Aug. 30, 1966 E. R. BURLING 3,268,923

EXTRUSION WASHER

Filed May 11, 1964 2 Sheets-Sheet 1

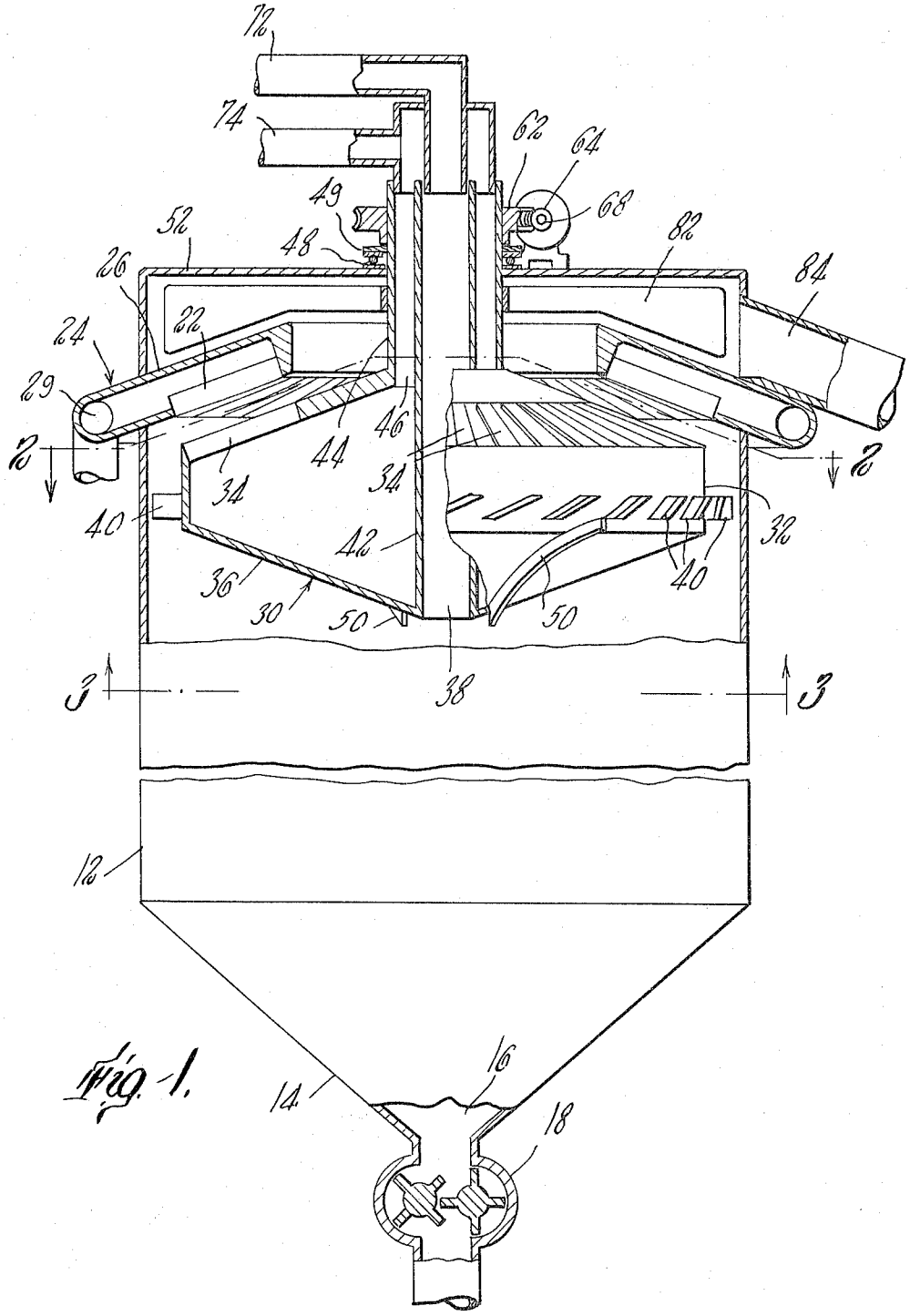

Fig. 1.

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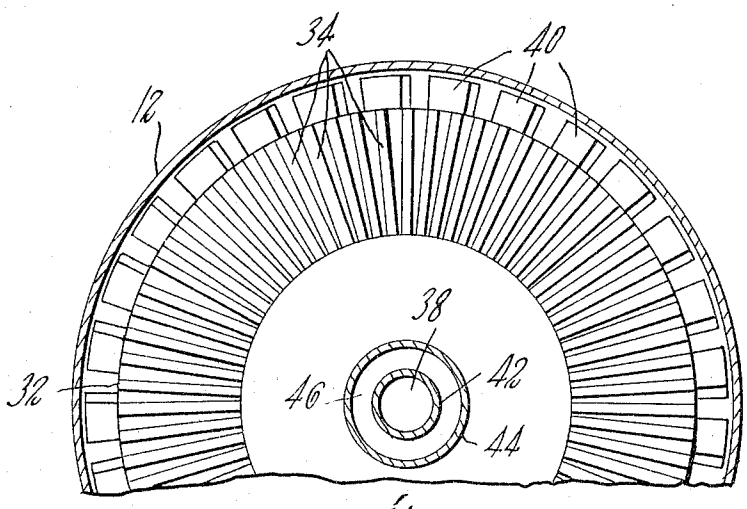

Fig. 2.

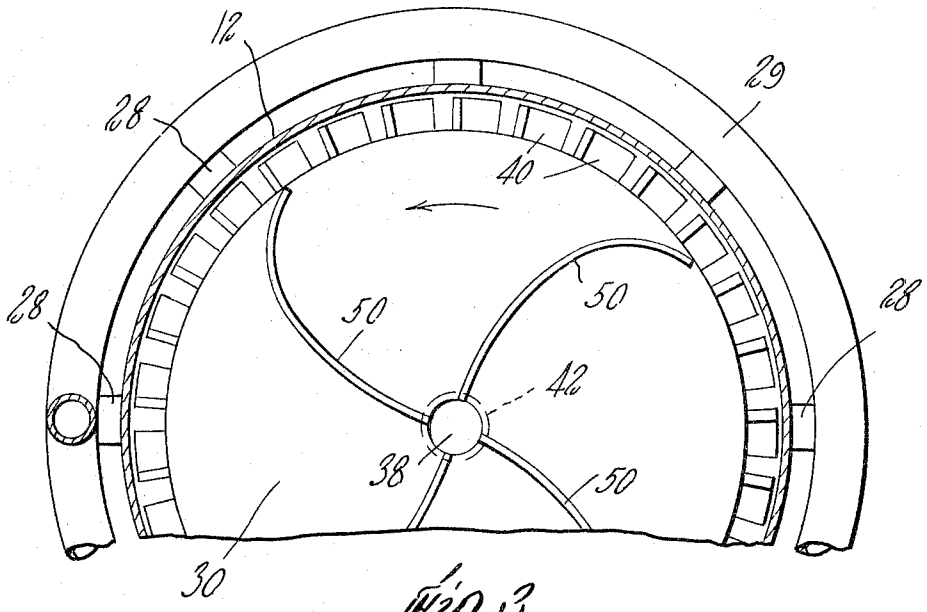

Fig. 3.

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EXTRUSION WASHER

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This invention relates to apparatus and methods for the treatment of wood pulp and the like. More particularly, it relates to the treatment, as by washing, of high consistency wood pulp in an upflow system, for example, following a retention step in a treating process.

In the treatment of wood pulp such as by bleaching with a suitable chemical, it is necessary, after the mixing of the bleaching chemical with the wood pulp has been completed, that a substantial time be allowed in which the bleaching reaction may be carried out, followed by washing of the bleached pulp. For a variety of reasons, involving both the chemical reaction and the huge volumes of pulp normally being treated, it is known to be advantageous to carry out the reaction or retention step in the bleaching process while the pulp is maintained at a high consistency of 10 to 40 percent (weight of dry fiber to weight of mixture). At such consistency, however, pulp has the physical characteristics of a solid and is difficult to handle, particularly insofar as transporting it is concerned. Thus, heretofore, the bleaching retention and washing have required separate apparatus, usually a retention vessel and a rotary drum filter, together with means for transporting the pulp from one to the other. More specifically, these steps have been carried out at the desired consistency treating of 3 to 15 percent, with the pulp being further diluted for transportation and pumping and for proper operation of a succeeding rotary drum filter for washing. In carrying out these steps, dilution was required, which is wasteful of water and of bleaching chemical, and a rotary drum filter had to be utilized as well as additional equipment to transfer the pulp from the retention vessel to the drum filter.

Accordingly, it is a major object of the present invention to provide novel apparatus and methods for carrying out retention and treating steps such as in the bleaching and washing of pulp.

It is a particular feature of the invention that it makes possible the carrying out of such steps in a single apparatus, resulting in substantial economy in the cost of pumping equipment, dilution water, etc.

It is another feature of the invention that such steps are carried out while the pulp remains at high consistency, without substantial dilution, and with discharge of pulp at high consistency.

These objects and features of the invention are accomplised by advancing high consistency pulp upwardly, usually in generally cylindrical columnar configuration throughout the length of an upright elongated vessel having a length to width ratio of at least about three to one with an annular strainer, preferably conical adjacent its upper end, and pulp inlet means adjacent its lower end. In conjunction with the strainer, the invention provides a novel coaxial rotor mounted within said strainer, said rotor having an upper hollow portion with a foraminous wall extended preferably at least about two feet and generally parallel to and spaced inwardly from said strainer surface by between one and six inches and preferably between about two and four inches. The rotor has a lower downwardly extending conical portion having central liquid inlet means adjacent its lower end, through which liquid may be supplied to dilute the pulp and so lubricate it as it passes radially outwardly along said conical portion. For treating the annular ring of pulp formed between the strainer and rotor, liquid is flowed between said strainer and the rotor. The rotor may be provided with helical vanes for advancing the annular ring of pulp thereby in a helical path upon relatively slow rotation of the rotor at a surface speed of a few feet per minute, say about 10 to 100, and may be provided with radially extending swept wall means along its lower conical surface as well for moving pulp radially outwardly therealong. For moving the pulp upwardly through the vessel in columnar form to the rotor, positive displacement means are preferably provided adjacent the bottom of the vessel acting solely on the bottom of the column of pulp. Suitable discharge means are also provided, such being positioned above the strainer surface and rotor for discharging high consistency treated pulp from the vessel.

For the purpose of explaining further objects and features of the invention, reference is now made to the following detailed description of a preferred embodiment thereof, together with the accompanying drawing, wherein:

FIG. 1 is a side elevation, partly broken away and partly in section, of apparatus according to the invention; and

FIGS. 2 and 3 are partial sections of the apparatus of FIG. 1 taken on lines 2—2 and 3—3 thereof, respectively.

Referring to the drawings, the apparatus according to the invention includes an upright elongated vessel having a cylindrical wall **12**, a lower conical portion defined by a conical wall **14**, with a central bottom inlet **16** at the downwardly extending point of said conical portion, and an upper discharge portion including an upper disklike wall **62**. A positive displacement pump **18** of a type capable of advancing high consistency pulp therethrough is provided at inlet **16**, such a pump being shown and described in Patent No. 3,001,481, for example. Other means, such as the foraminous piston structure of Patent No. 2,878,116 may also be utilized for feeding high consistency pulp into the bottom of the vessel and advancing it upwardly therethrough. A rotatable discharger having a plurality of arms **82** is provided in said upper discharge portion for discharging high consistency pulp into discharge conduit **84**.

According to the present invention, at the top of cylindrical wall **12** is provided an annular strainer portion having an inverted conical strainer surface defined at the inner surface of wall **12** and including a surrounding chamber **24**. Said strainer surface is defined by the inner faces of a plurality of longitudinal extending bars **22** while the chamber is defined by the outer faces of said bars and by an overlying conical outer wall **26**. Bars **22** define upwardly and radially inwardly diverging slots therebetween and are open at their upper inner ends as is shown and described in Patent No. 2,998,064. The inner surface of the strainer portion is defined by the inner faces of said bars, the slots therebetween being sufficiently narrow to prevent the passage of wood pulp therebetween, say about 0.01 inch. A plurality of radially outwardly extending liquid access openings **28**, herein utilized as outlets, are provided for strainer chamber **24**, such being connected to a suitable manifold **29**.

In conjunction with the strainer, the apparatus of the invention provides a novel coaxial rotor **30** mounted within said strainer. Said rotor is hollow and includes an upper conical wall and a lower conical wall with an interconnecting vertical annular wall **32**. The upper conical wall consists of a plurality of longitudinally extended bars **34** preferably at least about two feet in longitudinal dimension and generally parallel to and spaced radially inwardly from strainer bars **22**. The spacing provided between said bars may be between one and six inches and is preferably between about two and four inches in order to provide a relatively thin and extended

annular conical ring of pulp between the strainer and rotor, and is hereinafter more fully described. A series of generally helical lifting vanes 40 extending radially outwardly from side 32 and mounted adjacent the lower end thereof may be provided to and in upward movement of pulp in a generally helical path between the opposed series of bars.

The rotor has a lower downwardly extending conical portion including a conical wall 36 which has a central liquid inlet 38 adjacent its lower end. Said conical wall may be provided on its outer surface with a plurality of radially extending walls 50 swept backward with respect to the direction of rotation of the rotor 30 to aid in moving pulp radially outwardly therealong. For supplying liquid to said inlet 38 as well as to the hollow interior of said rotor, and for supporting said rotor for rotation about a vertical axis, an inner central tube 42 is provided connected to conical wall 36 about its inlet 38 and extending upwardly beyond upper rotor wall 32 and a tube 44 coaxial with and surrounding inner tube 42 is provided connected to and also extending upwardly beyond upper rotor wall 44 to provide an inlet 46 into said hollow rotor 30 in the annular space between said tubes. Outer tube 44 is rotatably mounted by a suitable bearing, herein shown as antifriction elements 48, on the upper disklike wall 52 of the vessel.

For driving the rotor, outer tube 44 has a suitable gear 62 affixed thereto, such being driven by a gear 64 connected to driving motor 66 by a shaft 68. Discharger means 82, by reason of their mounting on outer tube 44, are also rotated by said motor with rotor 30.

For supplying liquid to dilution liquid inlet 38 and treating liquid inlet 46, fixed conduits connected to suitable sources of liquids (not shown) are mounted on upper vessel wall 52, said conduits including a conduit 72 for supplying dilution liquid to pipe 42 and its inlet 38 and conduit 74 for supplying treating liquid to pipe 44 and its inlet 46.

In operation with rotor 30 rotating at a relatively slow surface speed of about 10 to 100 feet per minute, and with pulp at a high consistency of 10–40 percent, preferably about 15–30 percent, containing chemical to be reacted therewith, being delivered through vessel inlet 16 by pump 18, the mass of virtually solid pulp will advance upwardly through the vessel in generally cylindrical columnar configuration solely by reason of the lifting forces applied at the lower end of said column by positive displacement pump 18. With a length to diameter ratio of the vessel at least about 3 to 1 and a slope of its conical bottom portion of about 45–60 degrees to the horizontal plane, even with a vessel upwards of 20 feet in diameter, uniformly sufficient retention time is provided for the reaction to take place under optimum conditions with the pulp remaining at high consistency throughout.

When the advancing mass of pulp reaches the lower conical surface of rotor 30 with its overlying strainer 20, the mass is formed into an annular ring pulp defined between the rotor and vessel wall and strainer surfaces. For such to occur, the central portion of the mass of pulp is diverted outwardly by the lower surface of rotor 30, such being uniquely made possible by supplying sufficient dilution liquid through the rotor inlet 38 to dilute at least a portion of the mass of pulp along the surface of the rotor to a relatively low consistency of less than 10 percent at which consistency sufficient liquid characteristics are present at the upper end of the pulp mass to enable it to advance generally radially along the surface of the rotor to the annular space between the rotor and the surrounding vessel wall and strainer. Walls 50 are also helpful in the desired radial movement.

As the pulp enters the annular space between strainer and rotor, vanes 40 not only aid in advancing it, but also rotate the ring to advance the pulp therethrough in a generally helical path, not only to increase the length of the path through which the pulp must travel relatively to the longitudinal length of the ring, but also to eliminate so-called "channelling" as by direct flow of dilution liquid, either from rotor inlet 38 or from the strainer or rotor.

With the upwardly advancing pulp in the form of a relatively long, thin walled ring, either cylindrical or conical, treating liquid, such as water for washing the chemical from the bleached or otherwise treated pulp, may be flowed through the ring of pulp from the interior of rotor 30, outwardly between its bars 34 and inwardly between strainer bars 22 for discharge through strainer outlets 28, carrying with it chemical washed from the pulp. With a relatively thin layer of pulp of about one to six inches in thickness, preferably about two to four inches in thickness, at least about two feet long and possibly as long as four or five feet, the washing provided with equivalent volumes of washing water is at least equivalent to that provided by conventional drum filters, and with far less complex equipment.

After passing beyond the open ends of the opposed series of bars 22 and 34, the annular ring of pulp, still at high consistency, is advanced into contact with discharger arms 82 which move it into discharge conduit 84 for such further treatment as may be desired.

The arrangement of the opposed conical surfaces defined by bars 22 and 34, whether or not used as straining surfaces, makes possible a rotor structure self-balancing to a major extent insofar as pressure forces imposed on its lower surface by the upwardly advancing mass of pulp is concerned. This is especially important in large diameter vessels, in which pressures of many tons may be present on the rotor bottom. The apparatus and methods herein described are susceptible to various modifications. Thus, as has already been mentioned other means than the specific pump herein described may be utilized for advancing the high consistency pulp upwardly, and as may or may not be necessary with such other means, the shape of the lower portion of the tower may be modified from that herein shown. Also, the discharge means herein shown may be substituted by other known discharge means. More importantly, the hollow rotor and strainer combination of the invention may be altered in its configuration to provide an annular washing ring of cylindrical configuration, for example. Again the washing or other treatment zone may be varied in its cross sectional dimension, as to progressively decrease its cross section in the direction of pulp movement to squeeze the advancing pulp to remove liquid therefrom for increase of consistency. With the conical rotor configuration shown and described herein, the rotor may be adjusted vertically as by bearing shims 49 to vary said cross section, whether it be of the uniform cross section configuration as shown or of decreasing cross section. Furthermore, additional inlets and outlets may be provided to rotor and strainer, for example, including an uppermost vacuum chamber to draw air through the pulp just before its discharge to further increase its consistency. The apparatus of the invention, then, makes it possible to control the consistency within the apparatus as desired, as to dilute the pulp to a suitably low consistency for effective washing or other treating in the treatment zone, and then to thicken it to high consistency for discharge to any extent desired, such as that at which the pulp was introduced to the apparatus.

Various other modifications within the spirit of the invention and the scope of the appended claims will occur to those skilled in the art.

I claim:

1. Apparatus for treating high consistency pulp or the like comprising:

an upright elongated vessel having an annular extended strainer surface adjacent its upper end,

a hollow coaxial rotor mounted within said strainer surface having an extended foraminous surface generally parallel to and spaced from said strainer surface by between one and six inches and a lower downwardly extending conical portion,

liquid supply means for moving liquid between said strainer surface and said foraminous surface through said surfaces,

input means adjacent the lower end of said vessel for feeding high consistency pulp into the bottom of said vessel and advancing said pulp upwardly through said vessel and in annular ring form between said strainer surface and said foraminous surface and

discharge means positioned above said strainer surface for discharging high consistency treated pulp from said vessel.

2. Apparatus as claimed in claim 1 wherein said surfaces are slotted providing upwardly diverging slots with open ends.

3. Apparatus as claimed in claim 1 wherein said vessel is generally cylindrical with a length to diameter ratio at least three to one.

4. Apparatus as claimed in claim 3 wherein said strainer surface is at least about two feet in its longitudinal dimension.

5. Apparatus as claimed in claim 4 wherein said spacing is about two to four inches.

6. Apparatus for treating high consistency pulp or the like comprising:

an upright elongated vessel having an annular upwardly and radially inwardly extending conical strainer surface adjacent its upper end,

a hollow coaxial rotor mounted within said strainer surface having an extended conical foraminous upper surface generally parallel to and spaced downwardly from said strainer surface by between one and six inches,

liquid supply means for moving liquid between said strainer surface and said foraminous surface through said surfaces,

inlet means adjacent the lower end of said vessel for feeding high consistency pulp into the bottom of said vessel and advancing said pulp upwardly through said vessel and in annular ring form between said strainer surface and said foraminous surface and

discharge means positioned above said strainer surface for discharging high consistency treated pulp from said vessel.

7. Apparatus for treating high consistency pulp or the like comprising:

an upright elongated vessel having an annular extended strainer surface adjacent its upper end,

a hollow coaxial rotor mounted within said strainer surface having an extended foraminous surface generally parallel to and spaced from said strainer surface by between one and six inches and

a lower downwardly extending conical portion having liquid inlet means adjacent its lower end,

liquid supply means for moving liquid generally radially between said strainer surface and said foraminous surface through said surfaces,

dilution supply means for supplying dilution liquid to said liquid inlet,

input means adjacent the lower end of said vessel for feeding high consistency pulp into the bottom of said vessel and advancing said pulp upwardly through said vessel and in annular ring form between said strainer surface and said foraminous surface, and

discharge means positioned above said strainer surface for discharging high consistency treated pulp from said vessel.

8. Apparatus for treating high consistency pulp or the like comprising:

an upright elongated vessel having an annular upwardly and radially inwardly extending conical strainer surface adjacent its upper end,

a hollow coaxial rotor mounted within said strainer surface having an extended conical foraminous upper surface generally parallel to and spaced downwardly from said strainer surface by between one and six inches and a lower downwardly extending conical portion having liquid inlet means adjacent its lower end,

liquid supply means for moving liquid generally radially between said strainer surface and said foraminous surface through said surfaces,

dilution supply means for supplying dilution liquid to said liquid inlet means, input means adjacent the lower end of said vessel for feeding high consistency pulp into the bottom of said vessel and advancing said pulp upwardly through said vessel and in annular ring form between said strainer surface and said foraminous surface and

discharge means positioned above said strainer surface for discharging high consistency treated pulp from said vessel.

9. Apparatus for treating high consistency pulp or the like comprising:

an upright elongated generally cylindrical vessel with a length to diameter ratio of at least three to one having an annular upwardly and radially inwardly extending conical strainer surface,

a hollow coaxial rotor mounted within said strainer surface having an upwardly and radially inwardly extending foraminous conical surface generally parallel to and spaced radially inwardly from said strainer surface by between one and six inches, at least one of said surfaces having upwardly and radially inwardly diverging open-ended slots,

liquid supply means for moving liquid between said strainer surface and said foraminous surface through said surfaces,

positive displacement input means adjacent the lower end of said vessel for feeding high consistency pulp into the bottom of said vessel and advancing said pulp upwardly through said vessel and in annular ring form between said strainer surface and said foraminous surface and

discharge means positioned above said strainer surface for discharging high consisttency treated pulp from said vessel.

10. Apparatus as claimed in claim 9 wherein said strainer surface and said foraminous surface is at least about two feet in length with a spacing therebetween of about two to four inches.

11. Apparatus for treating high consistency pulp or the like comprising:

an upright elongated generally cylindrical vessel with a length to diameter ratio of at least three to one having an annular upwardly and radially inwardly extending conical strainer surface,

a hollow coaxial rotor mounted within said strainer surface having an upwardly and radially inwardly extending foraminous conical surface generally parallel to and spaced radially inwardly from said strainer surface by between one and six inches with generally helical lifting vane means extending radially outwardly from said rotor at least adjacent the bottom end of said foraminous surface and a lower downwardly extending conical portion having central liquid inlet means adjacent its lower end and generally radially extending swept wall means on its outer surface, at least one of said surfaces having upwardly and radially inwardly diverging open-ended slots,

means for rotating said rotor in a direction for lifting said pulp by said vane means and moving said pulp radially outwardly by said wall means,

liquid supply means for moving liquid generally radially between said strainer surface and said foraminous surface through said surfaces,

dilution supply means for supplying dilution liquid to said central liquid inlet,

positive displacement input means adjacent the lower end of said vessel for feeding high consistency pulp

into the bottom of said vessel and advancing said pulp upwardly through said vessel and in annular ring form between said strainer surface and said formainous surface and

discharge means positioned above said strainer surface for discharging high consistency treated pulp from said vessel.

12. A method of treating high consistency wood pulp comprising the steps of:

advancing upwardly in generally cylindrical columnar configuration with a height to width ratio of at least 3 to 1 a mass of wood pulp having a high consistency of from 10 to 40 percent by applying lifting forces solely at the lower end of said column,

forming said mass at its upper end into a longitudinally extended annular ring of pulp having a wall thickness of from one to six inches by diverting said pulp radially outwardly from its central axis along an upwardly diverging conical surface and

flowing a treating liquid generally radially through said annular ring of pulp to treat said pulp.

13. A method as claimed in claim 12, wherein said wall thickness is from two to four inches with a length of at least about two feet.

14. A method of treating high consistency wood pulp comprising the steps of

advancing upwardly in generally cylindrical columnar configuration with a height to width ratio of at least 3 to 1 a mass of wood pulp having a high consistency of from 10 to 40 percent by applying lifting forces solely at the lower end of said column,

forming said mass at its upper end into a longitudinally extended annular ring of pulp having a wall thickness of from one to six inches by diverting said pulp radially outwardly from its central axis along an upwardly diverging conical surface while diluting at least a portion of said pulp along said surface to a consistency of less than 10 percent and

flowing a treating liquid generally radially through said annular ring of pulp to treat said pulp.

15. A method of treating high consistency wood pulp comprising the steps of

advancing upwardly in generally cylindrical columnar configuration with a height to width ratio of at least 3 to 1 a mass of wood pulp having a high consistency of from 10 to 40 percent by applying lifting forces solely at the lower end of said column,

forming said mass at its upper end into a longitudinally extended annular ring of pulp having a wall thickness of from one to six inches by diverting said pulp radially outwardly from its central axis along an upwardly diverging conical surface,

rotating said annular ring of pulp to move pulp advancing therethrough in a generally helical path and

flowing a treating liquid generally radially through said anuular ring of pulp to treat said pulp.

16. A method of treating high consistency wood pulp comprising the steps of

advancing upwardly in generally cylindrical columnar configuration with a height to width ratio of at least 3 to 1 a mass of wood pulp having a high consistency of from 10 to 40 percent by applying lifting forces solely at the lower end of said column,

forming said mass at its upper end into a longitudinally extended annular ring of pulp having a length of at least about two feet and a wall thickness of from about two to four inches by diverting said pulp radially outwardly from its central axis along an upwardly diverging conical surface while diluting at least a portion of said pulp along said surface to a consistency of less than 10 percent,

rotating said annular ring of pulp to move pulp advancing therethrough in a generally helical path,

flowing a treating liquid generally radially through said annular ring of pulp to treat said pulp and

discharging said treated pulp from the upper end of said ring at a high consistency of from 10 to 40 percent.

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IRVING BUNEVICH, *Primary Examiner.*