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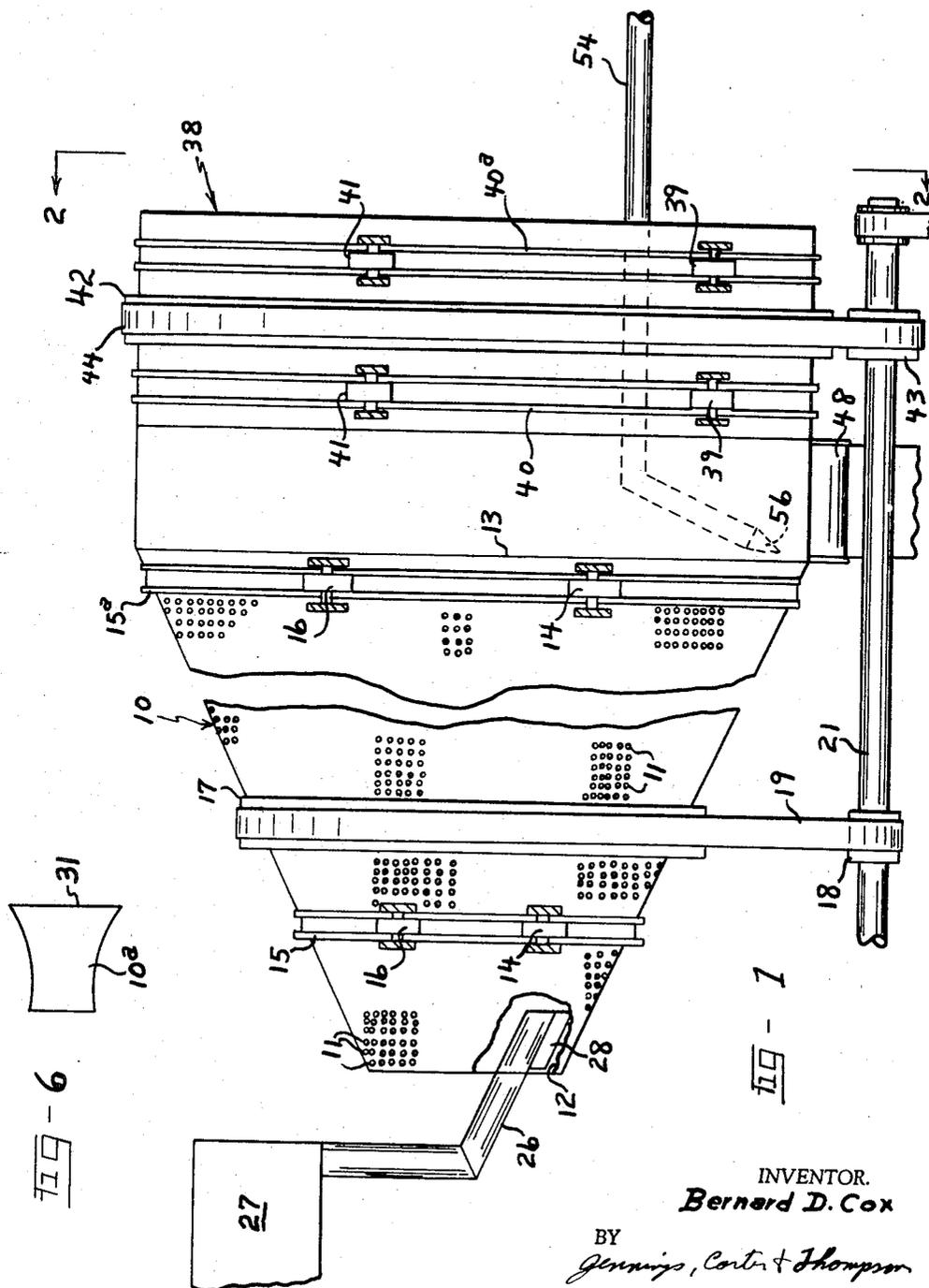
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2,995,484

PROCESS AND APPARATUS FOR FORMING A SHEET OF MATERIAL  
FROM A SUSPENSION OF SOLID PARTICLES IN LIQUID MEDIA

Filed April 28, 1958

2 Sheets-Sheet 1



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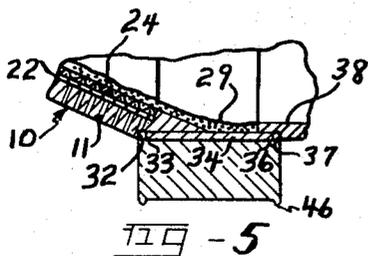
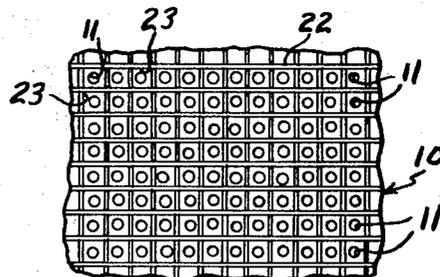
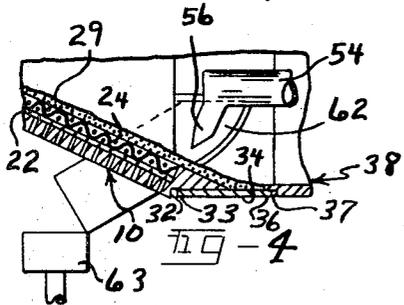
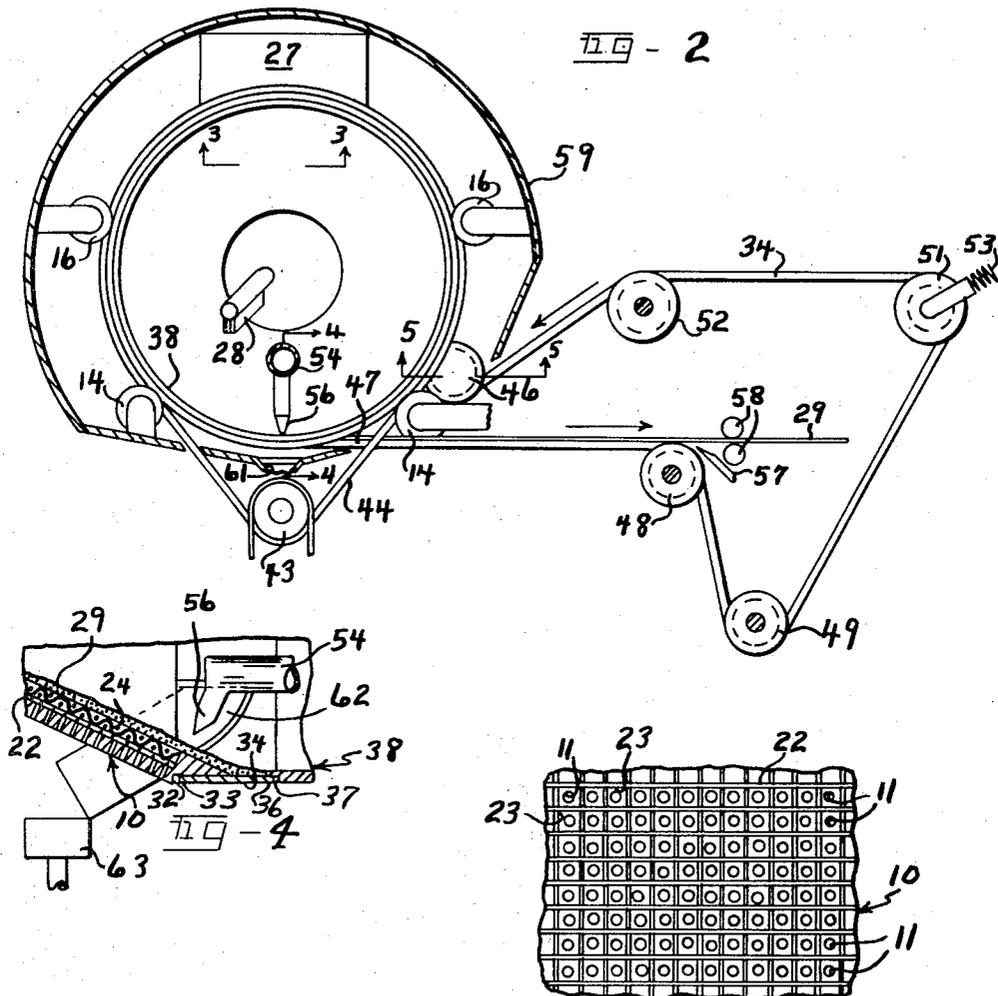
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2 Sheets-Sheet 2



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2,995,484

**PROCESS AND APPARATUS FOR FORMING A SHEET OF MATERIAL FROM A SUSPENSION OF SOLID PARTICLES IN LIQUID MEDIA**

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16 Claims. (Cl. 162-208)

This invention relates to a process and apparatus for forming a sheet or board of material from a suspension of solid particles in liquid media and more particularly to a process and apparatus for the manufacture of sheet material from suspensions of wood pulp in a liquid, such as water.

An object of my invention is to provide a process and apparatus of the character designated in which the liquid is removed from the solid particles by the positive pressure of centrifugal force instead of the negative pressure heretofore employed on vacuum-type liquid removal apparatus, whereby greater economy is achieved.

Another object of my invention is to provide a continuous process for the formation of sheet material from a suspension of solid particles in liquid media at a substantially increased rate over the rate at which sheet materials are now being manufactured by conventional type apparatus.

Another object of my invention is to provide a process of the character designated which shall produce a stronger, tougher and more dense sheet of material than is now produced by conventional processes using the same materials.

Another object of my invention is to provide a continuous process for forming a sheet of material from a suspension of solid particles in liquid media in which a greater percentage of the liquid is removed from the solid particles, thus resulting in a considerable saving in drying time, cost of drying equipment and cost of heating during the subsequent drying operation.

Another object of my invention is to provide apparatus of the character designated which shall have a prolonged life which is substantially greater than conventional type apparatus for forming sheet material, such as the conventional type Fourdrinier wire.

A further object of my invention is to provide a process and apparatus of the character designated which shall produce a sheet of material in which the fibers thereof are positioned closer together to form a closer bond or interlocking of the individual fibers, thereby obtaining higher tear resistance and higher burst resistance.

A still further object of my invention is to provide apparatus of the character designated which shall be simple of construction, economical of manufacture and which shall require a minimum of structural supports and a minimum of space for the installation thereof.

Heretofore in the art to which my invention relates, various processes and apparatus have been devised for removing the liquid from suspensions of solid particles in a liquid media. However, such processes and apparatus have been limited almost exclusively to negative-pressure means for removing the liquid from the suspension. Such methods are relatively inefficient and leave an undesirably high percentage of liquid remaining in the resulting sheet of material, which must subsequently be removed by evaporation or through the application of heat. Also, with conventional type apparatus, the consistency or percentage of solids by weight in the suspension must be limited due to the fact that the apparatus can economically remove only a certain percentage of the liquid from the suspension.

To overcome the above and other difficulties, I provide

a process for forming a sheet of material in which the suspension of solid particles in liquid media is introduced into one end of a rotary screen having a continuous sidewall which flares outwardly toward the other end thereof.

5 The rotary screen is rotated about a substantially horizontal axis at a speed to apply centrifugal force of a magnitude to remove liquid through the screen and form a sheet on the inner surface thereof. The sheet of material thus formed is moved continuously by centrifugal force toward the discharge end of the screen. The sheet of material is then removed continuously adjacent the discharge end of the screen.

Apparatus embodying features of my invention is illustrated in the accompanying drawings, forming a part of this application, in which:

15 FIG. 1 is a side elevational view, partly broken away and in section, the housing around the rotary screen being omitted for the sake of clarity;

FIG. 2 is a front elevational view, drawn to a smaller scale, and taken generally along the line 2-2 of FIG. 1;

20 FIG. 3 is a fragmental view taken generally along the line 3-3 of FIG. 2, the inner wire mesh being omitted for the sake of clarity;

25 FIG. 4 is a sectional view taken generally along the line 4-4 of FIG. 2;

FIG. 5 is an enlarged sectional view taken generally along the line 5-5 of FIG. 2; and,

FIG. 6 is a side elevational view, showing a modified shape of the rotary screen.

30 Referring now to the drawings for a better understanding of my invention, I show a rotary screen 10 having a perforated outer surface which is formed by providing a plurality of openings 11 therein, as clearly shown in FIGS. 1 and 3. The rotary screen 10 is in the shape of a frustum of a cone to provide a relatively small diameter inlet end 12 and a larger diameter outlet 13. As shown in FIGS. 1 and 2, the rotary screen 10 is mounted for rotation between rollers 14 and 16, the rollers 14 being below the horizontal center line of the screen and the rollers 16 being above the horizontal center line. Mounted on the rotary screen 10 are annular trackways 15 and 15<sup>a</sup> for receiving the rollers 14 and 16. Encircling the central portion of the screen 10 and secured rigidly thereto is an annular pulley 17 which is operatively connected to a pulley 18 by means of a belt 19. The pulley 18 is mounted on a drive shaft 21 which in turn is driven, from a suitable source of power, whereby the rotary screen 10 revolves at a speed of from 100 to 2,000 revolutions per minute. Preferably, the rotary screen 10 rotates at a speed of from 500 to 1,000 revolutions per minute.

Engaging the inner surface of the perforated screen 10 is a wire screen 22 which is of the open mesh type. As shown in FIG. 3, the space between the individual wires of the screen 22 form openings 23 which register with the openings 11 in the rotary screen 10. Positioned within the rotary screen 10 and in direct contact with the inner surface of the wire screen 22 is a wire mesh member 24 which may be of a construction similar to the conventional type Fourdrinier wire employed on conventional type apparatus for making paper. The wire screen 22 serves the purpose of holding the wire mesh member 24 in spaced relation to the inner surface of the rotary screen 10 and the openings 11 therein, whereby free flow of the drainage liquor is permitted at all times.

Communicating with the inlet end 12 of the rotary screen 10 is a conduit 26 for supplying a stock solution from a suitable reservoir 27. The discharge end of the conduit 26 is provided with an elongated discharge spout 28 which extends substantially parallel to the inner side wall of the rotary screen and off-center, as shown in

FIG. 2. The stock solution may have a consistency or percentage solids by weight in solution ranging from approximately 1% to 25%. However, I prefer to employ from 1.0% to 3.0% where the stock solution is employed to manufacture paper or the like. As the stock solution is introduced into the inlet end 12 of the rotary screen 10, the centrifugal force imparted by the rotation of the screen causes the liquid to move outwardly through the wire mesh 24, the wire screen 22 and the rotary screen 10, thereby forming a sheet 29 on the inner surface of the wire mesh 24, as shown in FIGS. 3 and 5.

The centrifugal forces acting upon the sheet 29 are divided into two components. First, the component which is perpendicular to the walls of the rotary screen serves to remove the liquid from the suspension whereby a fibrous sheet is left on the inner surface of the wire mesh 24. Second, the component which is parallel to the side walls of the rotary screen serves to produce a sliding action which causes the sheet 29 to be transferred continuously toward the discharge end 13. As a result of this sliding action, a force of friction results between the wire mesh 24 and the sheet 29 whereby the fibers are closely aligned relative to each other, thus resulting in a sheet which has extremely high tear resistance and high burst resistance. Also, the sliding action of the sheet 29 relative to the wire web 24 brings about a cleaning action whereby the wire mesh 24 is maintained in a clean condition at all times to permit free flow of the liquid there-through. The rate at which the stock solution is introduced into the inlet 12 of the rotary screen should correspond generally to the linear speed of the inner surface of the wire mesh 24, whereby a continuous sheet is formed as the screen 10 rotates.

While I have shown the rotary screen 10 as being frusto-conical, it will be apparent that the rotary screen could have other similar shapes. In view of the fact that there is more friction between the sheet 29 and the wire mesh 24 as the sheet becomes dry, it is often desirable to provide a rotary screen 10<sup>a</sup>, having a bell-type discharge end 31, as shown in FIG. 6.

The discharge end 13 of the rotary screen 10 is provided with a peripheral recess 32, as shown in FIGS. 4 and 5, for receiving an edge 33 of an endless belt 34. The other edge 36 of the belt 34 is adapted to engage a peripheral recess 37 provided in a rotary member 38. As shown in FIG. 1, the rotary member 38 is supported by suitable rollers 39 and 41 which engage annular trackways 40 and 40<sup>a</sup> which in turn are mounted on the rotary member 38, as shown in FIG. 1. The rollers 39 are positioned below the horizontal center line of the rotary member 38 and the rollers 41 are positioned above the horizontal center line. Encircling and secured to the longitudinal center of the rotary member 38 is an annular pulley 42 which is operatively connected to a pulley 43 by means of a belt 44. The pulley 43 is mounted non-rotatably on the shaft 21 whereby the rotary member 38 is driven at the same speed as the rotary screen 10.

As shown in FIG. 2, the endless belt 34 passes beneath a double flanged roller 46 and then around the outer periphery of the discharge end 13 and then leaves the discharge end of the screen 10 at a tangent, as at 47. The belt 34 then passes over a flanged roller 48, under a flanged roller 49 and over a flanged roller 51 to a flanged roller 52. To hold the belt 34 in contact with the recessed portions 32 and 37, I apply tension to the roller 51 by suitable tensioning means, such as by a spring 53, as clearly shown in FIG. 2.

As the sheet of material 29 moves outwardly of the rotary screen 10 it moves onto the endless belt 34 whereby it reaches the outer edge of the belt 34 at the time the rotary screen makes one complete revolution. That is, the sheet of material 29 moves the width of the belt 34 each time the rotary screen 10 makes one revolution. Extending through the rotary member, as shown in FIGS. 1, 2 and 4, is a conduit 54 having a jet nozzle 56 at the

discharge end thereof which is in position to direct a fluid, such as water, onto the sheet of material 29 whereby the portion which reaches the outer edge of the belt 34 is continuously removed by the lower flight of the endless belt 34.

To facilitate the initial separation of the sheet of material 29 from the belt 34, as shown in FIG. 2, I introduce a jet of air at the point of separation by means of a suitable jet 57. The sheet of material 29 then passes through suitable press rolls 58. Further processing of the sheet may follow conventional methods.

Surrounding the rotary screen 10 is a housing 59, as shown in FIG. 2. The bottom of the housing 59 slopes inwardly and is provided with a suitable discharge conduit 61 for recirculating the liquid removed from the rotary screen to the reservoir 27.

As shown in FIG. 4, I position a splash guard member 62 in the opening between the lower flight of the belt 34 and the roller 46 whereby any material which is thrown off of the upwardly moving sheet 29 does not contact the portion thereof which is conveyed away by the lower flight of the belt. Also, the material which falls onto the splash guard 62 passes into a suitable receptacle 63 where it may be recycled to the reservoir 27.

From the foregoing description the operation of my improved apparatus and the manner of carrying out my improved process will be readily understood. The stock solution is introduced continuously into the inlet end 12 of the rotary screen 10. As the rotary screen is revolved, the centrifugal force causes the fluid to move outwardly through the screen where it is discharged through the conduit 61. The sheet of material 29 moves continuously toward the discharge end 13 of the rotary screen where it passes onto the belt 34. The jet 56 continuously separates the portion of the sheet 29 on the lower flight of the belt 34 from the remainder of the sheet whereby a continuous sheet of material 29 is moved by the lower flight. A jet of air is introduced through the jet 57 to cause initial separation of the sheet 29 from the lower flight of the belt 34. After this initial separation, the sheet is continuously separated without the necessity of providing an air jet. The splash guard 62 receives any material which is slung off of the remaining portion of the sheet 29 which revolves with the screen 10 whereby it does not damage the subjacent sheet which is removed by the lower flight of the belt 34.

From the foregoing description, it will be seen that I have devised an improved process and apparatus for forming a sheet of material from a suspension of solid particles in a liquid media. By continuously introducing the suspension into a generally frusto-conical rotary screen and rotating the same at a speed to apply centrifugal force of a magnitude to remove the liquid through the screen, a maximum amount of liquid is removed from the sheet in a minimum of time. Also, by causing the sheet to continuously move by centrifugal force toward the larger or discharge end of the rotary screen, a sliding action occurs which causes the individual fibers to be closely aligned relative to each other, thereby providing a resulting sheet which is extremely strong. Also, by continuously removing the sheet in a tangential direction relative to the rotary screen, the sheet is not damaged in any way as it is separated from the remainder of the sheet carried by the rotary screen. Furthermore, by providing a generally frusto-conical rotary screen for separating the liquid from the solid particles, a minimum of space and a minimum of supporting structure is required.

While I have shown my invention in but two forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are specifically set forth in the appended claims.

**What I claim is:**

1. The process of forming a sheet of material from a suspension of solid particles in liquid media which comprises introducing said suspension continuously into one end of a substantially horizontally disposed annular column thereof having a continuous side wall which flares outwardly toward the other end thereof, rotating said column about its longitudinal axis at a speed to apply centrifugal force of a magnitude to remove liquid through said column whereby a continuous, uninterrupted sheet is formed and at a speed to move said sheet continuously toward said other end of the column whereby said uninterrupted sheet moves in a spiral path as said column rotates, and continuously removing an uninterrupted portion of said uninterrupted sheet thus formed as it moves adjacent said other end of the column.

2. The process as defined in claim 1 in which the solid particles suspended in the liquid media are wood pulp particles.

3. The process as defined in claim 1 in which the annular column is generally frusto-conical in shape and the suspension is introduced into the smaller end of the column as an uninterrupted portion of the sheet is removed continuously at the larger end of the column.

4. The process as defined in claim 1 in which the annular column is provided with a generally bell-shape discharge end.

5. In apparatus for forming a sheet of material from a suspension of solid particles in liquid media, a rotary screen having an inlet at one end and a continuous side wall which flares outwardly toward the other end thereof, means to introduce said suspension into said screen at the inlet end thereof, means to rotate said screen about a substantially horizontal axis at a speed to apply centrifugal force of a magnitude to remove liquid through said screen and form an uninterrupted, continuous sheet on the inner surface thereof and at a speed to move said sheet continuously toward said other end of the screen whereby said sheet travels in a spiral path as said screen rotates, and means to remove continuously an uninterrupted portion of said sheet from the remainder thereof adjacent said other end of the screen.

6. In apparatus for forming a sheet of material from a suspension of solid particles in liquid media, a generally frusto-conical screen having its longitudinal axis extending in a substantially horizontal plane and having an inlet at the smaller end thereof, means to introduce said suspension into said inlet, means to rotate said screen about its longitudinal axis at a speed to apply centrifugal force of a magnitude to remove liquid through said screen and form an uninterrupted, continuous sheet on the inner surface thereof and at a speed to move said sheet continuously toward the opposite end of said screen from said inlet whereby said sheet travels in a spiral path as said screen rotates, and means to separate continuously an uninterrupted portion of said sheet from the remainder thereof adjacent said opposite end of the screen, and means to remove continuously said uninterrupted portion thus separated.

7. In apparatus for forming a sheet of material from a suspension of solid particles in liquid media, a rotary screen having an inlet at one end and a continuous side wall which flares outwardly toward the other end thereof, a second screen positioned adjacent the inner surface of said rotary screen and having openings therethrough which are in register with openings through said rotary screen, a wire mesh screen adjacent the inner surface of said second screen, means to introduce said suspension onto said wire mesh screen adjacent the inlet end of said rotary screen, means to rotate said rotary screen about a substantially horizontal axis at a speed to apply centrifugal force of a magnitude to remove liquid through the screens and form an uninterrupted, continuous sheet on the inner surface of said wire mesh screen and at a speed to move said sheet continuously toward said other

end of the rotary screen whereby said sheet travels in a spiral path as said screen rotates, and means to remove continuously an uninterrupted portion of said sheet from the remainder thereof adjacent said other end of the rotary screen.

8. In apparatus for forming a sheet of material from a suspension of solid particles in liquid media, a rotary screen having an inlet at one end and a continuous side wall which flares outwardly toward the other end thereof, means to introduce said suspension into said screen adjacent the inlet end thereof, means to rotate said screen about a substantially horizontal axis at a speed to apply centrifugal force of a magnitude to remove liquid through said screen and form an uninterrupted, continuous sheet on the inner surface thereof and at a speed to move said sheet continuously toward said other end whereby said sheet travels in a spiral path as said screen rotates, an endless belt adjacent said other end of the rotary screen in position to receive an uninterrupted portion of said sheet as it moves outwardly of said screen, means to separate continuously the uninterrupted portion of said sheet which moves outwardly of the screen from the remainder of said sheet whereby the uninterrupted portion thus separated is removed continuously.

9. In apparatus for forming a sheet of material from a suspension of solid particles in liquid media, a rotary screen having an inlet at one end and a continuous side wall which flares outwardly toward the other end thereof, means to introduce said suspension into said screen adjacent the inlet end thereof, means to rotate said screen about a substantially horizontal axis at a speed to apply centrifugal force of a magnitude to remove liquid through said screen and form an uninterrupted, continuous sheet on the inner surface thereof and at a speed to move said sheet continuously toward said other end whereby said sheet travels in a spiral path as said screen rotates, there being an outwardly opening peripheral recess around the edge of said other end, an endless belt having one edge in engagement with said recess and surrounding approximately the entire outer edge of said other end to leave a relatively small opening between the upper and lower flights of said belt, said belt being in position for the lower flight thereof to receive an uninterrupted portion of said sheet as it moves outwardly of said screen, a rotary member supporting the edge of said belt opposite said one edge, means to separate continuously the uninterrupted portion of said sheet which moves outwardly of the screen from the remainder of said sheet whereby the uninterrupted portion thus separated is removed continuously on said lower flight of the endless belt.

10. In apparatus for forming a sheet of material from a suspension of solid particles in liquid media, a rotary screen having an inlet at one end and a continuous side wall which flares outwardly toward the other end thereof, means introducing said suspension into said screen adjacent the inlet end thereof at a rate equal substantially the linear speed of the inlet end of said screen, means to rotate said screen about a substantially horizontal axis at a speed to apply centrifugal force of a magnitude to remove liquid through said screen and form an uninterrupted, continuous sheet on the inner surface thereof and at a speed to move said sheet continuously toward said other end whereby said sheet travels in a spiral path as said screen rotates, and means to remove an uninterrupted portion of said sheet continuously at said other end of the screen.

11. In apparatus for forming a sheet of material from a suspension of solid particles in liquid media as defined in claim 5 in which the means to introduce the suspension into the screen adjacent the inlet end thereof comprises a discharge spout which extends substantially parallel to the inner side wall of said screen and out of parallel alignment with the axis of said screen.

12. In apparatus as defined in claim 8 in which the

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means separating the uninterrupted portion of the sheet which moves outwardly of the screen from the remainder of said sheet comprises a fluid pressure operated jet.

13. In apparatus as defined in claim 8 in which the endless belt surrounds approximately the entire outer edge of said other end of the rotary screen to leave a relatively small opening between the upper and lower flights on said belt for the removal of the separated uninterrupted portion of the sheet on the lower flight of said endless belt.

14. In apparatus as defined in claim 9 in which the rotary member which supports the edge of the belt opposite said other edge is rotated at the same speed as the rotary screen.

15. In apparatus as defined in claim 9 in which the rotary member which supports the edge of the belt opposite said outer edge and said rotary screen are driven by a common driving member.

16. In apparatus as defined in claim 9 in which a splash guard is provided in the small opening between the upper and lower flights of the belt whereby said uninter-

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rupted portion of the sheet on said lower flight is protected from splash.

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