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(54) Refining pulp

(57) A pulp refiner 10 incorporates at least one rotatable disc 12 connected to a drive shaft 14. Stock consisting of pulp in water is supplied to the refiner through an inlet 22 causing the stock to pass between the rotating disc 12 and an adjacent face of a stator disc 38 to refine the pulp.

The rotor disc 12 is caused to rotate sequentially

faster and slower than the surrounding stock in order to assist the shredding, opening and fibrillating of the pulp. The refining process is maximised by inducing resonance of the rotor disc 12 in the same circumferential direction as its rotation, with the flexure that permits such resonance coming from slight torsional movement of the shaft 14. The resonance is monitored and consequently adjusted to maximise circumferential vibration.

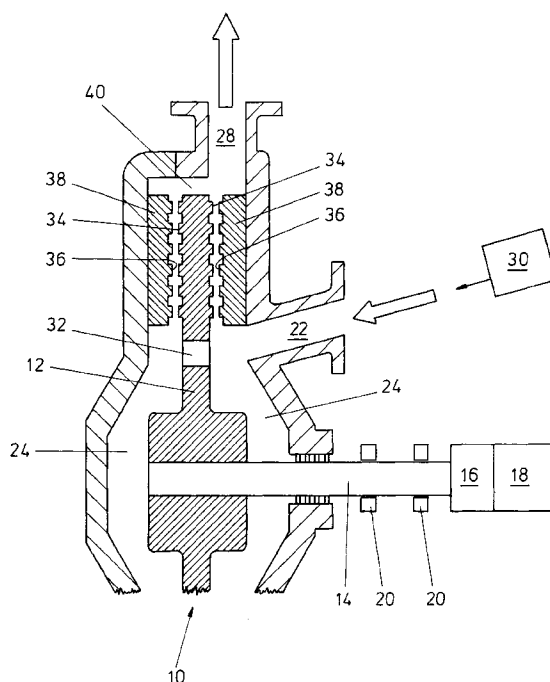


FIG. 1

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Description

[0001] The present invention relates to a method of operating a pulp refiner and to a pulp refiner when operating according to the method and to a pulp refiner.

[0002] The preparation of wood pulp and waste materials for paper and board manufacture is a very expensive operation. The capital equipment and process plant employed is substantial and the operating costs in terms of labour, power consumption and maintenance charges form a considerable proportion of the manufacturing costs of the final product.

[0003] Preparation of the basic raw material (stock) for the continuous Fourdrinier and Inverform sheet generating machines is usually a batch process using refining machines, often in series, to disperse, dilute and shred wood pulp or waste paper in aqueous solution. Following preparation large holding tanks for the reduced, dilute pulp/waste paper stock are filled and continuously agitated in readiness for discharge to the forming machine flow box.

[0004] The preparation capacity for each continuous paper making process comprises multiple beating and refining units which are used to simultaneously shred, "open" and fibrillate fibres to a given consistency commensurate with the product specification. The setting of the processing plant to achieve the required aqueous fibre solution is therefore of great importance upon which the physical properties of the final product depends.

[0005] Usually, trial and error sampling of the stock is undertaken initially, in order to achieve the desired quality control. However, this is time consuming and usually involves running the high powered refining, beating machines and pumps for much longer than is absolutely necessary in order to obtain the required degree of fibrillation.

[0006] Two types of refiner are widely employed in paper and board manufacturing they are:

a) the disc or Sutherland refiner where a powered, grooved, rotating disc runs at a constant preset speed in close proximity to a grooved stationary or idling disc with stock flowing under pressure between the two.

and

b) the conical plug and shell or Jordan refiner where stock is pumped through the annulus between the conical plug that rotates at a constant speed and its surrounding stationary shell both of which contain bronze or stainless steel bars which shear and fibrillate the stock.

[0007] Owing to the superior performance of the disc type refiner, for chemical and mechanical pulps, the larger plug refiners are steadily being replaced though

the action of the two machines, in terms of their shearing effects on the stock, appears to be very similar. Both processes are intrinsically mechanical in that the refining action depends on the rotating plug and stationary shell separation or alternatively on the powered disc and idling disc clearance for equivalent running speeds and pulp properties such as density etc.

[0008] Modern disc refiners run at high speed employing two or more grooved discs to achieve specific cutting and shearing actions. Generally the pulp/product is cycled through twin stator disc arrangements, in series or parallel until the desired composition of the refined homogeneous mixture is achieved.

[0009] It is an object of the present invention to attempt to overcome at least some of the above described disadvantages.

[0010] According to one aspect of the present invention a method of operating a pulp refiner incorporating at least one rotatable disc comprises supplying stock comprising pulp in fluid to the refiner, causing the stock to pass between a rotating face of a disc and an adjacent face to refine the pulp, and removing refined stock, the method being characterised in that the rotating disc is caused to resonate during rotation.

[0011] The method may comprise maintaining the disc in resonance during substantially all of the refining period.

[0012] The method may comprise monitoring the resonance, for instance by monitoring the resonance of a shaft on which the disc is mounted.

[0013] The method may comprise varying the rate of supply of stock in dependence upon the resonance monitored. Alternatively or additionally, the method may comprise varying the rate of rotation of the disc in dependence upon the resonance monitored.

[0014] The method may comprise supplying stock in pressure pulses and the method may comprise varying the frequency of those pressure pulses in dependence upon the resonance monitored.

[0015] The method may comprise attempting to maintain the resonance at a maximum value. That maximum value may be arranged to be between two lesser values at either side of that maximum value, for instance such that increasing the pulsation rate causes the resonance to go first from a lesser value then to a higher value and then to a lower value.

[0016] The method may comprise inducing the resonance by causing harmonic vibration of the disc.

[0017] The method may comprise causing stock to pass between adjacent faces on each side of the disc to cause refinement of the pulp on each side of the disc. The method may comprise causing pulp to move through the disc in order to reach both sides of the disc.

[0018] The method may comprise subjecting the stock to a varying shear force as the stock passes through the adjacent faces.

[0019] The method may comprise causing the disc to move sequentially faster and slower to thereby resonate

the disc. The method may comprise the disc moving alternately faster and slower than the adjacent portion of stock. The method may comprise the rotating disc alternately inducing an accelerating then a deceleration action on the adjacent stock. The method may comprise a shaft to which the disc is connected oscillating in a torsional manner.

[0020] The method may comprise causing the stock to pass through a reduced gap between the opposed faces as a result of the resonance and using less power in order to cause the fluid to go through that reduced gap than would otherwise be required if the gap was maintained at that reduced level throughout the refinement.

[0021] The present invention also includes a pulp refiner when operating as herein referred to.

[0022] According to a further aspect of the present invention, a pulp refiner incorporates a rotatable disc, the rotatable disc having a face adjacent to but spaced from a further face, through which faces, in use, stock comprising pulping fluid is arranged to pass, the refiner including stock supply means and means to monitor the resonance of the disc and means to alter the operating conditions of the refiner in order to maintain the resonance at an optimum level.

[0023] The means to alter the operating conditions of the refiner may comprise means to alter the flow rate of stock to the refiner and means to alter the frequency of pressure change in stock supplied to the refiner.

[0024] The present invention includes any combination of the features and limitations referred to.

[0025] The present invention can be carried into practice in various ways but one embodiment will now be described, by way of example only, and with reference to the accompanying drawings in which:-

Figure 1 is a schematic cross-sectional view through a disc refiner 10, and

Figure 2 is a view showing a disc refiner in an open position such that cooperating opposed surfaces are visible.

[0026] As shown in Figure 1, a rotor disc 12 is connected to a drive shaft 14 which is connected via a coupling 16 to a motor 18. The shaft 14 is rotatably supported on spaced bearings 20.

[0027] The refiner has a stock inlet 22 leading to a chamber 24 within a hinged housing 26. Stock leaves the refiner through an outlet 28.

[0028] In use, stock is supplied from a centrifugal pump 30, through the inlet 22 and into the chamber 24 on both sides of the rotor disc 12. The stock flows from one side of the disc to the other through circumferentially spaced openings 32 formed in the rotor disc.

[0029] Stock flows outwardly relative to the rotational axis of the shaft between working faces 34 on each side of the disc 12 and adjacent working faces 36 on a pair

of stator discs 38.

[0030] Material that leaves the radially outer cooperating regions of the discs flows into a circumferential chamber 40 and then through the outlet 28 for further processing into paper or board manufacture, for instance.

[0031] As shown in Figure 2 each of the working faces 34 and 36 comprises sectors 42 that are divided by channels 44 that lead from the inner chamber 24 to the circumferential chamber 40. The channels 44 extend from inner to outer parts of the sectors but they are offset from a radial direction. Each sector includes a series of ribs 46 that extend parallel with each other in a direction parallel with a channel 44 at one side of the sector.

[0032] A significant number of factors will affect the effect that the disc refiner has on stock passing through it. These include:

- a) the stock feed rate;
- b) the construction of the stock;
- c) the rate of rotation of the rotor disc;
- d) the spacing between the rotor disc and the stator discs;
- e) the resonance of the rotor disc;
- f) the pressure frequency of stock being supplied.

[0033] It is desired to use the disc refiner to shred, "open" and fibrillate fibres in the stock to a given consistency for use in subsequent processing by cutting and shearing the fibres.

[0034] Previously refiners have always been run in a smooth manner in order to achieve a consistent action on fibres in the stock.

[0035] What the present invention appreciates though is that a smooth manner, in the sense that no resonance take place, is surprisingly, not the desirable way to use the refiner. In fact the opposite is true and the most effective way to change the fibres is to maximise resonance such as torsional resonance which, at the same time, also allows less energy to be used for a given processing rate. This resonance occurs in the rotor disc which moves, when viewed in Figure 1 in a circumferential direction relative to the rotational axis of the shaft 14 such that working faces 34 oscillate torsionally while rotating enabling the leading and trailing groove edges to be engaged in the refining action. In this respect, the stock between the rotor and stator will be moving in a circumferential direction and the oscillatory circumferential movement of the rotor may cause the relative circumferential speeds of the rotor to oscillate between the rotor speed being repeatedly greater and then less than the circumferential speed of the adjacent stock.

[0036] The fibres in the fluid may be subject to low frictional levels in order to achieve torsional oscillation which may be preferable to high frictional non-oscillatory conditions.

[0037] The resonance could occur in the same circumferential direction simultaneously around the pe-

riphery of the rotor disc with the flexure that permits such resonance coming from slight torsional movement of the shaft 14.

[0038] The resonance of the rotor disc may be induced or be assisted in being induced by the pressure pulses coming from the centrifugal stock supply pump. This resonance may increase when the speed of the rotor is set at a certain rate that causes harmonic resonance of the rotor disc.

[0039] The refiner may be preset such that, for a given stock supply and for a given rate of supply of the stock, the rotor disc will be caused to rotate at a predetermined mean rate to maximise circumferential vibration.

[0040] Alternatively or additionally, the rate of supply of stock may be altered to a preset level for a given constitution of stock and for a given motor speed in order to maximise resonance.

[0041] Alternatively or additionally, the resonance of the rotor disc can be monitored with the rate of stock supply or the rate of rotation of the rotor being altered or both of those rates being altered to maintain optimum stock processing.

[0042] The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

[0043] All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

[0044] Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

[0045] The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. A method of operating a pulp refiner (10) incorporating at least one rotatable disc (12) comprising supplying stock comprising pulp in fluid to the refiner, causing the stock to pass between a rotating face of the disc and an adjacent face (38) to refine the pulp, and removing refined stock, the method

being characterised in that the rotating disc (12) is caused to resonate during rotation.

2. A method according to Claim 1 comprising maintaining the disc (12) in resonance during substantially all of the refining period.
3. A method according to any preceding claim comprising monitoring the resonance of a shaft (14) on which the disc (12) is mounted.
4. A method according to any preceding claim comprising varying the rate of supply of stock in dependence upon the resonance monitored.
5. A method according to any preceding claim comprising varying the rate of rotation of the disc (12) in dependence upon the resonance monitored.
6. A method according to any preceding claim comprising supplying stock in pressure pulses.
7. A method according to Claim 6 in which the method of supplying stock comprises varying the frequency of the pressure pulses in dependence upon the resonance monitored.
8. A method according to any of the preceding claims comprising attempting to maintain resonance at a maximum value.
9. A method according to any of the preceding claims comprising inducing the resonance by causing harmonic vibration of the disc (12).
10. A method according to any of the preceding claims comprising subjecting the stock to a varying shear force as the stock passes through the adjacent faces (12,38).
11. A method according to any of the preceding claims comprising causing the disc (12) to move sequentially faster and slower to thereby resonate the disc.
12. A method according to Claim 11 comprising the disc (12) moving alternately faster and slower than the adjacent portion of stock.
13. A method according to any of the preceding claims comprising a shaft (14) to which the disc is connected oscillating in a torsional manner.
14. A pulp refiner incorporating a rotatable disc, the rotatable disc (12) having a face adjacent to but spaced from a further face (38) through which faces stock comprising pulping fluid is arranged to pass, the refiner including means to monitor the resonance of the disc and means to alter the operating

conditions of the refiner in order to maintain the resonance at an optimum level.

15. A pulp refiner according to Claim 14 in which the means to alter the operating conditions of the refiner 5
comprise means to alter the flow rate of the stock to the refiner.

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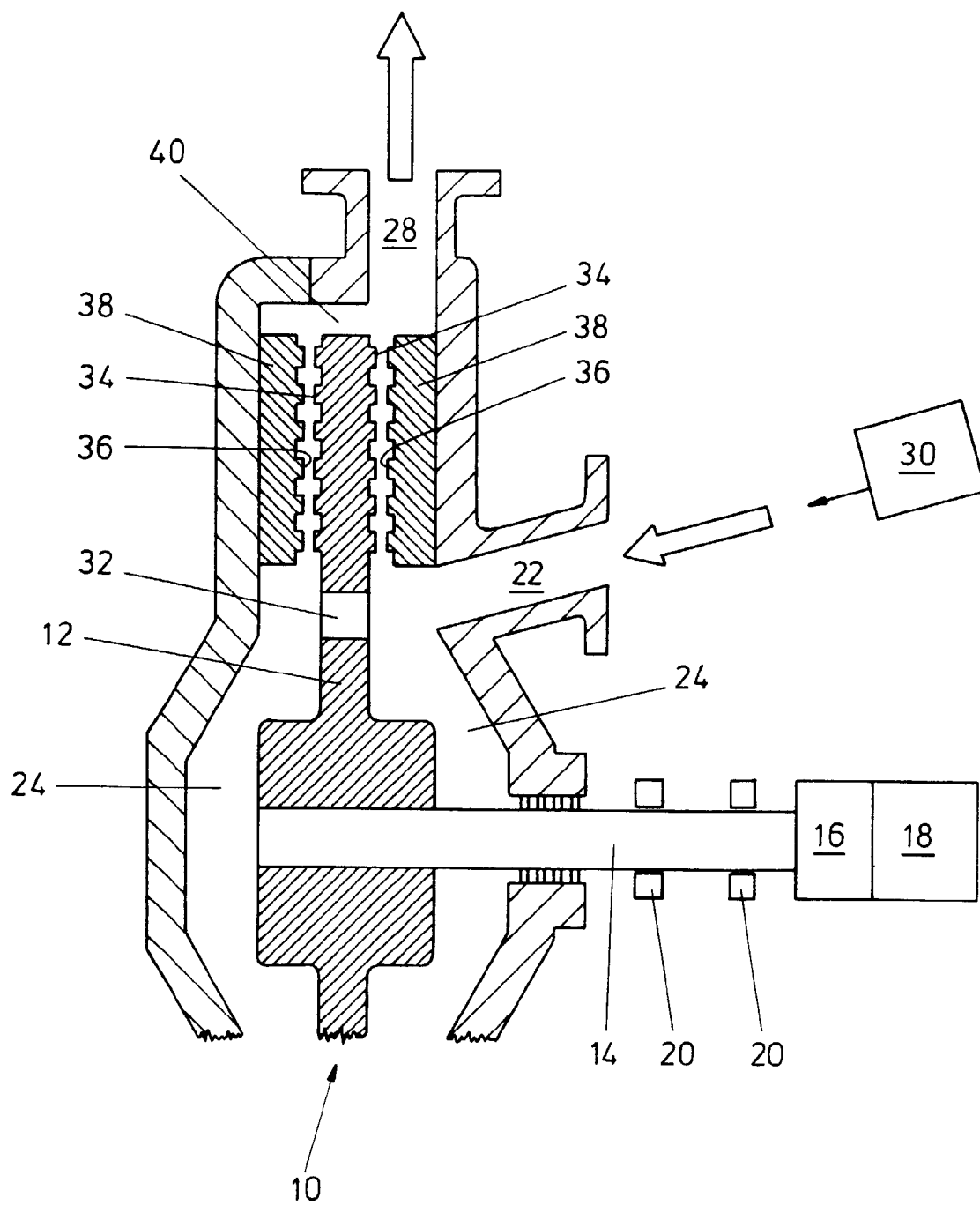


FIG. 1

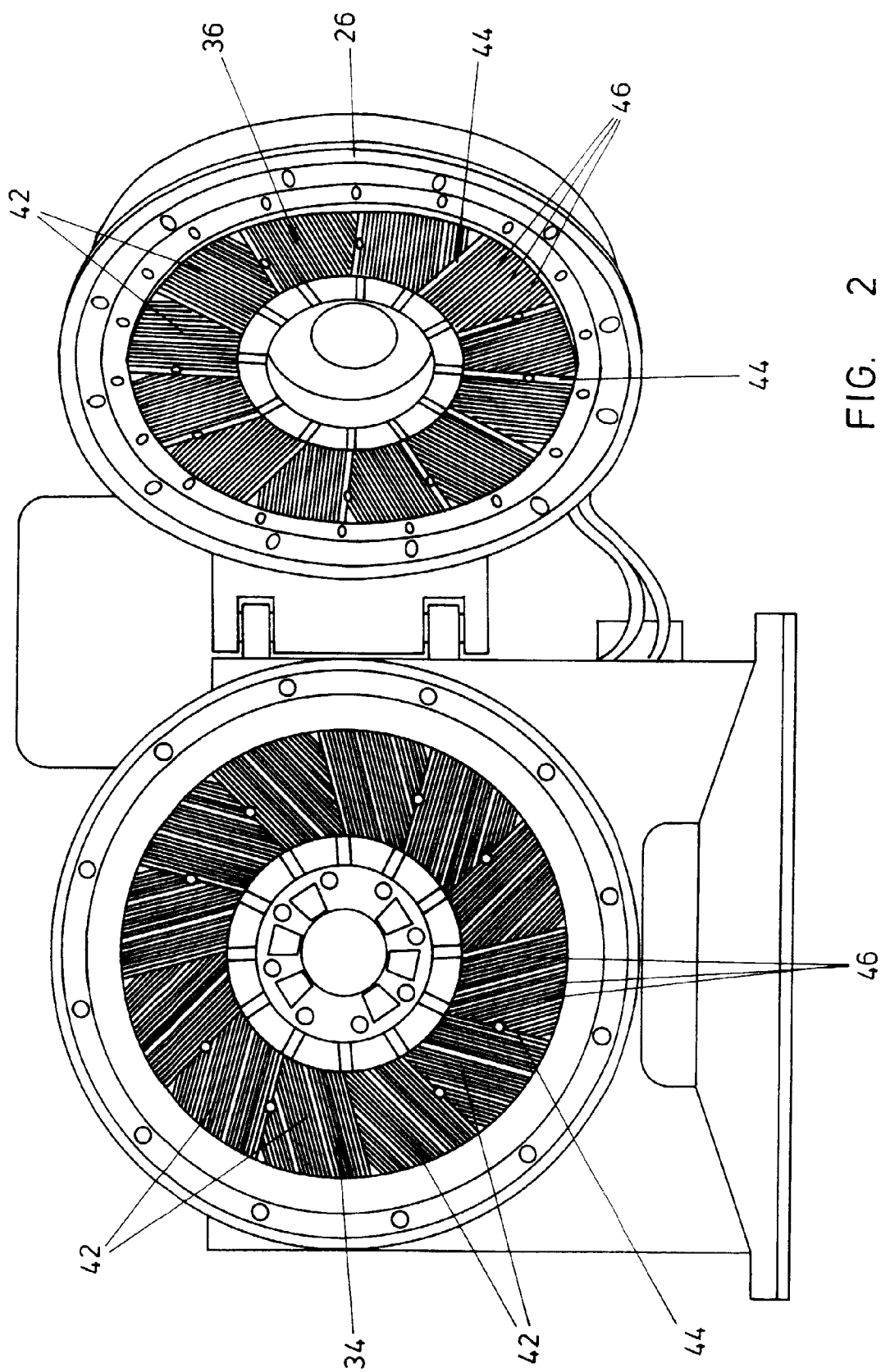


FIG. 2