Aug. 8, 1961 B. D. COX 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

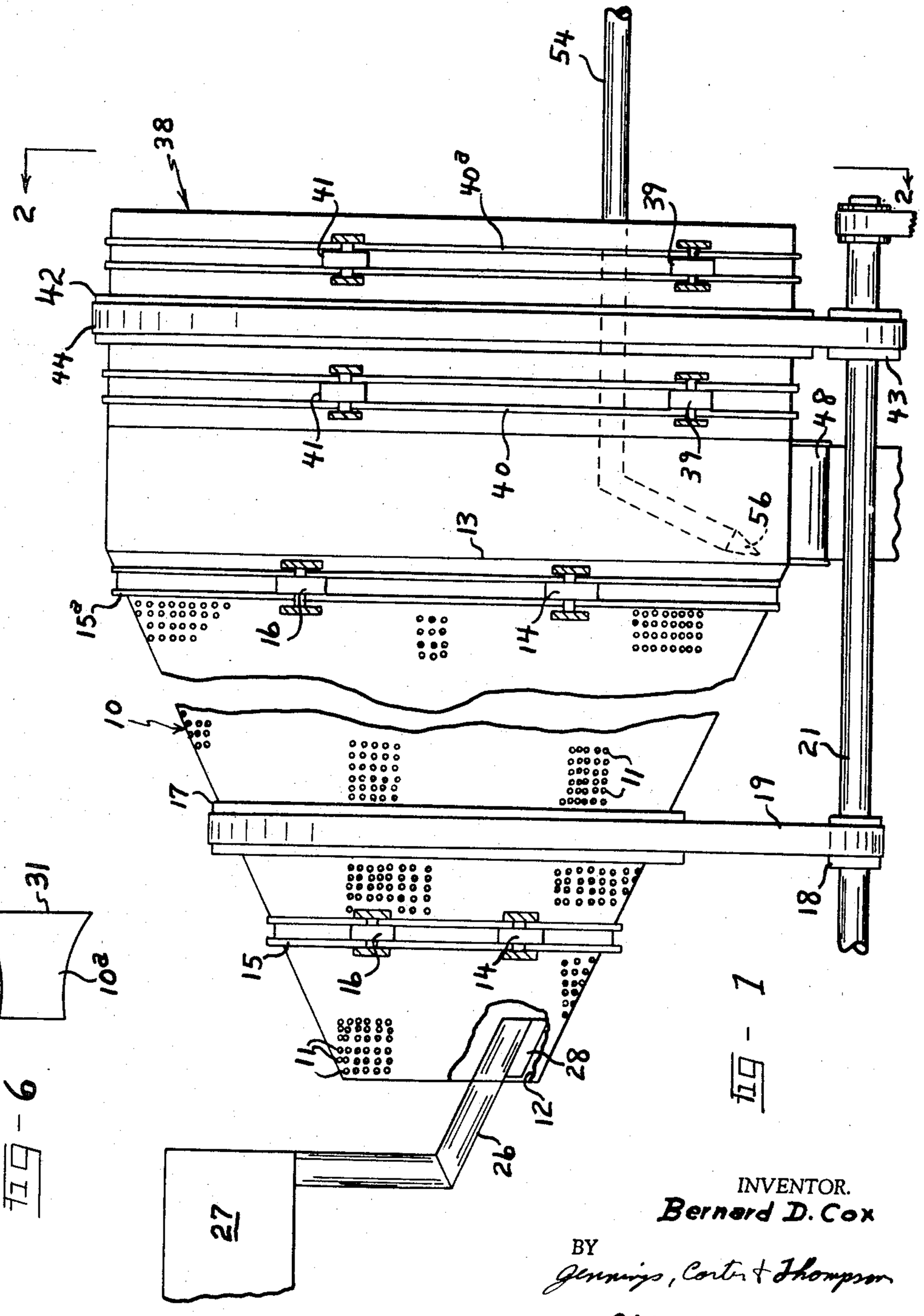

FIG - 6

FIG - 7

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Fig - 2

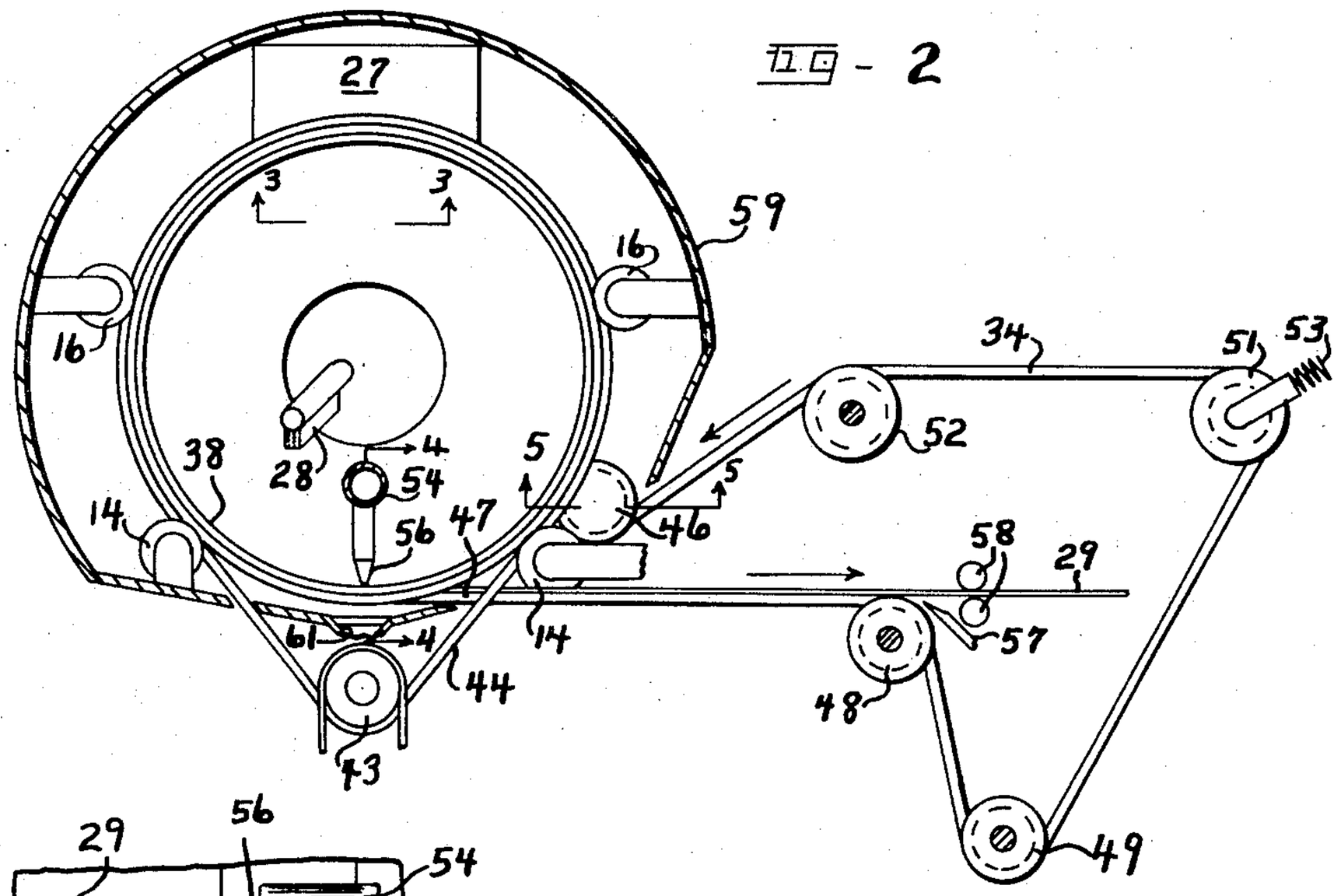


Fig - 4

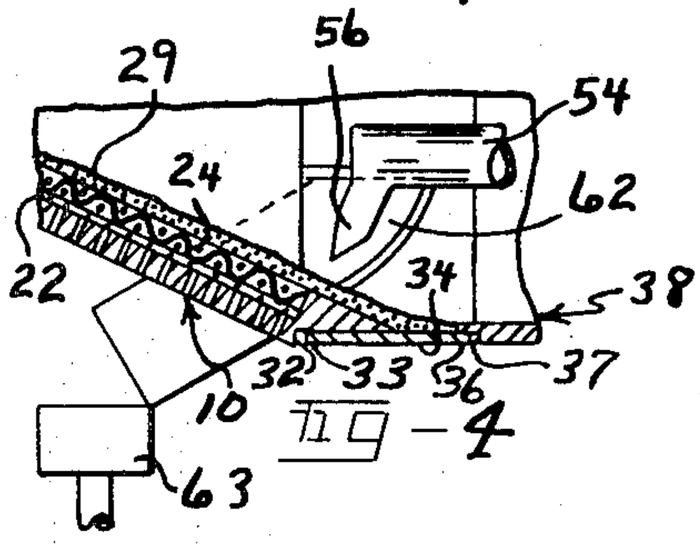


Fig - 3

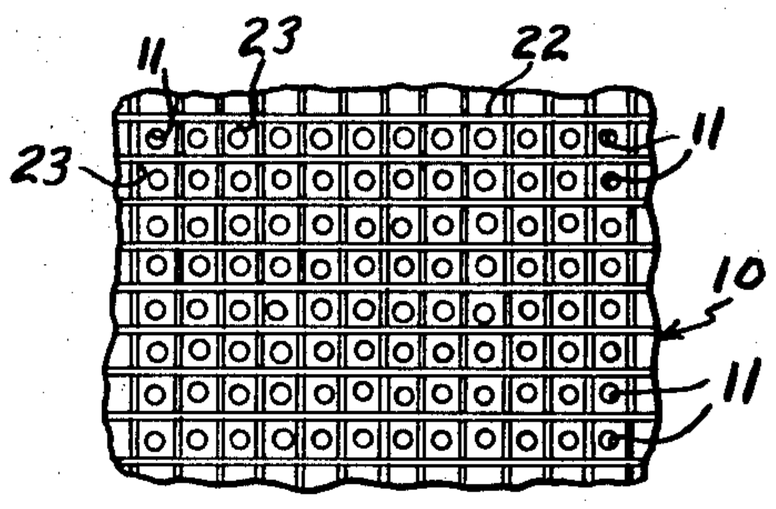
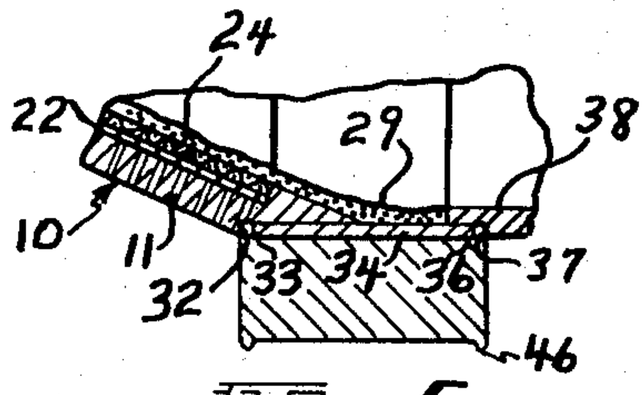


Fig - 5



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

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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 deviced 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. 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:

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;

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;

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.

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 frustrum 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 **15a** 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. 4 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 therethrough. 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 **10a**, 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 peripherial 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 peripherial 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 **40a** 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 nonrotatably 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 peripherial 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

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

References Cited in the file of this patent

UNITED STATES PATENTS

101,785	Taft	Apr. 12, 1870
283,480	Gathmann	Aug. 21, 1883
292,947	Porter et al.	Feb. 5, 1884
557,197	Fairbanks et al.	Mar. 31, 1896
1,054,323	Steele	Feb. 25, 1913
1,203,008	Kelleher	Oct. 31, 1916
1,531,482	Haug	Mar. 31, 1925
1,627,882	Berry	May 10, 1927
1,699,487	Hinde	Jan. 15, 1929
1,788,531	Little	Jan. 13, 1931
1,885,334	Darrah	Nov. 1, 1932
2,750,040	Strich	June 12, 1956

FOREIGN PATENTS

981,228	France	Jan. 10, 1951