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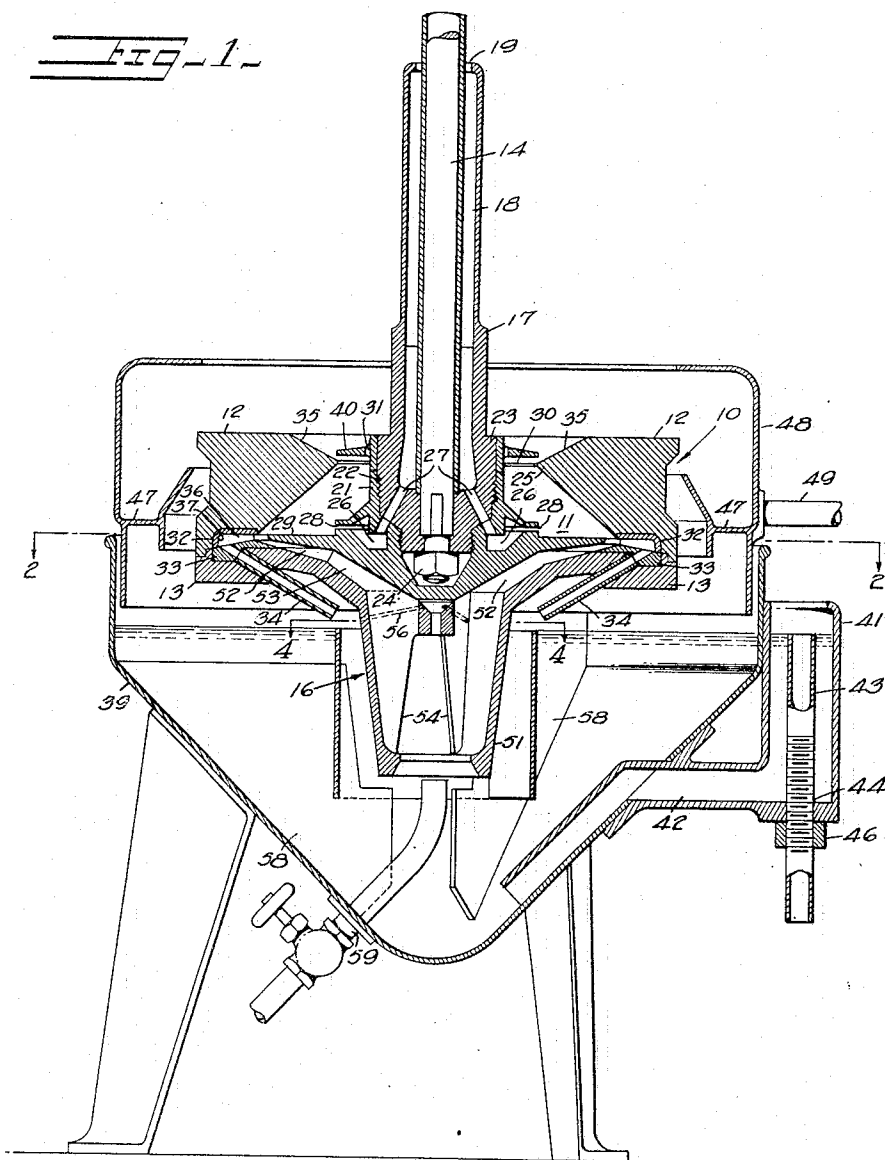
A. PELTZER ET AL

1,933,119

CENTRIFUGE METHOD AND APPARATUS

Filed June 23, 1930

4 Sheets-Sheet 1



INVENTORS
ALBERT PELTZER
ALBERT PELTZER JR.
BY
Spear, Middleton, Dunsen & Hall
ATTORNEYS.

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A. PELTZER ET AL
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4 Sheets-Sheet 2

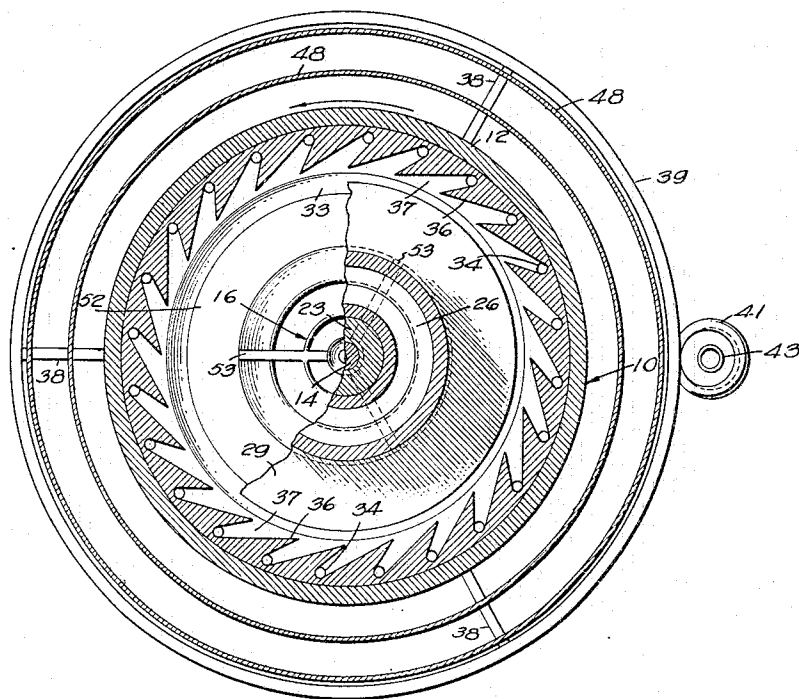


Fig. 2.

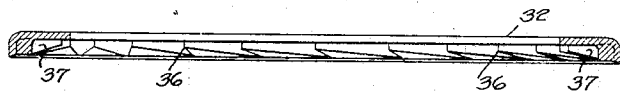


Fig. 3.

INVENTOR.
ALBERT PELTZER
ALBERT PELTZER JR.
BY
Spear, Middleton, Dunbar & Hale
ATTORNEYS.

Oct. 31, 1933.

A. PELTZER ET AL

1,933,119

CENTRIFUGE METHOD AND APPARATUS

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4 Sheets-Sheet 3

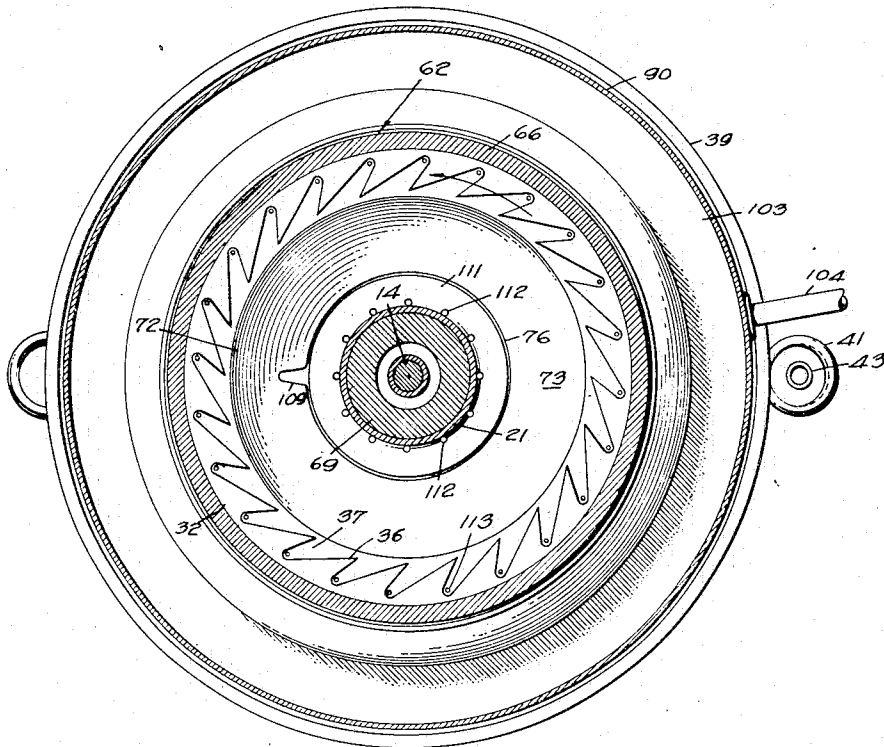


Fig. 6.

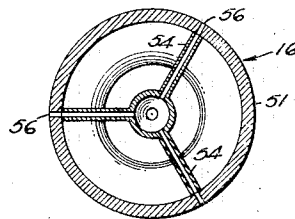


Fig. 4.

INVENTORS

ALBERT PELTZER
ALBERT PELTZER JR.

BY

Spear, Middleton, Dumas & Hall
ATTORNEYS.

Oct. 31, 1933.

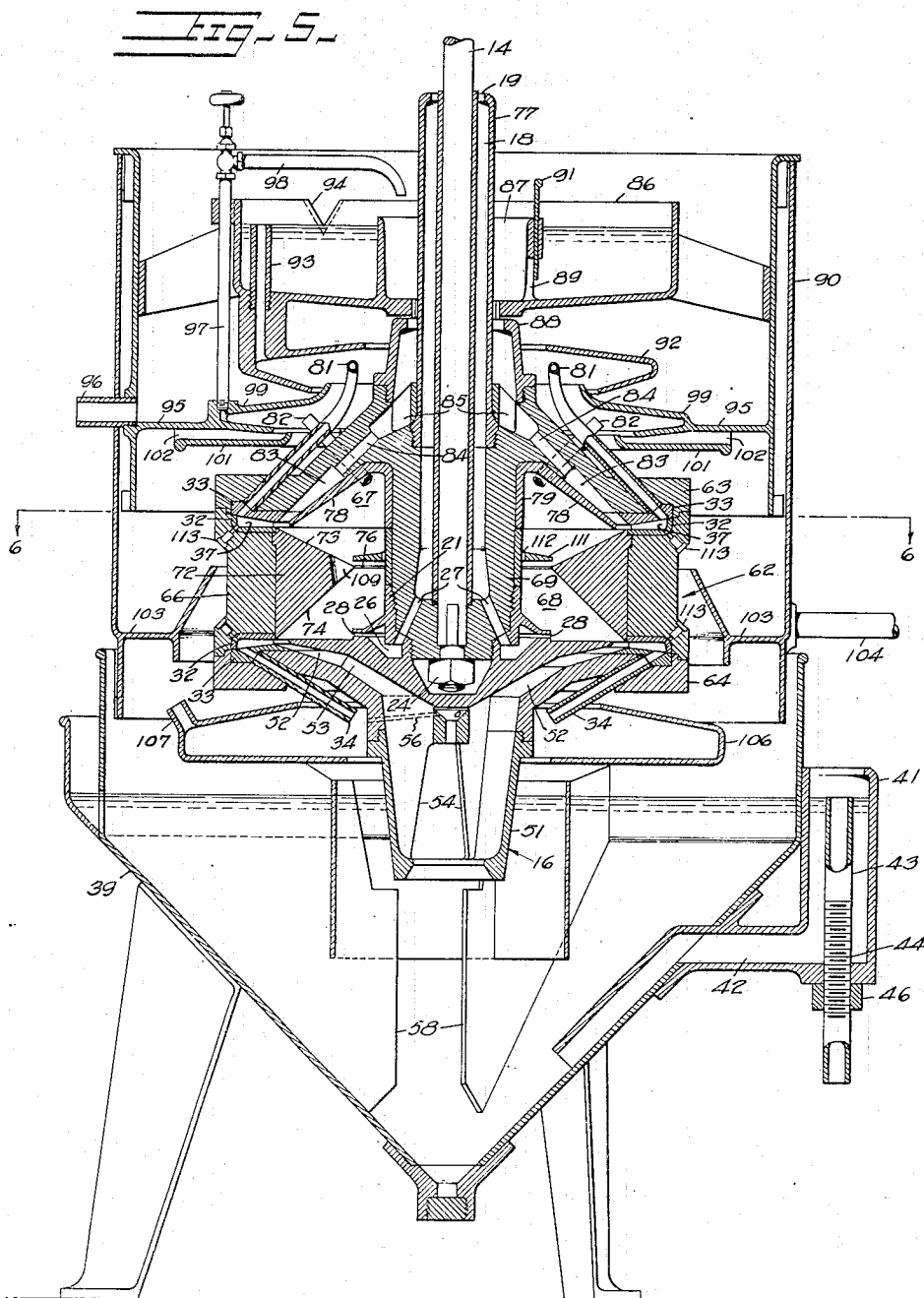
A. PELTZER ET AL

1,933,119

CENTRIFUGE METHOD AND APPARATUS

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4 Sheets-Sheet 4



INVENTORS
ALBERT PELTZER
ALBERT PELTZER JR.

BY *Spear. Middleton, Duvalson & Hall*
ATTORNEYS.

UNITED STATES PATENT OFFICE

1,933,119

CENTRIFUGE METHOD AND APPARATUS

Albert Peltzer, Palo Alto, Calif., and Albert Peltzer, Jr., Chicago, Ill., assignors to Merco Centrifugal Separator Co. Ltd., San Francisco, Calif., a corporation of California

Application June 23, 1930. Serial No. 463,204

12 Claims. (Cl. 233—28)

This invention relates generally to methods and apparatus for the centrifugal separation of components of different specific gravities from a fluid feed. The subject matter disclosed herein has been divided out of copending application No. 122,146, filed July 13, 1926, in the joint names of Albert Peltzer and Albert Peltzer, Jr.

It is a general object of the invention to secure more adequate and effective control of centrifuge methods and apparatus, particularly with respect to the characteristics of the discharge product. As will be presently explained the invention is characterized by the fact that the specific gravity of the discharge material can be controlled without making adjustments of the rotary parts of the machine.

It is a further object of the invention to devise a novel centrifuge method and apparatus making possible effective scouring action within the centrifuge chamber to prevent clogging of the discharge ports or passages, without detrimentally effecting centrifugal separating action within the chamber.

It is a further object of the invention to devise a novel centrifuge method and apparatus whereby material passing thru the rotary parts of the centrifuge apparatus or machine is retreated a plurality of times.

Further objects of the invention will appear from the following description in which the preferred embodiments of the invention have been set forth in detail in conjunction with the accompanying drawings. It is to be understood that the appended claims are to be accorded a range of equivalents consistent with the state of the prior art.

Referring to the drawings:

Figure 1 is a side elevational view in cross section illustrating a machine incorporating the principles of the present invention.

Fig. 2 is a cross sectional view taken along the line 2—2 of Fig. 1.

Fig. 3 is a side elevational view in cross section, illustrating an expeller ring such as is employed in the machine of Fig. 1, this view being enlarged.

Fig. 4 is a cross sectional detail taken along the line 4—4 of Fig. 1.

Fig. 5 is a side elevational view in cross section of a multiple effect centrifuge machine.

Fig. 6 is a cross sectional view taken along the line 6—6 of Fig. 5.

The single effect machine illustrated in Fig. 1 consists of a rotary structure 10, forming a centrifuge chamber 11. In practice rotary

structure 10 can consist of the upper and lower parts 12 and 13 adapted to be removably clamped together. Rotation is effected by a suitable shaft 14 which extends axially of chamber 11, and which is suitably connected to parts 12 and 13 as will be presently explained. The rotary structure 10 also includes a lower impeller or pump portion 16, which in practice can be formed as an extension of part 13. The function of impeller or pump portion 16 is to introduce fluid material into the centrifuge chamber in addition to the fluid feed.

As a means for introducing fluid feed material into the centrifuge chamber, a sleeve 17 is disposed concentrically with respect to shaft 14, so as to form an inner space or passageway 18 between the sleeve and the shaft. Fluid feed material introduced into the upper opening 19 of sleeve 17, can travel down the interior of this sleeve to be delivered into the centrifuge chamber 11. A connection between sleeve 17 and the rotary parts defining chamber 11 is formed by a collar 21 extending upwardly from the inner portion of part 13, this collar having a threaded connection 22 with the lower enlarged portion 23 of sleeve 17. The lower end of shaft 14 is in turn fixed to the lower enlarged end portion 23 of sleeve 17, by means of nut 24.

Part 13 is also formed to provide an annular pocket 26 which is concentric to the axis of shaft 14, and which is in communication with the lower portion of passageway 18 thru the outwardly extending ducts 27. Pocket 26 is in turn in communication with the interior of centrifuge chamber 11 thru the annular port or orifice 28. The feed material discharged thru annular orifice 28 is delivered over a relatively flat annular surface 29 formed upon the upper face of part 13, and defining one wall of the centrifuge chamber 11.

Centrifuge chamber 11 is also defined by the inclined surface 25 of part 12, which can be shaped to conform to a truncated cone. To afford provision for the discharge of lighter separated components of the feed part 12 is also formed to provide an annular wier 30, and fluid material discharged over this wier flows over the annular surface 35, which is shown inclined oppositely to surface 26. An annular baffle 40 can be mounted upon collar 21, so as to overlie the opening formed by wier 30. This baffle or deflector plate 29 can be provided with a vent 31 to prevent the formation of a trapped air pocket.

In order to provide expeller means or provi-

sion for the discharge of heavier separated components of the feed material, we have shown rings 32 and 33 which are fixed within the parts 12 and 13 of the rotary structure 10. Discharge pipes 34 are mounted upon the lower rotary part 13, and the discharge passages afforded by these pipes 34 communicate with pockets formed by the cooperative rings 32 and 33. Thus one of the expeller rings, in this instance ring 32, is provided with a plurality of inwardly tapered vanes 36 as shown in Fig. 2 which depend to the upper surface of ring 33 so as to define outwardly diverging pockets 37. It will be noted that the axes of pockets 37 are inclined with respect to radii drawn to the center of rotation, and that the pockets are faced toward the direction of rotation. A pipe 34 is provided for each pocket 37, and each pipe communicates with the apex of its associated pocket.

In addition to the regular feed material, fluid material is introduced into the centrifuge chamber by way of the impeller or pump portion 16. This additional fluid material has such characteristics that it tends in effect to increase the total rate of introduction of heavier components relative to the rate of introduction of lighter components, and preferably it is heavier discharge material which has been previously treated in the centrifuge chamber and discharged thru pipes 34. Thus in practice the rotary structure 10 is disposed within a suitable receptacle 39 serving to receive material discharged from pipes 34. As will be presently explained certain new results are obtained by controlling the gravity of the additional material introduced into the centrifuge chamber, and it has been found that such a control can be effected by varying the level of overflow pipe 43 within the receptacle 39. Thus receptacle 39 is in communication with an auxiliary reservoir 41, thru a conduit 42. Overflow pipe 43 extends upwardly within auxiliary reservoir 41, and the position of the upper open end of this pipe can be adjusted vertically, by providing a threaded pipe connection 44. Nut 46 enables pipe 43 to be locked in any one adjusted position.

The lighter separated components discharged over wier 30, can be collected by an annular trough or receiver 47, carried by an upper casing 48. From trough and receiver 47 the overflow or lighter separated components can be removed thru pipe 49.

Impeller or pump portion 16 can be formed of an inverted truncated section 51, having its lower end open to and immersed in the material within receptacle 39, and having its upper portion communicating with a plurality of radially extending vanes 53, the lower depending portions 54 of which are mounted upon the inner walls of conical section 51. Passages 52 are formed within the lower rotary part 13, and communicate at their outer ends in an annular zone adjacent the outer periphery of centrifuge chamber 11, and adjacent the inner ends of vanes 32. As shown in Fig. 4, air vents 56 can establish communication between the interior of pump portion 16 and the atmosphere above the liquid level within receptacle 39, in order to insure atmospheric pressure within the pump portion. Upon rotation of structure 10 and pump portion 16, fluid material from receptacle 39 is drawn into the lower end of pump portion 16, and is discharged thru passages 52 to the outer periphery of centrifuge chamber 11. Because of the presence of vanes 32, considerable rotary velocity is

imparted to this additional material as the material progresses outwardly thru passages 52, so that as the additional material is finally discharged into the centrifuge chamber, it is rotating at a relatively high velocity.

In order to prevent swirling within the receptacle 39 which might interfere with proper action of pump portion 16, a plurality of spaced vanes 58 are mounted upon receptacle 39 and extend inwardly towards pump portion 16. It is frequently desirable to introduce other liquids within receptacle 39, such as wash water, in order to wash the material delivered thru passages 52. For this purpose a pipe 59 is shown extending into receptacle 39, and arranged to deliver upwardly into the lower open end of pump portion 16.

To explain the mode of operation of the above machine and the method of the present invention, it will be presumed that a considerable quantity of fluid material discharged from pipes 34, exists in receptacle 39, as determined by the position of overflow pipe 43. Fluid feed material to be treated is introduced thru opening 19 and travels downwardly thru passageway 18 along the inner walls of sleeve 17. From the lower end of passageway 18 the feed material is discharged thru ducts 27 to chamber or pocket 26 and from this chamber it is delivered to the centrifuge chamber 11 thru annular orifice 28. Centrifugal separation takes place within chamber 11 and the lighter components or "overflow", is discharged over wier 30, to the receiver 47. Heavier centrifugally separated material is discharged into pockets 37 where it is mixed with the discharge material returned by pump portion 16 thru passages 52, and the mixture is discharged thru pipes 34.

Due to the continuous return of discharge material into the centrifuge chamber by pump portion 16, a relative high rate of flow occurs thru pockets 37 and the pipes 34, thus preventing clogging by formation of packed material. Due to lagging or slippage within the chamber 11, the material of the feed near the outer periphery of chamber 11 has substantially less rotary velocity than the rotary velocity of the discharge material returned to the centrifuge chamber. Therefore due to the intermingling of materials having different rotary velocities adjacent the outer periphery of chamber 11, an agitating effect is secured which serves to effectively scour out the pockets 37. This agitating action is prevented from interfering with proper separating action within the centrifuge chamber, by insuring that the difference between the rotary velocity of the return material and the rotary velocity of feed material, is not too great. By the structure which has been described, which utilizes vanes 36 extending radially for imparting rotary velocity to the return material, the difference between these rotary velocities is kept within such limits that proper separation takes place within the centrifuge chamber.

By controlling the gravity with which the return material is delivered into the centrifuge chamber by pump portion 16, we have found that it is possible to control the density or specific gravity of the material discharged thru pipes 34, without adjusting the diameter of the openings thru these pipes or without making other adjustments in the rotary part of the centrifuge machine. As has been previously explained, the gravity with which the return material is introduced into the centrifuge chamber can be adjusted by adjusting the level of the upper end of

overflow pipe 43. Thus by adjusting the pipe 43 it is not only possible to control the specific gravity or density of the material discharged thru pipes 34, but the density of the discharge material can be maintained substantially constant or within predetermined limits independently of variations in characteristics of the feed material. For example if for a certain period of operation the feed material is less dense or contains a smaller percentage of heavier components, thus tending to decrease the density of material discharged thru pipes 34, pipe 43 can be changed by trial to the proper level.

As explained in said copending application 122,146, it is possible to maintain a definite proportionality between the rate of introduction of the feed material, and the rate with which discharge material is returned into the centrifuge thru pump portion 16. However if the advantages of maintaining such a fixed proportionality are not desired, the discharge material can be returned irrespective of the rate of feed. In such event if the feed should be interrupted entirely, material of discharge consistency would be continuously recirculated thru the machine, substantially no discharge material would be removed from the apparatus thru pipe 43, and no overflow would occur over wier 30.

In Fig. 5 we have shown a modification which incorporates features of the invention described above, but which makes possible a multiple centrifugal effect. In this case the rotary structure 62 of the centrifuge is formed of upper and lower parts 63 and 64, which are interconnected by the intermediate part 66. Lower part 64 is provided with expeller rings 32 and 33, and discharge pipes 34, similar to the structure described with reference to Fig. 1. The interior of rotary structure 62 is formed to provide primary and secondary centrifuge chambers 67 and 68, the feed material being introduced into the lower chamber 68 thru opening 19, passageway 18, ducts 27, chamber 26, and annular orifice 28.

Rotary shaft 14 extends downwardly thru a hub 69 which is fixed to the central portion of lower part 64, the lower end of the shaft being fixed to the hub for driving the same. Annular member 72 is fixed within part 66, and is formed with oppositely inclined conical surfaces 73 and 74. This member 72 is also formed to provide an annular wier 76 communicating between the centrifuge chambers. Sleeve 77 surrounds shaft 14 to form passageway 18, and the lower end of this sleeve is fixed to the upper end of hub 69.

The upper side of chamber 67 is formed by a conical flange or hood 78 which is provided with a sleeve portion 79 surrounding and fixed to the hub 69. Expeller rings 32 and 33, are mounted between rotary parts 63 and 66, and are similar to the expeller rings surrounding the lower centrifuge chamber 68. The pockets 37 formed in between these expeller rings communicate with inwardly directed discharge pipes 81. For discharging lighter separated material from centrifuge chamber 67, a plurality of circumferentially spaced discharge pipes 82 are provided, the inner ends of these pipes communicating with chamber 67 at points spaced inwardly from the periphery thereof.

Pump portion 16 is disposed within receptacle 39 and serves to return heavier centrifugally separated discharge material into the centrifuge chamber 68, in the same manner as has been described with reference to Fig. 1. For introducing

discharge material into the upper centrifuge chamber 67, an annular pocket 83 is formed within the rotary part 63 and material introduced into this pocket is discharged thru outwardly extending passages 84, annular passage 85, and is delivered adjacent the periphery of chamber 67 at the outer edge of flange 78. As a means for feeding a material into the annular pocket 83, a suitable container 86 is disposed about sleeve 77, and this container can be supported by a housing 90 disposed above receptacle 39. The inner part of container 86 is formed to provide a hopper 87, and the lower part of this hopper is arranged to discharge its contents into a collar 88. Collar 88 is shown mounted upon part 63 of the rotary structure 62 and forms a pump together with the upper portion of this part. An opening 89 serves to admit fluid material from container 86 thru hopper 87, and flow thru this opening can be controlled by a suitable adjustable valve or gate 91. Pipes 81 are arranged to discharge into a stationary annular receiver, shell or volute 92, the peripheral portion of which is connected to container 86 thru pipe 93. The kinetic energy of material discharged into receiver 92 is sufficient to force this material, without the use of additional pumping means, thru pipe 93 and into container 86. A slot or wier 94 is provided in one side wall of container 86, whereby the level of material within this container is maintained substantially constant. Material flowing over this wier is collected by annular apron 95 and discharged thru pipe 96.

In some instances it may be desirable to dilute the discharge material admitted to hopper 87 and introduced into the upper centrifuge chamber 67, with lighter separated components. Therefore another annular receiver, shell or volute 99 is shown positioned to receive material discharged from overflow pipes 81, and the peripheral portion of this receiver is connected with valve controlled pipes 97 and 98, to permit discharge of such separated lighter components into hopper 87. An apron 101 can be cooperatively disposed with respect to the inner portion of receiver 99, so as to collect the components received by receiver 96 and not delivered thru pipes 97 and 98, and to deliver the same thru spouts 102. Another annular collector 103 is disposed about the rotary structure 62 so as to receive the material delivered from spouts 102 and to permit the same to be removed from the apparatus thru pipe 104. For receiving the material discharged from pipes 34, an annular collector, shell or volute 106 is provided, which discharges to receptacle 39 thru spout 107. The level of fluid material within receptacle 39 can be varied by adjustable pipe 43, as explained in connection with Fig. 1.

As shown in Fig. 6, it is desirable to provide the wier 76 between the chambers 67 and 68, with a slot or channel 109, having its outer wall disposed at an angle to the axis of the rotor as shown in Fig. 5. This slot insures delivery of material from chamber 68 to chamber 67, which due to its physical characteristics such as specific gravity and size, would be difficult to float over wier 76 without an appreciable loss of the heavy material with the lighter components. An annular baffle or deflector plate 111 is also preferably disposed adjacent to and slightly above wier 76, and this plate is preferably provided with one or more air vents 112 in order to prevent the formation of a trapped air pocket. It is also desirable to provide plugged vents or ports 113

communicating with the pockets 37 formed by expeller rings 32 and 33, in order to facilitate occasional removal of foreign objects which may not be capable of discharge thru pipes 34 and 71.

5 To explain the mode of operation of the structure shown in Fig. 5, it will be presumed that feed material containing lighter and heavier components is being introduced thru opening 19, and that an amount of material of discharge consistency has been collected by receptacle 39 as determined by the adjustment of pipe 43. Wash water or other washing liquid can also be introduced into receptacle 39 thru spout 116. The feed material is introduced into the lower centrifuge chamber 68 through annular orifice 28, and is subjected to the separating action of the centrifugal force. At the same time material of substantial discharge consistency is being continuously introduced into chamber 68 thru pump portion 16 and passages 52. A mixture of heavier components separated from the feed in chamber 68 and returned material, is discharged thru pipe 34, and returned to receptacle 39.

Lighter centrifugally separated components of the feed, together with a certain amount of the heavier unseparated components, are delivered to the upper centrifuge chamber 67 over wiper 76. Heavier separated discharge material delivered from pipe 81 is delivered to container 86, and by flowing thru opening 89 into hopper 87, a certain amount of this material is returned into the upper centrifuge chamber 67, thru passages 83 and 84. The second centrifuging effect taking place within the chamber 67 effects substantially complete separation between the lighter and heavier components, and the lighter components are delivered thru pipes 82, and finally removed thru pipe 104. The gravity with which discharge material is returned into the upper centrifuge chamber 67 can be controlled by adjusting gate 91 while the gravity of return to the lower chamber 68 can be controlled by adjusting pipe 43. By properly controlling both of these adjustments, the specific gravity of the heavier discharge material removed thru pipes 43 and 104, can be made to correspond to a certain desired value. Furthermore by varying these adjustments the specific gravity of the discharge material removed from the apparatus can be made to fall within certain predetermined limits irrespective of a change in the characteristics of the feed, or such adjustments can be made to control or vary the density of the discharge material without the necessity of adjusting moving parts of the machine.

While the apparatus which has been described above can be utilized with various fluid feeds, it can be employed to advantage in a novel wet starch process, for the separation and removal of various components from mill starch. In the manufacture of starch and gluten from corn, it has been common in prior wet starch processes to first form a liquor containing starch and gluten, from which the germs and the hulls of the corn kernels have been removed. This liquor is the "mill starch" referred to above. In prior processes this liquor is then passed over so-called tables where the gluten floats off separately from the starch, which settles out. The starch which is settled out from the gluten is then floated off the tables, washed in filters to remove remaining solubles, and then further refined. The gluten floated off the tables is thickened in suitable settlers, and the thickened gluten is then filter pressed, to further remove the moisture.

Prior wet starch processes as outlined above have certain inherent disadvantages. For example the gluten is not completely removed or separated from the starch, nor the starch completely separated from the gluten. Another disadvantage is that the separating and settling operations require relatively long periods of time, thus permitting bacteriological action to take place resulting in the growth of organisms commonly termed "wild yeast." In the process to be presently described centrifuging is utilized as a substitute for the tables previously employed for separating the starch from the gluten, for washing the solubles from the starch in place of continuous filters previously employed, and for thickening the gluten in place of the prior settlers.

The machine described with reference to Fig. 5 is capable of forming all of the above centrifuge operations in a single apparatus. Considering that a machine like that shown in Fig. 5 is operating at full capacity, the operation is as follows:—Mill starch of proper specific gravity, say about 6 Baumé, is introduced thru opening 19 and thus delivered to chamber 26. From chamber 26 the liquor flows outwardly thru the narrow annular orifice 28 into the lower centrifuge chamber 68. Due to friction between the liquor and the metal walls of orifice 28, proper rotary velocity will be imparted to the liquor as it is delivered to chamber 68. At the same time fresh water is continuously introduced into the tank 39, as by way of spout 116. The rate of introduction of fresh water by way of spout 116 is such as to provide a quantity of water equal in weight to the weight of the starch separated in chamber 68, and to provide a quantity of fresh water to carry out at the specific gravity desired, all of the starch separated from the mill starch entering chamber 68. For example supposing the mill starch entering opening 19 carries 1.2 pounds of solids (starch and gluten) to the gallon, and 1 pound of this substance is separated in the separating chamber 68 as starch. If it is desired to take out this starch from chamber 68 at a specific gravity of about 19 Baumé, 3 pounds of fresh water is added to carry out the starch. In addition one more pound of fresh water is added, making a total of 4 pounds of fresh water added to tank 39.

The fresh water introduced into tank 39 enters the pump portion or impeller 16 and is delivered through passages 52 to the inner diameter of expeller rings 32 and 33. Here the four pounds of water split into two parts. Three pounds of water is delivered thru the discharge pipe 34, together with starch separated within the chamber 68, and the other pound of water flows inwardly from the outer periphery of the separating chamber. The water which is discharged from pipe 34 together with separated starch is returned to the tank 39. The one pound of water flowing inwardly within separating chamber 68 intercepts the liquor issuing from orifice 28 and frees the starch from the gluten, giving each starch particle an individual thorough scrubbing, and finally flows over wiper 76, together with the gluten, the unseparated starch, and the process water.

Since the material including the wash water handled by pump portion 16 is delivered adjacent the outer periphery of chamber 68 with substantially the same rotary velocity as the velocity of the outer periphery of the chamber, that portion of the wash water which flows in-

wardly of the chamber tends to impart energy of rotation to the starch particles being separated. We have found that such an exchange of energy when properly controlled makes possible a near eddyless zone of separation, and in addition this portion of the wash water effects an instantaneous separation between starch and gluten. By proper control we have reference to a proper rate of introduction of wash water thru pump portion 16 for a given rate of feed, to produce a proper split between that portion of the wash water passing out with the discharge and the portion passing to the overflow. It is apparent that the maintenance of a near eddyless zone of separation is conducive to a perfect separation, and in fact starch made by our method and apparatus is of relatively high quality.

The fluid material or mixture flowing over wier 76 into the upper centrifuge chamber 67, can be termed the light gluten. Heavier solid components of this light gluten, including starch, are forced toward the expeller rings 32 and 33 and are discharged with a certain amount of liquid thru the pipes 81 into the receiver or volute 92. A certain amount of this discharge material is returned into the upper centrifuge chamber thru valve opening 89, collar or pump 88 and passages 83 and 84. The discharge material delivered to container 86 which is not returned into the upper centrifuge chamber 67, flows thru notch 94 and is finally discharged from pipe 96. This discharge material is the heavy gluten.

The overflow separated from the light gluten in separating chamber 67 is discharged thru pipe 82 into the receiver or volute 99, from which it can be removed from the centrifuge apparatus by flowing thru passages 102 and out thru pipe 104. A portion of this lighter overflow fluid, or gluten overflow, can be caused to flow thru valve controlled pipes 97 and 98 and can thus be reintroduced into the upper centrifuge chamber 67 together with the heavier material in container 86. Assuming that such a flow is occurring thru pipes 97 and 98, a certain amount of dewatering occurs in receiver or volute 99, the more concentrated material tending to flow thru pipes 97 and 98. The purpose of returning a portion of the lighter overflow into the upper centrifuge chamber together with the heavier material separated in the upper chamber 67, is to supply the necessary kinetic energy in chamber 67 to effect a proper separation of the solids.

In the method described above it will be noted that the lower chamber 68 serves mainly to effect a separation between the starch and gluten, while the upper chamber serves to effect a separation between the heavy gluten and the lighter gluten or gluten overflow, and to balance or control the flow over wier 76. When in normal operation both the impeller or pump portion 16 and the collar or pump 88, are forcing liquid or fluid material into the rotor of the centrifuge, and the level of liquid in separating chamber 68 is not controlled by wier 76, but is controlled by the locations of the inlets to pipes 82, provided of course that pump portions 16 and 88 can force more liquid into the rotor than can escape thru the discharge pipes 34 and 81.

As has been previously explained by adjusting the level of overflow pipe 43, the level of liquid within tank 39 can be adjusted, and correspondingly it is possible to vary and adjust the rate with which fluid material is being introduced into the lower chamber 68 thru pump portion 16.

Thus by properly positioning pipe 43, the rate of introduction to pump portion 16 can be made such that a good separation between the starch and gluten is effected within chamber 68, and so that a proper flow occurs over wier 76 into the upper chamber 67. Any fine hull fiber remaining in the mill starch being treated tends to remain below the level of wier 76 in chamber 67 until enough fine fiber has accumulated in the separating chamber 68 to force out as much fiber as enters. By being able to raise the level of liquid in chamber 67 above wier 76 by proper regulation of pipe 43, this fine fiber can be caused to flow over the wier into chamber 67, without carrying over an excess amount of starch. A certain amount of this fine fiber can also be drained into the upper chamber 67 thru the slot 109, and at the same time (because of the proper control of the liquid level in chamber 68) flow thru this slot will not prevent a proper flow of lighter liquid over wier 76. Assuming that the correct quantities of fresh water and mill starch are being introduced into the rotor, and it is desired to draw off the separated starch thru pipe 43 at a given specific gravity, the operator can simply vary the adjustment of gate 91, which results in drawing off of more or less heavy gluten thru notch 94 until the separated starch discharges at the proper specific gravity thru pipe 44. Varying the rate of flow thru pipes 97 and 98 has substantially no effect upon the specific gravity of the starch withdrawn thru pipe 43, as all water withdrawn thru these pipes is returned into the rotor. If desired volute or receiver 99 together with pipes 97 and 98 can be omitted and the upper chamber 67 employed principally to properly control flow over wier 76. In this case control of gate 91 also serves as a means for controlling the specific gravity of the starch removed thru pipe 43 and for effecting good separation within chamber 68.

It is evident that the method described above makes possible certain operations in a wet starch process within a minimum of time, so that bacteriological action is reduced to a minimum. Furthermore by the use of the above described method and apparatus wet starch processes can be carried out in a simpler manner, as the tables for separating the starch from the gluten are separated from the starch in one operation, thus making it unnecessary to wash the starch in continuous filters.

We claim:

1. In a centrifuge method characterized by the use of a structure forming a plurality of centrifuge chambers, the steps of supplying feed material to one of said chambers, effecting removal of heavier separated components from said one chamber, causing lighter separated components from said one chamber to flow into a second chamber, effecting separate removal of heavier and lighter components from said second chamber, and continually introducing previously separated heavier discharge material into said one chamber.

2. In a centrifuge method characterized by the use of a structure forming a plurality of centrifuge chambers, the steps of supplying feed material to one of said chambers, effecting removal of heavier separated components from said one chamber, causing lighter separated components from said one chamber to flow into a second chamber, effecting separate removal of heavier and lighter components from said second chamber, and continually returning heavier material

discharged from at least one of said chambers into said one chamber.

3. In a centrifuge method characterized by the use of a structure forming a plurality of centrifuge chambers, the steps of effecting successive centrifuging of components of the feed material in said chambers, effecting independent discharge of separated heavier components from each chamber, and continually returning the respective heavier separated components into each chamber.

4. In a centrifuge apparatus, a rotary structure formed to provide a plurality of centrifugal chambers, means for expelling heavier separated components from said chambers, means for supplying material for centrifugal separation to said chambers, and means for returning heavier separated components expelled from said chambers into said respective chambers.

5. In a centrifuge apparatus, a rotary structure formed to provide a plurality of centrifugal chambers, means for expelling heavier separated components from said chambers, means for supplying material for centrifugal separation to one of said chambers, means for introducing lighter overflow material from said one chamber into another of said chambers, and means for returning previously expelled heavier components into both said chambers.

6. In a centrifugal separator, a rotor having a passage for feeding original liquid adjacent its hub, a feed chamber at the lower end of said passage, a separating chamber communicating with the feed chamber at its base, a wier having an outwardly and downwardly inclined face forming the outer wall of said chamber, discharge means communicating with the lower end of said face, an inclined upper face upon said wier, a baffle member spaced from said face and disposed in the path of travel of the lighter components of the material separated, and a second centrifugal separating element communicating with the outer end of the upper face of the wier.

7. In a centrifugal separator, a rotor having a passage for feeding original liquid adjacent its hub, a feed chamber at the lower end of said passage, a separating chamber communicating with the feed chamber at its base, a wier having an outwardly and downwardly inclined face forming the upper wall of said chamber, discharging means communicating with the lower end of said face, an inclined upper face upon said wier, a baffle member spaced from said face and disposed in the path of travel of the lighter components of the material separated, a second centrifugal separating element communicating with the outer end of the upper face of the wier, and means for recirculating the heavier material delivered from

the secondary separator thru a passage to the upper end of the last mentioned wier face.

8. In a centrifugal separator, a rotor provided with a separating chamber disposed concentric to its axis, a wier having oppositely inclined faces, the lower face of which forms the outer wall of said chamber, means for delivering material at the outer periphery of said chamber, means at the base of said chamber for feeding original liquid thereto, and a secondary separator disposed at the upper portion of said rotor to receive material from the upper face of said wier.

9. In a centrifugal separator, a rotor provided with a separating chamber disposed concentric to its axis, a wier having oppositely inclined faces, the lower face of which forms the outer wall of said chamber, means for delivering material at the periphery of said chamber, means at the base of said chamber for feeding original liquid thereto, a secondary separator disposed at the upper portion of said rotor to receive material from the upper face of said wier, a hood carried by the rotor above the upper face of the wier to form a collecting chamber for lighter components and means for discharging said components from said chamber.

10. In a centrifuge apparatus, a rotary structure formed to provide a plurality of centrifuge chambers, means for supplying feed material to one of said chambers, means for introducing separated lighter overflow material from said one chamber to another of said chambers, and means for effecting continual discharge of heavier separated material from each of said chambers, the discharge from one chamber being separate from the discharge from the other chamber.

11. In a centrifuge apparatus, a rotary structure formed to provide a plurality of centrifuge chambers, means for supplying feed material to one of said chambers, means for introducing lighter overflow material from said one chamber to another of said chambers, and means for introducing an additional fluid material into said structure, both of said chambers having separate provision for the independent discharge of heavier separated material therefrom.

12. In a centrifuge apparatus, a rotary structure formed to provide a plurality of centrifuge chambers, means for supplying feed material to one of said chambers, means for introducing lighter overflow material from said one chamber to another of said chambers, and means for introducing heavier material previously separated from the feed into said structure, both of said chambers having separate provision for the independent discharge of heavier separated material therefrom.

ALBERT PELTZER.
ALBERT PELTZER, JR.