Jan. 17, 1933. F. A. QUIROZ 1,894,520

APPARATUS FOR SEPARATION

Filed May 31, 1929 2 Sheets-Sheet 1

Fig. 1.

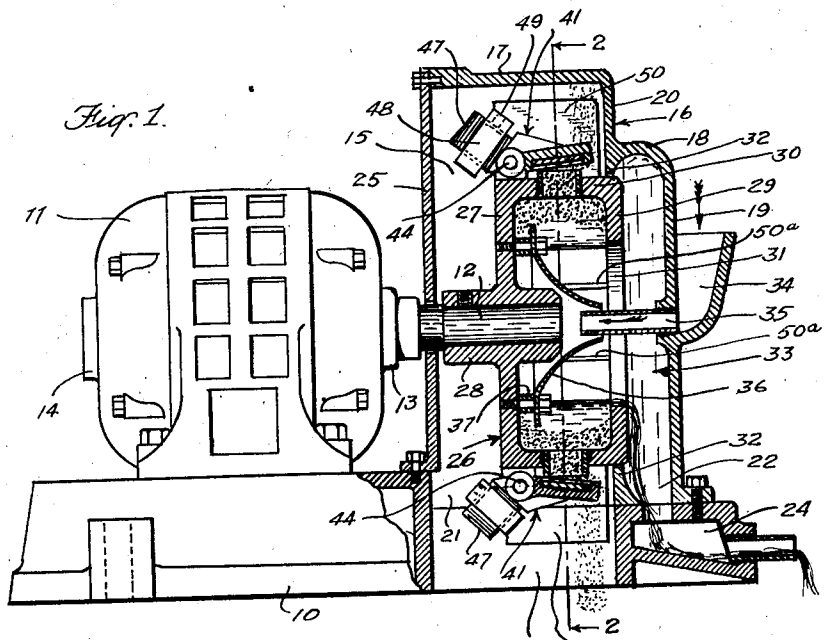
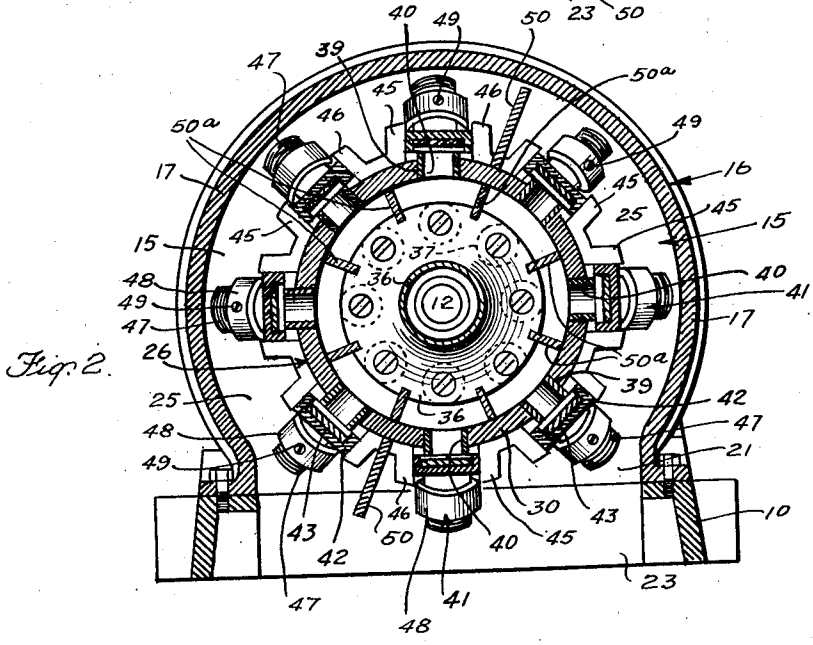


Fig. 2.



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Filed May 31, 1929 2 Sheets-Sheet 2

Fig. 3.

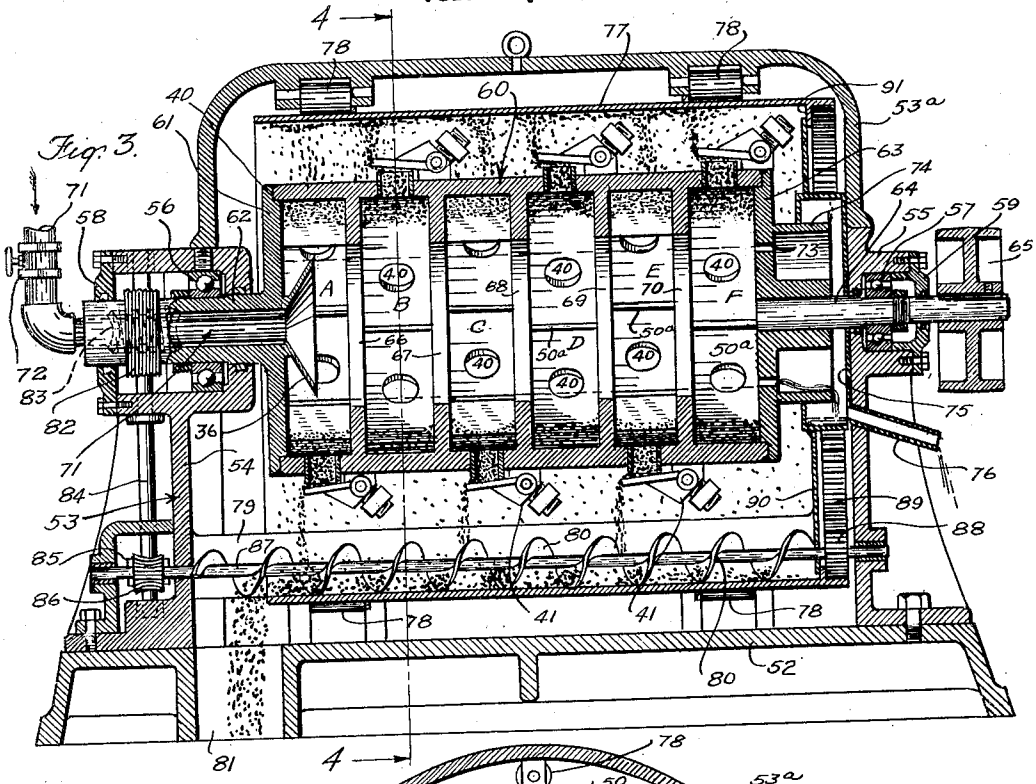
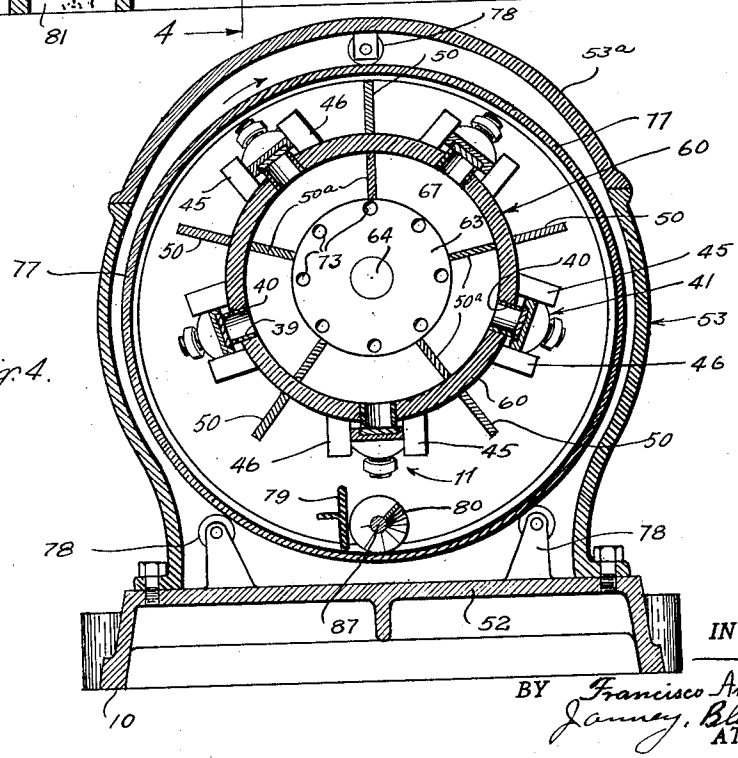


Fig. 4.



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APPARATUS FOR SEPARATION

Application filed May 31, 1929. Serial No. 367,406.

This invention relates to a method and apparatus for separating, for example, solid particles from a liquid in which they are suspended.

One of the objects of this invention is to provide a simple and thoroughly practical method for rapidly and efficiently separating solid particles suspended in a liquid and to provide, moreover, a method of the above-mentioned character which may be carried on in practice in a simple, efficient and reliable manner. Another object is to provide a method of the above-mentioned character for achieving high efficiency of separation and for removing solid matter from a liquid with constant uniformity. Another object is to provide a separating apparatus that will be of simple and thoroughly practical construction, thoroughly dependable action in practical use, and capable of effecting separation of solid matter from a liquid with a high degree of efficiency, uniformity and speed. Another object is to provide a separating apparatus of rugged and inexpensive construction and well adapted to meet the varying conditions of hard practical use. Another object is to provide a separating apparatus with means for dependably and efficiently removing therefrom the separated constituents and particularly for removing the solid matter or particles with a minimum or no admixture of liquid. Another object is to provide an apparatus for separating a liquid from suspended solid matter or particles by the action of centrifugal force in which the mixture of solid matter and liquid may be supplied to the apparatus without disturbance of the action of the apparatus and while maintaining continuity and uniformity of separation. Another object is to provide a separating apparatus of the above-mentioned character in which the removal of one of the constituents is automatically controlled by the constituent to be removed. Another object is to provide a separating apparatus of the above-mentioned character in which centrifugal forces may be dependably and reliably utilized not only for effecting a separation of the mixture into its constituents, but also for dependably and uniformly controlling the extent or rate of removal from the apparatus of a separated constituent in accordance with a predeterminable degree of isolation of the constituent from the mixture. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts and in the several steps and relation and order of each of the same to one or more of the others as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings in which are illustrated several of various possible embodiments of the mechanical features of my invention,

Figure 1 is a front elevation of a separating apparatus, certain parts being shown in vertical central cross-section in order to show the construction of the separating apparatus more clearly;

Figure 2 is a vertical transverse sectional view of the separating apparatus as seen along the line 2—2 of Figure 1;

Figure 3 is a vertical longitudinal section of a preferred form of construction of separating apparatus, and

Figure 4 is a vertical sectional view as seen along the line 4—4 of Figure 3.

Similar reference characters refer to similar parts throughout the several views of the drawings.

Referring now to the drawings and more particularly to Figure 1, there is shown at 10 a suitable base carrying at its left-hand end a suitable source of driving power illustratively shown in Figure 1 as taking the form of an electric motor 11. The motor 11 is provided with a driving shaft 12 supported in suitable bearings 13 and 14 carried by the motor frame.

The driving shaft 12 extends into a suitable enclosure or casing forming a chamber generally indicated at 15; the chamber 15 is made up of a casing member generally indicated at 16 and shaped to provide an outer peripheral substantially circular wall 17, a similar wall 18 of lesser radius and an end

wall 19. The peripheral wall members 17 and 18 are connected by a vertical wall member 20. The casing member 16 may conveniently take the form of a casting open at its bottom as at 21 and 22, the openings 21 and 22 registering with openings 23 and 24 in the base 10. The left-hand wall of the chamber 15 (as viewed in Figure 1) may be made up of a plate 25 suitably secured to the casing member 16 and to the base 10, the plate 25 being provided with a suitable opening through which the driving shaft 12 extends into the chamber 15.

The driving shaft 12 has mounted thereon to rotate therewith a separating vessel generally indicated at 26; this vessel 26 is preferably of substantially cylindrical shape, being provided with a circular end wall 27 preferably cast integrally with a hub 28 into which the shaft 12 extends and is securely connected therewith. Opposed to the end wall 27 is a circular end wall 29 connected with the end wall 27 by means of the peripheral or ring-like wall 30. The end wall 29, however, is provided with a preferably centrally disposed opening 31.

The separating vessel 26 is so proportioned with respect to the parts forming the chamber 15 that the end wall 29 is in substantial alinement with the wall 20, the latter being extended into the chamber 15 and beyond the peripheral wall 18, as at 32, to closely encompass the circular periphery of the vessel 26 while permitting free rotation of the vessel 26 with respect to the casing member 16. There is thus formed between the end wall 29 and the extended wall portion 32, on the one hand, and the peripheral wall and the end wall 19 of the casing member, on the other hand, a chamber generally indicated at 33, the latter being in communication with the interior of the vessel 26 by way of the opening 31 in the end wall 29 and being in communication with the discharge opening 24 in the base 10 by way of the opening 22 formed at the bottom of the casing member 16 and between the wall members 32 and 19.

Formed on the outer face of the wall 19 is a funnel 34 for supplying a mixture of liquid and solid material to the apparatus; the bottom of the funnel 34 is in communication with a pipe 35, carried by the wall 19, and extending in substantial alinement with the axis of rotation of the vessel 26 into the interior of the latter. The pipe 35 is of materially less diameter than that of the opening 31 in the end wall 29, thus leaving an ample area of the opening 31 for a purpose to be more clearly described hereinafter.

Mounted within the interior of the vessel 26 and with its axis coincident with the axis of rotation of the vessel 26 is a substantially conically shaped baffle 36, the side walls of which are preferably slightly curved. The baffle 36 is open-ended and into its smaller end extends the pipe 35, the relation between these two parts being such as to permit free rotation of the baffle 36 (with the vessel 26) relative to the pipe 35. Its larger or left-hand open end is held spaced from the wall member 27 by a series of spacers 37 (see also Figure 2) through which pass the screws 36 for securing the baffle 36 in place.

The peripheral or ring-like wall 30 of the vessel 26 is provided with a suitable number of apertures 39 shown in Figure 2 as eight in number; it is to be understood, however, that any other suitable number of apertures 39 with associated mechanism to be hereinafter more clearly described, may be used if desired and that the mechanism or apparatus associated with each is preferably of identical construction. Into each aperture 39 is fitted a tube-like member 40, the axis of which extends substantially radially (see Figure 2) and whose outermost annular end face is adapted to coact with a valve mechanism generally indicated at 41 (see Figure 1).

This valve mechanism 41 includes a valve member 42 of substantially cap-like shape and carrying on the inner face thereof a disk of suitable packing material 43, for coaction with the outermost end of the tube-like member 40. The valve mechanism 41 is pivoted upon a pin 44 fixedly supported by peripherally spaced ears 45 and 46 (see Figure 2), formed upon the vessel 26.

Preferably integrally formed with the valve member 42 and extending at substantially 45° with respect thereto, but on the other side of the pivot 44, is a threaded extension 47 upon which is threaded a weight 48. The weight 48 preferably is in the form a ring or collar, internally threaded to mate with the threads on the extension 47. The threaded connection between the members 47 and 48 permits the latter to be moved or adjustably positioned toward or away from the axis of the pivot pin 44, for a purpose more clearly described hereinafter. Any suitable means may be used to lock the weight member 48 in the position into which it has been moved with respect to the member 47; illustratively a set screw 49 (Figure 1) may be used for this purpose.

Considering now the manner of use of the apparatus for carrying out the process of this invention, it is first to be noted that the motor 11 is set into operation to rotate the vessel 26 at a suitable speed. The speed of rotation may vary according to various practical considerations, foremost among which is the character and physical properties of the solution or mixture to be separated into its liquid and solid components. The mixture is supplied to the apparatus through the funnel 34 at an appropriate rate and from the funnel 34 it flows through the pipe 35 into the baffle 36 which, of course, rotates with the vessel 26. As the mixture leaves the pipe 35 and

contacts with the baffle 36, the centrifugal force effective upon the mixture, due to the relatively high speed of rotation of the apparatus, causes the mixture to be relatively evenly distributed peripherally of the baffle 36 and, due to the increasing radius of the latter, the centrifugal force causes the mixture to move along the baffle 36 in a general direction toward the left, as viewed in Figure 1, as well as also in a general direction radially or outwardly away from the axis of rotation of the vessel 26. In this manner the mixture is gradually and uniformly supplied to the outer annular portion of the chamber 26 in which the mixture accumulates to a radial depth equivalent to the radial dimension of the wall 29. In Figure 1, the depth of the mixture is clearly indicated by dotted lines.

Prior to the supply of mixture to the apparatus, the weights 48 on the threaded stems 47 of the valve mechanisms 41 are adjusted in a predetermined way. In operation, with the apparatus running substantially without any mixture supplied thereto, the weight or mass to the left of the pivot pins, as viewed in Figure 1, is greater than the weight or mass of the parts of the valve mechanism to the right of the pivot pins 44; the rotational effect, due to the subsequent rotation of the apparatus, is therefore greater upon the parts 47—48 than it is upon the parts 42—43, so that centrifugal force is effective to swing the valve mechanisms in aperture-closing position and thereafter hold them in such position.

The subsequent supply of mixture to the apparatus, however, will be seen to impose upon the valve member 42 a column of the mixture whose cross-section is substantially equal to the area of the aperture 40, the column extending, as will be clear from Figure 2, with its axis substantially coincident with a radius. The adjustment of the weights 48, however, is such that the centrifugal action is still effective to hold the valves closed even though the centrifugal action on the above-mentioned column of the mixture has now been added in opposition to the centrifugal action upon the parts 47—48. That is, the weight of the parts to the left of the pivot pins, as viewed in Figure 1, is greater than the weight of the parts of the valve mechanism to the right of the pivot pins plus the weight of the above-mentioned column of the mixture, assuming that the masses or weights to either side of the pivot pins have substantially equal effective lever arms. With this adjustment, the valve mechanisms are maintained in a position where the apertures 40 are all closed.

However, as the rotation of the apparatus continues, the centrifugal effect on the particles suspended in the liquid is such that they become more and more concentrated about the peripheral portions of the vessel 26 and, in fact, due to this centrifugal action, the concentration or density of the solid particles in the liquid increases with increase in the distance from the axis of rotation. Solid matter thus becomes concentrated in the apertures 40 and as this concentration proceeds, the weight or mass of the above-mentioned column increases so that the unbalance of the centrifugal forces acting upon the two sides of the pivot pins of the valve mechanisms becomes reversed with the result that the valve mechanisms swing in valve-opening direction. In Figures 1 and 2 the valve mechanisms are shown in approximately the position they assume when this unbalance of centrifugal forces is reversed.

The opening of the valve mechanisms permits the solid matter or particles to escape, centrifugal force in effect making certain that they are thrown free and clear of the rapidly rotating vessel 26. Moreover, the valve mechanisms thereafter automatically adjust themselves to permit a predetermined rate of escape of solid particles from the rotating vessel 26, it being pointed out that the escape of liquid matter through the apertures 40 is practically precluded because the adjustment of the weights 48 is preferably such that the valves are held closed as long as there is not a substantial concentration of solid particles adjacent the valve members 42.

The valve mechanisms thus automatically assume positions to give a valve opening adequate to effect discharge of solid material at substantially the rate at which the solid material is centrifugally separated out of or segregated from the liquid within the rotating vessel 26. For example, should the solid particles and the liquid, which together form the mixture, be of such character as to cause a relatively slow separation of the solid material from the liquid, the rate at which the solid particles are concentrated against the valve members 42 is correspondingly less and likewise, also, the rate at which the unbalance of the centrifugal forces on the valve mechanisms takes place is diminished with the result that the valve openings are smaller. Thus, the rate of discharge of separated solid matter can be made to nicely equal the rate at which the separation takes place.

It might also be noted that should the character of the mixture supplied to the apparatus through the funnel 34 vary, for example, in the percentage content of solid particles, the apparatus automatically adjusts itself to these varying conditions and effects greater or lesser valve openings in accordance with the greater or lesser percentage content of solid matter in the liquid being supplied to the apparatus for separation into its constituents.

It is preferred to place as any apertures 40 and coacting valve mechanisms about the

periphery of the vessel 26 as possible and the eight apertures 40 and associated valve mechanisms shown in Figure 2 are to be understood as being for purposes of illustration only; the more apertures and valve mechanisms that can be accommodated about the periphery of the vessel 26, the more uniform and rapid will be the action and operation of the apparatus. At appropriate points spaced peripherally about the exterior of the vessel 26 are provided baffle plates 50 shown in Figures 1 and 2 as two in number, but it is to be understood that a baffle plate may, if desired, be placed between any two successive valve mechanisms. The baffle plate 50 acts to diminish the effect of the windage on the balance or unbalance of the valve mechanisms, it being noted that the peripheral velocity of the latter is substantial and that the windage effects may be correspondingly of substantial proportions. Thus, it is insured that centrifugal forces, determined by the concentration of separated solid matters, determine the opening of the valve without interference from external effects, such as windage, for example. The baffles 50 also act to prevent the accumulation of solid particles about the inside periphery of the casing 16 and insure the movement of the solid material discharged from the vessel 26 toward and through the discharge passage 23 in the base 10 of the apparatus.

In connection with the action and operation of the valve mechanisms, as above described, another feature of great advantage comes into play; it has been pointed out hereinabove that the threaded arm 47 of the valve mechanisms extends at an angle of substantially 135° to the valve member 42. As the forces above described become effective to cause a valve opening, the center of mass of the parts 47—48 is moved in a direction, due to the angular relation just described, so that the moment arm of the mass of the parts 47—48 slightly increases. This increased moment arm is the moment arm through which, of course, the centrifugal force acts, and the arrangement results in preventing overstepping of the mechanism in valve-opening direction and insures such a nicety of control that there is achieved great precision in the rate of discharge of solid material from the apparatus.

The liquid within the rotating vessel 26 becomes freed from solid particles at those portions of the body of the liquid that are nearest the axis of rotation, and as the mixture is continued to be supplied to the apparatus through the funnel 34, pipe 35 and baffle 36, this clear liquid constituent of the mixture overflows, as it were, through the end opening 31 in the end wall 29 of the vessel 26, being centrifugally discharged into the chamber 33, whence it passes out through the discharge conduit 24.

The action of the baffle 36, during the rotation and operation of the apparatus, is such as to prevent discharge of the mixture within the vessel 26 undergoing separation, the mixture being supplied to the vessel throughout its entire peripheral extent. Thus, eddy currents and the like are prevented and interference with the separating action prevented.

It will be understood, in view of the foregoing, that the degree of unbalance normally achieved by the weight 48 may be varied in accordance with various factors met with in practice. For example, the density or weight per unit volume of the solid matter intended to be separated out of the liquid may in practice vary widely. Where the density is low it is preferable to move the weights 48 inwardly toward the axis about which the valve mechanisms 41 pivot in order that the separated solid matter may have a less valve-closing force to overcome while, on the other hand, if the density of the particles is relatively greater, the weights 48 may be moved in the opposite direction or away from the pivot pins 44. In this manner the apparatus may be quickly adjusted to suit the varying conditions of practical use. By the same adjustment, it is possible readily to predetermine how great a quantity of solid particles need be concentrated against the valve member 42 in order to effect a valve opening for the discharge thereof; this factor may also in practice vary in accordance with various conditions or requirements to be met.

In Figures 3 and 4 of the drawings I have illustrated a preferred embodiment of my invention and in these two figures I have illustrated an apparatus adapted to have a greater capacity than the apparatus hereinbefore described.

The apparatus is mounted upon a base 52 to which is bolted a generally circular casing generally indicated at 53; the upper part 53ª of the casing is preferably removable to permit access to the interior of the casing and to the apparatus therein.

The end walls 54 and 55 of the casing 53 are suitably formed to receive therein anti-friction, bearings 56 and 57, respectively, suitable means, such as the end plates 58 and 59, respectively, acting, in cooperation with the rotating members carried by the bearings, to substantially encase or house the latter.

Supported within the casing 53 and rotatably carried by the bearings 56 and 57 is a separating vessel 60 preferably of drum-like or cylindrical shape; the left-hand end wall 61 of the vessel 60 is formed to provide a hollow trunnion 62 to which the inner race of the anti-friction bearing 56 is secured. The right-hand end wall 63 of the vessel 60 has secured thereto and coaxial with the trunnion 62 a shaft 64 which passes through

the end wall 55 and has the inner race of the anti-friction bearing 57 secured thereto. The shaft 64 is of sufficient length to have secured thereto and carried thereby at its outer end a driving pulley 65.

A series of annular or ring-like partitions 66, 67, 68, 69 and 70 divide the interior of the vessel 60 into a series of annular separating chambers A, B, C, D, E and F. While only six such chambers are shown in the drawings, it is to be understood that the number of chambers may be decreased or increased, as desired, or as may be required by practical conditions of use.

The peripheral wall of each chamber A, B, C, etc., is provided with a series of apertures 40, each having associated therewith a tube-like member 39 with which coacts the valve member 42 of a valve mechanism 41 pivotally carried between ears 45 and 46 formed upon the drum 60.

The detailed construction of these parts, as well as their action is preferably substantially similar to the construction and action of the corresponding parts hereinabove described in detail with respect to Figures 1 and 2 and they need not, therefore, be further described in connection with this preferred embodiment of my invention.

The apertures 40 and coacting valve mechanisms peripherally arranged about each separating chamber A, B, C, etc., are preferably closely spaced and, as in the case of the embodiment illustrated in Figures 1 and 2, they are preferably sufficient in number so that the valve members 42 constitute a substantial portion of the peripheral supporting wall of each separating chamber. In Figure 4 these parts are shown as five in number but it is to be understood that this number may be varied, and that these parts are preferably more numerous than five.

The mixture to be separated into its liquid and solid constituents is supplied to the apparatus through a pipe 71, the rate of flow being controlled by a valve 72; the pipe 71 extends through the hollow trunnion 62 into the first separating chamber A, a generally cone-shaped but preferably curved baffle 36 being mounted in the chamber A and acting similarly to the baffle 36 of Figure 1 to receive the mixture from the pipe 71 and distributed, centrifugally, to the outer end portions of the separating chamber A, without causing turbulence or eddy currents in the mixture undergoing treatment in chamber A. The construction, mounting and action of the baffle 36 are the same as described in connection with Figures 1 and 2.

The radial depth of mixture undergoing treatment in each of the separating chambers A, B, C, etc., is determined by the radial dimension of the adjacent annular wall or partition 66, 67, 68, etc., respectively, the mixture, after undergoing separating action in one chamber, as the vessel 60 is rotated at an appropriate speed through the driving pulley 65, passing into the next chamber by overflow over the right-hand partition or annular wall.

In each chamber the solid particles or solid matter is concentrated by centrifugal action against the valve members 42, the corresponding valve mechanisms 41 of which act, as described in detail in connection with Figures 1 and 2, to achieve and maintain a sufficient valve-opening to cause the discharge of solid matter from each chamber at substantially the rate at which the concentration of solid matter in that particular chamber takes place. It is to be noted, however, that the concentration of solid matter in each individual chamber need not be as great or as substantial as may be the case with the construction shown in Figures 1 and 2, for after leaving one separating chamber, such as chamber A, the mixture is passed into chamber B but only after a predeterminable amount of solid matter has been removed therefrom in chamber A. Thus, successive separating action takes place as the mixture overflows from one chamber to the next, the percentage content of solid particles in the mixture diminishing progressively as the last separating chamber F is approached or reached.

The liquid component, now free from solid material, discharges through the apertures 73 in the end wall 63, a circular flange 74 on the latter guiding the liquid component into a circular housing 75, mounted interiorly of the casing 53, whence the liquid component is discharged through the outlet 76.

By means of the weights 48 associated with each valve mechanism 41, the valve mechanisms of each separating chamber A, B, C, etc., may be given the same adjustment so as to require the same degree of concentration of solid particles in order to effect or maintain a predetermined valve opening, or these valve mechanisms may be given such an adjustment as will require a different degree of concentration of solid matter in successive chambers. For example, the mixture entering chamber A has, of course, a far greater percentage content of solid matter than is the case with that portion of the same mixture that has reached the second or third chamber or separating stage. The valve mechanisms, therefore, associated with the first separating chamber, such as chamber A, may be adjusted to effect a valve opening sufficient to maintain a more rapid removal of discharge of solid material, while the valve mechanisms of subsequent separating chambers may be adjusted to effect a valve opening commensurate wth a lesser rate of discharge of solid particles since, in subsequent stages or separating chambers, the rate of separation of the solid particles is less, due to the diminishing percentage content of solid matter in the

mixture as the final separating stage or chamber is reached or approached. Thus, a nicely graded action of the apparatus may be readily achieved, it being noted that once the centrifugally controlled valve mechanisms 41 have been set for a predetermined action, they automatically maintain the corresponding action or control.

It will thus be seen, in view of the foregoing, that a wide variation of the action of the successive separating chambers may be achieved and that the widely varying conditions of practical use may be readily met. It might at this point also be noted that, instead of maintaining such a flow of mixture to the apparatus (by control of the valve 72) as will cause a very definite successive treatment of a given quantity of the mixture, first in one chamber and then in the next, as has been above described, the rate of flow of the mixture may be varied (as by control of the valve 72), that the time interval allotted to each unit volume of the mixture for treatment in each successive chamber may be varied through wide limits. Thus, diminishing the rate of flow of mixture through the pipe 71, correspondingly diminishes the rate of flow of the material undergoing treatment from one chamber to the next and causes each portion to be subjected to a greater time interval of centrifugal separating action in each chamber. Increasing the rate of flow through the pipe 71 has the reverse effect and hence diminishes the time interval of centrifugal separating action to which a unit volume is subjected in each stage. By this means, also, the varying conditions of practical use may be readily met.

Between adjacent valve mechanisms 41 (see Figure 4), are provided baffles 50 which prevent windage from affecting the action of the centrifugally actuated valve mechanisms.

The solid particles, discharged centrifugally and peripherally under the control of the chamber mechanisms 41, all as the drum or vessel 60 rotates at an appropriate speed, are thrown against a drum 77 which is rotatably mounted within the casing 53 and is interposed between the latter and the rotating vessel 60, as is better shown in Figure 4. The drum 77 is of substantially the same axial length as the vessel 60 and is rotatably supported in any suitable manner, preferably by means of suitable pairs of axially spaced rollers 78; there are preferably three pairs of rollers 78 suitably distributed about the periphery of the drum 77 and suitably supported by the base 52 and the casing 53.

As is clear from Figures 3 and 4, the drum 77 has its axis displaced downwardly from the axis of the vessel 60 so as to provide a substantial space between the lower part of the drum 77 and the lower portions of the rotating separating vessel 60. The drum 77 is rotated in clockwise direction, as viewed in Figure 2, at preferably a very slow rate compared to the rate of rotation of the separating vessel 60, and as the drum 77 rotates it carries the separated solid matter, thrown against its interior surface, into the above-mentioned enlarged space between the drum 77 and the vessel 60; in this enlarged space there is fixedly positioned a scraper 79 against the right-hand face of which, as viewed in Figure 4, the solid particles accumulate. A spiral conveyor 80 extends along the right-hand face of the scraper 79, as viewed in Figure 4, and rotates in a direction to move the separated solid matter in a direction from the right to the left, as viewed in Figure 3, so that it may be discharged through the discharge opening 81 formed in the base of the apparatus 52.

Any suitable means may be utilized to rotate the conveyor drum 77 and to drive the spiral conveyor 80. By way of illustration, I have shown a worm 82 mounted upon the trunnion 62 and meshing with a worm wheel 83 which is thus made to drive, at a relatively low speed, a vertical shaft 84, the latter being suitably mounted preferably exteriorly of the casing 53.

At its lower end the shaft 84 carries a spiral gear 85 which meshes with and drives a spiral gear 86 mounted upon the shaft 87 which carries the spiral conveyor 80. The shaft 87 extends lengthwise of the apparatus and is mounted in suitable bearings preferably formed in the casing 53.

At the right-hand end of the shaft 87, the latter carries a spur gear 88 which meshes with an internal gear 89 suitably formed or secured upon the right-hand end of the drum 77. The housing 75 has secured to it a disk-like member 90 (see Figure 3) which overlaps an inwardly directed flange 91 associated with the drum 77 and positioned adjacent the gear 89. Thus, though the drum and flange 91 rotate with respect to the fixed disk 90, the flange 91 and disk 90 prevent solid separated particles or material from reaching the gears 88—89.

While the construction described, is generally sufficient for substantially perfect separation of the mixture introduced therein, it might happen that one valve will open before the others, as by reason of a slightly different adjustment of its weight, or greater concentration upon its surface. Should this occur the tendency might be produced of causing a flow of the mixture from other parts of the vessel, toward this open valve, resulting in an upsetting of the perfect functioning of the machine, until proper adjustments have been made. To obviate this possibility, a number of baffle plates 50a have been provided, which extend inwardly and radially from the interior surface of the peripheral wall 30 of the vessel. These baffles are disposed between the apertures 39, as is

clearly shown in the drawings, and divide the space interiorly of and adjacent each of said apertures from the similar space about the other apertures, thus providing a series of pockets into which the mixture is distributed by the cone-shaped baffle 36. This construction therefore ensures uniformly efficient separation at all times and under all conditions of operation.

It will thus be seen that there has been provided in this invention a method and apparatus for effecting rapidly and with a high degree of efficiency the separation of a mixture of solid particles and a liquid into its respective constituents. It will further be noted that the apparatus is of thoroughly practical construction and action, is simple and compact and of highly dependable and efficient action in practical use. It will also be seen that the method may be readily carried on in practice and achieves highly efficient results. Moreover, it is also to be noted that the varying conditions of practical use may be readily met.

As many possible embodiments may be made of the mechanical features of the above invention and as the art herein described might be varied in various parts all without departing from the scope of the invention, it is to be understood that all matter hereinabove set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

Having now particularly described and ascertained the nature of my invention and in what manner the same is to be performed, I declare that what I claim is:

1. In apparatus of the character described, in combination, a rotatably mounted container, means for driving said container, a plurality of discharge openings spaced apart about the periphery of said container, a plurality of valves for closing said openings, each mounted upon said container exteriorly thereof in operative relation to its respective opening, and a plurality of baffles provided upon the inner peripheral surface of said container and positioned to form a pocket adjacent each discharge opening.

2. In apparatus for separating solids from a liquid mixture, in combination, a rotatably mounted container for receiving a mixture and within which separation of the solid constituent takes place by centrifugal force, said container having a plurality of pockets formed interiorly of the peripheral wall thereof, openings in said wall adapted to discharge from said pockets a separated constituent of said mixture, and means operable by centrifugal force for automatically controlling the discharge from said openings, the centrifugal force acting also upon material in said pockets, and means affected by centrifugal force and presenting a fixed opposition to the opening of said discharge openings.

3. In apparatus for separating solids from a liquid mixture, in combination, a rotatably mounted container having a plurality of pockets formed interiorly of the peripheral wall thereof, openings in said wall adapted to discharge from said pockets a separated constituent of said mixture, means operable by centrifugal action for controlling the discharge from each of said openings, and means for preventing air currents caused by the rotation of said container from adversely affecting the operation of said discharge controlling means.

4. In apparatus for separating solids from a liquid mixture, in combination, a rotatably mounted container for receiving a mixture and within which separation of the solid constituent takes place by centrifugal force, said container having a plurality of pockets formed interiorly of the peripheral wall thereof, openings in said wall adapted to discharge from said pockets a separated constituent of said mixture, means controlling the discharge from each of said openings, a mixture inlet for said container, means associated therewith adapted to furnish a uniform supply of the mixture to said pockets, and outlet means provided in a wall of said container adapted to discharge therefrom the residue of said mixture and maintain a substantially constant radial level within said container.

5. In apparatus for separating solids from a liquid mixture, in combination, a rotatably mounted drum, a rotatably mounted container disposed within said drum and provided with openings for discharging separated solids against the interior surface of said drum, means for causing said drum and said container to rotate independently of one another, means for collecting said solids, and means for discharging said solids from the drum.

6. In apparatus for separating solids from a liquid mixture, in combination, a rotatably mounted drum and means to rotate it at a low rate of speed, a rotatably mounted container disposed within said drum the axis of said container being parallel to the axis of said drum and positioned above it, means for driving said container at a relatively high rate of speed, means for discharging separated solids from said container at a rate determined by the degree of concentration thereof and directing them against the interior of said drum, and means extending within said drum beneath said container for collecting and discharging said solids from said drum.

7. In apparatus for separating solids from a liquid mixture, in combination, a rotatably mounted drum, a rotatably mounted container disposed within said drums, means for

driving said container at a relatively high rate of speed, means for discharging separated solids from said container at a rate determined by the degree of concentration thereof, and directing them against the interior of said drum, and rotatable means extending within said drum for discharging said solids from said drum, means for driving said rotatable means, and cooperating means on said drum and on said rotatable means for causing rotation of said drum at a relatively low rate of speed.

8. In apparatus for separating solids from a liquid mixture, in combination, a rotatably mounted container provided with an axially disposed inlet for the admission of the liquid mixture thereto, a plurality of annular partitions disposed at spaced distances transversely of the interior of said container, said partitions serving to provide a plurality of separating chambers within said container, and to determine the radial level of the mixture within said chambers, a plurality of discharge valves arranged in spaced relation about the peripheral walls of each of said chambers for discharging separated solids, means controlling said valves to provide a determinable degree of separation in each of said chambers, and means for discharging the residual liquid from one of said chambers.

9. In apparatus of the character described, in combination, a rotatably mounted container having a peripherally disposed discharge opening, means controlled by a condition of the liquid within said container for controlling the discharge of a separate constituent through said opening, a drum about said container for receiving the constituent discharged from said container, means for relatively slowly rotating said drum, a baffle substantially contacting with the interior surface of said drum to collect the material carried thereby, and conveyor means for removing collected material from said drum and adjacent said baffle.

10. In apparatus of the character described, in combination, a rotatably mounted container having a peripherally disposed discharge opening, means controlled by a condition of the liquid within said container for controlling the discharge of a separated constituent through said opening, a drum about said container for receiving the constituent discharged from said container, means for relatively slowly rotating said drum, and means for removing material discharged onto the inner surface of said drum.

11. In apparatus of the character described, in combination, a rotatably mounted container having a peripherally disposed discharge opening, means controlled by a condition of the liquid within said container for controlling the discharge of a separated constituent through said opening, a drum about said container for receiving the constituent discharged from said container, means for relatively slowly rotating said drum, and conveyor means coacting with the inner surface of said drum for removing material collected thereon in a direction substantially parallel to the axis of rotation of said drum.

12. In apparatus of the character described, in combination, a rotatably mounted container having a peripherally disposed discharge opening, means controlled by a condition of the liquid within said container for controlling the discharge of a separated constituent through said opening, a drum about said container for receiving the constituent discharged from said container, means for relatively slowly rotating said drum, and a rotatable helical conveyor blade for removing material collected on the inner surface of said drum.

13. In apparatus of the character described, in combination, a rotatably mounted container having a peripherally disposed discharge opening, means controlled by a condition of the liquid within said container for controlling the discharge of a separated constituent through said opening, a drum about said container for receiving the constituent discharged from said container, means including speed reduction mechanism for rotating said drum relatively slowly with respect to the rotation of said container, and conveyor means driven by said mechanism for removing material collected on the inner surface of said drum.

14. In apparatus of the character described, in combination, a drum-like container adapted to be rotated at relatively high speed and having upon its interior a plurality of annular walls sub-dividing the container into a plurality of annular pockets, each pocket having at least one discharge opening in the wall of said container, and means responsive to a function of the speed of rotation of said container and to a condition of the liquid being operated upon for controlling the discharge of a separated constituent through the discharge openings, said annular walls being of such a radial extent as to permit the overflow of liquid from one pocket, after being operated upon therein, to an adjacent pocket, whereby progressive separation of the mixture into its constituents takes place.

15. In apparatus of the character described, in combination, a drum-like container adapted to be rotated at relatively high speed and having upon its interior a plurality of annular walls sub-dividing the container into a plurality of annular pockets, each pocket having at least one discharge opening in the wall of said container, means responsive to a function of the speed of rotation of said container and to a condition of the liquid being operated upon for controlling the discharge of a separated constituent through the dis-

charge openings, said annular walls being of such a radial extent as to permit the over-flow of liquid from one pocket, after being operated upon therein, to an adjacent pocket, whereby progressive separation of the mixture into its constituents takes place, means for receiving material discharged from the openings in said pockets, and means for removing discharged material from said receiving means.

In testimony whereof, I have signed my name to this specification this 27th day of May, 1929.

FRANCISCO A. QUIROZ.