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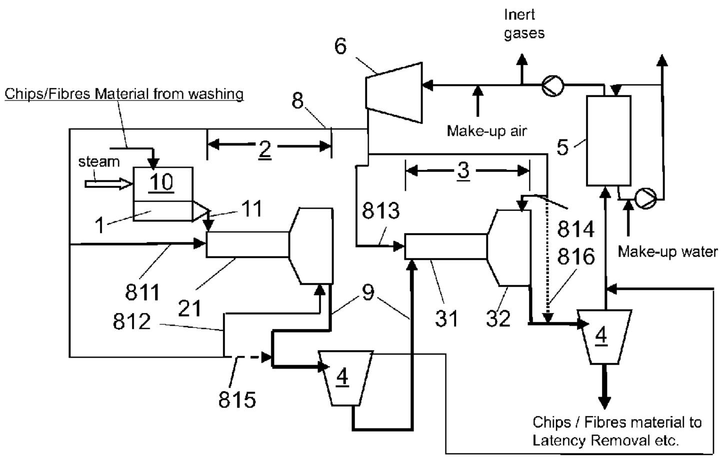

FIG.2

(57) Abstract: Method, system and refiner for refining of wood chips or pulp fibers are provided. The refining takes place in at least two subsequent refining stages (2, 3), through which the wood chips or pulp fibers are fed by a carrier medium, whereby an actual refining takes place in a plate gap, which is between a stator unit (221) and a rotor unit (222) or between two rotor units of a refiner (22, 32), which stator unit (221) and the rotor unit (222) comprise refiner segments. According to the invention, a gaseous carrier medium or steam-like carrier medium is utilized in the subsequent stages for feeding the mixture of the carrier medium and chips/fibers in the refining process, and that the fibers and the gaseous or steam-like carrier medium are fed separately into the refiner (22, 32) by a feeder means (21, 31).

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Method, system and refiner for refining of wood chips or pulp fibers

The present invention relates to a refining of wood chips of pulp fibres. More precisely the present invention relates to a method for refining of wood chips or pulp fibres according to the preamble of the independent claim 1 and to a system for refining of wood chips or pulp fibres according to the preamble of the independent claim 12. Further the present invention relates to a refiner for refining of wood chips or pulp fibres according to the preamble of the independent claim 24.

In the context of the present invention, the refining process takes place, in general, in at least two subsequent refining stages, through which the wood chips or pulp fibres are pass by means of a carrier medium, whereby an actual refining takes place in a plate gap, which is between a stator-rotor unit or between two rotor units of a refiner, which stator-rotor unit or rotor units comprise refiner segments. However, the refiner according to the present invention is applicable also in a single stage refining process.

The first step to an improved refining provided with heat recovery was a pressurization of the refiners; the first one was done at Kaipola Mills, in pilot scale 1976. This improvement was soon accepted, and 1977 a new TMP plant was supplied and started at Kaipola Mills (United Paper Mills). The TMP plant with a capacity of 300 T/d was provided with a pressurized first stage and with a non-pressurized second stage. After the good experiences at Kaipola Mills, the heat recovery as clean steam for the paper machine became a standard concept for TMP plants today.

Typically an actual refining takes place in a plate gap between a stator unit of a refiner and a rotor unit of a refiner or between two rotor units of a refiner, where both the stator unit and the rotor comprise refiner segments having different geometric designs for causing specific impact on flow phenomena, and on Specific Energy Consumption (SEC) and on pulp properties and on distribution of woods chips or pulp fibres.

A typical refining process is a thermomechanical refining process, in other words the TMP process, or a chemitermomechanical refining process, in other words the CTMP process, whereby the multi-stage refining process takes place in one, two or three refining stages in a TMP or in a CTMP main line. Refiners can be Single Disk (SD), Double Disk (DD), Conical Disk (CD) or Twin-refiners. Actual refining takes place in a plate gap, which is between a stator of the refiner and a rotor of the refiner or between two rotors of the refiner, whereby the rotor/-s may rotate typically between 1500 rpm and 1800 rpm. Both the stator unit and the rotor, which are preferably made of special alloy, comprise refiner segments having different geometric designs for causing specific impact on flow phenomena and on Specific Energy Consumption (SEC) and on pulp properties and on distribution of woods chips or pulp fibres.

Carrier medium fed into the refiner for carrying preheated chips in the process is typically water or another fluid. Refiner segments have different geometric design that will have a specific impact on mass and steam flow phenomena, and to SEC, pulp fibre distribution and pulp properties.

The “TAPPI” publication carrying the title “MEASURED MASS AND HEAT BALANCE OF THE TANDEM TMP LINE” made by Esa Viljakainen, Finland by Roland Pehrsson, Finland by Timo Sopanen, Finland and by Markku Perkola, Finland, is disclosed to present basics of designing TMP refining line. In general, this publication presents the total balances of the TMP refining line at Jämsänkoski TMP-plant. The results and calculations are based on measurements using conventional flow, pressure and temperature indicators and the process control system of the TMP plant. The TMP plant having five refiner lines (SD-60, 6.5 MW) was started in 1981 with the capacity of 575 t/d. Sixth refiner line was added in 1984. The TMP plant produces either dithionite or peroxide bleached TMP either for PM4 and/or PM5. In 1985, PM4 produced different coated wood-containing offset papers and PM5 produced SC-magazine papers. The heat recovery comprised a lamella heat exchanger for converting dirty high pressure steam into clean steam and a heat exchanger for heating mill water with the dirty low pressure steam. The recovered clean steam was used in the PM5. A portion of 50% to 60% of total steam demand was recovered by the TMP steam. The heat from low pressure heat recovery was used for heating the feed water of an auxiliary power station.

Different options for the TMP heat recovery are considered. The heat recovery for paper machine could be increased up to 70% of total refining energy. The basic concept of the TMP recovery was based on the fact that approximately 70% of the waste heat of the main line refiners can be recovered as clean steam for the paper machine. In practice, this has been verified in many installations. However, when more efficient heat recovery is needed, we should also know more exactly the heat losses and the heat balance of a TMP plant.

In this case of TMP plant disclosed by the “TAPPI” publication, several process values were obtained through the process control/information system (Honeywell TDC-2000). The flow measurements were made by using venture tubes, rotameters and orifice meters. Some difficulties occurred specially in measurements of process steam flows, because of the liquid condensate drops carried by the steam. Also the flow measurements of the fibre flow between the refiners failed due to the venture tube measurement failure. The production rate was correlated to the rotation speed of the pre-heaters feed screw. The pressure values were obtained through the monitor system, if needed. Temperatures were measured using thermocouples and thermometers. The consistencies of different fibre flows were calculated by separate samples and laboratory tests. The temperatures of dilution water (for cyclone sprays and refiner dilution) both white water were 61 °C. The average production rate during the tests 102 ± 2 t/d and the energy values for the SEC of the main line refiners and Canadian Standard Freeness level (CSF) during the three trial days were: SEC 2045 kWh/t and CSF 105 ml, respectively.

The US patent 7300540 discloses a system and a method for a TMP refining process of wood chips. According to the teaches of this publication, the chips for refining are provided by exposing the same to an environment of steam to soften the chips, compressively destructuring and dewatering the softened chips to a solids consistency above 55%, and diluting the destructed and dewatered chips to a consistency in the range of about 30% to 55%. The material is defibrated partially by the destructuring. This diluted material is fed to a rotating disc primary refiner wherein each of the opposed discs has an inner ring pattern of bars and grooves and an outer ring pattern of bars and grooves. The partially defibrated chips are defibrated essentially completely by the destructuring in the inner ring and the resulting fibres are fibrillated in the outer ring. The compressive destructuring, dewatering, and dilution can all be implemented in one integrated piece of equipment immediately upstream of the primary refiner, and the fiberizing and fibrillating are both achieved between only one set of relatively rotating discs in the primary refiner.

The US patent 6458245 discloses a CTMP refining process of wood chips. An absorbent, chemitermomechanical pulp produced from lignocellulosic material with a wood yield above 88%, a low resin content below 0,15% long fibre content above 70%, a short fibre content below 10% and shive content below 3 is provided according to the teaches of this publication. The method for producing the pulp comprises the steps of impregnating, preheating, defibering, and washing the material. The impregnation and preheating of the chips are effected in one and the same vessel over a combined time period of at most 2 minutes, particularly at most 1 minute, preferably at most 0.5 minutes; using a warm impregnating liquid having a temperature of at least 100°C., suitably at least 130°C, and preferably having essentially the same temperature as in the preheating process; and preheating the chips at a temperature between 150°C and 175°C., preferably between 160°C and 170°C. Defibering is carried out with an energy input which is at most half of the energy input required for defibering when the preheating and defibering are carried out at 135°C.

High electrical energy consumption (SEC) in mechanical pulping has been considered to be a serious disadvantage and problem for all mechanical pulping processes, like TMP and CTMP refining process, particularly in case of Softwood (SW) species. However, the increasing raw material and capital costs favour a mechanical pulp manufacture compared to a chemical pulp manufacture. Especially the TMP process and the CMTP process are becoming more and more popular, because of their good fibre properties and partly because of the high value of the recovered steam.

Due to a high turbulence, the energy efficiency is pretty low, it is estimated by different sources that less than 5 % of the primary energy goes into actual fibre processing. The rest energy goes into dilution water evaporation and into friction and other losses.

The main reasons for high SEC is the "blow-back steam" that flows backwards from the plate gap against the chip/pulp in-feed thus creating a lot of "useless" turbulence and mixing work. This blow-back steam is caused by evaporation of dilution water in the refining zone. Some studies (Esko Härkönen, JAMA-project 1992-1999) claim that 50% of total energy is consumed in this "mixing/feed" zone and only 50% in an actual refining zone. Some other studies (Hans-Olof Backlund, Lic Thesis) claim that 85 % is consumed in the refining zone.

The refining process according to the prior art involves, in addition, regardless of the carrier medium to the weakness that the wood chips or fibres carried by the carrier medium tend to layer and accumulate onto the inner wall of the refiner housing and to clog or block the outlet or exit of refiner. There is a reason to assume that the narrow flow ducts or passes for the mixture of carrier medium and wood chips or fibres through the refiner causes compaction of the carrier medium, which causes that the carried wood chips or the fibres moisturize and as a result of this will layer and accumulate onto the walls of the refiner housing as well as will block or clog the outlet or exit of refiner

A primary object of the present invention is to eliminate or at least essentially to decrease problems and disadvantages of the prior art. According to an aspect of the present invention, a second object of the present invention is to provide a new and inventive method for refining of wood chips of fibres. According to a second aspect of the present invention, a third object of the present invention is to provide a new and inventive system for refining of wood chips or fibres. According to a third aspect of the present invention, a fourth object of the present invention is to eliminate or to decrease a “blow-back steam” phenomena that is caused of the evaporation of water used as the carrier medium in the refining process according to the prior art. According to a fourth aspect of the present invention, a fifth object of the present invention is to decrease the high SEC of the refining process according to the prior art. According to a fifth aspect of the present invention, a sixth object of the present invention is to certify that that the interior of a refiner and especially the exit zone or area remain clean and unclogged.

In general, the objects of the present invention can be achieved by the method, the essential features of which are defined in the characterizing part of the independent claim 1. The additional and essential features of the method according to the present invention are defined in the depending claims 2 to 11.

In general, the objects of the present invention can also be achieved by the system, the essential features of which are defined in characterizing part of the independent claim 12. The additional and essential features of the system according to the present invention are defined in the depending claims 13 to 23.

In general, the objects of the present invention can also be achieved by the refiner, the essential features of which are defined in characterizing part of the independent claim 24. The additional and essential features of the refiner according to the present invention are defined in the depending claims 25 to 29.

The present invention is hence based on the basic idea that no dilution fluid or water is used, but the dilution fluid is replaced by gaseous carrier medium or by a steam-like medium in the refining process, which can be a multi-stage, or a single-stage TMP refining process or a multi-stage or a single-stage CTMP refining process. According to the present invention water steam is used as the steam-like carrier medium, and pressure air (or mixture of air and steam) is utilized as the gaseous carrier medium. Preferably a divided carrier medium supply to the input side and to the output side of the refiner is utilized.

According to a preferred embodiment of the present invention, supply of the steam-like/gaseous carrier medium is divided into at least two parts, preferably a first part of the steam/gas is fed into the refiner before the stator-rotor unit or rotor units, i.e. to the input side, and a second part of the steam/gas is fed into the refiner after the stator-rotor unit or rotor units, i.e. to the output side. At the output side of the refiner, steam/gas can be fed to an outer circumference of the refiner housing, especially to an exit area of the refiner to prevent stagnant areas where refined pulp could accumulate and plug refiner. At the output side of the refiner, steam/gas can be fed into a blowing pipe (flow pipe) that joins successive refiners. At the input side of the refiner, steam/gas can be fed into a supply pipe (inlet pipe) of the refiner. At the input side of the refiner, steam/gas can be fed into a crush zone in the housing of the refiner before the stator-rotor unit or rotor units.

According to an additional embodiment the supply of the steam like/gaseous carrier medium can be divided into three parts, whereby a first part of the steam/gas is fed into the refiner before the stator-rotor unit or rotor units, i.e. to the input side, and a second part of the steam/gas is fed into the refiner after the stator-rotor unit or rotor units, i.e. to the output side, and a third part of the steam/gas is fed into a supply pipe or into an inlet pipe of the refiner at the input side of the refiner.

As benefits of the present invention, one can state as follows. Evaporation of refiner dilution water is avoided. Primary electric energy consumed in dilution water evaporation is minimized or even eliminated. SEC could be reduced to a level of 25% in relation to the level of the prior art (at least in theory), whereby energy savings potential would be even 75% (in SW TMP). High refining consistency (part of chip/wood containing water is evaporated), which would further improve the refining efficiency. The air flow through the refiners can be controlled by variable compressor speed; this will give new options for practical refiner control. Lower system temperature may increase pulp brightness after the main line refining. Bleaching agents, such as hydrogen peroxide, ozone, could be used in refiner bleaching that may cause some potential capital savings. Some extractives, for example pitch etc., could be oxidized , which makes extractives more soluble and easier to wash-out, which would give further potential for using e.g. pine as raw material in wood containing papers.

Concerning the benefits of the present invention, there is further reason to state as follows. In TMP or CTMP process there can be some effect on mechanical pulp quality, it is assumable that in SW TMP fibre length will probably be reduced but in HW CTMP there is no effect. Definitely there will be a big impact on over-all energy balance of the whole integrated mechanical pulp plant and mill, when less steam is produced in the heat recovery a corresponding amount of steam must be replaced somehow. This may improve bio-material or waste utilization as fuel for heat and power generation in the mill. Primary energy demand (MWh/t product) for market pulp, paper or board will be reduced.

The above mentioned characteristics and the other crucial features of the present invention are defined in the accompanying claims and the same further described in the following special part of the description.

The present invention is described in the following special part of the description by means of preferred embodiments thereof with reference to accompanying drawings, where:

FIG.1 presents a refining process according to the prior art, where the carrier medium is water,

FIG.2 presents the refining process according to a first embodiment of the present invention, when pressure air is utilized as the carrier medium in the refining process,

FIG.3 presents the refining process according to a second embodiment of the present invention, when steam is utilized as the carrier medium in the refining process,

FIG.4 presents one preferred feeder unit that could be used for feeding the mixture of the chips/fibres material and the gaseous/steam-like carrier medium into the refining stages of Figure FIG.2 or of Figure FIG.3,

FIG.5 presents another preferred feeder unit, in other words a modified feeder unit that could be used for feeding the mixture of the chips/fibres material and the gaseous/steam-like carrier medium into the refining stages of Figure FIG.2 or of Figure FIG.3, and

FIG.6 presents an embodiment with divided carrier medium supply for a refiner.

For better understanding the basic idea of the present invention, reference is made to Figure FIG.1, which discloses the TMP refining line at Jämsänkoski Mills, according to the prior art. The TMP line comprises a pre-heating unit 10 and a first refiner 22 and a steam separator cyclone 23 and a second refiner 32 and a separator means, like a strip cyclone 7 and an outflow pipework and a reception container 12 for receiving the separated chip/pulp material from the strip cyclone 7. For the sake of simplicity, the feeder unit preceding a refining stage is referred in the following by the definition PeriFeeder that is the commercial trade name for a feeder unit preceding the reefing stage.

Production of a refiner line according to Figure FIG.1 can be regulated by means of controlling rotational speed of the plug screw 1 feeding wood chips, which have heated by a pre-heating unit 10, in a mixture having a temperature of 70°C with water into the first refining stage 2. Refining degree (e.g. Canadian Standard Freeness, CSF) or power consumption of the first refining stages 2 and of the second refining stage 3 can be controlled by means of adjusting plate gaps of the refiners 22, 32. For maintaining a residence time in the plate gap to remain in milliseconds, the pulp is forced out from the plate gap of the refiners 22, 32 by means of dilution water and centrifugal forces. Dilution water is fed in a temperature of about 83°C both into the first refiner 22 and into the second refiner 32, and by means of steam formed in the refiners 22, 32. Power consumption level can also be changed by means of the dilution water and hence chip/pulp pad thickness in refining zone can be controlled, in order to get the pulp out from the refiner 22, 32 and to blow into a blow line 9 with a reasonable flow speed between 20-60 m/s.

According to the basic idea of the present invention, no water is used as a carrier medium of material to be refined in subsequent refining stages. When gaseous carrier medium, like pressure air, or steam like carrier medium, like water steam, or mixture of gas and steam, are applied for refining there is a reason to reconsider the management and adjustment. One may consider that the general control principles described above remain in force. When the carrier medium is the gaseous medium, like pressure air, or the steam-like carrier medium, like water steam, the flow of the gaseous medium or steam-like medium is, however, possible to control by controlling residence time of chips/pulp in the plate gap of the refiner 22, 32 or by controlling the flow speed in the blow line 9. Then it is preferred that gas or steam is fed to different locations in system, which are preferably the feeder line 81 of the first refining stage 2 and the feeder line 81 of the second refining stage 3 and the flow pipe 9. As simplified, an energy consumption in chip/pulp refining follows ”the number of refining impulses x the residence time”, Then residence time in the refiner 22, 32 is possible to control by means of the gas flow rate or of the steam rate. In other words, it is possible to maximize the system power consumption into deforming of chips and fibre bundles, "in principal", because no energy is consumed for dilution water evaporation.

The gas/steam flow is intended to be fed into a refining zone along refiner segment grooves of a blade segment. Then, in an ideal case, the mass passes in the plate gap of the refiner 22, 32 and the gas/steam flows in segment grooves of the refiner.

Reference is made to Figure FIG.2, where pressure air is utilized as the carrier medium. A first feeder unit 21, in other words the first PeriFeeder 21, which is arranged in connection with the first refining stage 2, receives via a first carrier medium feeder line 81 pressure air that used as the carrier medium and wood chips or the pulp fibres to be refined via chips/fibres feeder line 11. The first PeriFeeder 21 separates the wood chips or the pulp fibres and the pressure air from each other and the PeriFeeder feeds the pressure air and the chips/fibres separately into the first actual refiner 22. The mixture of the pressure air and the chips/fibres flow from the first refining stage 1 to a second refining stage 2 via the main flow line 9. A second feeder unit 31, in other words the second PeriFeeder, which is arranged in connection with the second refining stage 3, receives via the main line 9 the mixture of the pressure air and the chips/fibres and an additional input of pressure air that is also used as the carrier medium via a second carrier medium feeder line 82. The second PeriFeeder 31seprates the wood chips or the pulp fibres and the pressure air from each other and the second PeriFeeder feeds the pressure air and the chips/fibres separately into the second actual refiner 32. Further refiners (not disclosed in Figure FIG.2) can be arranged after the second refining stage 3.

When the chips/fibres material and the pressure air are fed separately into the actual refiner 22, 32 the same are fed into an actual breaking/feed zone thereof by the PeriFeeder 21, 31. In the actual refining zone centrifugal forces push the chips/fibres material into a refining gap of the refiner 22, 32, and the pressure air will move/flow forward in segment grooves of the refiner 22, 32.

In the process of Figure FIG.2 utilizing pressure air as the carrier medium, preheated wood chips or pulp fibres are fed through a plug screw 1 to a first PeriFeeder 21 and pressure air is fed to the first PeriFeeder 21. The feeding of the pressure air is implemented preferably by a compressor 6 that is most preferably a turbo-compressor that will increase the pressure of air to be circulated in the process. Thereafter the first refining of the mixture of pressure air and wood chips or pulp fibres take place in a first stage refiner 22. The mixture is then blown from the first refining stage 2 into a second refining stage 3 by comprising a second PeriFeeder 31. More pressure air, in case needed, is fed the second PeriFeeder 31. The feeding of the pressure air is implemented preferably by a compressor 6 that is most preferably a turbo-compressor that will increase the pressure of air to be circulated in the process. Then the mixture of pressure air and wood chips or pulp fibres is further refined in the second stage refiner 32. The mixture is then blown into an air separator 4, where air and chips/fibres material are separated. The chips/fibres material then goes to latency removal and further processing. The pressure air is fed into an air scrubber 5, where the air is cooled and cleaned from chips/fibre based fine material.

The scrubber is needed for maintaining the turbine compressor 6 clean. An excess heat from refining can be transferred into water that can be utilized later in the pulp and papermaking process.

Clarification of terms of the process of Figure FIG.2: Make-up water is fed into the circulation of heat recover HR means or of the air scrubber 5 and the same can be pulp mill or PM White water or fresh water; Inert gases are released from circulated gas flow line to the compressor 6. The inert gases are typically "terpenes", mainly turpentine, which should be removed from gas flow circulated to the turbine compressor 6. This flow is more like a bleed into turpentine recovery or into incineration;
Make-up air is fed into the circulated gas flow line to the compressor 6; obviously some amount of this kind of air is needed. The make-up air could also be composed of some inert gas like CO_2 or N_2.

One of the benefits using this kind of inert gas (air, air-steam mixture etc.) as carrier media is the fact that inert gas – steam mixture in typical refining conditions (temperature and pressure) is above the “gas-steam saturation point”. That is: condensing effect is less likely to happen during the pressurized refining process.

When the pressure air is utilized as the carrier medium, the crucial novelties are to use separate pressure air feeder line 81 and preheated chips/fibre material feeder line 11 in the feed of the first PeriFeeder 21 of the first refining stage 2 and to use a pressure air feeder line also in the feed of the second PeriFeeder 31 of the second refining stage 3 and to utilize the pressure air as "carrier" medium both in the first refining stage 2 and in the second stage refining 3. Then the pressure air and the PeriFeeders 21, 31 are utilized in the feeding of the wood chips or the pulp fibres into the subsequent first stage refiner 22 and the second stage refiner 32. Preferably, the PeriFeeder would be used to feed the chips/fibres and pressure air separately into the breaking/feed zone of the refiner 22, 32. In the actual refining zone centrifugal forces push fibre material into refining gap, and the pressure air will move/flow forward in segment grooves.

Reference is made to Figure FIG.3, where water steam is utilized as the steam-like carrier medium. A first PeriFeeder 21, which is normally used as a cyclone to separate wood chips or the pulp fibres and carrier medium from each other, is used in the feed of the first refining stage 2 and a second PeriFeeder 31 is used in the feed of the second refining stage 3. Preferably water steam is used as a steam-like carrier medium for carrying the mixture of the water steam and the wood chips or the pulp fibres into and through the subsequent refining stages 2, 3. The mixture of chips/fibres material and the water steam are preferably fed separately into the breaking/feed zone of the refiner 22, 32 by the PeriFeeder. In the actual refining zone centrifugal forces push fibre material into refining gap, and the water steam will move/flow forward in segment grooves.

In the process of Figure FIG.3, preheated wood chips or pulp fibres are fed through a plug screw to a first PeriFeeder 21 and water steam is fed to the first PeriFeeder. Thereafter the first refining of the mixture of the water steam air and the wood chips or the pulp fibres takes place in a first stage refiner 22. The mixture is then blown from the first refining stage 2 into a second refining stage 3 that comprises a second PeriFeeder 31. In case needed, more water steam is fed to the second PeriFeeder. Then the mixture of the water steam and the wood chips or the pulp fibres is further refined in the second stage refiner 32. The mixture is then blown into a steam separator 4, where the water steam and chips/fibres material are separated from each other. The chips/fibres material then goes to latency removal and further processing. The water steam is circulated 911 back to at least into the first PeriFeeder of the first reefing stage and optionally, if needed, water steam is circulated 912, 913 also into the second PeriFeeder of the second refining stage. An excess heat from refining can be transferred in a heat recovery unit into water that can be utilized later in the pulp and papermaking process.

The described processes of Figures FIG.2 and FIG.3 can be called each as a "pneumatic refining process" because of the steam-like carrier medium, like water steam, or gaseous carrier medium, like pressure air. Perhaps a pressure level can be set quite freely according to practical optimum conditions. Obviously, system temperature should be high enough for lignin softening, that is: between 90°C to 150°C. Circulated steam-like or gaseous medium may be a mixture of pressure air and water steam.

Reference is made to Figure FIG.4 that presents a PeriFeeder, which comprises separate feeder lines, which are a first feeder line 11, which is a circumferential feeder line for wood chips or pulp fibres, and a second feeder line 811, 911, which is a central feeder line for gaseous carrier medium, like pressure air, or steam-like medium, like water steam, and which PeriFeeder could be used for feeding the mixture of the chips/fibres material and the gaseous/steam-like carrier medium into each of the refining stage (see refining stages 2, 3 in Figures FIG.2 and FIG.3). The PeriFeeder 21, 31 further comprises a fixed mantle element 213 and a rotating spiral blade element 211 that is circumferentially apart from the core element 213. The rotating blade element 211 causes movement of the chips/fibres material inside a fixed mantle element 213 and around a central core element 212 towards the refiner 22, 32 that comprises concentric rotor 222 and stator 221 rotating in relation to each other for causing the actual refining. Refiner segments are connected to the rotor 222 and stator 221.

The PeriFeeder 21; 31 functions like a cyclone that separate wood chips or the pulp fibres fed into the PeriFeeder via the feeder line 11 and carrier medium fed into the PeriFeeder via the feeder line 811; 911 from each other, and the PeriFeeder is used in the feed of the refiners 22, 32 for feeding the carrier medium and chips/fibres material separately into the breaking/feed zone of the refiner 22, 32 by the PeriFeeder. In the actual refining zone centrifugal forces push chips/fibres material into refining gap and the carrier medium will move/flow forward in segment grooves.

Reference is made to Figure FIG.5 that presents a PeriFeeder, which comprises separate feeder lines, which are a first circumferential feeder line 11 for wood chips or pulp fibres and a second circumferential feeder line 811, 911 for gaseous carrier medium, like pressure air, or steam-like medium, like water steam, and which Peri-Feeder could be used for feeding the mixture of the chips/fibres material and the gaseous/steam-like carrier medium into each of the refining stage (see refining stages 2, 3 in Figures FIG.2 and FIG.3). The PeriFeeder 21, 31 further comprises a fixed mantle element 213 and a rotating spiral blade element 211 that is circumferentially apart from a central core element 212. The rotating blade element 211 causes movement of the chips/fibres material inside a fixed mantle element 213 and around the core element 213 towards the refiner 22, 32 that comprises concentric rotor 222 and stator 221 rotating in relation to each other for causing the actual refining.

The PeriFeeder 21; 31 functions like a cyclone that separate wood chips or the pulp fibres fed into the PeriFeeder via the feeder line 11 and carrier medium fed into the PeriFeeder via the feeder line 811; 911 from each other, and the PeriFeeder is used in the feed of the refiners 22, 32 for feeding the carrier medium and chips/fibres material separately into the breaking/feed zone of the refiner 22, 32 by the PeriFeeder. In the actual refining zone centrifugal forces push chips/fibres material into refining gap and the carrier medium will move/flow forward in segment grooves.

The crucial technical difference between the PeriFeeder 21; 31 of Figures FIG.1 and FIG.4 and the PeriFeeder 21; 31 of Figures FIG,2 and FIG.5 relates to the in-feed 811,911; 813,913 and to the flow of the gaseous carrier medium, like pressure air, or steam-like medium in the PeriFeeder 21 that precedes the actual refining stage 2, 3.

According to the PeriFeeder embodiment of Figure FIG.4, the in-feed of the gaseous/ steam-like carrier medium is arranged to take place centrally through an end of the mantle 211 of the PeriFeeder from the in-feed line 811 via a central core element 212, like a flow pipe, such that the gaseous/steam-like carrier medium discharges from the central core element just ahead the core area 223 of the refining unit 22. In the PeriFeeder 21, the central core element is surrounded by a spiral blade element 211, which is with a distance from the outer surface of the core element and which rotated with a speed between 1500-3000 r/min. Hence a consequence is that centrifugal force impacts to the material flow of the chips/fibres. The centrifugal force tends to separate material fractions from each other, such that a heavier material is forced into a blade space formed between opposing sides of the spiral blade element 211. The outer surface of the central core element 212 is provided with flow grooves for assisting flows of gaseous/steam-like material, which is forced into the PeriFeeder 21 from the chips/fibres from washing, towards the centre of the refining unit 22. The disadvantage of the prior art solution, when the carrier medium is water, is the formation of the blow-back steam that causes an opposing directed steam flow in the PeriFeeder, which disturbs essentially the whole control of the refining process.

According to the PeriFeeder embodiment of Figures FIG.5, the in-feed of the gaseous/steam-like carrier medium is arranged to take place circumferentially through the mantle 213 of the PeriFeeder 211 from the in-feed line 811 and outside a central core element 212, like a flow pipe, such that the gaseous/steam-like carrier medium discharges from the outer surface of the central core element to a core area 223 of the refining unit 22. In the PeriFeeder 21, the central core element is surrounded by a spiral blade element 211, which is with a distance from the outer surface of the core element and which rotated with a speed between 1500-3000 r/min. Hence a consequence is that centrifugal force impacts significantly to the material flow of the chips/fibres. Depending of a specific weight of the carrier medium the same centrifugal force may impact also to the gaseous/steam-like carrier medium. The centrifugal force tends to separate different material, such that a heavier material is forced into a blade space formed between opposing sides of the spiral blade element 211. The outer surface of the central core element 212 is provided with flow grooves for assisting flows of gaseous/steam-like material, which is forced into the PeriFeeder 21 via the circumferential in-feed 811, 911, towards the centre of the refining unit 22. The disadvantage of the prior art solution, when the carrier medium is water, is the formation of the blow-back steam that causes an opposing directed steam flow in the PeriFeeder, which disturbs essentially the whole control of the refining process.

In the embodiments of Figures FIG1/FIG.4 and FIG.2/FIG5, the heavier chips/fibre material flows outside the central core element 212 in the spiral-type blade space of the spiral blade element 211, and the same flows as a turbulent ring flow to the core area 223 of the refining unit 22 and outside the discharge area of the gaseous/steam-like carrier medium flow, which may flow thereto from inside the central core element 212 or along and outside the central core element 212. Soon after the gaseous/steam-like carrier medium has been discharged the same is mixed with the chips/fibre material flow. In the actual refining stage 2, 3 the different material are flown as mixed, while the material fractions are also separated such that the heavier chips/fibre containing material discharged from lower parts of the refining unit 22 to a separate blow line 9 to an air separator 4 or to a steam scrubber 4 and such the lighter material fraction both gaseous/steam-like material is discharged from upper parts of the refining unit:. Each blow pipe 9 joining subsequent refining stages 2, 3 is preferably provided with an in-feed 912, 914 line foe keeping the lines open while the refining process is going on.

In order to emphasize the improved SEC that can be achieved by the process, where the carrier medium is gaseous medium, like pressure air, or steam-like medium, like water steam, reference is made again to Figures

- FIG.1 presenting a refining process according to the prior, where the carrier medium is water. The measured material flows and energy balances for a TMP process according to the prior art,
- FIG.2, where the gaseous carrier medium is pressure air, and
- FIG.3, where the steam-like carrier medium is water steam,

and the material flows and energy balances are compared with each other.

In the case of Figure FIG.1, the material flows are as follows:

IN:		**OUT:**	
Pulp:	1.00 t/bdt (48 %)	Pulp:	1.00 t/bdt (36 %)
Water:	1.08 t/bdt	Water:	1.77 t/bdt
Dilution water:	2.82 t/bdt	Steam	2.24 t/bdt
Sealing water:	0.40 t/bdt	Sealing water:	0.29 t/bdt
Total:	5.30 t/bdt	Total:	5.30 t/bdt

Whereby 0.11 t/bdt of sealing water goes into process and TMP steam (134 °C, 310 kPa) goes with volumetric flow of rate of 1350 m^3/bdt to heat recovery.

In the case of Figure FIG.1, the energy balance is as follows:

IN:	**OUT:**
Pulp: 1.00 x 70 x 1.3 = 91.0 MJ/bdt	Pulp: 1.00 x 134 x 1.3 = 174.2 MJ/bdt
Water: 1.08 x 70 x 4.2 = 317.5 MJ/bdt	Water: 1.77 x 134 x 4.2 = 996.2 MJ/bdt
Dil. water: 2.82 x 83 x 4.2 = 983.1 MJ/bdt	Steam: 2.24 x 2725 =6104.0 MJ/bdt
Seal. water: 0.40 x 37 x 4.2 = 62.2 MJ/bdt	Ref./Defibration: 0.054 x 3600 = 194.6 MJ/bdt
1 & 2 SEC: 1.859 x 3600 = 6692.7 MJ/bdt	Other losses: 0.188 x 3600 = 677.5 MJ/bdt

Total: 8146.5 MJ/bdt	Total: 8146.5 MJ/bdt

The balance discloses that approx. 74 % of SEC is consumed in steam generation.

In the case of Figure FIG.2, where carrier medium is water steam, the material flows are as follows:

IN:		**OUT:**	
Pulp:	1.00 t/bdt (48 %)	Pulp:	1.00 t/bdt (65 %)
Water:	1.08 t/bdt	Water:	0.54 t/bdt
"Carrier steam":	1.59 t/bdt	Steam:	2.24 t/bdt
Sealing water:	0.40 t/bdt	Sealing water:	0.29 t/bdt
Total:	4.07 t/bdt	Total:	4.07 t/bdt

It is assumed that "Primary SEC" is consumed only to evaporation of "chip bounded water". The steam volumetric flow rate to heat recovery is 1350 m^3/bdt (as in the prior art case).

In the case of Figure FIG.2, the energy balance is as follows:

IN:	**OUT:**
Pulp: 1.00 x 70 x 1.3 = 91.0 MJ/bdt	Pulp: 1.00 x 134 x 1.3 = 174.2 MJ/bdt
Water: 1.08 x 70 x 4.2 = 317.5 MJ/bdt	Water: 0.54 x 134 x 4.2 = 303.9 MJ/bdt
“Carrier steam”: 1.59 x 2725 = 4332.8 MJ/bdt	Steam: 2.24 x 2725 = 6104.0 MJ/bdt
Seal. water: 0.40 x 37 x 4.2 = 62.2 MJ/bdt	Ref./Def: 0.054 x 3600 = 194,6 MJ/bdt
1 & 2 SEC: 0.736 x 3600 = 2650.7 MJ/bdt	Other losses: 0.188 x 3600 = 677.5 MJ/bdt
Total: 7454.2 MJ/bdt	Total: 7454.2 MJ/bdt

When considering calculations above relating to cases of Figures Fig.1 and Fig.2, the energy balance calculations disclose a 60 % reduction in SEC when carrier medium is water steam instead of dilution water to be evaporated to generate necessary amount of steam (in the reference case).

In the case of Figure FIG.3, where carrier medium is pressure, the material flows are as follows:

IN:		OUT:	
Pulp:	1.00 t/bdt (48 %)	Pulp:	1.00 t/bdt (65 %)
Water:	1.08 t/bdt	Water:	0.54 t/bdt
"Carrier air":	1.59 t/bdt	"Carrier air":	1.59 t/bdt
		Steam:	0.65 t/bdt
Sealing water:	0.40 t/bdt	Sealing water:	0.29 t/bdt
Total	4.07 t/bdt	Total	4.07 t/bdt

The volumetric flow rate of discharge gas flow is estimated to be 1586 m^3/bdt.

In the case of Figure FIG.3, the energy balance is as follows:

IN:	OUT:
Pulp: 1.00 x 70 x 1.3 = 91.0 MJ/bdt	Pulp: 1.00 x 134 x 1.3 =174.2 MJ/bdt
Water: 1.08 x 70 x 4.2 = 317,5 MJ/bdt	Water: 0.54 x 134 x 4,2 = 303.9 MJ/bdt
Carrier air: 1.59 x 134 x 1 = 213.1 MJ/bdt	Carrier air: 1.59 x 134 x 1= 213.1 MJ/bdt
Seal. water: 0.40 x 37 x 4.2 = 62.2 MJ/bdt	Steam: 0.65 x 2725 = 1771.3 MJ/bdt
1 & 2 SEC: 0.736 x 3600 = 2650.8 MJ/bdt	Ref./Defibration: 0.054 x 3600 = 194.6 MJ/bdt
	Other losses: 0.188 x 3600 = 677.5 MJ/bdt
Total: 3334.6 MJ/bdt	Total: 3334.6 MJ/bdt

When considering calculations above relating to cases of Figures Fig.1 and Fig.2, the energy balance calculations disclose a 60 % reduction in SEC when carrier medium is pressure air instead of dilution water to be evaporated to generate necessary amount of steam (in the reference case).

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When considering calculations above which relate to cases of Figures Fig.2 and Fig.3, there is basically no difference in using "steam or air" as carrier media. The energy balance calculations disclose a 60 % reduction in SEC, when carrier medium is water steam or pressure air instead of water. Further it is notable that choose of the

“Carrier medium will not affect the basic material & energy balance. Still, approximately 60 % of primary SEC is consumed in water evaporation.

The present invention is described above only by means of preferred embodiments thereof, and several modifications as well as alternatives and functionally equivalent solutions can be applied within the scope of protection defined by the accompanying claims and within frames of basic idea of the present invention.

Claims

1. Method for refining of wood chips or pulp fibers, which method takes place in at least two subsequent refining stages (2, 3), through which the wood chips or pulp fibers are fed by a carrier medium, whereby an actual refining takes place in a plate gap, which is between a stator-rotor unit (221, 222) or between two rotor units of a refiner (22, 32), which stator-rotor unit comprise refiner segments, **characterized** in, that a gaseous carrier medium or steam-like carrier medium is used in the subsequent refiner stages (2, 3) for feeding the mixture of the carrier medium and chips/fibers in the refining process, and that the chips/fibers and the gaseous or steam-like carrier medium are fed separately into the refiner (22, 32) by a feeder means (21, 31).

2. Method according to the claim 1, **characterized** in, that a gaseous carrier medium or steam-like carrier medium is utilized in the subsequent stages for feeding the mixture of the carrier medium and chips/fibers in the refining process, and that the fibers and the gaseous or steam-like carrier medium are fed separately into the refiner (22, 32) by a mechanical separator used as the feeder means (21, 31).

3. Method according to the claim 1 and/or 2, **characterized** in, that gaseous carrier medium or steam-like carrier medium is utilized in the subsequent stages for feeding the mixture of the carrier medium and chips/fibers in the refining process, and that the mechanical separator (21, 31), of the chips or the fibers and the gaseous or steam-like carrier medium, such as a PeriFeeder, is used to feed the chips/fibers and the gaseous or steam-like carrier medium separately into a refiner (22, 32).

4. Method according to claim 1, **characterized** in, that the gaseous carrier medium or steam-like carrier medium is utilized in the subsequent refining stages of the refining process, which is preferably a TMP or a CTMP refining process, for carrying the mixture of the carrier medium and chips or the fibers in and between the subsequent refining stages, and that a feeder means, preferably a mechanical separator (21, 31) of the chips or the fibers and the gaseous or steam-like carrier medium, such as a PeriFeeder, is used to feed the chips or the fibers and the gaseous or steam-like carrier medium separately into a refiner (22, 32).

5. Method according to any of the preceding claims 1 to 4, **characterized** in, that the supply of the steam-like/gaseous carrier medium is divided into at least two parts, whereby one part (811, 813; 911, 913) of the steam/gas is fed into the refiner (22, 32) before the stator-rotor unit (221, 222) or rotor units, i.e. to the input side, and a second part (812, 814, 815, 816; 912, 914) of the steam/gas is fed into the refiner (22, 32) after the stator-rotor unit (221, 222) or rotor units, i.e. to the output side.

6. Method according to Claim 5, **characterized** in, that the steam/gas is fed by a first supply line (812, 814; 912, 914) of the said second part of the steam/gas supply through an outer wall of the refiner housing, most preferably to an exit area of the refiner (22, 32) at the output side of the refiner.

7. Method according to Claim 6, **characterized** in, that the steam/gas is fed by a second supply line (815, 816) into a blowing pipe (9) or into a flow pipe that joins successive refiners (22, 32) at the output side of the refiner.

8. Method according to any of the claims 1 to 4, **characterized** in, that the steam/gas is fed into a supply line (811, 813; 911, 913) or into an inlet pipe of the refiner (22, 32) at the input side of the refiner.

9. Method according to claim 8, **characterized** in, that the steam/gas is fed into a breaking zone, which is inside the housing of the refiner, at the input side of the refiner (22, 32) and precedes the stator-rotor unit (221, 222) or rotor units.

10. Method according to any of the preceding claims 1 to 9, **characterized** in, that pressure air, or mixture of air and steam, is used as the gaseous carrier medium.

11. System according to any of the preceding claims 1 to 9, **characterized** in, that water steam is used as the steam-like carrier medium.

12. System for refining of wood chips or pulp fibers, which system comprises at least two subsequent refining stages (2, 3), through which the wood chips or pulp fibers pass by means of a carrier medium, whereby an actual refining takes place in a plate gap, which is between a stator-rotor unit (221, 222) or between two rotor units of a refiner (22, 32), which stator-rotor unit comprise refiner segments, **characterized** in,

that the carrier medium is a gaseous carrier medium or steam-like carrier medium for feeding the mixture of the carrier medium and chips/fibers in the refining process, and that a feeder means (21, 31), is arranged to feed the chips/fibers and the gaseous or steam-like carrier medium separately into the refiner (22, 32).

13. System according to claim 12, **characterized** in, that the feeder means is a mechanical separator is arranged to feed the chips or the fibers and the gaseous or steam-like carrier medium separately into the refiner (22, 32).

14. System according to claim 12 and/or 13, **characterized** in, that, characterized in, that carrier medium is composed of gaseous carrier medium or steam-like carrier medium for feeding the mixture of the carrier medium and wood chips or the pulp fibres in the refining process, and that each of the subsequent refining stages comprises a feeder unit that is a mechanical separator of the chips or the fibers and the gaseous carrier medium or the steam-like carrier medium, i.e. a PeriFeeder, which feeds the chips or the fibers and the gaseous or steam-like carrier medium separately into a breaking or feed zone of a refiner in each refining stage.

15. System according to any of the preceding claims 12 to 14, **characterized** in, that the refining process is preferably a thermo mechanical (TMP) or a chemitermo-mechanical (CTMP) refining process that takes place in at least one or two subsequent refining stages.

16. System according to any of the preceding claims 12 to 15, **characterized** in, that carrier medium is composed of gaseous carrier medium or steam-like carrier medium in the subsequent stages of the TMP or of the CTMP refining process line for feeding the mixture of the carrier medium and chips or the fibers in the refining process.

17. System according to any of the preceding claims 12 to 16, **characterized** in, that the supply of the steam-like/gaseous carrier medium into the refiner is divided into at least two parts, whereby a first part (811, 813, 814, 815; 911, 913) of supply of the steam/gas is fed into the refiner before the stator-rotor unit (221, 222) or rotor units, i.e. to the input side, and a second part (812, 814; 912, 914) of the supply of the steam/gas is fed into the refiner after the stator-rotor unit (221, 222) or rotor units, i.e. to the output side.

18. System according to claim 17, **characterized** in, that the steam/gas is fed by a first supply line (812, 814; 912, 914) of the said second part of the steam/gas supply through an outer wall of the refiner housing, most preferably to an exit area of the refiner (22, 32) at the output side of the refiner.

19. System according to claim 17, **characterized** in, that the steam/gas is fed by a second supply line (815, 816) of the said second part of the steam/gas supply into a blow line (9) or into a flow pipe that joins successive refiners (22, 32) at the output side of the refiner.

20. System according to claim 17, **characterized** in, that the steam/gas is fed into the refiner (22, 32) via a supply line (811, 911) or an inlet pipe at the input side of the refiner.

21. System according to claim 20, **characterized** in, that the steam/gas is fed into a breaking zone of the refiner (22, 32), which is at the input side of the refiner before the stator-rotor unit (221, 222) or rotor units.

22. System according to any of the preceding claims 12 to 21, **characterized** in, that pressure air, or mixture of air and steam, is the gaseous carrier medium.

23. System according to any of the preceding claims 12 to 21, **characterized** in, that water steam is the steam-like carrier medium.

24. Refiner for refining of wood chips or pulp fibers comprising: a housing surrounding a stator-rotor unit (221, 222) or rotor units, separate supply means at the input side of the stator-rotor unit or of the rotor units for feeding carrier medium and the chips/fibers into the refiner and removal means at the output side of the stator-rotor unit or of the rotor units for removing the refined chips/fibres with carrier medium from the refiner; through which refiner (2, 3) the chips/fibres pass by means of a carrier medium, whereby an actual refining takes place in a plate gap, which is between a stator-rotor unit (221, 222) or between two rotor units of a refiner (22, 32), which stator-rotor unit or rotor units comprise refiner segments, **characterized** in, that a divided supply of the carrier medium supply is applied, whereby a first supply (811,

813; 911, 913) of the carrier medium is locating at the input side of the refiner (22, 32) preceding the stator-rotor unit (221, 222) or the rotor units, and at least one a second supply (812, 814; 912, 914) of the carrier medium is locating at the output side of the refiner (22, 32) after the stator-rotor unit (221, 222) or the rotor units.

25. Refiner according to claim 24, **characterized** in, that the supply of the steam-like/gaseous carrier medium into the refiner is divided into at least two parts, whereby a first part (811, 813, 814, 815; 911, 913) of supply of the steam/gas is fed into the refiner before the stator-rotor unit (221, 222) or rotor units, i.e. to the input side, and a second part (812, 814; 912, 914) of the supply of the steam/gas is fed into the refiner after the stator-rotor unit (221, 222) or rotor units, i.e. to the output side.

26. Refiner according to claim 25, **characterized** in, that the steam/gas is fed by a first supply line (812, 814; 912, 914) of the said second part of the steam/gas supply through an outer wall of the refiner housing, most preferably to an exit area of the refiner (22, 32) at the output side of the refiner.

27. Refiner according to claim 26, **characterized** in, that the steam/gas is fed by a second supply line (815, 816) of the said second part of the steam/gas supply into a blow line (9) or into a flow pipe that joins successive refiners (22, 32) at the output side of the refiner.

28. Refiner according to any of the preceding claims 24 to 27, **characterized** in, that the steam/gas is fed into the refiner (22, 32) via a supply line (811, 911) or an inlet pipe at the input side of the refiner.

29. Refiner according to claim 28, **characterized** in, that the steam/gas is fed into a breaking zone of the refiner (22, 32), which is at the input side of the refiner before the stator-rotor unit (221, 222) or rotor units.

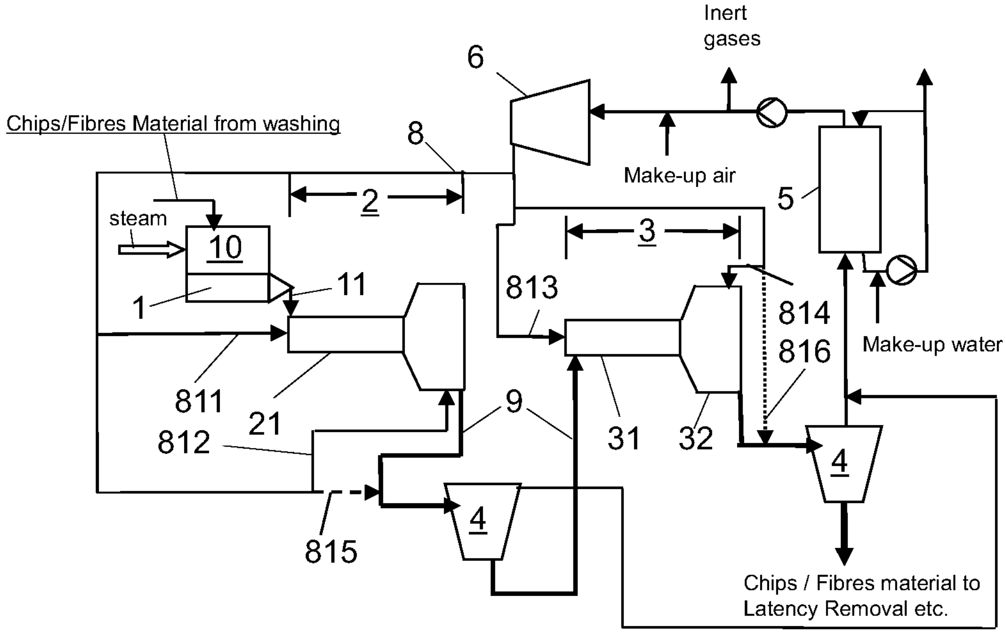
Inert gases
6
Chips/Fibres Material from washing
8
Make-up air
5
2
3
steam
10
1
11
813
814
816
Make-up water
811
21
9
812
31
32
4
815
4
Chips / Fibres material to Latency Removal etc.

FIG.2

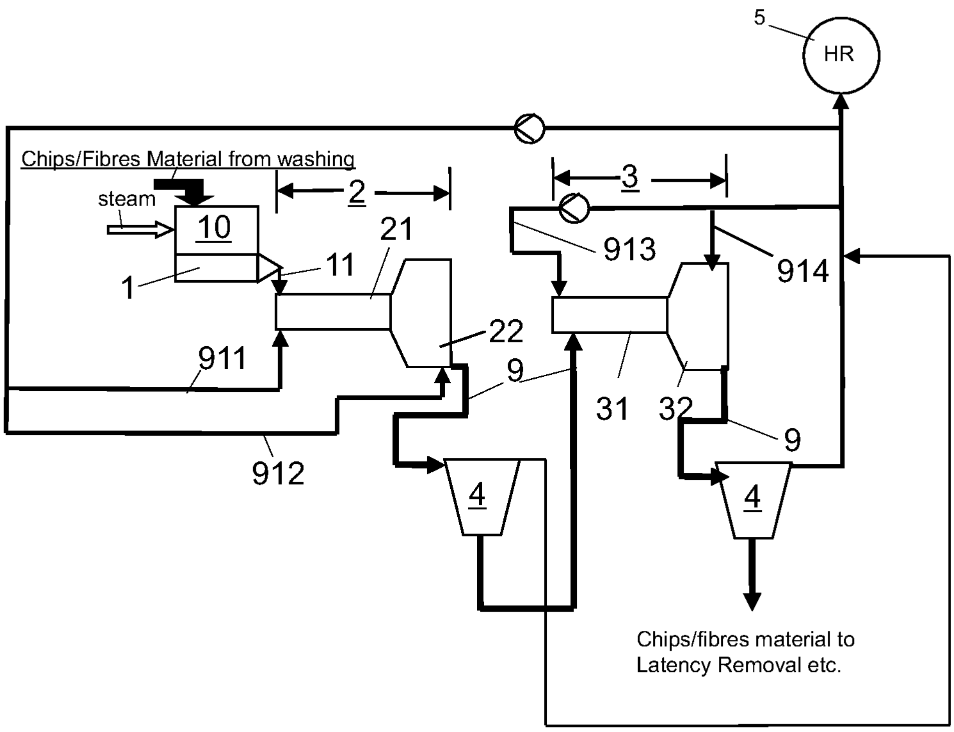
5
HR
Chips/Fibres Material from washing
3
2
steam
10
21
913
914
1
11
22
911
9
31
32
9
912
4
4
Chips/fibres material to Latency Removal etc.

FIG.3

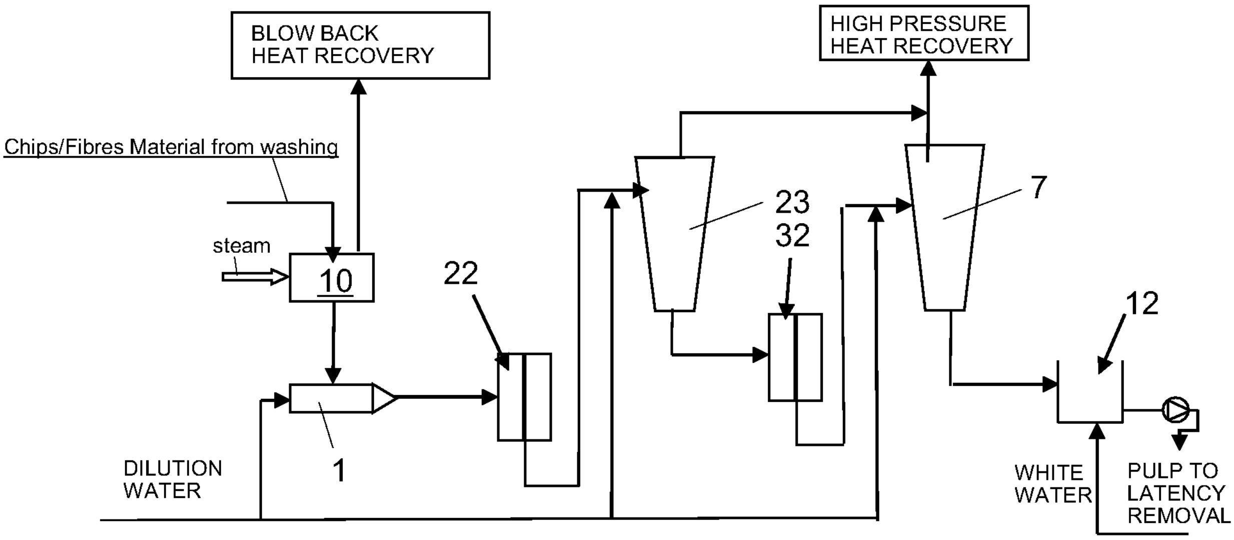

FIG.1

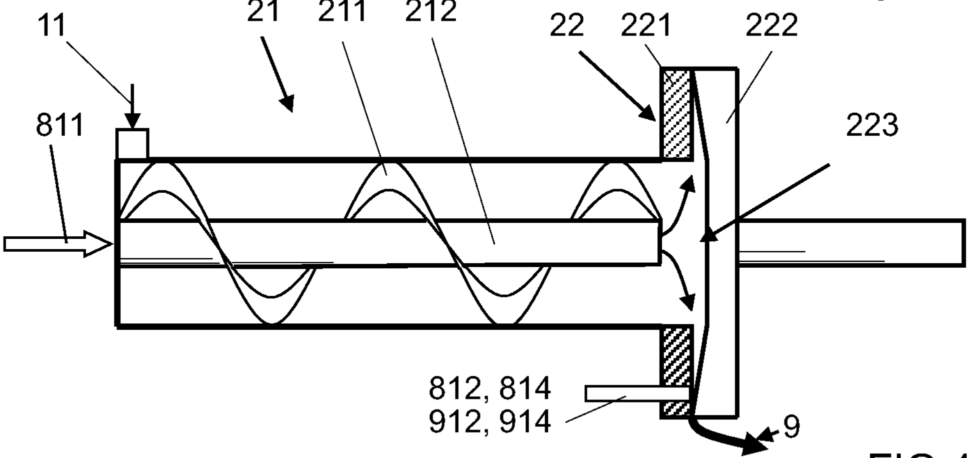

FIG.4

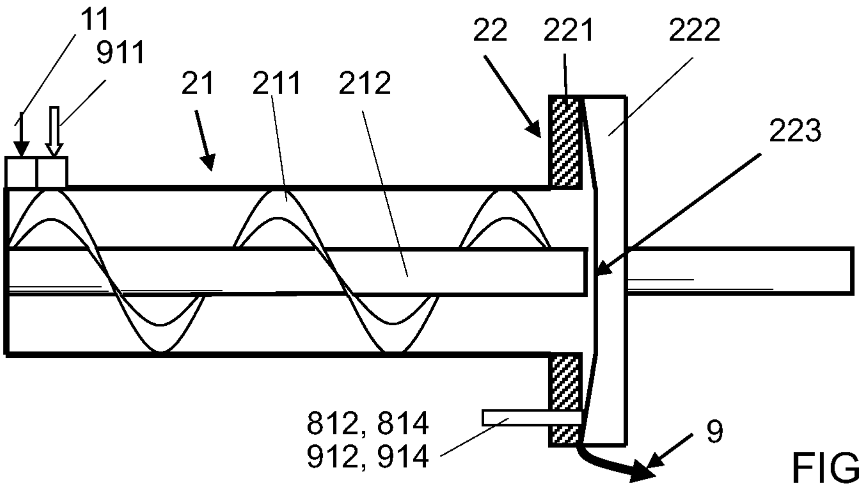

FIG.5

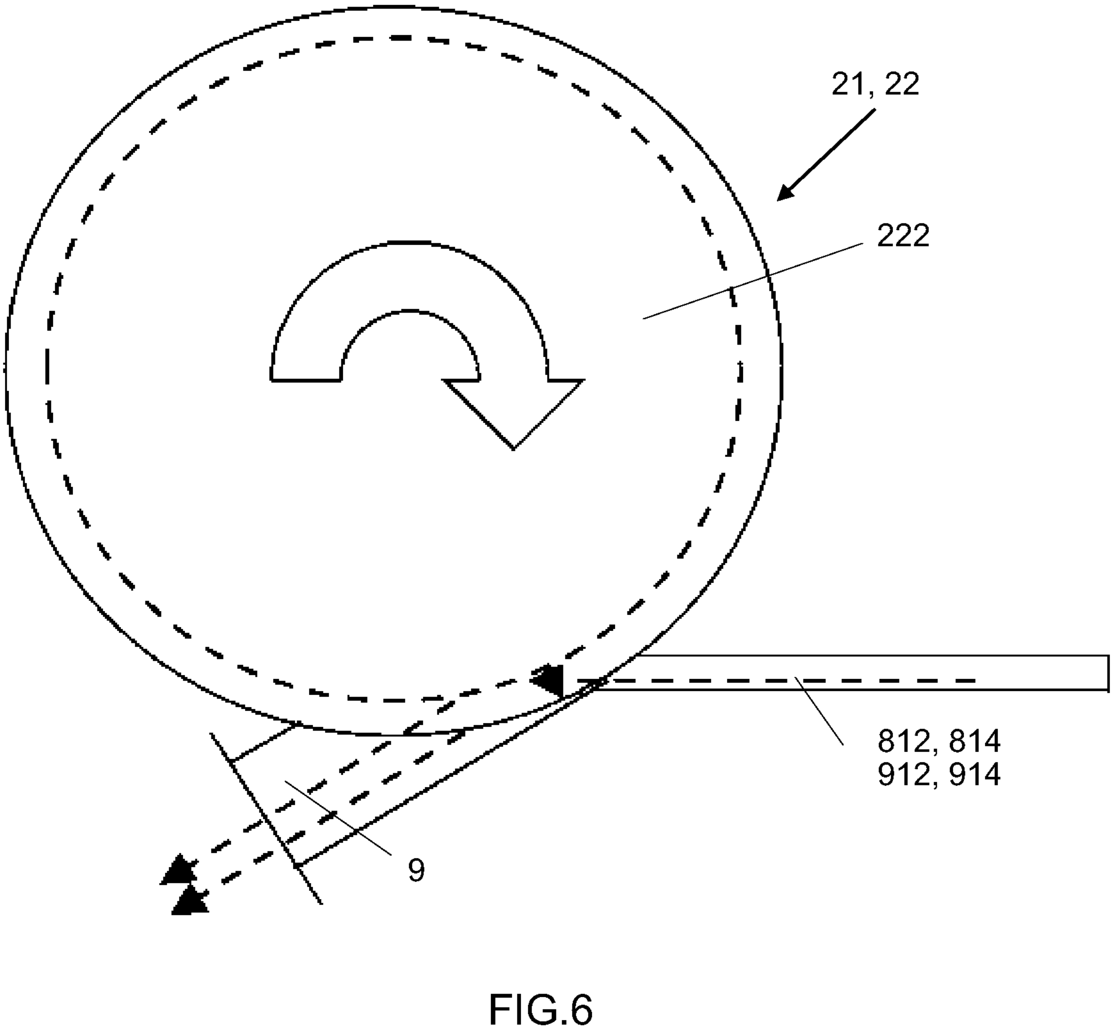

FIG.6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2010/050134

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: D21B, D21C, D21D, D21F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

FI, SE, NO, DK

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI, Internet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 4490578 T1 (AIR LIQUIDE) 13 April 1995 (13.04.1995) especially Fig. 1 and examples 1 and 2 on pages 6 and 7	1-23
A	US 4288288 A (FLECK JOHN A et al.) 08 September 1981 (08.09.1981) especially Fig. 1 and 3	1-23

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 June 2010 (09.06.2010)	11 June 2010 (11.06.2010)

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI2010/050134

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See supplement on extra sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-23

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

International application No.
PCT/FI2010/050134

CLASSIFICATION OF SUBJECT MATTER

Int.Cl.
D21B 1/12 (2006.01)
D21D 1/20 (2006.01)

According to Rule 13.1 PCT, an application shall relate to one invention only or to group of inventions so linked as to form a single general inventive concept.

Further, according to Rule 13.2, the requirement of unity of invention is fulfilled only when there is a technical relationship among claimed inventions involving one or more of the same or corresponding special technical features. The expression "special technical features" means those technical features that define a contribution which each of the claimed inventions, considered as a whole, makes over the prior art.

The International Searching Authority has found that this international application contains two groups of inventions that are not so linked as to form a single general inventive concept. The following inventions have been found.

Invention I: Claims 1-23 direct to a method and a system for refining wood chips or pulp fibers. The special technical feature is considered to be that the gaseous or steam-like carrier medium is used for feeding of the chips/fibers, and the chips/fibers and the carrier medium are fed separately into the refiner.

Invention II: Claims 24-29 direct to a refiner for refining wood chips or pulp fibers. The special technical feature is considered to be that the carrier medium supply is divided into the first and second supply.

Thus, according to the inventions defined in claims 1-23 the carrier medium and the chips/fibers are fed separately i.e. their supply is divided. On the other hand in the inventions according to claims 24-29 the carrier medium supply is divided. It is also odd that the preamble of independent claim 24 contains feature (separate supply means…for feeding carrier medium and the chips/fibers) that is presented in the characterizing part of the independent claims 1 and 12 (chips/fibers and the carrier medium are fed separately).

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/FI2010/050134

Patent document cited in search report	Publication date	Patent family members(s)	Publication date
DE 4490578 T1	13/04/1995	FI 944696 A	22/11/1994
		NO 943636 A	09/12/1994
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