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(54) Impregnation vessel with convergence side relief and method for heat injection at convergence

(57) An impregnation vessel (10) including: a vessel container including an upper inlet (14) to receive cellulosic material; a lower discharge port (27) to discharge the cellulosic material from a discharge section of the vessel container; a convergence section (22) internal to the vessel through which passes a flow of the cellulosic material in the vessel; a cavity (34) between an internal wall of the vessel and the convergence section (22), wherein the cavity (34) has a lower opening to the cellulosic material in the vessel and an upper section shielded from the flow of cellulosic material in the vessel, and an input port in the vessel and opening to the cavity (34), wherein the input port is connectable to a source of hot liquid to be added to the cellulosic material in the vessel.

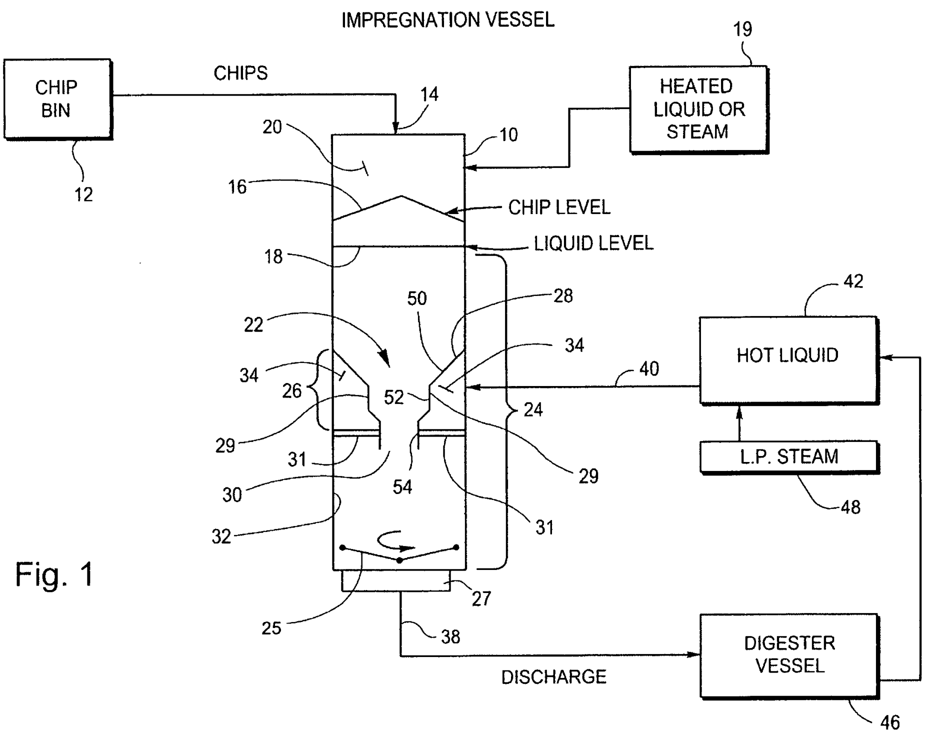

Fig. 1

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Description

BACKGROUND OF THE INVENTION

[0001] This invention relates to an impregnation vessel used with continuous cooking (such as but not limited to Kraft or soda cooking processes) of cellulosic material (such as wood chips and non-wood materials such as annuals, bagasse, etc.) to produce pulp. In particular, the invention relates to the addition of a hot liquid, e.g., liquor or steam, to add heat to the cellulosic material in an impregnation vessel.

[0002] Impregnation vessels pretreat cellulosic material before the material is fed to, for example, a digester vessel. While in the impregnation vessel, the cellulosic material is immersed in liquor and/or steam to heat the material. Examples of conventional vessels suitable for impregnation vessels are shown in U.S. Patent No. 4,746,400, which discloses a vessel having a bottom scraper and hot liquid injection below the scraper to flush cellulosic material out from the vessel, and U.S. Patent No. 5,500,083 and 5,628,873, which disclose vessels having a bottom section having a one-dimensional and two-dimensional convergences with a side relief device, currently marketed as the Diamondback® Chip Bin by Andritz, Inc. of Glens Falls, New York, USA.

[0003] Cellulosic material flows from an impregnation vessel to a digester vessel that generally operates at a higher temperature than does the impregnation vessel. Heat is added to the cellulosic material in the digester. While some heating of cellulosic material occurs in the impregnation vessel, the material in the impregnation vessel is conventionally heated in the digester vessel.

[0004] Increasing the temperature of the cellulosic material in an impregnation vessel could reduce the heat needed to be added to the material in the digester vessel. If hot liquid is added to a downstream portion of an impregnation vessel, the added hot liquor may form currents of hot liquid flowing up through the impregnation vessel. Such currents could disrupt the desired uniform treatment of the cellulosic material flowing down through the vessel. Accordingly, adding a heated liquid to the impregnation vessel is not conventional.

BRIEF DESCRIPTION OF THE INVENTION

[0005] An impregnation vessel has been developed that includes: a vessel container including an upper inlet to receive cellulosic material; a lower discharge port to discharge the cellulosic material from a discharge section of the vessel container; a convergence section internal to the vessel through which passes a flow of the cellulosic material in the vessel; a cavity between an internal wall of the vessel and the convergence section, wherein the cavity has a lower opening to the cellulosic material in the vessel and an upper section shielded from the flow of cellulosic material in the vessel, and an input port in the vessel and opening to the cavity, wherein the input port is connectable to a source of hot liquid to be added to the cellulosic material in the vessel.

[0006] The convergence section may converge in only a single direction within the impregnation vessel and include a tapered wall having an upper section sealed to the internal wall of the vessel and a lower section positioned radially inward of the internal wall, wherein the cavity is between the internal wall of the vessel and the tapered wall of the convergence section. The cavity may be below a liquid level in the vessel and arranged in the middle third elevation of the vessel. The source of hot liquid may supply hot liquid at a temperature, e.g., at least 120 degrees Celsius, above a discharge temperature of the cellulosic material from the impregnation vessel.

[0007] An impregnation vessel has been developed comprising: a vessel container including an upper inlet to receive cellulosic material; a lower discharge port to discharge the cellulosic material from a discharge section of the vessel container; a one-dimensional convergence section internal to the vessel through which passes a flow of the cellulosic material in the vessel; a cavity between an internal wall of the vessel and the convergence section, wherein the cavity has a lower opening to the cellulosic material in the vessel and an upper section shielded from the flow of cellulosic material in the vessel, and an input port in the vessel and opening to the cavity, wherein the input port is connectable to a source of hot liquid to be added to the cellulosic material in the vessel and the hot liquid is added to the cavity at a temperature above an average temperature of the cellulosic material in the vessel.

[0008] A method has been developed for heating cellulosic material in an impregnation vessel having an internal convergence, the method comprising: introducing cellulosic material to an upper inlet port in the impregnation vessel; adding a heated liquid to the vessel and forming a liquid level in a upper section of the vessel; heating the cellulosic material with the heated liquid as the cellulosic material flows downward through the vessel; funneling the flow of the cellulosic material below the liquid level and in the vessel through the internal convergence; introducing a hot liquid to a cavity in the vessel and behind the convergence, wherein the hot liquid is introduced to the cavity at a temperature above a temperature of the heated liquid; adding the hot liquid from the cavity to the flow of cellulosic material downstream of the internal convergence; heating the flow of cellulosic material downstream of the internal convergence with the hot liquid, and discharging the cellulosic material from a discharge port in a lower section of the vessel below the cavity and internal convergence.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIGURE 1 is a schematic side view diagram of an impregnation vessel with a single direction convergence.

[0010] FIGURE 2 is a top down, cross-sectional diagram of the impregnation vessel having a single direction convergence.

[0011] FIGURE 3 is a schematic side view diagram of an impregnation vessel with orthogonal direction convergence.

[0012] FIGURE 4 is a top down, cross-sectional diagram of the impregnation vessel having a orthogonal direction convergence.

DETAILED DESCRIPTION OF THE INVENTION

[0013] FIGURE 1 is a schematic diagram of an impregnation vessel 10 for pretreatment of cellulosic material, referred to herein as chips. The vessel may be a metallic cylinder having a height of 100 feet (30 meters) or more, a diameter of 70 inches (2 meters) or more, and may process 700 metric tons per day (700 mtpd) of pulp. The chips may flow continuously and simultaneously into, through and out of the impregnation vessel. The pretreated chips from the impregnation vessel 10 may flow to an upper inlet of a continuous digester vessel 46.

[0014] Chips may be supplied to the impregnation vessel 10 from a chip source 12 which may be a chip bin or a presteaming vessel or merely a holding location for the chips (such as if no chip bin is used). The impregnation vessel has an upper chip inlet 14 that receives the chips and optionally may receive the chips in a slurry that includes liquor. Within the impregnation vessel, a chip level 16 and a liquid level 18 is formed, where the chip level is likely to be above the liquid level. The liquid level 18 in the vessel may be formed by the addition of flashing liquor (such as white or black liquor) and/or steam with the purpose of heating the chips from a source 19 of heated liquid and/or steam. The gaseous volume 20 of the vessel above the liquid level 18 is preferably maintained at a temperature of about 100 degrees Celsius (°C) and at atmospheric pressure. The heated liquid and/or steam may flow directly into the gaseous volume 20 of the impregnation vessel 10.

[0015] A one dimensional convergence 22 is formed in the vessel in a liquid section 24 of the vessel below the liquid level 18. Preferably, the convergence 22 is in the bottom half of the vessel and above the bottom rotating scraper 25 or other device to move chips into the bottom discharge outlet 27. For example, the convergence 22 may be in the middle third elevation of the vessel and, preferably is below mid-elevation of the vessel and above the lower third elevation of the vessel.

[0016] The one dimensional convergence 22 may be embodied as a hollow transition section 26 having a substantially circular cross-section open top 28 and a substantially rectangular cross-section open bottom 30. The convergence 22 includes a transition section 26 having opposite non-vertical gradually tapering sidewalls 29 that may form an angle with respect to the vertical, typically of about 20 to 35 degrees, and preferably 25 to 30 degrees. The sidewalls 29 may extend straight across the vessel. The walls may be straight in a direction perpendicular to an axis of the vessel 10 and tapered (continuously or in segments) in a direction parallel to the axis and along the transition section 26.

[0017] Opposite side edges of the sidewalls 29 may attach to the interior vessel walls 32. The open top 28 of the transition section 26 may be curved to conform to the vessel wall 32 and welded to the vessel wall to provide a continuous fluid-tight seal between the vessel and the convergence 22. One dimensional convergence structures for chip vessels are disclosed in U.S. Patent 5,500,083 and 5,628,873. Support braces or ribs 31 may extend from the vessel wall 32 and to the tapered walls 27 of the transition section to support the convergence within the vessel.

[0018] FIGURE 2 is a top down, cross-sectional diagram of the impregnation vessel 10 to show the convergence 22. The opposing sidewalls 29 of the convergence are tapered and may include an upper tapered sidewall section 50, a straight vertical sidewall section 52, and a lower tapered sidewall section 54. Figure 2 shows the one dimensional nature of the convergence in that the bottom of the transition section is narrower than the top 28 in one direction and is as wide as the top 28 in a perpendicular direction.

[0019] The one dimensional convergence 22 of the transition section promotes flow of chips down through the vessel and through the transition section 26. The convergence may provide flow rate regulation of the chips in the vessel and promote adequate retention time of the chips in the vessel 10. Further, the one dimensional convergence 22 is less susceptible to chips clogging or bridging in the transition section than are conical convergence sections which converge in two-dimensions.

[0020] A cavity 34 is formed between the inside vessel wall 32 and the sidewall(s) 29 of the transition section 26. The cavity 34 is a shielded region in the vessel behind the sidewall 29 of the transition section 26. The cavity 34 is shielded by the sidewall from the downward flow of chips in the vessel. Because the cavity is below the tapered transition sidewall 29, the wall prevents heat currents flowing upward from the cavity and above the transition section 26. There may be two cavities 34 in the vessel on opposite sides of vessel, wherein one cavity is behind each of two sidewalls 29 of the convergence 22.

[0021] The cavity 34 provides a region into which additional hot liquid, such as black liquor or white liquor, can be added without the liquid flashing in the upper regions of the vessel 10. The hot liquid enters the cavity 34 and mixes with the liquids and chips that flow up into the cavity from below the outlet 30 of the transition section. Heat currents formed by the hot liquid cannot flow upward through the vessel because the cavity is capped by the tapered sidewall 29 of the transition section.

[0022] A source of hot liquor 42 (Fig. 1) feeds a pipe 40 that conveys the hot liquor to the cavity 34. The liquor source 42 may be excess hot liquor from the digester vessel 46, and specifically hot wash liquor extracted from a lower section of a digester vessel 46. If sufficient excess black liquor is not available, low pressure steam 48 may be used to heat the liquor 42 pumped through pipe 40 to the cavity 34. Additionally, other liquids having sufficient heat can be introduced into the cavity 34.

[0023] The temperature of the liquor fed to the cavity 34 may be maintained at a temperature, such as 120 degrees Celsius, which may be higher than the temperature in the vapor area 20 of the vessel. If allowed to flow into the vapor area 20, the heated liquid and/or steam may flash. Introducing the hot liquid in the cavity allows the sidewalls 29 to block any upward flow of the liquid.

[0024] The hot liquid from the liquid source 42, which is preferably black or white liquor, is introduced into the cavity 34 and preferably at an elevation above the outlet 30 of the transition section 26. Introduction of liquor into the cavity does not disrupt the flow of chips down through the vessel, because the chips are funneled through the convergence 22 and away from the cavity 34. The cavity 34 allows the liquid 42 to enter the vessel in the relatively quite, e.g., stagnant, flow of the cavity. From the cavity, the hot liquid diffuses into the chip flow being discharged 30 from the transition section.

[0025] The liquor 42 added to the cavity 34 preferably has a temperature above the average temperature of the chips in the vessel 10, and the temperature of the chips passing through the discharge outlet 38. The added liquor 42 heats the chips in the impregnation vessel 10. The heating is desirable for chips to be conveyed to a digester vessel 46 that typically operates at a higher temperature than the impregnation vessel.

[0026] The introduction of hot liquid 42 in the cavity 34 does not interfere with a conventional discharge devices 25, such as a scraper or other mechanical devices which may include a sluice system, to assist in the movement of the chips through the discharge 38 of the vessel.

[0027] The cavity 34 allows liquid 42 to flow into the vessel 10 without causing channeling or heat currents to form and rise through the chips in the vessel. Another advantage of adding hot liquid 42 to the cavity 34 is that it makes efficient use of excess hot liquid available in a pulp plant, which may include liquids at temperatures above 100 degrees Celsius.

[0028] If the hot excess liquid were added to the impregnation vessel 10 without the use of a convergence 22 with a sidewall, channeling (areas where there is a disruption in the homogeneity and uniformity of the chips) could occur as would heat currents. To add hot liquids from an inlet of the vessel directly to the chip flow through the impregnation vessel may cause heat currents in the chip flow that, in turn, may produce heat risers through the chip column and result is less efficient heating of the chips.

[0029] The addition of the liquid into the cavity 34 allows the hot liquid to mix with other liquids in the cavity and diffuse over a wide area to the chip flow exiting the outlet 30 to the transition section. Further, a stream of hot liquid entering a sidewall of the vessel and directly entering the chip stream in the vessel could disrupt the uniform movement and treatment of the chips through the impregnation vessel. Introducing hot liquid in the cavity 34 avoids creating a hot liquid stream in the chip flow and minimizes the risk of disrupting the uniform movement and treatment of chips through the vessel.

[0030] FIGURE 3 is a schematic side view diagram of a portion of an impregnation vessel 50 with orthogonal direction convergence 52. FIGURE 4 is a top down, cross-sectional diagram of the impregnation vessel 50 having a orthogonal direction convergence 52. The orthogonal direction convergence has a transition section 54 that reduces the flow path through the vessel in two orthogonal directions. The flow path reduces from the cross-sectional area of the entire vessel at the top of the transition section 54 to a smaller circular cross-sectional area of the output 56 of the convergence. Preferably, the transition section 54 includes diamond shaped side-panels 58 that are joined by curved side panels 60. A hot liquid inlet 62 to allow hot liquid, e.g., hot liquor and/or steam 64, is arranged in the annular cavity 66 between the inner sidewalls 68 of the vessel 50 and the outer surfaces of the side-panels 58, 60 of the convergence 52. The cavity provides a region of the impregnation that is out of the direct flow path of the chip and liquid flowing downward through the vessel. As they flow from the outlet 54 of the convergence 52, the chips and liquid mix with the hot liquid flowing down from the cavity. The hot liquid heats the chips as the chips flow further down in the vessel 50 to a discharge device 70, such as a scraper, and to the outlet 72 of the vessel.

[0031] While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiment, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the scope of the appended claims.

Claims

1. An impregnation vessel (10) comprising:

a vessel container including an upper inlet (14) to receive cellulosic material;
a lower discharge port (27) to discharge the cellulosic material from a discharge section of the vessel container;
a convergence section (22) internal to the vessel through which passes a flow of the cellulosic material in the vessel;
a cavity (34) between an internal wall (32) of the vessel and the convergence section (22), wherein the cavity (34) has a lower opening to the cellulosic material in the vessel and an upper section shielded from the flow of cellulosic material in the vessel, and
an input port in the vessel and opening to the

cavity (34), wherein the input port is connectable to a source of hot liquid (42) to be added to the cellulosic material in the vessel.

2. The impregnation vessel (10) as in claim 1 wherein the convergence section (22) converges in a single direction within the vessel.

3. The impregnation vessel (10) as in claim 1 wherein the convergence section (22) converges in orthogonal directions within the vessel.

4. The impregnation vessel (10) as in claim 3 wherein the flow of cellulosic material is funneled to a circular discharge (30) from the convergence (22).

5. The impregnation vessel (10) as in any one of the preceding claims wherein the convergence section (22) includes a tapered wall (29) having an upper section sealed to the internal wall (32) of the vessel and a lower section positioned radially inward of the internal wall (32), wherein the cavity (34) is between the internal wall (32) of the vessel and the tapered wall (29) of the convergence section (22).

6. The impregnation vessel (10) as in any one of the preceding claims wherein the convergence section (22) and cavity (34) are below a liquid level (18) in the vessel.

7. A method for heating cellulosic material in an impregnation vessel (10) having an internal convergence (22), the method comprising:

introducing cellulosic material to an upper inlet port (14) in the impregnation vessel (10);
adding a heated liquid to the vessel and forming a liquid level (18) in a upper section of the vessel;
heating the cellulosic material with the heated liquid as the cellulosic material flows downward through the vessel;
detecting the flow of the cellulosic material below the liquid level (18) and in the vessel through the internal convergence (22);
introducing a hot liquid to a cavity (34) in the vessel and behind the convergence (22), wherein the hot liquid is introduced to the cavity (34) at a temperature above a temperature of the heated liquid;
adding the hot liquid from the cavity (34) to the flow of cellulosic material downstream of the internal convergence (22);
heating the flow of cellulosic material downstream of the internal convergence (22) with the hot liquid, and
discharging the cellulosic material from a discharge port (27) in a lower section of the vessel below the cavity (34) and internal convergence (22).

8. The method as in claim 7 wherein the cellulosic material is continuously introduced to and discharged from the vessel.

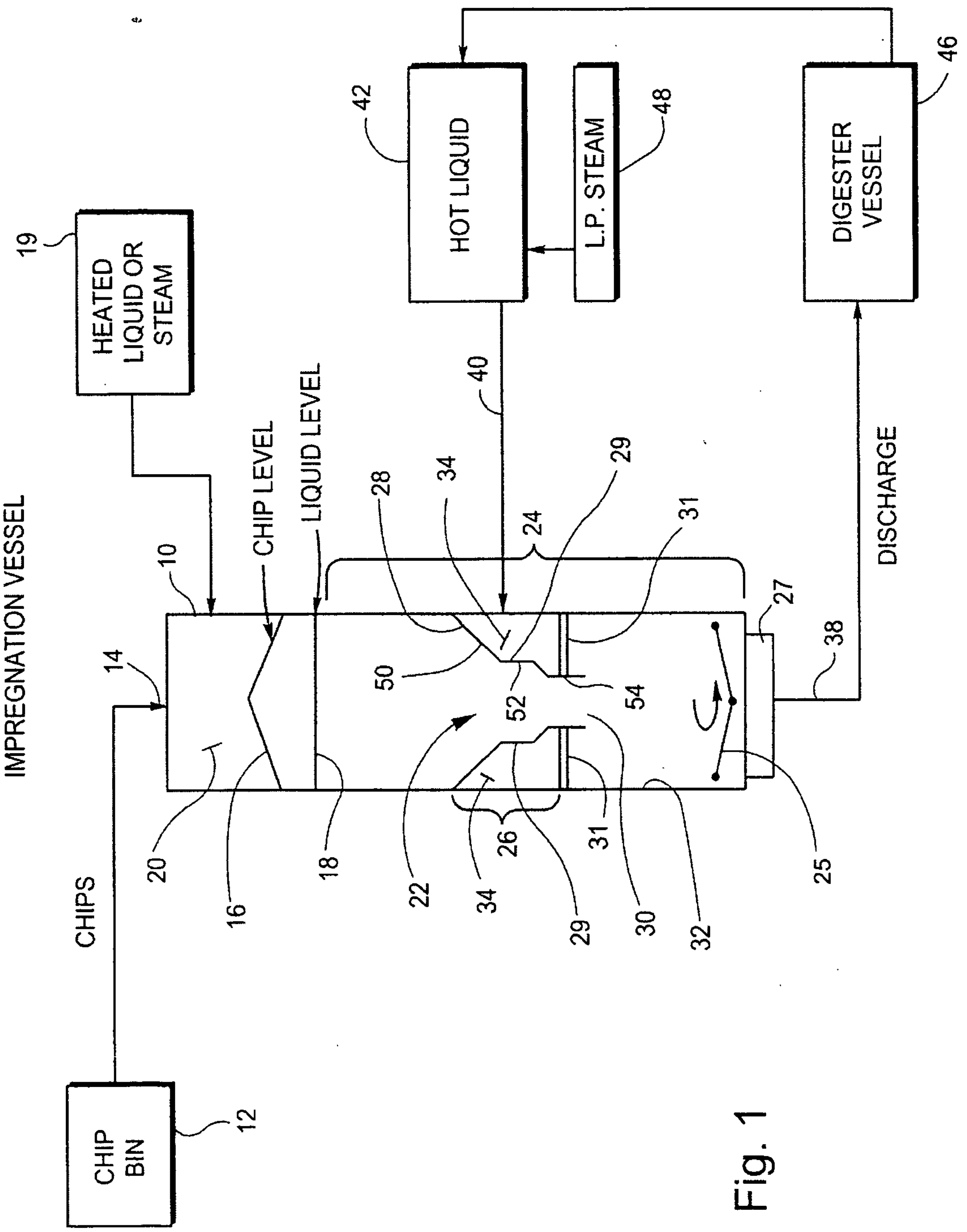
9. The method as in any one of claims 7 and 8 wherein the hot liquid (42) is supplied to the cavity (34) at a temperature above a discharge temperature of the cellulosic material from the vessel, and/or at a temperature above an average temperature of the cellulosic material in the vessel, and/or at a temperature of at least 120 degrees Celsius.

10. The method as in any one of claims 7 to 9 further comprising conveying the discharged cellulosic material to a digester vessel (46).

11. The method as in any one of claims 7 to 10 wherein the hot liquid includes hot black liquor extracted from the digester vessel (46).

12. The method as in claim 11 wherein the hot liquid includes hot black liquor extracted from a lower section of the digester vessel (46).

13. The method as in any one of claims 7 to 12 further comprising supplying the introduced cellulosic material from a chip bin (12).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HOT LIQUID
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DISCHARGE

Fig. 1

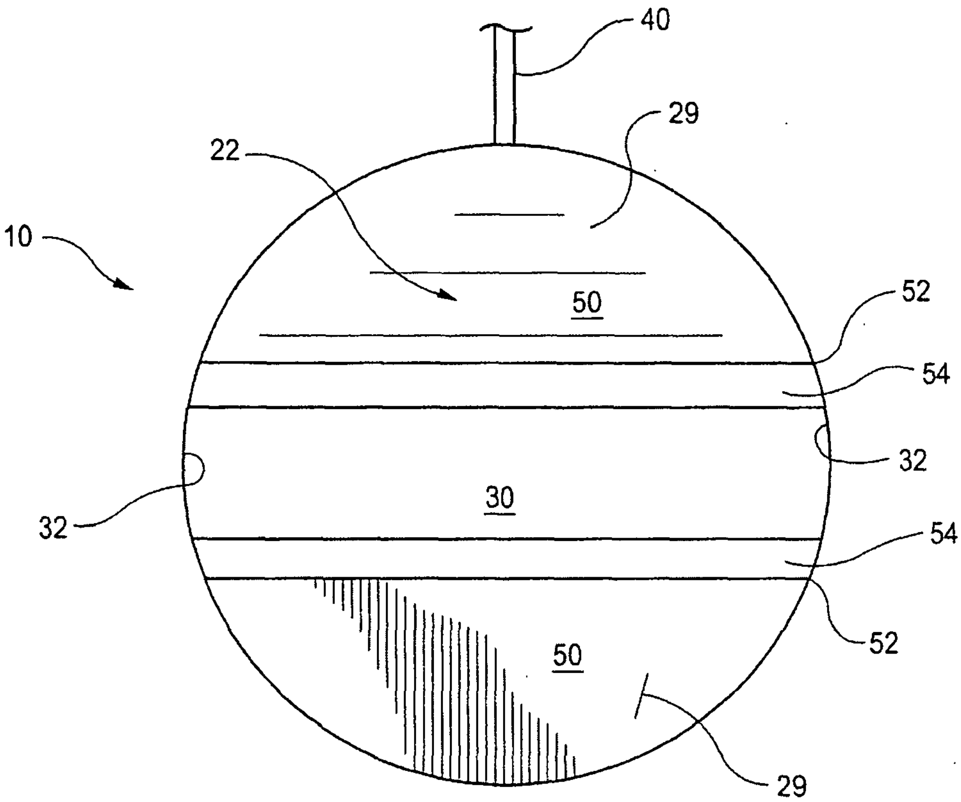

Fig. 2

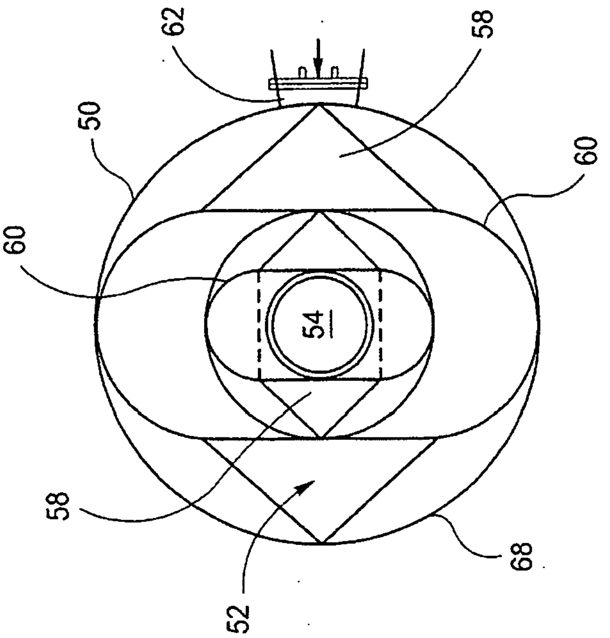
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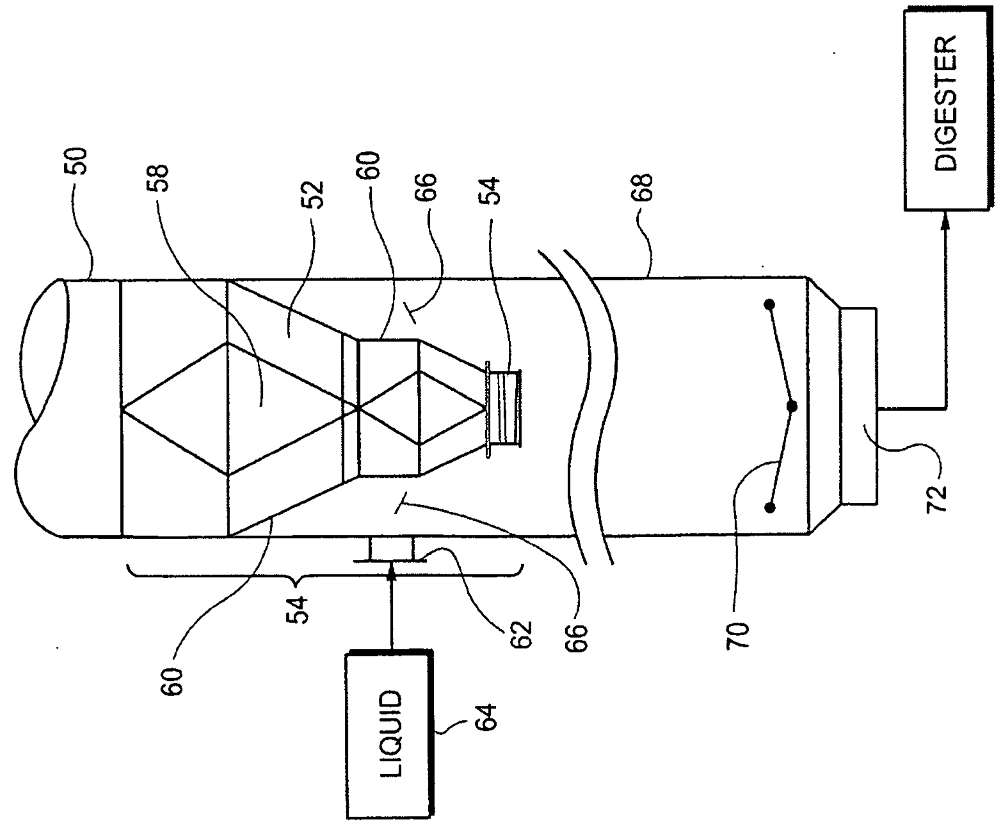
Fig. 4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LIQUID
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Fig. 3

REFERENCES CITED IN THE DESCRIPTION

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