

May 19, 1942.

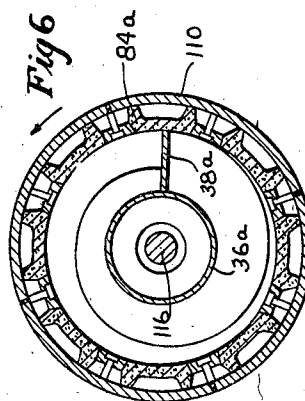
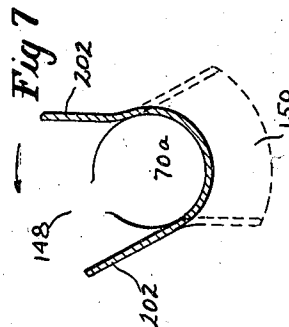
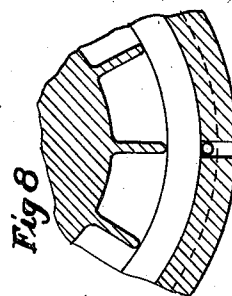
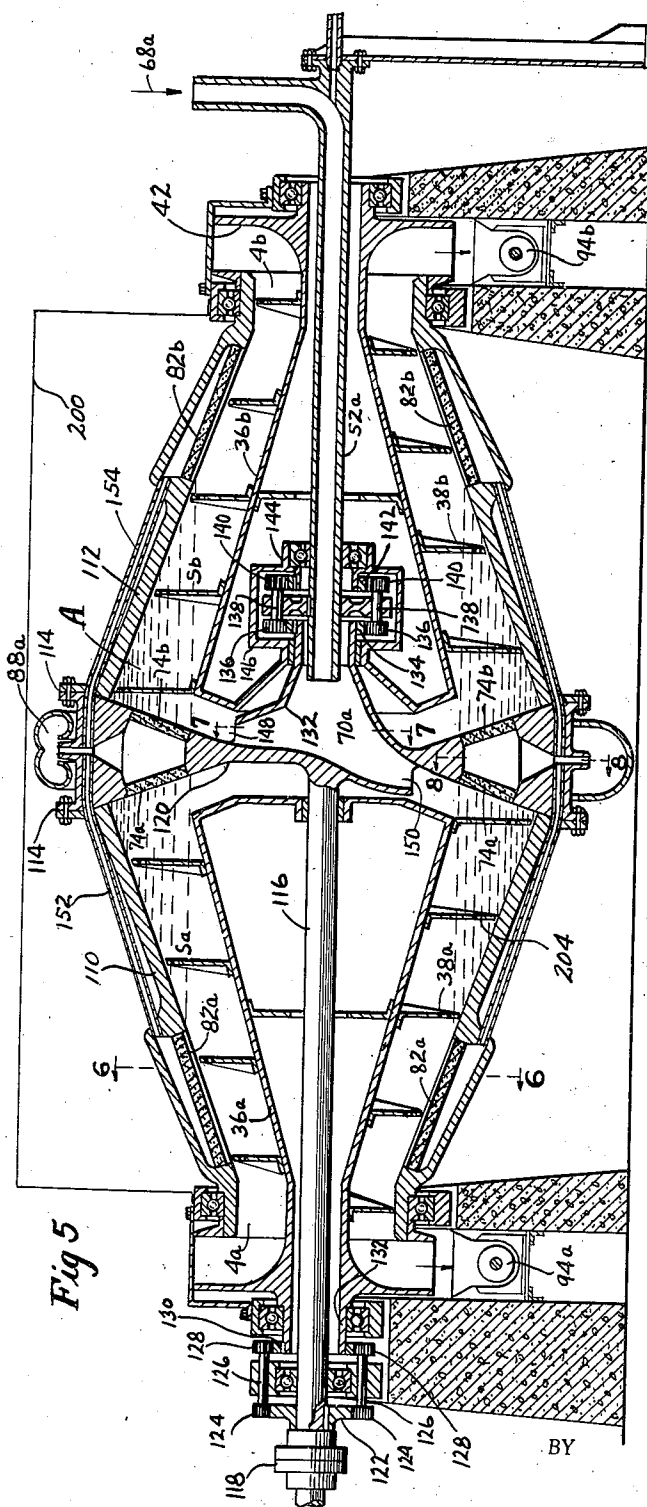
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2,283,457

CENTRIFUGAL SEPARATOR

Filed Feb. 19, 1938

4 Sheets-Sheet 2



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4 Sheets-Sheet 3

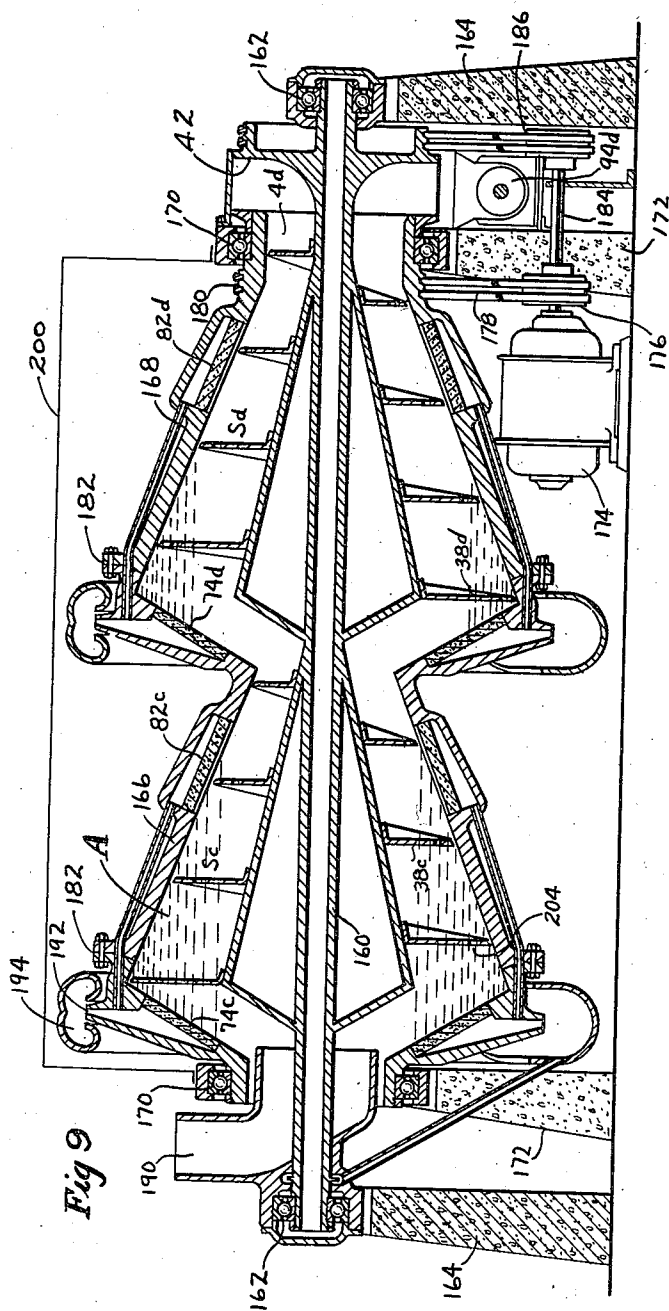


Fig 9

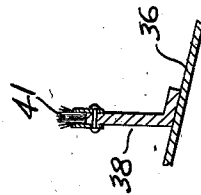


Fig 11

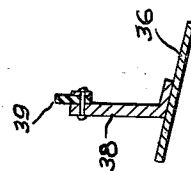


Fig 10

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2,283,457

CENTRIFUGAL SEPARATOR

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Application February 19, 1938, Serial No. 191,466

11 Claims. (Cl. 210—69)

My invention relates to a new and useful centrifugal separator of the type adapted for separating the liquid from the solid components of the material to be treated, and it relates more particularly to a centrifugal separator which is adapted for continuous operation as distinguished from centrifuges capable only of "batch operation," that is, a centrifugal separator in which the material to be treated is continuously fed into the separator and the resultant products are constantly ejected therefrom, without interruption, greatly to increase the utility and efficiency of the apparatus.

My invention still further relates to a centrifugal separator which is equally efficient whether the solid contents of the mixture to be treated be of a crystalline or of a fibrous nature.

My invention still further relates to a centrifugal apparatus in which varying degrees of clarification and dehydration may be obtained and in which a relatively high degree of dehydration and clarification is accomplished.

My invention still further relates to a centrifugal separator which also possesses the advantages of separators operated on the pressure or vacuum principle.

My invention still further relates to a centrifugal separator which may be mounted horizontally or vertically, as desired, without material change and without departing from the principle of construction or operation.

My invention still further relates to a centrifugal separator which may be composed of a plurality of units which can be mounted "in series" or in which a pair of units can be mounted to co-act as a single separator to double the capacity, depending on the degree of the dehydration and clarification desired and also varying according to the degree of fluidity or viscosity of the material to be treated, with reference to its consistency as well as to the relative percentages of the liquid and solids of said material.

My invention still further relates to a centrifugal separator which is so constructed and mounted as to minimize or perhaps entirely eliminate the gyration or radial, eccentric thrust which is usually attendant upon the extreme high speeds at which these units are run.

My invention still further relates to a centrifugal separator in which the shell which receives the material to be treated is provided with an internal, scraping device, and in which the shell and the scraping device are revolved at the same or at different speeds by a single driving element,

the movement of said scraping device being at an angle to the line of centrifugal force acting upon the material being treated.

My invention still further relates to a centrifugal separator including primary and secondary filtering surfaces spaced or separated by an imperforate section, said primary filtering surface being disposed at a relatively small angle with respect to the line of centrifugal force of said separator, while said secondary filtering surface is disposed at a relatively great angle with respect to the line of centrifugal force so that the material to be treated, while still possessing relatively large liquid content, is tangentially thrown against the primary filtering surface and so that the material, after having lost some of its liquid content, is pressed directly, or almost so, against the secondary filtering surface.

My invention still further relates to a new and useful centrifugal apparatus which embodies self-contained means for occasional flushing of the internal parts of the separator.

My invention still further relates to a centrifugal separator of a generally frusto-conical form in which a filtering element is disposed in proximity to the base of the conical structure, and in which the material to be treated is fed through the opposite end of the machine directly to or against said filtering element, with the rotary, scraping element impelling the solid contents in the opposite direction or towards the head of the cone.

My invention still further relates to a centrifugal separator which includes means for automatically and effectively disposing of the separated liquids and solids without any interruption.

My invention still further relates to a centrifugal separator which is equally effective whether the solid contents of the material to be treated are of a greater or lesser specific gravity than that of the liquid from which they are to be separated.

My invention still further relates to the novel method of separating and clarifying the material to be treated as the same is carried out in my novel apparatus.

In the accompanying drawings I have illustrated three forms of my invention, all of which utilize the same principle, and in all of the illustrations I have shown my centrifugal apparatus as horizontally disposed, but it is to be understood that I am not limited to horizontal mounting.

Fig. 1 represents a vertical cross-section of a

centrifugal apparatus embodying my invention.

Fig. 2 represents a left hand end view of Fig. 1.

Fig. 3 represents, on an enlarged scale, a section on line 3—3 of Fig. 1.

Fig. 4 represents a section on line 4—4 of Fig. 3.

Fig. 5 represents a view similar to Fig. 1 showing a modified form of my invention.

Fig. 6 represents a section on line 6—6 of Fig. 5.

Fig. 7 represents a section on line 7—7 of Fig. 5.

Fig. 8 represents a section on line 8—8 of Fig. 5.

Fig. 9 represents a view similar to Figs. 1 and 5 showing a still further modified form of my invention.

Figs. 10 and 11 represent fragmentary sectional views showing modified forms of construction.

Fig. 12 represents a view similar to Figs. 1, 5 and 9 showing a still further modified form of construction.

Fig. 13 represents a section on line 13—13 of Fig. 12.

Referring to the drawings in which like reference characters represent like parts, and referring more particularly to Fig. 1, my novel separator generally consists of the substantially conical shell 2 which terminates at its tapering end in the outlet 4 and which is closed at its flared end or base by the dished or concave section 6 which is suitably secured thereto as at 8 so that the conical section 2 and the dished base section 6 are integrated to rotate as a unit. The integrated shell is supported at its opposite ends by the bearings 10 mounted in the housings 12 which are provided with the lug extensions 14, which in turn, are mounted on rubber units 16 and are clamped to the pedestals 18 by the anchor bolts 20. The integrated shell, which is driven directly so that it serves as its own shaft, is rotated by the motor 22 which has the coupling flange 24 keyed on the motor shaft 26. 28 designates driving studs half of which are mounted in the extension support 30 of the dished base portion 6. 32 represents rubber gromlets supporting the ends of the studs 28. The extension support 30 is keyed at 34 to the dished base portion 6 as best seen from Figs. 1 and 3.

Within the conical shell 2 I position a screw ejector or scraper S formed of the substantially conical body 36 and the screw blade 38 for the purpose of scraping or impelling the solids that collect on the inside of the shell 2 in the direction of the arrow 40 towards the opening 4, it being noted that the tapered end of the shell 36 terminates in the ejector lip 42. The shell 36 is mounted on the bearings 46 and 48, it being noted that the bearings 46 rest on the pedestal 50 and that the bearings 48 are supported between the inlet pipe 52 and the hub 54 which, as will be clearly seen from Fig. 1, is an integral part of the screw shell 36. In order to drive the screw scraper S by the same means that drive the shell 2 and at the same time to drive it independently of the shell 2, that is, at the same, greater or lesser speed as desired, I provide the mechanism best shown in Figs. 1 and 3 which consists of the stationary ring gear 58 which is mounted on the flange 59 which is an extension of the bearing housing 12. The ring gear 58 meshes with the pinions 60 mounted on the shaft 62 which pass through the dished base 6 and which

carry the pinions 64 which in turn mesh with the ring gear 66 on the hub 54 which is a continuation of the body portion 36 of the screw ejector 5. As the shafts 62, supporting the pinions 60, rotate with the base 6, rotary motion is imparted to the pinions 60 by riding over the stationary ring gear 58 and this transmits rotary motion to the pinions 64. By varying the ratio of the pinions 60 and 64 and the ring gears 58 and 66 I can vary the speed of rotation of the screw ejector at will. While I have shown this method of controlling the speed of the screw ejector S, it is understood that other means of variable speed drive may be employed as illustrated hereinafter. The inlet pipe 52 is adapted to receive the material to be treated in the direction of the arrow 68 and it discharges the material into the receiving chamber 70 which is provided with ports 72 through which the material is ejected into the shell 2 or into the space between the body 36 of the screw ejector S and the inner surface of the conical shell 2, it being understood that the receiving chamber 70 is an extension of the dished base 6 and rotates therewith. In the dished base 6 I provide the filter elements 74 against which the material is tangentially impacted by centrifugal action for the purpose of primary filtration so that some of the liquid, under the pressure of centrifugal force, passes through the filter element 74 into the chamber 76 which communicates through the port or outlet 78 with the annular trough 80. The annular trough 80 is provided with an opening 81 (Fig. 2) through which the liquid, which has filtered through the element 72, may be discharged to be disposed of in any desired manner. The balance of the material, including the remaining liquid and solid contents is fed and held against the inner surface of the shell 2 between the filter element 74 and the filter element 82. As more material is fed into the shell 2 and as it rotates, the liquid is secondarily filtered through the element 82 and it passes into the chamber 84 which communicates through the outlet 86 with the second annular trough 88 which may be suitably supported at 90 and from which the water is allowed to emerge in any desired manner. As the liquid filters through the filtering elements 74 and 82, the solid contents, under the pressure of centrifugal action, form a film along the inner surface of the shell 2 and the blades 38 of the screw ejector S scrape the film thus formed and impel it forwards towards the opening 4 from which it is discharged past the lip 42 in the direction of the arrow 92 into any desired receptacle for removal, or onto a conveyor belt, or screw conveyor mechanism 94, the details of which are not shown or described as any conventional conveying mechanism can be employed. For the purpose of rigidity I provide the bracket 96 for supporting the outer portion of the inlet pipe 52.

In order to provide for occasional flushing or washing of the inside of the shell 2 I provide the inlet 98 through which water or other washing medium is admitted into the inlet pipe 52 to be discharged therefrom into the receiving chamber 70, and I also provide a plurality of pipes 100 through which the same washing or flushing medium may be discharged into the chamber 102 formed within the conical body 36 of the screw ejector S by means of the partition wall 104. The funnel-shaped structure thus produced is provided with the slots or ports 106 through which the flushing medium flowing through the pipes 100 may emerge into the space between the

ejector body portion 36 and the area corresponding with, and adjacent to the filter element 82. In practice I prefer to use three pipes 100 and to inject air, water and steam, respectively, and the pipes 100 are preferably slideably mounted in the brackets 101 so as to permit of longitudinal adjustment of their respective discharge nozzles. Where, in the process of treating the material it is found necessary to add catalysts or other physical or chemical reagents, it is possible to introduce them through the pipes 100. The partition 104 is in the form of an annular member which, not only serves to define a compartment for directing the flow of the washing medium from the pipes 100, but also constitutes a brace or reinforcement for the shell 36 of the screw ejector S.

In Fig. 5 I have shown a modified form of invention which utilizes the same principle of operation and substantially the same construction except that, in order to double the capacity, I utilize two shells 110 and 112, corresponding to the shell 2 shown in Fig. 1, and I omit the dished base 6 and its adjuncts and assemble the two shells 110 and 112 with their large ends abutting and secure the same by any suitable means as at 114. Within the shells 110 and 112 I position screw ejectors Sa and Sb which also are identical in operation and substantially identical in structure with the screw ejector S shown and described in Fig. 1. In order to drive the unit shown in Fig. 5 I utilize the shaft 116 which may be driven at 118 from any desired source of power and which, through the central connecting plate 120, drives the shells 110 and 112 as a unit. The screw ejector Sa is driven by the gear 122 which is rotatable with the shaft 116 and which engages the pinions 124 on the shafts 126 which also carry the pinions 128 which mesh with the ring gear 130 which is carried by the extension 132 of the body portion 36a of the screw ejector Sa. This construction serves to rotate the screw ejector Sa and, as previously stated, by varying the different ratios of gears and pinions the speed of the screw ejector Sa can be controlled. The screw ejector Sb is driven by substantially the same mechanism described in connection with the screw ejector Sa except that the rotation of the screw Sb is indirectly effected through the rotation of the shells 110 and 112. Thus, the spout extension 132, which is integral with the central connecting plate 120 constitutes a bearing and a support on which is mounted a ring gear 134 which meshes with the pinions 136 on the shafts 138 which also carry the pinions 140 which mesh with the ring gear 142 which is carried by the hub 144 which is carried by the extension 146 which forms part of the body portion 36b of the screw ejector Sb. Again, by varying the different ratios, the speed of the ejector Sb can be controlled independently of the shells 110 and 112 and as a matter of practice it is always synchronized with the rotation of the screw ejector Sa. In this construction, the material to be treated is fed into the pipe 52a in the direction of the arrow 68a and it is discharged into the chamber 70a which is the same as the chamber 70 in Fig. 1 and which is provided with the port 148 for delivering the material to be treated into the shell 112 and with the port 150 for delivering material to be treated in the shell 110. The material to be treated is then thrown against the filtering elements 74a and 74b and then against the secondary filtering elements 84a and 84b, it being understood that the

water passing through said filtering plates ultimately finds its way into the annular trough 88a, through the pipes or outlets 152 and 154, it being further understood that the annular trough 88a is provided with any suitable means for disposing of the liquid therein and which need not be shown or described. The solids forming on the inside surface of the shells 110 and 112 are scraped by the blades 38a and 38b of the screw ejectors Sa and Sb in the same manner heretofore described to be ejected through the openings 4a and 4b onto the screw ejectors 94a and 94b or any other suitable means.

In Fig. 9 I have shown a still further modified form of my invention in which I utilize two units mounted in series, that is, in such a manner that the material is treated primarily in one unit and secondarily and successively in a second unit to be discharged therefrom. In this construction the material to be treated is fed at one end and, after passing successively through the two or more units that may be used, it is discharged at the other end of the last unit through which it passes, it being understood that, while I have shown only two units, it is within the scope of my invention to utilize any number of such units so mounted. In this construction I utilize a single shaft 160 which is mounted in any suitable bearings 162 suitably supported by pedestals 164. The shaft 160 extends through the number of units that may be used, such as 166, 168, etc., said units being mounted in suitable bearings 170 on suitable pedestals 172. Mounted on the shaft 160 and rotatable therewith are the screw ejectors Sc and Sd which, except for this difference, are identical with the screw ejectors heretofore described. The units 166 and 168 are provided with the filtering elements 74c and 74d corresponding to the filtering elements 74 in Fig. 1 and the secondary filtering elements 82c, and 82d can be added to the structure of Fig. 9 or can be left out, at will. In this construction I drive the shells 166 and 168 from the motor 174 which drives the pulley, gear, or the like, 176, to actuate the belts or other driving connections 178 which engage the unit 168 in any suitable manner as at 180, it being understood that the units 166 and 168 are suitably integrated as at 182 for unitary rotation. The motor 174 also turns the stub shaft 184 which actuates the driving connections 186 of the shaft 160 to turn the screw ejectors Sc and Sd. Again in this construction, by varying the sizes of the pulleys or other driving mechanisms employed, I can drive the shaft 160 and hence the screw ejectors Sc and Sd independently of and at a different speed from the units 166 and 168. In this construction the material to be treated is fed through the inlet 190 and at first enters the shell 166 where some of the liquid is initially filtered through the filter elements 74c and passes through the outlet 192 into the trough 194 to be ejected therefrom in any suitable manner. The remaining material then passes into the second unit 168 and is actuated in the direction of said unit by the screw ejector Sc and, in the unit 168, the remaining moisture is filtered through the secondary filtering plate 74d and the remaining material is ejected by the screw Sd through the opening 4d onto the conveyor 94d. 200 designates any suitable cover which covers all of the machine or as much as is necessary, either for purposes of appearance or for preventing possible splash.

If desired, the edges of the blades 38, 38a, 38b,

33c and 38d can be provided with rubber tips or with bristles or other suitable medium for facilitating the scraping process of the screw ejectors if the nature of the material to be treated so requires.

The filtering elements 74 and 82, or 74a, 74b, 82a, 82b or 74c, 74d, can be made of any desired design, again depending on the nature of the material to be used, but, in cases where the material to be treated is fibrous or carries solid particles in colloidal suspension, I find that the filtering elements mentioned are preferably made in the form of a hard packed porous substance such as carborundum or similar porous "stone" construction which effects perfect separation and only permits a clear and highly purified liquid to pass therethrough along the lines of pressure filters, the centrifugal action on the liquid constituting the necessary pressure.

With particular reference to the receiving chamber 70 into which the material to be treated is discharged from the pipe 52 in Fig. 1, or its equivalent 52a in Fig. 5, I wish to point out that the walls of the chamber 70 curve outwardly thus presenting no obstruction to the flow of the material to be treated, and that the chamber 70, being integral with the dished base 6 in Fig. 1, or the connecting plate 120 in Fig. 5, rotates therewith so that the material reaching the chamber 70 is allowed free passage and is subject to immediate centrifugal action to discharge the same through the ports 72, 148 and 150 against the revolving plate 6 or 120 which automatically throws the material out radially against where the material impacts against the filtering elements substantially tangentially. It will also be seen from Fig. 7 that the walls 202 of the receiving chamber 70 or 70a are flared so as to constitute no obstruction whatsoever and thus prevent bulky solids, such as rags, strings, pieces of paper, or the like, that may be in the material to be treated from catching on and obstructing the port and thus insuring continued satisfactory operation. In order to produce this type of discharge port 72, 148 or 150 I find that only one, and at the most two, oppositely disposed ports can be advantageously constructed.

The ejector screw not only serves to propel the residue of the material treated towards the discharge openings 4, 4a, 4b or 4d but also serves to retain and retard the material when it first impinges upon it after leaving the chamber 70 and the adjacent filtering element, as well as during the progress of the material from the enlarged end of the shell towards the tapered end thereof. While the moisture is preliminarily extracted from the material by the initial filtering element 74, and while the material is progressing towards the secondary filter 82, mechanical separation takes place while the material is travelling along the imperforate portion of the shell. When the material has progressed towards the secondary filter portion 82, the remaining moisture is extracted while the solids or relative solids are propelled towards the discharge opening 4.

While the principle of structure is the same in all the forms I have illustrated, I shall, for convenience, only refer to Fig. 1 in which it will be seen that my novel centrifugal separator can be divided generally into three zones of operation comprising the feeding of the material and its impingement upon the initial filtering element 74, its travel through or along the imperforate section of the shell or basket, and finally

its secondary dehydration along the secondary filtering element 82. Thus the liquid mixture thrown against the primary filtering element 74 progresses on to the imperforate section of the shell 2 and I so regulate my feeding in relation to the consistency of the mixture to be treated and the nature of the filtering elements as to have, at all times, a predetermined volume of material which is approximately as shown by the lines A in which position the centrifugal action causes the solids to separate from the liquids forming a layer inwardly therefrom, and it will be seen that, while this process of separation is taking place, the separated or clear liquids at the innermost portion of the mixture have access to the filtering elements 74 and 82 so that filtering as well as mechanical separation are carried on simultaneously. In this connection I want to point out that the rotation of the screw ejector S is so regulated with respect to the rotation of the shell as to predetermine the length of time during which the mixture is subjected to centrifugal separation as well as primary and secondary filtration before the residue is ejected at the outlet 4. Thus, assuming the outer shell to rotate at 1500 R. P. M., and assuming that the screw ejector S is rotated at 1501 R. P. M., it would mean that the material is given one minute in which to traverse the entire length of the separator from the filter element 74 out to the discharge opening 4. Similarly, if the screw shell is made to rotate at 1502 R. P. M., it means that the material would traverse the entire length of the centrifugal separator in one-half minute. Conversely, if the outer shell 2 is rotated at 1500 R. P. M., and the screw ejector S is rotated at 1500 $\frac{1}{2}$ R. P. M., for instance, it means that the material is allowed six minutes in which to traverse the length of the centrifugal separator and is hence subject to a longer period of mechanical separation and simultaneous filtration. It is of course understood that the rate at which the material is fed through the pipe 52 is controlled accordingly. The consistency of the mixture, that is, the proportion of solids to liquids therein, as well as the degree of dehydration desired are taken into consideration in determining the speeds at which the machine is operated. To assist in this control I provide the blades 38 of the screw shell 36 (and corresponding blades in the other figures) with a suitable number of apertures 204 so that, while the material is being retained for a predetermined length of time against the imperforate section of the shell to effect mechanical separation, the liquid contents forming the inner layer are permitted to flow in either direction through the apertures 204 in the blades 38 towards the filtering elements 74 and 82. It will also be noted that instead of having an ordinary ejector screw I form my ejector screw S in the nature of the conical shell 36 concentric with the shell 2 of the separator so as to form a confining chamber in which the material is subjected to filtration and mechanical separation. Also, it will be seen that the movement of the ejector screw is from the enlarged to the tapered end of the separator, that is, against or at an angle to the radial lines of force inherent in centrifugal action so that the ejection of the solids is effected by positive mechanical action independent of and working against centrifugal force thus permitting complete mechanical separation and dehydration. If, as stated, it is desired to provide the blade

of the screw ejector with any special scraping or brushing device, it can be done as illustrated in Figs. 10 and 11 in which a rubber edging 39 is suitably secured to the blade 38 of the screw ejector 35 and in which an edging of brush bristles or the like 41 is similarly secured to the blade 38 of the screw shell 36. It is to be understood that the edging 39 or 41 or its equivalent may be so applied to the blades of the screw ejectors shown in the other figures as well, but I prefer to secure the edgings 39 and 41 in a detachable manner for replacement.

In Fig. 12 I have shown a still further modified form of construction in which I use the shells 212 and 214 which abut at their large ends, and in which I utilize the two juxtaposed filtering elements 216 and 218 which are preferably in the nature of a carborundum stone or similar homogeneous reticulated amorphous material, as distinguished from perforated metal plate with or without a fabric covering, or ordinary conventional mesh screens. In this construction the shells 214 and 216 are suitably supported on bearings 220 on the pedestals 224. The shells 216 and 218 are integrated as at 226 and are driven by the motor 228 through the sprocket chain 230 which engages a suitable sprocket wheel 232. On either of the shells 216 and 218, as on the shell 214, I provide a sprocket wheel 234 over which travels the sprocket chain 236 to turn the shaft 238 which carries the sprocket wheels 240 over which travel the sprocket chains 242 which engage sprocket wheels 244 carried by the hubs 246 of the inner screw ejectors SE and SF to rotate the latter within the shells 212 and 214. The screw ejectors SE and SF are provided with the blades 38e and 38f which may or may not be provided with the edging illustrated in Figs. 10 or 11 and which are otherwise identical in structure and function to the screw ejectors S to SD heretofore described. 248 designates inlet pipes for admitting the material to be treated, said pipes being suitably supported in the bearings 250 on the pedestals 252. While I have shown two inlet pipes 248 which lead to a common outlet 254, it is obvious that I can feed through one or through the other independently or simultaneously and that, in some cases, one of the pipes 248 may be sufficient. The material to be treated is discharged through the port 254 at a point near the junction of the two shells 212 and 214 or at the point of maximum diameter and hence maximum centrifugal force. The material thus discharged is thrown centrifugally against the filter elements 216 and 218 and the liquid passing through said filtering elements by the pressure of centrifugal force flows into the chambers 258 from which, through suitable openings, the liquid flows into the annular trough 260 to be discharged therefrom in any desired manner. The screw ejectors SE and SF work in opposite directions, that is, from the central enlarged junction of the two shells 212 and 214 to their respective tapered ends to discharge the residuary solids through the openings 4e and 4f into any suitable conveyor mechanisms 94e and 94f. The inlet pipes 248 are preferably supported by any desirable brackets 96e and 96f and are also provided with the flushing inlets 98e and 98f. The distinguishing feature of this form of construction is the juxtaposition of the filtering elements 216 and 218 which form the major part of the enlarged central portion where the greatest centrifugal action takes place and which, by being so disposed, and by constituting such a relatively

large surface at the central portion, serves to permit of a very great degree of dehydration, concomitant with the mechanical separation, so that the residuary solids propelled by the screw ejector blades 38 and 38f are effectively and almost completely dehydrated depending on the nature of the material being treated and the length of time which it is allowed to tarry within the shells 212 and 214. In this construction the rotation of of the screw ejectors SE and SF with respect to the shells 212 and 214, as well as the rate of feeding through the inlets 248 is also suitably controlled in the manner hereinabove explained.

With reference to the various filtering elements I have illustrated I wish to point out that the filtering elements heretofore in use, and which have consisted of perforated metal plates with or without cloth coverings or of wire mesh screens also with or without cloth covering, have not been practical since, if no cloth covering is used, it is impossible to make the mesh of the wire or the perforations of the plate small enough to prevent the passage of colloidal and near colloidal particles in suspension, and that, where we find woven cloth in one or more layers in order to rest the woven or colloidal particles, the construction was not only expensive in assembly but also in maintenance due to the fact that the abrasive action of particles against cloth, particularly under repeated rotation, resulted in excessive wear and tear on the cloth coverings thus used and necessitated frequent replacement. Furthermore, under the stress of centrifugal force it is not practical to use wire mesh screens with or without the cloth covering for the reason that additional exterior support for such a filter is necessary. The reticulated or porous homogeneous stone-like structure of my filter constitutes a rigid member which needs no support, which can be easily fed into the place provided for it in the shell of the filter, which is porous enough to permit the flow therethrough of the clear pure liquid but the pores of which are small enough to prevent the passage of any particles in suspension even if such particles be of colloidal size and finally it possesses the advantage of continuing to be effective even under the action of abrasion at least until the filter has been worn down so thin as not to be able to stand the pressure, at which time the replacement of the worn filter by a new one is very simple. In the drawings illustrating the invention I have not shown any special way of mounting the filtering elements, nor have I illustrated the manner in which they can be removed or installed since any mechanical expedient can be used. Thus the cover plate over the chamber 84 can be made removable from the rest of the casing 2 (see Fig. 1) to afford access externally to the filtering element 82 or the filtering element 82 can be installed internally by removing the screw chamber 35. In other words the filtering elements may be introduced into place and held there by any desired expedient.

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

1. A centrifugal separator, comprising a rotatable shell, one end of which is larger than the other, a closure for the larger end of said shell provided axially with a concave surface and with a perforate section adjacent to its periphery, a second perforate section adjacent to the smaller end of said shell, a coaxial inlet conduit entering the smaller end of said shell and

terminating in spaced relation with the central portion of said concave surface, to cause material being treated to enter said shell and impinge against said concave surface, means within and rotatable with respect to said shell to propel material towards the said smaller end, an outlet from said smaller end, and means to rotate said shell and said propelling means at different speeds.

2. A centrifugal separator, comprising a substantially conical rotatable shell provided with a concave surface in its larger end, perforate sections adjacent to the opposite ends of said shell, one of which comprises a section of said conical surface, liquid outlets protected by and leading from said perforate sections, an inlet and a solids outlet leading into and from the larger and smaller ends of said shell, respectively, and a spiral screw in substantially uniform engagement with and rotatable at different speeds with respect to said conical surface, to propel the material from the larger end towards the smaller end of said shell.

3. A centrifugal separator, comprising a rotatable shell having a continuously conical inner surface, a conduit for discharging the material to be treated axially into the larger end of said shell, a discharge opening at the smaller end of said shell, an intermediate liquid outlet, a conical screw in substantially uniform engagement with the said inner surface for propelling the residue of the material treated towards said discharge opening, and means to rotate said shell and said screw differentially.

4. A centrifugal separator, comprising a rotatable shell having a continuously conical inner surface, a conduit for discharging the material to be treated axially into the larger end of said shell, a discharge opening at the smaller end of said shell, a perforate section of said conical surface operative to permit the escape of liquid, a conical screw in substantially uniform engagement with and rotatable at differential speeds with respect to the said inner surface, and with said perforate section for propelling the residue of the material treated across said perforate section and towards said discharge opening, and means to rotate said shell and said screw differentially.

5. A centrifugal separator, comprising a rotatable shell having a continuously conical inner surface having an intermediate perforate section, a conduit for discharging the material to be treated axially into the larger end of said shell, a discharge opening at the smaller end of said shell, a liquid outlet leading from said perforate section, a conical screw in substantially uniform engagement with the said inner surface for propelling the residue of the material treated across said perforate section and towards said discharge opening, and means to rotate said shell at differential speeds relative to said screw.

6. A centrifugal separator, comprising a rotatable shell having a continuously conical inner surface, a conduit for discharging the material to be treated axially into the larger end of said shell, a discharge opening at the smaller end of said shell, a perforate section of said conical surface operative to permit the escape of liquid, a liquid outlet protected by and leading from said perforate section, a conical screw in substantially uniform engagement with the said inner surface including said perforate section, for propelling the residue of the material treated towards said discharge opening, and means to ro-

tate said shell at differential speeds relative to said screw.

7. A centrifugal separator, comprising a rotatable shell closed at one end by a concave wall, a filtering element in and comprising an integral section of the radially outer portion of the surface of said concave end wall, a liquid outlet protected by said filtering element, the opposite end of said shell being provided with a discharge opening, a conduit for feeding material to be treated substantially axially against said concave wall, so the rotation of said shell causes the material to progress radially outwardly across the surfaces of said wall and said filtering element before reaching said discharge opening, a conical screw in substantially uniform engagement with said shell, and means to rotate said shell and screw at differential speeds.

8. A centrifugal separator, comprising a rotatable shell closed at one end by a concave wall, a filtering element in and comprising an integral section of the radially outer portion of the surface of said concave end wall, a liquid outlet protected by said filtering element the opposite end of said shell being provided with a discharge opening and connected to said first end by a substantially conical wall, and a conduit for feeding material to be treated substantially axially against said concave wall, so the rotation of said shell causes the material to progress radially outwardly across the surfaces of said wall and said filtering element before reaching said discharge opening, a second filtering element within and comprising a section of the surface of said conical wall, a propelling screw within and substantially uniformly engaging said conical surface, including said second filtering element, to propel material being treated towards said outlet and means to rotate said shell and screw differentially.

9. A centrifugal separator, comprising a rotatable shell closed at one end by a concave wall, a filtering element in and comprising an integral section of the radially outer portion of the surface of said concave end wall, a liquid outlet protected by said filtering element, the opposite end of said shell being provided with a discharge opening and connected to said first end by a substantially conical wall, and a conduit for feeding material to be treated substantially axially against said concave wall, so the rotation of said shell causes the material to progress radially outwardly across the surfaces of said wall and said filtering element before reaching said discharge opening, a second filtering element within and comprising a section of the surface of said conical wall, and a propelling screw within and substantially uniformly engaging said conical surface, including said second filtering element, to propel material being treated towards said outlet, means to rotate said shell and screw differentially, said screw being perforated to permit separated liquid to travel reversely towards said first filtering element.

10. A centrifugal separator, comprising a rotatable shell and a differentially rotatable propelling screw within and continuously engaging the surface of said shell for scraping residual solids therefrom, means to rotate said shell and screw differentially, the blades of said screw being perforated to permit the flow of separated liquids in reverse direction therethrough, an inlet port, a solids outlet port, and an intervening liquid outlet port in said shell.

11. A centrifugal separator and dehydrator,

comprising a conical rotatable shell, a concave closure for the larger end of said shell having a perforate peripheral portion, a pipe entering said shell through the smaller end thereof and terminating axially at a point adjacent to the larger end of said shell for feeding the material to be treated directly against said concave closure, a

conical screw rotatable within said shell for propelling residuary solids reversely towards the small end of said shell, a portion of the conical wall of said shell near the small end thereof comprising perforate material and means to rotate said shell and screw differentially.

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