

June 15, 1926.

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APPARATUS FOR CONTINUOUSLY SEPARATING LIQUIDS FROM SOLIDS

Filed Dec. 4, 1923

4 Sheets-Sheet 1

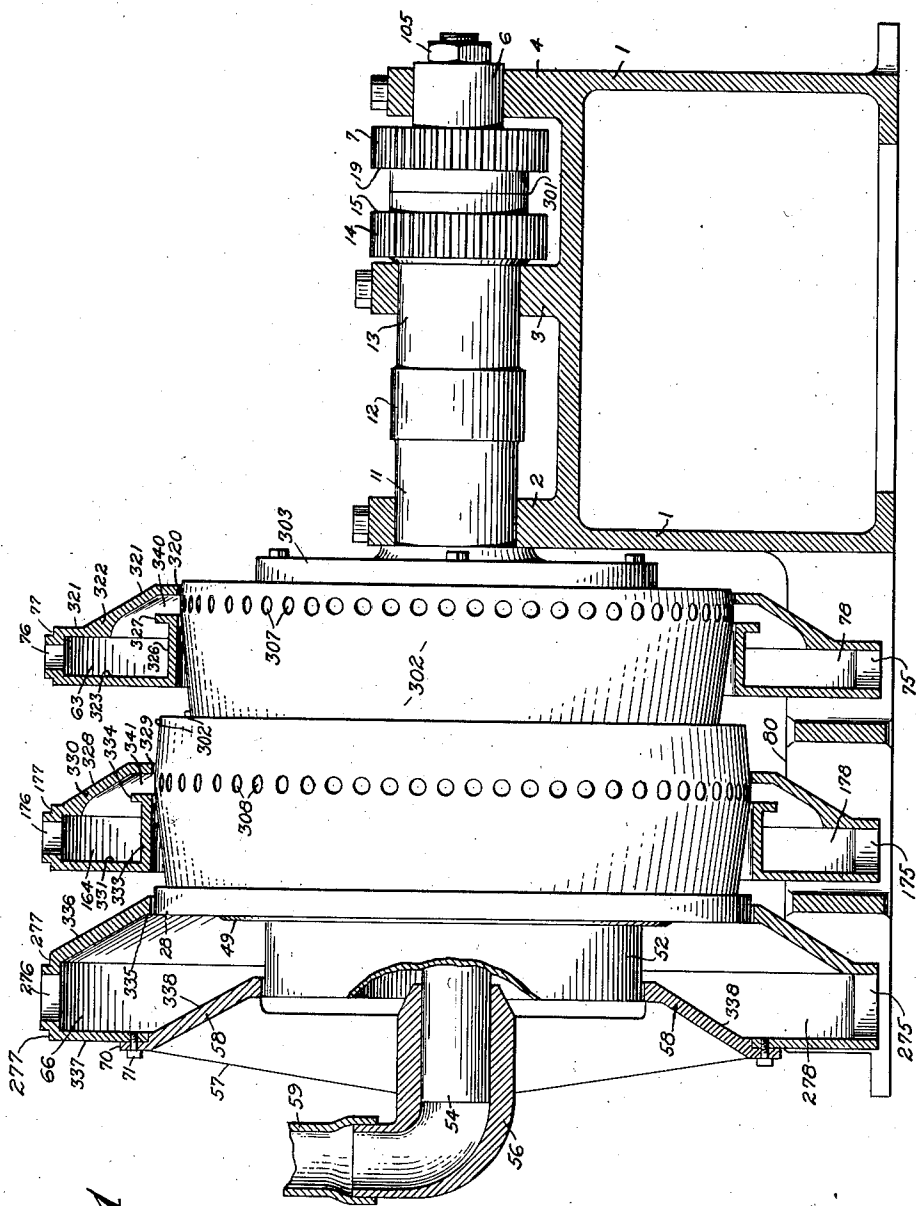


Fig. 1

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4 Sheets-Sheet 2

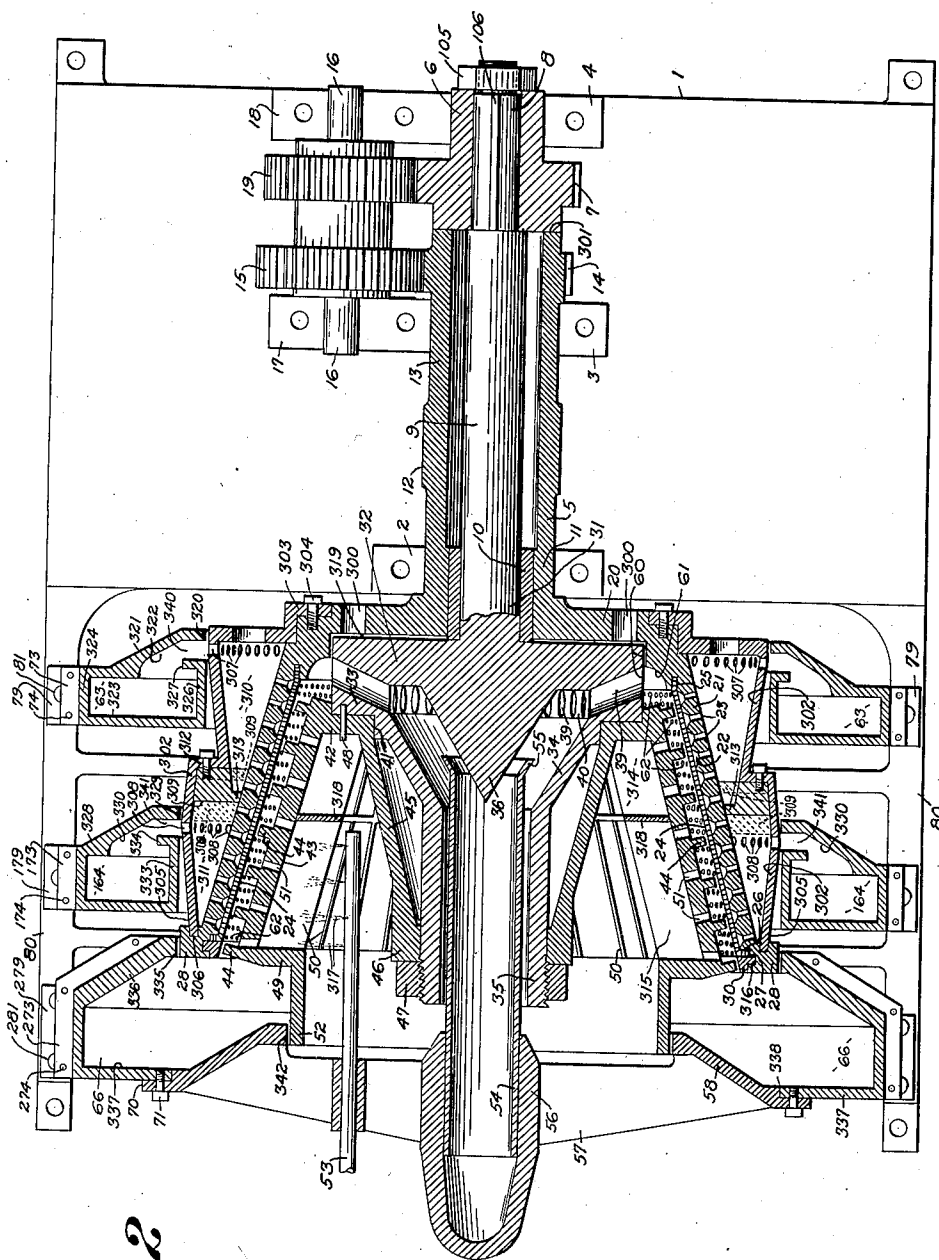


Fig. 2

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4 Sheets-Sheet 3

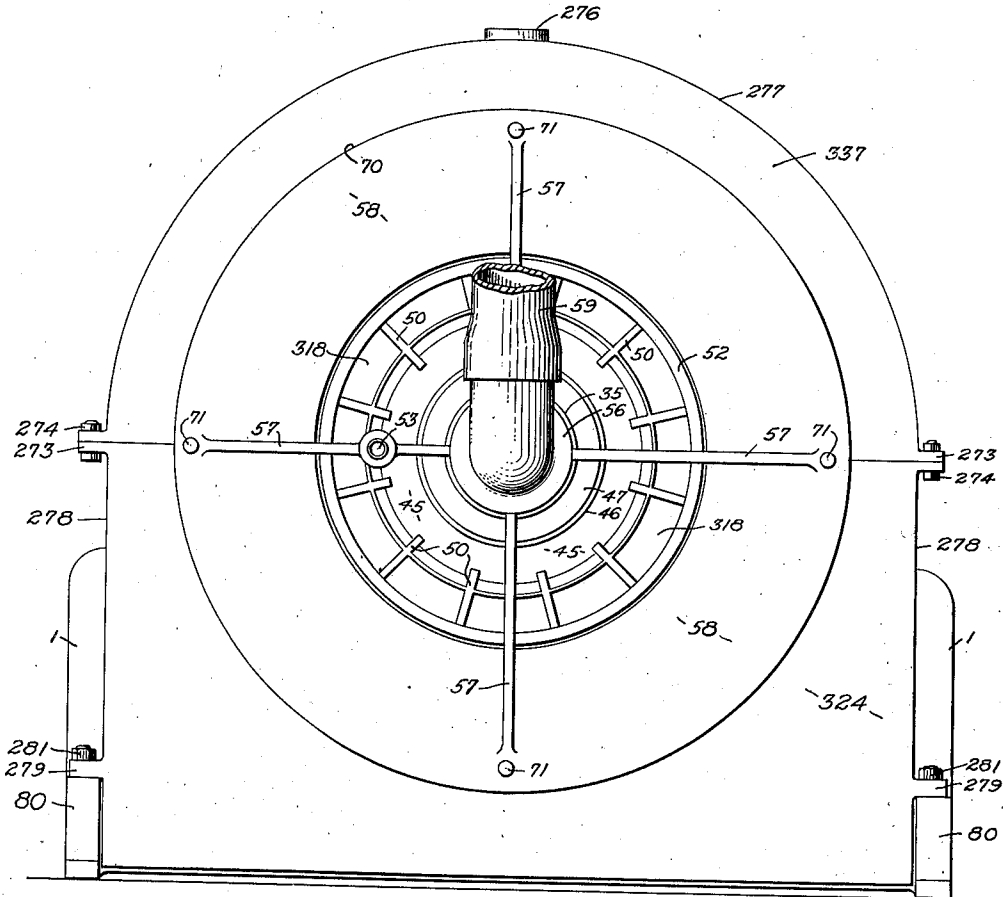


Fig. 3

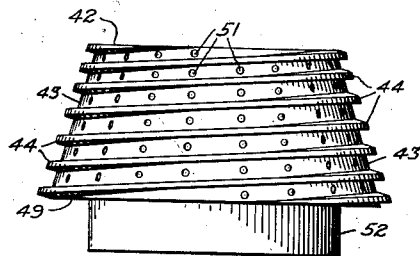


Fig. 4

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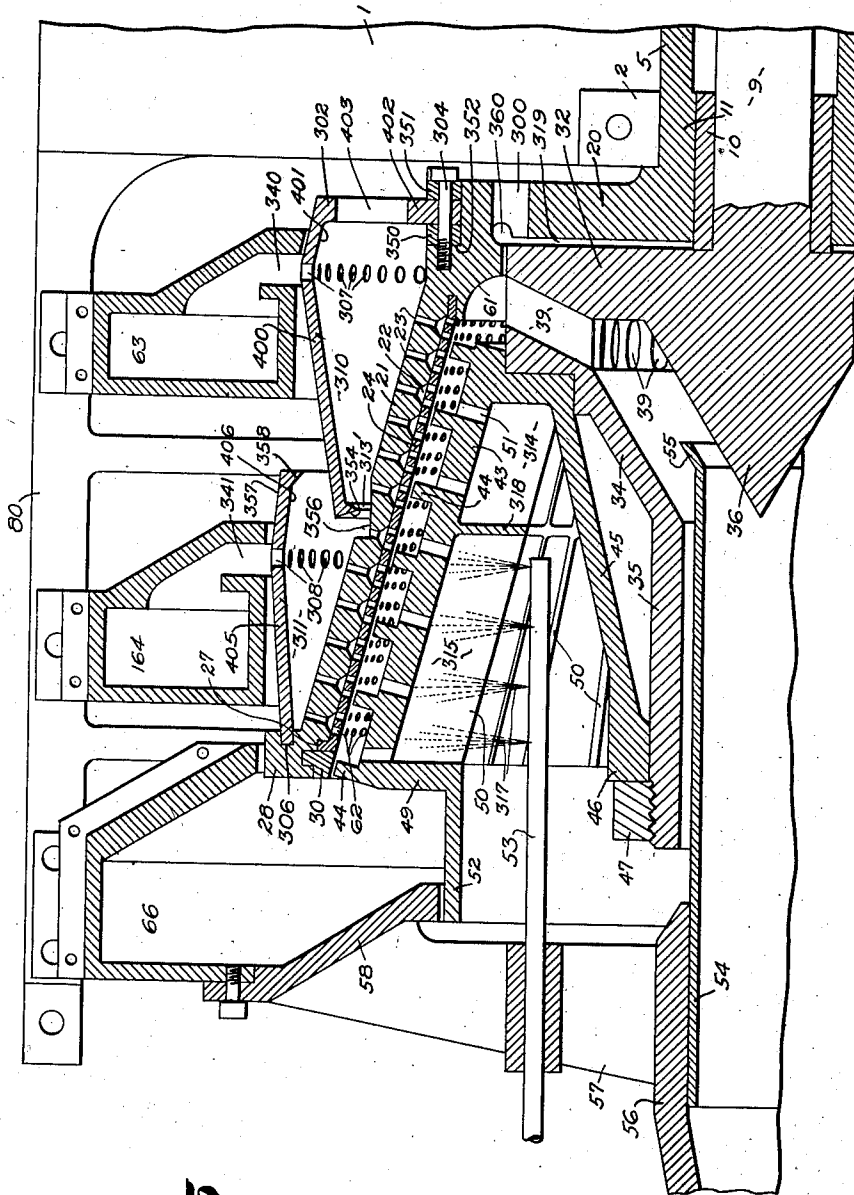
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APPARATUS FOR CONTINUOUSLY SEPARATING LIQUIDS FROM SOLIDS

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE.

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APPARATUS FOR CONTINUOUSLY SEPARATING LIQUIDS FROM SOLIDS.

Application filed December 4, 1923. Serial No. 678,542.

This invention relates to a process of and apparatus for the continuous separation of liquors from small solid particles in a centrifugal apparatus with a nonvertical axis, and has for its object to provide for the expulsion of the liquor in two stages, the first, and generally the larger, part of the liquor being eliminated without applying water or spray liquid, such as is usually employed for washing out the remaining liquor in the second stage of the operation.

With this and other objects in view, the invention consists in the novel steps and combinations of steps constituting the process, and in the novel parts and combinations of parts constituting the apparatus, all as will be more fully hereinafter disclosed and particularly pointed out in the claims.

Referring to the accompanying drawings forming a part of this specification, in which like numerals designate like parts in all the views;

Figure 1 is a vertical side elevational view partly in section, of an apparatus made in accordance with this invention;

Figure 2 is a plan view of the parts shown in Figure 1, chiefly in section through the main axis of the machine;

Figure 3 is an end elevational view of the machine as seen from the left hand end shown in Figure 2;

Figure 4 is an elevational view of the conveying member shown in section in Figure 2; and

Figure 5 is an enlarged sectional detail view of a portion of a slightly modified form of the invention.

Referring more particularly to Figures 1 and 2, 1 represents the frame of the machine, formed on top with the bearings 2 and 3 within which revolves the quill or sleeve 5 and associated with the bearing 4, which supports the hub 6 of gear 7. Gear 7 is fixed on the small end 8 of shaft 9 by the feather 106 and nut 105. Shaft 9 is carried at its large end 31 by the bearing sleeve 10, fixed in the end 11 of said quill 5. Quill 5 has fixed on it the pulley 12, which is rotated by a belt not shown from any suitable source of power. The end 13 of quill 5 has fixed to it the gear 14, which meshes with a gear 15 mounted on a shaft 16 carried in bearings 17 and 18, forming extensions respectively of the bearings 3 and 4. Gear 15 is rigid with gear 19, which meshes with gear 7

fixed on shaft 9, as previously explained. Gear 15 is somewhat larger than gear 14, and gear 7 is larger by the same amount than gear 19, so that shaft 9 is compelled to rotate at a somewhat slower rate than quill 5. End 11 of quill 5 is integral with disc 20, and the latter has fixed to it the small end of the conical mantle 21, having on its inner surface numerous grooves 22, at each of which said mantle is perforated with a circle of holes 23. Overlaying the inner surface of mantle 21 is the conical screen 24, fitting with its smaller end into the circular groove 25, and having at its large end the outward flange 26, which fits into the groove 27, formed inside the large end 28 of mantle 21. The snap ring 30, extending outward beyond flange 26 into a groove 316, secures the screen 24 in place.

The large end 31 of shaft 9 has formed on it the disc 32, rigid with the ring 33, the conical tube 34, and its cylindrical extension 35. At the center of disc 32, opposite shaft 9, is the conical boss 36. Ring 33, as shown in Figure 2, is perforated with numerous holes 39, the solid part 40 between them serving as impeller blades to impart velocity to the material fed to their inner ends.

Where conical tube 34 joins ring 33 it has on its outside a cylindrical part 41, over which is fitted the annular end plate 42, rigid with the conical screw conveyor 43, shown in section in Figure 2 and in side elevation in Figure 4. The conical shell 43 has fixed to its outer surface one or more helically disposed ribs 44, surrounding the shell 43 like the thread of a screw and forming the conveying element for the material being treated, and causing it to move over the screen 24 from the small to the large end of said shell 43. The inner periphery of end plate 42 is extended into or is rigid with the conical shell 45 provided with the thickened cylindrical part 46. This end or part 46 as shown in Figure 2 fits over the tube 35, which is threaded at its free end and fitted with the nut 47, securing the entire conveyor structure in place. A dowel pin 48 prevents the conveyor structure from turning on the ring 33.

The large end of conical shell 43 is rigid with or terminates in an inwardly extending disc 49, and in the space between this said disc 49 and end plate 42 are fixed the fan

blades 50, which by their rotation force air through the holes 51 in mantle 43, through the material being treated on screen 24, through said screen and through the holes 23 in mantle 21, this said air thus escaping with the separated liquor. Air is admitted to the inner edges of fan blades 50 through the cylindrical shell 52, forming a lateral extension from the inner edge of disc 49.

10 Water, or other liquid, or steam, is, or may be admitted through a stationary tube 53 longitudinally movable in its support by jets 317, to be caught up by the fan blades 50 near their larger diameter and is likewise
15 driven through the material and the mantle 21 near its larger end. A division plate 318 may be employed to confine the liquid coming from tube 53 to the large end of cone 43. The fan blades 50 are here for simplicity of illustration shown radially disposed, but
20 in an actual machine they may preferably have their inner edges curved forward in the direction of rotation, so as to pick up the air and liquid more efficiently.

25 The material to be separated is introduced into the center of the machine through a tube 54, preferably slightly enlarged at its discharge end 55. Tube 54 issues from elbow 56 supported by arms 57 from front plate 58,
30 attached with its flange 70 by bolts 71 to the front wall 337 of the solids receiver 66 more fully described below. Arms 57 at the same time serve to carry the wash tube 53 above described. The supply of material
35 comes through the flexible tube 59 attached to the free end of the elbow 56.

As best shown in Figure 2, disc 20 is pierced by a number of holes 300, forming a circle a little inside the periphery of disc
40 32. Holes 300 provide an escape for material, which might come over the edge of disc 32 and enter the space 319 between disc 32 and disc 20 in case the supply of material came to the machine at a greater rate than
45 the conveyer blades are designed to handle. Without these said holes 300 under abnormal conditions the material would be under great pressure between discs 20 and 32, tending to separate them with such force that an excessive end thrust and an abnormal friction
50 would be produced between the adjacent faces 301 of the hubs of gears 7 and 14. The holes 300, however, afford an escape for the said material when under pressure, and
55 thus prevent its getting between discs 20 and 32 and at the same time said holes enable the machine to give warning that it is being loaded beyond its capacity.

60 The liquor discharged through holes 23 in mantle 21 is eventually caught in two receivers 63 and 164, two such receivers being used, because in most cases of separating liquors from granular solid material, it is desired to separate and lead away as much
65 of the liquor as possible, in its pure state, in

the first stage of treatment, and thereafter, in a second stage, to wash off the remaining liquor, which can not be otherwise separated, and lead it off to a separate receptacle, all as will appear more fully hereinafter.

70 Since it is desirable generally to keep the diluted and pure liquors more effectually from commingling, even to a small extent, it will be of advantage to discharge the said diluted and pure liquors in narrow zones
75 spaced preferably some distance apart, as shown in Figures 1 and 2, where to this end the outer mantle 21 is enclosed circumferentially by a shell 302 attached at one end with its flange 303 by bolts 304 to the disc 20 at
80 the small end of mantle 21. The other end 305 of shell 302 is inserted in a groove 306 at the back of the enlarged end 28 of mantle 21. At the zone selected for the discharge of pure liquor the said shell 302 is perforated with a ring of discharge holes 307,
85 spaced close together. A similar circle of holes 308 is provided at the zone selected for the discharge of the diluted liquor. At a zone intermediate to the circles of holes 307
90 and 308 there is provided a division ring 309, separating with its inner edge 313 the space between mantle 21 and shell 302 into two circular chambers, one, 310, for the pure liquor, and the other, 311, at the large end
95 of mantle 21 for the diluted liquor. The inner sectional contour of shell 302, as will be seen from Figure 2, is so shaped that the circles of holes 307 and 308 are at the largest internal diameters of said chambers 310 and
100 311, so that the liquor discharged from holes 23 will flow more readily to the holes 307 and 308, but said contour may be cylindrical if desired. Outside of the division ring 309 the shells of the chambers 310 and 311 are
105 connected by the annular disc 312. The division ring 309 is made a separate part, so that differently shaped rings may be inserted, bringing the division edge 313 at different points along mantle 21, thereby vary-
110 ing at will the position of the zone of separation between the diluted and pure liquors along the slope of conical mantle 21. The insertion of new division rings 309 in the construction shown in Fig. 2, may be accom-
115 plished by making said rings in segmental sections, removing the shell member 302 from the machine after unscrewing its fastening means such as 304, removing the ring
120 fastening means 312 and the ring 309 from the said member 302, and inserting a segmental ring having the desired different thickness. In the case of the modified form of invention shown in Fig. 5, an entirely
125 new shell member 400 having the desired dimensions and disposition of its division rim or edge 313' is substituted for the one in use upon removing the latter member after unscrewing its fastening means 304.
130 Surrounding the large end of the pure liquor

chamber 310 is the inner edge 320 of the stationary deflecting ring 321, having a concave inner face 322, forming a part of the receiver 63. Opposite deflector 321 is the plane wall 323 connected to ring 321 by the semicircular shell 77, see Figure 1, at the top of which is the air vent 76. Extending inward from wall 323 is the circular channel 326 with the end ridge 327. It will be clear from Figs. 1 and 2 there are three receivers 63, 164, and 66, which are respectively provided with the vents 76, 176, and 276, and with the outside circular rims 77, 177 and 277, each being of the same construction, and therefore a description of the outside of receiver 66, will serve for the others. Referring more particularly to the outside of receiver 66, the edges of the semicircular rim or shell 277, as appears from Fig. 3, are continued down vertically as at 278, and provided with flanges 279, resting on forward extensions 80 of frame 1, to which they are secured by bolts 281. Below the center line, the outer edges of said rim or shell 277 are extended as a rectangular plane sheet 324, as shown. The upper semicircular part of receiver 66 above the center line is made removable, being attached to the lower part by bolts 274 passing through flanges 273. The bottom 275 of receiver 66 is left open for the escape of the products of separation.

The diluted liquor chamber 311 at the large end of mantle 21 is surrounded by said stationary receiver 164 similar to receiver 63, with deflecting plate 328 having its inner edge 329 near the largest diameter of said chamber, and its inner concave face 330 connected to the opposite plane wall 331 by said semicircular shell 177. Similarly there is extending from wall 331 the circular channel 333 with end ridge 334. As shown in Figures 1 and 2, the plane of discharge holes 308 falls between ridge 334 and the inner deflector edge 329. The upper semicircular part of receiver 164 is also connected by flanges 173 and bolts 174 to the lower rectangular part having an open bottom 175 and resting with lateral flanges 179 on the extensions 80 of frame 1.

Surrounding the enlarged end 28 of mantle 21 is the inner edge 335 of the conical deflector ring 336, pertaining to the said solids receiver 66 and connected by the semicircular shell 277 above the center line to the front wall 337 and below the center line by the vertical parts 278 and 324, as shown in Figures 1, 2 and 3. The bottom 275 of receiver 66, like the bottoms of receivers 63 and 164, is left open for the escape of the solids, while the part above the center line is also preferably made removable and connected to the lower part by flanges 273 and bolts 274. The said flanges 279 are suitably connected to the said extensions 80 of frame 1, by the bolts 281, as shown. The front

wall 337 has a large central circular opening 338, around the edge of which is bolted the flange 70 of the front plate 58, as previously described.

The operation of this machine, so far as now described, is as follows:

Power being applied to the pulley 12 by a suitable bolt, the quill 5 with attached disc 20 and mantle 21 at the separator end of the machine, are revolved, while gear 14 is coincidentally revolved at the gear end. Gear 14 in turn revolves gear 15 with the attached gear 19, and gear 19 revolves gear 7, with the shaft 9 and the attached conveyer mantle 43 at the separator end, rotation being in the same direction as that of quill 5 and mantle 21, only at the somewhat slower rate, due to the proportions of the gear train 14, 15, 19 and 7. At the same time material to be separated is continuously supplied at a uniform rate through the hose 59, elbow 56 and feed tube 54, issuing in an annular spreading jet over the cone 36 from the expanded tube mouth 55, and in proceeding outward is caught by the inner surface of cone 34, and through frictional contact is driven by centrifugal force to the large end of said cone. At the same time, and since the inner surface of the part 34 is necessarily truly centered from the axis of rotation, if there exists at any plane of rotation a difference in the thickness of material, the hydrostatic pressure due to such difference will cause an equalization of such thickness, so that the material will be distributed to the inner edges of blades 40 in practically equal amounts.

The material delivered to the inner edges of blades 40 as described, is further accelerated by them in a positive manner, and moved outward by centrifugal force, attaining the velocity of their outer circumference 60, at which velocity it is delivered on to the curved surface 61 at the junction of disc 20 with the small end of mantle 21. Frictional contact with 61 still further accelerates the material, carrying it outward and forward into the space 62 between conveyer mantle 43 and screen 24, occupied by the conveyer, helices 44, which now pick it up and screw it forward towards the large end of said screen. The screw like action of the helices 4 is thus caused by their speed being slower than that of the material carried along by friction with the faster rotating surface of screen 24. During this conveying process the bulk of the liquid content of the material is driven out through screen 24 and holes 23 at the small end of mantle 21, aided by air drawn into the interior of conveyer cone 43 by the action of the fan blades 50, which drive it outward through the holes 51 in said cone 43 into the space 62, whence it is driven further out with the liquor through the holes 23, the air aiding the

cleaning process by blowing off liquid films adhering to the solid grains of the material.

Generally the action will be to drive the bulk of the liquor off undiluted by any washing liquid at the small end of mantle 21 up to a point fixed by the position along said mantle of the division edge 313, and chosen to suit the characteristics of the particular material being treated. The pure liquor thus entering the rotating chamber 310 gathers at and is thrown outward from the circle of holes 307 in a plane sheet through the gap 340 between deflector edge 320 and ridge 327. This sheet of liquor strikes the deflector face 322 on a tangent within the plane of rotation, so as to be thrown tangentially against wall 323, and loses by frictional contact with these surfaces most of its energy of motion, so that it comes practically to rest and flows down, escaping either directly at the open bottom 75 or it may strike onto the circular channel 326, and from the sides of said channel it may drip off through said bottom 75. The stilling of the commotion in the liquid in the manner disclosed also permits the air blown in with the liquor to separate out and to escape also at the bottom 75 or at the vent 76 at the top.

The liquor still adhering to the solid particles, after the bulk of the liquor has been driven off in the manner just described, is subjected at the large end of mantle 21 to a wash of water, or other liquid, or steam, supplied through pipe 53, and directed in sprays 317 into the large end of conveyer mantle 43, separated from the rest of the interior space in said mantle by the division plate 318. The wash water thus gathered inside the large end of mantle 43 is forced out centrifugally through the holes 51, through the material treated while washing off the films or liquor from the solid particles, and through screen 24 and holes 23 into chamber 311. From chamber 311 the mixture of liquor and wash water is thrown outward in a thin plane sheet through the gap 341 between the ridge 334 and the inner edge 329 of deflector plate 330, and is deflected tangentially against opposite wall 331, its energy of motion being thereby destroyed as in the case of the pure liquor described above as being discharged into receiver 63. The diluted liquor also flows down in a similar manner, escaping at the open bottom 175 with some air, while some of the air escapes at vent 176.

The solids escaping over the edge of the large end of mantle 21 fly outward in the form of a plane sheet and the particles strike onto the conical surface 336 in a tangential direction, being thereby deflected laterally and caused to strike at an angle against front wall 337, whence they drop downward, some escaping directly through

the open bottom 275, while others drop first onto the inner conical surface 338 of front plate 58 and therefrom down and out at 275.

The injectorlike action of the disc shaped discharge from the circles of holes 307 and 308, respectively through the gaps 340 and 341, will have the effect of causing inward currents of air to pass at each side of said jets and through said gaps, thereby tending to prevent any liquid from escaping outward from the receivers 63 and 164 at these places.

The process of continuously separating the liquors from the solids in a mixture in two stages, with a liquid wash in the second stage, has been herein specified to be carried out in a continuous centrifuge of the horizontal type, because with this type the separate collection of more than two products of separation can be efficiently provided for. In the proposed vertical axis types of centrifuges, the discharged products are, by virtue of the vertical arrangement, necessarily collected in annular receivers arranged one within the other and at the same time enshrouding high class driving mechanism, so as to make the mechanism difficult of access. The difficulty is already serious when only a single liquid receiver is required. The horizontal type of continuous centrifuge, on the other hand, with its separating elements overhung at one side of the high speed bearings, gears and other delicate parts have herein been shown to be specially adapted for a simple and accessible arrangement of separate receivers for more than two products.

When the solids are soluble in the liquor of the mixture, like sugar or salt, by feeding the material cold, less of the solids will generally be carried in solution by the liquor and expelled therewith in the first stage of the liquor separation. The removal of the remaining liquor adhering to the solid particles may thereafter be performed more easily in the second stage with a smaller quantity of hot liquid or steam than with a larger quantity of cold wash with perhaps less waste in dissolved solids.

In the somewhat modified form of the invention illustrated in Figure 5, the construction is substantially the same as that disclosed in Figures 1, to 4, with the following exceptions: The removable partition 309 between the two chambers 310 and 311 has been dispensed with, and the cones or shells 302 enclosing the perforated mantle 21 have likewise been changed in construction, as illustrated. Further, the escape orifice 300 has been somewhat modified and there are other differences, which will now appear in detail.

Referring to the said shells forming the chambers 311 and 310 the pure liquid shell 400 is provided with substantially a cylin-

drical portion 401, and with the flange 402 adapted to be secured by the bolt 304 to the said mantle 21. Washers 350 and 351 are placed on each side of said flange 402 so that the said shell 400 may be adjusted longitudinally of the axis of the mantle 21, by varying the dimensions of said washers 350 and 351. An orifice 403 is provided in said flange or end 402 in order to facilitate the manipulation of the parts.

At its smaller end 354 the said shell 400 is provided with a thin rim 313' which may or may not contact with the cut away substantially cylindrical portion or surface 356, with which the said mantle 21 is provided. This said thin rim 313' serves to prevent the pure liquid from escaping from the chamber 310 into the chamber 311.

The shell 405 which forms the chamber 311 is conveniently rigidly secured to the enlarged end 28 of the mantle 21 by means of the annular groove 306 and other suitable fastenings not shown, so that it likewise rotates with the said mantle 21. Said shell 405 is also provided with a portion 406 similar to the portion 401, and the open end of said shell 405 is provided with a downwardly deflected rim portion 358 to aid in preventing the escape of liquid therefrom. The cylindrical surface 356 of the mantle 21 is made of a sufficient axial length to enable the operator to adjust the rim 313' to suitable distances to effectually separate the pure liquid from the washed liquids. The holes or perforations 307 with which the shell 400 is provided and the holes 308 with which the shell 405 is provided are preferably located at the greatest diameters of said shells, in order to facilitate the discharge of liquid from the chambers 310 and 311.

The open end of the shell 405 extends preferably well over the smaller end 354 of the shell 400 as shown in order to more effectually separate the pure from the impure liquids.

The disc 20 in this said modified form of the invention shown in Figure 5 is separated from the disk portion 32 by the space 319 as in the construction illustrated in Figure 2, but in addition to this said space 319 the disc 20 is provided with the annular groove 360 into which any oil that may collect in the space 319 will be received. In other words, any oil flowing outward from the bearing 10 along the opposing surfaces of the discs 20 and 32, will be caught in the circular groove 360 and from said groove it may readily escape into the holes 300.

It further constitutes an important feature of the invention that there is provided a replaceable separating means such as the partition 309 or the edge 313' shown in Figure 5, for the replaceable feature of these devices enables the operator to readily vary the pro-

portion or pure liquor to be separated out from the impure liquor. The annular groove 360 in Figure 5 is also an important feature of the invention for said groove effectually prevents oil from flowing through the space 319 into the material being treated and thus maintains the purity of said material to a very high degree.

Of course, excellent results can be attained without the foregoing features just mentioned, but the presence of such features in a machine of this character greatly adds to its efficiency.

It is obvious that those skilled in the art may vary the details of construction, as well as the arrangement of parts without departing from the spirit of the invention, and therefore, I do not wish to be limited to the above disclosure except as may be required by the claims.

What is claimed is:

1. In an apparatus for continuously separating a liquid from a solid material containing the same, the combination of means for expelling a portion of the liquid by centrifugal force; means for treating the partially depleted material with a fluid to aid in expelling another portion of said liquid from said material; means for acting upon said other portion by centrifugal force to expel the liquid while being so treated; removable means for varying the proportion of liquid thus treated; means for receiving each of said liquid portions in a separate container; means to facilitate the expulsion by centrifugal force of each of said portions from said containers into separate receptacles; and means for separately recovering the individual liquid portions thus produced from said receptacles.

2. In an apparatus for continuously separating a liquid from a solid material containing the same, the combination of means comprising a rotating foraminous surface for expelling a portion of the liquid by centrifugal force; means for treating the partially depleted material with a fluid to aid in expelling another portion of said liquid from said material; means comprising a second foraminous surface rigid with said first named surface for acting upon said other portion by centrifugal force to expel the liquid while being so treated; a plurality of containers for separately receiving the individual liquid portions thus produced; removable means for varying the proportion of liquid thus treated; means to facilitate the expulsion of said portions from said containers by centrifugal force; and means for collecting said portions for use.

3. In an apparatus for continuously separating a liquid from a solid material containing the same, the combination of means comprising a rotating foraminous surface for subjecting said material to the action of

centrifugal forces; a second foraminous surface rigid with said first named surface also adapted to subject said material to the action of centrifugal force; removable means dividing said surfaces the one from the other to vary at will the relative proportions of liquid passing through said first and second named surfaces; separated collecting chambers associated with said surfaces; means to facilitate the expulsion of liquid from said chambers through the action of centrifugal forces; and screw means associated with said surfaces for continuously moving said material while said centrifugal forces are acting.

4. In an apparatus for continuously separating a liquid from a solid material containing the same, the combination of means comprising a rotating foraminous surface for subjecting said material to the action of centrifugal forces; a second foraminous surface rigid with said first named surface also adapted to subject said material to the action of centrifugal force; removable means dividing said surfaces the one from the other to vary at will the relative proportions of liquid passing through said first and second named surfaces; separated collecting chambers associated with said surfaces; means to facilitate the expulsion of liquid from said chambers through the action of centrifugal forces; a liquid receiving means associated with each collecting chamber; and screw means associated with said surfaces for continuously moving said material while said centrifugal forces are acting.

5. In an apparatus for continuously separating a liquid from a solid material containing the same the combination of means comprising a rotating foraminous surface for subjecting said material to the action of centrifugal forces; a second foraminous surface rigid with said first named surface also adapted to subject said material to the action of centrifugal force; removable means dividing said surfaces the one from the other to vary at will the relative proportions of liquids passing through said surfaces; separated rotating collecting chambers rigidly associated with said surfaces; an annular liquid receiving means associated with each collecting chamber; and screw means associated with said surfaces for continuously moving said material while said centrifugal forces are acting.

6. In an apparatus for separating a liquid from a solid aggregate material containing the same, the combination of means comprising rotating foraminous surfaces adapted to pass liquids and having a substantially horizontally disposed axis in common; means to vary at will the relative proportions of liquids passed through said surfaces; a plurality of liquid collecting chambers rotating with said surfaces having

exits; a receiving means associated with each chamber in register with said exits; and rotating means for forcibly moving said material longitudinally of said axis.

7. In an apparatus for separating a liquid from a solid aggregate material containing the same, the combination of means comprising rotating foraminous surfaces adapted to pass liquids and having a substantially horizontally disposed axis in common; means to vary at will the relative proportions of liquids passed through said surfaces a plurality of liquid collecting chambers rotating with said surfaces each having a plurality of exits; an annular receiving means associated with each chamber in register with said exits; and a rotating screw means for forcibly moving said material longitudinally of said axis.

8. In an apparatus for separating a liquid from solid material associated with the same, the combination of a plurality of foraminous rotating surfaces adapted to pass liquids and having a substantially horizontally disposed axis in common; means to vary at will the relative proportions of liquids passed through said surfaces; means to rotate and move said material longitudinally of said axis beneath said surfaces; a ring like collecting chamber rotating with and connected to each of said surfaces; an annular receiving chamber connected to each of said collecting chambers; and means to receive said solid material after its removal from beneath said surfaces.

9. In an apparatus for separating a liquid from solid material associated with the same, the combination of a plurality of foraminous rotating surfaces adapted to pass liquids having a substantially horizontally disposed axis in common; means to rotate and move said material longitudinally of said axis beneath said surfaces; means to treat said moving material while being rotated with a fluid under pressure; a ring like collecting chamber rotating with and connected to each of said surfaces; means to vary at will the relative proportions of liquids passed through said surfaces; an annular receiving chamber surrounding and connected to each of said collecting chambers; and means to receive said solid material after its removal from beneath said surfaces.

10. In a centrifuge of the continuous horizontal type, adapted to separate liquors from granular aggregates the combination of a pair of concentrically disposed foraminous cones, one within the other, spaced apart; a substantially horizontal shaft, about the axis of which said cones revolve; means for rotating said cones about said axis as a center; a screw conveyer on the inner one of said cones adapted to move the said material over the interior surface of the outer foraminous cone from the small to the large

end by a difference in the rotation of said cones; means, integral with said outer cone and rotating therewith adapted to gather and expel outward in a narrow zone, pure liquor separated at the small part of said outer cone; a receiver for the liquor thus expelled at said zone; a second means, integral with said outer cone, adapted to gather and expel outward, in a narrow zone spaced apart from said first named zone, diluted liquor separated at the large part of said outer cone; a second receiver for the said diluted liquor; a removable partition for varying at will the relative proportions of diluted and undiluted liquors thus obtained; and a third receiver for the washed solids discharged over the large end of said outer cone.

11. In an apparatus for continuously separating a liquid from a solid material, containing the same, the combination of means for expelling a portion of said liquid by centrifugal force; replaceable means to vary at will the amount of liquid so expelled; means to collect said expelled portion; and by centrifugal force project the same in a limited zone; and a receiver having an inlet registering with said zone to receive said expelled portion of liquid.

12. In an apparatus for continuously separating a liquid from a solid material containing the same, the combination of means for expelling a plurality of portions of said liquid by centrifugal force; means to vary at will the relative proportions of the portions of liquids thus expelled; rotating means to collect said expelled portions and by centrifugal force project the same in limited zones; and separate receivers each having an inlet registering with one of said zones to receive said expelled portions of liquid.

13. In an apparatus for continuously separating a liquid from a solid material containing the same, the combination of means for expelling a plurality of portions of said liquid from said material; means to vary at will the relative proportions of the portions of liquids thus expelled; a plurality of rotating means for segregating and recovering

said separate liquid portions; and means for collecting and segregating any oil that might otherwise find its way into said material.

14. In an apparatus for continuously separating a liquid from a solid material containing the same, the combination of means for expelling a plurality of portions of said liquid from said material; means to vary at will the relative proportions of the portions of liquids thus expelled; a plurality of rotating means for segregating said separate liquid portions; a plurality of annular means for receiving said segregated liquid portions; and means comprising an annular groove for collecting and segregating any oil that might otherwise find its way into said material.

15. In an apparatus for continuously separating a liquid from a solid material containing the same, the combination of a cone shaped foraminous mantle through which said liquid may be expelled by centrifugal force; a plurality of rotating collecting cone shaped chambers surrounding said mantle for the reception of the expelled liquid; means to vary at will the relative proportions of liquids passed through said mantle and collected by said chambers; and stationary means for receiving and recovering liquid from said chambers.

16. In an apparatus for continuously separating a liquid from a solid material containing the same, the combination of a cone shaped foraminous mantle through which said liquid may be expelled by centrifugal force; a plurality of rotating collecting cone shaped chambers surrounding said mantle for the reception of the expelled liquid; means to vary at will the relative proportions of liquids passed through said mantle and collected by said chambers; annular shaped means for receiving and recovering liquid from said chambers; and means for delivering said liquid from said chambers into said receivers in the form of relatively thin rings.

In testimony whereof I affix my signature.

HANS C. BEHR.