(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 036 236 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent: **16.07.2003 Bulletin 2003/29**

(21) Application number: **98944033.4**

(22) Date of filing: **14.09.1998**

(51) Int Cl.[7]: **D21C 7/00**
// (D21C3/20, 5:00)

(86) International application number: **PCT/GB98/02712**

(87) International publication number: **WO 99/014424 (25.03.1999 Gazette 1999/12)**

(54) **PULP PRODUCTION METHOD**

VERFAHREN ZUR HERSTELLUNG VON ZELLSTOFF

PROCEDE DE FABRICATION DE PATE

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI NL PT SE

(30) Priority: **15.09.1997 GB 9719479**
08.04.1998 GB 9807593
14.09.1998 GB 9819865

(43) Date of publication of application: **20.09.2000 Bulletin 2000/38**

(73) Proprietor: **Melville, Gordon Brown**
Edinburgh EH14 2JH (GB)

(72) Inventor: **KROTOV, Vladimir**
Northbridge, W.A. 6003 (AU)

(74) Representative:
Cross, James Peter Archibald et al
R.G.C. Jenkins & Co.,
26 Caxton Street
London SW1H 0RJ (GB)

(56) References cited:
EP-A- 0 012 960
WO-A-97/20102
GB-A- 753 377
US-A- 3 096 234

EP 1 036 236 B1

Description

[0001] This invention relates to a method for the production of pulp from raw plant material, preferably by percolation organic solvent boiling. Most particularly the invention relates cellulose production from ground hemp stocks from the preliminary hemp processing at the fibre plants.

[0002] From the point of view of pulp production, bast-fibre plants consist of two different raw materials, the bast which comprises 20-25% of the plant, and the woody fibres that comprise the remainder of the plant. It was found initially when using these plants as raw materials that typical pulping conditions may be optimum for the bast portion but may not be optimum for the fibrous portion. A more progressive, modem pulping technology of bast fibre plants such as hemp, flax, and kenaf is based on the separation of stalks into its two parts: bast (fibre) and woody (shive). The mechanical separation of stalks by this conventional technology, typically involving stock preparation and its processing on breaking, scutching and hackling machines, is not only expensive, but also generates large quantities of waste, including both dust and chemical waste. A significant proportion of the waste is irretrievably lost, leading to pollution of the environment. Further, shive formed during the mechanical separation and cleaning of bast fibres is not very suitable for pulping by modem methods. In the pulp and paper industry only the bast portion of hemp is used.

[0003] At present only one technology is known that is capable of eliminating such wastefulness and converting 60 - 65% of stalks into high quality bleachable pulp. This technology is based on pulping using aqueous organic (aqueous alcohol) solutions of ammonia and sulphur dioxide as pulping liquors. This is known as alcohol-based ammonia-sulphite (AAS) pulping. AAS pulping is unrivalled in both the selectivity and the extent of delignification of the raw plant materials.

[0004] In the International Review for the Pulp and Paper Industry, Sterling Publishing Plc, 1994, pp. 67 - 70, V. Krotov discusses a method of using AAS technology involving drip percolation. The principle involves the trickling and drip percolation of pulping liquor (consisting of alcohol based ammonia-sulphite) through the layer of lignocellulosic material (chopped hemp, straw, shive, etc) in vapour / gas medium. The pulping was carried out at low liquor ratio close to that of vapour phase digestion. The liquor is continuously recovered by condensation before trickling.

[0005] A unit incorporating this technology was reported by Krotov V. S. and Lavrinenko T. F. in the 4th International Symposium of Scientists from Comecon Countries, Theses, Zinatne, Riga, 1982. This was a closed cycle system unit which contained the following components sequentially: a tank for chemical mixing, a first scrubber to which an exhauster is connected, a second mixing tank for ammonia water, a condenser, a second scrubber, third and fourth tanks, a hopper, a feeder, a spiral conveyor, a digester, a discharge unit, a fluffer, a discharge tank, an evaporator, a flasher, a moisture trap and a cyclone.

[0006] The most immediate advantage of this single unit plant was that it could integrate all major processes of pulp production including raw material impregnation and cooking, stock washing and dewatering, recovery of the liquid fraction of a spent solution, collection and utilisation of dirty condensates, utilisation of secondary steam and condensate heat, and collection and removal of non-condensable gases without air entrapment.

[0007] One factor that contributes to the efficiency of this pulping method within this unit is the retention of initial shape of the raw material particles during the whole process of AAS delignification. The delignified stock is turned into pulp under very limited mechanical action.

[0008] A significant advantage of this drip percolation and the unit disclosed by Krotov et al. was the effective reduction in environmental pollution. It is ensured by the closed-cycle production which is carried out in a space entirely isolated from the environment, with complete absence of effluents, including dirty condensates. Non-condensable gases are collected without entrained air and can be taken for neutralisation. This differs from multi-unit plants with a great number of unpressurized vessels where gas emissions are distributed along the production line, entrain air and are inevitably released into the atmosphere.

[0009] Before the raw material enters the digester, it undergoes a process known as Prex impregnation. A small portion of the raw material within the feeder apparatus (for a digester) is compressed and then expanded. At the point of expansion, the pulping liquor is injected into the feeder apparatus, whereby the raw material acts as a sponge and absorbs the liquid. This technique allows a significant proportion of the raw material to come into contact with the pulping liquor. However, it is unlikely that using the disclosed apparatus results in all the material being saturated. There thus exists the possibility of improving the technique by developing an improved feeder apparatus. Further, the prior art document does not discuss variations in condition, such as temperature for example that might improve this method of impregnation.

[0010] In this prior art unit the only cooking of the raw material occurs within the digester. It is possible that the efficiency of delignification could be improved by allowing some preliminary cooking prior to the material entering a digester or equivalent apparatus. There is also the problem with the design of the digester disclosed that the means by which the cooked and washed pulp is removed from the digester into the discharge unit is inefficient and this can lead to a congestion of material. There is scope for improvement of the means by which the material is removed from within any cooking device used.

[0011] Within this unit there is significant recovery of the components of the spent pulping solution / liquor. For example, up to 60-70% ammonia and up to 50% sulphur dioxide can be recovered quantitatively. Organic solvent can also be recovered quantitatively. However, there still exists the possibility of improving the recovery of the liquid fraction of the spent solution.

[0012] The document GB-A-753,377 discloses a method as defined in the pre-characterizing portion of claim 1. The document US-A-3,096,234 discloses a continuous digester system with a pressure differential between a digester and a dilution tank.

[0013] The present invention seeks to create an improved method by which a single, closed unit can be operated continuously for cellulose production from fibrous raw plant material. The unit in an embodiment must use AAS pulping technology and drip percolation and thus retains the advantages of these methods of delignification. As with the previously disclosed pulping unit using this technology, the unit must simultaneously perform the operations of saturation of the raw plant material by boiler solution, boiling (delignification) of the raw plant material, washing of the fibrous product, regeneration of the organic solvent, residue water and chemicals from the used boiler - washing solution, dehumidification of the washed fibrous product, collection and absorption of the steam and gases and preparation of the boiler solution from the recovered and fresh chemicals. However, most importantly, the unit seeks to provide the improved Prex impregnation of the raw material.

[0014] A further object of the invention is to improve the processing of the washed and cooked plant material and in particular to improve the efficiency of the collection - particularly from the cooking apparatus - dewatering and predrying of the fibrous product (pulp). Also the invention seeks to improve the collection, condensation and absorption of vapours released in the delignification, the collection, cleaning and centralised discharge for neutralisation and utilisation of non-condensable gases and also the preparation of pulping liquor from the recovered chemicals.

[0015] Another object of the invention is to produce a method which realises few waste products, and does not need fresh water technology or gas treatment facilities for processing the raw plant material into high quality cellulose. The method should be raw material, cost and energy efficient.

[0016] According to the present invention there is provided a method for the production of pulp from raw plant material comprising in sequence: regulating the input of raw material into a boiler by means of a first feeder containing a screw having a prolonged stem which extends beyond the screw thread; cooking the raw material in said boiler to generate pulp; receiving cooked material from the boiler in a second feeder extracting liquid from the cooked material in a liquid extraction apparatus; treating the material received from the liquid extraction apparatus with steam in an unloader maintained at a lower pressure than the liquid extraction apparatus; receiving pulp from the unloader in an accumulation reservoir; and removing pulp from the accumulation reservoir; characterised in that the regulating step includes injecting boiler solution into the raw material through a passage in the prolonged stem and that said second feeder is maintained at a lower pressure than the boiler.

[0017] Preferably the unit used to carry out the method is composed of two sections whereby the first section for the preparation of the boiler solution comprises: a first mixing device into which water is fed, a plunger pump with adjustable inputs, a first scrubber into which ammonia is fed by a first output tank, a first "tube in tube" heat exchanger, a second scrubber the contents of which are fed into a second tank; and the section for the boiling of raw material comprises; an input bunker, a spiral feeder, an inclined spiral conveyor, a boiler, a second mixing device, a second "tube in tube" heat exchanger, a rotor feeder, a dividing bunker, a screw apparatus, a screw unloader, a fluffer, an accumulation reservoir, a screw conveyor, a first casing tube heat exchanger, a fourth output tank, a first vaporising apparatus, a steamer, a second casing tube heat exchanger, a fifth output tank, a second vaporiser apparatus, a third vaporiser apparatus, a first cyclone, a third casing tube heat exchanger, a second cyclone, an emergency tank, a helper bunker, a fourth casing tube heat exchanger, and a system of pumps and interconnecting tubes.

[0018] The construction of the unit is described by reference to the appended drawings in which:

Figure 1 is a schematic of the boiler solution preparation section of the unit;
Figure 2 is a schematic of the section of the unit for boiling the raw plant material;
Figure 3 is a cross-section along the line A - A' through the input bunker for the raw material;
Figure 4 is a cross section taken along the line B - B' through the spiral feeder of the unit;
Figure 5 is a cross-section taken along line C - C' through the boiler of Figure 2;
Figure 6 is a cross-section taken along the line D - D' of the screw apparatus;
Figure 7 is a section taken along line E - E' of the accumulation reservoir of Figure 2; and
Figure 8 is a section taken along the line F - F' of Figure 7.

[0019] The two sections that together comprise the unit are respectively shown in Figures 1 and 2. The two sections are not separate entities but are constructed to interlink through specific pieces of apparatus; the two sections together form the closed cycle of the unit.

[0020] Figure 1 relates to the section for the preparation of the boiler solution. For this, ammonia water with an ammonia concentration between 25 and 27% is used, as well as sulphur dioxide, technical (95%) ethanol and water.

Water for the preparation of the boiler solution is supplied into the mixing device 2, which can also serve as a pot for the preparation of hard or liquid chemicals. The water is sent via the means of the plunger pump with adjustable input 7, 7a (working and spare respectively) from the mixing device 2 to the first scrubber 3 which is in the tail. Condenser 28 supplies non-condensable gases in to the first scrubber 3 where they are absorbed by the water which thus removes impurities. Non-purified gases also enter the first scrubber from the second scrubber 4.

[0021] The section for the preparation of the boiler solution is hermetic and works under raised pressure. The first scrubber 3 works under atmospheric pressure, and in the all the following apparatuses the pressure is slowly raised depending on the aerohydrodynamic resistance.

[0022] The weak solution from the first scrubber 3 goes via the pump 7b through the first 'tube in tube' heat exchanger 5 to the second scrubber 4. The 'tube in tube' heat exchanger has a different temperature within the tubes than between the tubes. The temperature within the tubes is considerably lower than that between them, typically the inside of the tubes being between 25 and 75 degrees celsius and that between the tubes being about 100 degrees.

[0023] When gases are absorbed in the scrubbers, heat may be emitted and the solution is warmed up to 45 - 50°C. The heat exchanger 5 ensures that the temperature of the solution is no more than 20°.

[0024] Sulphur dioxide is fed into the second scrubber 4 from the tank system. Sulphur dioxide feeding is also provided for the scrubber 3 as well. The scrubber 4 is also supplied with ammonia water for irrigation from the output tank 6 by the pump 7c. The output tank 6 is equipped with injectors, from which water is supplied to ensure safety of the servicing.

[0025] The solution from the second scrubber 4 is fed by the pump 7d to the tank with ready boiler solution, the mixing device 2a.

[0026] Plunger pumps with regulated flow 7a, 7b, 7c and 7d work without reserve but the scheme allows for these pumps to be interchanged.

[0027] Figure 2 shows the section of the unit for the boiling down of the raw plant material, typically composed of ground down hemp stock from the fibre plants. The raw material comes from storage into the input bunker 8. Unlike the hopper used in the prior art units, the input bunker 8 is situated immediately above the loading carbine of the spiral feeder 9 as illustrated in Figure 2.

[0028] The input bunker 8 itself is illustrated in Figure 3. It is equipped with a stirring device 80 which prevents raw material from getting stuck, as well as with a screw 81 for pressing the raw material. The stirring device 80 is typically rotated at between 0.25 and 0.52Hz (15 and 31 rotations per minute). The number of arms of the stirring device 81 is not limited to the two illustrated in the figure, but can be varied according to the required input rate of the raw material. The amount of raw material passing through the input bunker 8, and also the extent to which the raw material is pressed are controlled by changing the spinning speed of the screw 81, the speed being controlled by a thyristor converter. Such a converter serves as a control over the engines driving the equipment.

[0029] Preferably, the input bunker 8 will have a working volume of not more than 1.8 cubic metre. This volume ensures that the raw material is efficiently pressed before passing out of the bunker 8. Input and output from the bunker 8 are closely controlled such that the productivity of bunker 8 is within the range of 3.7 to 10.0 cubic metres / hour.

[0030] The pressed raw plant material is loaded from the input bunker 8 directly into the spiral feeder 9 situated immediately beneath it. A cross-section through the feeder 9 (along the line illustrated in Figure 2) is illustrated in Figure 4. The purpose of the feeder 9 is to further regulate the movement of the raw material to ensure a continuous flow of raw material into the boiler 11. The feeder 9 consists of cylindrical and conical parts, as well as a screw 90 which extends the entire length of the feeder 9. The shape of the screw by analogy to the shape of the feeder itself, has both cylindrical 90a and conical 90b parts. The diameter of the screw decreases as it passes from the cylindrical to the conical part of the feeder 9, as illustrated in figure 2. Unlike prior art feeders 9, the screw of this feeder has a prolonged stem 91 which extends beyond the screw thread in the conical region 90b of the screw 90.

[0031] In the conical part of the feeder 9 the raw material is compressed, and because of the slow decrease in the diameter of the screw, a plug is formed which resists the pressure of the boiler 11 - the relative positions of the boiler 11 and the spiral feeder 9 being illustrated in Figure 2 - and ensures the boiler 11 is airtight. The purpose of the prolonged stem 91 of the screw is to create a hole in the centre of the compressed plug. When the plug comes off the end part of the screw 90, the raw material is depressurised. In the zone where this depressurization occurs there is a hollow shaft 92 through which boiler solution is injected. With the help of needle valves situated around the perimeter of the output opening of the spiral feeder 9, the boiler solution irrigates the outside surface of the raw material plug. Also as the raw material is depressurized it, similarly to a sponge, absorbs the injected boiler solution such that a fast saturation of the raw material occurs. When the load drops to 70% the feeder engine is shut off and the output opening of the feeder is closed off by closing the disc of a hydrocylinder.

[0032] The boiler solution is fed through the hollow shaft 92 in the spiral feeder 9 by the pump 7f, 7g (working and spare respectively) from the apparatus 2a. The solution from 2a passes through the heat exchanger 5a, where it is heated to temperature of 75°C.

[0033] As with the input bunker 8, the spinning speed of the spiral feeder's screw 90 determines the efficiency of compression of the raw material. The speed of rotation also determines the time for which the raw material remains in the feeder 9; typically the throughput of the feeder 9 is maintained at a similar level to that of the input bunker 8. However, unlike the input bunker 8 which is at room temperature, the spiral feeder 9 is maintained at a temperature of approximately 100°C. This preliminary temperature increase of the raw material enables some preliminary cooking of the material when it is first impregnated with boiler solution in the depressurization zone of the feeder 9. Obviously most cooking occurs in the boiler 11 later in the unit, but the temperature increase in combination with this initial impregnation ensures increased cooking efficiency within the unit as a whole. The impregnation of the material is further improved by the hole in the centre of the plug generated by the prolonged stem of the screw 91.

[0034] The feeder contains attachments such that different screws 90 can be mounted within it. Obviously these screws will have both cylindrical 90a and conical 90b parts in correspondence to the shape of the feeder 9 but can differ in the length and diameter of the prolonged stem 91. This allows for the possibility of varying the size of the hole formed in the plug as it is extruded from the conical end 90b of the screw. As discussed, the hole is important for the impregnation of the central part of the raw material plug. However, no batch of raw material will be identical and changing the prolonged stem will allow for more efficient impregnation of material that may vary in fibrous or bast composition. It is also useful where the unit is adapted for use in processing different types of bast-fibred plants.

[0035] With the help of the inclined spiral conveyor 10, the raw material is sent to the lower part of the boiler 11, which is equipped with a vertical screw 111 that moves the raw material up and down and rods that both loosen the pulp and preclude the appearance of dense and stagnant zones in the boiler 11.

[0036] In the lower part of the boiler 11 the raw material is submerged in boiler solution. This is pumped from the second mixing device 2a by pump 7f into the boiler through the vertical screw 111 which has a perforated shaft. The level of the liquid is regulated by controlling the flow of the solution entering the boiler 11 and also by pumping away the used solution, through two circular pockets (not shown), protected by two to three rows of circular sieves (not shown), using the pumps 7h and 7i. The pockets together with the sieves are vital for changing the liquid level; this control is essential as it allows for the efficiency of the delignification process to be maintained even if slight fluctuations in raw material volume entering the boiler 11 occur. Any solution pumped out through the pockets in this way is heated in the casing tube heat exchanger 19 and returned to the boiler 11 through the perforated shaft of the vertical screw 111.

[0037] Importantly, the temperature and pressure conditions of the boiler 11 are strictly controlled The temperature is maintained at 170±10°C throughout the circulation of the boiler solution. The working pressure of the boiler is held at not more than 1.3MPa. The boiler 11 is equipped with a preventive valve, which will open at the pressure of 1.5MPa and also with features which allow for unloading of the boiler 11 when the pressure is raised. Unloading the material from the preventive valve is done into the tank 6b with the casing tube heat exchanger 22a. Those gases that do not condense in heat exchanger 22a, pass through cyclone 32 into the heat exchanger 28.

[0038] Raw material in the boiler 11 is raised from the liquid and enters into a steam and gas zone, where it is subjected to boiling and irrigation with drops of liquid condensed from the steam of the used solution on the surface of heat exchanger-condenser 25. Consequently, there is simultaneous washing and boiling of the fibrous product. The boiler-washing liquid used for irrigation becomes saturated with the reaction products. As the raw material rises further from the level of liquid it can be additionally heated by steam, supplied through a carbine in the middle part of the boiler 11.

[0039] In the upper part of the boiler 11 a coil of the reverse screw 116 with spirally welded ribs 117 is provided. The reverse screw 116, besides preventing the pulp from entering the steam portion of the boiler 11, also serves to distribute the irrigation liquid. As boiling liquid enters the boiler 11 it strikes the reverse screw 116 and the ribs serve to break up the stream and thus disperse the liquid over a larger area. This ensures that as large a portion of the raw material as possible comes into contact with the irrigation liquid and improves the effectiveness of the drip percolation.

[0040] It is also possible to change the spinning speed of the boiler shaft 112 using a thyistor converter. Typically, the shaft is rotated at about 0.53 Hz (32 rotations/min.).

[0041] The rate at which the pulp is raised through the boiler 11 is controlled such that it spends between 1 and 4 hours within the boiler 11. This ensures sufficient boiling and washing of the raw material. Additionally any gases released from the upper part of the boiler are blown away through tank 6b.

[0042] In the prior art unit shown in the 4th International Symposium of Scientists from Comecon Countries, Theses, Zinatne, Riga, 1982, the pulp passes from the boiler into a stepped series of screw feeders referred to as the discharge unit. The pulp is subjected to limited compression within this apparatus, which serves to press out some of the pulping liquor remaining in the material. In the present invention the raw material passes through a sequence of apparatus components which greatly improves the ease of removal of the material from the boiler 11 and which result in far more effective removal of liquid from the washed and boiled pulp.

[0043] Firstly, the resultant boiled and washed pulp is unloaded from the upper part of the boiler by the spiral conveyor 12. The pulp is supplied to the conveyor 12 by means of paddles 118 which are illustrated in Figure 5. The paddles are mounted on the rotating boiler shaft and thus the unloading process is regulated by varying the speed of rotation.

[0044] One important feature of the spiral conveyor is its high speed of rotation. The screw within it is rotated at approximately 16.7 Hz (1000 rot /min). This ensures a very high rate of throughput and helps to prevent congestion of the pulp at the top of the boiler.

[0045] Pulp unloaded in this way passes from the spiral conveyor 12 into a rotor feeder 13. The pressure in the rotor feeder 13 is lower than that of the boiler (1.3MPa), and is typically maintained at c. 0.7MPa to ensure an approximate pressure difference of 0.6MPa. Secondary boiling gases from the boiler 11 expand on entering the rotor feeder 13 allowing for their separation and removal.

[0046] The rotor feeder 13 supplies the pulp into a dividing bunker 14. This is constructed in the same way as the input bunker 8 and thus consists of both conical and cylindrical parts, and also comprises a corresponding stirrer 14a (within the conical part) and a pressing screw 14b (within the cylindrical region). The action of the stirrer 14b prevents the raw material getting stuck as in the input bunker 8. Again the screw 14b serves to compress the pulp and consequently squeeze liquid from the material.

[0047] The use of a dividing bunker 14 gives far more efficient pulp compression. The spinning speed of the pressing screw 14b can be varied which allows for greater control of both the throughput of pulp and the extent to which the pulp is actually compressed.

[0048] From the dividing bunker the cellulose pulp is loaded into the screw apparatus 15, where extra liquid is pressed out. This apparatus is illustrated in Figure 6. The loading sequence is maintained airtight by fitting the screw apparatus 15 with a closing device. In emergency situations the rotors of the closing device are set to a closed position, by which a steep decline of pressure of the system is prevented.

[0049] After closing the device the cellulose pulp is ground in the block of cams. These blocks are shown in detail in Figure 6. Along the length of the screw apparatus 15 the cams is varied; in Figure 6 there are three identified types of cam (150, 151, 152) which are interchanged as illustrated. This arrangement of cams is in no way limiting. Other cams can be used, or the order of the cams changed. The variation of cams within the screw apparatus 15 means that the pulp is ground with variable intensity along its length, which improves the efficiency with which extra liquid within the pulp is squeezed out. The rotation of the screw is typically maintained between 1.6 and 3Hz (100 to 180 rotations / min). It is also possible for each different type of cam to be rotated at a different frequency by connection of each part to a different driving engine.

[0050] Having passed through the screw apparatus 15 the pressed pulp is unloaded into the screw unloader 16 which serves to both unload and steam the cellulose pulp. Typically the screw unloader 16 is maintained at a pressure between 0.1 and 0.2 MPa such that gases are removed by the lowering of pressure. Additionally the screw unloader 16 is supplied with steam to take away the remnants of alcohol. The temperature of the pulp entering the screw unloader 16 is approximately 150°C but within this apparatus the temperature is set at 100°C.

[0051] From the screw unloader, the pulp is transported to the fluffer 17, which is designed to divide larger pieces of the pulp into separate packs of fibre so as to facilitate the process of blowing away and removal of the highly volatile fraction of any liquid still contained in the pulp. The fluffed up pulp then is sent to the conical accumulation reservoir 18 shown in Figure 7. In the upper part of this reservoir 18 there is an aperture through which steam is blown for the purpose of removing alcohol and other volatile species from the pulp. To prevent significant condensation of this steam, the reservoir 18 is maintained at a temperature of approximately 100°C.

[0052] Unlike the discharge tank shown in the unit in the 4th International Symposium of Scientists from Comecon Countries, Theses, Zinatne, Riga, 1982, this accumulation reservoir 18 has a 'live bottom' formed by four screws, as illustrated in the cross-section of Figure 8. Preferably the four screws have identical diameters and are divided into two sets 181, 182 each set rotating out of step with the other. The screws are driven by a motor such that they rotate at a speed of between 15 and 30 rotations per minute. This serves to keep the pulp in constant motion.

[0053] The choice of identical screws is only one possibility. Conceivably, the diameter of each screw or set of two screws could be different, or each screw could be attached to a different motor such that they rotate at different speeds if this improves the efficiency with which the steam blown into the apparatus removes alcohol or other remaining volatile liquids still remaining in the pulp after fluffing.

[0054] The cellulose pulp passes out of the accumulation reservoir on to a screw conveyor 18a for packing. The screw acts upon the pulp to press out any further liquid (filtrate) from it; liquid collected in this way is gathered in the apparatus 6c, which also receives the condensate from the heat exchanger (condenser) 22. The apparatus 6c is maintained at the same pressure as the screw apparatus 15, c. 0.7MPa. From apparatus 6c the boiler solution is recycled by pump 7j to the boiler 11 for use in irrigation of the raw material. The extra solution flows from the apparatus 6c to vaporising apparatus 20, where the pressure is lowered. When necessary the extra solution is sent by the pump 7k out of the system.

[0055] Used boiler solution is concentrated in a steamer apparatus 24 equipped with a flowing down pellicle consisting of a series of parallel tubes 25 as illustrated in Figure 2. This steamer apparatus 24 is made with a separate heating tank and a separator 26. The temperature within the tubes is maintained about 15°C lower than the temperature in between the tubes. Preferably, the temperature in the tubes is set at 175±5°C whilst that in between the tubes is set at 190±5°C. In line with the main theme of the unit the pressure inside the steamer apparatus is also closely controlled.

Preferably the working pressure inside the tubes is set at 1.25±0.05MPa and that between the tubes is also set at 1.25±0.05MPa. For effective boiling down of the used boiler solution the steamer must have a large surface area; the working surface area of a typical steamer used in the method according to this invention is about 25m^2.

[0056] From the boiler the solution enters the separator 26 from where it is pumped by pumps 7n and 7o (working and spare respectively) into the upper part of the steamer apparatus 24; the solution comes through a distribution device in the steamer apparatus 24 and flows down evenly on the inner surface of the tubes 25 in the form of a thin layer. Simultaneously the solution is being boiled down to the required concentration. The gases released in the steamer pass into the heat exchanger 27 (condenser). The condensed boiler solution is collected is gathered in tank 6d and later sent by pump 7m to the boiler 11 for irrigation. The extra solution from the tank 6d flows into the vaporiser apparatus 20a - which is maintained at a lower pressure - and if necessary is pumped away to be used in preparation of the boiler solution.

[0057] The concentrated boiler solution from the steamer apparatus is sent away to the vaporiser apparatus 20b, where it is further boiled down and collected in the an output tank.

[0058] The gases separated in the vaporiser 20b are sent through a first cyclone 31 to the 'casing-tube' heat exchanger 28. Secondary gases from the screw unloader 16, from the vaporisers 20 and 20a are also sent to this heat exchanger 28 through the second cyclone 32. The purpose of both cyclones 31, 32 is to catch fibres supported within the gases of the boiler solution. Both cyclones are held at a temperature of 100°C and work at atmospheric pressure. The first cyclone 31 has however a smaller working volume than the second cyclone 32 which directly relates to the relative volumes of gas circulated to each of them.

[0059] The condensed liquid is sent to the tank 2a and non-condensable gases go to scrubber 3 for the absorption and cleaning process. The pulp caught in the second cyclone 32-is periodically unloaded from it into a helper tank.

[0060] In the unit a means of emptying the contents of the boiler 11 in emergency is provided. There is an emergency tank 30, equipped with a stirrer and a net for removing drops of liquid. The lower part of the boiler 11 is connected through a blower tube 34 to the middle part of the emergency tank 30. When the pressure is lowered - the tank's working pressure is typically atmospheric pressure - secondary boiling gases form in the emergency tank 30, which pass through the second cyclone 32 into the condenser 28 and later into the first scrubber 3. The incoming solution from the boiler has a temperature of approximately 170°C but this is lowered to 100°C within the tank 30. At this point it is needed to maximise the usage of cooling water for the condenser 28 and the irrigation liquid Cl. The emergency tank 30 is unloaded periodically into the movable helper bunker 35.

[0061] Compared to the prior art unit of Krotov the unit used in the method of the present invention comprises two more vaporisers throughout (described as flashers in the prior art document). The function of each vaporiser apparatus is to lower the pressure and temperature of the boiler solution passing through it. The three vaporisers are of identical volume and all work at atmospheric pressure. Their increased number and their respective positions within the unit serve to improve the temperature efficiency of the apparatus. This contributes to an improvement in the preparation of the pulping liquor from recovered chemicals in this embodiment compared to the prior art unit.

[0062] Before a planned stop of the unit, the boiler solution must be taken away from the boiler. For this purpose, pump H7 directs the boiler solution into a diversionary path not encountering the heat exchanger T.

[0063] A number of the apparatus components are of standard construction within the field of pulping. The standard equipment include the mixing devices 2, 2a which are fixed with turbine mixers, the tanks (6 to 6e) and all pumps. With respect to the standard pumps used, these have a maximum working pressure flow of 16 kg/cm^2. The automation scheme of the unit provides for blocking of the pumps when the pressure inside exceeds this value.

[0064] The basic construction material for the unit is steel and more particularly most component apparatus are constructed from carbon steel. However, it is possible that the unit could be constructed from other materials with similar mechanical and chemical properties as steel, for example the resistance to the pH conditions within the boiler. The carbon steel may also be treated to enhance its resistance to corrosion or subjecting it to other preservation processes.

[0065] The unit of the embodiment does contain more component parts than the aforementioned prior art pulper. The importance of the increased number of vaporisers has already been discussed. Despite this increase the unit can be constructed in compact form such that it requires little more floor space than the known unit. The embodiment can be constructed as a highly-profitable low-capacity plant which even offers scope for the development of mobile units that can be used in the growing regions for the raw materials. The integration of the individual parts and assembly units used in the method of the invention is indicated by its high level of unification. The invention has a typical coefficient of unification of 52%.

[0066] The unit, although particularly suitable for ground hemp stocks, is not restricted to this type of raw material. Other bast-fibred plants such as flax or kenaf are obvious alternatives. These would require a different composition of pulping liquor i.e. a different relative proportion of components and also a different cooking and treatment time. The throughput of material through the unit can readily be varied to allow for this.

Example:

[0067] The following example illustrates the typical construction and operation details for a unit used in the method according to this invention. The unit described hereafter may be used for the production of cellulose at a rate of no more than 300 kg/hr. The conditions listed are the optimum for this total productivity limit.

Table 1

Component	Productivity/ kg/hr	Working Pressure / atm	Maximum Working Temperature/°C	Working Volume / cubic metres	Working surface area / square metres	Frequency of screw / shaft / stirrer rotation if relevant / rot / min
Boiler 11	250	1.3	170	14 .7		32 (shaft)
Input bunker 8	3 . 7 - 10 . 0			1.8		15 - 31
Dividing bunker 14	5 .8	0.7	170	6.2		18
Spiral feeder 9	2.9 - 12 .8		100			1000
Spiral conveyor 10	1000	1.3	170			1500
Spiral conveyor 12	1000	1.3	170			1500
Rotor feeder 13	2.89 - 5.8	0.7 - 1.3	170	0.00754		16 - 32
Screw apparatus 14	1000	0.7	150			100 - 180
Accumulation reservoir 18	1. 5 - 4 . 5		100			15 - 30
Screw conveyor 18a	4 . 5					4 . 5
Emergency reservoir 30		1	100	13	45	45 (stirrer)
Steamer apparatus 24		1 .25	175 (in tubes) 190 (bet. tubes)		25	
Vaporisers 20, 20a, 20b		1	150			
First cyclone 31		1	100	0 . 11		
Second cyclone 32		1	100	0 . 85		
Scrubbers 3,4	40 (gas) 154 (liquid)	1	25 - 65	0 . 25		
Output tank 6, 6b, 6e		1	20	2.65		
Output tank 6a, 6c, 6d		1	170	1		
Screw unloader 16	600	1	110			19 - 32 (screw)
'Tube in tube' heat exchangers 5, 5a		2 (in tubes) 0.15 (bet.ween)	25 (in tubes) 110 (between)		0.710	
Fluffer 17	600	0.1 - 0.2	100			

[0068] Other technical characteristics are:

Maximum working pressure of the steam supplied for heating, Mpa;

- to the boiler (11) 1.6
- to the steamer (24) and the heat exchanger (19) 1.3
- to the screw unloading device (12) 0.05
- to the second 'tube in tube' heat exchanger (5a) 0.05

Working temperature

- of the cooling water 25°C
- of the cooled water 7 - 18°C

Time pulp spends in the boiler 1 - 4 hrs
pH of the environment 4.5 to 13
Density of raw material in the input bunker 80 - 125 kg/m^3

Specific energy consumption,

kWt/ton, kg/hr, not more than 676

Maximum steam usage, kg/hr

- with pressure of 1.6 MPa 40
- with pressure of 1.3 MPa 481
- with pressure of 0.05 MPa 84

[0069] The volumes and operating temperatures and pressures represent the preferred values but are not limiting. The size of each component of the unit can be varied according to its location. For example, if a mobile unit is required, the dimensions of each piece of apparatus comprising the unit will be reduced correspondingly in scale. The unit is of direct importance to countries where wood supplies are limited and the unit must be sized according to the regional growth of bast-fibred plants and the associated demand of paper.

[0070] The amount of ethanol used is not given. This raw material is only supplied for the start-up of the unit since during pulping methanol, ethanol and acetone as formed from the components of the fibrous raw material, this being a well-known effect of the AAS delignification method. Subsequently, as organic components are accumulated in the pulping liquor, ethanol can be recycled. Excess organic solvent can be drawn and processed as a market chemical. Hence in a continuously operating unit there is no need to supply ethanol.

Claims

1. A method for the production of pulp from raw plant material comprising in sequence:

regulating the input of raw material into a boiler (11) by means of a first feeder (9) containing a screw (90) having a prolonged stem (91) which extends beyond the screw thread;
cooking the raw material in said boiler (11) to generate pulp;
receiving cooked material from the boiler (11) in a second feeder (13);
extracting liquid from the cooked material in a liquid extraction apparatus (15);
treating the material received from the liquid extraction apparatus with steam in an unloader (16) maintained at a lower pressure than the liquid extraction apparatus;
receiving pulp from the unloader (16) in an accumulation reservoir (18); and removing pulp from the accumulation reservoir; **characterised in that** the regulating step includes injecting boiler solution into the raw material through a passage (92) in the prolonged stem (91) and that said second feeder (13) is maintained at a lower pressure than the boiler.

2. A method according to claim 1, wherein the first feeder (9) consists of both cylindrical (90a) and conical (90b) parts, the prolonged stem (91) of the screw extending beyond the conical part of the screw thread.

3. A method according to claim 1 or claim 2, wherein the prolonged stem (91) is of variable length and diameter.

4. A method according to claim 1, wherein the boiler (11) for cooking the raw material to generate pulp contains a substantially vertical screw (111) having a rotatable, perforated shaft.

5. A method according to claim 4, wherein the boiler (11) further comprises a reverse screw (116) of opposite sense to the substantially vertical screw.

6. A method according to claim 5, wherein the reverse screw (116) has at least one spirally extending rib (117).

7. A method according to any of claims 4 to 6, wherein the cooked material is removed from the boiler (11) by means of paddles (118) mounted on the shaft of the substantially vertical screw (111).

8. A method according to any preceding claim, wherein the liquid extraction apparatus for extracting liquid from the cooked material comprises a screw apparatus (15) containing at least two different rotatable cams.

9. A method according to claim 8, including rotating each cam within the screw apparatus (15) at a different frequency.

10. A method according to any of claims 1 to 9, including keeping the pulp in constant motion in the accumulation reservoir (18).

11. A method according to claim 10, wherein the bottom of the accumulation reservoir (18) is formed by rotatable screws.

12. A method according to claim 11, wherein at least one of the screws in the accumulation reservoir (18) rotates out of step with the other screws.

13. A method according to claim 12, wherein two of the screws in the accumulation reservoir (18) rotate at the same frequency.

14. A method according to any of claims 11 to 13, wherein each of the screws in the accumulation reservoir (18) is of different diameter.

15. A method according to any of claims 1 to 4, further comprising supplying raw material into the first feeder by means of a first bunker (8) positioned on top of the first feeder (9), the first bunker (8) including a stirring device (80) and rotatable screw (81).

16. A method according to any of claims 1 to 15, further comprising receiving cooked material removed from the boiler with a conveyor (12), positioned between the boiler (11) and the second feeder (13).

17. A method according to any of claims 1 to 16, further comprising compressing the cooked material in a second bunker (14) positioned between the second feeder (13) and the liquid extraction apparatus, the second bunker comprising a stirrer (14a) and a pressing screw (14b).

18. A method according to any claims 1 to 17, further comprising dividing the cooked material into separate packs of fibre to facilitate liquid removal from the material by means of a flutter (17), positioned between the unloader (16) and the accumulation reservoir (18).

19. A method according to any of claims 1 to 18, wherein pulp is removed from the accumulation reservoir (18) by means of a screw conveyor (18a).

20. A method according to any of claims 1 to 19, wherein the boiler solution is produced and supplied to the boiler and/or first feeder by the steps of:

supplying water to a mixing device (2);
receiving water from the mixing device in a first scrubber (3) and supplying sulphur gas to generate a weak solution;
passing the weak solution from the first scrubber through a heat-exchanger (5);

receiving the weak solution from the heat exchanger in a second scrubber (4) and supplying ammonia water and sulphur dioxide gas to the second scrubber (4);
passing the solution from the second scrubber (4) to an output tank (6) in which the boiler solution is generated;
transferring the boiler solution from the output tank (6) to the boiler and/or first feeder; and
regulating gas and/or liquid flow with one or more pumps (7a-d).

21. A method according to claim 20, wherein the heat-exchanger (5) comprises a 'tube-in-tube' heat exchanger.

22. A method according to any of claims 1 to 21, further comprising regenerating boiler solution from the used solution formed within the boiler, by the following steps in sequence:

receiving used solution from the boiler (11) in a separator (26);
boiling down used solution to a required concentration in a steamer apparatus (24), the steamer apparatus including a heater and receiving steam and removing gases released from the boiling down of the used solution; and
returning the regenerated solution from the steamer apparatus to the boiler.

23. A method according to claim 22, wherein the steamer apparatus (24) further includes a distribution device for distributing used solution received from the separator, and a series of parallel tubes (25).

24. A method according to claim 23, in which the temperature inside the parallel tubes (25) is different to that outside the parallel tubes.

25. A method according to claims 22 to 24, wherein the regenerated boiler solution is temporarily stored in a tank (6d) before return to the boiler.

26. A method according to any of claims 22 to 25, wherein the used solution is further boiled down in a vaporiser apparatus (20b) before return to the boiler.

27. A method according to claim 26, wherein a cyclone receives gases generated in the vaporiser and removes fibres of material supported within the gases.

28. A method according to any of claims 1 to 27 further including treating fluids generated in the boiler by means of two vaporisers, a cyclone for removing fibres supported in the gases entering the cyclone from the vaporisers, and a heat-exchanger to condense the gases received from the cyclone.

29. A method according to claim 28, whereby the step of treating fluids also includes receiving gases generated in the unloader (16).

30. A method according to claim 28 or 29, whereby the step of treating fluids also includes receiving gases generated in the fluffer (17).

31. A method according to any of claims 28 to 30, whereby the step of treating fluids also includes receiving gases generated in the accumulation reservoir (18).

32. A method according to any of claims 28 to 31 further including receiving condensed liquid from the heat-exchanger in a tank.

33. A method according to any of claims 28 to 32, further including supplying gases not condensed in the heat-exchanger to the first scrubber (3) for use in the preparation of the boiler solution.

34. A method according to any of claims 1 to 33, wherein an emergency tank (30) is connected to the boiler through a blower tube (34).

35. A method according to any of claims 1 to 34, further including unloading pulp caught in the emergency tank or cyclones into a helper bunker (35).

Patentansprüche

1. Verfahren zum Herstellen einer Pulpe aus einem Rohpflanzenmaterial in folgender Schrittabfolge:

   Regulieren der Eingabe von Rohmaterial in einen Kessel (11) durch eine erste Zugabevorrichtung (9), die eine Schraube (90) mit einem verlängerten Schaft (91) aufweist, der sich über das Schraubengewinde hinaus erstreckt;
   Kochen des Rohmaterials in dem Kessel (11), um die Pulpe zu erzeugen;
   Empfangen des gekochten Materials aus dem Kessel (11) in einer zweiten Zugabevorrichtung (13);
   Entziehen von Flüssigkeit aus dem gekochten Material in einem Flüssigkeitsentziehungsgerät (15);
   Behandeln des aus dem Flüssigkeitsentziehungsgerät empfangenen Materials mit Dampf in einem Entlader (16), der auf einem geringeren Druck als das Flüssigkeitsentziehungsgerät gehalten wird;
   Empfangen der Pulpe aus dem Entlader (16) in einem Sammelreservoir (18); und
   Entfernen der Pulpe aus dem Sammelreservoir;

   dadurch gekennzeichnet, dass
   der Regulierschritt das Einspritzen einer Kessellösung in das Rohmaterial durch einen Durchgang (92) in dem verlängerten Schaft (91) beinhaltet, und dass die zweite Zugabevorrichtung (13) auf einem geringeren Druck als der Kessel gehalten wird.

2. Verfahren nach Anspruch 1, wobei die erste Zugabevorrichtung (9) aus einem zylindrischen (90a) und einem konischen (90b) Teil besteht, und sich der verlängerte Schaft (91) der Schraube sich über den konischen Teil des Schraubengewindes hinaus erstreckt.

3. Verfahren nach Anspruch 1 oder 2, wobei der verlängerte Schaft (91) eine variable Länge und einen variablen Durchmesser aufweist.

4. Verfahren nach Anspruch 1, wobei der Kessel (11) zum Kochen des Rohmaterials eine im wesentlichen vertikale Schraube (111) mit einem drehbaren perforierten Schaft umfasst.

5. Verfahren nach Anspruch 4, wobei der Kessel (11) weiterhin eine der im wesentlichen vertikalen Schraube gegenläufige Schraube (116) aufweist.

6. Verfahren nach Anspruch 5, wobei die gegenläufige Schraube (116) zumindest eine spiralförmig verlaufende Rippe (117) aufweist.

7. Verfahren nach einem der Ansprüche 4 bis 6, wobei das gekochte Material aus dem Kessel (11) mittels Schaufeln (118) entfernt wird, die an dem Schaft der im wesentlichen vertikalen Schraube (111) angebracht sind.

8. Verfahren nach einem der vorhergehenden Ansprüche, wobei das Flüssigkeitsentziehungsgerät zum Entziehen der Flüssigkeit aus dem gekochten Material ein Schraubengerät (15) mit mindestens zwei unterschiedlichen rotierenden Nocken aufweist.

9. Verfahren nach Anspruch 8, wobei sich jede Nocke innerhalb des Schraubengeräts (15) mit einer unterschiedlichen Frequenz dreht.

10. Verfahren nach einem der Ansprüche 1 bis 9, wobei die Pulpe in dem Sammelreservoir (18) in konstanter Bewegung gehalten ist.

11. Verfahren nach Anspruch 10, wobei der Boden des Sammelreservoirs (18) aus drehbaren Schrauben gebildet ist.

12. Verfahren nach Anspruch 11, wobei sich zumindest eine der Schrauben in dem Sammelreservoir (18) nicht synchron mit den anderen Schrauben dreht.

13. Verfahren nach Anspruch 12, wobei sich zwei der Schrauben in dem Sammelreservoir (18) mit der gleichen Frequenz drehen.

14. Verfahren nach einem der Ansprüche 11 bis 13, wobei jede der Schrauben in dem Sammelreservoir (18) einen

unterschiedlichen Durchmesser aufweist.

15. Verfahren nach einem der Ansprüche 1 bis 4, wobei weiterhin der ersten Zugabevorrichtung Rohmaterial mittels eines ersten Bunkers (8) zugeführt wird, der oberhalb der ersten Zugabevorrichtung (9) angeordnet ist und eine Rührvorrichtung (80) und eine drehbare Schraube (81) aufweist.

16. Verfahren nach einem der Ansprüche 1 bis 15, wobei weiterhin gekochtes Material, das aus dem Kessel mit einer zwischen dem Kessel (11) und der zweiten Zugabevorrichtung (13) angeordneten Fördervorrichtung (12) entfernt wird, empfangen wird.

17. Verfahren nach einem der Ansprüche 1 bis 16, wobei weiterhin das gekochte Material in einem zwischen der zweiten Zugabevorrichtung (13) und dem Flüssigkeitsentziehungsgerät angeordneten zweiten Bunker (13) zusammengepresst wird, der einen Rührer (14a) und eine Pressschraube (14b) aufweist.

18. Verfahren nach einem der Ansprüche 1 bis 17, wobei weiterhin das gekochte Material zur Erleichterung der Flüssigkeitsentfernung aus dem Material mittels einer Auflockervorrichtung (17), die zwischen dem Entlader (16) und dem Sammelreservoir (18) angeordnet ist, in unterschiedliche Faserpacks geteilt wird.

19. Verfahren nach einem der Ansprüche 1 bis 18, wobei die Pulpe aus dem Sammelreservoir (18) mittels eines Schraubenförderers (18a) entfernt wird.

20. Verfahren nach einem der Ansprüche 1 bis 19, wobei die Kesselflüssigkeit gemäß folgender Schritte hergestellt und an dem Kessel und/oder der ersten Zugabevorrichtung bereitgestellt wird:

Zuführen vom Wasser zu einer Mischvorrichtung (2);
Empfangen des Wassers aus der Mischvorrichtung in einem ersten Wascher (3) und Zugeben von Schwefelgas, um eine schwache Lösung zu erzeugen;
Weiterführen der schwachen Lösung aus dem ersten Wascher durch einen Wärmetauscher (5);
Empfangen der schwachen Lösung aus dem Wärmetauscher in einem zweiten Wascher (4) und Zuführen von Ammoniakwasser und Schwefeldioxidgas zu dem zweiten Wascher (4);
Weiterführen der Lösung aus dem zweiten Wascher (4) zu einem Ausgabetank (6) in welchem die Kessellösung erzeugt wird;
Transferieren der Kessellösung aus dem Ausgabetank (6) zu dem Kessel und/oder der ersten Zugabevorrichtung; und
Regulieren des Gas- und/oder Flüssigkeitsstroms mit einer oder mehreren Pumpen (7a-d).

21. Verfahren nach Anspruch 20, wobei der Wärmetauscher (5) einen Rohr-in-Rohr-Wärmetauscher umfasst.

22. Verfahren nach einem der Ansprüche 1 bis 21, wobei weiterhin die Kessellösung aus der benutzten Lösung, die sich innerhalb des Kessels gebildet hat, mittels folgender Schritte zurückgewonnen wird:

Empfangen der benutzten Lösung aus dem Kessel (11) in einer Trennvorrichtung (26);
Einkochen der benutzten Lösung auf die erforderliche Konzentration in einem Dampfgerät (24), wobei das Dampfgerät eine Heizvorrichtung aufweist, Dampf empfängt und Gase, die aus dem Einkochen der benutzten Lösung stammen, entfernt; und
Zurückgeben der wiedergewonnenen Lösung aus dem Dampfgerät zu dem Kessel.

23. Verfahren nach Anspruch 22, wobei das Dampfgerät (24) weiterhin eine Verteilvorrichtung zum Verteilen der benutzten von der Trennvorrichtung empfangenen Lösung und eine Reihe von parallelen Röhren (25) aufweist.

24. Verfahren nach Anspruch 23, bei welchem die Innentemperatur der parallelen Röhren (25) von der Außentemperatur der parallelen Röhren verschieden ist.

25. Verfahren nach Anspruch 22 bis 24, wobei die wiedergewonnene Kessellösung zeitweise in einem Tank (6d) aufbewahrt wird, bevor sie an den Kessel zurückgegeben wird.

26. Verfahren nach einem der Ansprüche 22 bis 25, wobei die benutzte Lösung weiterhin in einem Verdampfgerät (20b) eingekocht wird, bevor sie an den Kessel zurückgegeben wird.

27. Verfahren nach Anspruch 26, wobei ein Zyklonabscheider die in dem Verdampfgerät erzeugten Gase empfängt und Materialfasern, die von den Gasen getragen werden, entfernt.

28. Verfahren nach einem der Ansprüche 1 bis 27, wobei weiterhin Fluide, die in dem Kessel erzeugt werden, mit zwei Verdampfgeräten, einem Zyklonabscheider zum Entfernen der in den Gasen, die von den Verdampfgeräten in den Zyklonabscheider eintreten, getragenen Fasern und einem Wärmetauscher, um die von dem Zyklonabscheider empfangenen Gase zu kondensieren, behandelt werden.

29. Verfahren nach Anspruch 28, wobei der Schritt der Fluidbehandlung ebenfalls umfasst, dass Gase, die in dem Entlader (16) erzeugt werden, empfangen werden.

30. Verfahren nach Anspruch 28 oder 29, wobei der Schritt der Fluidbehandlung ebenfalls umfasst, dass Gase, die in der Auflockervorrichtung (17) erzeugt werden, empfangen werden.

31. Verfahren nach einem der Ansprüche 28 bis 30, wobei der Schritt der Fluidbehandlung umfasst, dass Gase, die in dem Sammelreservoir (18) erzeugt werden, empfangen werden.

32. Verfahren nach einem der Ansprüche 28 bis 31, wobei weiterhin eine kondensierte Flüssigkeit aus dem Wärmetauscher in einem Tank aufgefangen wird.

33. Verfahren nach einem der Ansprüche 28 bis 32, wobei weiterhin Gase, die nicht in dem Wärmetauscher kondensiert sind an dem ersten Wascher (3) für die Benutzung zur Vorbereitung der Kessellösung bereitgestellt werden.

34. Verfahren nach einem der Ansprüche 1 bis 33, wobei ein Nottank (30) mit dem Kessel über eine Druckröhre (34) verbunden ist.

35. Verfahren nach einem der Ansprüche 1 bis 34, wobei weiterhin die in dem Nottank oder den Zyklonabscheidern aufgefangene Pulpe in einen Hilfsbunker (35) entladen wird.

Revendications

1. Un procédé de production de pâte à papier à partir de matières premières végétales, comprenant successivement :

la régulation de l'admission des matières végétales dans une chaudière (11) au moyen d'un premier chargeur (9) comprenant une vis (90) laquelle est prolongée par une tige (91) qui s'étend au delà du filetage de la vis ;
la cuisson des matières végétales dans la dite chaudière (11) afin de produire de la pâte à papier ;
la réception des matières cuites provenant de la chaudière (11) dans un second chargeur (13) ;
l'extraction du liquide provenant des matières cuites dans un extracteur de liquide (15) ;
le traitement des matières provenant de l'extracteur de liquide avec de la vapeur dans un déchargeur (16) maintenu à une pression inférieure à celle de l'extracteur de liquide ;
la réception dans un réservoir de stockage (18) de la pâte à papier provenant du déchargeur (16) ; puis transfert de la dite pâte depuis le réservoir de stockage ; **caractérisé par le fait que** l'étape de réglage inclut l'injection de la solution du réservoir dans les matières végétales en empruntant un passage (92) situé dans la tige prolongée (91) et que le dit second chargeur (13) est maintenu à une pression inférieure à celle du réservoir.

2. Un procédé selon la revendication 1, où le premier chargeur (9) est formé de deux parties, cylindrique (90a) et conique (90b), la tige prolongée (90) de la vis s'étendant au delà de la partie conique du filetage de la vis.

3. Un procédé selon la revendication 1 ou la revendication 2, où la tige prolongée (91) est de diamètre et de longueur variables.

4. Un procédé selon la revendication 1, où la chaudière (11) pour la cuisson des matières végétales afin de produire de la pâte à papier contient une vis principalement verticale (111) disposant d'un arbre perforé, mobile autour d'un axe.

5. Un procédé selon la revendication 4, où la chaudière (11) comprend en outre une vis inversée (116) de sens opposé à la vis principalement verticale.

6. Un procédé selon la revendication 5, où la vis inversée (116) est munie d'au moins une nervure d'extension spiralée (117).

7. Un procédé selon une des quelconques revendications 4 à 6, où les matières cuites sont extraites de la chaudière (11) au moyen de spatules montées sur l'axe de la vis principalement verticale (111)

8. Un procédé selon une des quelconques précédentes revendications, où l'extracteur de liquide destiné à extraire le liquide à partir des matières cuites comprend un mécanisme à vis (15) comprenant au moins deux différentes cames rotatives.

9. Un procédé selon la revendication 8, **caractérisée par le fait que** chacune des cames rotatives à l'intérieur du mécanisme à vis est d'une fréquence différente.

10. Un procédé selon une des quelconques revendications 1 à 9, comprenant le stockage de la pâte à papier dans le réservoir de stockage (18).

11. Un procédé selon la revendication 10, où le fond du réservoir de stockage (18) est formé de vis rotatives.

12. Un procédé selon la revendication 11, où au moins une des vis situées dans le réservoir de stockage (18) tourne autour du pas avec les autres vis.

13. Un procédé selon la revendication 12, où deux des vis dans le réservoir de stockage (18) tournent autour de leur axe à la même fréquence.

14. Un procédé selon une des quelconques revendications 11 à 13, où chacune des vis dans le réservoir de stockage (18) est d'un diamètre différent.

15. Un procédé selon une des quelconques revendications 1 à 4, comprenant en outre l'approvisionnement des matières végétales dans le premier chargeur au moyen d'un premier réservoir (8) positionné au dessus du premier chargeur (9), le dit premier réservoir (8) comprenant un mécanisme de brassage (80) et une vis rotative (81).

16. Un procédé selon une des quelconques revendications 1 à 15, comprenant en outre une réception des matières cuites provenant de la chaudière avec un transporteur (12), dans un second réservoir (14) positionné entre la chaudière (11) et le second chargeur (13).

17. Un procédé selon une des quelconques revendications 1 à 16, comprenant en outre une compression des matières cuites dans un second réservoir (14) positionné entre le second chargeur (13) et l'extracteur de liquide (15), le second réservoir comprenant un agitateur (14a) et une vis de serrage (14b).

18. Un procédé selon une des quelconques revendications 1 à 17, comprenant en outre un système de séparation des matières cuites en différents paquets de fibres afin de faciliter le mouvement du liquide obtenu à partir des matières, au moyen d'un malaxeur pelucheur (17) positionné entre le déchargeur (16) et le réservoir de stockage (18).

19. Un procédé selon une des quelconques revendications 1 à 18, où la pâte à papier est extraite du réservoir de stockage (18) au moyen d'un transporteur à vis (18a).

20. Un procédé selon une des quelconques revendications 1 à 19, où la solution d de la chaudière est produite et alimente la chaudière et / ou le premier chargeur, selon les étapes suivantes :

alimentation en eau vers un mélangeur (2) ;
réception de l'eau, provenant du mélangeur, dans un premier purificateur (3) et approvisionnement de gaz sulfureux afin de générer une solution étendue ;
passage au travers d'un échangeur de chaleur (5) de la solution étendue provenant du premier purificateur ;
réception dans un deuxième purificateur (4) de la solution étendue provenant de l'échangeur de chaleur et approvisionnement en eau ammoniacale et en anhydride sulfureux dans le second purificateur (4) ;
transport de la solution provenant du second purificateur (4) dans un réservoir de sortie (6) dans lequel la solution de la chaudière est générée ;

transfert de la solution de la chaudière provenant du réservoir de sortie (6) vers la chaudière et / ou un premier chargeur ; et
régulation du débit de gaz et / ou du débit du liquide à l'aide d'une ou de plusieurs pompes (7a-d).

21. Un procédé selon la revendication 20, où l'échangeur de chaleur (5) comprend un échangeur de chaleur de type « tube dans le tube », .

22. Un procédé selon une des quelconques revendications 1 à 21, comprenant en outre une régénération de la solution de la chaudière, la dite solution provenant de la solution usagée générée à l'intérieur de la chaudière, selon les étapes successives dont l'ordre est le suivant :

réception, dans un séparateur (26), de la solution usée provenant de la chaudière (11);
concentration, par cuisson dans une chaudière à vapeur (24) , de la solution usagée jusqu'à obtention de la concentration requise, la dite chaudière à vapeur comprenant un réchauffeur ainsi qu'un dispositif de réception de la vapeur et d'évacuation des gaz provenant de la concentration par cuisson de la solution usagée ; et
renvoi, depuis la chaudière à vapeur, de la solution régénérée dans la chaudière.

23. Un procédé selon la revendication 22, où chaudière à vapeur (24) comprend en outre, d'une part un dispositif pour la distribution de la solution usagée reçue depuis le séparateur et d'autre part une série de tubes parallèles (25).

24. Un procédé selon la revendication 23, où la température à l'intérieur des tubes parallèles (25) est différente de celle régnant à l'extérieur des tubes parallèles.

25. Un procédé selon les revendications 22 à 24, où la solution régénérée de la chaudière est temporairement stockée dans un réservoir (6d) avant d'être renvoyée dans la chaudière.

26. Un procédé selon une des quelconques revendications 22 à 25, où la solution usagée est en outre concentrée par cuisson dans un dispositif de vaporisation (20b) avant d'être renvoyée dans la chaudière.

27. Un procédé selon la revendication 26, où un clarificateur reçoit les gaz générés dans le vaporisateur et extrait les fibres des matières contenues dans les gaz.

28. Un procédé selon une des quelconques revendications 1 à 27, comprenant en outre un traitement des fluides générés dans la chaudière au moyen de deux vaporisateurs, un clarificateur pour extraire les fibres contenues dans les gaz provenant des vaporisateurs et pénétrant dans le clarificateur ainsi qu'un, échangeur de chaleur pour condenser les gaz provenant du clarificateur.

29. Un procédé selon la revendication 22, **caractérisée par le fait que** l'étape du traitement des liquides inclut également une réception des gaz générés dans le déchargeur (16).

30. Un procédé selon la revendication 28 ou 29, **caractérisée par le fait que** l'étape du traitement des liquides inclut également la réception des gaz générés dans le malaxeur pelucheur (17).

31. Un procédé selon une des quelconques revendications 28 à 30, **caractérisée par le fait que** l'étape du traitement des liquides inclut également la réception des gaz générés dans le réservoir de stockage (18).

32. Un procédé selon une des quelconques revendications 28 à 31, comprenant en outre une réception, dans un réservoir, du liquide condensé provenant de l'échangeur de chaleur.

33. Un procédé selon une des quelconques revendications 28 à 32, comprenant en outre l'approvisionnement des gaz non condensés dans l'échangeur de chaleur pour le premier purificateur (3) à fin d'utilisation dans la préparation de solution de la chaudière.

34. Un procédé selon une des quelconques revendications 1 à 33, où un réservoir de secours (30) est connecté à la chaudière au moyen d'un tube de soufflante (34).

35. Un procédé selon une des quelconques revendications 1 à 34, comprenant en outre un déchargement, dans un réservoir auxiliaire (35), de la pâte à papier se trouvant dans le réservoir de secours ou les clarificateurs.

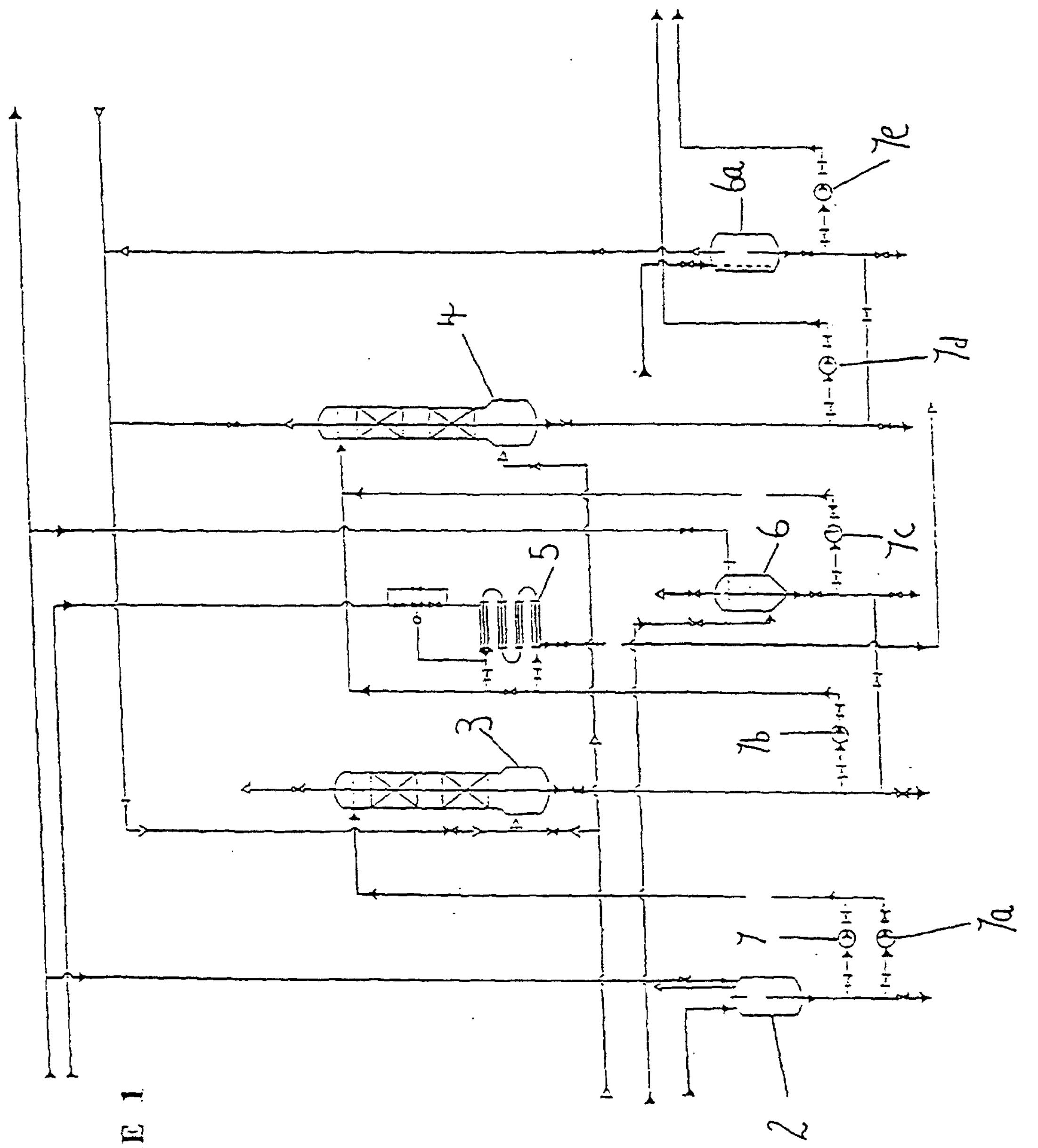
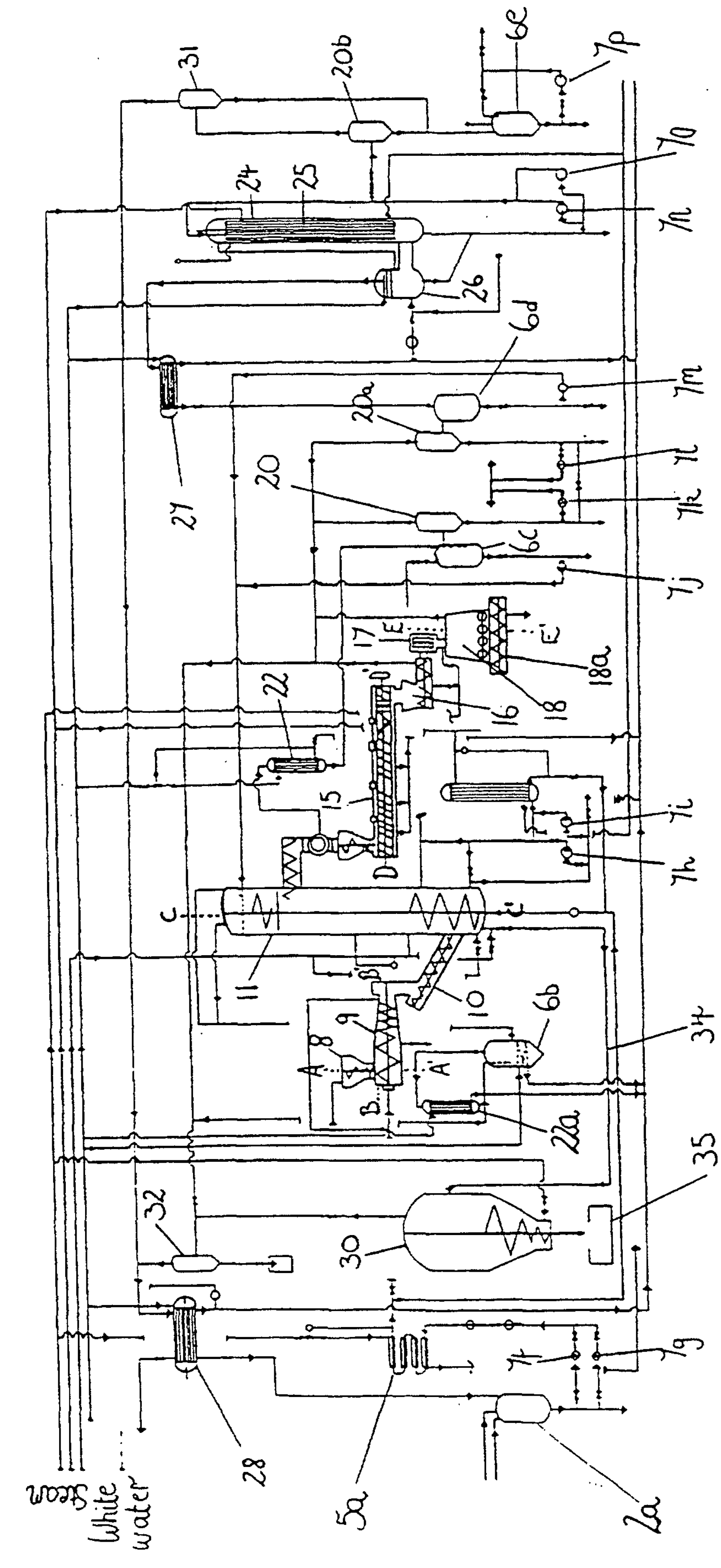


FIGURE 1

FIGURE 2


Steam
White water
2a
5a
28
32
30
35
34
22a
6b
9
10
11
15
16
17
18
18a
20
20a
20b
22
24
25
26
27
31
6c
6d
6e
7f
7g
7h
7i
7j
7k
7l
7m
7n
7o
7p
A
A'
B
B'
C
C'
D
E
E'

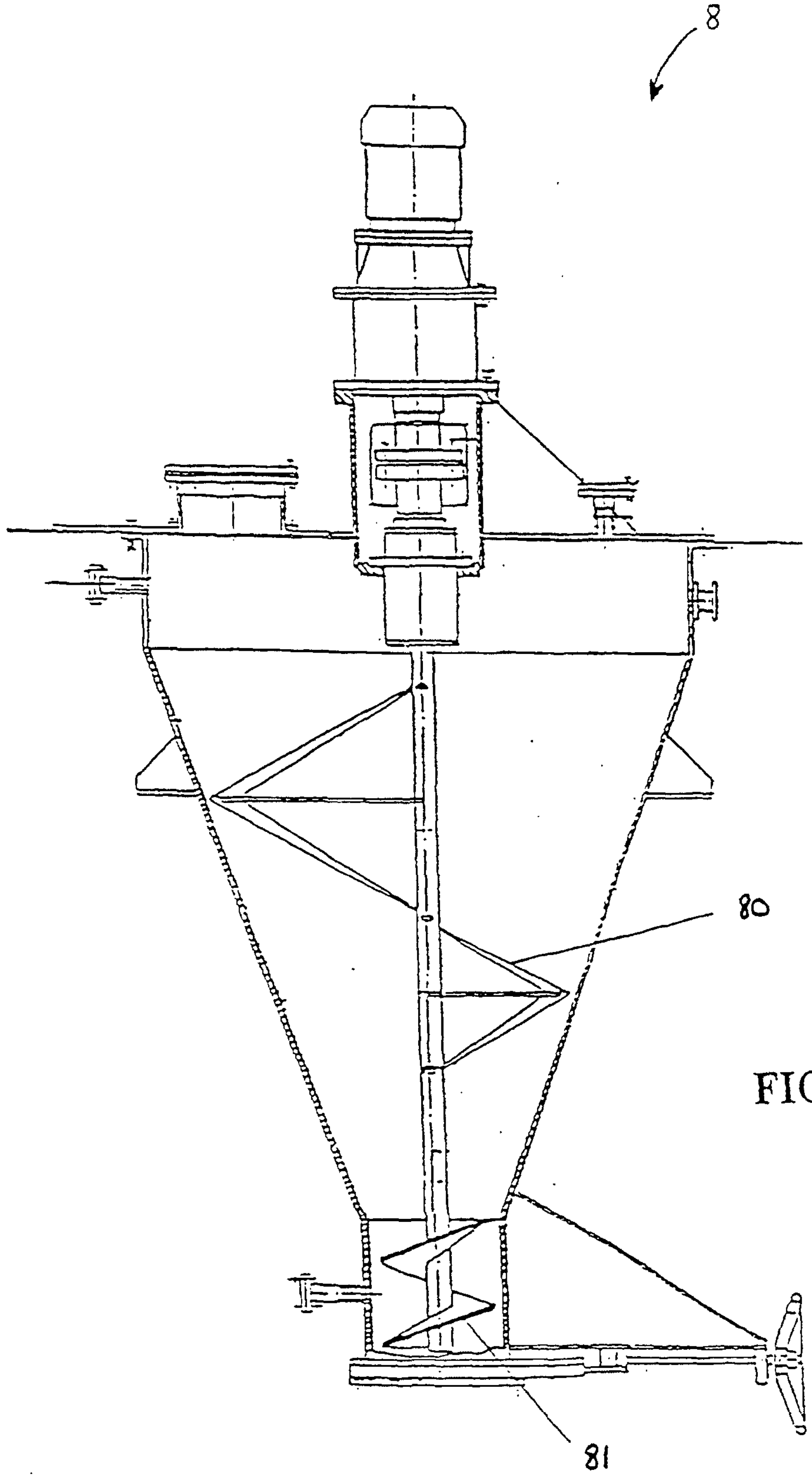


FIGURE 3

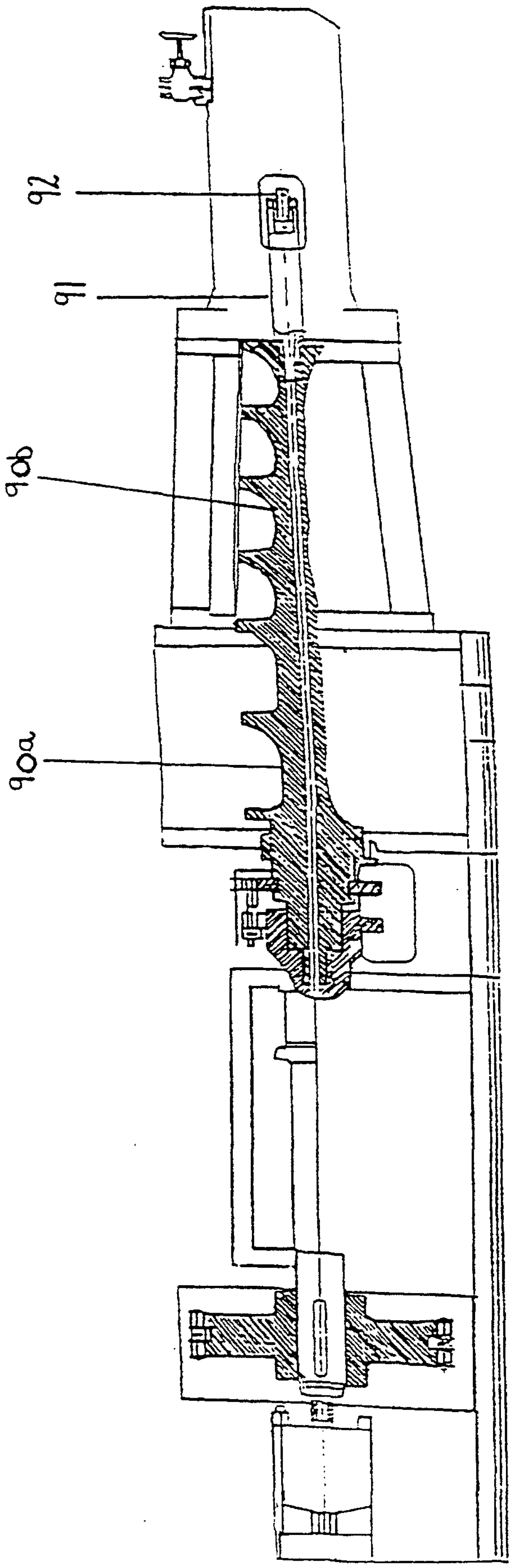


FIGURE 4

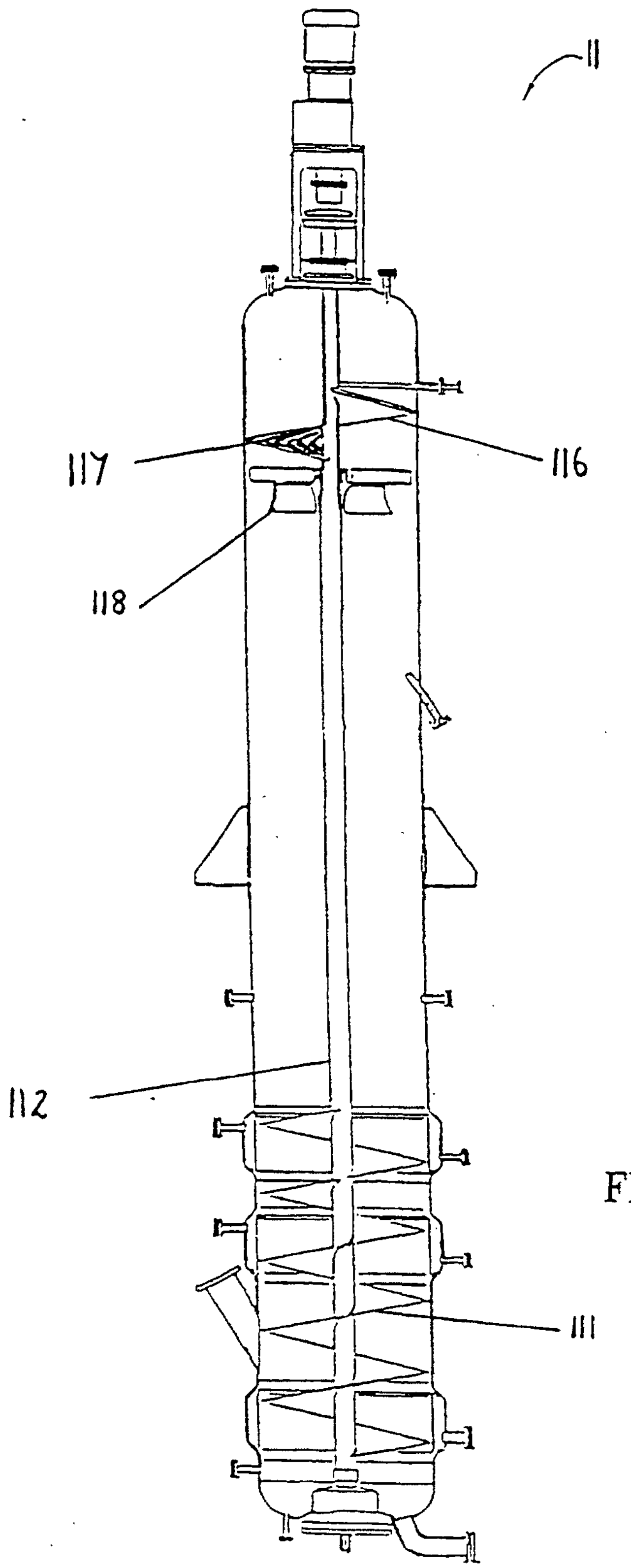


FIGURE 5

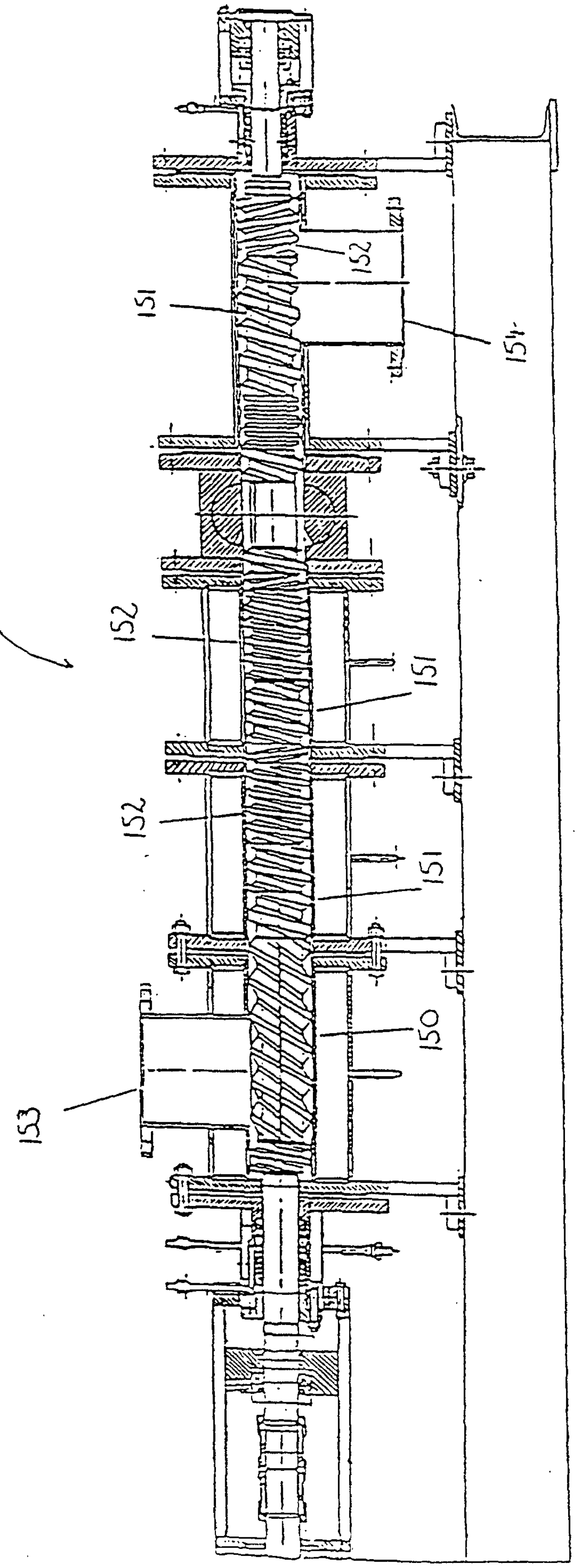


FIGURE 6

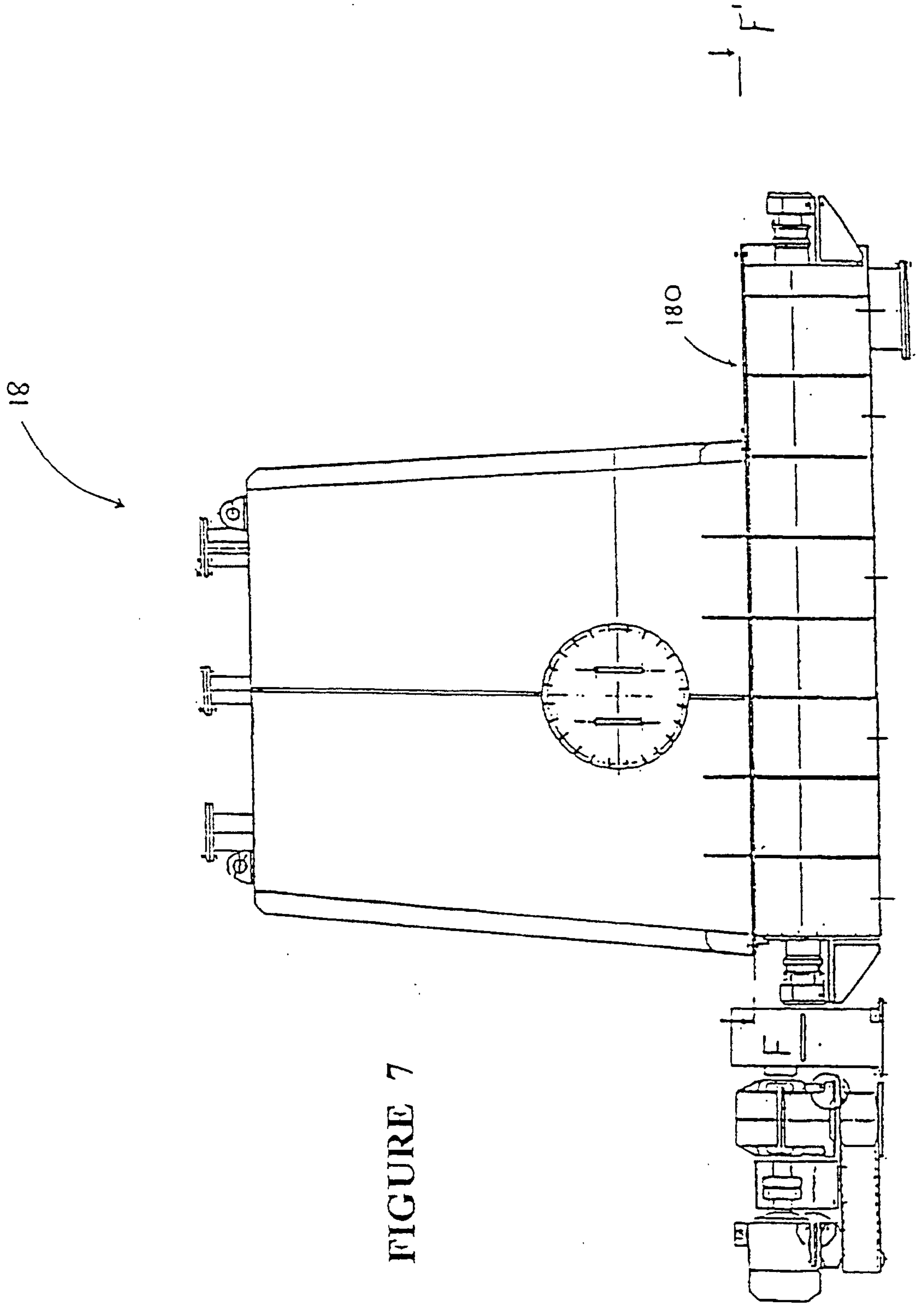


FIGURE 7

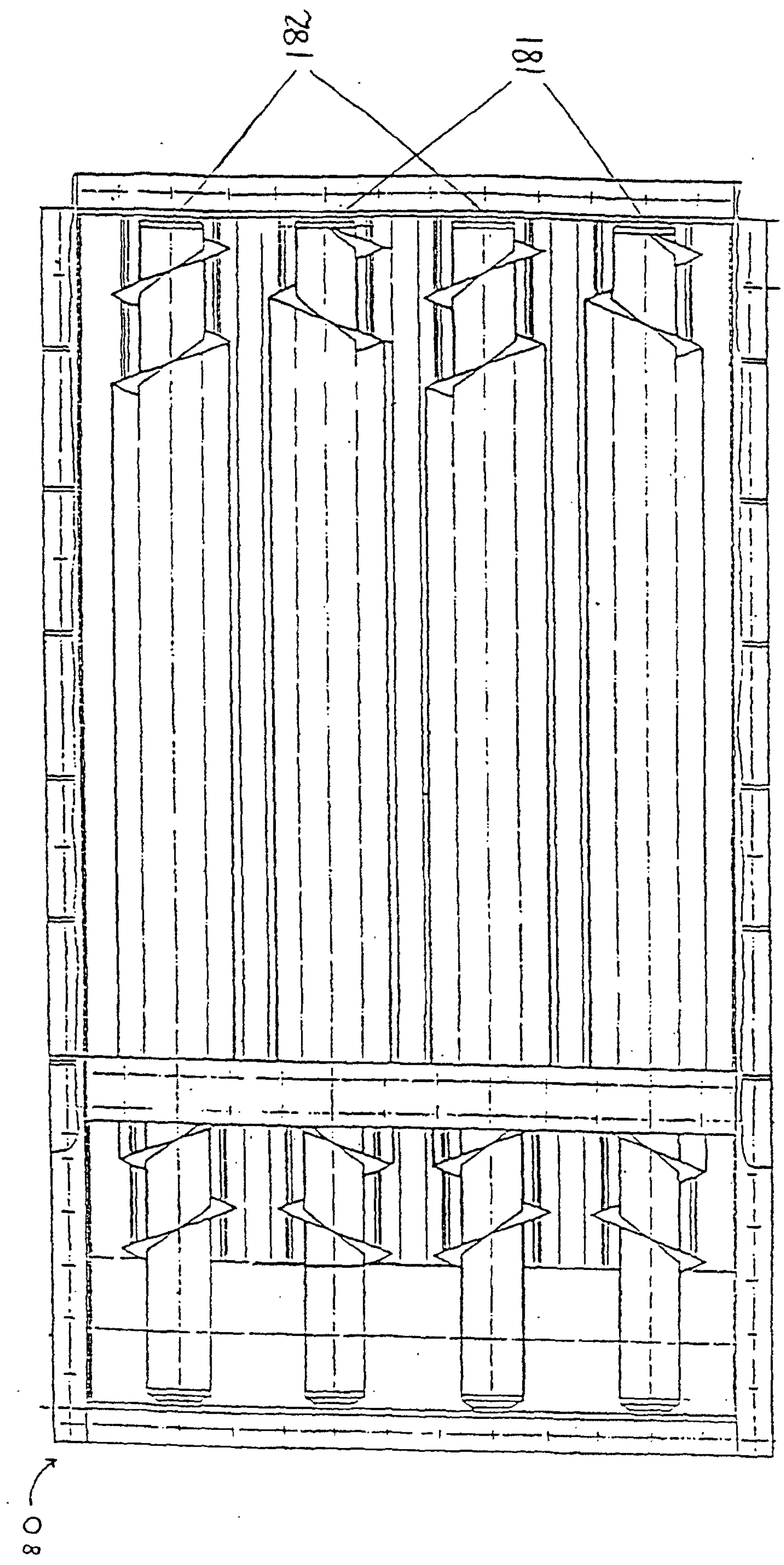


FIGURE 8