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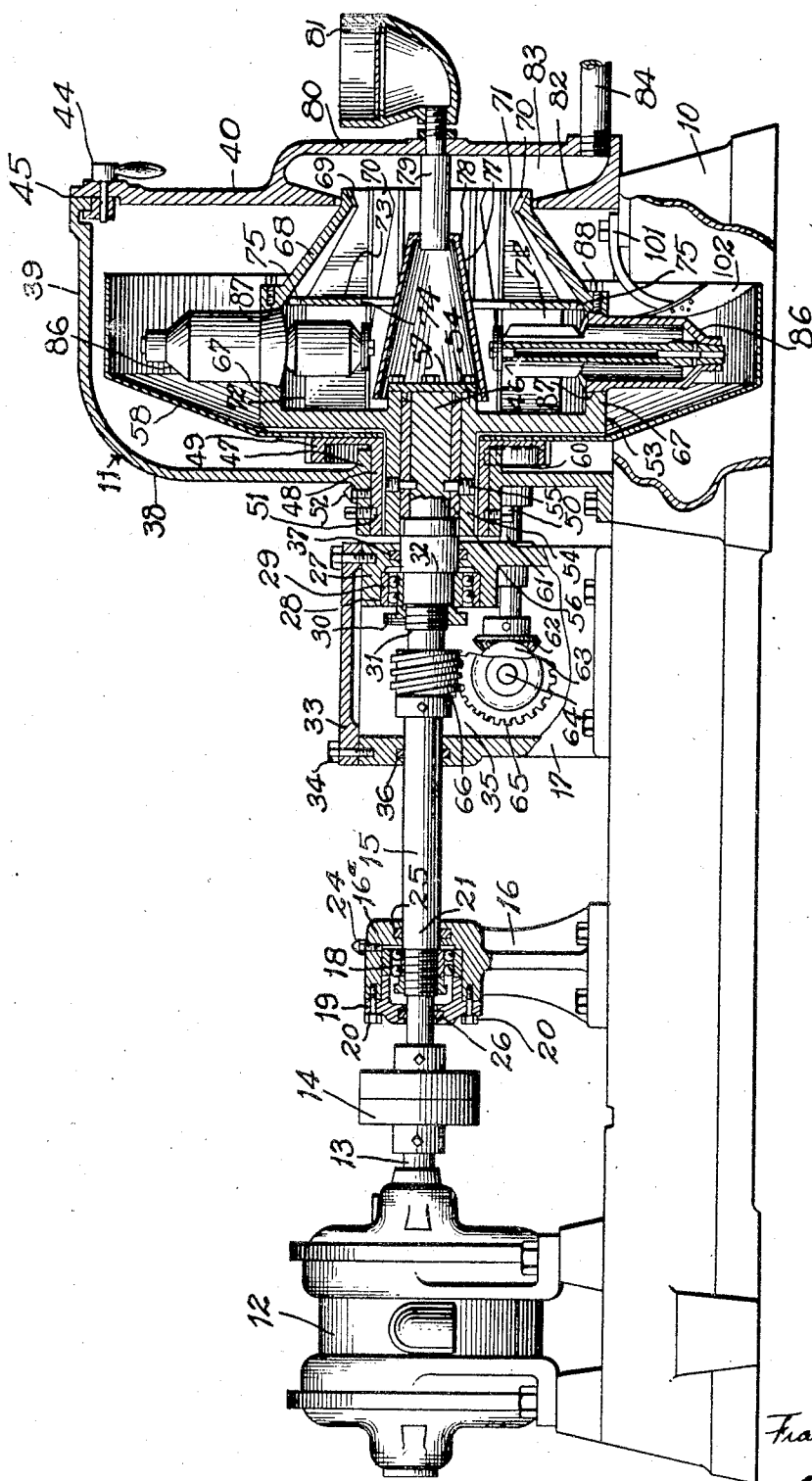
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1,895,104

APPARATUS FOR SEPARATION

Filed May 29, 1929

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 2.

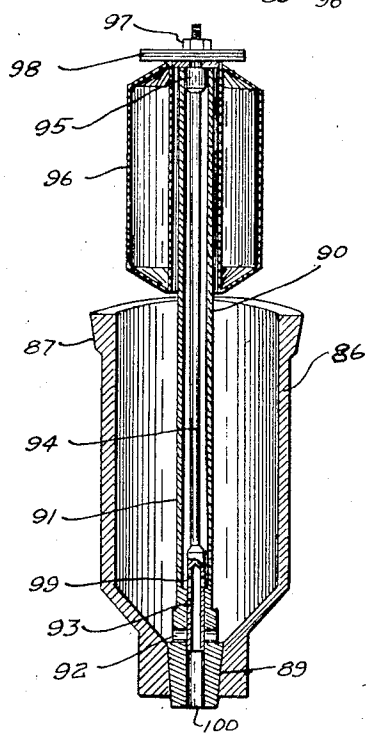
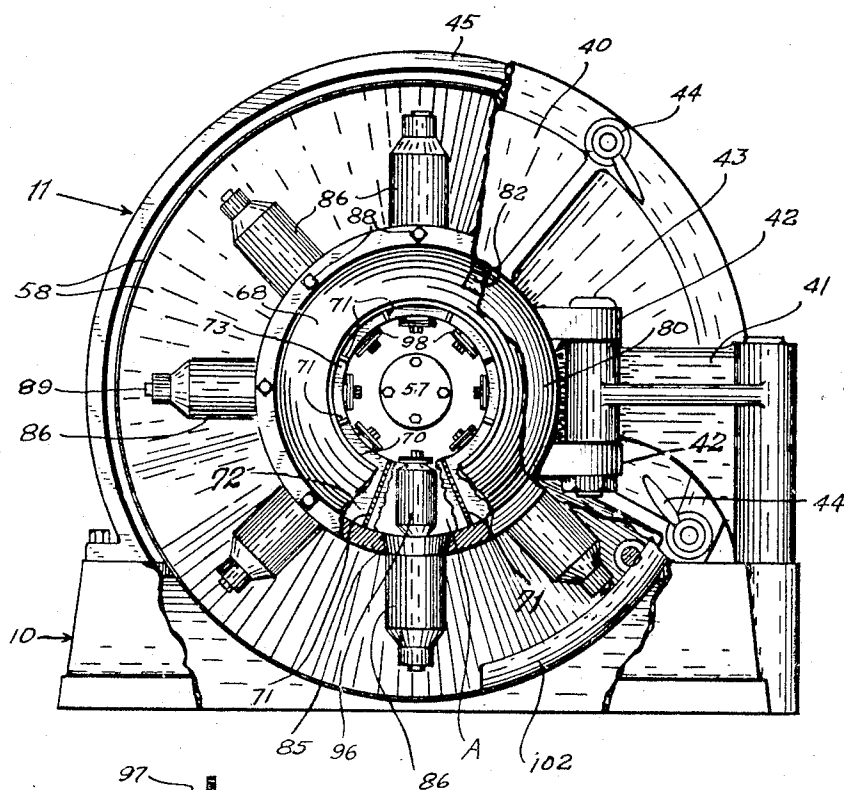


Fig. 3.

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APPARATUS FOR SEPARATION

Application filed May 29, 1929. Serial No. 366,841.

This invention relates to a method and apparatus for separating, for example, a solid constituent from a liquid in which particles thereof 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 of 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 uni-

formly 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 in part a side elevation and in part a longitudinal cross section of separating apparatus embodying the features of my invention.

Figure 2 is an end elevation of the apparatus with certain parts broken away and other parts shown in cross section in order to show the construction of the apparatus more clearly.

Figure 3 is a central cross section on an enlarged scale of a float valve member used for discharging a solid constituent from the separator and illustrating the receptacle in which the valve is seated.

Similar reference characters refer to similar views throughout the drawings.

Referring now to the drawings, and more particularly to Figure 1, there is shown a base 10 and supported at one end thereof a separator housing indicated generally by the numeral 11. The base supports at its other end any suitable driving means, as, for instance, the motor 12. The motor shaft 13 is connected by means of a coupling 14 with the separator shaft 15, which is rotatably supported by the bearings generally indicated by the numerals 16 and 17. Bearing 16 comprises a housing 16A, a ball bearing unit 18 and a cover member 19, the latter being secured to the member 16A by means of bolts 20.

Bearing member 18 is in contact upon one side with the shoulder 21 of the shaft 15 and is held against movement endwise of the shaft in the other direction by means of a nut 22, which engages a threaded portion 23 of said shaft. Means is provided at 24 for introducing a lubricant to the interior of the bearing, and packing rings are supplied at 25 and 26 for the purpose of preventing the lubricant from creeping along the shaft.

The bearing member 17, which serves also as a gear box, has a wall 27 counter-bored as at 28 to receive the ball bearing unit 29 in which the shaft 15 is supported. A nut 30, threaded upon the shaft 15 as at 31, holds the bearing member 29 against the shoulder 32, provided on the shaft 15. Thus the bearings and shaft are held against endwise movement.

The bearing casing 17, which is provided with a cover 33 held on by bolts 34, provides a chamber 35 in which are disposed gearing elements to be hereinafter described, and which may be packed with a suitable lubricant in the usual manner, said lubricant being prevented from creeping along the shaft by means of the packing rings 36 and 37.

The housing 11 comprises a rear wall 38, a peripheral wall 39, a cover 40, which is pivotally supported upon a bracket 41 (see Figure 2), which is also pivotally mounted in relation to the housing 11 and provides with the lugs 42, and pin 43, a hinged connection for said cover. Means are provided as at 44 for clamping the cover tightly against the front edge 45 of the housing 11. The shaft 15 extends part way into the housing 11, as shown at 46, through a bearing 47 of relatively large diameter, which is provided in the wall 38 of the housing 11. This bearing supports the hub 48 of a spur gear 49, which is held against relative endwise movement by means of set bolts 50 engaging an annular channel 51 formed in said hub. Means for lubricating this bearing is shown at 52.

Mounted upon the extension 46 of shaft 15 is a separating vessel 53, which is provided with an elongated hub 54 of larger bore than the said shaft and which is united to the shaft for rotation therewith by means of stud members 55. These studs are threaded into the hub of the vessel and are provided with inwardly extending pins having a somewhat loose driving fit in said shaft, thus providing a universal driving connection which permits the vessel to assume a certain oscillatory movement relative to the shaft. Interposed between the shaft and the hub 54 is a rubber sleeve 56 which restricts or limits the freedom of oscillatory movement of said vessel. The function of the said universal joint driving connection and the rubber sleeve will be more fully described hereinafter.

A plate 57 bolted upon the inner end of the hub 54 protects the sleeve and driving

connection generally from contact with the liquid mixture introduced into the vessel for separation. Secured to the face of the gear 49 is a drum 58, which is adapted to rotate with said gear within the housing 11 and about the vessel 53. Slight clearance is allowed, as shown at 59, between the hub of the vessel 53 and the hub of the gear 49, in order that the vessel may have limited lateral movement within said gear. The separating vessel 53 is intended to rotate at a rapid rate of speed with the shaft 15, while the drum 58 rotates at a slow rate of speed about said vessel. The drum receives its rotative movement by the engagement therewith of a pinion 60, mounted upon the inner end of a shaft 61, having upon its other end a bevel gear 62, which in turn is engaged and driven by a bevel gear 63, mounted upon the same shaft 64 with a spiral gear 65, which is rotated through engagement with a worm 66 rigidly mounted upon the shaft 15.

This transmission mechanism is all enclosed within the chamber 35 of the gear box 17, which has already been described.

The separating vessel 53 comprises a cylindrical portion 67, secured integrally upon the hub 54 and extending toward the cover end of the housing. About midway of the housing, the peripheral wall of the said vessel continues to the right in the form of a cone whose tapering walls terminate substantially in or slightly beyond the plane of the peripheral edge 45 of the housing. This conical section is shown at 68, and at 69 is indicated a large circular discharge opening formed at the outer end of said conical section. Upon its interior, the walls of this discharge opening taper inwardly to form an annular inwardly extending ridge, or lip, as indicated at 70.

A plurality of baffles 71 radially arranged and extending inwardly from the peripheral wall of the vessel, divide the separating space therein into a plurality of pockets 72, as best shown in Figure 2. An annular partition wall 73, having a large central opening 74, divides the interior of the cylindrical portion of the vessel from the interior of the conical portion of the vessel, thus dividing the interior of the vessel into chambers A and B. Adjacent the wall of the vessel this partition is supplied with apertures 75, which provide communication between the chambers A and B. It is to be noted here that the diameter of the central opening 74 formed in the partition 73 is less than the effective diameter of the discharge opening at 70. This serves a purpose to be later described.

Rigidly secured to said partition 73, as by means of the bolts 76, is a liquid distributing cone 77, the inner edge of which is spaced a slight distance from the left hand wall of the separating vessel. The smaller end of the cone, as indicated at 78, extends outward-

ly toward the discharge opening of the vessel where the walls are intumed to fit closely about a liquid supply conduit 79, supported in a wall 80 of the cover 40. The cone 77 and conduit 79 are both positioned in axial alignment with the drive shaft 15, so that the cone rotates about the inner end of the conduit 79 in close fitting relation thereto.

A funnel 81 is carried upon the outer end of conduit 79 in a position to receive the liquid to be separated. The cover 40 provides also an inner wall 82, of annular form fitting closely about the discharge end of the receptacle 53, sufficient space being allowed between the inner edge of the annular wall and the free surface of the receptacle to permit of the rotation of said vessel within the cover opening. Between the walls 80 and 82 a liquid discharge chamber is formed, which is provided with an outlet pipe 84. The bottom of the housing 11 is open, as is also the wall of the base 10 upon which it is seated.

The lower portion of the drum 58 extends downwardly into the base, as shown in the drawings, in a position to discharge the solid constituent separated out of the mixture into any suitable receptacle or conveyance.

A plurality of spaced openings 85 are provided in the cylindrical wall 67 of the separating vessel, and in these openings and extending outwardly therefrom are a plurality of valve seat members 86 secured within the walls of the vessel, in any desired manner. As shown, the upper part of a receptacle is provided with a tapered flange 87, which fits the opening 85, the receptacle being held in place by a set screw 88 (see Figure 1).

Referring to Figure 3, it will be seen that the receptacle 86 furnishes a tapered bore 89, within which is seated a fixed tube 91 having apertures 92 adapted to be closed by a sliding sleeve valve member 93, which is itself carried at the lower end of a valve stem 94. At the upper end of the stem a shoulder 95 is provided, upon which is supported a float member 96. This member is secured to the stem by means of a nut 97, in threaded engagement therewith; and between the nut and the upper surface of the float a variable number of weights, in the form of disks, may be interposed, as indicated at 98. By changing the number of disks, the buoyancy of the float which controls the operation of the valve 93 may be changed to meet varying conditions of separation.

As some leakage may take place from the interior of the receptacle 86 into the interior of the tube 91, the sleeve valve 93 is provided with apertures 99, by means of which any liquid collecting in said tube will be discharged through the valve seat opening 100.

Supported upon the base 10, as at 101, is a scraper 102, which extends into and is positioned closely adjacent the interior of the peripheral wall of the drum 58. This scrap-

er removes solid particles of the separated constituent of the mixture which have been discharged through the valves 90 upon the interior surface of the drum.

The apparatus operates in the following manner:

The liquid mixture containing a solid constituent is introduced through the funnel 81 and conduit 79 to the interior of the cone 77, the inner edge of which distributes the mixture uniformly within the pockets 72 of the separating vessel. Here, as the vessel rotates at high speed, the solid particles accumulate upon the interior of the cylindrical surface 67 and within the valve seat members 86. The mixture also flows into the discharge chamber B of the vessel through the openings 75, where it rises to the level of the lip or discharge edge 70.

As the portion of the mixture near the periphery of the vessel becomes progressively more dense, a point will be reached when the liquid overflowing at 70 will be substantially free from solid matter. The float valve is so designed and the weights thereon so adjusted that it has not sufficient buoyancy to overcome the centrifugal action thereon, tending to hold the valve in closed position. However, when the process of separation has been continued long enough for the concentration of solid particles to cause an accumulation thereof to a height covering, or partially covering, the communicating openings 75, the level of the mixture within the chamber A will rise above the level within the chamber B, and if this action were to continue, would overflow into the chamber B through the central opening 74 in partition 73. But the buoyancy of the float valve is nicely adjusted so that when the rising level within the chamber A has reached a predetermined point, the valve will be lifted so that the solid particles may be discharged from the members 86 through the openings 92 and 100. A partial discharge of these particles reduces the level of the solid material, partially freeing the opening 75 to the passage of liquid from one chamber to another, and permitting the valve to close. By properly adjusting the weights upon the valve, having in view the density of the mixture to be separated, substantially continuous discharge of solid material may be had, and substantially uniform and continuous separation may be had.

While the float valve may also be influenced in its action by the increasing density of the mixture, as separation progresses, and this increasing density may be a factor in determining the opening and closing of the valve, the rise in level in the chamber A, due to the concentration of the solid constituent and the consequent blocking of the passages 75, provides a controllable means for promoting the sure operation and nice regulation of the valve. The solid particles discharged

from the various valves are thrown against the interior of the drum 58, which rotating slowly, brings these solids into contact with the rigidly mounted scraper 102, which removes and deposits them through the open base 10 into any suitable receptacle or conveyor.

It will be understood that, as the separating vessel rotates at a high rate of speed, the opening and closing of the peripherally disposed valves, which may not act entirely simultaneously may cause, in the rotation of said vessel, an unbalanced centrifugal effect.

Were the vessel rigidly mounted for rotation, strains would be set up by this state of unbalance, resulting possibly in serious consequences. This possibility is, however, removed by the particular driving connection hereinbefore described which exists between the shaft and the separating vessel, whereby the separating vessel is permitted to find its own axis of rotation, thus eliminating all undue strain and wear upon the apparatus.

It will be seen also that by furnishing a hinged door for the housing 39, the interior of the apparatus becomes accessible for cleaning, adjustment or repairs.

It is evident, therefore, 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 be further noted that the apparatus is of thoroughly practical construction in 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 to be noted that the varying conditions of practical use may be readily made.

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 drive shaft, a separating vessel mounted thereon, a universal drive connection between said shaft and said vessel, and an elastic sleeve interposed between said shaft and said vessel to limit the free operation of said universal connection.

2. In apparatus of the character described, in combination, a drum-like member rotatable about a fixed axis at a slow rate, a separating

vessel positioned substantially concentrically within said member and rotatable about a self-adjusting axis at a high rate, a source of rotary movement, and means for driving both said drum-like member and said separating vessel from said source.

3. In apparatus of the character described, in combination, a rigid housing, a drum journalled in a wall of said housing and rotatable within said housing, a drive shaft concentrically supported within said drum journal and radially spaced therefrom, a separating vessel arranged substantially concentrically within said drum and supported in spaced relation to both said shaft and said drum journal, a driving connection between said shaft and said vessel to permit oscillation of the latter about the axis of said shaft, and means interposed between said shaft and said vessel for limiting the extent of such oscillation.

4. In apparatus of the character described, in combination, a rigid housing, a drum journalled in a wall of said housing and rotatable within said housing, a drive shaft concentrically supported within said drum journal and radially spaced therefrom, a separating vessel arranged substantially concentrically within said drum and supported in spaced relation to both said shaft and said drum journal, a driving connection between said shaft and said vessel adapted to permit oscillation of the latter about the axis of said shaft, means interposed between said shaft and said vessel for limiting the extent of such oscillation, a gear mounted on said drum journal, and driving means connecting said gear with said shaft.

5. In apparatus of the character described, in combination, a rotatably mounted vessel for separating a solid constituent from a liquid mixture, means for determining a minimum radial liquid level therein, a valve for discharging said solid constituent, which valve is held in closed position while said minimum level is maintained, means for permitting a rise in liquid level when a predetermined amount of said constituent has been separated from the mixture, and a float member rendered operative by a predetermined rise in said level to open said valve.

6. In apparatus of the character described, in combination, a rotatably mounted vessel for separating a solid constituent from a liquid mixture, means for determining a minimum radial liquid level therein, a valve for discharging said solid constituent, which valve is held in closed position by centrifugal action while said minimum level is maintained, means for permitting a rise in liquid level when a predetermined amount of said constituent has been separated from the mixture, and a float member rendered operative by a predetermined rise in said level to open said valve.

7. In apparatus of the character described, in combination, a rotatably mounted vessel for separating a solid constituent from a liquid mixture, means for determining a minimum radial level therein, a plurality of valves for permitting a centrifugal discharge of said constituent from points spaced about the periphery of said vessel, said valves being maintained in closed position while said minimum level is maintained, means providing concentration chambers for said constituent about each of said valves, means for permitting a rise in said liquid level when a predetermined degree of concentration has been reached, and a float member associated with each of said valves, each float member being actuated to open its respective valve upon said liquid rising to a predetermined level.

8. In apparatus of the character described, in combination, a rotatably mounted chamber for separating a solid constituent from a liquid mixture, collection chambers for said constituent arranged radially about said vessel, valves for discharging said constituent from said chambers, said valves having the tendency to remain closed through centrifugal action, means providing for discharge of liquid from said vessel at a certain radial liquid level therein, means associated therewith for causing a rise of liquid level when the collection of said constituent has reached a predetermined point, and means adapted to open said valves when said rise reaches predetermined proportions, said means including a member buoyed by the liquid mixture.

9. In apparatus of the character described, in combination, a rotatably mounted vessel for separating a solid constituent from a liquid mixture, means dividing said vessel into a separating chamber and a liquid discharge chamber, means fixing a radial discharge level in said discharge chamber, means fixing a radial overflow level from said separating chamber, said overflow level being higher than said discharge level, means providing communication between said chambers at a point radially below both of said levels, and a float control valve buoyed by the liquid and adapted to permit discharge of said solid constituent from said separating chamber, when the level of said constituent stands in a predetermined relation to said communicating means.

10. In apparatus of the character described, in combination, a rotatably mounted vessel for separating a solid constituent from a liquid mixture, means dividing said vessel into a separating chamber and a liquid discharge chamber, means fixing a radial discharge level in said discharge chamber, means fixing a radial overflow level from said separating chamber, said overflow level being higher than said discharge level, means providing communication between said chambers

at a point radially below both of said levels, and a plurality of float control valves adapted to permit the discharge of said solid constituent from said separating chamber, when the level of said constituent stands in a predetermined relation to said communicating means.

11. In apparatus of the character described, in combination, a rotatably mounted vessel for separating a solid constituent from a liquid mixture, means dividing said vessel into a separating chamber and a liquid discharge chamber, means fixing a radial discharge level in said discharge chamber, means fixing a radial overflow level from said separating chamber, said overflow level being higher than said discharge level, means providing communication between said chambers at a point radially below both of said levels, a plurality of float control valves adapted to permit the discharge of said solid constituent from said separating chamber, when the level of said constituent stands in a predetermined relation to said communicating means, and a plurality of radial baffles extending inwardly from the peripheral wall of said vessel.

12. In apparatus of the character described, in combination, a rotatably mounted separating vessel for separating a solid constituent from a liquid mixture having a cylindrical portion, and a conical portion terminating in a discharge opening of less diameter than said cylindrical portion, a circular portion disposed between said cylindrical and said conical portions and having a central circular opening of less diameter than said discharge opening, said partition serving to divide said vessel into separating and discharge chambers, means adjacent the periphery of said partition for providing communication between said chambers, a discharge opening for said constituent disposed at the periphery of said separating chamber, and a float valve disposed within said separating chamber and slidably seated in said discharge opening.

13. In apparatus of the character described, in combination, a rotatably mounted separating vessel for separating a solid constituent from a liquid mixture having a cylindrical portion, and a conical portion terminating in a discharge opening of less diameter than said cylindrical portion, a circular partition disposed between said cylindrical and said conical portions and having a central circular opening of less diameter than said discharge opening, said partition serving to divide said vessel into separating and discharge chambers, means adjacent the outer edge of said partition for providing communication between said chambers, and a plurality of float valve controlled openings disposed about the periphery of said separating chamber.

14. In apparatus of the character de-

scribed, the combination with a rotatably mounted vessel adapted to separate a solid constituent from a liquid mixture and having a peripherally disposed discharge opening, 5 of a valve for said opening held closed by centrifugal action, and buoyant means for opening said valve and having a displacement sufficient to overcome said centrifugal action in response to the achievement of certain conditions in said liquid mixture in said 10 vessel, said buoyant means being immersed in the liquid mixture.

15 15. In apparatus of the character described, the combination with a rotatably mounted vessel adapted to separate a solid constituent from a liquid mixture and having a peripherally disposed discharge opening, of a slide valve adapted to control the discharge of said constituent through said 20 opening, and means connected to said valve having a weight sufficient to cause the centrifugal force to assist in holding said valve closed but insufficient in weight to prevent said means from being buoyed in a direction 25 toward the axis of rotation of said vessel upon the achievement of certain conditions in the liquid in said vessel, said means being immersed in the liquid.

30 16. In apparatus of the character described, the combination with a rotatably mounted vessel adapted to separate a solid constituent from a liquid mixture and having a plurality of peripherally disposed discharge openings, and a plurality of float 35 valves adapted to control said openings, each of said float valves having a weight sufficient to cause centrifugal force to keep said valves in closing position but insufficient in weight to prevent certain conditions in the liquid in 40 said rotating vessel from moving said valves into opened position, the float portions of said valve being immersed in the liquid.

45 17. In apparatus of the character described, the combination with a rotatably mounted vessel adapted to separate a solid constituent from a liquid mixture and having a plurality of peripherally disposed discharge openings, of a plurality of float actuated slide 50 valves adapted to control the discharge of said constituent through said openings, the float portions of said valves being immersed in the liquid.

55 18. In apparatus of the character described, the combination with a rotatably mounted vessel adapted to separate a solid constituent from a liquid mixture and having a peripherally disposed discharge opening, of a float valve actuated by centrifugal 60 action to close said opening, and having such a mass and volume as will cause changes in the condition of said liquid mixture to buoy said float valve against the force of said centrifugal action, the float portions of said valves being immersed in the liquid.

65 19. In apparatus of the character de-

scribed, the combination with a rotatably mounted vessel adapted to separate a solid constituent from a liquid mixture and having a plurality of peripherally disposed discharge openings, of a plurality of float valves 70 actuated by centrifugal action to close said openings, and having such a mass and volume as will cause changes in the condition of said liquid mixture to buoy said float valve against the force of said centrifugal action, the float 75 portions of said valves being immersed in the liquid.

80 20. In apparatus of the character described, the combination with a rotatably mounted vessel adapted to separate a solid constituent from a liquid mixture and having a peripherally disposed discharge opening, of a float valve actuated by centrifugal 85 action to close said opening, and means whereby the separation of said constituent beyond a predetermined point causes a rise in the radial level of said mixture within said vessel and the opening of said discharge 90 valve, the float portions of said valves being immersed in the liquid.

95 21. In apparatus for separating a solid constituent from a liquid mixture, in combination, a rotative vessel having a journal and a discharge opening disposed in axial alignment, a housing enclosing said vessel 100 and providing a bearing for said journal, and a movable closure for an end of said housing comprising a discharge chamber having an apertured inside wall disposed in operative relation to said discharge opening, an 105 outer wall, and inlet means supported by said outer wall and extending into the interior of said vessel through said discharge opening.

110 22. In apparatus for separating a solid constituent from a liquid mixture, in combination, a rotative vessel having a journal and a discharge opening disposed in axial alignment, a housing enclosing said vessel and providing a bearing for said journal, and a 115 hinged closure for an end of said housing comprising a discharge chamber having an apertured inside wall disposed in operative relation to said discharge opening, an outer wall, and inlet means supported in said outer 120 wall and comprising a funnel exteriorly thereof, and a conduit connecting said funnel with the interior of said vessel through said 125 discharge opening.

130 23. In apparatus for separating solids from a liquid, in combination, a rotatably mounted vessel having a discharge opening and adapted to receive a mixture of a liquid and solid material, a valve controlling said discharge opening, and a float immersed in the liquid for controlling said valve, said float 135 being rotatable with said vessel and coacting under the effect of centrifugal force thereon to close said valve but adapted upon the attainment of predetermined conditions in said mixture to be buoyed by the latter sufficiently 140

to overcome said centrifugal force and effect an opening of said valve.

24. In apparatus for separating solids from a liquid, in combination, a rotatably
5 mounted vessel having a discharge opening and adapted to receive a mixture of a liquid and solid material, a valve controlling said discharge opening, and means for controlling said valve, said controlling means in-
10 cluding a body immersed in the liquid connected to said valve having its weight so proportioned with respect to its volume and its weight so proportioned with respect to the
15 speed of rotation of said vessel that the buoyant effect of the liquid in said vessel upon said body is sufficient to overcome centrifugal force upon said body and cause a movement
of the latter in a direction toward the axis
20 of rotation of said vessel upon the attainment of certain conditions in said mixture, thereby to open said valve.

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

FRANCISCO A. QUIROZ.