an inclined seat j^4 , to which is riveted or otherwise secured said nozzle g^4 . The action in the lower separating-bowl c' is the same as in the upper.

A seal or sealing-wing j^6 on the bracket j^3 is provided for a special purpose. This seal does not touch the surface of the solid matter deposited on the inner wall of the separating-bowl; but it does extend into or below the surface of the liquid and is provided with a lip or flange j^7 , which cuts off the discharge as the discharge pipes or nozzles h^2 pass the partition in the trough h^3 . This lip or flange j^7 permits but a partial discharge-opening on one side of the seal for a short distance or until the discharge-opening is drawn away from the liquid crescent. The partial discharge or cut-off at one side of the seal is due to the fact that the edge j^5 of the lip j^7 is so located with respect to the circular series of discharge-openings h' that as these openings pass around substantially one-half of each at the side nearest the inner wall of the separating-bowl is cut off. The described seal is of service in case there may be three products or portions to be separated from the mass fed into the separating-bowl. These products may be the solid matter, the liquid, and a scum or lighter liquid, as is the case in sugar separation, where there is a sugar, the syrup, and a glutinous matter which is lighter than the liquid syrup. With the seal the operation will be substantially as follows: When the material is fed through the feeding device into the separating-bowl, the liquid must flow to the center of the crescent to be discharged. As this flow takes place the scum or lighter material rises to the surface of the liquid and is caught by the seal, thus preventing the clinging of the scum to the solid as the liquid crescent is drawn away and causing the scum or lighter material to be discharged only at one side of the partition h^3

or through the nozzle h^5 . When the seal is arranged as shown, the level of the liquid on one side of the seal and that of the scum on the other side is not the same, for the scum being lighter than the liquid its surface will be higher and nearer the center of the bowl than that of the liquid upon the other side of the seal. By providing that the discharge-openings will be fully open on the clear-liquid side of the seal and a partial opening on the scum side of the seal the clear liquid will be discharged on one side of the partition through the nozzle h^4 , while the scum will be discharged on the other side of the partition through the nozzle h^5 , thus separating the scum or lighter liquid from the clear or heavier liquid, thereby making it possible to separate liquids of different specific gravities in the separator.

Briefly, the operation of the double separator described may be summed up as follows: The wet material is fed into the feed-hopper g and passes through the feed-nozzle g' , being discharged against the inner wall of the eccentric separating-bowl c , or if the mass is to be re-separated the same is discharged through the nozzle g^4 into the lower bowl c' . Inasmuch as the eccentric separating bowl or bowls are revolved at a high rate of speed, the material is thrown against the side of the bowl in the form of a crescent, as shown by Fig. 9. The solid matter being heavier than the liquid, it is thrown against the inner surface of the separating-bowl and the liquid remains nearer the center of the bowl, it being the lighter. When the line of the liquid reaches the discharge-openings h' , it is thrown out and into the trough h^3 . The discharge of the liquid will evidently be through the discharge-opening which is located between the ends of the liquid crescent. As the outer bowl d or d' , as the case may be, revolves the liquid is thrown from the trough through the discharge nozzle or nozzles of the outer casing or pans. The revolution of the outer bowl d being faster than the eccentric separating-bowl c , the eccentric hub d^4 turns in the bottom or top flange, as the case may be, of the eccentric separating-bowl, thus causing the bowls to rotate in relation to each other, so that the pans or area of the inner surface of the eccentric bowl farthest from the center of rotation is slowly changed, thus bearing the liquid away from the solid, which clings to the inner surface of said separating-bowl. The before-described flexible connection between the separating bowl and its supporting-bowl d or d' permit of said motion, as the sliding connection at one side of the ring e^9 permits the eccentric bowl to slide in one direction, and the sliding connection at the other side of the ring permits the motion at right angles to the first motion. These combined motions at right angles to each other permit of the relative rotation of the eccentric sepa-

rating-bowl. As the outer bowl d or d' revolves faster than the eccentric separating-bowl within it and carries with it the scraper before-described, the knife-edge of the scraper scrapes the solid material from the separating-bowl and forces it toward the center of rotation through the connecting-pipe g^3 or the discharge-opening j^2 , as the case may be. As the eccentric separating-bowl is being moved around relatively to the outer bowl the liquid portion of the crescent moves around the inner surface of the separating-bowl and the feed-nozzle follows the forward point of the crescent, thus making the feed in regard to the crescent always the same. As the crescent moves around the bowl the solid material clinging to the bowl is carried nearer to the center of rotation, and when it reaches a point which may be nearest to the center of rotation it is caught by the scraper and discharged. It will be seen that as the liquid crescent moves around the separating-bowl it drains off of the deposited solid and carries with it any of the solid which is not properly separated and leaves only a hard substantially dry layer, which is caught by the scraper that bears against the inner surface of the separating-bowl, thus removing the solid in a substantially unbroken sheet at its line of contact with the bowl. When the scraper is arranged in this manner, the hardest cake of slimes is very easily removed, as it simply peels away from the bowl. The liquid-discharge opening being directly above the deepest part of the crescent and the feed at the extreme end or point of the crescent, the liquid must travel from the point to the approximate center of the crescent and thence up to the discharge.

The double separator described is particularly useful in the cyanid process, as a water-pipe k may enter into the feed-hopper g . The scraper i brings the solid material directly over the pipe g^3 and causes the same to pass through said pipe and out of the nozzle g^4 . As the scraper i brings the solid material over the pipe g^3 the stream of water from the pipe k washes the material into the pipe and thence into the lower bowl.

Referring to Figs. 10 and 11, which, however, for a clear understanding must be supplemented by the description of the double separator, these figures which illustrate a single separator show a frame l in the upper sleeve or bearing l' of which turns a hollow shaft l^2 , to which is keyed or otherwise rigidly fixed a driving sheave or pulley l^3 . A gear-casing m , constructed as shown and described, Figs. 3 and 4, is fixed on the frame l and incloses parts corresponding with those previously described. These parts are a driving-plate n , rigidly supported on the shaft l^2 , a worm-gear n' , supported at one side of said plate in bearings thereof, and a worm-wheel n^2 , which is rigidly secured upon a hollow

shaft o , which projects upwardly from the outer bowl. An internally-threaded ring n^3 is firmly fixed by the sections of the gear-casing m , so that the teeth formed on the worm-thread of the gear n' will travel along the inclined threads of said ring, and thus impart a slow rotation to said worm-gear n' , just as before. As far as the other parts of the single separator shown in Figs. 10 and 11 are concerned at least the ones shown in said figures, they are the same as the lower bowl portions of the double separator. A detailed description, therefore, of the single separator other than a description of the driving mechanism which has been given, being superfluous, is omitted. The single separator not being so complicated may be desired for general use more than the double separator, which is more particularly useful for special treatments.

The single separator shown in Fig. 12 is substantially the same as that shown in Figs. 10 and 11, and the same reference-letters are used in this figure to indicate corresponding parts. The difference consists in a larger eccentric p at the top of the outer bowl d' , which receives a circular central opening p' in the top of the eccentric separating-bowl. Below the opening p' the top of the separating-bowl is provided with an annular series of internal gear-teeth q , with which meshes the internal gear-wheel q' , that is fixed on the end of the hollow shaft t^2 . The inner separating-bowl is on a fixed eccentric in this form of invention and is driven on its own center by the internal and external gears q q' , respectively. The internal and external gears q q' and the eccentric p and the top p' of the separating-bowl take the place of the eccentric hub and top of the separating-bowl of the former figures and of the flexible connection comprising the sliding ring and concomitant parts.

In Fig. 13 another modification of a single separator is shown, and only the modified parts are illustrated. Here it will be seen that by the use of external and internal gears r' r , respectively, the minimum distance between the center of the inner separating-bowl s and the outer or separating bowl s' may be zero. It is apparent that the external gear r' drives the internal gear r , which in turn drives the inner separating-bowl s through the medium of a flexible connection at t , which is similar to the flexible connections of the former figures; but the eccentricity of the inner separating-bowl s or the distance from its center to the center of the outer bowl s' is governed by the position of an eccentric-ring s^2 , which is fixed in the bottom of the outer bowl s' , and is consequently driven at the same speed as the outer bowl. The center of the eccentric-ring s^2 is not the center of the internal gear r , thus differing from the construction shown in Fig. 12, in which these centers are

the same. This eccentric-ring s^2 could evidently be made adjustable, thus varying the eccentricity of the inner separating-bowl, and it need not necessarily be in the location in which it is shown. Its adjustment will permit it to be given a position to govern the inner bowl.

Fig. 14 illustrates a still further modification of a form of a single separator and in which, instead of the eccentric separating-bowl being rotated at a differential rate of speed relatively to the support or outer bowl, it is rotated at the same rate of speed; but the said eccentric-bowl is mounted in the outer bowl so that it can be bodily shifted sidewise. The inner or separating bowl here shown has a motion similar to an eccentric-strap and also a motion similar to the eccentric-shaft. The outer bowl u is provided with a hollow shaft u' for driving it, which shaft is mounted in a bearing of the frame u^2 . Turning within the hollow shaft u' at a differential rate of speed is another hollow shaft v , which shafts u' and v correspond with the similar hollow shafts of the other forms of the invention and are preferably driven by substantially the same differential gear. Fixed on the lower end of the shaft v is an eccentric v' , at one side of which eccentric is a counterbalance v^2 similar to the counterbalance heretofore described. This counterbalance is provided with a strap or band v^3 , the axis of which is coincident with the axis or center of the eccentric v' and forms a bearing or seat within which the separating-bowl w may turn. The upper part of the separating-bowl is provided with discharge-openings w' , from which extend the discharge-nozzles w^2 for the liquid, which rises from the crescent formed within the separating-bowl in substantially the same manner as described with reference to the other forms of the invention. The upper part or top of the separating-bowl turns relatively to the eccentric v' . To permit of the functioning of the eccentric v' , the separating-bowl w is connected with the bottom of the outer bowl u by means of a flexible connection y , which is similar to the flexible connection heretofore described, excepting that it is located at the bottom instead of at the top of the separating-bowl. As the two bowls revolve at the same speed and the inner bowl is swung by the eccentric, thus swinging the crescent, a liquid-discharge trough x , extending entirely around the upper part of the outer bowl, is required, this trough being provided with discharge-nozzles x^2 . In the discharge-trough of the outer bowl a partition would be extended around it, dividing the trough into two circular parts. The plow or scraper, the seal, and the feed-nozzle would here be driven at the same speed as the eccentric; but these parts are here omitted.

It is evident that various changes of construction and operation are within the scope

and spirit of this invention—as, for instance, the parts may be so constructed and operated as that the discharge will be upwardly instead of downwardly, and the relative speeds may be reversed, in which case the scraper or plow would extend in the opposite direction to that shown. Neither is the invention limited to a single or double separator driven by any one particular method, as it will be readily seen by skilled mechanics that all the arrangements shown for driving the bowls may be used for either a single or double separator. Also the driving-shafts may be driven by independent pulleys instead of the worm-gearing, which is preferred.

Having thus described my invention, what I claim as new therein, and desire to secure by Letters Patent, is—

1. In a centrifugal separator, the combination of a bowl to receive the mass to be separated having a discharge-opening in its lower portion, means for supporting the bowl eccentrically to a given center, means for rotating said bowl to cause the mass to be disposed on an area of the inner surface thereof which is remote from said center, mechanism for moving the bowl to carry the heavier portions of the mass clinging to the bowl-surface out of the presence of the lighter portions, and continuously-operative means for guiding said heavier portions into said discharge-opening.

2. In a centrifugal separator, the combination of a bowl to receive the mass to be separated having a discharge-opening in its lower portion, means for supporting the bowl eccentrically to a given center, means for rotating said bowl to cause the mass to be disposed on an area of the inner surface thereof which is remote from said center, mechanism for moving the bowl to carry the heavier portions of the mass clinging to the bowl-surface out of the presence of the lighter portions, and a scraper continuously operating on the inner surface of the bowl at a point outside of said area, to discharge the heavier portions of the mass through said opening.

3. In a centrifugal separator, the combination of a bowl to receive the mass to be separated, means for supporting the bowl eccentrically to a given center, means for rotating said bowl to cause the mass to be disposed on an area of the inner surface thereof which is remote from said center, mechanism for moving the bowl to carry the heavier portions of the mass clinging to the bowl-surface out of the presence of the lighter portions, top outlets in the bowl, for the lighter portions, means for discharging the heavier portions, means for gravimetrically dividing the lighter portions issuing from said top outlets.

4. In a centrifugal separator, the combination of a bowl to receive the mass to be separated, means for supporting the bowl eccentrically to a given center, means for rotating said bowl to cause the mass to be disposed on

an area of the inner surface thereof which is remote from said center, mechanism for moving the bowl to carry the heavier portions of the mass clinging to the bowl-surface out of the presence of the lighter portions, top outlets in the bowl for the lighter portions, means for discharging the heavier portions, a suitably-supported trough outside the point of discharge of the lighter portions, means for gravimetrically dividing the lighter portions issuing from said top outlets.

5. In a centrifugal separator, the combination of a bowl to receive the mass to be separated having a discharge-opening in its lower portion, an outer casing inclosing the bowl, means for supporting the first bowl in and eccentrically to the outer casing, means for rotating said bowl to cause the mass to be disposed on an area of the inner surface thereof which is remote from said center, mechanism for shifting the bowl to carry the heavier portions of the mass clinging to the bowl-surface out of the presence of the lighter portions, and continuously-operative means for guiding said heavier portions into said discharge-opening.

6. In a centrifugal separator, the combination of a bowl to receive the mass to be separated and having discharge-openings for the separated portions of said mass, one of said discharge-openings being in the lower portion of the bowl, means of support for the bowl, means for imparting initial rotation to one of said parts, a differential gear between the bowl and said means of support for rotating them at slightly different speeds, and continuously-operative means for guiding the heavier portions of the mass into said lower discharge-opening.

7. In a centrifugal separator, the combination of a bowl to receive the mass to be separated and having top and bottom discharge-openings for the separated portions of said mass, the bottom opening being for the heavier portions and the top opening for the lighter portions, means of support for the bowl, means for imparting initial rotation to one of said parts, a differential gear between the bowl and said support, and continuously-operating means for guiding said heavier portions into said lower bottom discharge-opening.

8. In a centrifugal separator, the combination of a bowl to receive the mass to be separated and having discharge-openings for the separated portions of said mass, one of said discharge-openings being in the lower portion of the bowl, means for supporting the bowl eccentrically to a given center, means for imparting initial rotation to one of said parts, a differential gear between the bowl and said support for rotating them at slightly different speeds, and continuously-operative means for guiding the heavier portion of the separated mass into said lower discharge-opening.

9. In a centrifugal separator; the combination of a bowl to receive the mass to be separated and having top and bottom discharge-openings for the separated portions of said mass, means for supporting the bowl eccentrically to a given center, means for imparting initial rotation to one of said parts, a differential gear between the bowl and its support, and continuously-operative means for guiding the heavier portions into said bottom discharge-opening.

10. In a centrifugal separator, the combination of a separating-bowl having an unobstructed discharge-opening in its lower portion, means for supporting the same eccentrically to a given center, means for rotating said support, means for moving said support and bowl relatively to each other, a continuously-operative scraper fixed independently of the separating-bowl, its edge working against the inner surface of said bowl to remove the heavier portions of the mass being separated and to guide them into said discharge-opening, and means for discharging the liquid portions of the mass.

11. In a centrifugal separator, the combination of a separating-bowl, means for supporting the bowl eccentrically to a given center, means for rotating said bowl to cause the mass thereof which is remote from said center, mechanism for moving the bowl to carry the heavier portions of the mass away from the lighter portions, means for discharging the heavier portions, means for discharging the lighter portions, and means interposed between said bowl and said support for counterbalancing the separating-bowl.

12. In a centrifugal separator, the combination of a separating-bowl, means for supporting the bowl eccentrically to a given center, means for rotating the bowl from said center, mechanism for moving the bowl at a differential rate of speed relative to its first said motion, means providing an outlet in the bottom of said bowl for discharging the solid portions of the separated mass therefrom, and means providing outlets at the top of the bowl provided with nozzles for discharging the liquid portions separated.

13. In a centrifugal separator, the combination of a separating-bowl, means for supporting the bowl eccentrically to a given center, means for rotating the bowl from said center, mechanism for moving the bowl at a differential rate of speed relative to its first said motion, means providing an outlet in the lower portion of said bowl for discharging the solid portions of the separated mass therefrom, means providing outlets in the upper portion of said bowl for the liquid portions, a trough into which the latter outlets discharge, and a partition in said trough for gravimetrically dividing separate parts of the lighter portions.

14. In a centrifugal separator, the combina-

tion of a separating-bowl, means for supporting the bowl eccentrically to a given center, means for rotating the bowl from said center, mechanism for moving the bowl at a differential rate of speed relative to its first said motion, means providing an outlet in the lower portion of said bowl for discharging the solid portions of the separated mass therefrom, means providing outlets in the upper portion of said bowl for the liquid portions, a trough into which the latter outlets discharge, a partition in said trough for gravimetrically dividing separate parts of the lighter portions, and discharge-nozzles supported by said trough at opposite sides of said partition.

15. In a centrifugal separator, the combination of a separating-bowl, means for supporting the bowl eccentrically to a given center, means for rotating the bowl from said center, mechanism for moving the bowl at a differential rate of speed relative to its first-said motion, means providing an outlet in the lower portion of said bowl for discharging the solid portions of the separated mass therefrom, means providing outlets in the upper portion of said bowl for the liquid portions, a trough into which the latter outlets discharge, a partition in said trough for dividing gravimetrically separate parts of the lighter portions, discharge-nozzles supported by said trough at opposite sides of said partition, and separate pans for the said separate discharge-nozzles, for receiving the lighter portions of different specific gravities.

16. In a centrifugal separator, a separating-bowl having discharge-openings in its upper portion for the relatively liquid portions of the separated mass, and means for gravimetrically separating such liquid portions before their discharge through said openings.

17. In a centrifugal separator, a separating-bowl having discharge-openings in its upper portion for the relatively liquid portions of the separated mass, means for gravimetrically separating such liquid portions before their discharge through said openings, and separate means exterior of said bowl for receiving each of said separated liquid portions.

18. In a centrifugal separator, the combination with supporting means having a center of rotation, a separating-bowl mounted on said means eccentric to said center, means for imparting to the separating-bowl a rate of speed differing from that of said supporting means, and a flexible connection within said supporting means and surrounding the separating-bowl.

19. In a centrifugal separator, the combination with supporting means having a center of rotation, a separating-bowl mounted on said means eccentric to said center, means for imparting to the separating-bowl a rate of speed differing from that of said supporting means, and a flexible connection between the said center of rotation and the separating-

bowl, said flexible connection comprising a shiftable ring, and angularly-disposed tongue-and-groove connections at both sides of said ring, one tongue-and-groove connection being with the said center of rotation and the other with the separating-bowl.

20. In a centrifugal separator, the combination with supporting means having a center of rotation, a separating-bowl mounted on said means eccentric to said center, a flexible connection between the separating-bowl and the said center of rotation, and a differential worm-gear carried by the rotary support and connecting the center of rotation with the separating-bowl to impart a slightly different rate of speed thereto.

21. In a centrifugal separator, the combination with supporting means having a center of rotation, a separating-bowl mounted on said means eccentric to said center, a flexible connection between the separating-bowl and the said center of rotation, and a differential worm-gear connecting the center of rotation with the separating-bowl to impart a rate of speed thereto differing from that of said supporting means, said worm-gear comprising a rotary driving-plate, a worm mounted in bearings thereof, a worm-wheel for said center of rotation intermeshed with said worm, and means for rotating the said worm on its own axis.

22. In a centrifugal separator, the combination with supporting means having a center of rotation, a separating-bowl mounted on said means eccentric to said center, a flexible connection between the separating-bowl and the said center of rotation, and a differential worm-gear connecting the center of rotation with the separating-bowl to impart a differential rate of speed thereto, said worm-gear comprising a rotary driving-plate, a worm mounted in bearings thereof and provided with teeth on its thread, a worm-wheel for said center of rotation meshing with said worm, and a ring provided with inclined threads on its inner periphery along which the teeth of the said worm travel.

23. In a centrifugal separator, the combination with supporting means having a center of rotation, a separating-bowl mounted on said means eccentric to said center, a flexible connection between the separating-bowl and the said center of rotation, and a differential worm-gear connecting the center of rotation with the separating-bowl to impart a differential

rate of speed thereto, said worm-gear comprising a rotary driving-plate, a worm mounted in bearings thereof and provided with teeth on its thread, a worm-wheel for said center of rotation meshing with said worm, a ring provided with inclined threads on its inner periphery along which the teeth of said worm travel, and a casing for lubricating-oil, inclosing the said gearing.

24. In a centrifugal separator, the combination with a separating-bowl provided with a discharge-opening for the lighter portions of the separated mass, and a separate discharge-opening for the heavier portions, of a continuously-operated scraper, the edge of which works against the inner surface of the said separating-bowl and restrained except as to rotary motion thereon, said scraper being provided with a twist.

25. In a centrifugal separator, the combination with a separating-bowl provided with a discharge for the lighter portions of the mass to be separated, and a separate discharge-opening for the heavier portions, of a feed-nozzle projecting into the separating-bowl, a continuously-operated scraper projecting into the discharge-opening for the heavier portions of the mass, its edge working against the inner periphery of the separating-bowl and restrained except as to rotary motion therein, said feed-nozzle and scraper moving together relatively to the said bowl.

26. In a centrifugal separator, a separating-bowl having discharge-openings in its upper portion for the relatively liquid portions of the separated mass, a plurality of receiving means into which said openings discharge, and means in said bowl for opening and closing said discharge-openings, whereby liquids of different gravities are discharged through said openings into each of said receiving means.

27. In a centrifugal separator for mingled solids and liquids, the combination of a separating-bowl and means providing outlets in the top of said bowl and at substantially the same level for separating the liquid contents of said bowl into two separate portions.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

WILBUR G. LAIRD.

Witnesses:

GEORGE STEINWEDELL,
WM. A. SMITH.