Dec. 1, 1953 W. G. ABBOTT, JR 2,661,150

CENTRIFUGE

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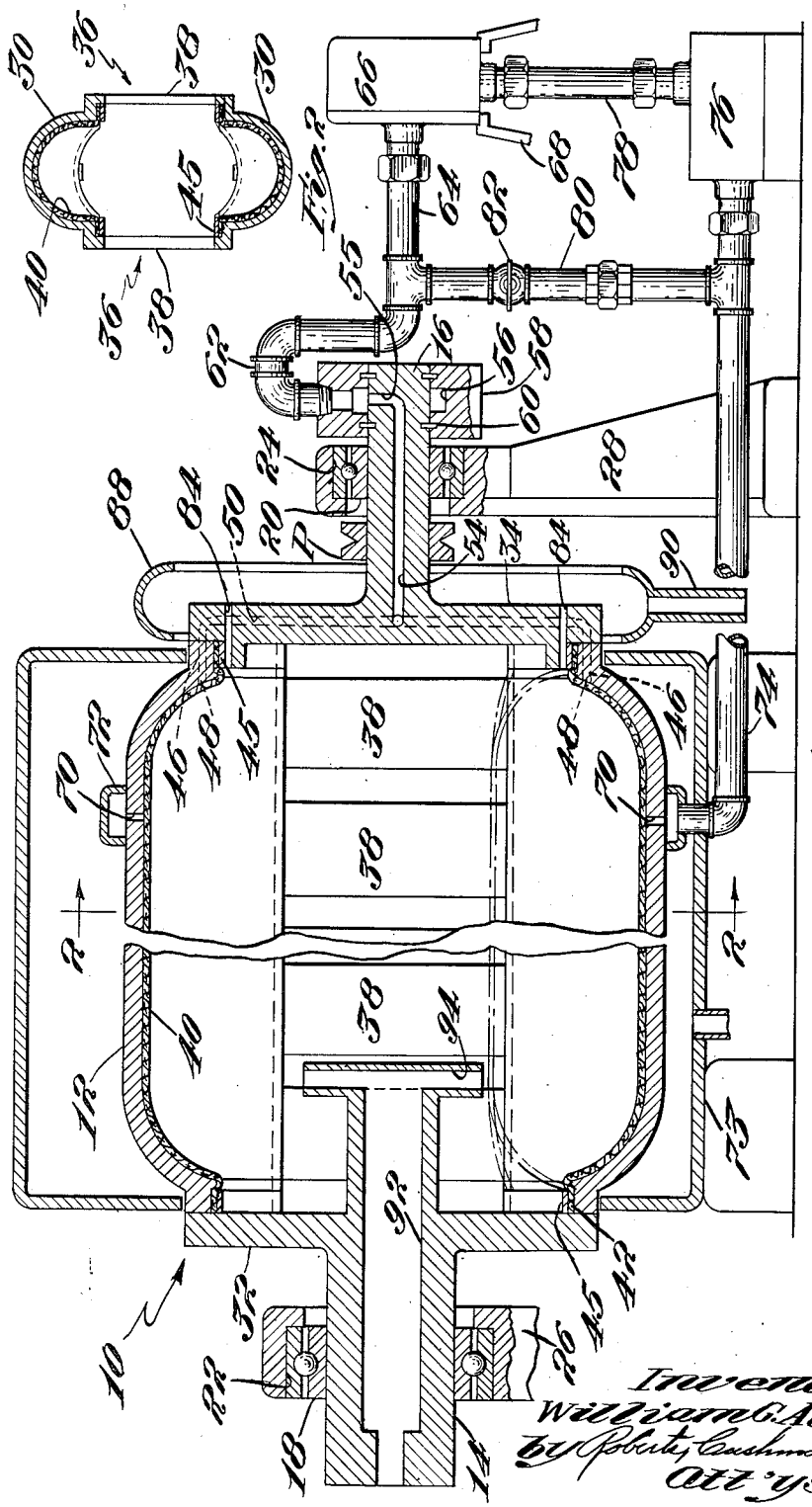


Fig. 1

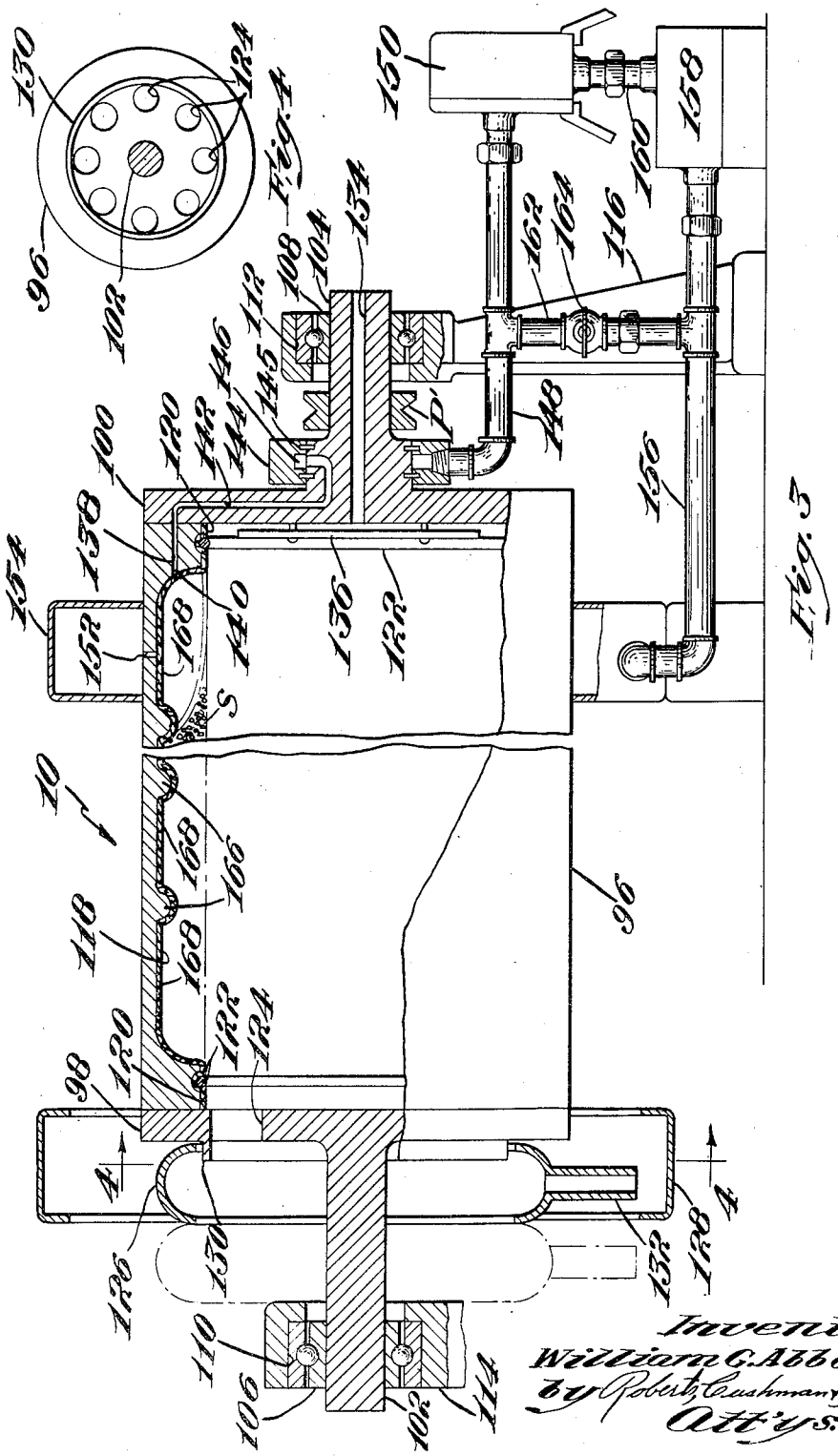
Fig. 2

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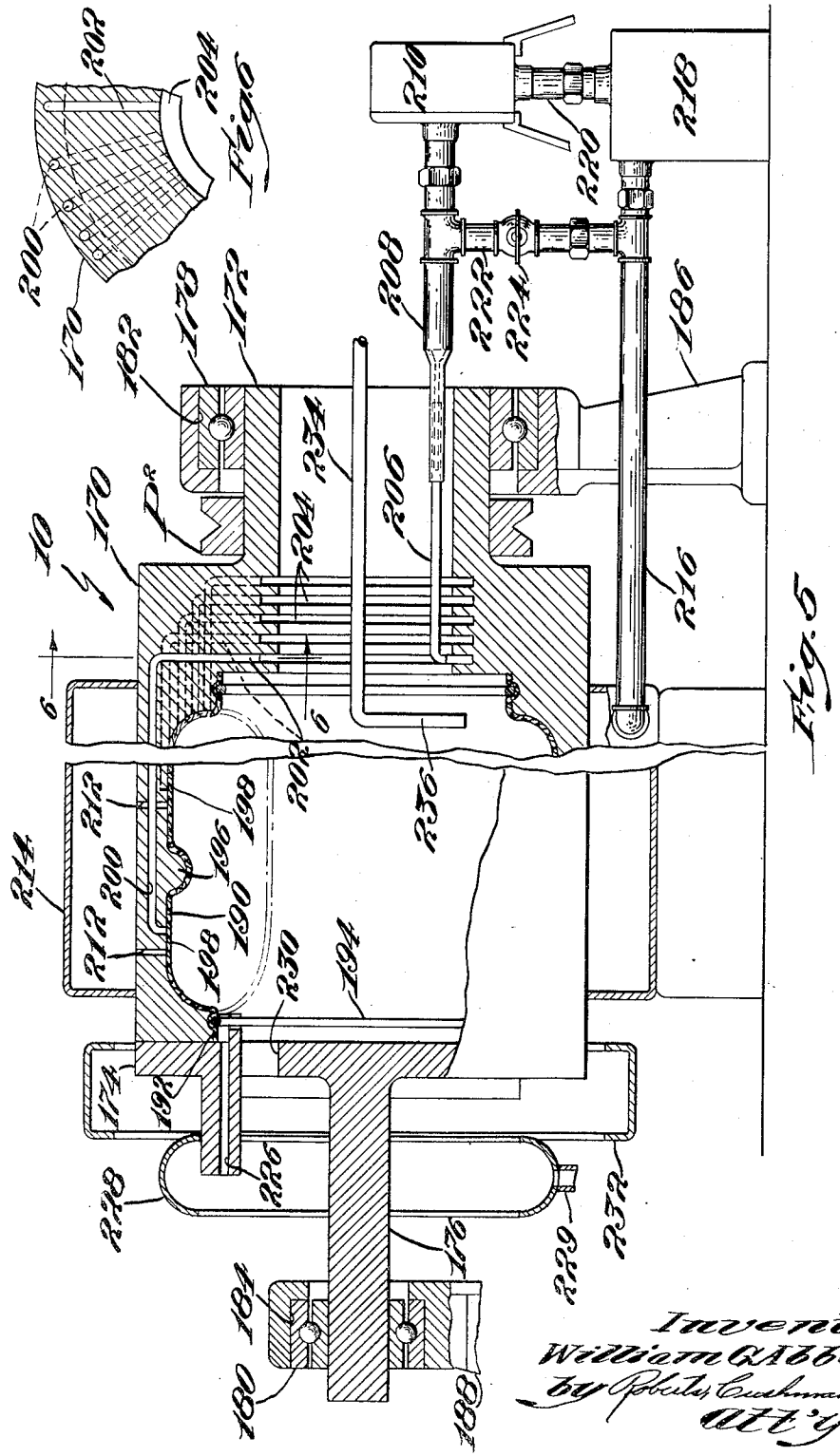


Fig. 5

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CENTRIFUGE

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12 Claims. (Cl. 233—27)

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This invention relates to centrifuges and particularly to improvements in the centrifuges for substantially continuously separating the dirt from wool-scouring liquors and thereafter effecting a discharge of the dirt from the centrifuge.

Heretofore in such machines as have been available the charging and discharging openings have been provided with valves to prevent escape of the liquid being centrifuged and, when a sufficient separation of the liquid from the dirt had been effected, certain of these valves were opened to allow discharge and then others were opened to admit a new charge of liquor. The sticky nature of the wool grease and fat quickly fouled the valves so that they became inoperable and the abrasive character of the dirt wore the valves out rapidly even when made of the hardest steels, with the result that at frequent intervals costly repairs had to be made. In such machines the discharge of the dirt or sludge after it had accumulated therein was accomplished by screws or plungers disposed within the centrifuge arranged to plow the sludge from the walls, but due to the fluidity of the sludge a considerable amount ran back along the threads of the screw or through the clearance between the plunger and the wall and was not discharged.

Objects of this invention are to provide a machine in which no valves are required for controlling the charging and discharging of the liquor to be centrifuged and in which complete discharge of the sludge may be effected. Other objects of the invention are to provide a centrifuge in which the liquor separated from the sludge may be discharged substantially continuously and may closely be controlled, and in which the sludge which accumulates adjacent to the wall of the centrifuge may be expelled while the centrifuge is in operation so that the liquor may substantially continuously be introduced thereto without having to stop the machine for cleaning. Still other objects are to provide a machine which is economical to operate, comparatively simple to construct and maintain in good working order, is efficient and durable.

In its broadest aspects the centrifuge comprises a rotatable container a portion of which is adapted to receive a quantity of the liquid from which dirt and other heavy matter is to be separated and from which the liquid may be discharged in a continuous manner leaving the sludge at the bottom thereof. In this liquid receiving portion there is located a flexible diaphragm which is substantially coextensive therewith, the diaphragm being movable relative to the liquid receiving portion to effect discharge of the sludge from the container after it has accumulated to a sufficient extent to interfere with further separation. The diaphragm is moved inwardly toward the axes of rotation of the container to effect the aforesaid discharge of the sludge and while this may be an overall inward movement of the enteire diaphragm, preferably a portion of the diaphragm is moved radially inward at one end and then succeeding portions are moved inwardly proceeding from that end to the other so that the entire diaphragm is ultimately displaced. This progressive displacement of the diaphragm creates a centrifugal differential that causes flow of the accumulated sludge adjacent to the diaphragm from one end toward the other or from the displaced portion toward an undisplaced portion. To insure a progressive inward displacement of the diaphragm, in one form of the invention finite sections are established as herein illustrated by inwardly directed annular ribs formed on the inside of the container over which the diaphragm lies. These ribs form hinge points about which the diaphragm will bend and are of such a character that one section will be substantially completely displaced inwardly before the next section begins to move inwardly. To bring about displacement of the diaphragm in an efficient, simple and inexpensive manner, a passage is formed in the wall of the container, one end of which terminates behind the diaphragm and there is means for delivering a liquid usually water to the passage and hence between the wall and the diaphragm. Each ridge serves as a dam blocking the passage of water between the diphragm and the wall between sections until the particular section has been substantially completely displaced. A plurality of such passages may be employed, one for each section of the diaphragm as divided by the aforesaid ridges and the means for introducing the liquid thereto may be adjustable selectively to introduce the liquid to a given section thus providing means for flexing a given section independently of the others if necessary to displace sludge therefrom. Each section may have an independent drain orifice therein so that by controlling the amount of water delivered to a section the diaphragm covering that section may alternately be displaced and allowed to return to its normal position.

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While both the liquid and the sludge may be discharged through the same discharge openings,

preferably there are relatively small openings for discharge of the liquid to afford a closer control of the discharge by minimizing the depths of flow and hence the turbulence during discharge. To rid the centrifuge of the sludge however as rapidly as possible larger openings are provided, and these are necessarily situated radially inward of the smaller openings. To prevent fouling of the small openings during ejection of the sludge, the diaphragm is arranged when displaced to cover the smaller openings and hence to seal the same against admission of the sludge.

More specifically the centrifuge as illustrated in one form comprises a pair of semicylindrical liquid receiving sections joined at their ends for rotation about a common horizontal axis with intervening spaces extending longitudinally thereon. The intervening spaces afford discharge openings along the entire length of the centrifuge through which the sludge may be ejected rapidly and also access to the interior of the centrifuge in the event the mechanical means must be employed to dislodge adhering sludge. While the liquid component could be discharged through the intervening side opening for the reason assigned above, a relatively small discharge passage is formed at one end of each section for this purpose. A diaphragm or flexible lining member is situated in each section which may be moved initially to effect discharge of the liquid component through the end opening and finally to cover the latter and to effect discharge of the sludge through the longitudinal intervening spaces.

The centrifuge container, however, may be completely closed along the sides having the discharge openings in an end. Hence in an alternative form the container is a substantially closed cylinder in which there is disposed a substantially continuous flexible diaphragm or lining, the opposite ends of which are secured to the wall thereof and the intermediate portion of which is free. The container has openings in its ends for the discharge and for the introduction of both the liquid to be centrifuged and the liquid to displace the diaphragm. As illustrated the discharge openings are a plurality of circular openings arranged concentrically with respect to the axes of rotation of the container at one end through which the liquid component of the centrifuge liquid may be discharged. While only one set of discharge openings are employed herein, separate openings may be provided for effecting discharge of the sludge. As herein illustrated the discharge holes are neither too large to spoil the control of the discharge nor too small to prevent rapid discharge of the sludge. The liquid tc be centrifuged is introduced at the opposite end of the container through a centrally located passage extending through that end wall and the liquid for displacing the diaphragm is introduced through a suitable radial passage, one end of which terminates behind the diaphragm. In this form of the centrifuge there are annular ridges on the inside peripheral wall to divide the diaphragm into a plurality of sections for the reasons assigned above.

In a modification of the closed centrifuge, each of the sections of the diaphragm is supplied separately with liquid as by a passage terminating behind the diaphragm at each section so that each section may selectively be moved inwardly. As illustrated this centrifuge comprises a cylinder, one end of which is closed by a plate having two sets of discharge openings therein and the other end of which has formed integral with it a hub through which there is a comparatively large central opening. The liquid to be centrifuged is introduced through this central opening. Within this opening there are a plurality of annular grooves each of which is connected to one of the aforesaid passages. Water is delivered to a given section behind the diaphragm by an adjustable conduit which enters through the opening and by movement therein may be brought into registration with a given one of the grooves.

The invention will now be described with reference to the accompanying drawings in which:

Fig. 1 is a vertical section taken longitudinally through a form of the centrifuge wherein there are a plurality of liquid receiving sections separated by intervening spaces;

Fig. 2 is a vertical section taken on the line 2—2 of Fig. 1 considerably reduced in size showing the shape of the liquid receiving sections and their disposition;

Fig. 3 is a vertical section taken longitudinally through a modified form of centrifuge of the closed cylinder type embodying substantially the same principles of separation as shown in Fig. 1;

Fig. 4 is a vertical section taken on the line 4—4 of Fig. 3 considerably reduced in size;

Fig. 5 is a vertical section taken longitudinally through a modified form of the centrifuge shown in Fig. 3; and

Fig. 6 is a vertical section taken on the line 6—6 of Fig. 5.

Referring to Figs. 1 and 2 there is shown an open type centrifuge 10 comprising a receptacle 12 having hubs or journals 14 and 16 at opposite ends thereof for supporting it for rotation about a horizontal axis. A pulley P fixed to the hub 16 affords means by which the necessary rotation may be imparted to the centrifuge. The hubs 14 and 16 pass through ball-bearing assemblies 18 and 20, the latter being housed in recesses 22 and 24 formed in the upper ends of posts 26 and 28 which support the centrifuge at a convenient height from the floor. The receptacle 12 as shown is a casting comprised of two cylindrical sections 30, Fig. 2, which are held in spaced relation substantially diametrically opposite to each other and equidistant from the axis of rotation by spaced struts or webs 38 which extend across spaces or openings 36 between the sections. Disks or end plates 32 and 34 are fastened to the opposite ends of the sections 30 forming closures therefor. The hubs 14 and 16 are formed integral with the end plates.

Within each of the semi-cylindrical sections 30 there is situated a flexible diaphragm or lining 40, the ends and edges 42 of which are secured to the ends and edges of the section by overlying flat metal straps 45 while the portion intermediate the ends and edges is left free to move relative to the peripheral wall of the section. The diaphragm or lining is preferably a sheet of impervious waterproof material such as rubber, plastic or a waterproofed textile fabric.

The liquid to be centrifuged is introduced into the centrifuge, as will appear hereinafter, and occupies each of the cylindrical sections 30, overlying and being contained by the diaphragms. The liquid component is discharged continuously from the section through openings which will be referred to hereinafter. In order to discharge the sludge which accumulates adjacent to the wall means is provided for moving the diaphragms 40 inwardly toward the axis of rotation of the centrifuge. To bring about inward move-

ment of the flexible diaphragms, passages 46 are formed in the ends of the section 30 which terminate at one end at 48 behind the diaphragm. The opposite ends of the passages 46 are connected by radial passages 50 formed in the end plate 34 to an axial passage 54 formed in and extending along the hub 16. The outer end of the axial passage 54 intersects a radial passage 55 which extends radially through the side of the hub and this latter passage is in communication with an annular chamber 56 formed in a ring 58 surrounding the hub 16 and rotatably held thereon by key rings 60. Conduits 62 and 64 connect the chamber 56 the former being screwed into an opening in the ring and the latter being secured to the discharge side of a pump 66 supported from the floor on legs 68. By means of the pump 66 a liquid, usually water, may be supplied to the ring 58 and hence through the passages 54, 50 and 46 to the back side of the diaphragm 40. In order to avoid confusion between the liquid being centrifuged and the liquid employed to displace the diaphragm, the latter will hereafter be referred to as water although it is to be understood that other liquids than water may be employed for this purpose. As the water enters between the diaphragm 40 and the wall of a section 30, it is forced inwardly and, by varying the quantity of water introduced partial or total displacement of the diaphragm may be effected. Apertures 70 are formed in the walls of the sections 30 to allow a constant discharge of water introduced between the diaphragms and the walls of the sections into an annular housing 72 surrounding the centrifuge and within which it rotates. These apertures afford means for emptying water from between the diaphragms and the walls so that the diaphragms may return to lie against the walls after the sludge has been discharged. The housing 72 has at the bottom a conduit 74 which is connected to a sump 76, and the latter is connected by conduit 78 to the pump 66. In order to vary the amount of water supplied to the sections and hence the position of the diaphragms to bring about discharge, a bypass 80 is connected between the conduits 64 and 74 and in this bypass there is interposed a valve 82. At the beginning of the process the valve 82 is in a wide-open position, hence most of the water delivered by the pump 66 merely circulates from the discharge side of the pump to the suction side through the conduit 64, the bypass 80, the sump 76 and conduit 78. The apertures 70 are of sufficient size to permit the water delivered behind the diaphragm to leak out as fast as it is delivered into the housing 72 so that it does not accumulate and push the diaphragms away from the walls. When it is desired to discharge the sludge, the valve 82 is rotated partially to close the bypass 80, whereupon more water is delivered to the sections than can be discharged through the apertures 70 and hence the diaphragm is moved inwardly. By properly positioning the valve 82 a given volume of water may be introduced and maintained between the diaphragms and the walls of the section. It is to be understood that while a pump is disclosed for introducing the water, any means for creating a sufficient pressure head to cause the water to flow into the space between the diaphragm and the wall is suitable.

While the liquid component may be discharged through the longitudinal openings 36 at opposite sides of the centrifuge, a closer control of the discharge may be obtained by providing comparatively small openings for discharge of the liquid component. The smaller openings have the advantage that the flow is of less depth and hence there is less turbulence and tendency to cause intermingling of the liquid with the sludge. For this reason separate discharge passages 84 are formed in the end plate 34 at the ends of the sections. The passages 84 open into a chamber 88 concentric with and surrounding the end plate 34. The bottom of the chamber 88 is provided with a drain passage 90 through which the discharged components may be drawn off.

The sludge is discharged through the longitudinal openings 36 since these are much larger and permit a much more rapid discharge. This is accomplished by movement of the diaphragm 40 to the dotted-line position shown at the bottom of Fig. 1. A suitable housing 73 surrounding the container will receive the sludge. If desired the housing 72 may be omitted and the water allowed to discharge into the housing 73 together with the sludge. This would have the effect of keeping the discharged sludge fluid and preventing it from sticking to the wall of the housing. If this is done the return conduit 74, sump 76, bypass 80 and valve 82 may be omitted and the amount of water retained between the diaphragm and wall controlled by the speed of the pump.

It is to be observed that in this fully extended position the diaphragm will cover the inner open ends of the discharge passages 84 rising above the sides of the sections 30 hence preventing the sludge from fouling or chocking up the openings 84 which are small in diameter and would quickly be blocked by dirt and other viscous matter.

The liquid to be centrifuged is introduced to the centrifuge through the hub 14 by way of an axial chamber 92 formed therein which terminates at its inner end in radial passages 94 located in positions to deliver the liquid into the sections 30.

A centrifuge as described above may be operated substantially continuously since the liquid to be centrifuged may be introduced and the separated liquid component free of solid matter may be discharged while the centrifuge is in operation and for the further reason that after the sludge or foreign matter has accumulated to such an extent as to interfere with further separation, it may be removed without stopping the machine. Since the accumulation of the sludge is relatively slow, the centrifuge may be operated for a long time without interrupting the flow of liquor to it. In operation the centrifuge is driven at a given speed depending upon the liquid to be centrifuged and the liquor is supplied in a continuous stream to the container through the chamber 92 in sufficient quantity to fill the sections 30 and continuously to the discharge through the openings 84 separated from the sludge. The diaphragms 40 are at this time in contact with the peripheral walls of the sections 30 and the valve 82 is adjusted to its open position so that most of the water delivered by the pump 66 is bypassed and the small amount of water delivered to the sections is discharged through the apertures 70 in the walls thereof. The process in continued until the sludge accumulates within the sections to a point where it will begin to discharge with the separated liquid whereupon the introduction of liquor is stopped. At this point the valve 82 is rotated to a partially closed position whereupon the diaphragm is displaced inwardly and the sludge is ejected through the opening 84. As soon as the sludge has all

been discharged the valve 82 is rotated to its fully open position whereupon the diaphragms return to their initial positions against the walls of the sections and the introduction of liquid is resumed.

Referring to Figs. 3 and 4, there is shown a somewhat modified form of centrifuge in which a substantially closed cylindrical container 96 is employed, the opposite ends of which are closed by disks or end plates 98 and 100. The centrifuge is supported for rotation about a horizontal axis by means of hubs or journals 102 and 104 formed integrally with the aforesaid ends 98 and 100 and which pass through ball-bearing assemblies 106 and 108. The latter are housed in recesses 110 and 112 formed in the upper ends of posts 114 and 116 which support the centrifuge at a convenient height from the floor. Rotation of the centrifuge may be effected by way of a pulley P' fixed to the hub 104. Within the cylindrical container 96 there is disposed a substantially continuous flexible diaphragm or lining 118 the end portions 120 of which are fastened to the peripheral wall adjacent to the end plates 98 and 100 by the spring rings 122 and the intermediate portion of which is free. This diaphragm or lining, as in the previously described centrifuge, is adapted to be moved inwardly to effect discharge of the liquid component through discharge openings 124 formed in the end plate 98 and arranged concentrically with respect to the axis of rotation, Fig. 4. As herein illustrated there is only one set of openings for discharge of the liquid component. The size of these openings is carefully chosen so that they are not large enough to spoil the control of discharge by eddying and yet are large enough to permit rapid discharge of the sludge. Two sets of discharge openings could be employed if desired. The discharge openings 124 permit discharge of the liquid component into an annular chamber 126 situated at the end of the receptacle and surrounding a short annular flange 130 formed on the end plate 98. The lower side of the chamber 126 has a drain passage 132 through which the liquid component which accumulates therein may be drawn off. Surrounding the chamber 126 is a second chamber 128 the purpose of which will be described hereinafter.

The liquid to be centrifuged is introduced through the end plate 100 by way of a passage 134 formed longitudinally of the hub 104, the former entering the container through the center of the end plate 100 behind a baffle plate 136 the latter serving to spread the liquid radially and to prevent splashing and disturbing the separation of the liquid from the sludge.

To bring about movement of the diaphragm toward the axis of rotation of the centrifuge, one or more passages 138 are formed in the peripheral wall of the container, end portion 140 of which terminate behind the diaphragm 118. The passages 138 are connected to radial passages 142 formed in the end plate 100 and the latter are in communication with a chamber 146 formed in a ring 144 surrounding the hub 104 and rotatably retained thereon by means of key rings 145. One end of a conduit 148 is threaded into the ring and the opposite end connected to the discharge side of a pump 150. Apertures 152 are found in the container wall through which water introduced between the diaphragm and the wall of the container may pass into a chamber 154 surrounding the centrifuge and within which it rotates. The lower portion of this chamber is connected by a conduit 156 to a sump 158 and the pump draws the water therefrom through a return pipe 160. Prior to discharge of the sludge, the water delivered by the pump 150 circulates from the discharge side of the pump to the suction side through a bypass 162 which is connected between the conduits 148 and 156 and in which there is interposed a valve 164. To bring about displacement of the diaphragm, the valve 164 is partially closed so that more water is delivered to the container than can pass through the apertures 152 and hence water accumulates between the wall of the container and the diaphragm, pushing it inwardly. By adjusting the delivery of the water to the container, the diaphragm may be pushed inwardly sufficiently to eject all of the sludge through the discharge openings 124.

It has been found that when the water is introduced between the wall of the container and the diaphragm to displace the latter inwardly, there is a tendency for the sludge and heavy matter next to the diaphragm to accumulate at separated points along the container resisting uniform displacement of the diaphragm with the result that pockets are formed which retain the sludge preventing free flow toward the discharge opening at the end of the container. To prevent this, a progressive movement of the diaphragm inwardly from one end to the other, that is, toward the discharge end, is preferable. By progressively displacing the diaphragm inwardly from one end toward the other, a centrifugal differential is set up between the inwardly displaced portion and the undisturbed portion causing a flow of the sludge and other dirt from the inwardly displaced portion toward the undisturbed portions. Thus the sludge is moved toward the discharge end and there will be no pockets of accumulated sludge at various points within the centrifuge which cannot be displaced. To accomplish this, annular ridges 166 are formed on the inner surface of the wall of the centrifuge at spaced points to divide the container and hence the diaphragm into a plurality of adjacent but separated sections 168. As is illustrated, when water is introduced to the section most remote from the discharge end, it will separate the diaphragm in that section from the wall, Fig. 3, but, since the ridge 166 acts as a dam, the water will be held more or less confined to that section until the diaphragm is substantially completely displaced, the diaphragm hinging at the ridge separating this section from the next section. Thus the sludge accumulated on the diaphragm in the section is pushed or caused to flow toward the next section. When the first section becomes completely filled with water, the addition of more water will cause it to rise above the dam and flow over into the second section separating the diaphragm from the second section, and so on progressively to the last section, thereby moving the sludge toward the discharge end. When it is desirable finally to discharge the sludge which has accumulated at the discharge end, the chamber 126 is moved longitudinally to the dotted-line position so as to withdraw it from the chamber 128 and the sludge is allowed to discharge into this latter chamber.

The operation of the centrifuge described above is similar in most respects to the operation of a centrifuge illustrated in Figs. 1 and 2 and hence will not be recounted in detail herein. In one respect it differs, however, in that positive means, namely the ridges, are provided to effect displace-

ment of the diaphragm inwardly in a progressive manner from one end toward the other, that is, toward the discharge end so as to cause a continuous flow of the sludge adjacent to the diaphragm toward the discharge end.

In still another form of the invention, as shown in Figs. 5 and 6, the centrifuge comprises a substantially cylindrical container 170 which comprises a hollow cylindrical casting having formed integral with one end thereof a hollow hub 172. There is fastened to the opposite open end of the casting a disk or plate 174 having formed integral therewith a hub 176. The hubs 172 and 176 pass through ball bearing assemblies 178 and 180, the latter occupying recesses 182 and 184 in the top of posts 186 and 188 which support the centrifuge at a convenient height for rotation about a longitudinal axis. As in the previous centrifuges, there is a flexible diaphragm or lining 190 disposed within the container with its end portions 192 secured to the peripheral inner wall adjacent to the ends by means of spring rings 194. A plurality of annular ridges 196 are formed on the inner wall of the container which separate the container and hence the diaphragm into a plurality of spaced sections 198. As constructed, water may be introduced behind that portion of the diaphragm in each of these sections through independent passages 200. As illustrated, the passages 200 are formed in the peripheral wall of the container and extend from the various sections longitudinally to one end of the container where each is connected to a radial passage 202, the latter in turn being connected to annular grooves 204 formed on the inside surface of the hollow hub 172. An adjustable conduit 206 is arranged to be moved axially within the hub 172 to bring its inner end into registration with any given one of the grooves 204 so that a liquid may be introduced to any given one of the sections 198. The adjustable conduit 206 is connected in any suitable manner, for example by a telescoping joint, to a conduit 208, the latter being connected to the discharge side of a pump 210. Apertures 212 are formed through the wall of the container at each section through which the liquid may drain from between the diaphragm and the wall into a housing 214 surrounding the container and within which it rotates. Hence any liquid which may leak from a displaced section to an adjacent undisplaced section will run out of the latter through its aperture 212 without causing displacement thereof and liquid that is properly introduced may drain out. The liquid from the housing 214 is returned to the pump by way of a conduit 216 and a sump 218, the latter being connected to the pump by a pipe 220. Normally a bypass 222 diverts most of the liquid delivered by the pump to the sump 218 without its passing through the container. A valve 224 interposed in the bypass, however, may be adjusted to cause an excess of liquid to be delivered to the container and hence to separate the diaphragm from the wall of the container. The selective feature included in this centrifuge, that is, the provision of means for separating any one of the sections of the diaphragm, makes it possible to dislodge stubborn or heavy coatings of sludge which will not flow readily toward the discharge end of the centrifuge and to eliminate pockets formed along the diaphragm. By manipulation of the adjustable conduit 206 an undulating or wave-like motion may be imparted to the wall of the diaphragm to push the sludge toward the discharge end of the container.

The liquid component is normally discharged through one or more passages 226 formed in the end plate 174 as the diaphragm is moved inwardly, which in turn delivers the liquid to an annular chamber 228 surrounding the hub 176 and having a drain 229. The passages 226 are of small cross-sectional area and hence would be readily fouled or clogged by the sludge next to the diaphragm and hence larger openings 230 are provided for discharging the sludge, these openings being in communication with an annular chamber 232 surrounding the end of the container. To prevent access of the sludge to the passages 226 after the liquid components have been discharged and the sludge is being discharged, the inner ends thereof are arranged so that they will be covered by the diaphragm as it assumes its inwardly displaced position, as shown by the dotted lines.

The liquid to be centrifuged is delivered to the container through an axially arranged pipe 234 extending through the hollow hub 172 having at its inner end within the container a radial nozzle 236 which delivers the liquid close to the wall of the container hence minimizing disturbance of the liquid therein.

The operation of the centrifuge just described is similar to that of the previously described centrifuges with the additional feature that by introducing liquid between the diaphragm and the wall of the container at different points pockets formed during the discharge of the sludge may be eliminated and the diaphragm may actually be given an undulating or wave-like motion to promote movement of the sludge and to prevent adhesion thereof to the diaphragm.

It is to be understood that in any of the forms of the centrifuge as described above, the displacement of the diaphragm may be employed to effect a discharge of the liquid component of the liquid being centrifuged as well as the sludge.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. A centrifuge comprising a rotatable container having an elongate portion adapted to receive a liquid to be separated into components of different specific gravity and separate discharge openings at different radii through which separated components of the centrifuged liquid may be discharged from said liquid receiving portion, an impervious diaphragm coextensive with the wall of said liquid receiving portion, said diaphragm being movable relative to said wall to displace the components from the liquid receiving portion through said openings and by movement to a given position to cover certain of the discharge openings while leaving others uncovered, and means for effecting movement of said diaphragm.

2. A centrifuge comprising a rotatable container having an elongate portion adapted to receive a liquid to be separated into components of different specific gravity and separate discharge openings at different radii through which separated components of the centrifuged liquid may be discharged, certain of the openings being of small cross-sectional area through which the liquid component may be discharged and others being of larger area through which the sludge

may be emptied, an impervious diaphragm coextensive with the wall of said cylindrical portion, and the diaphragm being movable radially inward to discharge the liquid component through the openings of small area and thereafter being movable further to an extreme position to cover said small openings and to discharge sludge through the larger openings, and fluid passages communicating with the other side of the diaphragm for effecting such movement thereof.

3. A centrifuge comprising a container, rotatable about an axis, having an elongate cylindrical portion adapted to receive a liquid from which solid matter is to be separated, a flexible impervious diaphragm coextensive with the wall of said portion within which the liquid is introduced, a discharge opening, and means for displacing successive portions of the diaphragm successively radially inward to a smaller radius than the adjoining as yet undisplaced portion of the diaphragm, to cause the centrifugal action of the rotating container to effect flow of the dirt, deposited on the diaphragm, along the diaphragm from such displaced portion toward such undisplaced portion.

4. A centrifuge comprising a rotatable container having a portion adapted to receive a liquid from which solid matter is to be separated, a flexible inpervious diaphragm coextensive with the said portion within which the liquid to be centrifuged is introduced, discharge openings, means for introducing a liquid between the diaphragm and the wall of said cylindrical portion to displace the diaphragm radially inward, and dams spaced along said wall dividing the cylindrical portion into a plurality of sections, the diaphragm bearing radially outwardly by centrifugal force against the dams in an outer running position of the diaphragm but being disengageable from said dams by inward displacement, said dams preventing flow of liquid from one section to the next between the diaphragm and wall until the one section is fully displaced by the liquid introduced thereto.

5. A centrifuge comprising a rotatable closed container, a flexible impervious diaphragm coextensive with the peripheral wall of the container the ends of which diaphragm are fastened to the wall of the container and the intermediate portion of which is free to be moved inwardly, spaced annular ridges on the inner peripheral wall dividing the container into sections, the free intermediate portion of the diaphragm bearing radially outwardly by centrifugal force against said ridges in an outer running portion of the diaphragm but being disengageable from said ridges by inward displacement, said ridges forming hinge lines along which one section of the diaphragm may be displaced relative to the next, and means for introducing a liquid between the diaphragm and the wall to cause successive sections of the diaphragm to be displaced successively radially inward.

6. A centrifuge comprising a rotatable closed container, a flexible impervious lining diaphragm coextensive with the peripheral wall of the container the ends of which diaphragm are fastened to the wall of the container and the intermediate portion of which is free to be moved inwardly, said peripheral wall having a passage therein an end of which terminates behind the lining through which a liquid may be introduced to displace the lining, spaced annular ridges on the inner peripheral wall dividing the container and the overlying diaphragm into sections the free intermediate portion of the diaphragm bearing radially outwardly by centrifugal force against said ridges in an outer running portion of the diaphragm but being disengageable from said ridges by inward displacement, said ridges forming dams to restrain the flow of liquid between sections until preceding sections are filled, and means for introducing the liquid through the passage.

7. A centrifuge comprising a rotatable container a portion of which is adapted to receive a liquid from which solid matter is to be separated, an impervious flexible diaphragm within and coextensive with the liquid-receiving portion of the container and secured to the container at both ends, a discharge opening in the container through which the liquid component free from solid matter is adapted to be discharged from the container and independent fluid passages communicating, respectively, at different distances along the container with the outside of respective portions of the diaphragm for admission of fluid behind given portions of the diaphragm.

8. A centrifuge comprising a substantially closed container rotatable about a longitudinal axis having in one end a discharge opening, a charging opening, a flexible impervious lining member coextensive with the peripheral wall of the container the ends of which are fastened to the wall of the container and the intermediate portion of which is free to be moved inwardly, independent passages in the wall of the container having ends which terminate at longitudinally spaced points behind the lining and respectively corresponding opposite ends which terminate in the vicinity of the charging opening, a conduit for introducing a liquid to be centrifuged through the charging opening into the container and an adjustable conduit for delivering a liquid to any selected one of said opposite ends of said passages.

9. A centrifuge comprising a substantially closed container rotatable about a longitudinal axis having in one end a discharge opening, and having a centrally located charging opening in the opposite end, said opening having in its inner surface a plurality of annular grooves, a conduit passing through the charging opening for delivering liquid to be centrifuged to the container, a flexible lining member coextensive with the peripheral wall of the container the ends of which are fastened thereto and the intermediate portion of which is free to be moved inwardly, spaced annular ridges on the inner peripheral wall dividing the container and the overlying lining into sections, passages in the wall of the container having ends one of which terminates in each section behind the lining and opposite ends one of which terminates in each of said annular grooves, a conduit adjustable axially of the container for movement into registration with a given one of the grooves, and means for delivering a liquid to the conduit.

10. A centrifuge comprising a rotatable container, an impervious, flexible diaphragm constituting a liner for the container wall and subject to the outward force of the material under centrifugal treatment, and separate fluid conduits communicating separately with the outer side of said impervious diaphragm at respective points spaced longitudinally of the container, said separate conduits extending inward of the container to smaller radii than those of their points of communication with the diaphragm,

to supply fluid under centrifugal pressure between the diaphragm and container wall, whereby by supplying fluid to said conduits in succession the diaphragm can be caused to undulate in opposition to the centrifugal force of the material under treatment.

11. A centrifuge comprising a container rotatable about a longitudinal axis, a flexible impervious lining member within and coextensive with the peripheral wall of the container, the lining member being secured to the container at its ends and the intermediate portion of the lining member being free to be moved inwardly, independent passages in the wall of the container having ends which terminate at longitudinally spaced points and communicating separately with the outer side of the lining member, the container having at one end a portion of smaller radii having an inner surface formed in a plurality of annular grooves, said passages being connected respectively to said grooves, and means for delivering a liquid to said grooves in succession.

12. A centrifuge comprising a container rotatable about a longitudinal axis, a flexible impervious lining member within and coextensive with the peripheral wall of the container, the lining member being secured to the container at its ends and the intermediate portion of the lining member being free to be moved inwardly, independent passages in the wall of the container having ends which terminate at longitudinally

spaced points and communicating separately with the outer side of the lining member, the container having at one end a portion of smaller radii having an inner surface formed in a plurality of annular grooves, said passages being connected respectively to said grooves, and a conduit adjustable axially of the container for delivering a liquid to said grooves in succession.

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