Feb. 16, 1954 J. BAXTER, JR 2,669,165

PAPER MACHINERY

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Fig-1

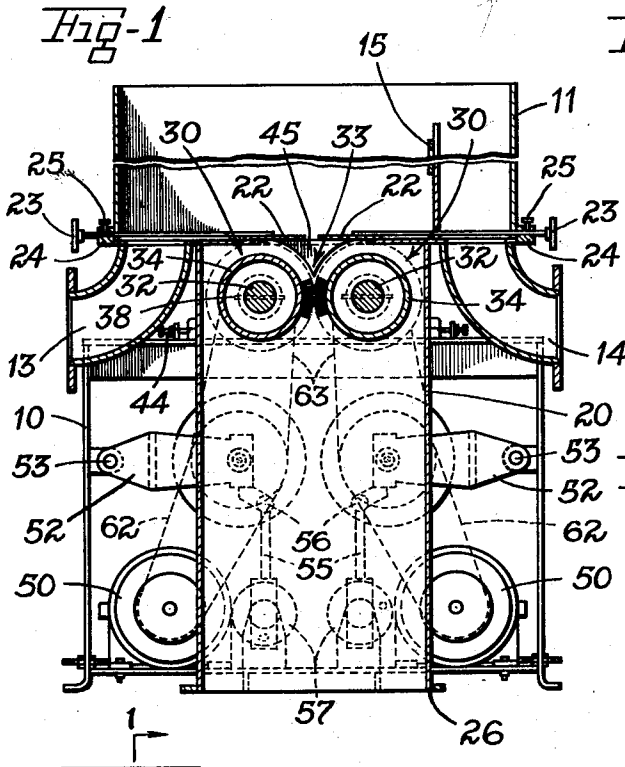


Fig-3

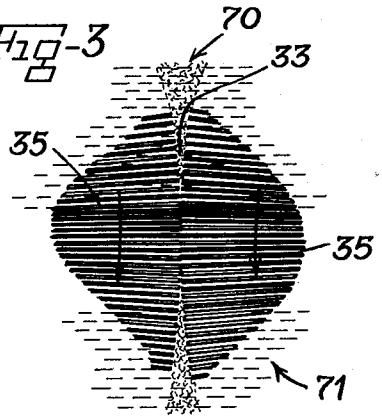


Fig-4

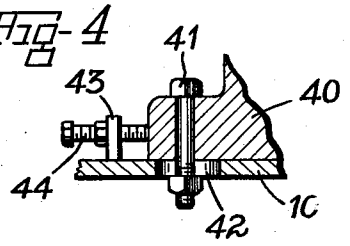


Fig-2

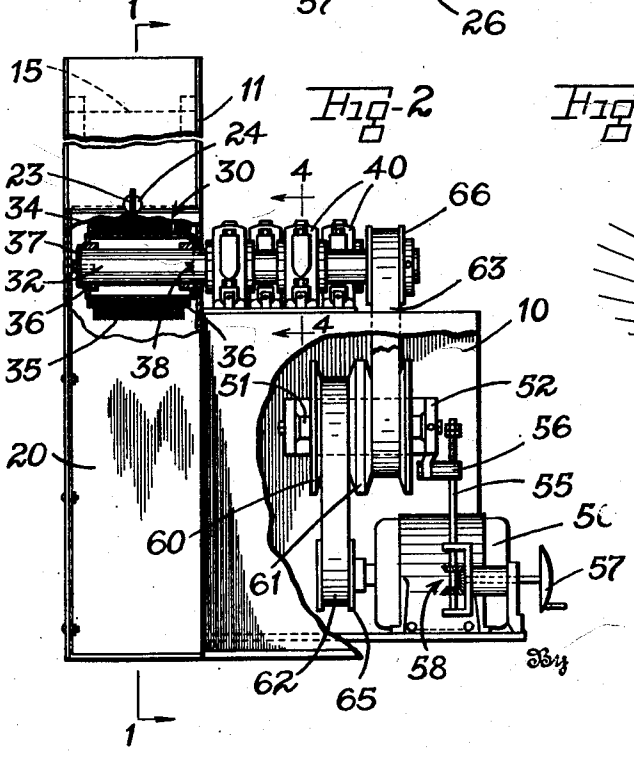
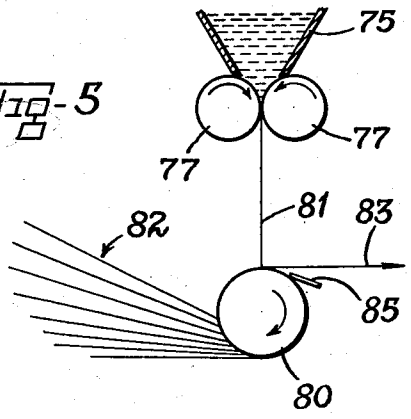


Fig-5



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2,669,165

PAPER MACHINERY

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10 Claims. (Cl. 92—20)

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This invention relates to apparatus and a method for the treatment of paper making stock and other liquid slurry stocks.

The invention has particular relation in paper making to the defibering of the stock as it comes from the beater or other pulping apparatus, for the purpose of effecting separation of the individual fibers from the bundles or lumps of fiber in the pulp before the stock is treated in a jordan or other like refiner. It is a conventional practice to defiber the stock at this stage of its preparation by a so-called slushing operation in a jordan, with the plug backed off to provide substantial clearance between the cutter bars of the plug and shell. However, this is not an efficient procedure, since it is necessary to throttle the output in order to assure an adequate period of treatment, and the power requirements are accordingly relatively high in comparison with the capacity. Furthermore, in a jordan or other conventional refiner employing bars, disks or plates for the refining action, a large portion of the stock passes through the channels between the cutting surfaces while only a small fraction of the fibers are actually worked on, which further reduces the efficiency of such apparatus for this purpose.

The present invention provides an entirely different type of action on the stock and employs a pair of rapidly rotating cylindrical brushes which are covered with closely spaced bristles and which are arranged in parallel and close relation to form a nip for receiving the stock to be treated. In operation the stock is fed to the nip in a controlled flow such that it is all forced to pass between the brushes, and with the bristles thereon relatively closely arranged, there is an effective straining and dewatering action such that the fibers are concentrated in a thin layer which passes through the nip of the brushes while the liquid component of the stock flows through the bristles on either side of the nip. The thickness of this concentrated layer depends on both the relative spacing of the bristles on each brush and the closeness of the brushes to each other, as well as on the speed of rotation of the brushes and the consistency of the stock, and if the bristles are sufficiently close and the brushes rotate at high speed and are arranged in substantially touching relation, the layer will approach the effective thickness of the individual particles of which it is composed, with the result that each individual particle will be directly worked upon as it passes through the nip. Also, this action will be substantially uniform for all

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particles since there is no opportunity for the stock to pass through the device except by passage through the nip of the brushes.

The effectiveness of the apparatus and method of the invention is increased by suitable control of the rate of the approach flow of the stock with respect to the peripheral speed of the rotating brushes. Thus if the approach flow is relatively slow in comparison with the brush speed, there will be a sudden acceleration of the stock entering the nip of the brushes as it passes through the nip. When the fibers are thus suddenly accelerated, and particularly with the acceleration imparted by the rotation of the brush surfaces against the inertia of the relatively slow approach flow, the fibers are brushed out in the direction of flow through the nip, and there is thus a teaseling effect by the action of the ends of the bristles against the slow moving approach flow of the body of the stock which causes the individual fibers to be literally drawn or snatched out of the suspension with resulting highly effective and complete separation of these fibers from each other.

It is accordingly one of the principal objects of the present invention to provide apparatus and a method for treating liquid slurry stocks wherein the stock to be refined is caused to pass between rotating cylindrical brushes under such controlled conditions of relative speeds and spacing that substantially complete separation of the individual fibers or other particles is accomplished in a single pass.

Another object is to provide apparatus and a method for refining liquid slurry stocks wherein the refining power is applied directly to the individual fibers or other solid particles in the stock, rather than to bundles or groups of fibers, and wherein all the solid material in this stock is caused to come in working contact with the working surfaces of the refining members with no opportunity for channeling or bypassing.

An additional object is to provide such an apparatus and method wherein the solid material in the stock is concentrated and dewatered during working thereon for effective separating action and is then remixed with the liquid part of the stock for effective resuspension as it is discharged, and wherein knots and other undesired non-fibrous particles, lumps or the like, are passed through without comminution and without damage to the apparatus.

It is also an object of the invention to provide refining apparatus of the character described which is simple to construct and to maintain,

which is economical of power and space in operation, and which is readily varied in its action in accordance with the desired characteristics of the refined stock.

Other objects and advantages will be apparent from the following description, the accompanying drawing and the appended claims.

In the drawing—

Fig. 1 is a view partly in elevation and partly in section on the line 1—1 of Fig. 2 showing refining apparatus constructed in accordance with the invention;

Fig. 2 is a side elevation, partly broken away and in section, of the apparatus of Fig. 1;

Fig. 3 is an enlarged and schematic view illustrating diagrammatically the action of the apparatus;

Fig. 4 is an enlarged fragmentary section on the line 4—4 of Fig. 2; and

Fig. 5 is a schematic view illustrating diagrammatically a combined refining and thickening operation in accordance with the invention.

Referring to the drawing, which illustrates a preferred embodiment of the invention, the base frame 10 supports a headbox 11 which receives the stock to be refined through an inlet connection 13, and which is provided with an overflow discharge connection 14 controlled by an adjustable overflow dam 15. A housing 20 which is rectangular in horizontal section is mounted below the headbox 11 to receive the stock therefrom, and communication between the headbox and housing is controlled by a pair of laterally adjustable gates 22 having suitable handle rods 23 slidable in bushings 24 and provided with set screws 25 for holding the handles with the gates 22 in desired adjusted position. The housing 20 is adapted for connection at 26 to a suitable conduit or the like for receiving the discharged stock.

Within the upper end of the housing 20 and just below the gates 22 is a pair of cylindrical brushes 30 mounted on a pair of parallel shafts 32 and arranged with their adjacent surfaces in substantially touching or kiss contact relation to form a nip 33 which receives the stock flowing downwardly between the gates 22. As shown in Fig. 2, each brush 30 includes an annular core or mandrel 34 covered with closely spaced bristles 35 and mounted on the shaft 32 by means of a pair of end hubs 36 and an end cap 37 bolted to the end of the shaft, with one of hubs 36 keyed to the shaft by means of the pin and slot arrangement indicated at 38. Satisfactory results have been obtained with the bristles 35 formed of thin wire, such as stainless steel wire $\frac{1}{64}$ inch in diameter arranged with approximately 256 wires per square inch at the surface of the brush, and in order to assure that the outer ends of the bristles will be closely spaced, the length of the bristle is preferably comparatively short in comparison with the diameter of the core 34. For example, satisfactory results have been obtained with each of the bristles only about one inch in length in comparison with a diameter of eleven inches for the core.

Provision is made for supporting the shafts 32 in accurately parallel and spaced relation to maintain the desired uniformly close relationship of the brushes 30. Each shaft is of relatively large diameter for adequate stiffness and is supported in a pair of similarly large pillow blocks 40 adjustably mounted on the top of the base frame 10 by means of bolts 41 in slots 42. As shown in Fig. 4, lugs 43 are welded to the top of the frame 10, and bolts 44 are threaded therethrough to engage the pillow block 40 on either side and thus to provide for laterally adjustable positioning of each of the pillow blocks in proper relation with the others to give the desired spaced alignment of the shafts 32 before the bolts 41 are tightened to hold the parts in the desired proper relation. The openings in the side of housing 20 are formed with sufficient clearance for shafts 32 to provide for such lateral adjustment as may be necessary, and fillets 45 are provided at each end of nip 33 and just inside the ends of the brushes 30 to serve as dams assuring proper guiding of the stock between the brushes, the lower edges of these fillets being curved as shown for a running fit with the surfaces of the brushes.

Each of the brushes 30 is shown as provided with a separate drive motor 50 and an adjustable speed drive. Each drive includes an intermediate shaft 51 carried by a frame 52 pivoted at 53 to the base 10. The frame 52 is adjustable about its pivot 53 by means of a screw 55 threaded through a swivel 56 on the frame 52 and operated by a handle 57 through gearing indicated at 58. Each of the intermediate shafts 51 carries two axially fixed outer sheaves 60 and an axially movable inner sheave 61, and the belts 62 and 63 connect these sheaves with the drive pulley 65 on the motor shaft and a pulley 66 on the shaft 32. Accordingly, when either of the shafts 51 is raised or lowered with its frame 52, the floating sheave 61 will be caused to move to the right or left respectively as viewed in Fig. 2, and the effective relative diameters of the intermediate sheaves are thus changed to vary the drive speed of the shaft 32 connected therewith.

In operation with this construction, the stock to be refined is supplied to the headbox 11, and the gates 22 are adjusted to admit this stock to the nip 33 at a desired rate. Highly desirable results are obtained when the rate of approach flow to the nip is relatively slow in comparison with the peripheral speed of the brushes 30, for example an approach flow of the order of 16 feet per second for stock at a consistency of approximately 4% by weight when the peripheral speed of the brushes is of the order of 200 feet per second. Under these conditions, it will be seen that the stock entering the nip is drawn quickly therethrough, and also with the brushes arranged as shown in Figs. 1 and 2 in close fitting relation to the bottom of the headbox 11 and to the fillets 45, all of the stock passing through the gates 22 also passes through the nip of the brushes, since the effect of the rotation of the brushes at high speed is such as to inhibit bypassing of the stock around them.

Maximum effectiveness in refining or defibering action, as well as the minimum power requirements, have been obtained when the brushes are arranged and operated as described at the same relatively high rotational speed. Under these conditions, the individual bristles become substantially rigid as a result of centrifugal force, and with the peripheral speed of the brushes materially greater than the rate of approach flow of the stock to the nip 33, the ends of the bristles work against the comparative inertia of the pool of stock in the nip, which causes a brushing or drawing out action on the fibers before they reach the smallest part of the nip effective to separate the bundles or groups of fibers into their individual components.

Another result of a substantial speed differen-

tial between the approach flow of stock and the peripheral speed of the brushes is to produce sudden and violent acceleration of the stock as it passes between the brushes, which further aids the desired separating action. Also, since the relative inertia of the approach flow provides a drag on the fibers against which the ends of the bristles work, there is a separating action on the individual fibers which is similar to the effect of teaseling or raising the nap on a blanket or other fabric, with the individual fibers being literally drawn or dragged out of suspension by stapling over the rapidly moving ends of the bristles. Furthermore, this abrading action of the bristle ends creates zones of intense hydraulic shear which further aid the desired effect of tearing apart the bundles or lumps of fibers.

In addition to these actions on the stock as it approaches the nip 33, the fibers or other solid particles therein are concentrated in a thin layer as they pass between the brushes, as indicated diagrammatically at 70 in Fig. 3, since with the bristles closely packed and the brushes rotating at high speed, there is considerable resistance to penetration of the brushes by the fibers. On the other hand, the liquid component of the stock can flow through the spaces between the sides of the bristles, as indicated at 71 in Fig. 3. There is thus a straining and dewatering action on the fibers as they pass through the nip of the brushes, so that the brushing or teaseling effect of the ends of the bristles is applied directly to the individual fibers in an increasingly dewatered and compacted condition.

The thickness of the layer 70 of fibers depends upon the relative spacing of the brushes 30, and optimum effectiveness in the defibering action has been obtained when the ends of the bristles are in substantially kiss contact and the speed of rotation of the brushes is uniformly high. Under such conditions, the effective thickness of the layer approaches the thickness of the individual fibers, and the maximum work is done on each fiber. At greater spacing of the brushes, the action may be less effective for a single pass through the device, and if the brushes are closer together, the resulting rubbing action due to intermeshing of the ends of the bristles causes undesirable wear and friction.

The invention accordingly provides a highly effective refining action which has the further advantage of economical cost both in the production of the apparatus and in the operating cost and power requirements. Since all of the stock is forced to pass through the nip of the brushes, it is all subjected substantially equally to the effective forces, and there is no opportunity for channeling such as can take place in a jordan type of refiner. Also, the power is applied directly to the individual fibers in concentrated and partially dewatered condition, thus giving high efficiency as well as highly effective defibering and refining action. As a result, it is often found that adequate defibering is accomplished on a single pass through the apparatus.

Another valuable advantage provided by the invention in operation is that if there are hard lumps or the like in the stock, such for example as knots, paper clips or the like, they will merely depress the bristles of the brushes sufficiently to permit their passage through the nip. This is a highly advantageous feature when the apparatus is employed for refining cooked wood chips including knots or incompletely cooked portions, since it is thus possible to remove substantially

all usable fiber from the knots which may be present without grinding up the knots themselves, which are readily removed by a suitable screen at a later stage in the refining system. The same result is obtained with respect to pieces of cellophane or the like, which are passed through the nip substantially without disintegration and can thus be readily removed by a subsequent screening step.

With the brushes supported as shown at the upper end of housing 20 and thus above the liquid level in the housing, the lower part of the housing forms a chamber open to atmosphere at the discharge side of the nip of the brushes which provides an open space for free discharge of stock from the nip without back pressure such as would result if the brushes were submerged, and since the stock is thus able to attain a high speed in passing through the nip of the rotating brushes, it is discharged relatively violently into the open lower part of the housing 20, and the fibers or other particles are thus thoroughly remixed with the liquid component of the stock by this high velocity discharge. Effective resuspension of the fiber is thus effected substantially immediately, and the stock may be piped away if desired from the lower end of the housing 20 for further refining or other treatment. In addition, centrifugal force is particularly effective at the point of discharge of the stock from the nip, since it causes any fiber which may have penetrated between the bristles to be thrown clear into the lower part of the housing. Thus in addition to the other advantages of the apparatus, its natural action in operation is such as to cause continuous self-cleaning of the brushes.

Fig. 5 illustrates somewhat diagrammatically an arrangement of apparatus wherein the high velocity of the discharge from the rotating brushes is utilized for high speed thickening of the stock after its passage between the brushes. In Fig. 5, the stock to be treated is shown as conducted by a funnel 75 to a pair of rotating cylindrical brushes 77 of the same general characteristics and arrangement as described in connection with Figs. 1 to 3. A wire covered roll 80 is mounted below the nip of the brushes to receive the discharge therefrom as indicated at 81. The high speed discharge from the brushes thus impinges on the roll 80 so that a large proportion of the liquid component will be thrown through the wire covered roll surface, leaving the fiber on its outer surface. With the roll 80 rotating in clockwise direction as indicated by the arrow in Fig. 5, the liquid will be discharged as indicated at 82 and may be collected and recirculated as required to recover such fibers as may be thrown through the wire covered surface of the roll. Similarly the fiber will in large measure be thrown off from the top of the roll 80 in the opposite direction as indicated by the arrow 83, and this removal of fibers from the roll may be facilitated by a doctor as indicated at 85.

The apparatus and method of the invention have been found particularly useful in connection with the refining of paper making stock, but their use is not limited to this field and they are applicable to the refining of other liquid slurry stocks, particularly where high speed and low cost of operation are desirable, and they offer similar advantages of effective and low cost refining for such purposes and may be readily adapted to the particular conditions involved in such other uses.

Accordingly, while the methods and forms of

apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise methods and forms of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. Apparatus for treating a liquid slurry stock comprising a pair of cylindrical brushes, means including a frame supporting said brushes for rotation with the axes thereof in predetermined spaced and parallel relation in substantially the same horizontal plane to locate adjacent surface portions thereof in close relation forming a horizontal nip adapted to receive said stock in vertical flow therethrough, means forming an inlet located substantially directly above and in line with said nip for supplying said stock in direct vertical flow thereto, means controlling said supply flow of stock to said nip to a relatively slow rate of approach flow, drive means effective to rotate said brushes at a relatively high peripheral speed materially greater than said approach flow rate to draw said stock through said nip at a suddenly accelerated rate of flow for effective separation of the solid component of said stock into substantially individual particles and to discharge said separated stock with high centrifugal force substantially directly downwards, and means forming a chamber open to atmosphere below said nip to provide an open space for receiving said freely discharged stock from said nip.

2. Apparatus for treating a liquid slurry stock comprising a pair of cylindrical brushes, means including a frame supporting said brushes for rotation with the axes thereof in predetermined spaced and parallel relation in substantially the same horizontal plane to locate adjacent surface portions thereof in close relation forming a horizontal nip adapted to receive said stock in vertical flow therethrough, means forming an inlet located substantially directly above and in line with said nip for suppling said stock in direct vertical flow thereto, means controlling said supply flow of stock to said nip to a relatively slow rate of approach flow, means confining the effective width of said inlet to substantially less than the distance between said brush axes to limit said approach flow of stock to a width not substantially greater than the minimum width of said nip, drive means effective to rotate said brushes at a relatively high peripheral speed materially greater than said approach flow rate to draw said stock through said nip at a suddenly accelerated rate of flow causing effective separation of the solid component of said stock into substantially individual particles and maintaining said limited width of said approach flow in the upper portion of said nip, and means forming a chamber open to atmosphere below said nip to provide an open space for receiving said freely downward discharged stock from said nip.

3. Apparatus for treating fibrous paper making stock comprising a pair of cylindrical brushes, means including a frame supporting said brushes for rotation with the axes thereof in predetermined spaced and parallel relation in substantially the same horizontal plane to locate adjacent surface portions thereof in close relation forming a horizontal nip adapted to receive said stock in vertical flow therethrough, means forming an inlet located substantially directly above

and in line with said nip for supplying said stock in a direct vertical flow not substantially greater than the minimum width of said nip, drive means effective to rotate said brushes at a relatively high peripheral speed in the direction to draw said stock through said nip, means for maintaining the rate of said approach flow of stock materially lower than said peripheral speed of said brushes to establish a relative inertia effect on the stock entering said nip causing a teaseling action on the individual fibers therein by the more rapidly moving ends of the bristles on said brushes for effective separation of said fibers from each other, and means forming a chamber open to atmospheric pressure below said nip to provide an open space for free downward discharge of said stock from said nip.

4. Apparatus for treating fibrous paper making stock comprising a pair of cylindrical brushes, means including a frame supporting said brushes for rotation with the axes thereof in predetermined spaced and parallel relation in substantially the same horizontal plane to locate adjacent surface portions thereof in close relation forming a horizontal nip adapted to receive said stock in vertical flow therethrough, means forming an inlet located substantially directly above and in line with said nip for supplying said stock in a direct vertical flow thereto at a relatively slow rate of approach flow, means controlling said approach flow of stock to an effective width substantially less than the distance between said brush axes, drive means effective to rotate said brushes at a relatively high peripheral speed materially greater than said approach flow rate to produce a straining action on said stock causing the fibrous constituents thereof to be concentrated in a central layer with a reduced fibrous content in the layers on either side thereof, means forming a chamber open to atmospheric pressure below said nip for receiving free discharge of said stock from said nip, and said drive means being effective also to create a centrifugal force on said discharged stock sufficient for effective releasing thereof in said chamber.

5. Apparatus for treating a liquid slurry stock comprising a pair of cylindrical brushes, means including a frame supporting said brushes for rotation with the axes thereof in predetermined spaced and parallel relation in substantially the same horizontal plane to locate adjacent surface portions thereof in close relation forming a horizontal nip adapted to receive said stock in vertical flow therethrough, means forming an inlet located substantially directly above and in line with said nip for supplying said stock in direct vertical flow thereto, means controlling said supply flow of stock to said nip to a relatively slow rate of approach flow, drive means effective to rotate said brushes at a relatively high peripheral speed materially greater than said approach flow rate to draw said stock through said nip at a suddenly accelerated rate of flow for effective separation of the solid component of said stock into substantially individual particles and to discharge said separated stock with high centrifugal force substantially directly downwards, a perforated roll supported substantially directly below and in spaced relation with said nip in position to receive said discharge stock on the upper surface thereof, the perforations of said perforated roll being proportioned to cause collection of the solid constituents of said stock on said perforated surface while the liquid constituents of said stock passes into the interior of said

roll, and means for rotating said perforate roll to effect discharge therefrom of said solid and liquid constituent in substantially the opposite direction.

6. The method of treating a liquid slurry stock which includes the steps of flowing said stock directly downwardly into the horizontal nip formed by a pair of brush rolls having the axes thereof in spaced and parallel relation in substantially the same horizontal plane, limiting the supply flow of said stock to said nip to an effective width substantially less than the distance between said brush axes, controlling the rate of approach flow of said stock to a relatively slow rate, and rotating said brushes at a relatively high peripheral speed materially greater than said approach flow rate to draw said stock through said nip at a suddenly accelerated rate of flow causing effective separation of the solid component of said stock into substantially individual particles followed by substantially directly downward discharge of said stock from said nip.

7. The method of defibering paper making stock which includes the steps of flowing said stock directly downwardly into the horizontal nip formed by a pair of cylindrical brushes having the axes thereof in spaced and parallel relation in substantially the same horizontal plane, rotating said brushes at a relatively high peripheral speed in the direction to draw said stock through said nip, limiting the supply flow of said stock to said nip to an effective width substantially less than the distance between said brush axes, controlling the rate of said supply flow of stock to said nip to a rate materially lower than said peripheral speed of said brushes to establish a relative inertia effect on the stock entering said nip causing a teaseling action on the individual fibers therein by the more rapidly moving ends of the bristles on said brushes for effective separation of said fibers from each other, and maintaining the discharge side of said nip open and for free downward discharge of said stock therefrom to promote maximum acceleration of said stock in passing through said nip.

8. The method of defibering paper making stock which includes the steps of flowing said stock to a working station at a relatively slow rate of approach flow, suddenly accelerating the rate of flow of said stock at said station and simultaneously effecting laminar flow thereof to create zones of hydraulic shear therein, dewatering said stock and concentrating the fibers thereof in a relatively thin layer substantially simultaneously with said acceleration step, mechanically working said concentrated fibers to effect separation of the individual said fibers from each other, and thereafter discharging said stock from said working station with sufficient violence to effect thorough remixing of said fibers with the liquid component of said stock.

9. The method of defibering paper making stock which includes the steps of flowing said stock directly downwardly into the horizontal nip formed by a pair of cylindrical brushes having the axes thereof in spaced and parallel relation in substantially the same horizontal plane, limiting the supply flow of said stock to said nip to an effective width substantially less than the distance between said brush axes, rotating said brushes at a relatively high peripheral speed downwardly through said nip to produce a straining action on said stock causing the fibers therein to be concentrated in a central layer surrounded on either side by essentially liquid layers, and discharging said stock freely downwardly from said nip into a chamber open to atmospheric pressure to cause thorough remixing of said fibers and said liquid.

10. The method of defibering and thickening paper making stock which includes the steps of flowing said stock directly downwardly into the horizontal nip formed by a pair of cylindrical brushes having the axes thereof in spaced and parallel relation in substantially the same horizontal plane, limiting the supply flow of said stock to said nip to an effective width substantially less than the distance between said brush axes, controlling the rate of approach flow of said stock to a relatively slow rate, rotating said brushes at a relatively high peripheral speed materially greater than said approach flow rate to draw said stock through said nip at a suddenly accelerated rate of flow causing effective separation of the individual fibers in said stock, discharging said accelerated stock directly downwardly from said nip upon the surface of a perforated roll to cause concentration of said fibers on the surface of said roll while the liquid component of said stock passes into the interior of said roll, and continuously rotating said roll to effect discharge of said fibers and said liquid in opposite directions while continuously presenting a clean surface of said roll to said discharged stock.

JOSEPH BAXTER, JR.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
399,984	Gessl	Mar. 19, 1889
583,229	Harrell	May 25, 1897
773,479	Cornell	Oct. 25, 1904
1,258,568	Howard	Mar. 5, 1918
1,859,224	Swan	May 17, 1932
1,936,843	Jonsson	Nov. 28, 1933
1,947,106	Plumstead	Feb. 13, 1934
2,138,715	Thorsen	Nov. 29, 1938
2,385,781	Faris	Oct. 2, 1945
2,395,217	Ford et al.	Feb. 19, 1946
2,425,236	Ferrante	Aug. 5, 1947
2,503,633	Ratley	Apr. 11, 1950
2,523,642	Becker	Sept. 26, 1950
2,589,639	Staege	Mar. 18, 1952