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CENTRIFUGAL SEPARATOR

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2 Sheets-Sheet 2

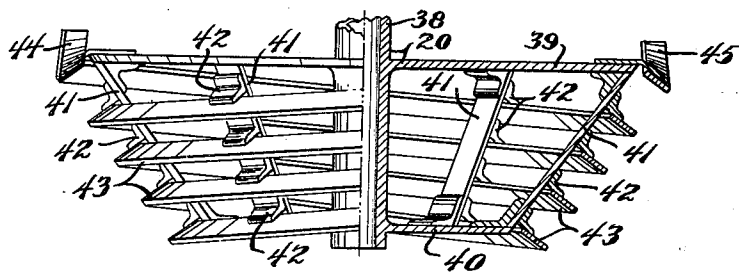


Fig. 3.

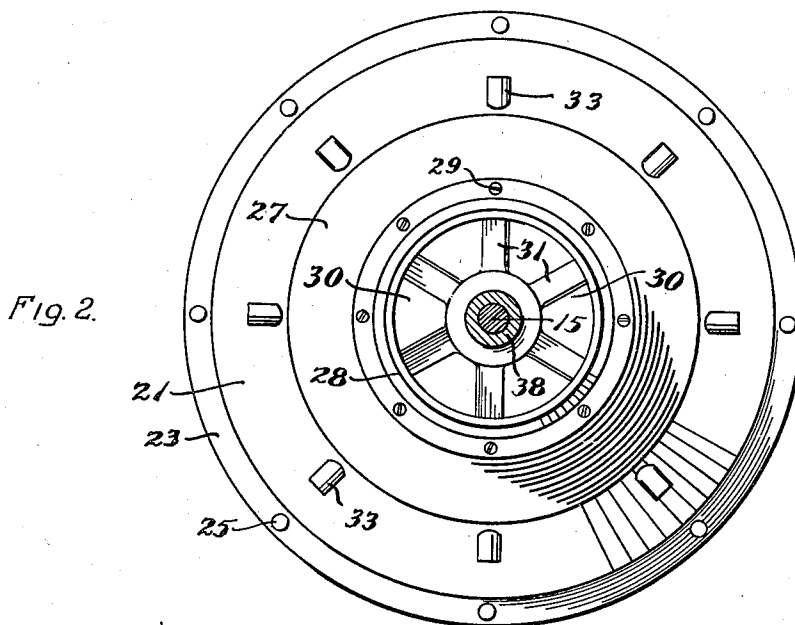


Fig. 2.

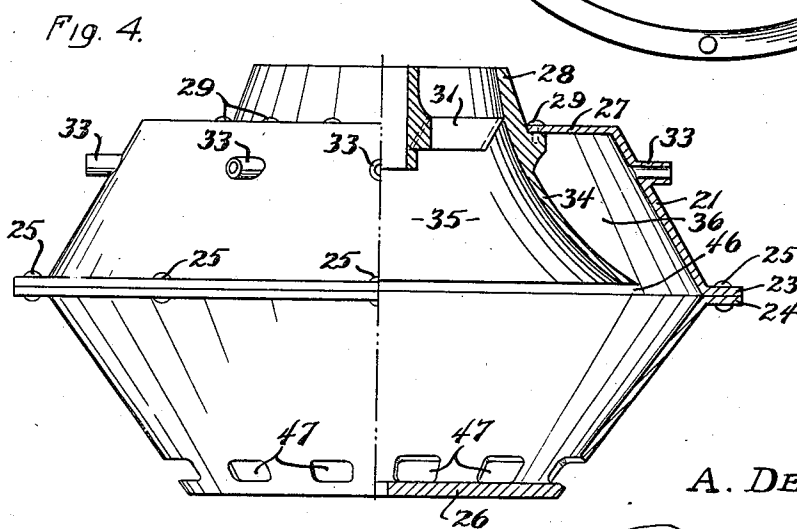


Fig. 4.

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CENTRIFUGAL SEPARATOR

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5 Claims. (Cl. 233—7)

This invention appertains to centrifugal separators, and more especially, to apparatus for separating solids from fluids.

One of the primary objects of the invention is to provide a separator of the above mentioned type wherein the separation of solids from fluids may be carried out in a continuous process, as distinguished from those apparatus which require periodic charging of the mix into the separator, requiring that the apparatus be stopped from time to time to permit the introduction of fresh batches of mix to be introduced into the separating chamber.

Another object of the invention is to provide an improved device for separating solids from fluids, which device is so constructed as to attain a relatively high efficiency of separation, whereby the solids may be substantially completely extracted from the fluids, or vice versa, without any material waste of the solids. To this end, the invention contemplates the provision of a rotatable hollow shell disposed with its central axis in a substantially vertical position, and having provision for introducing the mix into the same at the upper end thereof, and discharge of the solids from the lower end, together with screw blades mounted within the shell for rotation in the same direction but at a speed slightly less than the speed of rotation of the shell, whereby to cause the screw blades or worm to slowly feed the solids downwardly within the shell as the solids are separated from the fluid, to a point where the solids may be discharged at the lower end of the shell.

A still further object of the invention is to provide in a separator device of the above mentioned type, an improved mounting which affords a substantial universal support for the relatively high speed centrifugal mechanism, whereby the same is substantially self-centering to minimize the likelihood of breakage or damage to the parts due to misalignment of the parts or unbalancing of the same. In attaining this object, the invention contemplates the suspension of the separator shell and screw blades or worm mentioned above, from a universal bearing which affords a limited cushioning movement of the mechanism which is suspended therefrom, in all directions laterally respecting the vertical axis.

Other and further objects and advantages of the invention will be hereinafter described, and the novel features thereof defined by the appended claims.

In the drawings:—

Figure 1 is a vertical sectional view through a

separator device constructed in accordance with my invention, certain of the parts being shown in elevation;

Figure 2 is a horizontal sectional view taken approximately on the line 2—2 of Figure 1, looking in the direction of the arrows;

Figure 3 is a detail view, partly in section and partly in side elevation, of the inner screw blade unit or worm which forms a part of the separator instrumentalities;

Figure 4 is a detail view, partly in section and partly in elevation, of the outer shell which forms the separating chamber in which the screw blades or worm of Figure 3 are mounted; and

Figure 5 is a fragmentary detail view of a separator unit, generally similar to that illustrated in Figures 1 to 4 inclusive, but illustrating a modified type of discharge for the solid materials, which, in this case, are adapted to be discharged in an axial direction, as distinguished from the lateral type of discharge illustrated in the other views.

Like reference characters designate corresponding parts in the several figures of the drawings.

My improved separator device embodies primarily a motor means, generally designated M, differential gears D, and a separator unit, generally designated S, the latter unit being interconnected with the motor means M through the intermediary of the gearing D in a manner hereinafter more particularly described.

As seen in Figure 1, the motor M is preferably an electric motor having a power output which is sufficient to drive the mechanisms hereinafter described at the desired rate of speed, and it is to be understood that the rate of speed of the motor will depend in a measure upon the type of material which is to be handled by the separator. As shown, the motor M is mounted upon a suitable frame *m*, which in turn is mounted upon a base 1. The base 1 is secured to a supporting platform or table 2 in such a manner as to be substantially spaced above the same. To this end, I provide a series of tie bolts 3, which extend through the base 1 and table 2 at spaced intervals, and in order to maintain the base 1 and the parts carried thereby elevated above the table 2, I provide spacers 4, which are nothing more than tubular sleeves encircling the tie bolts 3 and interposed between the lower side of the base 1 and the upper side of the table 2. Also encircling the tie bolts 3 at their upper extremities, and interposed between the heads 5 of the bolts and the upper side of the base 1, I provide resilient cushion members or buffers 6. These

members 6 may be composed of rubber, and serve to permit the base 1 and the parts carried thereby to have a limited cushioned rocking movement relatively to the table or platform 2. It is to be understood that I do not wish to be limited to the precise construction just described, as the same may be modified in any desired manner to attain the same results. Secured to the upper side of the table or platform 2, as by means of bolts 7, I provide a central bearing block 8, which has formed in its upper end a partly spherical recess or socket 9 for receiving therein a complementary, partly spherical head 10 formed at the upper end of a hub 11. This hub 11 extends downwardly through a central opening 12 in the bearing block 8, and also through a central opening 13 in the table 2. As shown in Figure 1, both of these openings 12 and 13 are substantially larger than the hub 11 so as to permit the hub to have a limited lateral movement responsive to relative rocking movement between the partly spherical head 10 and the bearing block 8. The head 10 is fixedly secured to the lower side of the base 1 by means of the bolts 14 which pass through the base 1 and extend into the upper end of the head 10, with which the bolts 14 have threaded engagement. The hub 11 and head 10 are provided with a continuous axial bore for receiving a drive shaft 15 which is freely rotatable therein. Thus the parts 10 and 11 constitute a bearing for the shaft 15. The drive shaft 15 is extended upwardly beyond the upper end of the head 10, where it is fixed to the motor shaft by means of any suitable coupling such as the coupling 16. 17 designates a thrust bearing which is seated in a recess provided therefor in the upper end of the head 10, and this thrust bearing is adapted to take care of axial thrusts imposed upon the shaft 15. The base 1 is provided with a central opening 18 through which the upper end of the shaft 15 is adapted to extend so as to enable the same to be coupled to the motor shaft through means of the coupling 16.

The drive shaft 15 is thus directly driven by the motor means M, and is extended substantially below the table or platform 2, as best seen in Figure 1. The separator unit S is mounted upon the lower end of the drive shaft 15 so that practically the entire weight of the separator unit is sustained by the drive shaft 15.

The separator unit proper is primarily composed of an outer hollow, two-part shell, generally designated 19, and an inner screw blade, or blades, generally designated 20, which may be termed a worm. The two parts of the shell 19 are preferably composed of steel castings, the upper section 21 tapering upwardly and inwardly, and the lower section 22 tapering downwardly and inwardly. In other words, the shell sections 21 and 22 are frusto-conical in shape, and are disposed base-to-base. To facilitate assembly of the shell 19, and to permit the shell to be taken apart to afford access to the interior thereof, the bases of the upper and lower shell sections 21 and 22 are flanged, as at 23 and 24 respectively, these flanges being adapted to be disposed in abutting relation and secured together by any suitable fastening means such as rivets 25. Instead of employing rivets for the purposes just mentioned, bolts may be substituted therefor, in which case, the shell 19 may be more quickly assembled or taken apart. The lower end of the lower shell section 22 is closed, according to one form of my invention, by the imperforate head or end wall 26. The upper end of the upper shell section

21 is partially closed by the upper head or end wall 27. At the center of the upper end of the upper shell section 21, I provide an upwardly extended spider or hopper 28, which may be formed separately and secured to the upper end wall 27, as by means of the bolts 29, or formed integrally with the upper shell section, whichever is preferred. The spider or hopper 28 is provided with a series of circumferentially spaced intake ports 30, through which the mixture of liquid and solids is adapted to be introduced into the separator unit S for separation of the solids from the liquid. The intake ports 30 are preferably inclined with respect to the vertical in order to facilitate the passage of the mixture through the ports 30 as the same rotate about the axis of the separator unit. According to the construction illustrated in the drawings, the intake ports 30 are formed by a series of radially disposed circumferentially spaced vanes 31, and these vanes are inclined from their lower edges to their upper edges in the direction of the rotation thereof so that as the leading upper edges of the vanes 31 come into contact with the mix as it is directed into the upper end of the hopper 28, they will serve to impel the mix downwardly through the ports 30 and into the separator shell, as should be perfectly obvious from inspection of Figures 1, 2 and 4.

The upper shell section 21 is provided with a series of liquid discharge ports 32, arranged in circumferentially spaced relation to each other about the periphery thereof, and adjacent to the upper end of this shell section. To better control the discharge of the liquid as it escapes through the ports 32, I preferably provide a series of radially disposed spouts 33 arranged about the periphery of the upper shell section 21 in communication with the discharge ports 32, and constituting extensions of said discharge ports.

In order to prevent the mix from passing directly to the discharge ports 32 and spouts 33 after the same has been introduced into the separator unit, I provide within the upper shell section 21, a depending shield or hood 34 which is generally bell-shaped; that is to say, the shield 34 flares downwardly and outwardly from the lower side of the intake ports 30. As best seen in Figure 1, the shield 34 may be formed as an integral extension on the lower end of the spider or hopper 28, although it is to be understood that it may be constructed separately from the hopper 28 if desired, in which case, it will be fixedly secured in any suitable manner to the hopper 28 or the upper shell section 21. The shield is spaced inwardly from the inclined side walls of the upper shell section 21, and terminates at its lower extremity preferably just above the base of the upper shell section, thus providing an inner chamber or passage 35 within the shield 34, and, together with the upper shell section, an annular chamber 36 within the upper shell section.

From the foregoing description, it will be understood that the hopper 28, the shield 34 and the upper and lower shell sections 21 and 22 respectively, are all rigidly secured together, and constitute a unit such as has been illustrated in Figure 4, which unit is fixedly secured to the lower extremity of the drive shaft 15, as by means of the nut 37, so as to be driven directly by the drive shaft 15 at the same speed as this drive shaft is operated by the motor means M.

The screw blade unit or worm 20 is separate from the outer shell unit described above, as will be best understood from reference to Figure 3.

This unit 20 is composed of an elongated sleeve 38 which is adapted to be mounted upon the drive shaft 15 in such manner that it is free to rotate relatively to said drive shaft. Adjacent to the lower extremity of the sleeve 38, I provide upper and lower imperforate heads or plates 39 and 40 respectively, these plates or heads being disc-like in shape, and the upper plate 39 being substantially larger than the lower plate 40. Fixedly secured to the outer margins of the plates 39 and 40 are a plurality of straps or bars 41, these bars 41 being arranged in circumferentially spaced relation to each other, and extending downwardly from the upper plate 39 to the lower plate 40 at such an angle that they lie substantially parallel to the inclined lateral wall of the lower shell section 22. Each of the bars 41 carries a plurality of angular brackets 42 arranged in spaced relation one above the other, the brackets being welded or otherwise fixedly secured to the outer faces of the bars. These brackets 42 serve to support the helical blade or blades 43, which are wound edgewise about the bars 41. As illustrated in the drawings, the blades 43 are wound as a double helix, which is to say, there are two separate blades, each of which is preferably continuous from top to bottom. In such a case, the upper extremities of the separate blades should be displaced 180 degrees from each other about the axis of the unit 20, as will be best understood from reference to Figures 1 and 3. The pitch of the blades is such that when the worm unit 20 is rotated in the same direction as the outer shell unit 19, at a speed slightly less than the speed of rotation of the outer shell unit, the blades 43 will act to feed the material which is engaged by the blades in a downward direction within the outer shell unit. The upper extremities of the blades 43 are preferably extended upwardly, as shown at 44 and 45, so as to provide upwardly extending paddle-like members at diametrically opposite points at the upper end of the worm unit 20.

As previously mentioned, the sleeve 38 is adapted to be mounted on the lower end of the drive shaft 15, and when so mounted, the worm unit 20 will be disposed within the lower shell section 22 of the shell unit 19, as seen in Figure 1.

The upper head or plate 39 lies slightly spaced below the lower extremity of the shield or guard 34, thereby forming an annular passage 46 between the lower extremity of the shield 34 and the plate 39 which permits the materials introduced into the hopper 28 and chamber 35 to pass outwardly therethrough into the annular chamber 36 where the separation of the solids from the liquid primarily takes place. As will be seen from Figure 1, the outer edges of the blades 43 which comprise the worm, closely engage the inner face of the lateral inclined wall of the lower shell section 22 so that when the worm is rotated at a speed relatively less than the speed of rotation of the shell 19, the worm will produce a scraping action, preventing any material from adhering to the sides of the lower shell section 22, and positively causing the solids to be fed slowly downwardly towards the bottom of the lower shell section, from which the solids are ultimately discharged through the outlet ports 47. The shell engaging edges of the blades 43 may be rotated, if desired, at intervals so as to prevent the fluid from being trapped between the blades and retained in the separator when operation thereof is discontinued.

The worm unit 20 is adapted to be driven by the drive shaft 15 through the intermediary of a differential gear mechanism D which will now

be described. As seen in Figure 1, the upper extremity of the sleeve 38 terminates below the lower extremity of the hub 11, and intermediate these parts there is provided a carrier plate 48, which is fixedly secured in any suitable manner to the drive shaft 15 for rotation therewith. The carrier plate 48 carries at diametrically opposite sides of its axis the planetary gears 49 and 50. Each pair of gears 49, 50 is fixed on a common shaft 51 which is rotatably mounted in the carrier plate 48. The gears 49 are disposed at the upper side of the plate 48, and the gears 50 are disposed at the lower side of the plate 48. Fixedly secured to the lower extremity of the hub 11, is a pinion 52, the teeth of which mesh with the teeth of the upper planetary gears 49. The lower planetary gears 50 mesh with a pinion 53 which is fixedly secured to the upper end of the sleeve 38. Thus when the drive shaft 15 is rotated, it causes the carrier plate 48 to rotate with it, and the rotation of the carrier plate 48 moves the gears 49 around the fixed pinion 52 with a planetary motion, thereby causing the shafts 51 to rotate and transmit power to the lower planetary gears 50, which in turn transmit power to the pinion 53 to impart rotation to the sleeve 38. The sizes of the various gears and pinions and their number of teeth will be determined by the speed of the motor M and the relative difference in speed desired between the shell 19 and worm 20 of the separator unit S. I have found that a motor speed of 1200 R. P. M. and a worm speed of approximately 980 R. P. M. are satisfactory under ordinary conditions of use and afford efficient separation of the solids from the liquid in the average mixture. In such a case, the pinion 52 will have twenty-four teeth, the gears 49 forty teeth, the gears 50 fifteen teeth and the pinion 53 forty-nine teeth. It is to be understood, however, that I do not wish to be limited to these precise gear ratios and speeds, as the same may be varied, to accord with the type of mixture which is to be handled by the separator.

The differential gear mechanism D is preferably enclosed in a housing 54, and this housing 54 is removably secured by means of bolts 55 to a supporting yoke or hanger 56 which is fixedly secured to the hub 11. The housing 54 is adapted to contain a suitable lubricant for lubricating the gear unit, and to prevent the lubricant from leaking out around the sleeve 38 at the bottom of the housing, I preferably provide a stuffing box, generally designated 57. 58 designates a splash plate or guard which extends at least partially over the gear unit at the upper end of the housing to prevent the lubricant in the housing from being thrown upwardly out of the housing during the operation of the gear mechanism.

The operation of the separator apparatus may be briefly summarized as follows: The mixture of fluid and solids is led from a suitable source, such as a vat or tank T, through a conduit 59 having a control valve V therein to control the rate of flow of the mixture to the separator unit S, the discharge end 60 of the conduit being disposed over the hopper 28 at the upper end of the separator unit. The separator unit S is preferably started up and brought up to operating speed before the control valve V is opened to allow the mixture to pass into the hopper. When the mixture enters the hopper 28, it passes downwardly through the intake ports 30 and into the chamber 35 within the downwardly and outward-

ly flaring guard or shield 34, where it spreads outwardly away from the axis of the separator unit under the centrifugal action. The mixture continues through the inner chamber 35 and escapes outwardly through the annular passage 46 between the lower extremity of the shield 34 and the upper head or plate 39 of the worm unit 20, and enters the space 36 between the shield 34 and the outer shell 19. In this space, the separation of the solids from the liquid takes place, and the liquid rises in the chamber 36 and passes outwardly from the shell through the ports 32 and spouts 33, the solids passing downwardly into engagement with the blades 43 which are rotating in the same direction as the shell, but at a slightly lower speed. The blades 43 gradually and slowly feed the solids downwardly in the lower shell section 22, from the lower end of which they are ultimately discharged through the outlets 47 into a suitable container or receptacle R, where they may be collected for suitable disposition of the same. As the separation takes place in the space 36, the paddle-like extremities 44 and 45 of the blades 43 slowly stir the mixture and facilitate the complete separation of the solids from the liquid.

In order to conveniently dispose of the fluids which are thrown off during the separating action above described, I preferably provide a collecting pan or tray, generally designated 61, this pan being composed of annularly arranged inner and outer walls 62 and 63 respectively, which are interconnected at their lower ends by a bottom wall 64, forming a trough 65 of suitable depth. As the liquid collects in this trough 65, it drains through an outlet 66 which may be extended to any desired point for disposal of the fluid. The inner and outer walls 62 and 63 are spaced from the separator unit S so as not to interfere with the rotation thereof, and as illustrated in Figure 1, the walls 62 and 63 are inclined so as to be disposed substantially parallel with the outer peripheral wall of the upper shell section 21. The outer wall 63 of the fluid collecting tray or pan is extended upwardly to a point above the fluid outlet spouts 33 so as to deflect the fluid downwardly into the trough 65 as the same is thrown out of the spouts by the rapid rotary motion of the separator shell.

Due to the provision of the universal bearing afforded by the parts 8 and 10, previously described, which bearing parts serve to support the weight of the entire apparatus, any inadvertent or accidental unbalancing of the apparatus during operation will be accommodated by the self-centering action of the bearing parts. Any vibrations due to an unbalanced condition will be absorbed or yieldably cushioned by reason of the provision of the resilient cushion members 6 previously described.

To prevent the partly spherical head 10 from rotating in the socket 9 of the bearing block 8, during rotation of the drive shaft 15, there is provided a recess 66 in the bearing block 8 at the upper end thereof which is adapted to receive therein a laterally projecting stud or pin 67 which is fixed to one side of the head 10. The recess 66 is sufficiently large to allow a limited amount of play for the pin or stud 67, having in mind that the head 10 is intended to be movable relatively to the bearing member 8 to carry out its self-centering function.

The fluid collecting pan or tray 61 may be fixedly mounted in any suitable manner so that it will be held stationary. 68 designates suspen-

sion brackets or hangers by means of which the tray 61 may be secured to the table or platform 2 to support the tray at the proper elevation respecting the fluid discharge spouts 33.

Referring to Figure 5, I have shown a slightly modified form of shell for the separator unit S, which is adapted to effect an axial discharge of the solids from the bottom of the separator unit, as distinguished from the radial discharge resulting from the provision of the discharge ports 47 as arranged in Figures 1 and 4. In this modified construction, the lower shell section 22' is provided at its lower end with a perforate spider 26', affording downwardly opening discharge outlets 47' disposed at circumferentially spaced intervals about the axis of the separator. If desired, the spider 26' may be provided with a series of radially disposed vanes 69 which are inclined in a manner similar to the vanes 31 within the hopper 28. In other words, the spider 26' may be of a construction which is generally similar to the upper hopper 28 with the inclined vanes 69 serving to facilitate the discharge of the solids through the bottom of the separator shell.

While the specific details have been herein shown and described, the invention is not confined thereto, as changes and alterations may be made without departing from the spirit thereof, as defined by the appended claims.

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

1. A centrifugal separator of the class described, comprising a shell composed of two sections of generally frusto-conical configuration secured base-to-base, a downwardly outwardly flaring annular shield disposed within the upper shell section in spaced relation to the peripheral wall thereof, said upper shell section being provided with a central intake hopper at its upper end opening into the space within the shield aforesaid, and also provided with a plurality of fluid outlet ports in its peripheral wall adjacent to the upper end thereof and communicating directly with the annular space between the peripheral wall of the upper shell and the shield, said shield extending downwardly within the upper shell at least a substantial distance below the fluid outlet ports, a helical screw blade coaxially mounted within the lower shell section and arranged to contact the peripheral wall thereof, said screw blade being secured to a plurality of inclined bars arranged in circumferentially spaced relation to each other, and the bars being secured to the outer margins of a pair of axially spaced imperforate disc-like heads, one of which heads is disposed in a position spaced slightly below the lower extremity of the shield aforesaid to provide an annular passage therebetween, said lower shell section having a discharge opening at its lower extremity through which solid materials are adapted to be discharged, and means for rotating the shell aforesaid and screw blade in the same direction about their common axis but at relatively different speeds, whereby to cause the fluid of a mixture of fluid and solid matter to be separated and discharged through the aforementioned outlet ports, and the solid matter to be positively fed by the screw blade to the lower discharge opening through which it is adapted to be discharged when the mixture is introduced into the shell through the hopper aforesaid and subjected to the centrifugal force produced by the rotatable parts.

2. In a centrifugal separator of the class described, including coacting rotary parts coaxially arranged for rotation in the same direction but at relatively different speeds about a common vertical axis, and means for admitting a mixture thereto and for separately discharging therefrom the fluid and solid portions of said mixture responsive to the centrifugal action of said parts thereon, driving means for said rotary parts comprising a vertically disposed drive shaft operatively connected to one of said parts and serving to suspend the same at the lower end thereof, a sleeve rotatably mounted on said drive shaft and operatively connected thereto and to the other of said rotary parts so as to produce differential rotation thereof, and a self-centering support for said drive shaft, the latter including a fixed part having a partly spherical socket formed in its upper side, a hub embracing the upper end of said drive shaft and extending through said fixed part and having a partly spherical head provided at its upper end, which head is adapted to be seated in the socket aforesaid, and coacting abutment means extending between the head and the spherical socket aforesaid for positively restraining said head against rotary movement within the socket relative to the axis thereof, but permitting axial rocking movement of the head in the socket.

3. Apparatus as claimed in claim 2, in combination with motor means mounted upon the upper end of said head so as to be supported thereby and operatively connected with the drive

shaft, and means disposed intermediate the motor means and fixed part aforesaid for yieldably cushioning the rocking movement of said motor means responsive to axial rocking movement of the supporting head.

4. Apparatus as claimed in claim 2, in combination with motor means mounted upon the upper end of said head so as to be supported thereby and operatively connected with the drive shaft, and means disposed intermediate the motor means and fixed part aforesaid and arranged in substantially radially spaced relation to the axis of the supporting head for yieldably cushioning the rocking movement of said motor means responsive to axial rocking movement of the supporting head.

5. Apparatus as claimed in claim 2, in combination with motor means mounted upon the upper end of said head so as to be supported thereby and operatively connected with the drive shaft, and means disposed intermediate the motor means and fixed part aforesaid and arranged in substantially radially spaced relation to the axis of the supporting head for yieldably cushioning the rocking movement of said motor means responsive to axial rocking movement of the supporting head, said last named means comprising a plurality of vertically disposed tie bolts, and each of said tie bolts having a resilient buffer mounted on the end of the same intermediate its head and the motor means.

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