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2 Sheets-Sheet 1

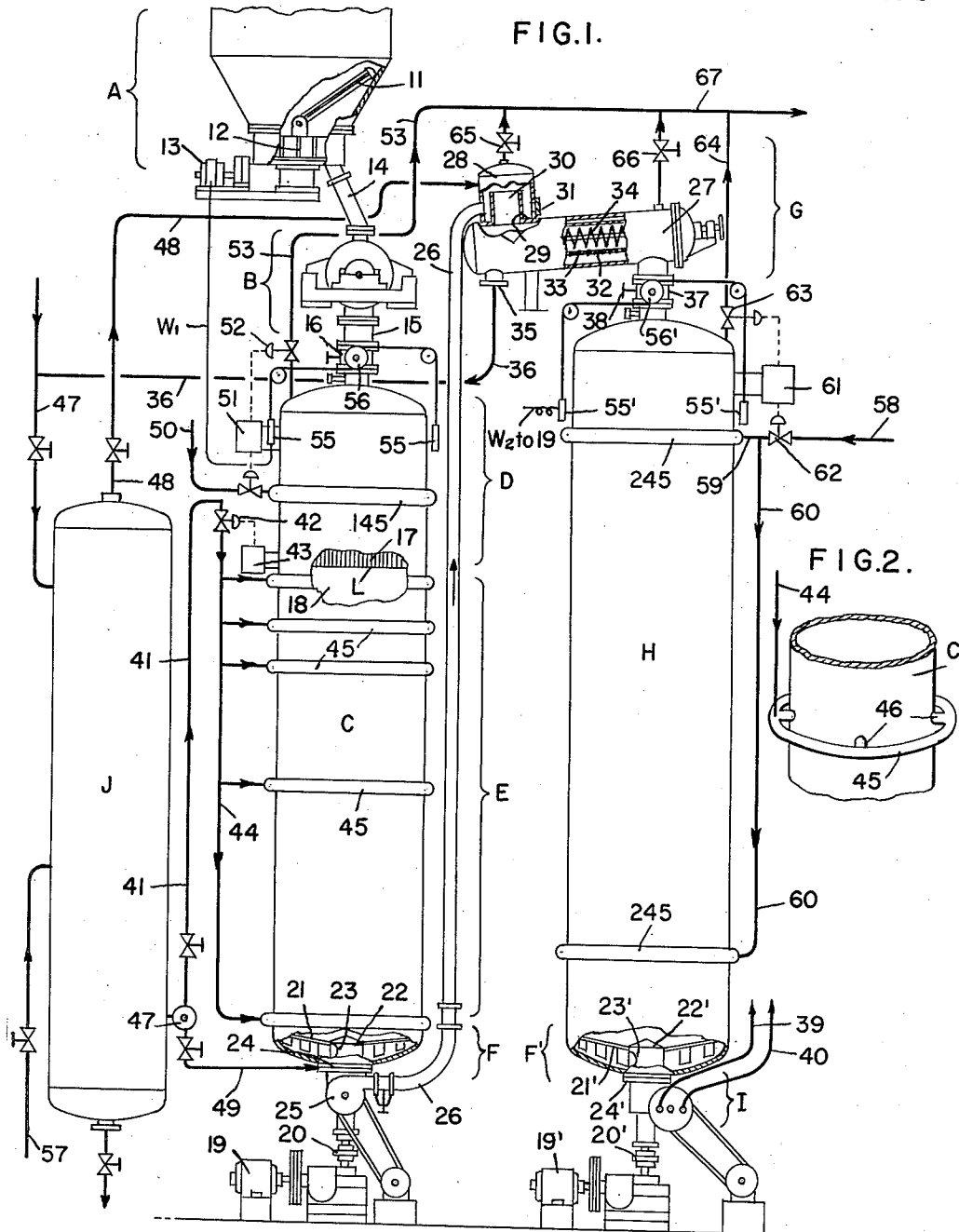


FIG. 1.

FIG. 2.

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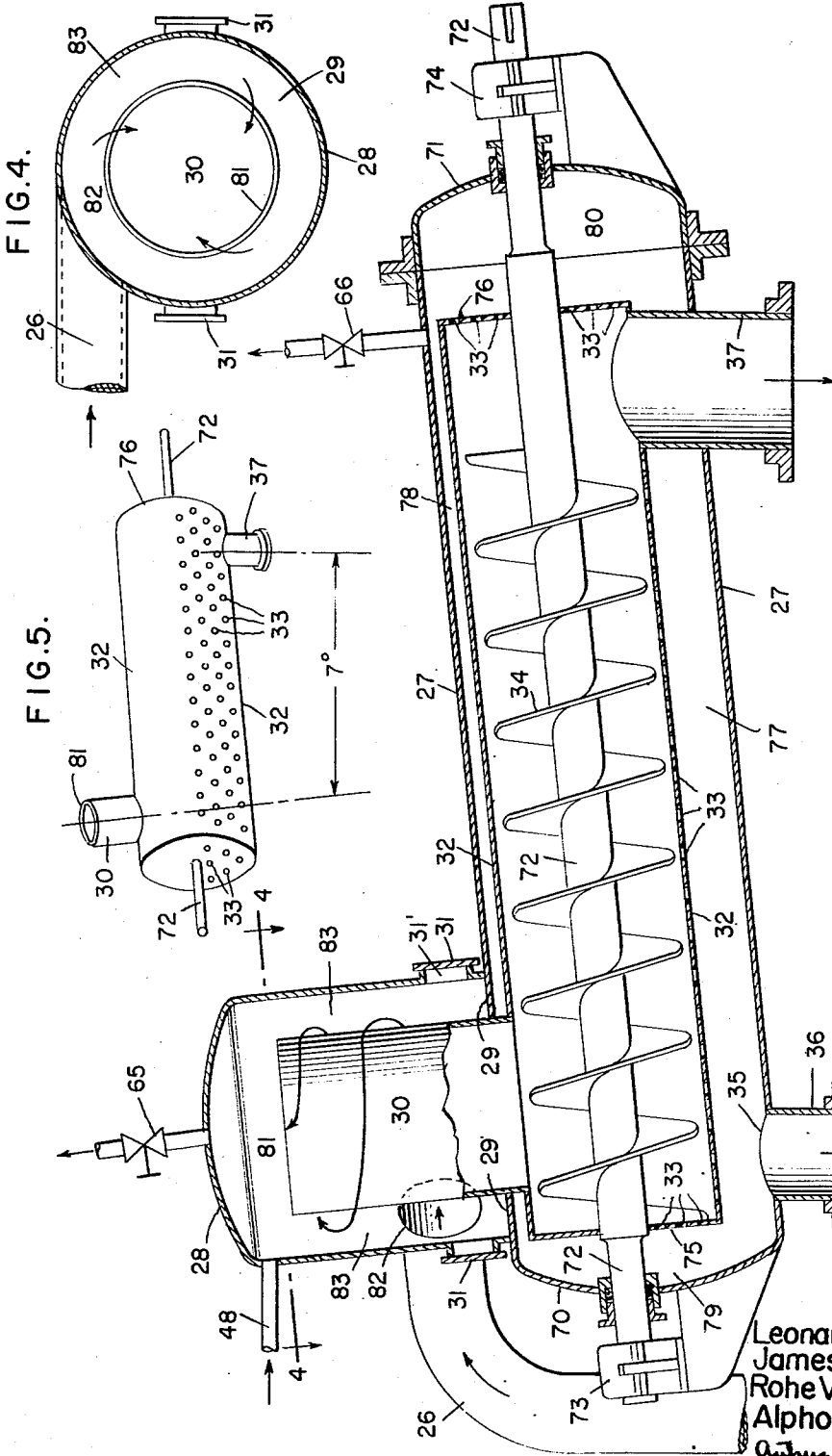
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## APPARATUS FOR WOOD CHIP DIGESTION

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11 Claims. (Cl. 92-7)

This invention relates to the continuous digestion of cellulosic material such as wood-chips for making them into pulp. A current new type of such digestion treats the chips in a primary enclosed tank or vessel wherein the chips in columnar formation are first steamed and then immersed in a pond of cooking liquor with which the chips are then impregnated. The chips are then evacuated from the vessel to a pipe wherein they are diluted with cooking liquor to a controllable pumpable consistency and are immediately pumped to a drainage station wherein they are drained of the liquor in which they are immersed, whereupon they are pumped to a secondary vessel wherein they are digested, again in columnar formation, but in non-submergence and only in their absorbed and adsorbed liquor. When their digestion is completed, they are evacuated from the digester and ejected from the system for subsequent treatment. This invention is directed to the construction and operation of such a drainage station. In such a station, the hot impregnated chips must be received while they are under pressure and are in submergence in their cooking liquor. So it is an object of this invention to provide ways and means for receiving them in this condition and draining them of all but their absorbed and adsorbed liquor, meanwhile maintaining them under the pressure and at the temperature at which they are received. A further object is to devise means for aiding in the pumping of the chips from the evacuator in the impregnating vessel to the drainage station by adding thereto sufficient additional cooking liquor to make the chips readily pumpable. Another object is to entrap in the drainage station the tramp metal and other heavy detritus which wood-chips usually have associated with them. And another object is to arrange for the ready removal of such entrapped contaminants.

These and possibly other objects can be realized by interposing above the digester vessel in the system above described a drainage station comprising a main enclosing or housing inclined tank having a steam dome rising from its lower end, a stack rising spacedly in the dome surrounded by an annular floor that closes off the dome from the main tank, a fixed perforated drainer cylinder or second tank axially disposed within the main tank above its bottom, screw conveyor means rotatable in the drainer for moving chips uphill therein to drain them, a chip-discharge outlet from the drainer, and a liquor-discharge outlet from the tank below the drainer cylinder, with a feed of chips and liquor pumped tangentially into the space between the stack and the dome, means for regulating the dilution of submerged chips being pumped tangentially into the dome, and means for removing from the annular floor surrounding the stack tramp metal and detritus collecting thereon from the pumped feed of chips. In such an arrangement, the pumped chips in appropriate liquor upon being tangentially fed to the steam dome swirl around the stack wherein they rise floatingly to spill over the upper edge or weir of the stack to descend therethrough into the drainer cylinder, while tramp metal and detritus settles in the swirling mass to collect on the

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annular floor around the stack, from which it is removed from time to time. The moving chips drained during their passage along the drainer cylinder, are discharged therefrom to the digester in non-submergence and have only their absorbed and adsorbed liquor.

The invention is illustrated in the accompanying drawings in which Figure 1 is a somewhat diagrammatic side elevation, with parts in section, of a continuous digestion plant or system that forms the environment of the invention. Fig. 2 is a partial isometric view of a detail of the manifold used to inject either steam or liquor or both into the vessels. Fig. 3 is a vertical sectional view through the drainage station. Fig. 4 is a horizontal sectional view taken along the line 4-4 in Fig. 3, indicating the tangential feed to the steam dome of the drainage station. Fig. 5 is an isometric view of the cylindrical drainer 32.

Referring now to Figs. 1 and 2, showing the system, there is a chip-bin A for receiving chips, or other cellulosic material to be treated, having an arch-breaker 11, and a suitable rotary chip-discharging mechanism 12, operated by a variable speed motor driven mechanism 13, passes chips downwardly of the feed pipe 14 at a regulatable rate to a multivane chip feeding mechanism B for delivering chips through pipe 15, valved as at 16 to and into a primary cylindrical tank or vessel C divided by a liquid-level L into an upper steaming zone D having a steam atmosphere 17 and a lower impregnating zone E made up of a pond of cooking liquor 18. In the bottom of tank C (sometimes called the impregnator vessel) there is an evacuator mechanism F for accomplishing continuous discharge of chips from the column thereof in the tank by means of a motor mechanism 19 driving a shaft 20, that rotates blade-bearing arms 21 extending radially from a shroud 22 having an opening 23 therein through which chips are passed downwardly through pipe 24 into pump 25 that forces the chips while submerged in cooking liquor and under pressure up through delivery conduit 26 to deliver them under pressure tangentially to a drainage station G that comprises the main or outer steam-tight inclined tank 27 having a steam dome 28 with an annular bottom 29 from which uprising a stack 30 down which fall chips and liquor fed tangentially to the steam dome 28 by the delivery conduit 26. The chips and liquor swirl upwardly to spill over the upper weir-like edge of the stack 30, but meanwhile tramp metal or other detritus gravitates to the annular bottom or floor 29 from which it can be removed through closable access means or other closable access means such as hand-hole 31' and cover 31. Above the bottom of the main inclined tank 27, there is fixed an inner tank or cylindrical drainer 32 having perforations 33, and rotatable therein is a screw conveyor 34. Thus chips and liquor descending through stack 30 enter drainer 32 up which the screw conveyor 34 moves them meanwhile their liquor drains from them through the perforations 33 and flows from the tank through outlet 35 and pipe 36 for recovery treatment such as in accumulator tank J. The chips that are so drained of the cooking liquor but while retaining their absorbed and adsorbed liquor pass downwardly through pipe 37, valved as at 38, into digestion tank or zone H, where the chips are digested in non-submergence but in the presence of steam and their own adsorbed and absorbed liquor. After being properly digested, they are removed from the digester tank or zone H by another evacuator mechanism F' by means of a motor mechanism 19' driving a shaft 20', that rotates blade-bearing arms 21' extending radially from a shroud 22' having an opening 23' therein through which chips are passed downwardly through pipe 24'. But here pipe 24' leads into an axial flow ejector station I, from whence through pipes 39 and 40 digested chips are blown by a steam stream to further treatment such as into a blow

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tank from which they go to refining or any other desired treatment. Since it usually becomes important to reclaim and otherwise control the cooking liquor used, J indicates an accumulator tank or station. Cooking liquor of controlled strength is pumped by pump 47 from that tank J through suitable valved liquor inlet line 41 to a conventional automatic valve 42 controlled and regulated by a differential pressure type recording controller 43 for regulating the elevation of the liquid-level L of the pond 18 of cooking liquor so that it is maintained constant, or at least as nearly so as possible. So the automatic valve 42 regulates the flow of liquor through pipe 44 and its branches, each of which leads to an annular manifold 45 having injection nozzles such as 46 extending therefrom into the tank C, whereby liquor can be sprayed into the tank in a fairly well dispersed or distributed manner. The manifolds 45 are distributed along the tank C as may seem desirable. Another pipe 49 also leads from the accumulator tank J and goes to and into the pipe 24 for giving control of the quantity of liquor mixed with the chips discharged from tank C by evacuator F to make them pumpable (at a consistency of say 10%) by pump 25 up through pipe 26 to the drainage station G. Still another pipe 48 is used to lead from the top of the accumulator tank J upwardly to the steam dome 28 of the drainage station G. Other valved pipes 47 and 57 leading into the accumulator tank J are for conducting certain incoming chemical-bearing liquids thereinto.

From any suitable source, steam under pressure is supplied through steam inlet line 50 to the steaming zone D in the primary tank C by means of an annular manifold 145 in all respects like manifold 45 and having the same kind of injection nozzles 46 to supply steam into the tank, in a well distributed manner. The inlet of steam into the manifold 145 is controlled and regulated by a conventional pressure-temperature recording controller 51, that also controls and regulates valve 52 in vapor-outflow line 53. And a final control is indicated generally at 55 that is a chip level gauge and controller that consists of a transmitter containing a radio-active material, and a receiver is connected electrically by connection W<sub>1</sub> to the motor-drive 13 of chip bin discharger 12, to automatically regulate the chip level to be substantially constant. The instrument is so mounted that the "set point" can be raised or lowered such as by pulley 56 by the operator. A similar chip-level sensing gauge and controller 55' is applied to the digester zone or tank H, with its raising and lowering pulley 56' but in this case the controller 55' is connected by a connection W<sub>2</sub> to, and regulates the motor drive 19 on, the evacuator station F on the primary vessel C.

Digester zone or station H is provided with a steam-inlet line 58, for delivering steam under pressure to the branch lines 59 and 60, each respectively feeding steam to an annular manifold 245 having injection nozzles, patterned after manifold 45 and its nozzles 46. Inlet of steam through line 58 is controlled and regulated by a conventional pressure-temperature recording controller 61 (similar to controller 51) operating an automatic valve 62 and also an automatic valve 63 included in vapor outflow line 64. Valved vapor outlet pipe 65 from the steam dome 28 of the drainage station G, and also from valved vapor outlet pipe 66 from the high point of the inclined tank 27 of that station, can all join into a common exhaust line 67 leading to further treatment of the vapors, if desired, such as for turpentine recovery.

The continuous digestion of cellulosic material such as wood chips carried out by this system in successive treatment zones may be said to comprise feeding chips continuously to the steaming zone where while in columnar formation they are prepared for the ready acceptance of the cooking liquor by appropriate steaming, thus releasing non-condensable gases and otherwise preparing the chips for ready acceptance of the cooking liquor; next submerging the thus conditioned chips in

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hot cooking liquor under controlled conditions of time and temperature that assure complete penetration and diffusion of the liquor into the chips but limit the chemical reaction therebetween so that in this zone of impregnating treatment, there is minimized any fiber-degrading action; the chips themselves now contain an amount of absorbed and adsorbed liquor of controlled chemical concentration sufficient to be cooked rapidly but insufficient to cause cellulose degradation, so they are transferred while in submergence and still under pressure from the impregnation zone to a drainage zone where they are relieved of their excess liquor which drains freely therefrom during their uphill conveyance along the perforated cylindrical drainer therein; the drained chips are then cooked also while in columnar formation in only their retained liquor and in non-submergence in a vaporous environment enclosed in a digester; after being cooked, the chips are evacuated from the digester into an ejection zone having a receiver for the digested chips, from whence digested chips are ejected while in suspension in steam and projected or blown to a place of subsequent treatment. All of the action steps are carefully controlled as to pressure, temperature, and the rate of downward movement or the time of transit of the chips through each treatment zone and between such zones, which is a reason why the chip level is maintained substantially constant in each of the vessels C and H; the liquid-level L in vessel C is also so maintained; and the temperature and pressure of the steam is also carefully automatically controlled.

Referring again to the drainage station or zone G and to its details of construction, the station has a main or outer tank or housing 27 that is inclined and is closed at its lower end by a dished cover 70 and at its upper end by a dished cover 71, through which the screw conveyor 34 has its shaft 72 pass to be supported by a journal 73 at its lower end and by a journal 74 at its upper end. The conveyor shaft is motivated by any suitable motive power. In the main or outer tank 27 there is fixedly mounted eccentrically therein, a second or inner tank (see Fig. 5) with a drainer cylinder 32, having perforations 33 in its lower section and in its end closures or walls 75 and 76. The drainer cylinder or inner tank 32 is mounted concentrically around the conveyor 34 and its shaft 72, which shaft is eccentrically mounted in main tank 27, so that the drainer 32 has a space 77 between its bottom and the bottom of the main tank 27 that is substantially deeper than the space 78 between the top of the drainer 32 and the tank 27. A space 79 is provided between the end wall 75 of the drainer and end cover 70 of the tank while another such space 80 is provided between the end wall 76 of the drainer and end cover 71 of the tank so there is ample space all around the drainer whereby it can be completely enveloped in a steam atmosphere. The cylindrical drainer 32 has rising at a right angle from its lower section, the stack 30 that is surrounded by the steam dome 28. The stack terminates at its open top in a weir edge 81. Chips immersed in liquor are forcibly fed to the steam dome through pipe 26 that enters the periphery of the steam dome through inlet opening 82 for delivering the chips tangentially into the steam dome and the space 83 between its peripheral walls and the stack 30 in the steam dome. The elevation of the inlet opening 82 corresponds to a line less than half the height of either the steam dome or the stack because it is desirable not only to cause the incoming chips to swirl around the stack but to be forced upwardly or to surge upwardly to cause all the chips in their liquor to rise floatingly and spill over the weir 81 down into and through the stack 30. In spite of this upward surge, tramp metal and other heavier detritus settles there-through to collect on the annular bottom or floor 29 from which it can be removed from time to time through the ports or hand-holes 31'. The tank 27 is inclined downwardly toward its steam domed end at an angle of about 7°; substantially as that shown. The reason for this is to assure drainage from the chips of all but their

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absorbed and adsorbed liquor as they are moved up-hill over the draining perforations, that is, conveyed up the incline of the cylindrical drainer 32 whereupon they fall vertically through the chip discharge outlet pipe 37, that passes from the drainer to a place outside of the tank 27.

So in operation, the impregnated chips discharged with their liquor by the evacuator station F from impregnation zone E, are pumped by pump 25, with liquor added through pipe 49 to make the chips thoroughly pumpable, up through delivery conduit 26, to the drainage station or zone G. Through tangential inlet opening 82 into the steam dome 28, the chips and their liquor are swirled around the stack 30 as shown by the arrows in Fig. 3, to floatingly surge upwardly until they reach the elevation of weir edge 81 of the stack over which the chips and their liquor spill and descend down the stack into the cylindrical drainer or inner tank 27. The chips are moved upwardly along the inclined drainer by the screw conveyor 34, meanwhile being drained of their liquor that drains away from the moving chips through the perforations 33 to be received by the space 77 beneath the bottom of the inner tank or drainer, from whence the liquor flows away and downwardly through liquor discharge pipe 36 to subsequent treatment or recovery. The drained chips moved uphill by the screw conveyor 34 fall down vertical chip discharge pipe 37 that leads them, with only their absorbed and adsorbed liquor, into the digester tank H.

The temperature and pressure surrounding the chips is maintained by steam from two sources. The drainer is open to the digester through the large pipe 37 and valve 38 so that digester pressure and temperature are maintained. The dome 28 is also connected through equalizing pipe 48 to the accumulator J whence steam can be introduced to the dome 28. The chips flow down through the stack 30 to fill the inner tank 32 from which liquor drains through the perforations 33 to fill the space surrounding the inner tank 32 and from which space vapors and non-condensable gases can be drawn off through valved outlet pipes 65 and 66, that can be seen from Fig. 1, to join pipe 67 carrying such vapors to subsequent treatment such as turpentine recovery. The perforations in the low end wall 75 will be helpful in draining liquor from the chips while the perforations in the upper end wall 76 will allow steam pressure from the digester coming up through pipe 37 to pass easily into the spaces 77, 78, 79 and 80. Since the pressure in the drainage station G is the same as the pressure in the impregnator tank E, there is the same pressure on each side of pump 25, and this facilitates very much the operation of that device. The drainer then drains chips of all but their absorbed and adsorbed liquor while in a high pressure high temperature steam atmosphere. The drainer steam pressure normally used will be that of the digester H that ranges ordinarily from 100 to 170 pounds per square inch gauge pressure.

As this invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, the present embodiment is therefore illustrative and not restrictive, since the scope of the invention is defined by the appended claims and all changes that fall within the metes and bounds of the claims or that form their functional as well as conjointly cooperative equivalents, are therefore intended to be embraced by those claims.

We claim:

1. Continuously operable wood-chip digesting apparatus which comprises a system having a combined steaming and impregnating tank enclosed for holding a pond of cooking liquor overlain by a steam atmosphere, means for regulatably supplying steam to the tank, means for regulatably feeding chips to the steam atmosphere, means for feeding such liquor to the pond, means for maintaining a constant liquid-level on the pond, a chip drainage station, pump means and a pipe for regulating delivery to the

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drainage station of impregnated chips immersed in liquor, a chip digester under pressure enclosing a steam atmosphere, means for passing chips from the drainage station to the digester, means for supplying steam to the digester for controlling its temperature, and means for discharging digested chips from the digester; wherein the drainage station comprises a steam-tight inclined enclosing cylindrical tank having a steam dome rising from its lower end, a perforated cylindrical drainer longitudinally disposed in the tank above the bottom of the tank, a stack rising spacedly in the dome from the drainer surrounded by an annular floor that closes off the dome from the tank, said delivery pipe delivering chips tangentially into the space between the stack and the steam dome, screw conveyor means rotatable in the drainer, a chip-discharge outlet from the drainer, and a liquor-discharge outlet from the tank below the drainer.

2. Apparatus according to claim 1, with the addition of means for adding cooking liquor to the pump means for regulatably diluting the consistency of the submerged chips being pumped to the drainer.

3. Apparatus according to claim 1, with the addition of closable access means through which can be removed tramp metal and detritus settling to and collecting on the annular floor surrounding the stack in the steam dome.

4. Apparatus according to claim 1, with means for maintaining substantially the same steam pressure on each side of the pump means delivering submerged chips to the drainer.

5. Apparatus according to claim 1, wherein the cylindrical drainer is eccentrically mounted in the tank.

6. Apparatus according to claim 1, wherein the drainer is perforated in its lower longitudinal section with a closed upper longitudinal section while the stack rises through the tank into the steam dome from the periphery of the closed upper section of the drainer.

7. A chip-digesting system, comprising means for digesting chips while in submergence; means for feeding chips thereto; means for draining chips received from the digester that includes a main enclosing inclined steam-tight cylindrical tank having at its lower end a bottom drained-liquor discharge outlet and a chip-receiving steam dome rising from its upper end, a cylindrical drainer eccentrically disposed in the tank having a perforated bottom section through which liquor from the chips drains from the drainer into the tank, an open-ended stack into which chips cascade from the dome rising from the top of the lower end of the drainer to and into the steam dome while providing an annular space between it and the dome, an annular floor surrounding the stack closing off the bottom of that space, a motivated screw conveyor mounted longitudinally and concentrically in the drainer while eccentrically journaled in the ends of the tank for moving chips from the stack along the drainer, and a chip discharge outlet receiving chips from the conveyor leading from the bottom of the higher end of the drainer and extending through the tank bottom to the outside thereof, and chip delivery means for forcibly feeding a supply of chips immersed in cooking liquor tangentially into the space between the stack and the dome at an elevation from which they swirlingly and floatingly surge upwardly to spill over the open top of the stack.

8. Apparatus according to claim 7, with means including a port and cover therefor in the steam dome adjacent the annular floor therein for removal therethrough of tramp metal and detritus descending from the upwardly swirling chips and collecting thereof.

9. A chip-digesting system, comprising means for digesting chips while in submergence; means for feeding chips thereto; means for draining chips received from the digester that includes an outer main enclosing inclined steam-tight cylindrical tank having at its lower end a bottom drained-liquor discharge outlet and a chip-receiving steam dome rising from its upper end, an inner second cylindrical drainer tank located within the main tank hav-

ing a perforated bottom section through which liquor from chips within the second tank drains from the latter into the main tank, an open-ended stack into which chips cascade from the dome rising from the top of the lower end of the second tank to and into the steam dome while providing an annular space between it and the dome, a motivated screw conveyor mounted longitudinally and concentrically within the second tank for moving chips from the stack along the drainer, a shaft for the screw conveyor passing through the main tank and journaled therefrom, a chip discharge outlet pipe receiving chips from the conveyor and leading from the bottom of the higher end of the second tank and extending therefrom through the main tank, and means for supplying steam to the steam dome, and means for forcibly feeding a supply of chips and liquor tangentially into the space between the stack and the dome for swirling the chips and liquor upwardly to spill over into the stack and fall into the second tank, which stack forms the only pathway whereby chips reach the inner tank and the perforations in the inner tank form the only pathway whereby liquor from the chips reaches the outer tank.

10. Apparatus according to claim 9, wherein the stack

extends at a right angle to the inner tank whereas the chips discharge outlet extends from the inner tank at less than a right angle.

11. Apparatus according to claim 9, wherein the inner tank and its concentrically mounted screw conveyor are located eccentrically in the outer tank to provide a shallower space between the tops of the inner and outer tanks and a deeper space between the bottoms of the inner and outer tanks for receiving liquor draining thereinto from the perforated section of the inner tank.

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