Sept. 29, 1959 W. J. NOLAN 2,905,973

PROCESS FOR SEPARATING PITH FROM FIBERS

Filed April 16, 1956 3 Sheets-Sheet 1

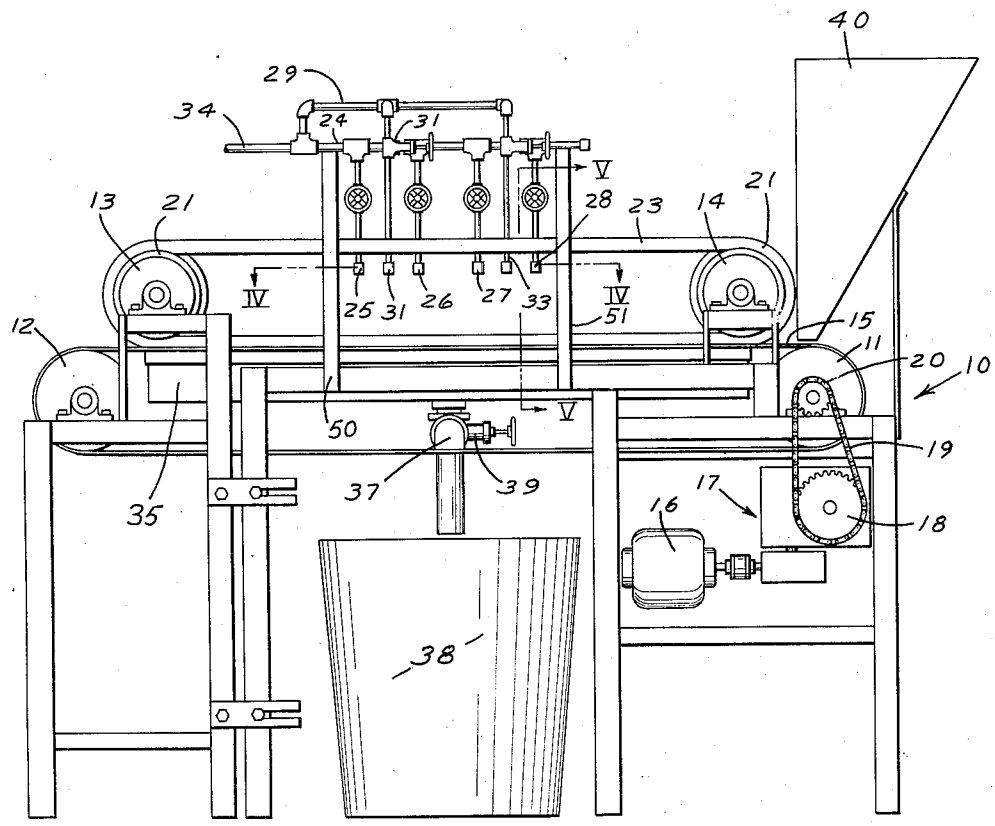


Fig. 1

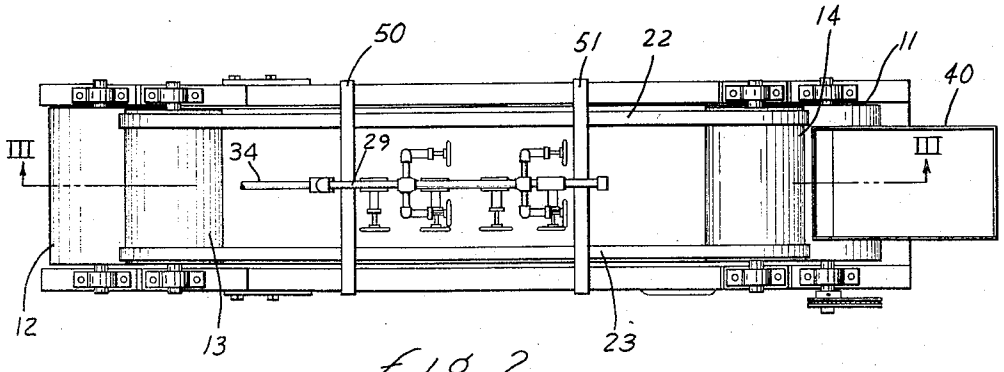


Fig. 2

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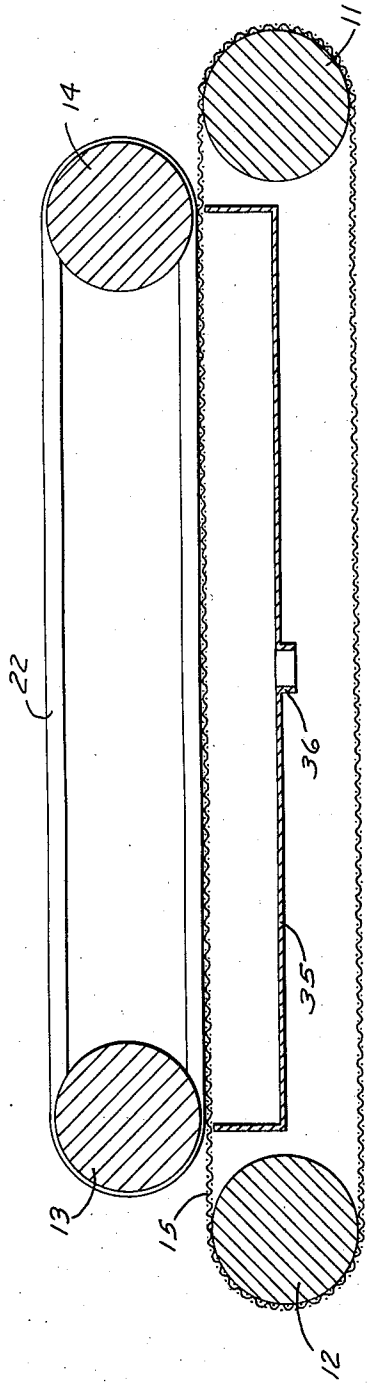


Fig. 3

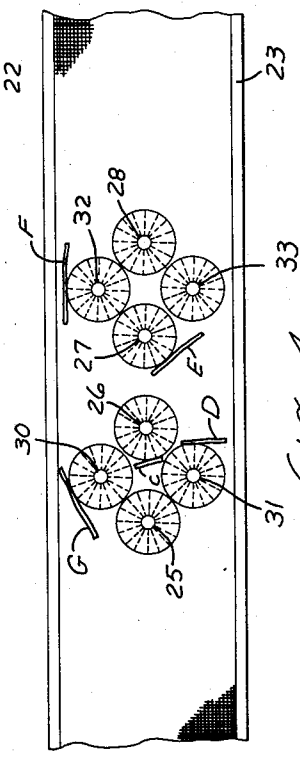


Fig. 4

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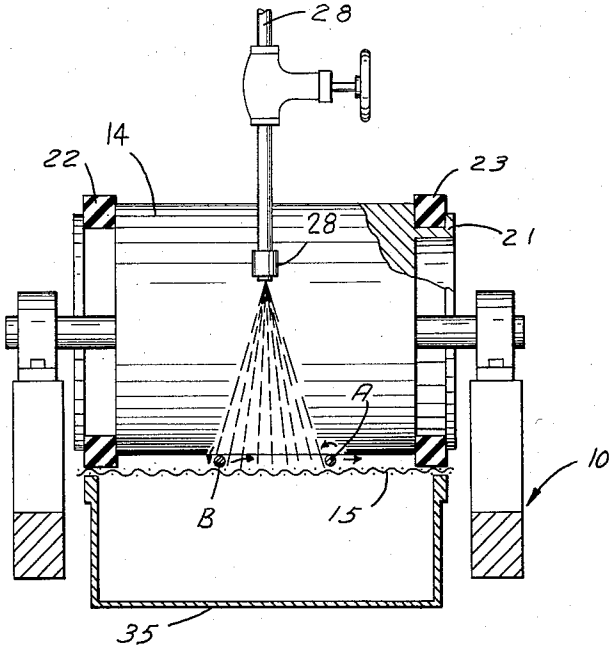


fig. 5

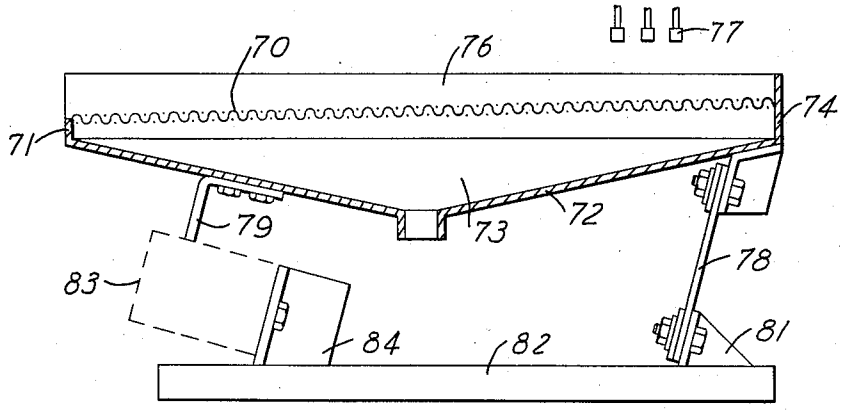


fig. 6

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PROCESS FOR SEPARATING PITH FROM FIBERS

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Application April 16, 1956, Serial No. 578,379

1 Claim. (Cl. 19—8)

This invention relates to a process and apparatus for treating fibers and more particularly to a process and apparatus for separating relatively long cellulose fibers useful for making paper and dissolving pulp from pith and other materials which are shorter and unsatisfactory for pulping purposes.

It has been proposed many times to use bagasse, cornstalks and other cereal straws as a source of paper making and dissolving pulp raw material. These materials and others similar thereto are composed of thick-walled elongated rind fibers, fibrovascular bundles, and pith or parenchymatous cells. The pith cells surround and adhere both to the fibrovascular bundles and to the rind fibers. Both the rind fibers and the fibrovascular bundles are fibrous but the pith, or parenchymatous cells, is not a fibrous material but rather is composed of soft, rather inorganized tissue. The pith particles are quite short and broad and contribute little, if anything, in the way of desirable properties to a paper product. Furthermore, during the preparation of a paper-making or dissolving pulp, the pith is more readily attacked by the digestion chemicals, increasing the consumption thereof, and is then lost when the aqueous pulp suspension is dewatered, pumped, etc., because of the small size thereof. Thus, even disregarding the fact that the pith does not contribute any desirable qualities to the product, the presence of pith is undesirable because it causes an increased consumption of the digestion chemicals without any corresponding increase in the yield of the pulp. In addition, the presence of pith, which absorbs more dirt, proportionately, than does the fibrous material because of its greater surface area, requires larger amounts of bleaching agents resulting in weaker pulps and lower yields. Also the presence of pith causes the pulp to be slower draining on the paper-making machine thereby causing a decrease in the rate at which the paper is produced or requiring a larger machine to produce at the same rate. Therefore, except for certain types of specialty products, it is necessary to remove the pith from its contact with the fibrous material. However, insofar as I am aware, no completely satisfactory process and apparatus for separating pith from the fibrous material has been found prior to my invention.

The diameter of the pith particles, which are generally cylindrical in shape, is considerably larger than the diameter of the fibers and fibe bundles. However, the length of the pith cylinders is only a small fraction of the length of most of the fibers and fiber bundles. The ratio of length to diameter of the fibers is many times as great, ordinarily being at least twenty times as large, as the same ratio for the pith cells. It should be noted that any screen which has openings large enough for the passage of the pith cylinders therethrough will also be large enough to allow the fibers to pass through lengthwise if the fibers are oriented endwise to the screen opening. In addition to the problems involved in separating pith from fibers set forth above, because of the size distribution of the material, it has been observed that separation of the

pith from the fibers by dry screening or similar means is generally unsatisfactory because either an exorbitantly high percentage of the fibers are lost with the pith or the operation cannot be carried out with the rapidity necessary for commercial operation.

When it is desired to use a wet screening operation for pith separation purposes, a number of problems arise. First, part of the pith will tend to float freely in the water because of the air held in some of the pith cells. Second, wet pith has a very pronounced tendency to cling to the fiber. Thirdly, any wet screening operation will tend to permit a significant number of fibers to orient themselves so that they can flow through the screen openings.

Accordingly, it is an object of this invention to provide a method and apparatus for separating pith from fibers which is economical to effect and rapid in operation.

It is a further object of this invention to provide a method and apparatus for separating pith from fibers which is adaptable to large scale commercial operation.

It is a further object of this invention to provide a method and apparatus for separating pith from fibers which will clean the fibers more effectively than has been possible heretofore.

It is a further object of this invention to provide a method and apparatus for removing pith from fibers which will permit greater yields of cleaned fibers than has been possible heretofore.

It is a further object of this invention to provide an improved wet screening process and an apparatus for carrying out said process.

It is a further object of this invention to provide an improved wet screening process and apparatus, as aforesaid, particularly adaptable to use in the separation of pith from fibers.

Other objects and advantages of this invention will become apparent to those with knowledge of this art upon reading the following description.

The method of separating pith from fibers as described in greater detail hereinbelow is preferably performed on fibrous materials which have previously been subjected to an initial fiber separating and treating action to break the bond between the pith and the fibers. Advantageously, but not necessarily, the stalks or lengths of vegetable materials are preliminarily treated in the apparatus disclosed in application Serial No. 297,078, filed July 3, 1952, now Patent No. 2,747,232 which preliminary treatment may occur, for example, as part of the process for removing sugar from sugar cane. The apparatus described in the above mentioned application Serial No. 297,078 subjects stalks or stems which have been cut to lengths on the order of a few inches or so, to a fiber separating and fiber treating action of progressively increasing intensity by subjecting the lengths of fiber bearing vegetable materials to repeated bendings, said bendings taking place over progressively smaller portions of the lengths of materials and also taking place in different directions and on different portions of the lengths of material so that the unequal stresses set up in the material by such bending break the bond between the pith and the fibers and do so completely. The fiber separating action described in this application is particularly advantageous because it effectively breaks the bond between the pith and the fibers and between the fibers themselves but does so without breaking the fibers to any appreciable extent. The product of this process consists of intimately mixed fibers and pith, with little, if any, of the pith remaining bonded to fibers. The fibers themselves are virtually all relatively long in comparison with the pith cells because the fibers are substantially unbroken. There are few, if any, broken fibers to interfere with the operation of the pith separating mechanism and process hereinafter described in greater detail nor are there

broken fibers capable of remaining with the pith as it is separated from the fibers to decrease the yield of depithed fibers. In addition, the relatively large difference in the lengths of the unbroken fibers on the one hand and the length of the pith particles makes a sharp separation of the two components more easy and rapid to effect.

Thus, in general, my process is intended to be operated on mixtures of pith and fibers, produced by some preliminary treatment which has broken the natural bond between the constituents so that the fibers themselves have little, if any, pith remaining bonded thereto. My process is not limited to use with the particular preliminary treatment discussed above but may be practiced in conjunction with any preliminary treatment which affects the desired breaking of the bond between the pith and the fibers.

The raw mixture of pith and fibers is placed on a screen which may be stationary but which is preferably in the form of an endless conveyor belt. A spray of a suitable fluid cleaning agent, such as water, is directed against the material on the screen with sufficient force to drive the relatively small pith particles through the openings in the screen and leave the relatively long fibers on the screen. The mixture of pith and fibers, when placed on the screen, is manipulated by hand or by a suitable feeding device so that it forms a mat of substantially uniform thickness on the screen. A body of water is provided on top of the screen which body is at least equal in depth to the thickness of the mat of fibers and pith. This body of water maintains the components of the mat in a somewhat dissociated condition to thereby permit freer flow of the pith particles through the mat and through the belt. The water spray to cause the pith particles to pass through the screen is provided by the use of suitable nozzles. In the preferred embodiment wherein the screen is in the form of an endless conveyor belt, a series of such nozzles are provided, which nozzles are offset longitudinally and transversely of each other. This arrangement of the nozzles causes movement in a rolling fashion of the mat as it moves along the belt which causes fresh portions of the mat to be exposed to the spray and insures that each portion of the mat is thoroughly contacted and cleansed by the spray. Preferably, a spray of rather strong force is applied to the mat which not only insures a more effective cleansing of the fibers but also tends to keep the fibers in the same relative longitudinal alignment thereby preventing any movement of the fibers that would allow the fibers to follow the pith through the openings in the belt.

For the greatest effectiveness and control over the separation of the pith from the fibers, it is desirable that the mixture of pith and fibers form a mat of substantially constant thickness. While the thickness of the mat can be varied somewhat depending on the effectiveness of the cleaning action desired and the economics of the process variables, as a practical matter it is ordinarily necessary that the mat thickness not exceed about one and one-half inches. Otherwise it becomes exceedingly difficult to obtain a satisfactory cleaning of the fibers except by passing the fibers through the machine a large number of times. As a general rule, a mat thickness in the range of about one-half inch to about one inch is preferred since it has been found to give unexpectedly good results in terms of output and yield of clean fiber and also gives significant operating economies. The use of mat thickness of less than one-eighth inch is not as satisfactory, because an undesirably large amount of fibers are carried through the screen with the pith.

The screen may be formed with relatively large openings. When the material is preliminarily treated as discussed above and the bond between the pith and the fibers is broken with little breakage of the fibers, it is possible to use a relatively large opening screen, such as ordinary fourteen mesh window screening, because the fibers are of sufficient length that they, if properly oriented, will not pass through openings of such size. However, the pith particles have been broken up into such small size particles that they will easily pass through openings of such size. It is, of course, necessary to properly orient the fibers to prevent them from passing lengthwise through the screen. This is accomplished by insuring that the longitudinal axis of the fibers is at all times substantially transverse to the axis of the screen opening. If the preliminary process for breaking the bond between the pith and the fibers is not as effective as the process previously discussed and some of the fibers are broken, the intermediate size fibers will interfere somewhat with the separation of the pith from the fibers and the cleaned product will generally have a somewhat greater pith content while an appreciable amount of the fibers, particularly fibers of small length, will be washed out with the pith thereby decreasing the yield of the cleaned fiber product. Obviously, the screen size can be varied somewhat depending on the desired characteristics of the product and the operating economies that are required. However, in general, it is undesirable to use screens whose openings are larger than ten mesh to prevent an excessively large amount of fibers from being washed out with the pith. To some extent, the maximum permissible size opening depends on the average fiber length of the type of material being treated, but in general a ten mesh screen appears to be the maximum permissible size when it is desired to have high yields of cleaned fibers. On the other hand, it is generally undesirable to use screens smaller than twenty mesh in size because smaller screens will slow down the separation and will make it exceedingly difficult to remove the pith, particularly the large size particles, from the fibers.

The cleaning agent is deposited on the material in the form of a series of sprays. For reasons of economy and ease of operation, water is the preferred cleaning agent although it will be appreciated that the process and apparatus is adapted for use with other fluid agents if their use is desirable. When water is used, it is contemplated that various types of additives, such as surface active agents, etc., may be added to the water in order to increase the effectiveness of the cleaning action or to prepare the fibers for subsequent processing.

During its passage beneath the sprays, the mat is kept in a somewhat dissociated state by the provision of a body of water on top of the screen which is equal to, or slightly greater in depth than, the thickness of the mat. This body of water diminishes the amount of interlacing between the fibers, which interlacing would otherwise hinder the movement of the pith particles through the mat and the separation of the fibers. Thus, the fibers in the mat, to a considerable extent, are substantially individually supported in the body of water, rather than being interlaced to form a self-sustaining mat, and are capable of relatively independent movement.

The sprays, which preferably are circular in form, direct a relatively strong stream of water against the fibers and the pith. The sprays are spaced longitudinally and/or laterally of each other but are in relatively closely adjacent position. The sprays contact the individually supported, randomly arranged fibers at an angle with respect to the longitudinal axis of the fibers and cause the fibers to roll somewhat. This rolling action results in a gentle agitation of the fibers which continuously exposes fresh portions of the fibers to the action of the water and insures that no portions of the fibers remain untouched by the washing agent. As discussed above, the thickness of the mat is of importance to this rolling operation since a mat which is too thick will not give a satisfactory exposure of all the fibers to water whereas a mat which is too thin will be agitated to an undesirable extent.

The actual force with which the water spray contacts the fibers to obtain the desired rolling of the fibers depends upon a number of factors such as the condition of

the fibers, the speed of the conveyor, the desired characteristics of the product and the relative location of the spray nozzles and the conveyor. Therefore, no definite statement as to the force required for the water spray can be made and it will be a matter of experimentation to determine the proper operating characteristics of the spray nozzle to obtain the desirable gentle agitation of the fibers under any given set of conditions.

The rather strong flow of the water spray also keeps the fibers from orienting themselves transverse to the axis of the screen, in which position it would be comparatively easy for the fibers to follow the pith through the openings in the screen. Thus, the water spray will keep the fibers relatively flat on the screen and will effectively prevent movement of the fibers through the screen openings.

The total amount of water used to remove the pith is important since an excessive amount of water will cause undue agitation of the fibers, thereby causing an appreciable amount of the fibers to flow through the screen which decreases the yield of the cleaned fiber. Too small an amount of water results in failure to remove enough of the pith to give fibers the proper condition for pulping. In general, less than fifteen gallons of water per pound of fiber processed is unsatisfactory for most purposes because insufficient cleaning of the fibers is obtained. While there is no true upper limit to the amount of water that can be used, generally it is inadvisable to use more than one hundred gallons of water per pound of fiber because of the increased water and water treatment costs involved and also because lower yields of cleaned fibers result. It has been found that a satisfactory fiber product results when a total of between twenty-five and fifty gallons of water are used per pound of clean fiber produced. Using quantities of water within this range will give fibers which contain only a very small amount of pith in the cleaned fibers and will give yields of cleaned fibers of from seventy percent to over eighty percent based on the weight of raw material fed to the pith separating apparatus. In general, it has been found that the fibers should be run through the pith separating apparatus at least twice, using approximately equal amounts of water in each run. One run generally does not completely clean the fibers whereas more than two runs generally does not result in a significantly improved product over the two run product.

Reference is now made to the accompanying drawings which illustrate preferred embodiments of the apparatus capable of performing the previously disclosed process.

In the drawings:

Figure 1 is a side view of the apparatus.

Figure 2 is a top view of the apparatus.

Figure 3 is a central sectional view of the upper and lower rollers and the fluid collecting trough taken along the line III—III of Figure 2.

Figure 4 is a schematic view taken along the line IV—IV of Figure 1 showing the spray pattern of the nozzles.

Figure 5 is a sectional view taken along the line V—V of Figure 1.

Figure 6 is a view, partially in central section, of a modified apparatus.

General description of the apparatus

In general, my invention provides a screen in the form of an endless belt conveyor. A trough is provided below the upper course of the screen and is adapted to receive water and pith particles entrained therein and direct them through an outlet pipe into a suitable receptacle. A valve is provided in the outlet pipe and is adapted to control the flow of fluid so as to maintain a body of water on top of the screen. A resilient deckle strip engages the edges of the screen to define a compartment for the body of water. A series of nozzles are disposed above the upper course of the screen and are adapted to spray water on the material carried on the screen.

Detailed description

In Figure 1 there is shown a frame **10**, which frame rotatably suports a lower pair of rolls **11** and **12** and an upper pair of rolls **13** and **14**. A screen **15**, which may be ordinary fourteen mesh screen in the form of an endless conveyor belt, passes around the rolls **11** and **12** and is drivingly conected thereto. A motor **16** is connected through a speed reduction unit **17** to a sprocket **18**. Chain **19** supplies power from the sprocket **18** to a further sprocket **20**. Sprocket **20** drives lower roll **11**. Further gearing is provided on the other side of roll **11** to drive upper roll **14** in timed relationship with the driving of lower roll **11**.

The upper rolls **13** and **14** are provided with cup-shaped flanges **21** at either longitudinal end thereof (Figure 5), which flanges receive and guide endless deckle strips **22** and **23**. The deckle strips are preferably made of a suitable resilient material, such as rubber, and their lower course sealingly contacts the edge of the screen **15** in the upper course thereof to define the sidewalls of a compartment on top of the screen. The compartment retains the wash water and the fibers being washed.

The frame **10** also includes support frames **50** and **51** which support a series of nozzles. While the arrangement of nozzles may vary considerably, in the disclosed embodiment a center pipe **24** supports four longitudinally spaced nozzles **25**, **26**, **27** and **28**. A branch pipe **29** supports two pairs of nozzles **30**, **31** and **32**, **33**. Nozzles **30** and **31** are located between nozzles **25** and **26** but are offset transversely therefrom in either direction. Likewise nozzles **32** and **33** are located intermediate nozzles **27** and **28** but are offset transversely therefrom. Center pipe **24** and branch pipe **29** are connected by hose **34** to a source of water under pressure. Valves are provided in each of the conduits leading to the nozzles to control the amount of water passing therethrough.

A trough **35** is provided adjacent the under side of the upper course of the screen. An outlet **36** from the trough communicates with an outlet pipe **37** which in turn communicates with a collecting receptacle **38**. A valve **39** is provided in pipe **37** to control the volume of the fluid flowing therethrough.

A hopper **40** may be provided to feed a supply of fibers and pith to the screen.

Operation

The pith and fiber mixture is fed from the hopper **40** onto the screen **15** so that it forms a mat of substantially uniform thickness thereon. To place the apparatus in its substantially steady state condition, valve **39** is adjusted so that a body of water, whose depth is at least equal to the thickness of the mat, is maintained on top of the continuously moving screen **15**. The sealing engagement of the deckle strips **22** and **23** with the edges of the screen **15** and the movement of the strips with the screen forms a compartment for the body of water and prevents sidewise escape of the water from the top of the screen. With this body of water present on the screen, the fibers making up the mat will be somewhat dissociated from each other and will approach a state of independent suspension in the water with a minimum of interlacing therebetween. The sprays of water impinging on the fibers will be of sufficient force to overcome the rather pronounced tendency of the pith to cling to the wet fibers and will dislodge the pith from contact with the fibers. Some of the pith will tend to float in the water because of the air held in some of the pitch cells and accordingly, it is necessary that the water flow with such velocity that it will entrain and carry the otherwise buoyant pith therewith. The dislodged

pith will travel through the screen openings into the trough 35 and from there into the receptacle 38.

As the water sprays impinge on the fibers they will cause a rotation of the fibers about their longitudinal axis as well as a lateral movement of the fibers. Referring to Figure 5, the elongated fiber A when contacted by the water will tend to rotate counterclockwise about its longitudinal axis and also will be urged to move rightwardly as appearing in this figure and as shown by the arrows therein. The fiber B will be rotated and moved in the same direction as fiber A. Refering to Figure 4, it will be observed that the use of a circular spray is advantageous because it insures that all fibers, regardless of their orientation, will be contacted by and moved by the water spray in the manner previously described. Thus, randomly disposed fibers C, D, E, F and G will all be contacted and agitated by the spray. This construction and mode of operation therefore assures a thorough washing of every portion of the fibers because of the rotation thereof and furthermore assures a continuous circulation of fibers toward and away from the water spray because of the gentle agitation and rolling action produced by the water sprays. This highly effective movement of the fibers is also advantageous since it constantly opens new paths through which the pith particles may move to and through the screen.

The water spray is of sufficient strength that it holds the fibers rather firmly in a flat position on the screen and prevents the fibers from moving to a position where they could follow the pith through the screen.

Modification

Figure 6 discloses a modification of the apparatus for practicing the invention in which a vibratory screen 70 is utilized to effect the pith separation. The screen 70 is mounted on a frame 71. The frame includes a bottom wall 72 defining a fluid collecting trough 73, an end wall 74 and a pair of side walls, of which one appears at 76, and which define a compartment for retaining the fibers and fluid. A series of nozzles 77 are positioned above the screen for directing fluid onto the fibers. A leaf spring 78 and a motion transmitting member 79 are connected to frame 71. Leaf spring 78 is connected by bracket 81 onto a suitable base 82. Motion transmitting member 79 is connected to a suitable mechanism 83 for effecting vibratory movement of the frame 71. Mechanism 83 may, for example be of the type utilizing electromagnetic vibration of an armature, such as shown in United States Patent No. 2,187,717. Mechanism 83 is connected to base 82 by bracket 84. It is apparent that other mechanisms for effecting vibratory movement of screen 70 may be used in place of that described in the foregoing patent. For example, a high speed unbalanced pulley may be used to effect such motion as will be apparent to those acquainted with equipment of this type.

In use, the construction of Figure 6 will operate in a fashion generally similar to the previously described embodiment. Thus, operation of mechanism 83 will cause a relatively slow movement of the frame 71 leftwardly as appearing in Figure 6 and then a rapid movement rightwardly, said movements being repeated at a very high frequency. This effects a progressive movement of the pith and fiber mixture leftwardly as appearing in Figure 6 along screen 70. Water is sprayed onto the mixture from nozzles 77 to effect the depithing operation. The vibrations effectively dislodge water from the fibers and such water, with the pith entrained therein, passes through the perforations in the screen. A layer of water is maintained on top of the screen as in the previously described embodiment. Likewise, the frequency of vibration of the frame 71 is sufficiently high that material fed to the screen from a hopper, such as shown in the aforementioned patent, forms a mat of substantially uniform thickness thereon as in the previously described embodiment.

Although the above description and accompanying drawings disclose preferred embodiments of my invention, it will be understood that modifications coming within the scope of such disclosure are fully contemplated by this application unless specifically stated to the contrary in the appended claim.

I claim:

A process for removing pith from fibers, including the steps: continuously feeding a mixture consisting of small pith particles and elongated cellulose fibers and fiber bundles onto one end of a continuously moving, substantially horizontal screen to form a mat of between no less than about ⅛ inch and no more than about 1½ inches in depth thereon, said screen having a mesh size of between about 10 and about 20 mesh; continuously maintaining a body of water at least as deep as the mat above the upper surface of said screen so that the fibers and fiber bundles in said mat are supported in a loosely interwoven condition so as to be capable of a limited amount of movement with respect to each other within the mat; continuously moving said screen and thereby moving successive portions of said mat through a horizontal path and beneath a plurality of closely adjacent, longitudinally and transversely spaced water streams; directing said streams substantially vertically against said mat with sufficient force to hold the fibers and fiber bundles substantially flat on said screen and to dislodge the pith mixed with or adhering thereto, said streams also contacting the mat with a small horizontal force so that they roll the fibers and fiber bundles about their longitudinal axes within said mat so that the entirety of the periphery thereof is contacted by said sprays and the pith thereon is dislodged therefrom; continuously removing water from above said screen by draining same through said screen to thereby remove pith particles suspended in the water from said mat, the rate of removal of the water through the screen being such with respect to the rate of feeding water in said streams that the aforesaid body of water is at all times maintained above said screen.

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