June 21, 1966 L. M. KOELSCH 3,256,994

CENTRIFUGAL SEPARATOR

Filed Feb. 11, 1963 3 Sheets-Sheet 1

Fig. 1.

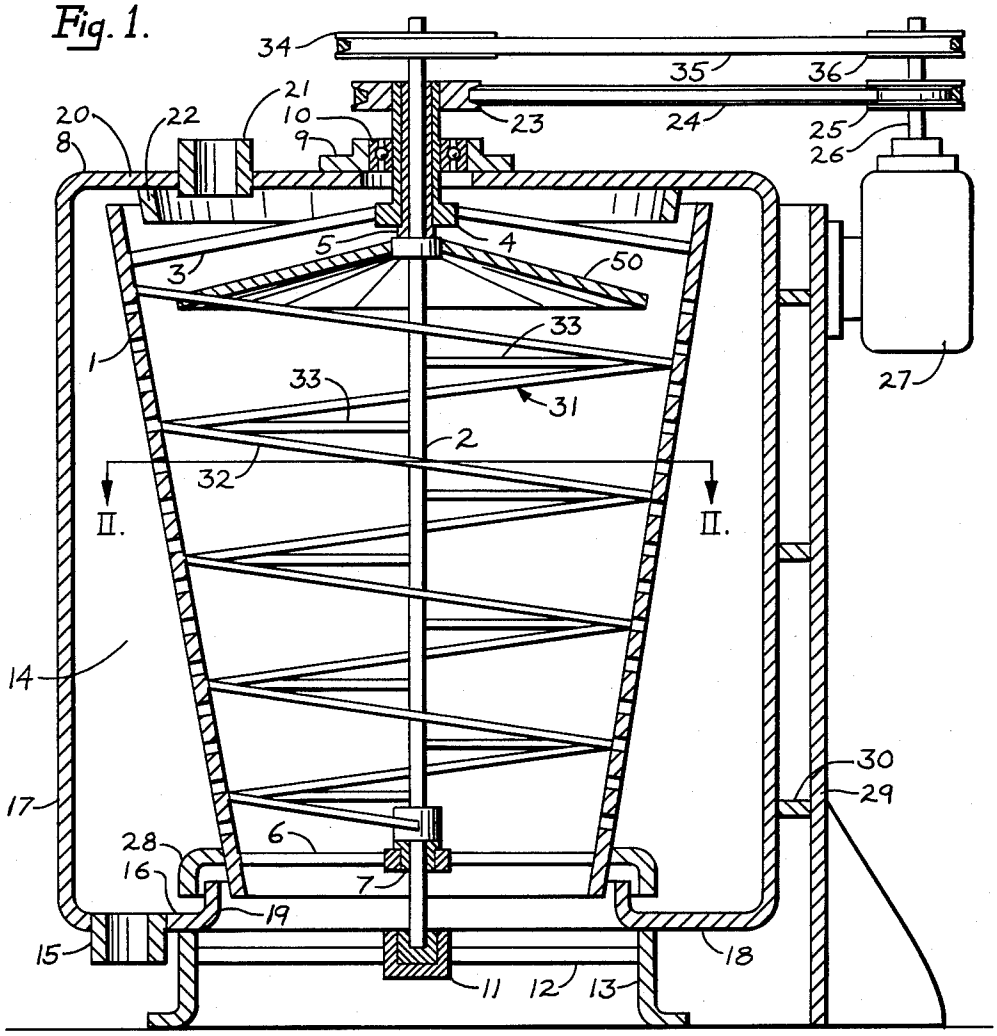
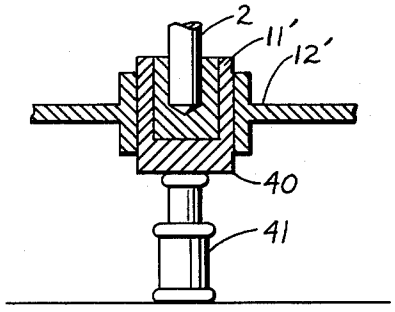


Fig. 4.



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Fig. 2.

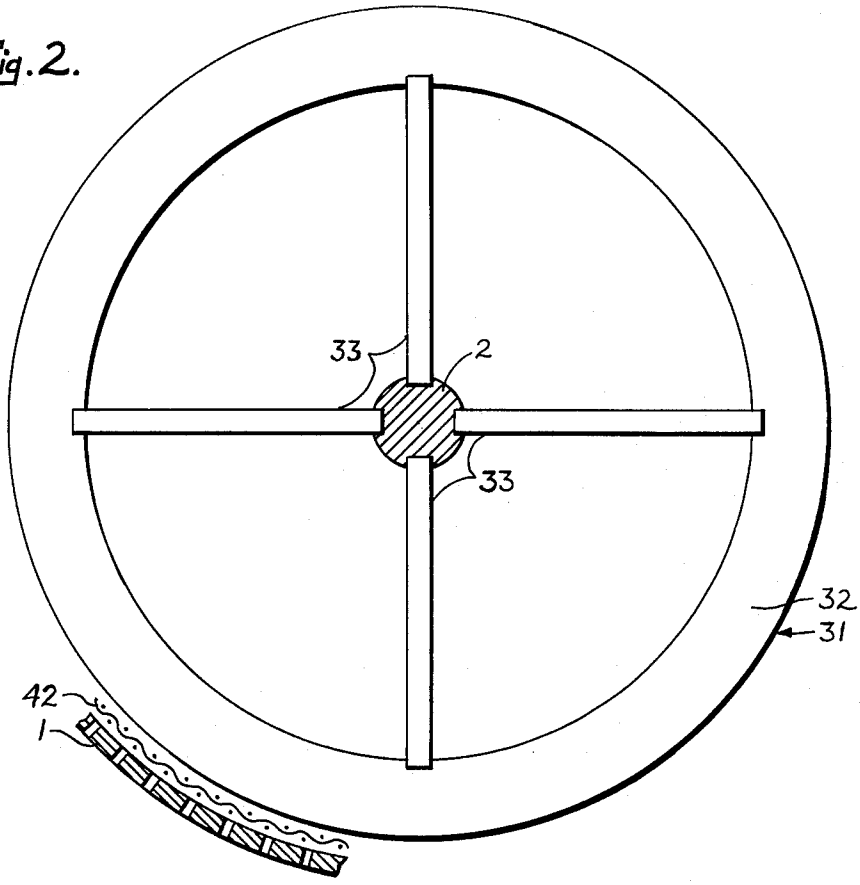
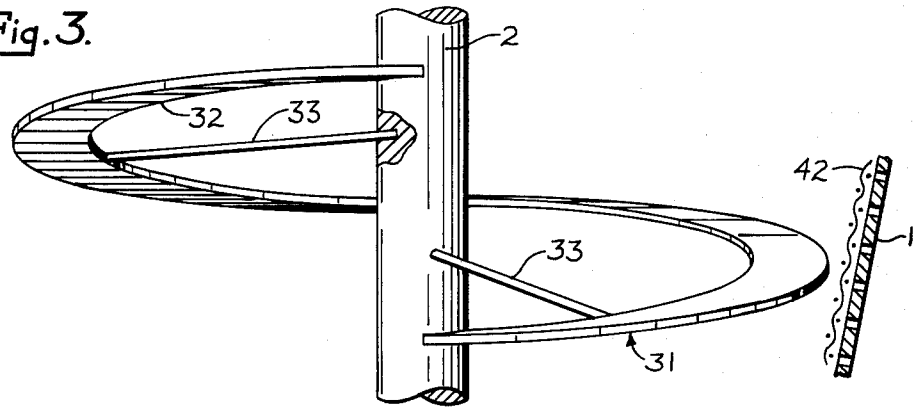


Fig. 3.



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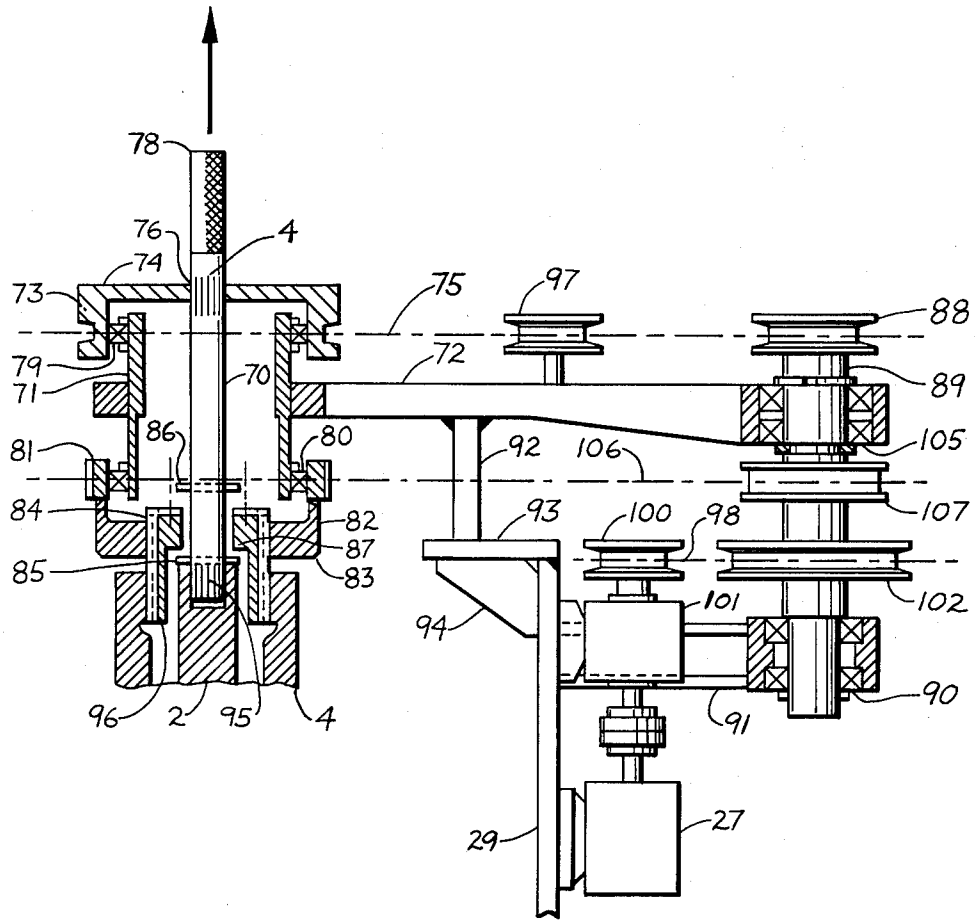
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Fig. 5.



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3,256,994

CENTRIFUGAL SEPARATOR

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3 Claims. (Cl. 210—374)

This invention relates to separators and more particularly to a continuous centrifugal separator for separating liquid from solid substances in stock material containing the same.

Generally, centrifugal separators comprise a continuously rotating basket having concentrically mounted within it a helical flight or screw rotating at a different rate to provide a differential motion between them. The rotation of the basket impels stock material, containing liquid and solid fractions, fed into it outwardly against the basket sidewalls while the relative motion between the screw and basket adapts the screw to advance the stock material through the basket to a suitable point of discharge. Heretofore all such centrifugal separators involved positive movement of the stock material through the basket to the point of discharge. Typical centrifugal separators are described in U.S. Letters Patent No. 1,804,108, No. 2,462,098, No. 2,499,457 and No. 2,858,-942.

It has been discovered that increased separation can be obtained between liquid and solid fractions of stock material containing them by adapting the centrifugal separators to continuously expose new areas or portions of the layer or mat of stock material constrained against the sidewalls of the basket under centrifugal force. Generally this is accomplished by adapting the centrifugal separator to move the stock material, on the basket wall, against the positive stock advancing influence of the screw which thereby continuously plows up the stock layer in its travel through the basket thereby providing a continuous churning or tumbling action which constantly exposes new portions of the stock to centrifugal action which as a result enables increased separation and removal of the liquid fraction from the stock.

Accordingly it is an object of this invention to provide a centrifugal separator of increased efficiency.

Another object of this invention is to provide a centrifugal separator adapted to provide an increased separation of liquids from liquid containing stock material, such as juice from food pulp and the like.

A further object of this invention is to provide a novel and improved centrifugal separator adapted to continuously disturb and agitate, in tumbling-like action, liquid containing stock therein so as to obtain an increased separtion of liquid from solid material in said stock.

Other objects and advantages of this invention will become more apparent from the following drawings and description in which:

FIGURE 1 is an elevational sectional view of a centrifugal separator illustrating one embodiment of this invention;

FIGURE 2 is a partial sectional view taken along lines II—II of FIGURE 1;

FIGURE 3 is an elevational view of a portion of the helical flight element illustrated in the preceding figure;

FIGUURE 4 is a partial view for a modification of the embodiment illustrated in the preceding figure; and

FIGURE 5 is a diagrammatic illustration of a novel independent drive means for actuating a separator in accordance with the invention.

Referring to the drawings, the centrifugal separator illustrated therein comprises a rotatable open-ended perforated basket or shell **1** of tapered conical configuration rotatably mounted about a main shaft **2**, at one end, through connecting spider top supports or braces **3** fixedly secured to the sleeve support **4** which is disposed about a sleeve bushing or bearing **5**. The basket is rotatably mounted at its other bottom end to the main shaft **2** by means of the spider bottom supports or braces **6** fixedly secured to bottom bushings **7** which is rotatably disposed about the shaft.

The upper portions of the basket and main shaft **2** are mounted on a housing or casing assembly **8** by means of a flanged support collar **9** rotatably mounted through bearing **10** to the exterior of sleeve bushing **5** and fixedly secured to the top of housing **8** which encloses the basket. The lower portion of shaft is secured in position by rotatable extension of the shaft into a radial thrust bearing assembly **11** mounted, by means of spiders **12**, to a housing support or stand **13** fixedly secured by suitable means to the housing **8** bottom wall **18**.

The housing **8** is of imperforate construction and forms an annular liquid containing area **14** with the exterior of basket **1**, and has a liquid drain conduit **15** provided in its housing bottom wall **18** for removal of liquid expelled through the basket side wall and collecting in trough **16** defined between the housing side wall **17** and the upwardly extending flange **19** of the housing bottom wall **18**. Also provided in the housing top wall **20** is a stock inlet or feed conduit **21** disposed above and in communicating relation with the basket interior to feed stock material thereinto. In order to guard against passage of stock into the liquid containing area **14**, the housing top wall **20** is also provided with a downwardly depending conical baffle **22** extending into the interior of the basket **1** and in overlapping relationship with the top thereof.

The basket or shell **1** is rotated by means of a drive assembly which includes a pulley or sheave **23** fixedly secured or keyed, in any suitable manner, to the sleeve support **4** and drivingly connected by means of a belt **24** to another pulley **25** mounted on a motor shaft **26** of a motor **27** which in accordance wth this invention powers the drive assembly to rotate the basket at a rapid rate sufficient to provide enough centrifugal force to, both, expel the liquid fraction or effluent from the stock through the basket wall and to move the stock constrained against the basket wall upwardly thereon toward the divergent end of the basket. In this regard it is noted that although the basket may be used by itself for the separation of the liquid fraction of the stock, the basket may also be employed as a backing support for secondary screen material **42** having any desired mesh as may be required for specific applications.

Also provided on the external wall of the basket **1**, adjacent the bottom thereof, is an annular deflector plate **28**, in overlapping relationship with the interior of the housing bottom wall flange **19** to channel the expelled liquid fraction or effluent into the trough **16** of housing **8**.

To advance the stock material through the separator, the basket **1** has provided and concentrically disposed within it a helical flight arrangement or conveyor **31** fixedly mounted to the main shaft **2** with which it rotates by

means of an independent drive assembly. The flight arrangement is provided with radially extending screw or flight elements disposed in helical convolutions from end to end of the drum or shell, and the entire flight conveyor is of conical configuration with the periphery of the helix extending in close proximity with side walls of the basket to provide, for example, a clearance of the order of 20 to 30 thousandths of an inch. Accordingly, as will be appreciated, in such a close relationship the flight arrangement has substantially the same corresponding radial dimensions as the basket chamber. As illustrated in the drawing the top of the flight arrangement terminates above the point at which the flow of stock feed is directed against the basket wall as determined by means of a conical diffuser plate **50** fixedly mounted in rotation to the main shaft **2** whereby the stock fed into the mechanism is deflected to the basket wall. Also in the preferred embodiment illustrated the flight arrangement comprises a ribbon screw element **32** spirally edge wound into a conical configuration and mounted for rotation with the main shaft **2** by spider bars or rods **33** fixedly secured therebetween.

The drive assembly for rotation of the flight conveyor comprises, for the embodiment illustrated, a conveyor drive pulley or sheave **34** fixedly mounter to main shaft **2** and driven through a belt **35** mounted on a drive pulley **36** of motor shaft **26**.

Although various means for the mounting of motor **27** may be employed in combination with or separate of the press, as in the embodiment illustrated the motor **27** may be mounted on a motor stand **29** which may be rigidly affixed to or integrated with the separator by a plurality of support brackets **30** which are rigidly secured in spaced relationship vertically along and between the housing **8** and the motor stand **29**. In addition, it is also to be understood that although a specific belt and pulley arrangement has been illustrated, other drive arrangements such as gear trains, sprocket and chain assemblies and the like may be employed driven by a single drive source or by independent drive means to effect rotating relative motion for and between the basket and the conveyor which adapts them for extraction of the liquid fraction of the stock material with simultaneous advancement of the stock material to the discharge end of the press where the substantial liquid free stock is discharged. To propel the stock material, constrained under centrifugal action against the basket wall, through the separator, the drive assembly for the conveyor is powered at a different rate than that for the basket so as to rotate the conveyor and the basket at different rates providing sufficient relative movement between them to adapt the conveyor to overcome the movement of the stock material in accordance with this invention, upwardly on the basket wall, under centrifugal action, and to positively advance the stock material toward and out of the discharge or open end of the basket where it may be removed by suitable means known in the art. By this novel relationship between the conveyor and basket, the helical flight is adapted to continuously engage, and as a result peel and pare back the mat or layer of stock material moving toward the divergent inlet end of the basket wall, to provide in effect a plowing action which churns and tumbles the stock material toward the convergent discharge end of the basket thus continuously exposing new portions of the stock material for centrifugal action which as a result increases the extraction of the liquid fraction therein.

It is to be understood that although a specific clearance has been noted above between the flight conveyor and the side walls of the perforated basket or shell, the invention is not to be restricted thereto since such clearances may and do vary for various stock materials and all that is required is that the clearance would should only be sufficient to impart a positive advance of the stock material through the basket. In addition, the centrifugal separators may be adapted to control the variation in the clearance to the

amount desired. For example, as illustrated in FIGURE 4, the radial thrust bearing mounting **11**[1] may be movably mounted in axial movement with a main shaft support **40** carried by the spider supports **12**. Reciprocal vertical movement of the main shaft **2** and the flight conveyor **31** is obtained by means by a hydraulic actuator or lift **41** suitably secured to the bottom of the bearing mounting **40**. In this manner the hydraulic lift is adapted to raise or lower the main shaft **2** and the flight conveyor **31** carried thereon and thereby to vary and obtain the desired clearance between the helical flights and the sidewalls of the basket depending on the manner in which the hydraulic lift is actuated.

FIGURE 5 illustrates a novel drive assembly adapted for use in independent driving of the basket and helical conveyor of the separtor described above. As shown therein, a coupling rod **70** is detachably connected to and in alignment with the main shaft **2** by means of splines **95** which places them in drive relationship with each other. A tubular support **71** is concentrically mounted about the rod **70**, and held in position thereabout by means of a support arm **72** operatively connected to the unit in a manner to be described below. Rotatably mounted about the upper portion of the tubular support **71**, by means of any conventional bearings **79**, is the inner wall of the flange **73** of a cupped drive wheel **74** with the external wall thereof suitably grooved for driving thereof by a belt **75**. Driving engagement between the drive wheel **74** and coupling rod **70** is effected by means of a splined aperture **76** in the bottom wall thereof for slidable mounting about complementary splines **77** provided on the rod **70**. As will be appreciated, the coupling rod **70** may be actuated in axial movement with spline **77** thereof slidably cooperating within the splined aperture **76** sufficiently to enable the disengagement of the rod from its splined connection with the end of the main shaft **2**. If desired, the distal end of the coupling rod **70** may be knurled at **78** to facilitate gripping thereat.

Mounted at the lower portion of the tubular support **71**, by means of bearings **80**, is a gear pulley **81** having the bottom wall thereof provided with a splined passage **84**. An externally splined tubular coupling **96** is concentrically mounted about the main shaft **2** and coupling **70** and adapted for driving engagement with sleeve support **4** by a sliding splined connection with the splined passage **84** and in sliding relationship with complementary splining provided internally in the sleeve support **4** adjacent the upper end thereof.

Co-action between coupling rod **70** and the tubular coupling **96**, for removal thereof from splined connection with main shaft **2**, is effected by means of spaced pins **85** and **86** suitably mounted in coupling rod **70** as by perforations therethrough, to project radially therefrom, with the lower pin **85** adapted, on axial movement of coupling rod **70**, to abut a shoulder **87** formed on the inner wall of the tubular coupling **96**. As will be observed, continued upward movement of coupling rod **70** will bring its projecting lower pin **85** into contact with the tubular coupling shoulder **87** to force the tubular coupling **96** out, off its splined connection with the sleeve support **4** with concurrent disengagement of the coupling rod **70** from its splined connection with main shaft **2**. Conversely, for re-engagement of the separated units, the control rod **70** is urged downwardly to effect its splined connection with main shaft **2**, with concurrent connection effected between the tubular coupling **96** and sleeve support **4** by means of the upper pin **86** suitably mounted on the control rod **70** to cause the pin to abut on and urge the coupling sleeve **84** into the desired connection.

As indicated above, power connection to drive the drive wheel **74** is provided by means of a belt **75** frictionally seated thereon and on a take-off pulley **88** which is mounted for driving rotation on take-off shaft **89** having its lower end supported through bearings **90** to a carrier arm **91** which is suitably secured to motor stand **29**.

Similarly, sleeve support **4** is rotated through its connection with gear pulley **8** by means of a belt **106** drivingly engaged thereon and on a second take-off gear pulley **107** mounted on the take-off shaft **89**. Also, as shown in the drawing, the take-off shaft **89** is radially supported by means of the above referred to support arm **72** having secured thereto, at an intermediate point along its length, a downwardly depending vertical support **92** disposed in sliding relationship along a shelf **93** which is suitably mounted to motor stand **29** and reinforced with any form of a suitable bracing **94**. Also, as shown in the drawings, the belt **75** may be looped about an idler pulley **97** suitably secured to support arm **72**. As will be appreciated the ability of the vertical support **92** to slide along shelf **93** permits swinging, by means of the adaptability of the support arm **72** to pivot about take-off shaft **89** through bearing **105**, the disengaged driving assembly out of registry with the connecting elements of the separator for more convenient access to the interior thereof.

The foregoing is operatively connected for driving thereof by a take-off pulley **88** powered by means of a belting **98** engaging a drive pulley **102**, mounted on the take-off shaft **89**, and on a power pulley **100** suitably connected, if desired, through any conventional adjustable speed coupling **101** to the motor **27**.

Although the invention has been described with reference to specific materials, embodiments and details, various modifications and changes, within the scope of this invention, will be apparent to one skilled in the art and are contemplated to be embraced within the invention.

What is claimed is:

1. A centrifugal separator for separating the liquid and solid fractions of a stock material containing said fractions comprising an open ended perforated shell of tapered conical configuration having a lower convergent end for discharge and an upper divergent end for receiving stock material and mounted for rotation about a substantially vertical axis,

a first drive means to rotate the shell at a rapid rate to provide sufficient centrifugal force to expel said liquid fraction from said stock material through the perforations of said shell and to move said solid material by centrifugal force toward the divergent end of said shell,

a ribbon screw element having an open center with an unobstructed inner edge forming a spiral flight conveyor of conical configuration concentrically disposed within said shell with the periphery thereof positioned in close proximity to and coextending with the inner wall of said shell to engage solid material thereon,

the areas between turns of the spiral being open radially inwardly,

second drive means to rotate said conveyor at a rate different than said shell to provide sufficient relative movement therebetween to simultaneously plow and propel said solid material toward the convergent end of said shell against the flow of said solid material toward the divergent end of said shell under the centrifugal action whereby the solid fraction is discharged at the convergent end,

said conveyor and said shell constructed and arranged to propel portions of said solid stock material upwardly by centrifugal force toward the divergent end radially within the inner edge of the ribbon screw element of the flight conveyor,

and liquid conducting means for receiving the expelled liquid fraction.

2. A centrifugal separator for separating the liquid and solid fractions of a stock material containing said fractions comprising an open ended perforated shell of tapered conical configuration having a lower convergent end for discharge and an upper divergent end for receiving stock material and mounted for rotation about a substantially vertical axis,

an inlet at the upper divergent end of the shell delivering stock material thereto and displaced from the axial center of the shell,

a first drive means to rotate the shell at a rapid rate to provide sufficient centrifugal force to expel said liquid fraction from said stock material through the perforations of said shell and to move said solid material by centrifugal force toward the divergent end of said shell,

a ribbon screw element having an open center with an unobstructed inner edge forming a spiral flight conveyor of conical configuration concentrically disposed within said shell with the periphery thereof positioned in close proximity to and coextending with the inner wall of said shell to engage solid material thereon,

the areas between turns of the spiral being open radially inwardly,

second drive means to rotate said conveyor at a rate different than said shell to provide sufficient relative movement therebetween to simultaneously plow and propel said solid material toward the convergent end of said shell against the flow of said solid material toward the divergent end of said shell under the centrifugal action whereby the solid fraction is discharged at the convergent end,

said conveyor and said shell constructed and arranged to propel portions of said solid stock material upwardly by centrifugal force toward the divergent end radially within the inner edge of the ribbon screw element of the flight conveyor,

and liquid conducting means for receiving the expelled liquid fraction.

3. A centrifugal separator for separating the liquid and solid fractions of a stock material containing said fractions comprising an open ended perforated shell of tapered conical configuration having a lower convergent end for discharge and an upper divergent end for receiving stock material and mounted for rotation about a substantially vertical axis,

an annular housing surrounding said shell,

an upturned annular flange in the housing surrounding the lower convergent end of the shell,

an annular deflector plate on the lower end of the shell projecting outwardly and downwardly over said flange for deflecting liquid fractions of the stock material outwardly within said housing,

a first drive means to rotate the shell at a rapid rate to provide sufficient centrifugal force to expel said liquid fraction from said stock material through the perforations of said shell and to move said solid material by centrifugal force toward the divergent end of said shell,

a ribbon screw element having an open center with an unobstructed inner edge forming a spiral flight conveyor of conical configuration concentrically disposed within said shell with the periphery thereof positioned in close proximity to and coextending with the inner wall of said shell to engage solid material thereon, the areas between turns of the spiral being open radially inwardly,

second drive means to rotate said conveyor at a rate different than said shell to provide sufficient relative movement therebetween to simultaneously plow and propel said solid material toward the convergent end of said shell against the flow of said solid material toward the divergent end of said shell under the centrifugal action whereby the solid fraction is discharged at the convergent end,

said conveyor and said shell constructed and arranged to propel portions of said solid stock material upwardly by centrifugal force toward

the divergent end radially within the inner edge of the ribbon screw element of the flight conveyor,

and liquid conducting outlet means in the lower end of the housing for receiving expelled liquid fractions.

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