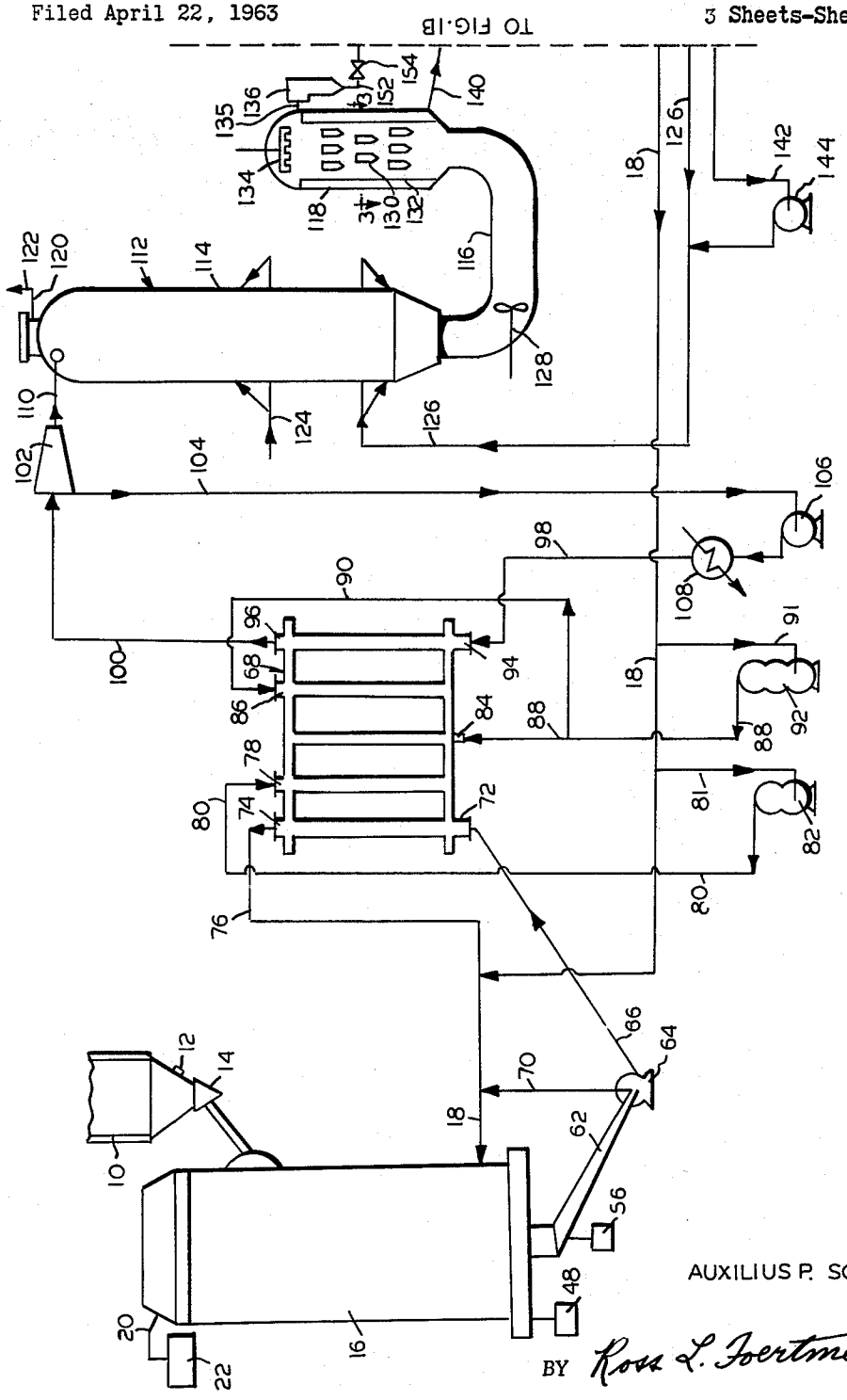
July 5, 1966 A. P. SCHNYDER 3,259,538

COMPREHENSIVE PULPING SYSTEM FOR PRODUCING PAPER PULP

Filed April 22, 1963 3 Sheets-Sheet 1



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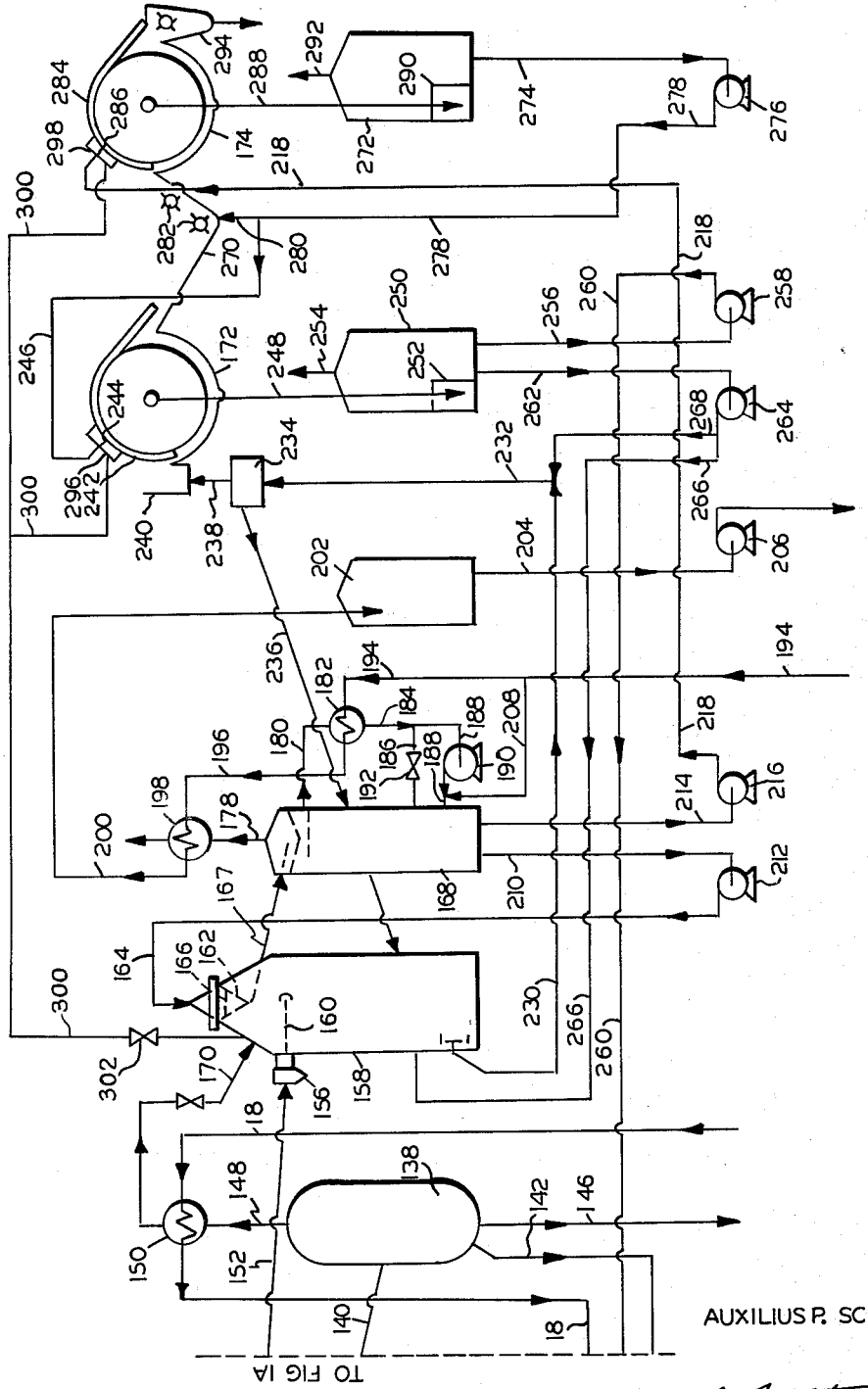


FIG. 1B

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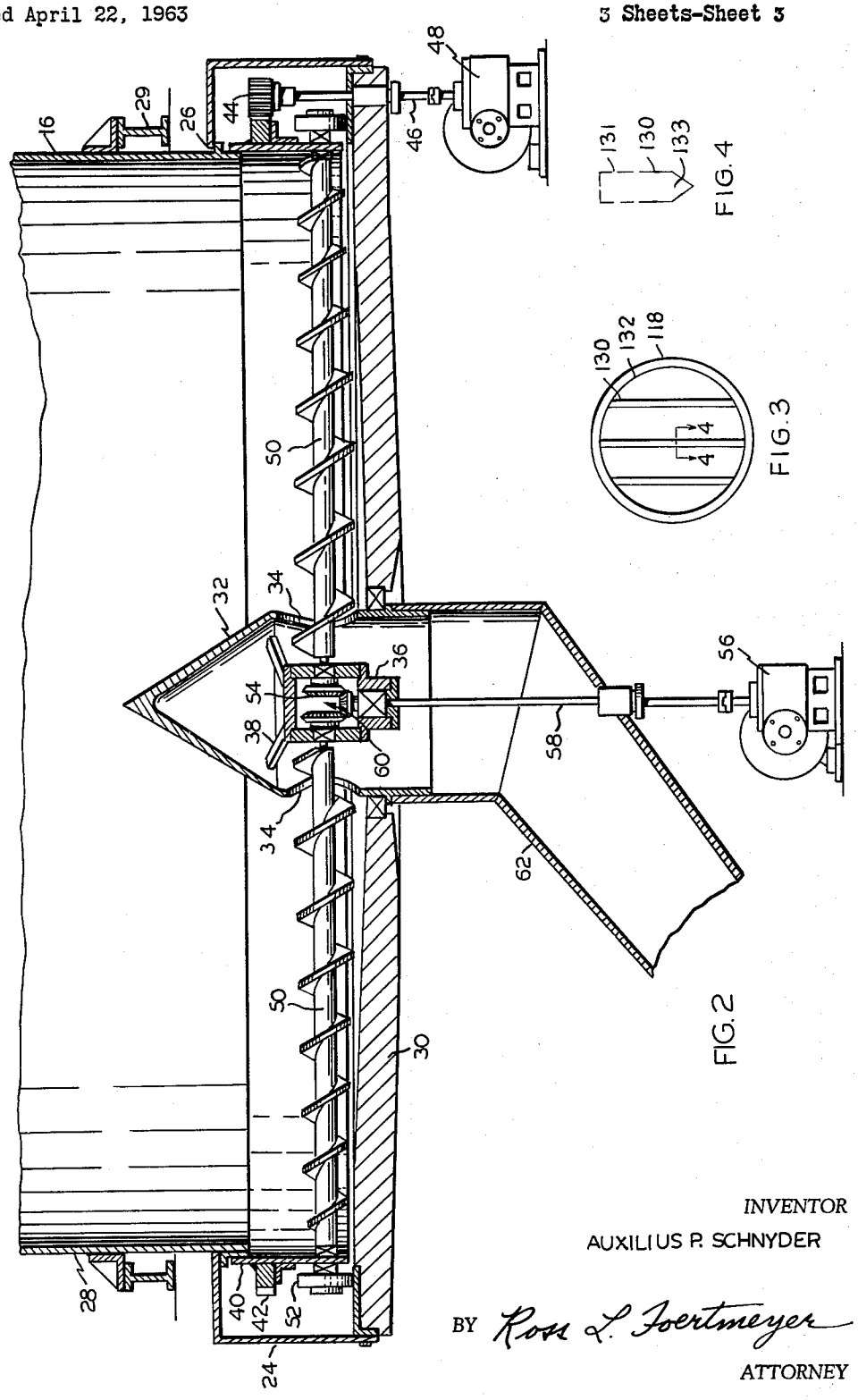


FIG. 2

FIG. 4

FIG. 3

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COMPREHENSIVE PULPING SYSTEM FOR PRODUCING PAPER PULP

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Filed Apr. 22, 1963, Ser. No. 274,419
12 Claims. (Cl. 162—19)

This present invention relates to an improved method and apparatus for the delignification of cellulosic materials to prepare cellulosic fibers and, more particularly, to a comprehensive, continuous system for treating cellulosic material which extends from a raw chip supply source through discharge of the washed pulp for final processing.

In accordance with a preferred embodiment of the present invention, the chips are initially deaerated in a feed tank maintained under vacuum and submerged in liquor therein to form a slurry of suitable consistency. The slurry is then pumped to an impregnator where the chips are impregnated with cooking liquor by being subjected to successive, incrementally increasing hydraulic pressures. From the impregnator, the chip slurry is passed to a digester, and excess liquor is recycled to the feed tank. After digestion, the chips are washed within the digester. A high temperature liquor of high solids concentration is separated from the pulp in the initial washing within the digester. The pulp is discharged into a blow tank provided with means to enable improved heat recovery and condensing of flash steam within the blow tank. The pulp is then further washed in vacuum type washers. A portion of the steam flashed in the blow tank is passed to the headers of the vacuum type washers to minimize air infiltration and foaming. The waste liquor is sent to conventional multiple-effect evaporators for concentration prior to smelting.

A primary object of the present invention is to provide an improved comprehensive pulping system.

Another object of the present invention is to provide an improved continuous process for delignifying cellulosic material to pulp of high quality and yield.

Another object of the present invention is to provide an improved continuous process for delignifying cellulosic material including a method of washing digested pulp within a continuous digester.

Still another object of the present invention is to provide an improved continuous process for delignifying cellulosic material including improved tank discharge means for submerging cellulosic material within cooking liquor to form a slurry of suitable pumping consistency.

A further object of the present invention is to provide an improved continuous process for delignifying cellulosic material including a continuous digester of novel structure enabling an initial washing operation to be carried out within the digester.

A still further object of the present invention is to provide an improved continuous process for delignifying cellulosic material including means to recover heat from the pulp and liquor leaving the digester.

These and other objects, features and advantages of the present invention will become more apparent from the following description taken in conjunction with accompanying drawings wherein:

FIGURES 1*a* and 1*b* together show a schematic flow diagram illustrating one embodiment of the comprehensive pulping system;

FIGURE 2 is a vertical sectional view through a portion of the vacuum tank and chip submergence means of FIGURE 1*a*;

FIGURE 3 is a horizontal cross sectional view on the line 3—3 of FIGURE 1*a* through the washing zone; and

FIGURE 4 is an enlarged cross-sectional view of a drainage member of the washer taken along the lines 4—4 of FIGURE 3.

Referring now to the drawings, and more particularly to FIGURE 1*a*, wood chips or like cellulosic material are passed from a main chip silo **10** including a vibration hammer **12** into a vibrating feeder device **14** or other suitable chip metering device and introduced into a vacuum tank **16**. Liquor in line **18**, comprised of a solution of fresh cooking liquor and recirculated liquor, is introduced into tank **16** as will be explained more fully hereinafter. Suitable liquid level control means (not shown) may be provided to maintain the liquor level in tank **16** within the desired range so that only a portion of the body of chips within tank **16** is below the level of the liquor. Air is withdrawn from the tank **16** through vacuum line **20** and pump **22**. The chips, after being subjected to the vacuum, are gradually submerged beneath the level of the cooking liquor within tank **16**. This gradual submergence is also effective to displace air from the pores of the chips.

The slurry discharge mechanism of tank **16** is best shown in FIGURE 2. An annular housing **24** is rigidly secured to a flange **26** of the side walls **28** of vessel **16**. Suitable support means **29** are welded or otherwise fastened to side walls **28** above housing **24**. Housing **24** is also rigidly secured to the bottom wall **30** of tank **16**. A hollow chip deflecting member **32** having an essentially conical upper surface projects upwardly through the center of bottom wall **30**. Member **32** is provided with opposed openings **34** and with a gear housing **36** mounted interiorly thereof by suitable support elements **38**. Casing **40** is rotatably positioned within housing **24** by means of an annular gear ring **42** driven by gear **44**, a shaft **46** extending through bottom wall **30**, and a motor **48**.

Opposed screw conveyors **50** are mounted above and adjacent to the slightly tapering inner surface of bottom wall **30**. Screw conveyors **50** extend at their outer ends through apertures in casing **40** and are secured to roller members **52** which support the lower end of casing **40** above the upper surface of bottom wall **30**. At their inner ends, screw conveyors **50** are secured to bevel gears **54** within gear housing **36**. A motor **56** having a drive shaft **58** extending through suitable bearing means into housing **36** is provided with a drive gear **60** engaging gears **54** for rotating screw conveyors **50**. Screw conveyors **50** are provided with screw threads of progressively increasing height to facilitate movement of the slurry through apertures **34** and into a discharge conduit **62**. In addition to rotation about their own axes, the screw conveyors **50** slowly rotate about the axis of vessel **16** by means of motor **48** and gears **42** and **44**, so that the entire bottom of vessel **16** is swept by conveyors **50** to prevent stagnation of the chips within vessel **16**.

Referring to FIGURE 1*a*, the slurry in conduit **62** is passed to transfer pump **64** and is pumped through the line **66** to an impregnator, generally designated by reference numeral **68**, which is preferably of the type shown in my copending application entitled "Pressure Impregnation Device" S.N. 274,422 filed April 22, 1963 now Patent No. 3,215,591, which is incorporated herein by reference. A bypass line **70** is connected from pump **64** to liquor line **18**.

As set forth more fully in my copending application, the impregnator **68** consists of a stationary outer casing and an inner revolving barrel assembly including a plurality of open ended tubular members constituting chip receiving passageways. Impregnator **68** is shown in a developed view of FIGURE 1*a* to better illustrate its func-

tion. The slurry in line 66 is introduced through an inlet port 72 in the stationary casing into a tubular member present at the inlet station. A corresponding port 74 in the top of the stationary outer casing is provided with a screen to prevent chip passage therethrough while allowing excess liquor to be recycled in line 76 to liquor supply line 18. During the residence period of a tubular member in alignment with ports 72 and 74, the member will be filled with chips.

The rotor assembly is then cyclically rotated to bring a tubular member filled only with liquor to the inlet station and to move the chip-filled tubular member into alignment with port 78. Port 78 is supplied with a higher pressure liquor through line 80 by pump 82, and line 81 leading from liquor supply line 18. Similarly, the chips are subjected to successively increasing hydraulic impregnating pressure when in alignment with ports 84 and 86 which are supplied with high pressure liquor through lines 88 and 90, respectively, by pump 92 connected to liquor supply line 18 by line 91. Upon the next cyclical rotation of the rotor assembly, the filled tubular member is moved to a discharge station in alignment with the ports 94 and 96. Port 94 is supplied with liquor through line 98 to flush chips out of the tubular member through discharge port 96 into line 100 as a chip-liquor slurry. During passage through impregnator 68, the chips are uniformly impregnated by subjecting the chips to a high hydraulic pressure several times that of the standard cooking pressure. Additionally, by limiting the volume of chips subjected to successively higher hydraulic pressure stages with a final pressure in the order of 600 p.s.i.g., rapid impregnation of the chip may be effected.

The slurry in line 100 is introduced into a chip drainage device 102 of known construction including a tapering, perforated internal screen member containing a screw conveyor. Liquor in excess of that required for digestion is passed through the screen member and is recycled through line 104, pump 106 and heat exchanger 108 to line 98 and port 94 of the impregnator 68. This external heating cycle is described more fully in my aforementioned copending application.

The chips are now passed from strainer 102 through line 110 into a digester 112 corresponding in size and shape to a standard digester. The digester 112 is provided with a conventional access manhole 120 and vent line 122. Steam at a pressure of 125 p.s.i.g. is introduced into the digester 112 through steam line 124 to effect digestion of the chips in non-submergence. The chips may be digested while submerged in cooking liquor by supplying the entire heating requirements by the recycled liquor passing through heat exchanger 108. A combination of steam and heated cooking liquor is also contemplated to supply the heating requirements for effecting delignification of the cellulosic material.

The chips are delignified to pulp during passage downwardly through the digester 112, and the residence time is regulated by suitable control means (not shown) to insure substantially complete digestion. Recycled liquor in line 126, as more fully hereinafter described, is introduced into the digested pulp in the lower portion of digester 112 to dilute the suspension to a consistency of from about 1% to about 3%. The pulp is passed through a conduit 116 to a washer 118. A suitable agitator 128 may be provided in conduit 116 to insure good pulp dispersion within the chip liquor suspension.

The suspension is passed upwardly through washer 118 which includes a plurality of perforated liquor drainage members 130. Drainage members 130 preferably extend in a saw-tooth offset fashion transversely from one side to the other of an internal perforated drainage cylinder 132 provided within washer 118. The drainage cylinder 132 is in communication with the ends of drainage members 130. Drainage members 130 preferably consist of support pipes secured to the walls of drainage cylinder 132 which support a mesh or other similar perforated wall portions. The apexes of members 130 are preferably imperforated V-shaped troughs and serve as drain troughs which discharge the liquor into perforated cylinder 132. Liquor is removed from the dilute suspension through members 130 and cylinder 132. In FIGURE 4, a drainage member 130 is illustrated having perforations 131 along the side walls and having an imperforated V-shaped trough 133. The consistency of the pulp is increased to about 10% to about 12% at the top of washer 118 where the pulp is skimmed off by a scraper 134 and passed via line 135 into a launder 136.

The liquor removed by means of members 130 and cylinder 132 is introduced into a spent liquor tank 138 through line 140 at a temperature below the cooking temperature, for example, between about 250° F. to about 300° F. with a high concentration of dissolved solids. A portion of the liquor in tank 138 is passed through line 142 by pump 144 to be introduced through line 126 into digester leg portion 114. The remainder of the spent liquor is passed through line 146 to multiple-effect evaporators (not shown) for concentration and subsequent smelting, as is conventional in the art. However, since the liquor is recovered at a higher temperature than in prior art installations, an improved overall heat recovery is achieved. Steam liberated in tank 138 is vented through line 148 to heat exchanger 150 to preheat make-up cooking liquor in line 18.

The pulp in launder 136 is passed through blow line 152 provided with a blow valve 154 into a small cyclone 156 at the inlet to a blow tank 158. Cyclone 156 distributes the stock in a thin sheet for tangential discharge through line 160 into blow tank 158 to facilitate the liberation of steam from the stock with minimum fibre entrainment.

Flash steam is liberated from the blown stock and is passed upwardly into a conically-shaped funnel 162 wherein the steam is condensed by contact with cooling water introduced through line 164 and discharged in spray form through a perforated plate 166. Steam condensate and cooling water is removed from the funnel 162 through line 167 and is passed into an accumulator tank 168. Blow tank 158 also receives condensate from the heat exchanger 150 through line 170. Blow tank 158 additionally functions as a stock storage vessel balancing digester operations with final washing operations in vacuum washers 172 and 174.

Accumulator 168 is provided with an external liquor circuit including line 180, heat eychanger 182, lines 184, 186, 188 and pump 190. A temperature responsive flow control valve 192 is provided in bypass line 186 to regulate the flow of water to heat exchanger 182 through line 180, and the temperature of incoming fresh water supplied to heat exchanger 182 through line 194. From heat exchanger 182, the fresh water is passed through line 196 to a heat exchanger 198 in vent line 178. The heated water is passed through line 200 to a hot water storage tank 202 from which water is removed to process as desired through line 204 by pump 206. A portion of the incoming fresh water in line 194 may be introduced directly into the accumulator 168 through lines 208 and 188.

From accumulator 168, water is passed through line 210 by pump 212 to line 164 and perforated plate 166 for condensing flash steam as previously described. Water is also withdrawn from accumulator 168 through line 214 by pump 216 and is passed through line 218 to vacuum washer 174 as will be discussed hereinafter.

Pulp diluted to a suitable consistency in blow tank 158 is withdrawn through line 230 and is passed through line 232 to a pressurized pulp screen assembly 234. Screen assembly 234 further refines the stock and returns oversized fibre masses to blow tank 158 through line 236. The stock from screen assembly 234 is passed through line 238 to an inlet box 240 adjacent vacuum washer

172. The stock is taken up on a conventional perforated drum 242 and sprayed with a wash medium from spray head 244. The wash medium is supplied to spray head 244 from the third stage vacuum washer 174 through line 246. Liquor and wash medium drain through perforated drum 242 and are removed by line 248 to a washer liquor seal tank 250 which is provided with a baffle 252 and a vent line 254. A portion of the liquor in tank 250 is removed through line 256 and passed by pump 258 through lines 260 and 126 to digester 112. The remainder of the liquor in tank 250 is passed through line 262 by pump 264 and is passed through line 266 to blow tank 158 to dilute the stock therein, or through line 268 for admixture with the diluted pulp in line 230 being introduced into the screen assembly 234 through line 232.

The pulp stock from vacuum washer 172 is discharged into a trough 270 for treatment to break up sheeted pulp. The pulp is diluted in trough 270 with liquor supplied from a liquor seal tank 272 through line 274, pump 276, and lines 278 and 280. The diluted pulp in trough 270 is acted upon by blades 282 and is passed to the rotating perforated drum 284 of vacuum washer 174. Here the pulp is washed by water supplied to a spray head 286 through line 218 from accumulator 168. The wash water passes through the perforations of drum 284 and is removed by line 288 to the liquor seal tank 272 provided with suitable baffles 290 and a vent 292. The pulp which has now undergone a three-stage washing is discharged from cylinder 284 into hopper 294 for further processing.

Spray heads 244 and 286 of vacuum washers 172 and 174, respectively, are enclosed within housings 296 and 298, respectively. Housings 296 and 298 are supplied with flash steam from blow tank 158 through line 300 under control of valve 302 to essentially prevent foaming at vacuum washers 172 and 174 and their seal tanks 250 and 272 by eliminating air infiltration.

While I have shown and described several embodiments in accordance with the present invention, it is understood that the same is not limited thereto, but is susceptible of many changes and modifications within the spirit and scope thereof, and I, therefore, do not wish to be limited to the details shown and described herein, but intend to cover all such changes and modifications as are encompassed by the scope of the appended claims.

I claim:

1. A process for digesting cellulosic material comprising vacuum deaerating said material, submerging said material in liquor forming a slurry of pumpable consistency, impregnating said material by subjecting the material to progressively increasing hydraulic pressures, introducing the impregnated material into a digester, digesting said impregnated material to pulp in non-submergence in the presence of steam, diluting the pulp within the digester with additional liquor, transferring the diluted pulp to a washer, washing the diluted pulp in said washer, removing liquor from the diluted pulp substantially at the cooking temperature, introducing the washed pulp as a thin stream into a blow tank, condensing the steam within the blow tank by direct contact with cooling water, passing the steam condensate and cooling water to an accumulator tank, vacuum washing the pulp removed from said blow tank in a vacuum washer having a wash liquid sprayer, returning liquor from the vacuum washing step to said blow tank, and injecting steam from said blow tank into a header surrounding the wash liquid sprayer of the vacuum washer.

2. A process for digesting cellulosic material comprising vacuum deaerating said material, submerging said material in liquor forming a slurry of pumpable consistency, impregnating said material by subjecting the material to progressively increasing hydraulic pressures, introducing the impregnated material into a digester, continuously digesting said impregnated material to pulp in said digester, diluting the pulp within said digester, removing liquor from the pulp substantially at the cooking temperature, introducing the pulp into a blow tank, condensing the steam within said blow tank by direct contact with cooling water, passing the steam condensate and cooling water to an accumulator tank, vacuum washing the pulp removed from said blow tank in a vacuum washer having a wash liquid sprayer, returning liquor from the vacuum washing step to said blow tank, and injecting steam from said blow tank into a region surrounding the wash liquid sprayer of the vacuum washer.

3. In a process for digesting cellulosic material comprising deaerating said material, impregnating said material, introducing said material into a digester, digesting, said material to pulp, introducing the pulp into a blow tank, vacuum washing the pulp removed from said blow tank in a vacuum washer having a wash liquid sprayer, the improvement which comprises returning liquor from the vacuum washing step to said blow tank, and injecting steam formed in said blow tank into a header surrounding the wash liquid sprayer.

4. A process for digesting cellulosic material comprising deaerating said material, impregnating said material, introducing said material into a digester, digesting said material to pulp, diluting the pulp within the digester with additional liquor, transferring the diluted pulp to a washer, washing the diluted pulp in said washer, removing liquor from the diluted pulp, introducing the washed pulp into a blow tank, vacuum washing the pulp removed from said blow tank in a plurality of vacuum washers, each having a wash liquid sprayer, returning liquor from the vacuum washing step to said blow tank, and injecting steam formed in said blow tank into headers surrounding the wash liquid sprayers.

5. Apparatus for treating wood chips or the like, comprising a substantially upright tank, an annular housing rigidly secured to the bottom of said tank and closed off by a bottom wall, a hollow chip deflecting member having an essentially conical upper surface projecting above said bottom wall substantially in the center thereof, said deflecting member being provided with openings into the interior thereof, gear means mounted within the interior of said deflecting member, a casing rotatably positioned within said housing, drive gear means for rotating said casing, and a plurality of screw conveyors mounted at the outer ends thereof upon said casing and at the other ends thereof being adapted to convey chips through said openings into the interior of said deflecting member.

6. Apparatus for treating wood chips or the like, comprising a substantially upright tank, an annular housing rigidly secured to the bottom of said tank and closed off by a bottom wall, a hollow chip deflecting member having an essentially conical upper surface projecting above said bottom wall substantially in the center thereof, said deflecting member being provided with opposed openings to the interior thereof, gear means mounted within the interior of said deflecting member, a casing rotatably positioned within said housing and provided with an annular gear ring, drive gear means cooperating with said gear ring, a plurality of screw conveyors mounted adjacent to the upper surface of said bottom wall with their outer ends mounted upon said casing and with their inner ends extending through said openings in said deflecting member, means to rotate said screw conveyors to convey chips through said openings into the interior of said deflecting member, and a discharge conduit in communication with the interior of said deflecting member.

7. Apparatus for pulping cellulosic material which comprises: tank means to submerge said cellulosic material in cooking liquor to form a slurry of said cellulosic material and said liquor; a first conduit means; an impregnator for receiving said slurry in fluid communication with said tank means through said first conduit means, said impregnator including means to progressively increase the hydraulic pressure of said slurry; a digester; a liquor supply means for diluting said pulp leaving said

digester; a second conduit means; a washer in fluid communication with said digester through said second conduit means for receiving diluted pulp, said washer having a plurality of perforated drainage members extending transversely across said washer in a saw-toothed arrangement; and a third conduit means for withdrawing liquor out of said washer from said drainage members.

8. Apparatus for pulping cellulosic material which comprises: tank means to submerge said cellulosic material in cooking liquor to form a slurry of said cellulosic material and said liquor; a first conduit means; an impregnator for receiving said slurry in fluid communication with said tank means through said first conduit means, said impregnator including means to progressively increase the hydraulic pressure of said slurry; a digester; a liquor supply means for diluting said pulp leaving said digester; a second conduit means; a washer in fluid communication with said digester through said second conduit means for receiving diluted pulp, said washer having a plurality of perforated drainage members extending transversely across said washer in a saw-toothed arrangement; and a third conduit means for withdrawing liquor out of said washer from said drainage members; a fourth conduit means; a blow tank for receiving discharge pulp from said washer through said fourth conduit means; and condensing means including cooling water spray means within said blow tank to condense steam flashed by entry of the pulp into said blow tank.

9. An apparatus for digesting cellulosic material which comprises: a digester; means to supply cellulosic material and cooking liquor into said digester; means to introduce liquor into a lower region of said digester to dilute digested pulp; conduit means; a washer in fluid communication with said digester through said conduit means for receiving diluted pulp, said washer including a plurality of drainage members spaced in a staggered arrangement, each drainage member including essentially V-shaped imperforated bottom portions and perforated side wall portions, said imperforated bottom portions constituting drainage troughs for liquor passing through the side wall portion; and means to remove washed pulp from the top of said washer.

10. An apparatus for digesting cellulosic material which comprises: a digester; means to supply cellulosic material and cooking liquor into said digester; means to introduce liquor into the lower portion of said digester to dilute digested pulp; conduit means, a washer in fluid communication with said digester through said conduit means for receiving diluted pulp, said washer including a plurality of drainage members spaced in staggered arrangement, each drainage member including essentially V-shaped imperforated bottom portions and perforated side wall portions, said imperforated bottom portions constituting drainage troughs for liquor passing through said side wall portions, an annular perforated drainage cylinder within said washer in fluid communication with the drainage troughs of said drainage members; and means to remove wash pulp from the top of said washer.

11. An apparatus for digesting cellulosic material which comprises: a digester; means to supply cellulosic material and cooking liquor into said digester, means to supply steam into said digester to effect delignification of the cellulosic material; means to introduce liquor into the lower portion of said digester to dilute delignified pulp; conduit means; a washer in fluid communication with said digester through said conduit means for receiving diluted pulp, said washer including a plurality of drainage members spaced in a staggered arrangement, each drainage member including essentially V-shaped imperforated bottom portions and perforated side wall portions, said imperforated bottom portions constituting drainage troughs for liquor passing through said side wall portions; and means to remove wash pulp from the upper portion of said washer.

12. An apparatus for delignifying cellulosic material which comprises: a digester; means to supply cellulosic material and cooking liquor into said digester; means to supply steam to said digester to effect delignification of the cellulosic material; means to introduce liquor into a lower portion of said digester to dilute the delignified pulp; conduit means; a washer in fluid communication with said digester through said conduit means to receive diluted pulp, said washer including a plurality of drainage members spaced in a staggered arrangement, each drainage member including essentially V-shaped imperforated bottom portions and perforated side wall portions, said imperforated portions constituting drainage troughs for liquor passing through the side wall portions; an annular perforated drainage cylinder positioned within said washer in fluid communication with the drainage trough of said drainage members; and means to remove washed pulp from the upper portion of said washer.

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