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HIGH DENSITY PULP AND STEAM MIXING

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2 Sheets-Sheet 1

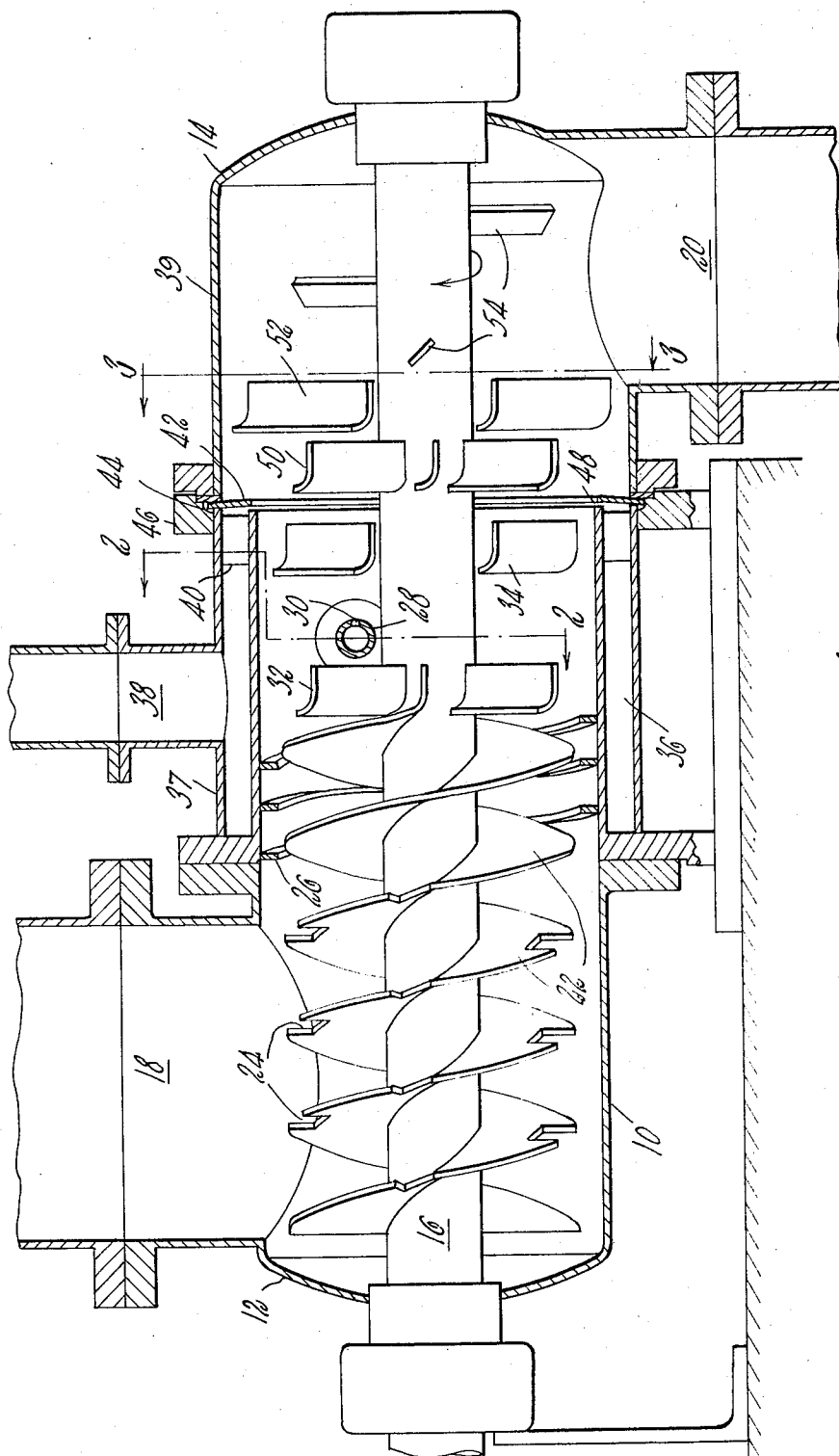


Fig. 1.

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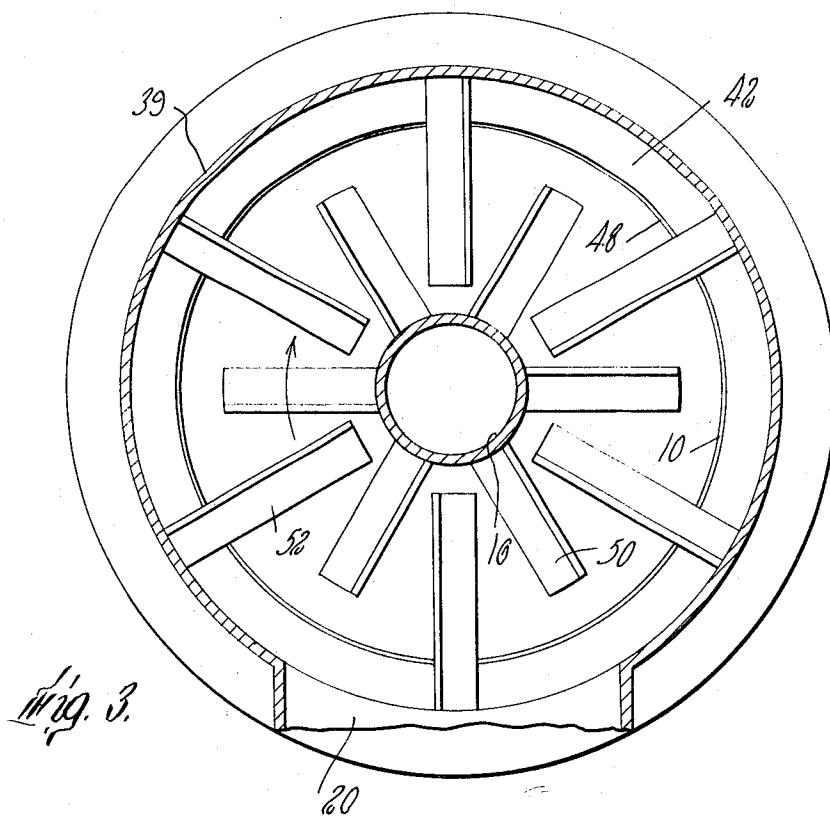
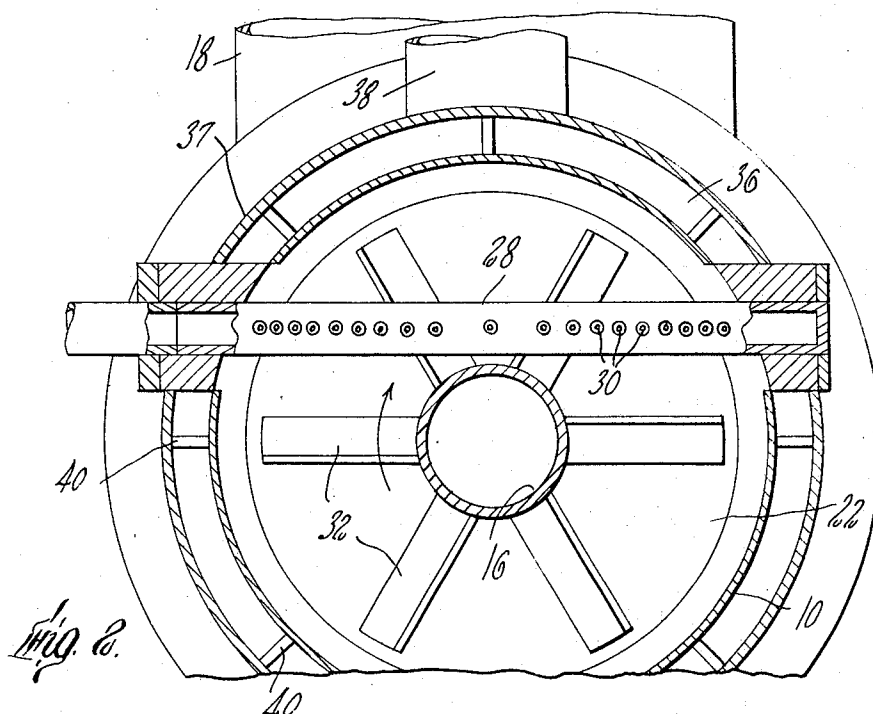
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HIGH DENSITY PULP AND STEAM MIXING

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by mesne assignments, to Improved Machinery Inc.,
Nashua, N.H., a corporation of Delaware
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3 Claims. (Cl. 162—236)

This invention relates to the heating and mixing of wood pulp, cellulose or the like with steam and more particularly to the mixing of high concentrations or densities of chemically treated pulp with injected steam in a continuous flow fashion as distinguished from batch mixing processes.

The basic problem in the continuous mixing of steam and pulp is to expose enough surface area of the pulp and chemical mixture to the injected steam so as to condense all of the steam and heat the entire pulp mass within the time available in the process. This time is governed, of course, by the ratio of the mixing chamber volume to the through-put rate of the pulp. In presently known equipment, if the pulp through-put rate is conducted slowly enough to give the steam time to penetrate and heat throughout the moving pulp, the entire process is unduly delayed. In pulp and steam mixers of known design an increase of speed of operation or pulp feed may result in uneven or incomplete heating of the pulp and insufficient condensation of the steam within the reduced time then available. High density pulps emphasize these problems.

One object of the present invention is to provide equipment and a method for the continuous mixing of steam with high density pulp at faster rates than heretofore, so that the time of the process may be shortened. A further object is to provide equipment in which the high speed heating and mixing of steam in pulps may be carried out in such a fashion that the injected steam is distributed evenly and diffused thoroughly throughout the pulp before the pulp is further processed. Improved results in less time are therefore sought according to this invention.

A special object of this invention is to provide steam inlet means which will be closed when the steam supply is discontinued, thus preventing plugging of the steam supply source with pulp.

These and other objects are met, according to a preferred embodiment of the invention, by providing a mixing chamber in the general form of a hollow cylinder with a rotary pulp impeller shaft mounted axially therein. The pulp enters near one end of the cylinder, is fed under pressure forward or longitudinally initially therein, and may be moved past a liquid chemical injector introducing activating materials into the pulp. When this has been accomplished the pulp is given a rotary motion in a single transverse plane in the chamber normal to the longitudinal pulp flow, and, at the outer edge of this plane of rotary movement of the pulp, steam is introduced in a thin sheet from the periphery of the casing toward the central rotor. This steam is preferably at super atmospheric pressure and is fed from an outer annular steam jacket which has been heating the pulp while it was progressing toward the area of circumferential steam injection. The rotation of the pulp means that a rapidly rotating interface of the pulp is continuously exposed to the sheet of steam, producing alternate layers of pulp and steam, thus insuring adequate exposed surface area to accomplish complete and rapid condensation of the steam and consequently rapid heating of layers of the pulp. A novel pivoted-gated valve ring is provided to inject the steam but to close the steam jacket in case the steam supply is discontinued and lowered pressure from condensation in the jacket or other causes

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should threaten entry of pulp and plugging of the steam inlet. The steam admission zone preferably is followed by means to check pulp rotation and break up the layers of steam and pulp which were formed upon introduction of the steam, and the steamed pulp mixture may then be worked further in the chamber or immediately discharged for further processing.

Other objects and further details of that which is believed to be novel and included in this invention will be clear from the following description and claims, taken with the accompanying drawings in which is illustrated an example of mixer embodying the present invention and incorporating the steam injection features and method described generally above.

In the drawings:

FIG. 1 is a vertical sectional view taken longitudinally through a mixing apparatus or chamber according to a preferred form of the invention;

FIG. 2 is a vertical sectional view transversely of the mixing chamber of FIG. 1 substantially on the line and in the direction of the arrows 2—2 thereof, and

FIG. 3 is a similar vertical sectional view transversely of FIG. 1 substantially on the line 3—3 thereof.

In carrying out the objects of this invention, in one embodiment thereof, a mixing chamber is provided in the form of a hollow cylinder 10 closed at its ends 12 and 14 and carrying a rotatable impeller shaft 16 which extends centrally and axially through the entire chamber. Near one end of the mixing chamber shell a pulp inlet opening 18 is provided and a suitable outlet opening 20 is located near the other end. In the form shown, the inlet 18 is conveniently arranged above the chamber and the outlet 20 is at the bottom of the other end of the chamber. However, by making the total chamber out of several separate flanged sections as indicated, the direction of either the inlet or the outlet may be changed by rotation of the various sections relative to one another.

If desired, pulp may be pressure-fed through the inlet into the chamber by means of an external thick-stock pump of known design (not shown) which will introduce the pulp under pressure and force it through the chamber and out of the outlet. On the other hand, the pulp might be fed by gravity through the inlet and for that purpose, as shown in the drawing, a series of helical feeding or conveyor screws 22 on the impeller shaft 16 are used to impart the desired longitudinal forward motion and exert pressure on the pulp from the inlet through the chamber, to the outlet. In any case, means is provided for impelling the pulp to move or flow longitudinally in the chamber under pressure.

The flights of the conveyor screw immediately opposite the inlet may be provided with external notches 24 to catch or grab any lengthy unshredded stock or fiber bundles in the pulp which might bridge over the inlet and block the free entry of further pulp to the chamber. Also, if desired, the interior walls of the chambers may be provided with spiral rifling ribs 26. These ribs can be used to prevent an undesirable amount of gross rotation of the pulp mix within the chamber where such rotary motion is not desired. They may be so arranged as to assist or impede rotation of the pulp mass to any desired degree depending upon the circumstances of each particular installation.

In cases where liquid bleach or other chemical is desired to be introduced, the liquid may be injected through a transversely arranged inlet pipe 28 having a series of liquid feeding inlet openings 30 therein facing in a downstream direction considering the general progress of pulp through the mixing chamber. The bleach or other chemical is thus introduced under pressure in a transverse line extending chordally of the cylinder near the impeller

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shaft across approximately a full diameter of the chamber. The pulp at this point or closely adjacent it may be rotated as by a series of radially extending curved vanes 32 fixed to the impeller shaft 16 so that as the chemical liquid is introduced it will be spread in helical layers or "sandwiches" throughout the pulp.

Following the introduction of chemicals, where such chemical addition is desired, most or all of the rotary motion of the pulp may be stopped or checked by inwardly radially extending curved vanes 34 secured to the walls of the chamber. These also serve to break up layers of pulp and chemical previously introduced. It will be understood that the primary pulp impelling means, either the screw conveyor 22 or an external pump or both, is causing the pulp to move generally longitudinally under pressure in the chamber at all times.

The diametrical or crosswise introduction of liquid chemical in a pulp mixer is taught by the copending patent application of Rohe V. Pennington, Jr., and John P. Rich entitled, "High Density Pulp Mixing," Serial No. 268,250, filed March 27, 1963, and assigned to the same assignee as the present invention and application.

Outside the mixing chamber an annular steam chamber or jacket 36 is provided by an outer annular wall 37, and steam at super-atmospheric pressure is fed to the jacket as through a steam feed inlet 38 connected to a suitable source. The steam jacket not only heats the walls of the mixing chamber and thus transfers heat to pulp moving in contact with the walls of the mixing chamber while the pulp is being fed longitudinally and agitated, but the temperature of the steam in the jacket is being reduced by this heat exchange process. Beyond the steam chamber the mixing chamber is enlarged as at 39 to match the diameter of the annular wall 37. The downstream end of the annular steam chamber 36 is a discharge end in communication with the mixing chamber. It is held open as by spacer blocks 40 extending at intervals around the outer wall of the mixing chamber proper and the inner circumference of the annular wall 37.

According to this invention steam under pressure is introduced all around the periphery of the mixer casing at this end of the steam chamber, through a novel pressure-actuated, pivoted-gate valve member shown here as a thin flexible metallic ring or flat annular plate 42 covering the discharge end of the steam jacket, loosely held at its outer edge in a supporting groove 44, which may be provided in one of the flanges 46 connecting sections of the casing together. The inner circular edge of the flat ring 42 is free and unsupported. Steam under super-atmospheric pressure in the annular chamber will flex the thin ring plate 42 about its outer edge in one direction and swing the free inner edge of the ring to provide a slit opening 48 circumferentially of the mixing chamber for the admission of steam in a thin sheet. The reason the outer edge of the ring 42 is loosely held and not clamped firmly in place is that the force required to flex or swing the ring (and thus open the valve) and the resulting stress in the ring plate due to this rotation, are far less with a loosely held outer edge than with a clamped edge. In the event that a large amount of back pressure is built up in the pulp in the mixing chamber, or if the pressure of the steam in the annular steam chamber otherwise should drop below the pressure of pulp in the mixing chamber, the ring 42 would flex or swing reversely to cause its inner edge to close the circumferential steam opening and prevent the back flow of pulp into the steam jacket. The normal action of the ring plate 42 will be to keep the slit 48 open to a degree suitable to maintain injection of steam at a desirable pressure or velocity. In the use of equipment of this nature this valving action is important and if the outer edges of the ring were clamped, the high forces and high stresses involved would make this type of steam admission valve impractical.

In order to take full advantage of the circumferential inlet for steam, there is provided, immediately trans-

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versely adjacent the circumferential opening 48, a series of radially extending curved vanes 50 which are secured to the impeller shaft 16 and rotate at high speed therewith. The effect of these rotary vanes 50 is to provide a constantly changing broad surface transversely of the chamber where the incoming steam and moving pulp will come into contact with each other to condense the steam. Multiple layer "sandwiches" of pulp and steam result. The curvature of the vanes 50 imparts some longitudinal motion to the pulp as well as rotary motion at this point and the rotary motion or component of the pulp movement is shortly thereafter impeded by a series of radially inwardly extending fixed curved vanes 52 secured to the inner walls of the mixing chamber. When rotary pulp motion is stopped by the vanes 52, the alternating layers of pulp and steam are broken up and the steam distributed in the pulp more completely than if the rotary motion component were continued.

Thereafter the pulp may be worked or kneaded within the mixing chamber by appropriate elements carried by the rotary impeller shaft or, as shown, the heated pulp may be broken up further and directed to the outlet by bridge-breaker impeller blades 54 carried by the rotary shaft. With this arrangement, further working of the pulp, if necessary, is accomplished by other equipment beyond the mixing chamber.

It will be noted that the mixing chamber illustrated consists of three zones, an inlet zone, a compaction zone and a steam introduction zone. The inlet zone receives either gravity fed or pressurized stock and the screw flights in this zone are notched to prevent bridging of unshredded stock. The compaction zone is equipped with spiral rifling on the inside of the mixing chamber shell to insure complete filling of the annular space between the rotor core and the shell and to control the speed of advance and rotation of the stock. The pitch of the rifling is arranged to permit rotation of the stock mass at approximately one-half the speed of the rotor. As the stock enters the steam injection zone its rotational velocity is increased to approach that of the rotor itself at the place where the steam is circumferentially introduced. The curved rotating vanes and stationary vanes alternately accelerate and decelerate the stock to reorient the mixture and disperse the steam and chemical in the pulp.

The apparatus above described will perform the steps of: *first*, moving and compacting the pulp mass longitudinally in a cylindrical mixing chamber; *second*, heating the pulp at the walls of the chamber by heat exchange contact therewith while it is moving; *third*, injecting steam under pressure from the entire periphery of the chamber in a thin sheet extending in a plane normal to the direction of longitudinal advance of the stock; *fourth*, while at the same time rapidly rotating the pulp in the plane of steam injection so as to form successive constantly changing helical contact surfaces between pulp and steam; and *fifth*, collapsing and crumbling the successive contact surfaces by stopping or checking the rotational motion of the pulp in the chamber before discharge.

The heating of the pulp by steam introduced all the way around the chamber insures adequate exposed pulp surface area to accomplish complete and rapid condensation of the steam and thorough rapid heating of the pulp. The rapid rotation of the pulp while the steam is being injected, followed by the checking of the rotational motion of the pulp, insures a uniformity of heating that is not equalled by other arrangements. The entire process is thus completed within a substantially shorter time and smaller space than has previously been considered necessary.

The valve construction described above may be useful in controlling fluid flow for other applications than the pulp and steam mixing chamber here shown. However, it has particular utility as a pressure-actuated, pivoted-gate annular valve control for introducing steam or other

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fluid from a pressure chamber around the circumference of a cylinder, pipe or similar receptacle.

As will be evident from the foregoing description, certain aspects of this invention are not limited to the particular details set forth and it is contemplated that various and other modifications and applications of the invention will occur to those skilled in the art. It is therefore intended that the appended claims shall cover such modifications and applications as do not depart from the true spirit and scope of the invention.

What is claimed as new and is desired to be secured by Letters Patent of the United States is:

1. Apparatus for heating a pulp mass with steam, comprising

- a longitudinally extending cylindrical mixing chamber having a pulp inlet opening near one end and a pulp outlet opening near the other end,
- means for feeding pulp under pressure longitudinally of said chamber from said inlet, through said chamber, to said outlet,
- a pressure-actuated, pivoted-gate annular valve member surrounding said chamber for injecting steam under pressure and directing said steam in said chamber from the entire circumference thereof towards its center in a plane transverse of the chamber, said valve member comprising a flexible flat annular valve member covering said open end of said steam jacket, said annular valve member being loosely supported at its outer edge in said mixing chamber, the inner edge of said valve member being free to flex under pressure to open said end of said jacket for peripheral injection of steam under pressure therefrom into said chamber directed in a plane transversely thereof,
- a set of radially extending vanes rotating in said transverse plane for imparting a rotary component of pulp movement at the location of circumferential steam injection, whereby alternating layers of pulp and steam are produced, and
- a set of fixed vanes in said chamber beyond said rotating vanes, for checking rotary movement of the pulp, whereby the layers of pulp and steam are broken up.

2. Apparatus for heating a pulp mass and mixing it with steam, comprising

- a longitudinally extending cylindrical mixing chamber having a pulp inlet opening near one end and a pulp outlet opening near the other end,
- means for feeding pulp under pressure longitudinally of said chamber from said inlet, through said chamber, to said outlet,

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a cylindrical jacket for steam under pressure surrounding a part of said mixing chamber, said jacket having a discharge end in communication with the circumference of said mixing chamber, a flexible flat ring member covering said discharge end of said jacket, and

means loosely supporting the outer edge of said ring member in said chamber,

the inner edge of said member being free to flex under pressure in one direction from steam in said jacket to open said discharge end of said jacket to said chamber around the entire circumference of the chamber and direct steam into said chamber inwardly in a plane transverse of the chamber and to flex under pressure in the opposite direction from pulp in said chamber to close said discharge end.

3. In the combination of a cylindrical receptacle and an annular fluid pressure chamber surrounding said receptacle having an annular end in communication with the entire circumference thereof; a pressure-actuated valve for opening and closing said annular end to said receptacle, comprising

a flat annular plate covering said annular end, and means loosely supporting the outer circular edge of said plate,

the inner circular edge of said plate being unsupported and free to move under fluid pressure from the pressure chamber in one direction to open said annular end of said pressure chamber to said receptacle around the entire circumference thereof and to move under pressure from said receptacle in the opposite direction to close said annular end to said receptacle, said plate, when opening the end of said pressure chamber, directing fluid from the chamber inwardly of the receptacle in a plane transverse of said receptacle.

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