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(54) **Title**: A REFINER AND A METHOD FOR REFINING PULP

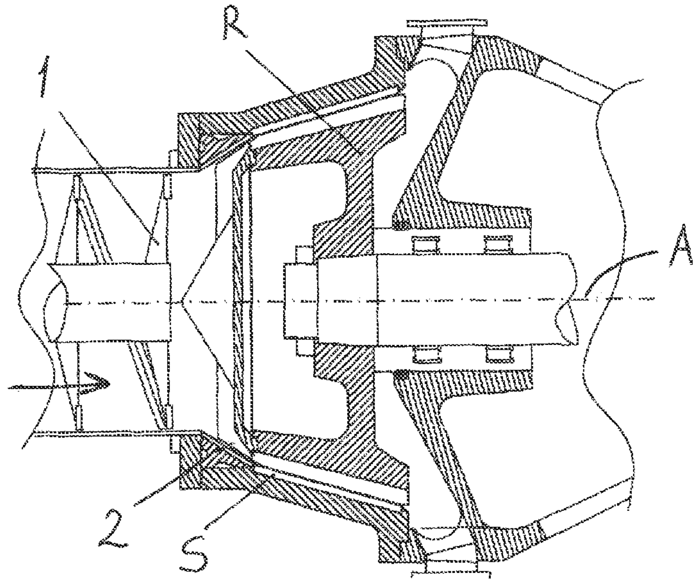

Fig. 1

(57) **Abstract**: A refiner comprises a rotor (R) arranged rotatable around an axis inside a stator (S) and comprising blades arranged on the circumference of the rotor, opposite the stator, wherein an annular refining space is formed between the rotor and the stator, extending in the axial direction and having a blade clearance between the blades and the inner surface of the stator (S). The feeding means (1) of the refiner are arranged to feed high-consistency pulp to the refining space. The blade clearance is 0.5 to 5 mm, advantageously 1 to 3 mm.

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A REFINER AND A METHOD FOR REFINING PULP

The invention relates to a refiner which is of the type presented in the preamble of the appended claim 1. The invention further relates to a method for refining pulp. The field of invention is the manufacture of mechanical pulp from a wood-based raw material.

Mechanical pulp is manufactured industrially by grinding or refining wood raw material. In grinding, whole trees are pressed against a rotating cylindrical surface, whose surface structure is formed to detach fibres from a tree. The obtained pulp is discharged with shower water from the grinder to fractionation, and the reject is ground with a disc refiner. This method produces pulp that contains short fibres and scatters light well. A typical example to be mentioned of a grinding process is US patent 4,381,217. In the manufacture of refiner mechanical pulp, the starting material consists of wood chips which are directed to the centre of a disc refiner, from where they are transferred by the effect of a centrifugal force and a steam flow to the circumference of the refiner while being disintegrated by the blades at the surface of the disc. Typically, multi-phase refining is necessary for obtaining finished pulp in this process. The coarse fraction separated in the process can be directed into so-called reject refining. This method produces pulp with longer fibres compared to the above-described groundwood. Refining processes have been presented in, for example, publications WO-9850623, US 4,421,595, and US 7,237,733.

High energy consumption is characteristic to both methods of manufacturing mechanical pulp. For example, in the production of groundwood, the energy consumption for LWC paper pulp is about 2 MWh/ton, and in addition, because of the short fibres, chemical pulp fibres are needed for strengthening the structure in order to achieve sufficient runnability of a paper web. In the manufacture of refiner mechanical pulp, the typical energy consumption for LWC paper pulp is about 3 MWh/ton. Because of the long fibres of the product obtained with this method, it is not necessary to strengthen the structure of the paper with chemical pulp.

In countries with strong forest industry, the production of mechanical pulp can form a significant part of the total energy demand of the industry, and it can even affect the energy policy of the country. Due to the energy intensiveness of the defibration process, the ways to reduce the energy needed for one product ton by even a few percent can lead to significant savings in production costs.

The present invention relates precisely to a refiner mechanical pulp manufacturing process, in which the fibre raw material fed to the process is in the form of particles, for example wood chips or similar, and it is refined by bringing it into a blade gap where the mechanical working of the moving surfaces refines it and detaches fibres from it. This kind of a process is typically implemented by high-consistency refining (HC refining) in the above-described disc refiner, between two refiner disc with profiled surfaces, where the pulp to be refined and the steam generated are carried outwards in the radial direction of the discs. Such a refiner has a small blade gap, about 0.2 mm at the smallest.

Another refiner type is the conical refiner, in which the fibre raw material is fed into a refining zone formed by a conical rotating rotor and a stator surrounding the rotor, in which zone it is refined to pulp. This process is carried out in the form of low consistency pulp processing at the consistency of about 4%, wherein the blade gap is also very small, close to a blade contact. The refining is based on the fact that in such a small blade gap, the fibre is flattened and the blade gap is lubricated by water that is amply present. This kind of processing is not suitable for refining in the first step.

It is an aim of the invention to present a novel refiner and a method for refining pulp, which can be applied in refining of the first step at a high consistency, to replace the conventional manufacture of refined mechanical pulp by disc refiners which are energy-consuming. To attain this purpose, the refiner according to the invention is primarily characterized in what will be presented in the characterizing part of the appended claim 1. The refining zone is between a rotor arranged to rotate around an axis and a stator surrounding the rotor, wherein the high-consistency pulp can be directed to the blade gap, thanks to the centrifugal force generated by the rotor. The blade gap is larger than conventionally, about 0.5 to 5 mm, advantageously about 1 to 3 mm, and its opposite surfaces (the refining surface of the rotor blade and the inner surface of the stator) has a sufficient roughness/fine toothing to generate a sufficient friction with the pulp therebetween. In this way, shearing forces are generated in the pulp, and the fibres are also rubbed against each other in the blade gap. In the annular refining zone, the pulp is conveyed in the axial direction, that is, in the direction of the rotating axis of the rotor, from the feeding end to the discharging end, all the time subjected to said phenomena. Refining energy can be directed to the pulp at a good efficiency.

The appended dependent claims present advantageous structural solutions of the refiner, as well as ways of implementing the method.

In the following, the invention will be described in more detail with reference to the appended drawings, in which

Fig. 1 shows a refiner according to the invention in a longitudinal section in the direction of the rotor axis,

Fig. 2 shows the rotor of the refiner seen from the front,

Fig. 3 shows the surfaces of the rotor and the stator of the refiner in a detailed view in a section perpendicular to the rotor axis, and

Fig. 4 shows an example of a rotor blade in a top view.

Figure 1 shows a refiner according to the invention, comprising a rotor R arranged rotatable around an axis A and rotating inside a stator S. Between the rotor and the stator, an annular space is formed, in which refining takes place at the same time when the pulp to be refined advances in the direction of the rotation axis of the rotor. In the refiner of Fig. 1, said space expands in the direction of feeding the raw material, or the direction of flow of the pulp, wherein the refiner in question is a conical refiner with a conical rotor. It may also be a refiner in which said annular space has a constant diameter, wherein it is a cylindrical refiner with a cylindrical rotor R.

Wood-based raw material, consisting of wood chips or pulp that has already been partly refined, is fed in the direction of the arrow to the first end of the rotor, that is, to the initial end of the refining zone, for example with a feed screw 1. At the initial end of the refining space between the rotor and the stator, there are crushing teeth 2 attached to the rotor, having the function of crushing the fed wood chips before they enter the actual refining space where they are refined to fibres. The chips to be refined pass the refining space between the rotor and the stator in the axial direction with a given retention time, after which they are taken out of the refiner as refined pulp. The retention time is longer than in conventional disc refiners, in which the centrifugal force rather carries the pulp away and cannot press it to the refining zone.

The refining is high-consistency pulp refining, in which the consistency of the pulp is at least 10%, advantageously at least 18%. The consistency may be at least 30%, for example in the order of 50%. The consistency is adjusted by supplying a suitable quantity of water with the wood raw material entering the refiner, for example into the feed screw 1.

Figure 2 shows the rotor of the refiner seen from the front, that is, from the direction of the first end (initial end of the refining zone). The rotor of the refiner typically comprises axially directed blades 3 spaced at certain intervals on its circumference, passages 4 being formed between them, the bottom of the passages being the body of the rotor R. Because the thermal energy generated in high-consistency refining converts water present in the pulp into steam, the passages 4 extending in the axial direction from the feeding end to the discharging end constitute a means to guide the steam out of the refining zone. Said blades 3 and passages 4 extend at an angle outwards according to the conicality of the rotor R. The height of the blades 3 from the body of the rotor R, that is, the depth of the passages 4, may be in the order of a few millimetres, for example 5 to 15 mm, advantageously about 10 mm.

Furthermore, the passages 4 of the rotor R typically and preferably have no obstacles or “dams” known from low-consistency refining, but the passages formed by them are open from the initial end (feeding end) of the rotor to the terminal end (discharging end) of the rotor, so that the steam generated during the refining can flow without obstacles to the terminal end of the rotor and out of the refining zone. However, it is possible to place obstacles extending from the bottom to the height of 2/3, at the most, in the passages, to prevent unrefined wood material from being entrained in the steam flow. With the invention, however, refining energy is directed to the mechanical processing of the pulp in the refining space, and the generation of steam from the water in the pulp is minimized, because it takes energy.

Figure 3 shows the refining space 5 between the rotor R and the stator S in a larger scale. Between the outer surface 3a (refining surface) of each blade 3 and the inner surface of the stator S, a so-called blade clearance d is formed, which is in this case larger than in low-consistency refining, that is, in the order of 0.5 to 5 mm, advantageously 1 to 3 mm. The blade clearance can be easily adjusted by changing the position of the rotor in the axial direction. Because of the centrifugal force effective in the refining, the fibre material M to be refined is against the inner wall of the stator S, and it moves, being continuously ground against the wall of the stator, in the axial direction towards the discharging end. With diameters of the rotor R (the maximum diameter of a conical refiner or the constant diameter of a cylindrical refiner is normally greater than 1 m) and rotating speeds used in industrial refiners, and thanks to the high solids content of the high-consistency pulp, a centrifugal force is generated that presses the pulp into the refining space, against the inner wall of the stator S, and the refining takes place when the outer surfaces 3a (refining surfaces) of the blades 3 rub this pulp. To direct energy to the fibres, both the refining surfaces of the blades 3 and the inner wall of the stator must have a structure that maintains friction. In this way, the fibres are not entrained in the movement of the rotor R but rub against each other also in the blade gap. At the same time, the steam generated in refining is allowed to pass freely in the radial direction inwards in the refining space, from the pulp compressed against the inner wall of the rotor into the passages 4 and further away in the axial direction, along the bottoms of the passages 4.

To give the stator friction properties, it may be provided with zones of a given width distributed on the circumference, having a fine toothing or a surface that is otherwise rougher than the smooth surface of the stator. This can be achieved by techniques of metal machining or surface treatment. A rougher surface can be provided by attaching, for example, hard particles (grits) to the surface. If these zones are oriented directly in the axial direction, their fine toothing (alternating grooves and elevations) may be in parallel or at an angle with the axial direction (for example, at an angle of 45 degrees at the maximum), to give a forward transferring effect in addition to the refining effect. The zones may protrude slightly from the smooth surface of the rotor, for example at a maximum of 3 mm, advantageously 1 to 1.5 mm. If the roughness of the zones has no orienting property as such, these rougher surfaces may extend at an angle to the axial direction, for example at an angle of 45 degrees at the maximum, so that they can also have a forward transferring effect.

The width of said zones of the stator in the direction of the circumference is, for example, 15 to 30 mm, and their spacing in the direction of the circumference may be 15 to 30 mm. Figure 3 shows a blade gap formed momentarily between a blade 3 of the rotor R and the toothed zone of the inner surface of the stator S. It is obvious that when the rotor is rotating, the blades 3 come by such zones and the smoother sections of the rotor in an alternating manner.

It is possible to provide the stator with said friction-increasing surface on the whole circumference, but experience has shown that a better result is obtained by the alternation of zones with varying friction properties (smooth – fine toothed or containing particles embedded in the surface).

Figure 3 shows that a fine toothing may be provided at the outer surface 3a of the rotor blade as well, wherein the grooves/elevations may extend in parallel with the blade or at an angle of 45 degrees, at the maximum, to that, as shown in Fig. 4. Also this has a directing effect, thanks to the rotation of the rotor R, for example in the case that the zones on the inner surface of the stator are equipped with axial grooves, or the inner surface of the stator comprises zones that are otherwise rougher and extend in the axial direction. Also, the roughness of the refining surfaces 3a of the rotor blades can be achieved with suitable techniques of metal machining or surface treatment, for example by attaching hard particles (grits) to it.

The invention is not limited solely to the embodiment presented above and in the drawings, but it can be modified within the scope of the claims. The refiner used in the invention is advantageously a conical refiner, because it has the possibility of adjusting the blade gap easily, and furthermore, the risk of blade contact is small, because the axial forces are smaller than in disc refiners. In the conical refiner, the cone angle of the rotor (the angle of the surface to the rotation axis A) is, for example, 10 to 30 degrees, advantageously 15 to 25 degrees, but these numerical values should not be considered limiting. However, the invention also encompasses a cylindrical refiner.

The refining surfaces of the rotor blades may be spaced at a constant distance from the surface of the stator, or they may also open slightly in the advancing and/or trailing directions. The above-defined blade gap is thus the minimum distance between the refining surface and the stator surface.

The invention is particularly intended for refining in the first step, wherein the wood raw material to be fed consists of wood chips, but it may also be applied in high-consistency pulp refining in the second step, for processing pulp that has already been refined once.

Claims:

1. A refiner comprising a rotor (R) arranged rotatable around an axis inside a stator (S) and comprising blades (3) arranged on the circumference of the rotor, opposite the stator, wherein an annular refining space is formed between the rotor and the stator, extending in the axial direction and having a blade clearance (d) between the blades (3) and the inner surface of the stator (S), **characterized** in that the feeding means (1) of the refiner are arranged to feed high-consistency pulp into the refining space, and that the blade clearance (d) is 0.5 to 5 mm, advantageously 1 to 3 mm.

2. The refiner according to claim 1, **characterized** in that passages (4) extending from the feeding end to the discharging end are arranged between the rotor blades (3) and arranged to convey steam, released from the pulp to be refined, away from the refining space.

3. The refiner according to claim 1 or 2, **characterized** in that the blades (2) of the rotor (R) and the inner surface of the stator (S) are provided with a roughness, such as fine toothing, which is capable of transferring shearing forces to the pulp to be refined.

4. The refiner according to claim 3, **characterized** in that the roughness is oriented at an angle to the axial direction in such a way that the rotating movement of the rotor (R) generates a component in the pulp that moves it in the axial direction from the feeding end towards the discharging end.

5. The refiner according to any of the preceding claims, **characterized** in that it is a conical refiner.

6. A method for refining pulp, wherein wood raw material is fed into a ring-shaped refining space between a rotating rotor (R) and a stator (S), **characterized** in

– refining high-consistency pulp in the refining space,

– pressing the pulp against the inner surface of the stator (S) by a centrifugal force generated from the rotation of the rotor (R), and

– refining the pulp pressed against the inner surface of the stator in a blade clearance (d) between the rotor blades (3) and the inner surface of the stator (S), the blade clearance being 0.5 to 5 mm, advantageously 1 to 3 mm.

7. The method according to claim 6, **characterized** in that it is high-consistency refining of the first step, to which particle-like raw material, such as wood chips, is fed.

8. The method according to claim 6 or 7, **characterized** in that it is applied in a conical refiner.

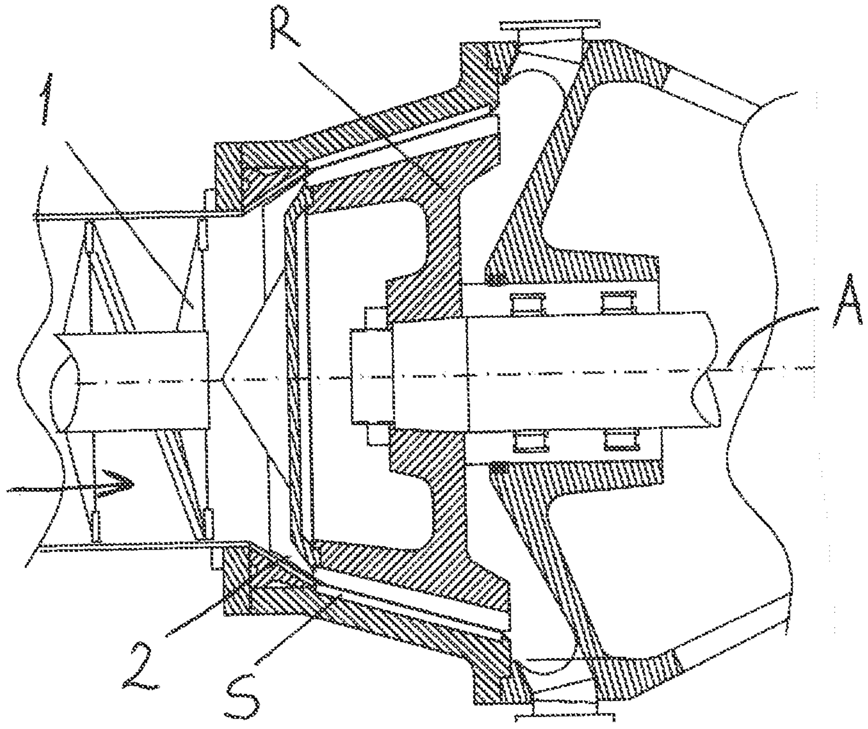

Fig. 1

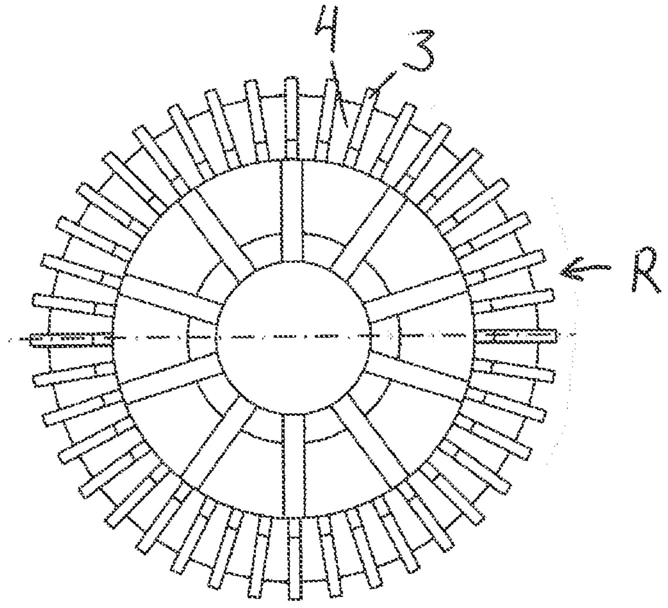

Fig. 2

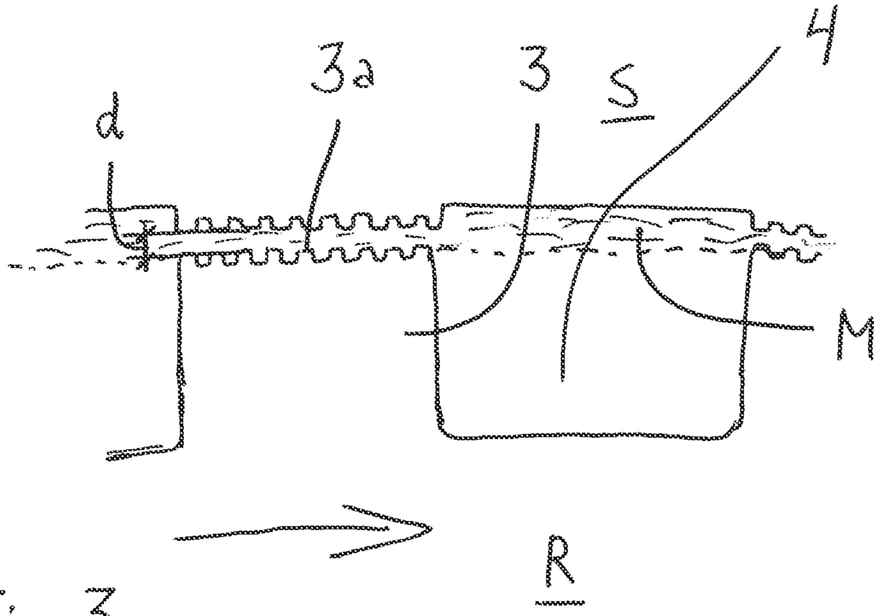

Fig. 3

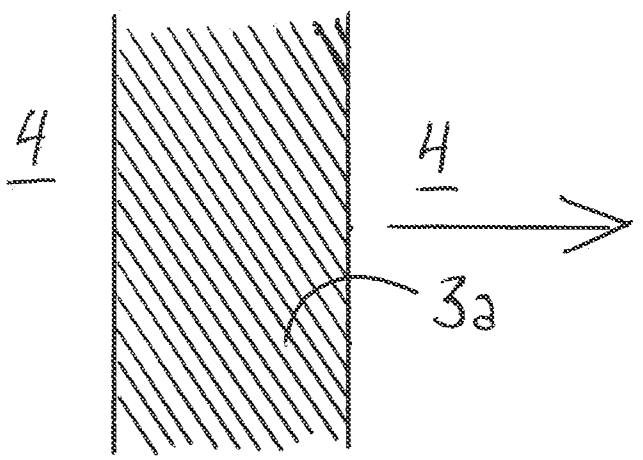

Fig. 4