

June 4, 1963

R. F. LACKER
CENTRIFUGE

3,092,582

Filed March 20, 1959

2 Sheets-Sheet 1

FIG-1

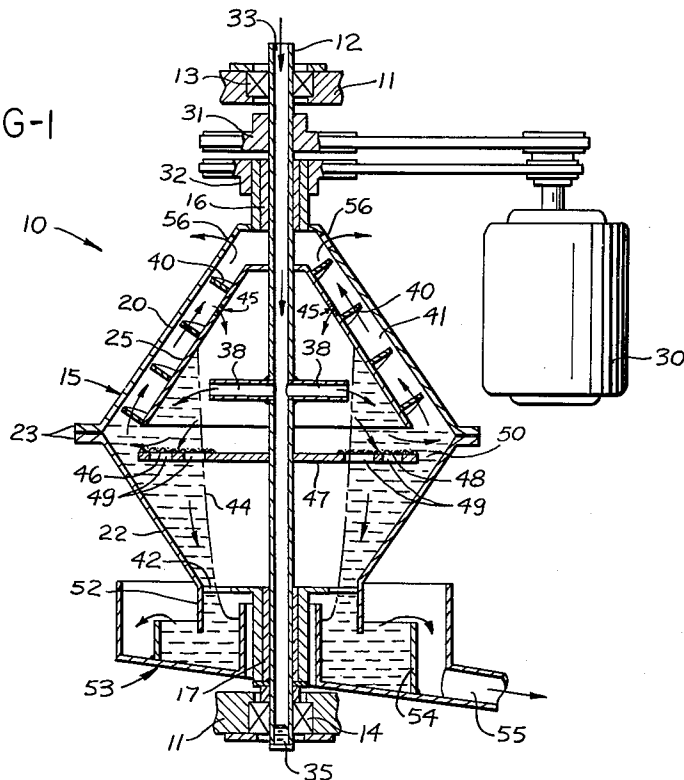
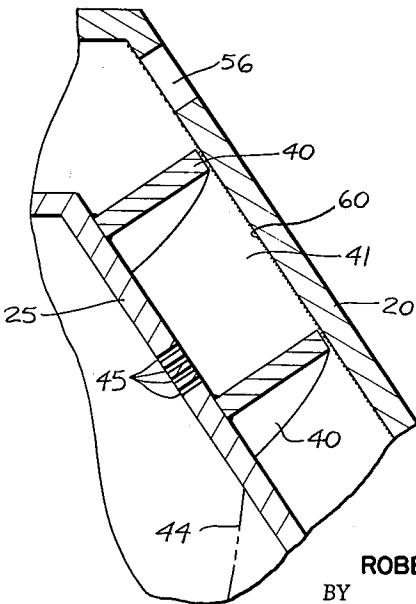


FIG-2



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FIG-3

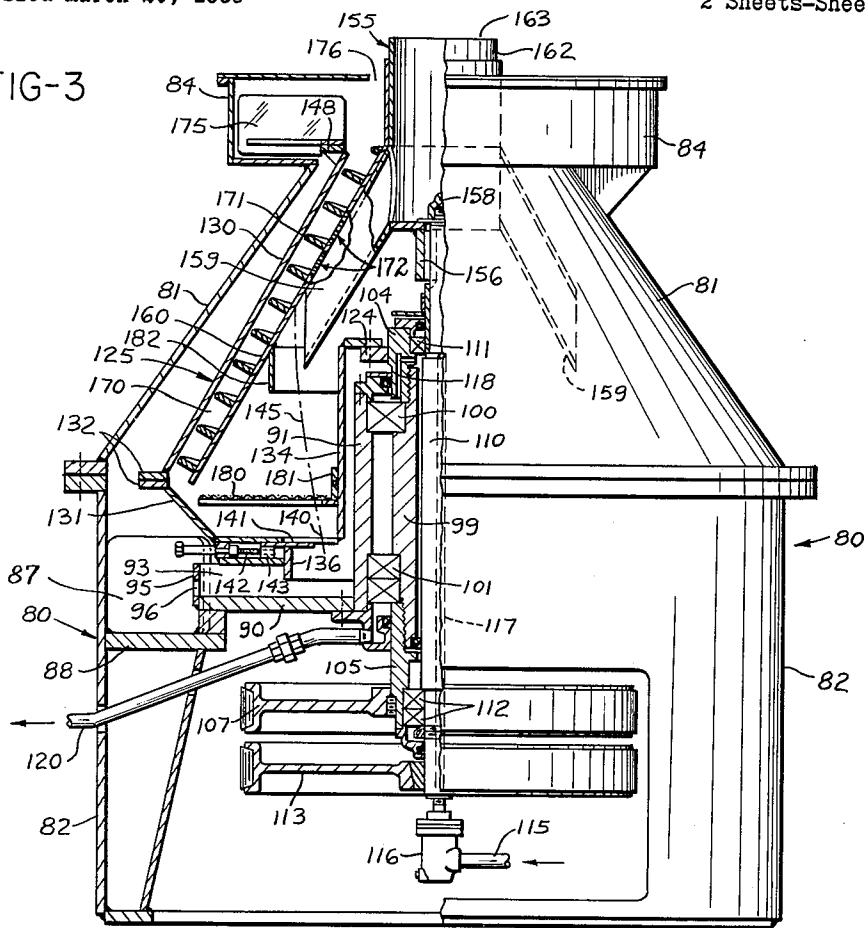


FIG-4

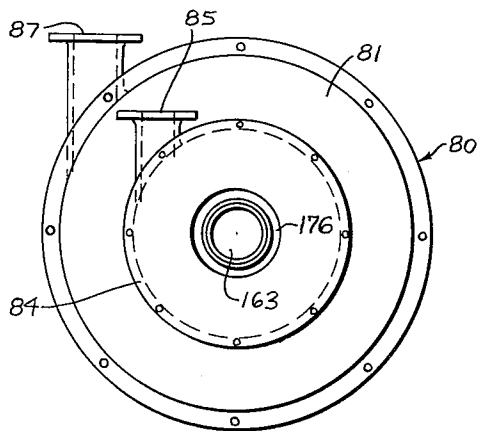
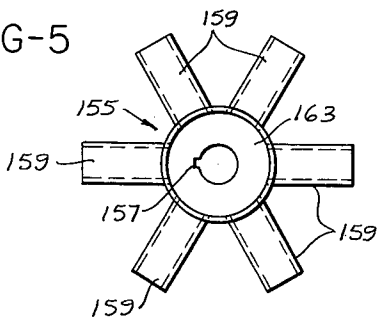


FIG-5



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CENTRIFUGE

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Filed Mar. 20, 1959, Ser. No. 800,773

3 Claims. (Cl. 233—2)

This invention pertains to centrifuges and more particularly to centrifuges for separating solid particles from a liquid slurry stock.

This invention is particularly applicable to centrifuges of the kind having relatively rotatable basket members and is characterized by its efficiency and high capacity for separation. Thus the invention has utility in the paper industry as a dewatering device for increasing the consistency or percent of solid in paper stock, and the invention is also adapted for continuous use and high capacity operation in any application where it is desired to remove suspended solid from a liquid, such as the clearing of effluent from a mill, and is characterized by its ability to handle abrasive mixtures. The invention is further adapted to provide a centrifuge capable of delivering a fixed consistency discharge regardless of variations in the incoming consistency so as to stabilize a mixture of pulp and liquid and thus to permit the accurate control of succeeding paper mill operations. In particular, the invention is characterized by its ability to deliquify softened chips and pulp as it comes from the blow pits, thus retaining high Baumé of liquor and minimizing the wash water required.

The centrifuge of the invention includes relatively rotating outer basket and inner cone members with suitable elevator means interposed, such as spiral fighting, for the delivery of the particles from a point of high centrifugal force to a point radially within a liquid wall within the rotating basket. A separating screen, rotatably carried within the cone, is interposed within the path of stock flow between the inlet and the liquid discharge outlet and adjacent the path of outward flow from the inlet to the spiral fighting. Openings are provided within the cone through which liquid carried by the fighting may escape directly into the interior of the basket thereby minimizing the counterflow against the particles and with a minimum of remixing with the incoming stock. The apparatus further includes provision for minimizing agitation of the inflowing stock and the outgoing liquid to prevent foaming.

It is therefore a primary object of this invention to provide a centrifuge as outlined above characterized by high efficiency of separation for continuous process with particular utility for separating abrasive solids from liquids.

A further object of this invention is to provide a centrifuge as outlined above having a separating screen located in the path of stock flow between a stock inlet and a liquid outlet and preferably adjacent the path of outward flow from said inlet to a centrifugal separating zone.

Another object of this invention is to provide a centrifuge as outlined above with openings in a cone member for separated liquid flow into the interior of the centrifuge.

A still further object of this invention is to provide a centrifuge as outlined above having its inlet and outlet ports so arranged that the liquid is admitted and released with a minimum of agitation and foaming.

Another object of this invention is to provide a centrifuge as outlined above characterized by an ability to separate a liquid slurry stock wherein at least some of

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the particles have specific gravities lower than the liquid vehicle.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawings, and the appended claims.

5 In the drawings—

FIG. 1 is a sectional view of a centrifuge constructed according to the teachings of this invention;

10 FIG. 2 is an enlarged detail of a portion of FIG. 1 illustrating a modification of the basket for the separation of slippery stocks;

FIG. 3 is a partial sectional view of a centrifuge illustrating another modified form of the invention;

15 FIG. 4 is a plan view of the centrifuge of FIG. 3 showing the inlet and the outlets; and

FIG. 5 is a detail of the stock inlet and the centrifuge of FIG. 3.

Referring to the drawings, which illustrate preferred embodiments of the invention, a centrifuge constructed according to the teachings of this invention is shown at 10 in FIG. 1. The centrifuge 10 includes an outer encasing frame 11 which is almost fully broken away to expose the details of the interior. A hollow shaft 12 has its opposite ends rotatably mounted by a pair of bearings 13 and 14 within the frame 11. A generally conical basket 15 is rotatably mounted on the shaft 12 on an upper sleeve bearing 16 and a lower sleeve bearing 17. The basket 15 includes a conical upper section 20 and an annular enclosing bottom 22 joined to each other by any suitable means such as by welding at reinforcing rings 23. A cone 25 is fixed on the shaft 12 for rotation coaxially within and spaced from the upper section 20 of the basket 15.

35 The cone 25 and the basket 15 are caused to rotate in the same direction at a constant speed differential by a drive motor 30 through a cone driving pulley 31 fixed to the shaft 12 and a basket driving pulley 32 fixed to the basket 15 at the upper bearing 16. The shaft 12 is open at the top end to provide a stock inlet 33 for the entry of a slurry containing liquid and solid particles suspended therein for separation within the centrifuge. The bottom end of the shaft 12 is closed as by a plug 35. The shaft 12 may also be fed from the bottom by the removal of the plug 35.

45 Means are included on the shaft 12 for the distribution of the stock within the basket 15 with the least amount of agitation and foaming. This is accomplished by the provision of two or more radially extended tubes 38 fixed to the shaft 12 within the basket 15 and open to the interior of the shaft to receive the stock therefrom for angular acceleration and delivery into the basket. Elevator means are interposed between the cone 25 and the upper conical portion 20 of the basket 15 by means of which the solid particles in the stock are carried upward toward the apex of the upper section 20 by the relative motion between the basket 15 and the cone 25. This elevator means is shown as a spiral fighting 40 formed on the outer surface of the cone 25 and defining with the upper section 20 an annular particle separating zone 41.

55 A plurality of outlet openings 42 in the annular bottom 22 provide outlet means for the discharge of the separated liquid from within the basket. The radial placement of the openings 42 in the bottom 22 defines and establishes the position of a wall 44 of liquid within the interior of the basket in response to the rotation of the basket by the drive motor 30. The cone 25 is provided with a plurality of liquid escape openings 45 located radially within this liquid wall 44.

70 Means are included defining a separating screen indicated generally at 46 and interposed in the path of stock

flow between the inlet tubes 38 and the outlet openings 42 and adjacent the path of outward flow from the tubes 38 to the separating zone 41. The screen 46 restrains the direct flow of particles to the outlet openings 42 for entrainment with the outward flow from the tubes 38 into the separating zone 41. In this manner, the screen 46 tends to be self-cleaning. The screen 46 includes a radial supporting disk 47 fixed for rotation with the cone 25 on the shaft 12. Screen material 48 such as wire mesh or perforated sheet metal is supported on the upper surface of disk 47 in superimposed relation over openings 49 formed in the disk 47. The gauge of the screen material 48 is such that only clear liquid may pass through the outlet openings 42 while the solid particles are restrained for entrainment into the zone 41.

The employment of the screen 46 is particularly useful for the separation of mixtures wherein some of the particles have a lower specific gravity than the liquid vehicle. This for instance may occur when the device of the invention is used for dewatering and thickening the cellulose fiber pulp from paper stock where the specific gravity of the individual particles of fiber may vary between 0.9 and 1.2. Particles of lower specific gravity cannot flow directly to the liquid outlet openings 42 due to the interposition of the separating screen 46, and such of those particles which may tend to collect upon the screen become entrained by the flow of the stock from the inlet tubes 38 into the separating zone 41 where they are acted upon by the spiral fighting 40.

The screen 46 has a radial dimension which is less than the radial dimension of the basket in the plane of the screen, as shown in FIG. 1. This therefore defines an annular opening 50 through which liquid may flow directly from the inlet tube 38 to the outlet 42, such as may be desired for flushing the interior with water.

The frame 11 includes means defining a pool forming chamber for receiving liquid from the liquid outlet openings 42 as a film with a minimum of agitation and foaming. The bottom 22 includes a dependent circumferential skirt 52 formed radially outward of the openings 42 and extended therebelow into a chamber or tank 53 fixed on the frame 11. The tank 53 includes an annular spill plate 54 extended above the bottom of the skirt 52 to establish a liquid head within the tank 53 into which liquid from the outlet openings 42 is discharged along the inside of the skirt 52 as a film with a minimum of agitation and foaming. A centrifuge liquid outlet 55 is formed in the frame 11 to receive the liquid which flows from tank 53 over the spill wall 54 for connection with a suitable liquid discharge conduit as may be desired.

The conical upper section 20 of the basket 15 includes a plurality of solid particle outlet openings 56 positioned radially inwardly of the axial projection of the outlet openings 42 as shown in FIG. 2. Deliquified particles are thrown through the openings 56 by centrifugal force, it being understood that the frame 11 normally includes means, which may taken the form of a housing (not shown), for collecting the particles discharged through the openings 56. A particular arrangement for this purpose is described in connection with FIG. 3.

Since stock on the spiral fighting 40 frictionally coats with the inside surface 60 of the basket 15 to effect the rise of solid particles within the separating zone 40 to the outlets 56, the effectiveness of this screw action depends upon the centrifugal force of the particles against the surface 60 and the relative speed of rotation of the cone to the basket. As a means for elevating slippery stocks, the inside surface 60 of the basket may be roughened, such as by spatter welding, as shown in FIG. 2.

In the operation of the device shown in FIG. 1, the basket 15 and the cone 25 are rotated by the drive motor 30 in the same direction at a constant differential speed. Stock to the centrifugally separated is admitted into the inlet 33 of the shaft 12 and is angularly accelerated by the tubes 38 to substantially the speed of the stock within the

basket and expelled into the adjacent liquid wall 44 with a minimum of agitation and foaming. The relative rotation of the cone 25 and the basket 15 causes the spiral fighting 40 to draw the stock into and upward through the separating zone 41.

The spiral fighting 40 carries the already thickened stock toward the apex of the basket 15 where it is subjected to the deliquifying caused by the constriction of the spaces between the fighting as the stock proceeds upward. At the same time, it is to a substantial degree stratified, with the solid material being concentrated along the inner surface 60 of the basket 15 whence it is ultimately ejected outwardly through the outlet openings 56. The free liquid which is concentrated along the outer surface of the cone similarly flows upwardly until it reaches the openings 45 where it drains back to the interior of the cone. Since the openings 45 are located radially within the liquid wall 44, this separated liquid tends to flow relatively directly to the outlet openings 42 as a film along the liquid wall 44.

The separated liquid at the outlet openings 42 flows outwardly against the skirt 52 and into the pool forming chamber or tank 53 as a continuous film without foam-causing agitation. The liquid within the tank 53 flows over the spill wall 54 into the outlet 55. The deliquified particles are ejected at the particle outlet openings 56 by the fighting 40 and may be collected by a housing (not shown) suitably arranged on the frame 11.

The centrifuge illustrated in FIGS. 3-5 incorporates basically the same operating principles as the centrifuges shown in FIGS. 1-2 with certain additional modifications. A main frame 80 includes a generally frustoconical upper section 81 and a cylindrical bottom section 82 within which the rotary components of the centrifuge are contained. The frame 80 further forms a particle discharge housing 84 on the top of the upper section 81 and includes a particle discharge outlet 85, and a liquid outlet 87 is formed in the bottom section 82. The frame 80 further includes an internal annular ledge 88 upon which is mounted a floor 90. A shaft supporting axle member 91 is vertically mounted on the floor 90. The floor 90 also includes means defining a pool forming liquid outlet chamber 93 circumferentially enclosed by an annular wall 95 having an opening 96 through which the clear separated liquid flows to the outlet opening 87.

The axle member 91 contains an outer basket drive shaft 99 rotatably carried upon an upper outer bearing 100 and a lower outer bearing 101. The drive shaft 99 includes a cap 104 threaded on the top thereof and a tubular extension 105 threaded on the bottom. A basket drive pulley 107 is fixed in driving relation to the extension 105 for the rotational drive of the shaft 99 by a suitable prime mover (not shown). A cone drive shaft 110 is rotatably mounted concentrically within the outer shaft 99 upon an upper bearing 111 within the cap 104 and a lower bearing 112 within the extension 105. A cone drive pulley 113 is fixed in driving relation to a lower extension of the cone drive shaft 110 and is adapted to be rotatably driven by a prime mover at a constant speed differential as compared to the basket pulley 107.

The bearings 111 and 112 are pressure lubricated from an oil inlet pipe 115 through a rotary oil joint 116 which is connected to a drilled concentric oil passageway 117 within the cone drive shaft 110. The cap 104 includes a drilled passageway 118 for the supply of oil from the passageway 117 to the outer bearings 100 and 101, and an oil outlet pipe 120 is tapped into the axle member 91 below the lower bearing 101 for the return and recirculation of lubricating oil.

The cap 104 includes an annular ledge 124 upon which a basket 125 is supported. The basket 125 includes a generally frustoconical upper section 130 and an enclosing annular bottom 131 joined to each other at reinforcing rings 132. The basket 125 is folded within

itself to form a cylindrical supporting wall 134 having an upper connection at the ledge 124 and a lower connection at the bottom 131.

An annular depending plate 136 is mounted on the bottom 131 and is extended downwardly into the pool forming chamber 93. A plurality of liquid outlet openings 140 are formed in the bottom 131, and each is coverable by a plate 141 by the adjustment of a screw 142 threadedly received in a block 143. The position of the plate 141 over the outer openings 140 defines the position of a liquid wall 145 established upon the operation of the centrifuge. The upper section 130 of the cone 125 is extended within the housing 84 of the frame 80 and is reinforced by a terminal annular ring 148 received for rotation within the housing 84.

An inlet casting 155 includes a collar 156 for mounting an upper end of the cone drive shaft 110 by a keyway 157 and a nut 158 with the shaft 110. The inlet casting 155 also includes a plurality of downwardly sloped, radially extended inlet tubes 159 on the upper surface of which is fixedly mounted a cone 160 for rotation therewith. A tubular neck portion 162 is formed on the casting 155 and is extended through the housing 84 to form a stock inlet opening 163 in communication with the inlet tubes 159 for the delivery and angular acceleration of stock into the interior of the centrifuge.

The cone 160 defines with the upper section 130 of the basket 125 an annular particle separating zone 170. Spiral fighting 171 is interposed within the zone 170 and fixed to the cone 160 for delivery of the particles centrifugally separated within the basket 125 toward the apex of the cone 160. The cone 160 is provided with a plurality of liquid escape openings 172 located radially within the liquid wall 145 established within the centrifuge by the rotation of the basket 125.

The basket 125 also carries on the ring 148 a pair of particle discharge vanes 175 which rotate within the housing 84. The casting neck portion 162 and the housing 84 define an annular air inlet 176 for the housing 84. Solid particles having the free liquid extracted therefrom are carried into the housing 84 by the fighting 171 and are removed through the outlet 85 by the vanes 175.

A radial screen 180 is fixed for rotation with the basket 125 by a cylindrical flange 181 secured to the wall 134 by any suitable means such as by welding. The screen 180 is extended into the liquid wall 145 in the path of flow between the inlet tubes 159 and the outlet openings 140 for the entrapment and entrainment of particles into the flow of stock from the inlet opening 163 to the zone 170. A circumferential depending skirt 182 may be fixed to the inner surface of the cone 160 for rotation within the liquid wall 145 for downwardly directing stock from the inlet tubes 159 along the wall 145. The skirt 182 aids in the reduction of foaming and agitation of the stock, and, at the same time, causes it to flow in more direct contact with the entire surface of the screen 180 for initial thickening.

It will be understood that the embodiment shown in FIG. 3 has certain structural advantages over the embodiment shown in FIG. 1 resulting in greater stability and capacity. The bottom portion 131 of the basket 125 is more nearly flattened and is therefore self-cleaning. The axle member 91 which carries the supporting shafts and bearings within the cylindrical wall 134 is arranged to utilize the interior space which would otherwise be unused and thereby provides a unit of relatively compact proportions and high capacity.

The operation of the centrifuge of FIG. 3 is essentially the same as that described for FIG. 1. The pulleys 107 and 113 are driven in the same direction at a constant speed differential with the magnitude of the differential being such that the spiral fighting 171 imparts a lifting action upon the stock within the separating zone 170. Liquid stock containing solid particles is admitted through the stock inlet opening 163 to the inlet tubes 159

which impart an acceleration to the stock to bring it substantially up to the angular speed of the stock within the basket 125 and discharge the stock adjacent the liquid wall 145. The gauge of the screen 180 is such that only clear liquid may pass through to the outlet openings 140, and the particles intended to be centrifugally separated are carried outwardly into the separating zone 170.

The spiral fighting 171 of FIG. 2 carries the already thickened stock toward the apex of the basket 125 where it is subjected to the deliquifying caused by the constriction of the spaces between the fighting as the stock proceeds upward. Preferably, the operation of the centrifuge is such that the space between the fighting 171 is filled with stock so that the counterflow of liquid, either spirally down the fighting, or between the fighting and the cone 160, is restricted. When this stock reaches a point on the cone 160 radially within the liquid wall 145 established by the outlet openings 140, the free liquid in the stock is provided with a path of lower resistance to the basket outlet openings 140 by means of flow through the cone openings 172.

The liquid thus separated at the cone openings 172, and the liquid previously centrifugally separated within the basket 125, flows through the outlet openings 140 into the chamber 93. From there it flows through the opening 96 in the spill wall 95 into the centrifuge outlet 87 for ultimate discharge or use, as the case may be. The deliquified particles are ejected by the fighting 171 into the vane housing 84 where they are acted upon by impingement with the vanes 175 for acceleration through the particle discharge outlet 85. It will be understood that by means of the control of the basket speed, the output consistency of the stock may be controlled and stabilized.

The centrifuges of the invention thus offer a plurality of practical advantages. They are comparatively simple to construct and maintain and they are also easy to control as noted to establish a desired consistency of the deliquified solid material. In particular, they are applicable to a wide variety of materials, including slurries containing abrasive solids, and they are especially efficient in the separation of particles lighter than the carrying liquid along with the heavier separated particles.

While the forms of apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise forms of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. A centrifuge for separating solid particles from a liquid slurry stock comprising, a generally conical rotatable basket having a closed bottom, a cone having an open base rotatably mounted within said basket and defining therewith an annular particle separating zone, drive means for rotating said cone and basket at a speed differential, spiral stock fighting fixed to said cone and interposed in said zone between said cone and said basket to cause said stock to travel toward the apex of said cone in response to relative rotation of said cone and basket, stock inlet means extending into the interior of said cone for delivery of said stock for outward flow into said separating zone, means in said basket defining a fiber discharge opening adjacent the apex thereof, a perforated separating screen fixed to rotate with said cone and extending outwardly within said basket and terminating in an outer periphery in spaced relation to the base of said cone and to the adjacent surface of said basket defining an annular opening between the interior of said cone and the interior of said basket, and means in said basket bottom defining an unrestricted liquid discharge opening positioned radially inwardly in relation to the periphery of said screen and operable to define a liquid wall in response to the rotation of said centrifuge which wall includes at least a portion of said screen.

2. A centrifuge for separating solid particles from a liquid stock comprising a generally conical rotatable basket having a closed bottom, a cone having an open base rotatably mounted within said basket and defining therewith an annular particle separating zone, drive means for rotating said cone and basket at a speed differential, spiral stock flighting fixed to said cone and interposed in said zone between said cone and said basket to cause said stock to travel toward the apex of said cone in response to relative rotation of said cone and basket, stock inlet means extending into the interior of said cone for delivery of said stock for flow into said separating zone, means in said basket defining a fiber discharge opening adjacent the apex thereof, means in said basket bottom defining a liquid discharge opening positioned radially of the axis of rotation to define a liquid wall in response to the rotation of said centrifuge, a radially extending perforated separating screen in said basket fixed to rotate with said cone and extending outwardly into said liquid wall and terminating in an outer periphery spaced from the base of said cone, the radial extent of said screen being less than the adjacent radial dimensions of the interior of said basket to define an annular opening there-

between providing for substantially unrestricted liquid flow therethrough from the inlet means to said liquid discharge opening.

3. The centrifuge of claim 1 further including means in said cone defining a plurality of openings positioned inwardly of said liquid wall to provide escape of separated liquid from said separating zone and recirculation of such liquid into the interior of said cone.

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