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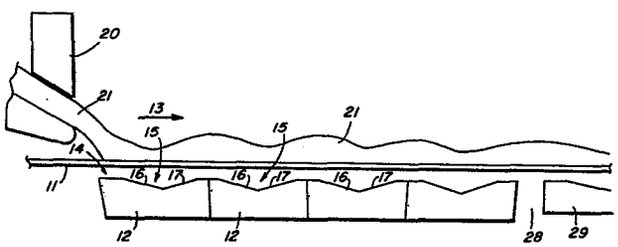
(71) Applicant: **M/K Systems Inc., Gardenstreet, Danvers Massachusetts (US)**

(72) Inventor: **Kallmes, Otto J., 53 Evans Road, Marblehead, Massachusetts 01945 (US)**

(74) Representative: **Paul, Dieter-Alfred, Dipl.-Ing., Erftstrasse 82, D-4040 Neuss 1 (DE)**

(54) Method and apparatus for stock deflocculation on the Fourdrinier machine wire.

(57) Paper stock is deflocculated on the machine wire by laying down a ridged layer of stock and phase-shifting the ridges without substantial dewatering. This phase shifting creates cross-machine direction (MCD) mass transfer of the stock and deflocculating CMD shear forces within it. Apparatus comprises a serrated slice or other means for delivering ridged-stock to the wire in combination with a series of foil blades beneath the machine wire adjacent to the headbox, each blade having a recessed land inclined first downward and then upward in the direction of machine motion and with substantially no dewatering of the stock on the wire until the stock reaches a location downward form the blades, causing water to be repeatedly drawn through the wire and directed upwardly by the inclined land, causing phase shifting of the ridges and hence CMD shear and significant deflocculation befor any web formation occurs.



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Method and Apparatus for Stock Deflocculation on the Fourdrinier Machine Wire

One of the perennial problems in papermaking is floccing of the paper stock, particularly when it emerges from the headbox and is deposited on the machine wire in the forming board area. Almost invariably floccing is observed at this point. For example, rectifier roll headboxes generally deliver only flocculated stock, and in the case of nozzle-type hydraulic headboxes, turbulence disappears within a few inches of travel on the wire, and reflocculation occurs. The matter of turbulence is analyzed in a paper in 1978 TAPPI pages 115 to 120 by the present inventor.

Various procedures for reducing floccing or the adverse effects of floccing include such things as the use of special headboxes, profile bars, jet impingement on the Fourdrinier wire and the like. A prior means separately suggested by the present inventor was to use an elongated non-dewatering forming board, as disclosed in the TAPPI reference, and agitator

blades which create pressure pulses, thereby causing stock jump-type turbulence as described in US patent 3,573,159 by O. Sepall, and 3,874,998 by D. Johnson. Both of these patents refer to turbulence created throughout the forming period rather than prior to it when it is most needed. This is because the stock delivered to the wire by rectifier roll headboxes is badly dispersed due to their lack of fine-scale dispersing elements. In the case of high-turbulence headboxes, the fine scale turbulence dissipates in a few centimeters of travel down the wire, even at high machine speeds, and reflocculation occurs virtually instantaneously. Finally, stock jump-type turbulence is less effective in redispersing stock than CMD shear as created by wire shakes on slow papermachines, i.e., those running under 200 m./min. These slow papermachines, with their CMD-shear inducing shakes, produce by far the most uniform, least flocculated papers in spite of their almost complete lack of stock-jump type turbulence. This is because the pressure pulses created at low machine speeds by dewatering elements are of negligible amplitude. Thus, the problem of flocculation remains, and flocculation continues to result in a far from optimum paper.

According to the present invention, improved defloccu-
lation is accomplished on the machine wire itself, prior to any substantial web formation and throughout it. The stock is delivered to the wire with a multiplicity of ridges running in the machine direction (MD), and is redispersed on the Fourdrinier wire both before any significant dewatering occurs on the forming board, and thereafter while mat formation takes place. The uniform flow of stock inside the headbox just prior

to the slice is formed into a series of ridges running in the MD at or as soon as possible after the slice of the headbox, and CMD shear is produced in the forming board area and thereafter by causing a phase shift of the ridges.

The mechanism producing deflocculation by means of phaseshifting of the MD ridges is as follows:

When parallel ridges of stock, which are unstable structures, collapse on their own, like waves on a pond, or are forced to do so by being bounced off a surface or subjected to a vacuum pulse like that of a foil blade. Half of the fluid in a collapsing given stock ridge combines with half of the fluid from the collapsing ridge on one side of it, and the other half mixes with half of the fluid from the collapsing ridge on its other side. This collapse and reforming of the ridges, producing valleys along lines in the MD where there originally were ridges, and vice versa, is referred to as a phase shift. The collapse and regeneration of the ridges, and especially their phase shifting involves considerable CMD mass transfer, and hence strong fiber dispersing CMD shear.

The more phase shifts which can be produced on the wire without permitting substantial dewatering in the forming board area, and during dewatering and web formation thereafter, the further down the table is the stock which remains to be dewatered kept deflocculated, and the more uniform the sheet produced.

In one embodiment of the invention the result is achived by a serrated slice or other means to produce a

stock flow onto the wire with MD ridges, this flow being in combination with a forming board having non-dewatering cross direction steps which cause repeated phase shifts of the ridges. The stock on the wire then passes to the foils for dewatering.

An important characteristic of these non-dewatering blades is that they do not generate any stock-jump type turbulence. This is the form of turbulence foils are generally designed to create. Stock-jump type turbulence severely damages or destroys the MD ridges, and thereby prevents phase shifting, and hence CMD shear of the stock. Repetitive ridging is maintained and even improved, and stock jump turbulence prevented, by causing the change in the direction of the flow of fluid under the wire from downward to upward at a point close to where the phase shift of the ridges would have occured in the absence of the blades.

The general nature of the invention having been set forth, the invention is more fully described in connection with the drawings in which:

Fig. 1 is a diagrammatic side view of a portion of the forming board area of a Fourdrinier machine according to one embodiment of the invention.

Fig. 2 is a similar view of a similar area according to another embodiment of the invention.

Fig. 3 is a similar view of still another embodiment of the invention.

Fig. 4 is a similar view of still another

embodiment of the invention.

Fig. 5 is a perspective view of a serrated slice according to one embodiment of the invention.

Fig. 6 is a diagrammatic top view of a portion of paper stock on a machine wire in one embodiment of the invention.

In Fig. 1 is shown a Fourdrinier machine wire 11 passing over a forming board 14 in the machine direction indicated by arrow 13. The board 14 comprises a series of foil blades 12, each having a recessed zone 15 which falls and rises toward the next blade 12. The downward edge 16 or bottom wall of the recessed land may be a vertical step or, as shown, a downwardly inclined step, or a sloped land like that of a conventional foil blade. The gradually rising portion of the blade 12 has a sloping angle 17 like that of a conventional foil blade set in a reversed position, and butting up against the following double angled foil blades 12. Spaced beyond board 14 is the first regular blade 29 of a conventional foil box of the Fourdrinier machine.

A serrated top slice lip 20 (see Fig. 5) is positioned before the area of board 14 to deliver a flow of stock 21 from the headbox (not shown) to the wire 11. This slice 20 delivers the stock 21 to the wire 11 in a layer having a series of parallel ridges in the machine direction (see also Fig. 6). As the machine wire moves along the forming board 14 the layer is laid down on the wire 11 and as it passes the first part 16 of the blade 12 and moves over the recessed land 15, water is drawn through the wire 11 and into the recess. The machine

motion carries the water upwards on the slanting land of the upward facing land area 17, directing the water through wire 11 and into the layer of stock 21. As is shown in Fig. 1, the level of the stock on the wire 11 rises and falls as it passes over and beyond the various blades 12.

In Figure 2 is shown a Fourdrinier wire 11 passing over a forming board 14 in the machine direction indicated by the arrow 13. Instead of a serrated slice lip to create the MD ridges in the stock, which could have been used, a formation shower 34 is employed to form the MD ridges (see Fig. 4). The board 14 is comprised of individual conventional foil blades butted up against one another. The first foil blade 18 is a conventional forward facing blade having a downward facing land area 16, followed in contact with it by a reversed blade 19 with an upward facing land area 17, the two blades in combination creating the recessed zone 15. Butting up against the reversed blade 19 is another forward facing blade 18, then a reversed blade 19, and so forth. Beyond the last reversed blade 19 is a gap 28 followed by the first conventionally-dewatering foil blade 29.

In Fig. 3 is illustrated a different form of the invention having a machine wire 11 receiving a layer of stock 21, again from a serrated slice 20. Positioned beneath wire 11 at the board area are the several individual blades, each pair of blades creating a recessed land area 25 which has a downward slanting zone 24 of the conventional foil 22 followed by a reversed conventional foil creating an upward wall 27 rising toward the far end, or slanting upwardly in the direction of machine motion. Between each successive

pair of blades 22 and 23 is a very small gap 26 permitting the passage of a small quantity of drained water to the box beneath the blades 22 and 23. This permits flow of a small quantity of water, sufficient to keep the blades rinsed clean but insufficient to accomplish significant dewatering of the stock 21. The extremely thin layer of sheet formed by this small amount of dewatering is redispersed by the re-entry of the drained water from the upward sloping land area 27 into the layer of stock 21 above the wire 11.

In the case of either the form in Fig. 1 or the form in Fig. 2, or the form in Fig. 3, or in a combination of the three forms, the wire 11 passes from the blades 12 or 18 and 19 or 22 and 23 to the first regular blade of a foil box, preferably after passing a small gap 28 before blade 29 where dewatering begins.

Fig. 4 illustrates an embodiment of the invention further on down the Fourdrinier wire wherein a single foil box combines a non-dewatering board 32 with subsequent dewatering foil blades. As illustrated, box 31 has a board 32 with a plurality of blades 23 with rising recessed lands 17. Positioned further along in the direction of wire motion are a plurality of foil blades 39 with support surfaces 36 at their initial ends. A formation shower 34 directs a series of jets 35 of water across the width of the wire onto the layer of stock 21, which thereby becomes ridges. In this form, as in the others, the ridges undergo successive phase shifts across board 32 before dewatering at blades 39.

In Fig. 5 is shown a serrated slice 20 having a declined

front face 41 terminating at its lower edge in a series of serrations 42 or curved edges comprising a succession of protrusions 43 and recessions 44. This slice 20 is of conventional dimensions and shape except for these serrations 42. The slice 20 is positioned at the delivery of the stock 21 to the machine wire 11 (see Figs.1, 2 and 3) and is adapted to deliver a layer of stock which is thinner at the center of the protrusions 43 and thicker at the recessions 44, thus forming longitudinal ridges in the layer of stock being delivered.

Fig. 6 is a diagrammatic top view of a layer of stock 21 on a machine wire (not visible) according to any of the Figs. 1 through 4. This layer of stock 21 has a series of ridges 51 running longitudinally along the direction of machine motion, as delivered to the wire by the serrated slice 20 or a formation shower positioned just ahead of the slice at the point where the stock lands on the wire. At a point generally coinciding with the end of a blade (see, for example, blade 12 in Fig. 1) these ridges trail away, decaying and reforming as new ridges 52 displaced or phase-shifted between each of the original ridges 51. The result is a phase shift in which the original ridges have become valleys and the original valleys have become ridges. The decay and reformation of these ridges 51 and 52 is repeated at each blade in both the non-dewatering area and in the dewatering area where sheet formation occurs and the conventional foil blades are set at a distance apart equal to the length of the ridges formed in the absence of foil blades.

The mechanism of operation of the invention is a consequence of this repetitive decay and re-forming of

these ridges 51 and 52 as shown in Fig. 6. The constant repeated motion of the stock in the formation of such ridges is, on the fast moving wire of a Fourdrinier machine, CMD shear of such nature as to reduce floccing of the stock and to generate a stock of improved smoothness and evenness.

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Method and Apparatus for Stock Deflocculation on the Fourdrinier Machine Wire

Claims:

1. In a paper machine having a Fourdrinier wire and a headbox to feed stock to the machine wire, a forming board adjacent to the headbox prior to substantial dewatering of stock and having a plurality of blades transverse to the direction of machine motion, at least one blade with a downward step, said step being adapted to create vacuum beneath the moving machine wire, a rising land area following said downward step, said rising land area being angled upwardly toward the wire, whereby water at said land area is directed upwardly toward said wire, said blade and rising land area restricting water removal from the wire location, and means to deliver stock to said wire with longitudinal machine direction ridges, whereby stock in a layer having longitudinal ridges is placed on the machine wire and the

ridges are phase shifted by moving water at the recessed areas formed by said downward step and rising land area.

2. The apparatus of Claim 1, having a plurality of blades each with a downward step and a rising land area.

3. The apparatus of Claim 1 wherein said means to deliver stock to said wire includes a serrated slice positioned to deliver stock to said wire.

4. The apparatus of Claim 2, wherein said blades are positioned closely together to prevent substantial dewatering in the blade area.

5. In papermaking apparatus wherein stock is delivered from a headbox to the Fourdrinier wire of a paper machine adjacent to the headbox, the combination comprising means for delivering said stock in a layer having ridges along the direction of machine motion, a stepped surface adjacent to said headbox supporting and beneath the machine wire, said surface having a plurality of steps transverse to the direction of machine motion, longitudinal recesses located at positions following each step and transverse to the direction of machine motion, said recesses being adapted to form partial vacuum beneath said wire to draw water from the stock into said recesses and to retain water therein, and base surfaces in said recesses rising in the direction of machine motion, whereby cross machine direction shear is created in the stock at the location of said ridged surface.

6. The apparatus of Claim 5, wherein said ridged surface is substantially impermeable to water flow therethrough.

7. The apparatus of Claim 5, wherein said ridged surface has a plurality of narrow openings therein for passage of water in limited amounts sufficient to maintain surface cleanliness and insufficient for substantial dewatering of the stock.

8. A method of deflocculating paper stock on a Fourdrinier machine wire comprising forming said stock in a layer having ridges longitudinal in the direction of machine motion, repeatedly drawing water through said wire immediately after delivery of stock thereto, retaining the withdrawn water beneath the wire and in contact with the wire, repeatedly directing the withdrawn water back to and through the wire prior to dewatering of the stock, whereby the longitudinal ridges in the layer of stock are repeatedly shifted in phase to reverse the ridges and the valleys between the ridges, and thereafter dewatering said stock.

9. A method of deflocculating paper stock on the Fourdrinier wire comprising forming stock in a layer having ridges therein which ridges are longitudinal in the direction of machine motion, repeatedly drawing water through the wire and immediately returning water through the wire to the stock in the substantial absence of dewatering of the stock, whereby said ridges are repeatedly collapsed and formed again in displaced parallel positions.

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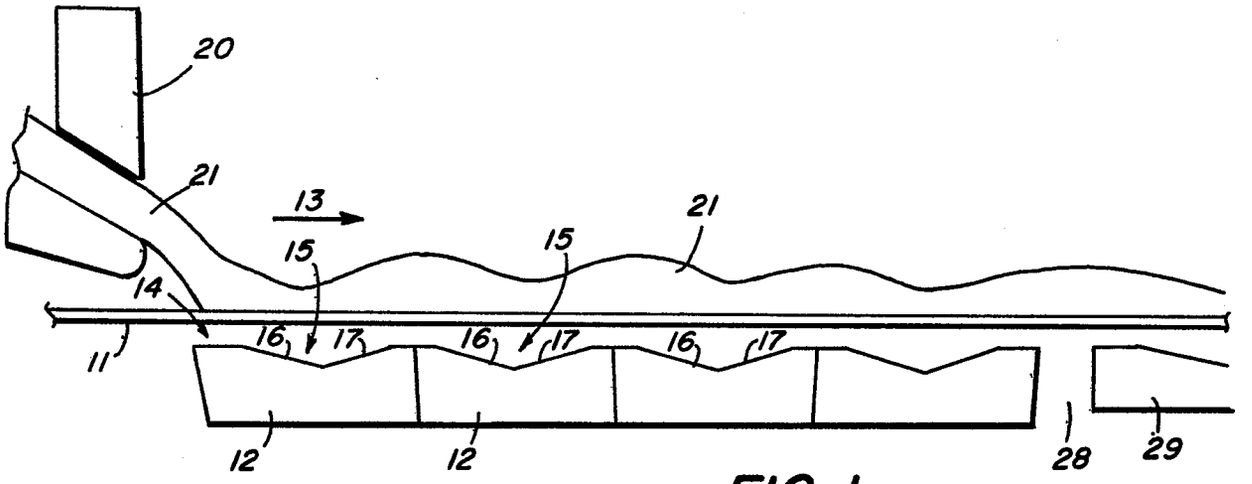


FIG. 1

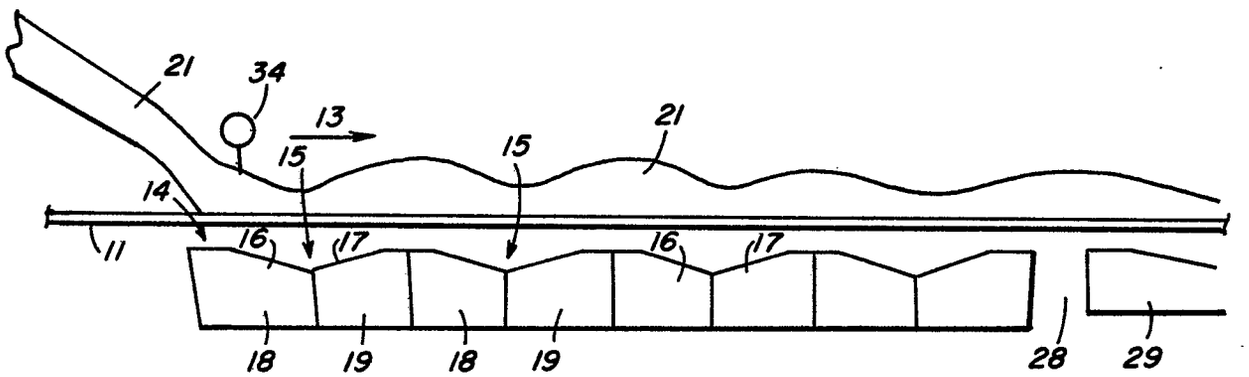


FIG. 2

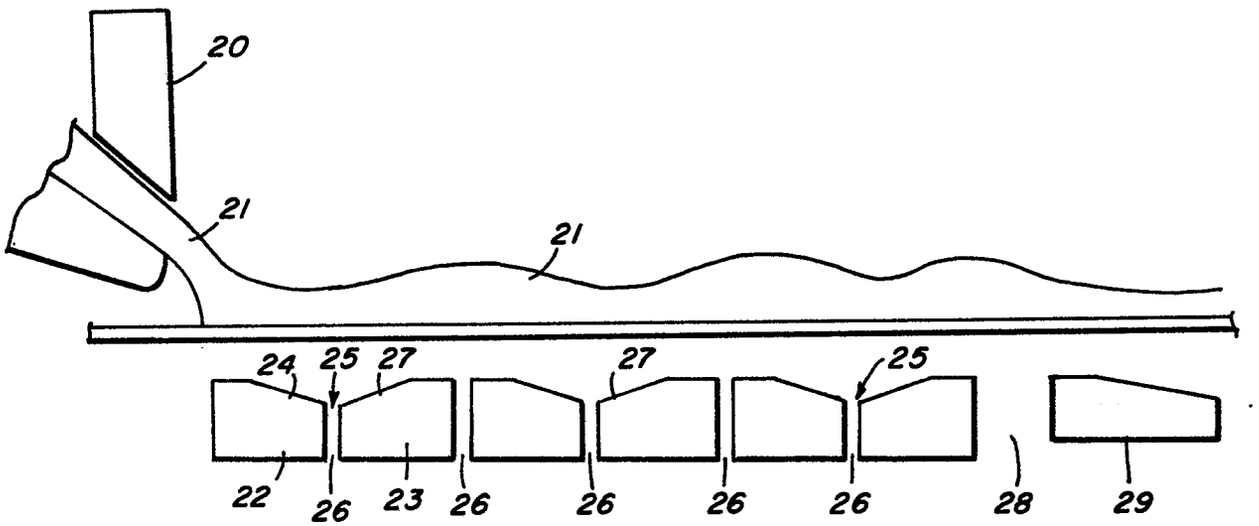


FIG. 3

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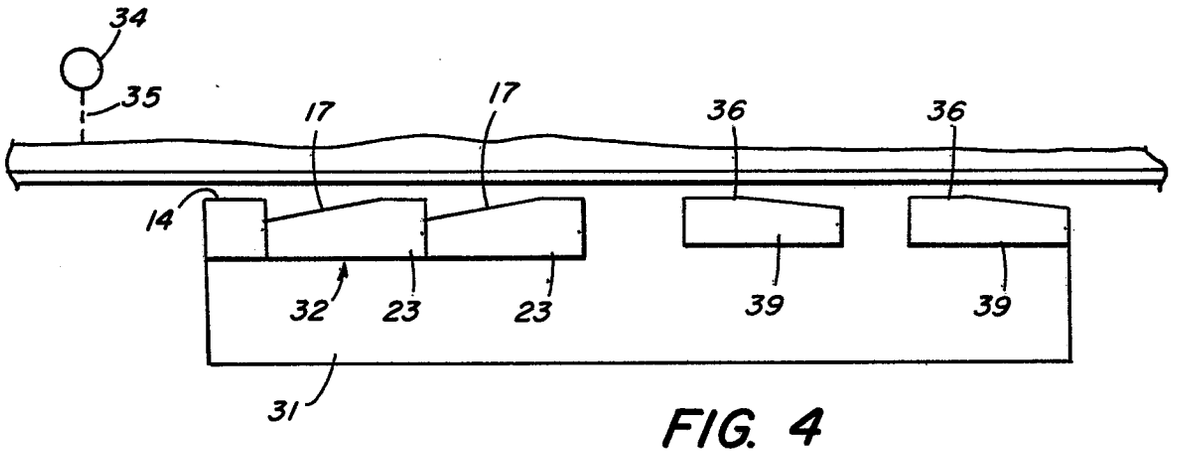


FIG. 4

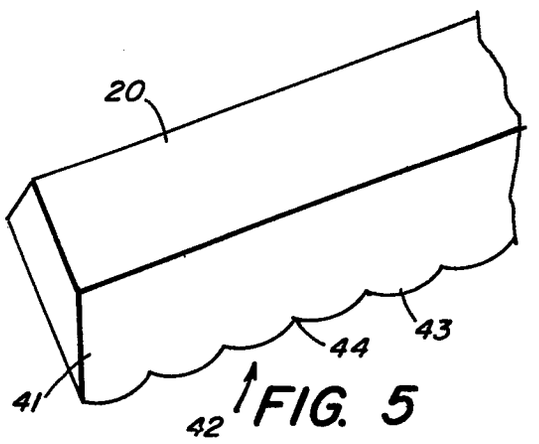


FIG. 5

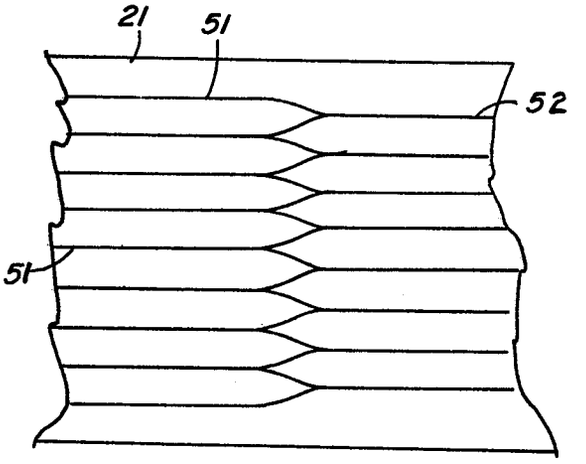


FIG. 6