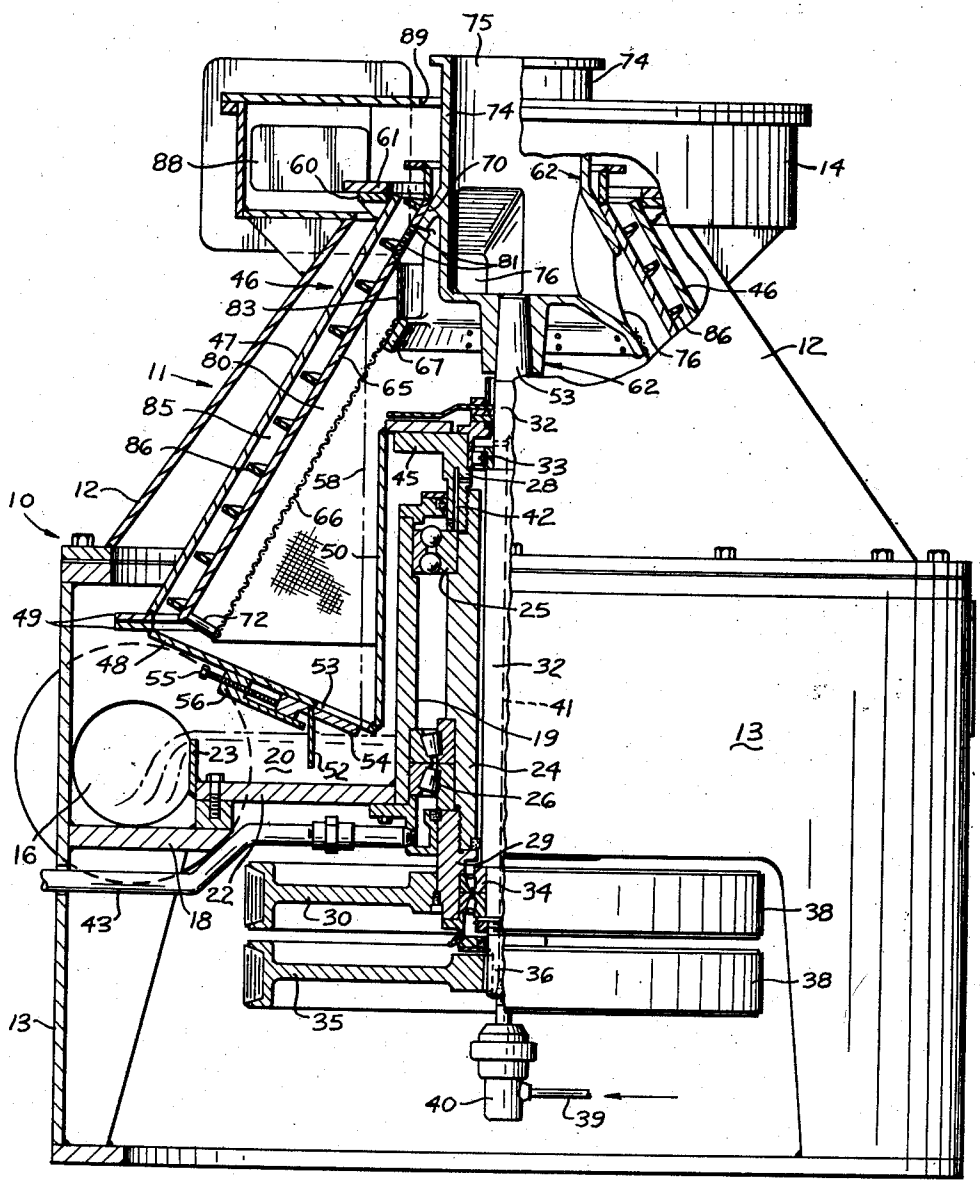
March 12, 1963 R. F. LACKER ETAL 3,081,026

CENTRIFUGE

Filed March 20, 1959

2 Sheets-Sheet 1

FIG-1



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CENTRIFUGE

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FIG-3

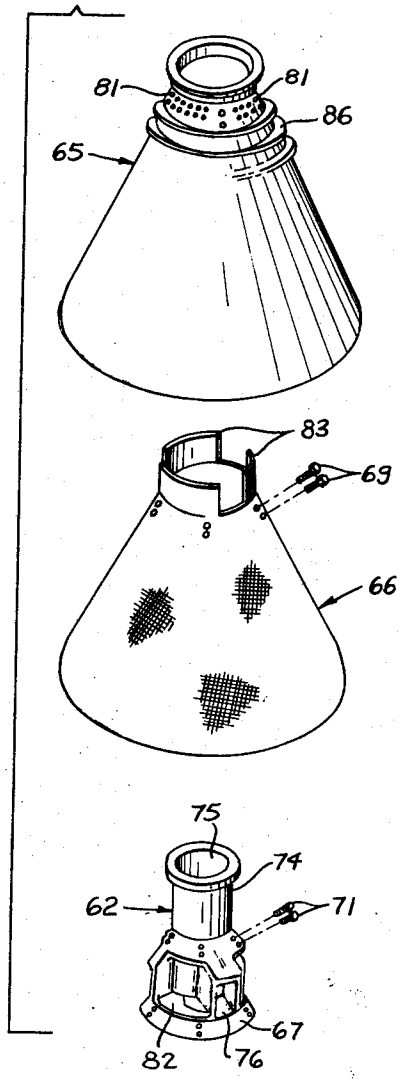


FIG-2

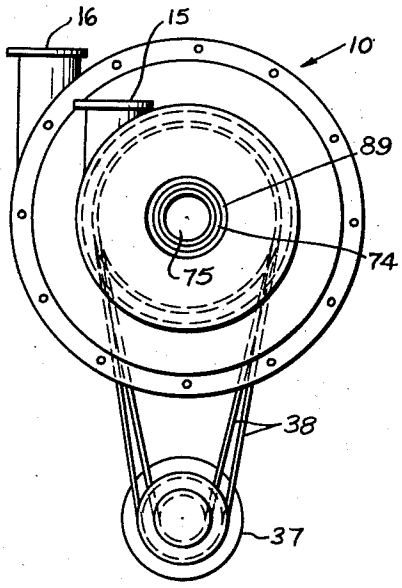
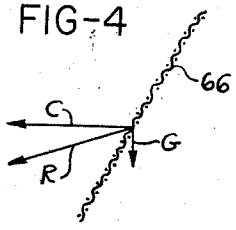


FIG-4



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3,081,026
CENTRIFUGE

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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 flighting, 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 is rotatably carried within the cone and the screen is arranged so that the particle movement is outward away from the screen to prevent abrasion and clogging. Openings are provided within the cone through which liquid carried by the flighting may escape directly into the interior of the basket without causing a counterflow against the particles and without 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 processes 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 therein and arranged so as to be self-cleaning and abrasion resistant.

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 and guide means for the delivery of the separated liquid to prevent remixing with the incoming stock.

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 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.

In the drawings—

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

FIG. 2 is a plan view of the centrifuge;

FIG. 3 is an exploded perspective view of the stock inlet, screen, and cone; and

FIG. 4 is a vector diagram of the forces on the conical screen.

Referring to the drawings, which illustrate a preferred embodiment of the invention, a centrifuge constructed according to the teachings of this invention is shown at **10** in FIG. 1. The centrifuge includes an outer encasing frame **11** having a generally frustoconical upper section **12** and a cylindrical bottom section **13** within which the rotary components of the centrifuge are contained. The frame **11** further forms a particle discharge housing **14** on the top of the upper section **12** which includes a particle outlet opening **15** as shown in FIG. 2. A liquid outlet opening **16** is formed by the bottom section **13**. The frame **11** further includes an internal floor **18** extended across the bottom section **13** and upon which is mounted a shaft-supporting axle member **19**. The floor **18** also includes means defining a pool forming liquid outlet chamber **20** in the form of a raised floor portion **22** circumferentially enclosed by a spill wall **23** over which the clear separated liquid flows to the outlet opening **16**.

The axle member **19** contains an outer basket drive shaft **24** rotatably carried upon an upper outer bearing race **25** and a lower outer bearing race **26**. The drive shaft **24** includes a cap **28** threaded on the top thereof and a tubular extension **29** threaded on the bottom. A basket drive pulley **30** is fixed in driving relation to the extension **29** for the rotational drive of the shaft **24**. A cone drive shaft **32** is rotatably mounted concentrically within the outer shaft **24** upon an upper bearing race **33** within the cap **28** and a lower bearing race **34** within the extension **29**. A cone drive pulley **35** is fixed in driving relation to a lower extension **36** of the cone drive shaft **32**. The pulleys **30** and **35** define means for driving the basket drive shaft **24** and the cone drive shaft **32** at a constant speed differential from any suitable source of power such as by a motor **37** and drive belts **38**.

The bearing races **33** and **34** are pressure lubricated from an oil inlet pipe **39** through a rotary oil joint **40** which is connected to a drilled concentric oil passageway **41** within the cone drive shaft **32**. The cap **28** includes a drilled passageway **42** for the supply of oil from the passageway **41** to the outer races **25** and **26**, and an oil outlet pipe **43** is tapped into the axle member **19** below the lower bearing race **26** for the return and recirculation of lubricating oil.

The cap **28** includes an integral annular ledge **45** upon which a basket **46** is supported. The basket **46** includes a generally frustoconical upper section **47** and an enclosing annular bottom **48** joined to each other at reinforcing rings **49**. The basket **46** is molded within itself to form a cylindrical supporting wall **50** having an upper connection at the ledge **45** and a lower connection at the bottom **48**.

An annular depending plate **52** is mounted on the bottom **48** and is extended downwardly into the pool forming chamber **20**. A plurality of liquid outlet openings **53** are formed in the bottom **48**, and each is coverable by a plate **54** by the adjustment of a screw **55** threadedly received in a block **56**. The position of the plate **54** over the outer openings **53** defines the position of a liquid wall **58** established in response to rotation of the basket **46** on the shaft **24** by the prime mover. The upper section **47** of the basket **46** is extended within the housing **14** of the frame **11** and is reinforced by a pair of terminal annular rings **60** and **61** received for rotation within the housing **14**.

A stock inlet casting **62** is mounted on the tapered upper end **63** of the cone drive shaft **32** for rotation therewith.

The inlet casting 62 includes means for supporting a cone 65 and a conical separating screen 66 in spaced relation, the arrangement of which is best shown in the exploded view of these centrifuge components in FIG. 3. An annular screen supporting flange 67 is dependently formed at the bottom of the casting 62 onto which the conical screen 66 is fixedly mounted by screws 69 for rotation therewith. The casting also includes a second annular flange 70 in spaced coplanar relation to the screen supporting flange 67 and upon which the cone 65 is fixedly mounted by screws 71 for rotation therewith. The screen 66 and the cone 65 are held in spaced relation at their bases by a plurality of spacing lugs 72.

A tubular neck portion 74 is formed on the casting 62 and is extended through the housing 14 to form a stock inlet means consisting of an inlet opening 75. Three stock inlet tubes 76 are radially formed in the casting 62 between the flanges 67 and 70 and are opened into the neck portion 74 for the downward delivery and angular acceleration of stock from the inlet opening 75 into an annular centrifuge annular stock inlet region 80 defined between the cone 65 and the screen 66. The arrangement of the screen 66 is such that it is interposed within the liquid wall 58 in the path of stock flow between the inlet means and the outlet openings 53 and adjacent the flow of stock within the inlet region 80.

The cone 65 is provided with a plurality of liquid escape openings 81 located radially within the liquid wall established upon the rotation of the basket 46 as described above. The casting 62 includes three liquid return openings 82 positioned between the inlet tubes 76 immediately below the escape openings 81. The screen 66 includes guide means for the delivery of liquid from the openings 81 in the cone 65 into the openings 82 in the casting 62 for delivery of clear separated liquid into the interior of the basket with a minimum of remixing with the incoming stock. This guide means includes three equally spaced shields 83 which prevent the liquid extracted at the openings 81 from reentering the region 80 between the screen 66 and the cone 65 and guide this extracted liquid through the openings 82 for ultimate discharge through the basket outlet openings 53.

The cone 65 defines with the upper section 47 of the basket 46 an annular particle separating zone 85. Stock elevator means in the form of spiral flighting 86 is interposed within the zone 85 and fixed to the cone 65 for delivery of the particles centrifugally separated within the basket 46 toward the apex of the cone 65 in response to the relative rotation of the basket and the cone. The basket 46 also carries on the rings 61 a pair of particle discharge vanes 88 which rotate within the housing 14. The casting neck portion 74 and the housing 14 define an annular air inlet 89 for the housing 14. Solid particles having the free liquid extracted therefrom are carried into the housing 14 by the flighting 86 and are removed through the outlet 15 by the vanes 88.

In the operation of the centrifuge, the pulleys 30 and 35 are driven by the motor 37 in the same direction at a constant speed differential with the magnitude of the differential being such that the spiral flighting 86 imparts a lifting action upon the stock within the separating zone 85. Liquid stock containing solid particles is admitted through the stock inlet opening 75 to inlet tubes 76 which impart an acceleration to the stock to bring it substantially up to the angular speed of the stock within the basket 46 and which discharge the stock into the inlet region 80 between the cone 65 and the screen 66, and substantially at the liquid wall 58.

The gauge of the conical screen 66 is such that only clear liquid may pass through to the outlet openings 53, and the particles intended to be centrifugally separated are carried outwardly within the region 80 along the inside surface of the cone 65 into the separating zone 85. The screen 66 is both self-cleaning and abrasion resistant

as is illustrated in FIG. 4, wherein the gravity vector of any particle adjacent the screen is represented as G. The vector of the centrifugal force on the particle is shown as C, and the resultant of C and C is represented by the vector R. The resultant vector R is away from the screen, and as the mass of the particles is taken as greater than the mass of the liquid, the particles move generally away from the screen 66 without clogging or abrading.

The arrangement of the screen in this invention makes possible the separation of mixtures wherein some of the particles have lower specific gravities than the specific gravity of the liquid. 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 centrifuge liquid outlet 15 due to the interposition of the separating screen 66, and such of those particles which may tend to collect upon the screen become entrained by the flow of the stock within the region 80 from the inlet tubes 76 into the separating zone 85 where they are acted upon by the spiral flighting 86.

The spiral flighting 86 carries the already thickened stock toward the apex of the basket 46 where it is subjected to the deliquifying caused by the constriction of the spaces between the flighting as the stock proceeds upward. When the stock reaches a point on the cone 65 radially within the liquid wall 58 established by the outlet openings 53, the remaining free liquid is extracted by the escape openings 81. This extracted liquid is prevented from remixing with the stock between the screen and the cone by the shields 83 and is directed through the return openings 82 in the casting 62 for downward flow as a film along the liquid wall 58 to the outlet openings 53.

The separated liquid at the openings 53 flows outward against the plate 52 and into the pool forming chamber 20 as a continuous film without foam-causing agitation. The liquid within the chamber 20 flows over the spill wall 23 into the outlet 16. The deliquified particles are carried by the flighting 86 for ejection into the housing 14 where they are caught up in the air circulated by the vanes 88 and blown through the particle outlet opening 15. 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 centrifuge of the invention thus offers a plurality of practical advantages. It is comparatively simple to construct and maintain and easy to control as noted to establish a desired consistency of the deliquified solid material. In particular, it is applicable to a wide variety of materials, including slurries containing abrasive solids, and is especially efficient in the separation of particles lighter than the carrying liquid along the heavier separated particles.

While the form of apparatus herein described constitutes a preferred embodiment of the invention, it is to be understood that the invention is not limited to this precise form 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. In a centrifuge for separating solid particles from a liquid slurry stock, the combination of a generally conical rotatable basket having an annular bottom, a cone rotatably mounted coaxially within said basket and defining with said basket an annular particle separating zone, a conical screen coaxially mounted within said cone for rotation therewith and defining therebetween an annular stock inlet region, stock inlet means adjacent the apex of said cone for delivering stock into said inlet region for outward flow into said separating zone, drive means operable to rotate said cone and said basket at a constant speed differential, spiral stock flighting fixed for rotation with said cone and interposed 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 said basket, means in said basket bottom defining a liquid outlet spaced radially of the axis of rotation of said basket and inwardly in relation to the bottom of said cone to establish a liquid wall within said cone in response to rotation of said cone and basket, means defining openings in said cone located radially inwardly of said liquid wall, and means positioned adjacent said openings for receiving liquid therefrom and delivering such liquid to the interior of said basket at a point disposed inwardly in relation to said screen to minimize remixing thereof with said stock.

2. In a centrifuge for separating solid particles from a liquid slurry stock, the combination of a generally conical rotatable basket having an annular bottom, a cone rotatably mounted coaxially within said basket and defining with said basket an annular particle separating zone, stock inlet means for delivering stock into the interior of said cone for outward flow into said separating zone, drive means operable to rotate said cone and said basket at a speed differential, spiral stock flighting fixed to rotate with said cone and interposed 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, means in said basket bottom defining a liquid outlet spaced radially of the axis of rotation of said basket and inwardly in relation to the bottom of said cone to establish a liquid wall within said cone in response to rotation of said cone and basket, a separating screen interposed in the path of stock flow between said inlet means and said outlet, means defining openings in said cone located radially inwardly of said liquid wall for the removal of liquid from said zone, and liquid guide means fixed to rotate with said cone and positioned adjacent said openings to receive liquid therefrom for delivery to said outlet at a point between said screen and said outlet.

3. In a centrifuge for separating solid particles from a liquid slurry stock, the combination of a generally conical rotatable basket having an annular bottom, a cone rotatably mounted coaxially within said basket and defining with said basket an annular particle separating zone, stock inlet means for delivering stock into the interior of said cone for outward flow into said separating zone, drive means operable to rotate said cone and said basket at a speed differential, spiral stock flighting fixed to rotate with said cone and interposed 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, means in said basket bottom defining a liquid outlet spaced radially of the axis of rotation of said basket and inwardly in relation to the bottom of said cone to establish a liquid wall within said cone in response to rotation of said cone and basket, a separating screen interposed in the path of stock flow between said inlet means and said outlet, means defining openings in said cone located radially inwardly of said liquid wall for the removal of liquid from said zone, and said stock inlet means including liquid guide means positioned to receive liquid from said openings for delivery to said outlet at a point between said screen and said outlet.

4. A centrifuge for separating solid particles from a liquid slurry stock, comprising a generally conical rotatable basket having a closed bottom, a cone rotatably mounted coaxially within said basket and defining with said basket an annular particle separating zone, drive means operable to rotate said cone and said basket at a speed differential, spiral stock flighting 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, a conical perforated separating screen received within and fixed to said cone in inwardly spaced relation thereto for rotation therewith, said screen defining with said cone a stock inlet region including an annular stock exit opening between the bottom of said screen and the adjacent surface of said cone, stock inlet means adjacent the apex of said cone arranged to discharge stock into said inlet region between said cone and screen for outward flow through said annular opening into said separating zone, and means in said basket bottom defining an unrestricted liquid discharge outlet for the centrifuge positioned radially inwardly in relation to the base of said screen to define a liquid wall which includes at least a portion of said screen in response to the rotation of the centrifuge.

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