

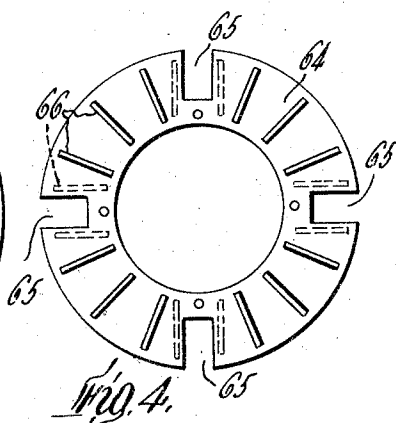
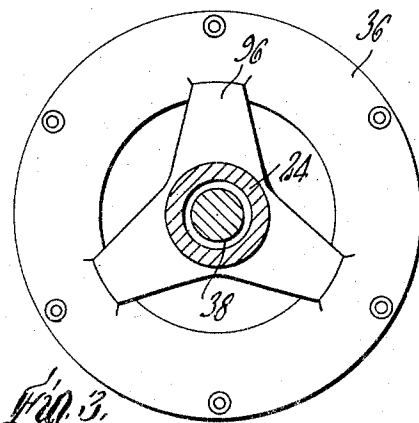
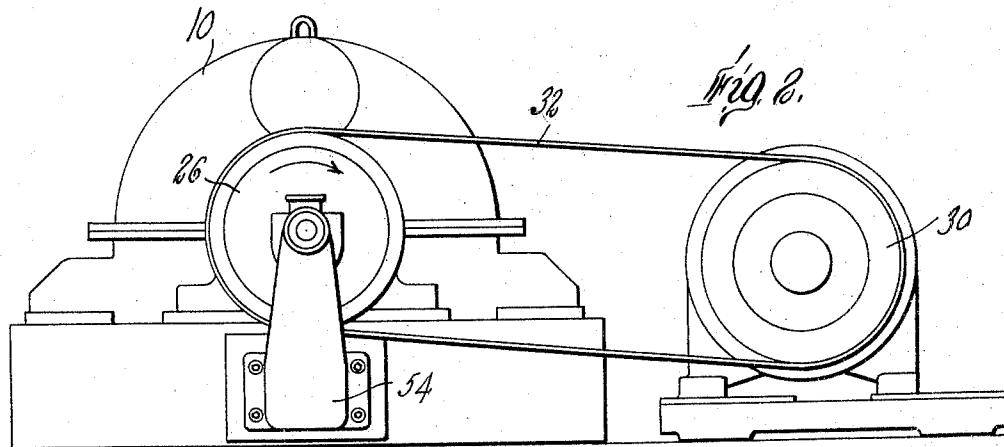
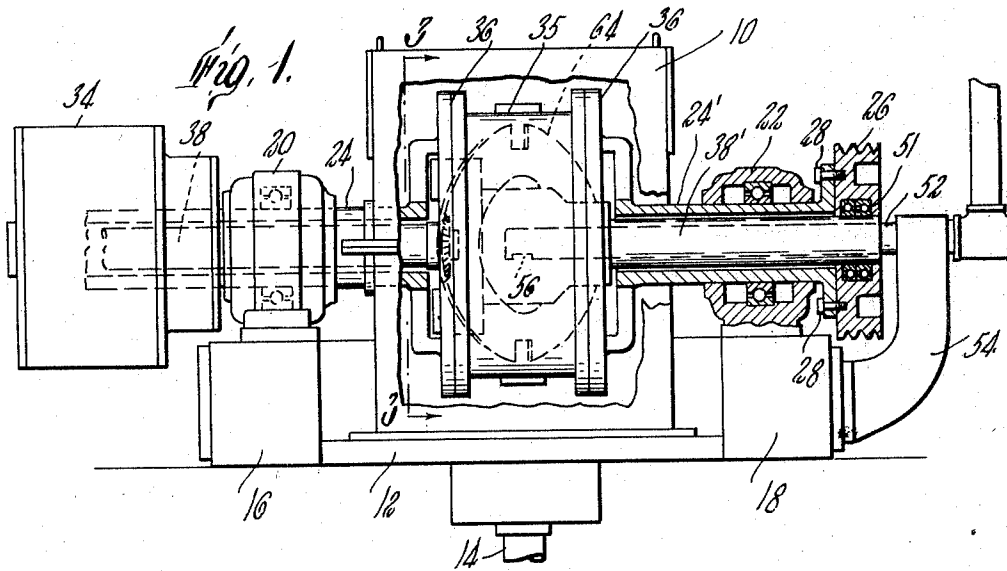
Oct. 14, 1958

H. F. COOK ET AL
CENTRISWEEP

2,856,124

Filed Sept. 6, 1956

3 Sheets-Sheet 1



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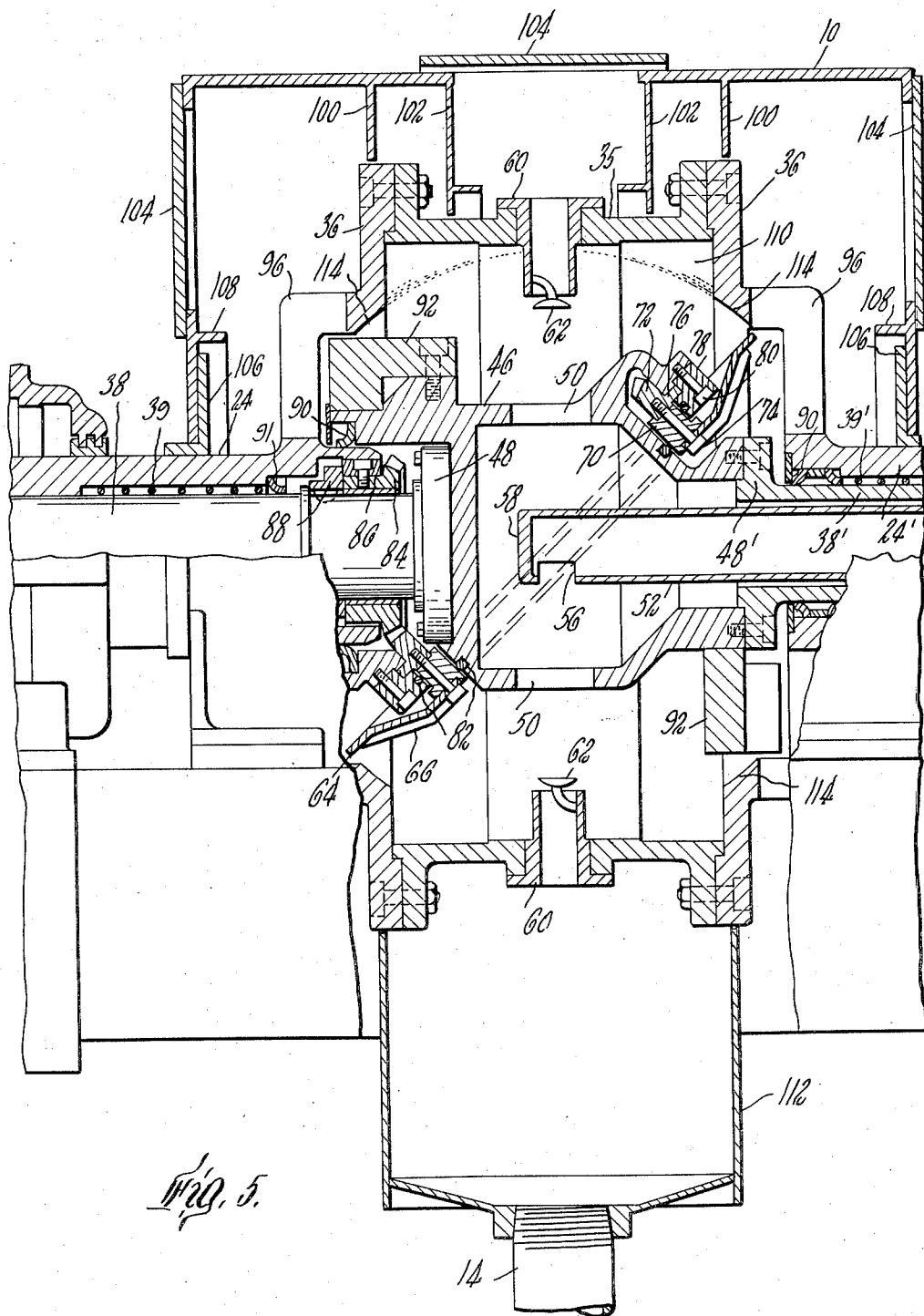
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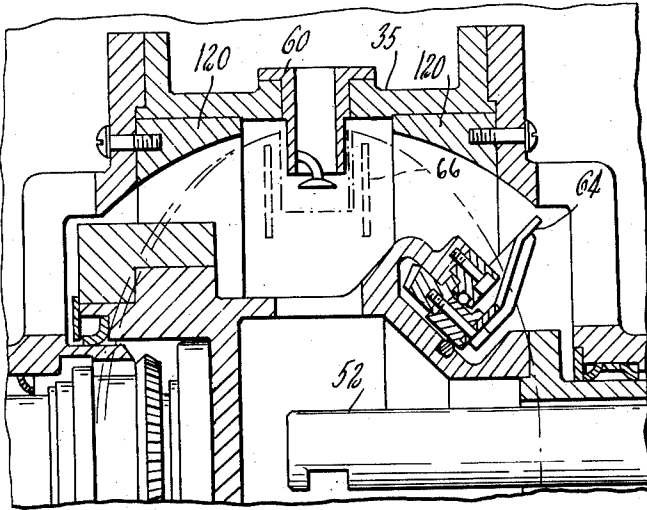


Fig. 6.

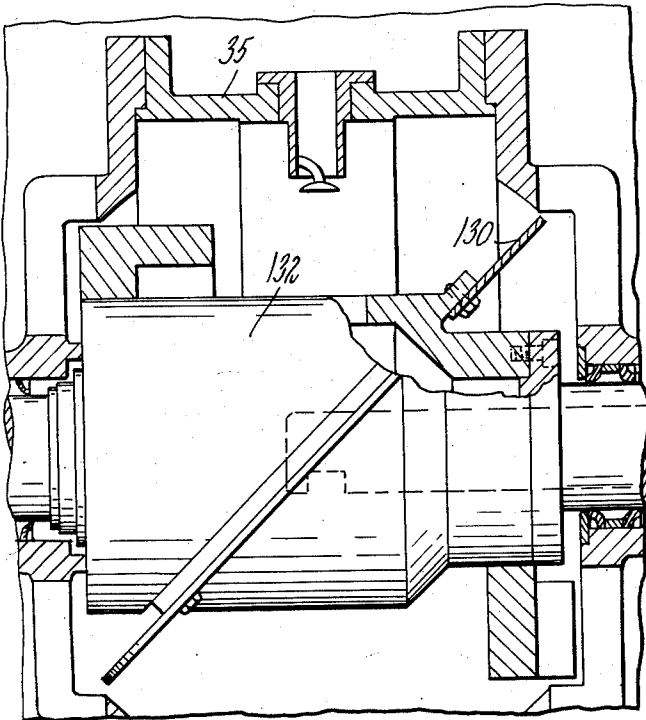


Fig. 7.

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2,856,124

CENTRISWEEP

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6 Claims. (Cl. 233—7)

This invention relates to a centrifugal separator of the type having a sweeper blade for sweeping the interior of the centrifuge bowl to remove the solid particles of the centrifuged material from the bowl endwise thereof, the separation of the solid particles from the liquid being carried out by centrifugal sedimentation.

One object of the present invention is to provide a centrifugal separator of the foregoing type constructed and arranged to handle a slurry containing friable solid particles with a minimum of degradation and attrition of the particles.

Another object is to provide a separator of the type described capable of handling liquid suspensions of fibrous material without jamming and with a minimum of tearing or degradation of the fibers.

Another object is to provide a centrifugal separator of the type described having an improved construction in which the interior rotating assembly as a whole can be dynamically balanced.

Another object is to provide a centrifugal separator for which means for driving the sweeper blade are shielded from contact with the material to be centrifuged.

Still another object is to provide such a separator in which the relative movement of the centrifuge bowl and of the sweeper blade is such that each particle of centrifuged material swept out of the bowl follows a smoothly curved path of the same geometrical shape across the interior of the bowl, the periphery of the sweeper blade being maintained perpendicular to the path of sweeping at each point on the path to minimize the shearing, or fracturing forces on any solid particles being swept out.

A further object is to provide such a separator in which the rotational speed of the sweeper blade about its own axis is substantially constant, thereby maintaining a substantially uniform load on the sweeper blade rotating mechanism and avoiding problems of backlash.

Other and further objects will be apparent from the drawing and from the description which follows:

In the drawings:

Fig. 1 is a view in side elevation, partly broken away and in section, of one embodiment of the invention;

Fig. 2 is a view in end elevation of the embodiment shown in Fig. 1;

Fig. 3 is a view in section taken along the line 3—3 of Fig. 1;

Fig. 4 is a view in elevation of the sweeper blade;

Fig. 5 is a view in side elevation on an enlarged scale, partly broken away and in section, showing the manner in which the sweeper blade is mounted within the rotary bowl;

Fig. 6 is a view in cross-section showing another embodiment of the invention; and

Fig. 7 is a view in cross-section showing still a third embodiment of the invention.

Referring to Fig. 1, the device of the present invention comprises a housing 10 mounted on a support 12 having an outlet 14 for liquid effluent material. A pair of pedes-

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tals 16, 18 support main bearings 20, 22 in which are journaled aligned hollow shafts 24, 24'. Sheave 26 is secured to the flanged end of shaft 24' by means of bolts 28, 28 and is driven from motor 30 by means of belt 32.

Rotary bowl 35 is supported between and secured to opposing ends of shafts 24, 24' by means of spiders 36, 36, bowl 35 being located within stationary housing 10 and being rotatably driven together with shafts 24, 24' by means of motor 30 (Fig. 2).

At the opposite end of shaft 24 and driven therefrom is a differential drive mechanism 34 of the type described in Piper U. S. Patent 1,962,461 granted June 12, 1934. Within the interior of hollow shaft 24 is mounted a second shaft 38 supported by bushing 39 and driven from drive mechanism 34, which may be adjusted to provide any desired speed ratio between shafts 24 and 38. It will be understood that any other suitable means may be provided for maintaining a predetermined differential between the speeds of the two shafts. In practice it has been found that a ratio of the order of 144:143 is satisfactory but it will be understood that the ratio may be varied over a wide range.

Shaft 38 serves to support and rotate a hub member 46 (Fig. 5) bolted to a flanged end 48 of shaft 38 within rotary bowl 35 so that bowl 35 and hub 46 have a common axis of rotation. Hub 46 is provided with diametrically opposing passages 50, 50 connecting the interior of hub 46 with the interior of rotary bowl 35, and is supported at its opposite end by bushing 39' on hollow shaft 38', being secured thereto by bolting to flanged end 48'. The free end of shaft 38' is positioned by thrust bearings 51 within sheave 26.

Extending through hollow shaft 38' is a stationary influent supply pipe 52 mounted on bracket 54 which is secured to pedestal 18. An aperture 56 adjacent the inner closed end 58 of supply pipe 52 at the center of hub 46 is provided to introduce the liquid influent or slurry into the interior of the device, the influent passing through apertures 50, 50 in hub 46 as the latter rotates.

A pair of oppositely disposed effluent discharge pipes 60, 60 extend inwardly from the periphery of rotary bowl 35, each pipe being adjustable in position and provided with a deflector 62, 62 which serves to deflect influent slurry as it emerges through openings 50, 50 and prevent loss of feed solids into the filtrate.

Sweeper blade 64 (Fig. 4) has a generally closed periphery matching that of the interior of bowl 35, being preferably of generally circular configuration and is mounted on hub 46 (Fig. 5) for rotation about its own axis of symmetry, as represented by a line passing through the center of blade 64 perpendicular to the plane defined by its periphery. The axis of symmetry of blade 64 intersects the axis of rotation of bowl 35 and of hub 46 at an acute angle, so that as bowl 35 rotates with respect to hub 46 about their common axis of the plane of rotation of the blade oscillates with respect to the bowl with the margin or periphery of the blade sweeping across substantially the entire inner face of the shell from end to end. At every position of blade 64, opposite portions of its periphery extend adjacent opposite ends of bowl 35. To permit simultaneous rotation of blade 64 about its own axis of symmetry, it is secured to bearing ring 70 and to ring gear 72 by means of bolts 74, 74. Ring gear 72 is provided with a radially outwardly extending flange 76 which is engaged by an overlying shoulder of locking ring 78 which in turn is secured to a flange of hub 46 by means of bolts 80, 80. Two O-rings 82, 82 are provided to seal ring gear 72 from contact with the slurry entering the hub and rotary shell through inlet 56.

Meshing with ring gear 72 and serving to drive the same is a pinion gear 84 mounted for rotation about

shaft 38, and keyed at 86 to shaft 24 for rotation therewith. The ratio of diameters of ring gear 72 to pinion 84 in the embodiment illustrated is 2:1, although other suitable ratios may be employed. A conventional thrust ring 88 is secured in place on shaft 38 by means of a snap ring. Seals 90, 90 are provided to prevent access of the slurry or its components to the shaft bearings or to the gears, while seal 91 serves to contain the lubricant for the gears. Bolted to hub 46 and extending axially outwardly beyond rotary bowl 35 are members 92, 92 which serve to balance the unsymmetrical distribution of mass of hub 46, ring gear 72 and blade 64, and also serve as plows to remove from the interior of spokes 96 of spider 36 any accumulated material which tends to build up in these locations.

Because of the 2:1 ratio between ring gear 72 and pinion 84 and the speed differential between bowl 35 and hub 46 (on which sweep plate 64 is mounted), bowl 35 advances 90° with respect to sweep blade 64 during each one-half revolution of the sweep blade about the axis of bowl 35. Accordingly, it is necessary to provide four gaps or apertures 65, 65 (Fig. 4) which are 90° apart in the periphery of sweep blade 64 to permit it to pass the two discharge pipes 60, 60 during its sweeps. Since the path across the face of bowl 35 traced by these apertures is different during the return half of the sweep of blade 64, any particulate material left during the first half of the sweep in the track of the gaps 65 is swept out during the return half. Blade 64 may also be provided with ribs 66, 66 which serve both as reinforcing or strengthening elements and as deflectors tending to prevent material from sliding across the face of rotating blade 64 and through gaps 65, 65.

Baffles 100, 100, 102, 102 are provided within the interior of stationary housing 10 to compartmentalize this housing and separate the central zone between baffle members 102, 102 into which discharge pipes 60 empty, from the side compartments adjacent spiders 36, 36. Access openings provided with removable covers, 104, 104 may be provided at any suitable locations about stationary housing 10. A labyrinth type seal between shaft 24 and housing 10 is provided by means of finger plates 106, 106 which are secured to shaft 24 adjacent the end walls of housing 10. Semi-circular shields 108, 108 are provided extending inwardly from the walls of housing 10 and overlying the upper half of finger plates 106, 106 as seen in Fig. 5 to deflect toward the interior of housing 10 any material running down the walls of the housing.

In operation of the device, rotary bowl 35 is driven together with shaft 24, 24' at any suitable speed, say from 1000 to 3000 R. P. M., in the case of a machine having a bowl 35 which is 15 inches in diameter, by means of motor 30, belt 32 and sheave 26. Simultaneously hub 46 is driven from shaft 38 through drive mechanism 34 at a slightly lower speed, hub 46 rotating in the same direction as rotary bowl 35. When bowl 35, for example, is driven at 1800 R. P. M. and the speed ratio in drive mechanism 34 is 144:143, the speed of hub 46 is 1787½ R. P. M., so that bowl 35 rotates at a speed of 12½ R. P. M. with respect to hub 46. This difference in speed may be varied without limit, but preferably is from 4 to 40 R. P. M. Because of this speed differential the plane defined by the outer periphery of sweep blade 64 mounted on hub 46 oscillates with respect to bowl 35, sweeping from one end of the bowl adjacent shaft 24 to the other end adjacent shaft 24', the number of cycles per minute being equal to the speed differential, which in the specific example given above is at the ratio of 12½ cycles per minute. Furthermore, sweep blade 64 is simultaneously rotated about its own axis of symmetry by the interaction of ring gear 72 and pinion 84, so that the total speed of rotation of the sweep blade about the axis of the hub

is different from the speed of the bowl and the speed of the hub and midway between these two speeds when the ratio of ring gear 72 to pinion 84 is 2:1. That is, the speed of blade 64 about its own axis of symmetry is 6¼ R. P. M. with respect to the hub 46. Accordingly, the apparent speed of blade 64 with respect to bowl 35 (measured about the axis of rotation of bowl 35) is also 6¼ R. P. M., the speed of blade 64 about the axis of the hub being intermediate the speed of the hub and the bowl. This rotation of sweep blade 64 simultaneously about two divergent axes causes each portion of the periphery of blade 64 to sweep across the inner face of bowl 35 with the blade being maintained substantially perpendicular to the direction of sweep at each point along the path and with a minimum of shearing effect upon the material being swept out of bowl 35, as will be explained more fully hereinafter.

The slurry which is to be separated into its solid and liquid components is introduced through inlet pipe 52 and emerges through aperture 56 into the interior of hub 46 whence it passes through passages 50, 50 into the interior of rotary bowl 35, on opposite sides of sweep blade 64, and impinges upon the inner face of the generally cylindrical bowl 35, being held in place by centrifugal force as bowl 35 rotates. Because the slurry is equally divided between passages 50, 50 each of which is always on the opposite side of sweep blade 64 from the other aperture, there is a balanced load on opposite faces of the sweep blade as well as on bowl 35. In other words, the influent slurry is deposited uniformly and progressively on the inner face of bowl 35 in synchronism with the sweeping advance of sweep blade 64. The centrifugal force also causes the first particles of the slurry introduced to become concentrated adjacent the inner face of bowl 35, separating from the lighter liquid component to build up a layer or bed of solid particulate material 110 as shown in Fig. 5. As soon as sufficient slurry has been introduced, the liquid from which the solid particles 110 have been separated begins to overflow the inner margin of outlet pipes 60, 60 whence it passes into the zone between baffles 102, 102 of housing 10 and accumulates in chamber 112 at the bottom of housing 10 whence it may be withdrawn through effluent pipe 14 at the same rate at which it is introduced thereafter.

While the solid particulate material 110 is accumulating in a layer adjacent the inner face of rotary bowl 35, sweep blade 64 is sweeping slowly back and forth and sweeps the solid material toward spiders 36, 36 until a bed of solid material has accumulated in the form shown in Fig. 5. Thereafter each sweep of sweep blade 64 scrapes all additional centrifugally settled solid material from the surface of the bed and sweeps it across arcuate faces 114, 114 of spiders 36, 36 into the side compartments of housing 10. It will be noted that the position of outlet pipes 60, 60 is adjusted so that the level of liquid within rotary shell 35 reaches to a point between pipes 60 and the outer margins of faces 114. That portion of the arcuate faces 114 together with any portion of the bed of solid particles beyond the margin of the liquid may be termed a "beach" across which the solid particles are swept or scraped by blade 64. This mode of operation permits substantially complete separation of the solid and liquid phases as the solid is swept across the beach by sweep blade 64. Any solid material impinging upon the inner face of spokes 96, 96 is removed by plows 92, 92 and the solid material drops out the bottom of the side compartments of housing 10, into any suitable storage or conveying means.

The construction of the present device provides for relative rotation of sweep blade 64 simultaneously about two axes with respect to rotary bowl 35, and provides that the outer margin of sweep blade 64 is substantially perpendicular at all times during each sweep to the path or track of each solid particle being swept across

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the bed of solid material 110 and the beach. This construction and mode of operation provides for a direct push upon each solid particle substantially in the direction of travel of the particle at all times and moves each particle out of rotary bowl 35 with a minimum shearing effect of sweeper blade 64 upon solid particles.

This minimal shear effect provides improved operation of the device when separating frangible or friable crystalline materials from liquid slurries. The solid material separated from the slurry by the action of the present device is remarkably free from broken or fractured particles, as well as free from scratches on the smooth faces of the particles, a feature which is particularly important in the case of certain crystalline materials such as sugar and a variety of other organic and inorganic crystalline solids. The minimal shear effect also makes the machine of the present invention particularly useful for separating fibrous material from liquid suspensions with strikingly improved results as compared with conventional centrifugal separators. When used with such fibrous suspensions the machine is remarkably free from jamming, does not appreciably tear or degrade the fibers, and provides highly effective separation of liquid from the fibers.

As pointed out above, the solid portion of the slurry may be allowed to accumulate within rotary bowl 35 to form a bed across the surface of which fresh solid material is swept out of bowl 35 by means of sweeper blade 64. However, in the embodiment shown in Fig. 6, the accumulation of the bulk of this solid material is rendered unnecessary by the provision of filler members 120, 120 made of any suitable material such as rubber, plastic, stainless steel, etc., and shaped to provide a generally spherical inner surface for bowl 35. This embodiment provides for use of the machine with slurries containing solids which might decompose if allowed to stand for appreciable periods of time.

There is shown in Fig. 7 still another embodiment of the invention in which sweeper blade 130 is rigidly secured directly to hub 132 as by bolting thereto. In this embodiment of the invention, in which sweeper blade 130 rotates about only a single axis of rotation, namely the axis of rotation of hub 132 and of rotary bowl 35, there is a small amount of shear between the face of the sweeper blade and the particles of solid material being swept out of bowl 35. However, only two apertures 65, 65 in the periphery of sweeper blade 130 which are 180° apart are required in this embodiment, in order to clear any given number of outlet pipes provided they all lie in the same plane perpendicular to the axis of rotation. In addition, in this embodiment the bowl 35 may be polygonal instead of circular in cross-sectional configuration and blade 130 may have a mating or matching polygonal periphery. Indeed, in this embodiment blade 130 may be polygonal even when bowl 35 is cylindrical or spherical, the centrifugally settled solid particles building up on the inside of bowl 35 providing a configuration which matches that of blade 130. While this small amount of shear may be tolerated in the case of certain solid materials without producing excessive fracturing or tearing of the solid material, the embodiments of Figs. 5 and 6 in which the sweeper blade 64 rotates about its axis of symmetry are preferred.

Although specific embodiments of this invention have been described herein, it is not intended to limit the invention solely thereto but to include all of the obvious variations and modifications within the spirit and scope of the appended claims.

We claim:

1. A centrifugal separator comprising a rotary bowl, a hub mounted within said bowl for rotation about the axis of rotation of said bowl, a sweeping blade mounted on said hub within said bowl, said blade having a periphery lying generally in a plane, the axis of symmetry normal to said plane intersecting the axis of rotation of the bowl at an acute angle with opposite portions of

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the periphery extending adjacent opposite ends of the bowl, said blade being mounted for rotation with respect to the hub about said axis of symmetry, and means for rotating said bowl and said hub simultaneously at different speeds in the same direction about said axis of rotation and for simultaneously rotating said blade about said axis of symmetry at a speed different from both the speed of the bowl and the speed of the hub about said axis of rotation while maintaining a fixed ratio between the speed of the bowl and that of the blade to cause the blade to sweep the bowl from end to end and to remove material from the bowl endwise thereof.

2. A centrifugal separator as defined in claim 1 in which the hub and bowl both rotate in the same direction with the hub rotating at a speed less than that of the bowl, and the apparent rotation of the blade about the axis of rotation of the bowl is in the same direction as the hub and bowl and at a speed intermediate that of the hub and that of the bowl.

3. A centrifugal separator as defined in claim 1 in which the difference in speed between the hub and the bowl is from 4 to 40 revolutions per minute, and the speed of the blade is approximately one-half of said difference.

4. A centrifugal separator comprising a rotary bowl, a hub mounted within said bowl for rotation about the axis of rotation of the bowl, a sweeping blade having a closed periphery lying generally in a plane mounted on said hub within said bowl with the axis of symmetry normal to the plane of the periphery of the blade intersecting the axis of rotation of said bowl at an acute angle whereby opposite portions of said periphery extend adjacent opposite ends of said bowl, means for rotating said bowl and said hub simultaneously in the same direction while maintaining a fixed ratio between the speed of the bowl and that of the hub, and drive means interconnecting said bowl and said blade for simultaneously rotating said blade about said axis of symmetry at a speed different from both the speed of the hub and the speed of the bowl while maintaining a fixed ratio between the speed of the bowl and that of the blade, whereby the periphery of the blade sweeps the interior of the bowl from end to end to remove therefrom endwise of the bowl a portion of the centrifuged material.

5. A centrifugal separator as defined in claim 4 in which the drive means includes a gear mounted for rotation with said bowl and a second gear intermeshing with the first mounted for rotation with said blade about said axis of symmetry and in which said hub includes means for shielding said gear from contact with the material being centrifuged within said bowl.

6. A centrifugal separator comprising a rotary bowl, a hub mounted within said bowl for rotation about the axis of rotation of the bowl, means for rotating said bowl and hub simultaneously while maintaining a fixed ratio between the speeds thereof with the speed of the bowl exceeding that of the hub by 4 to 40 revolutions per minute, a sweeping blade having a generally circular periphery mounted on said hub for rotation about the axis of symmetry of the periphery of the blade, said axis of symmetry intersecting the axis of rotation of the hub and bowl at an acute angle whereby opposite portions of the periphery extend adjacent opposite ends of the bowl, the blade sweeping the interior of the bowl from end to end upon rotation of said bowl and hub to remove endwise of the bowl a portion of the centrifuged material, and means interconnecting said bowl and blade for simultaneously rotating the blade about said axis of symmetry while maintaining the speed of the blade with respect to the hub about said axis of symmetry equal to a fixed fraction of the difference in speed between the hub and the bowl.

References Cited in the file of this patent

UNITED STATES PATENTS

2,414,421 Small Jan. 14, 1947

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,856,124

October 14, 1958

Horace F. Cook et al.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 49, for "gear" read -- gears --.

Signed and sealed this 27th day of January 1959.

(SEAL)
Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents