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PROCESS OF MAKING POROUS LONG FIBERED NONHYDRATED PAPER

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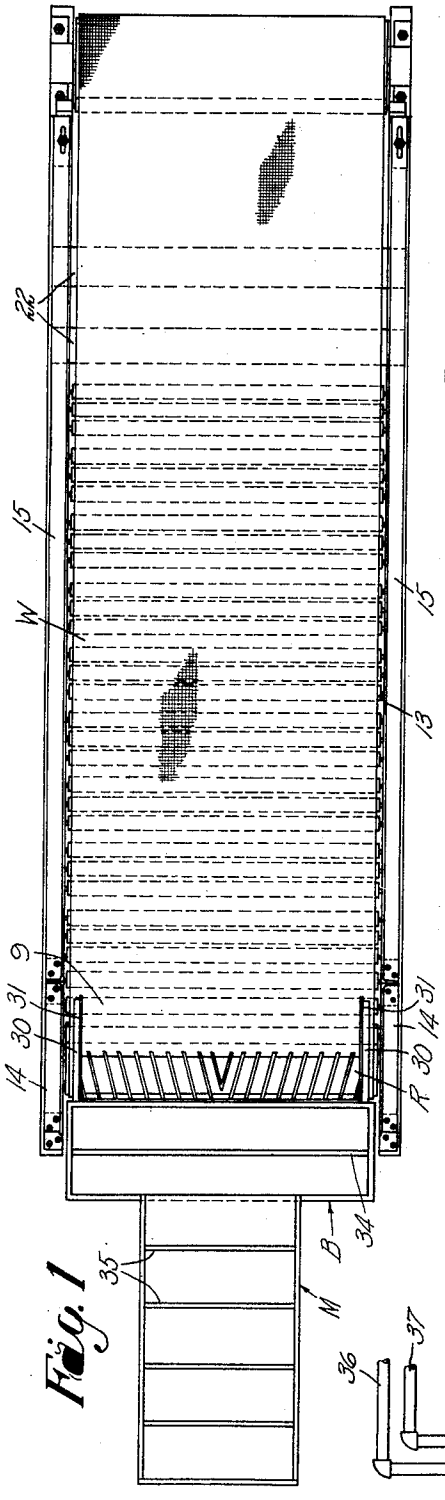

Fig. 1

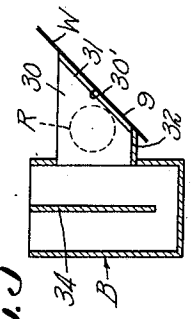

Fig. 3

Fig. 2

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PROCESS OF MAKING POROUS LONG FIBERED NONHYDRATED PAPER

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This invention relates generally to the art of making a light weight, long fibered, non-hydrated, porous paper which is very soft and pliable, substantially lintless, and very absorbent. Paper having these characteristics finds a large variety of uses, such, for example, as a base for stencils; for packing and cleaning lenses, it being lintless and free of abrasive material; as a wrapping for glassware and polished metals where flexibility and strength, soft texture, and freedom from abrasives are important factors; in the electrical field where its extreme absorbent characteristics are made use of to absorb electrical resisting solutions, thus making a dielectric for condensers, wire covering, and similar products; and to cover the wings of model airplanes where its lightness and ability to absorb the "dope" are factors.

Heretofore, so far as I am aware, paper of this general sort has been made exclusively by hand and only in small sheets. Such hand-made paper (known as Japanese yoshino paper, as it is principally made in Japan where labor is very cheap) leaves much to be desired in the way of strength and durability, uniformity of thickness and distribution of fibers, the absence of lint, and other qualities. Such yoshino paper is made up of fibers varying greatly in length from one another, some of the fibers being relatively minute and others being crushed or frayed, resulting in a paper which, to a noticeable degree, is linty and which has thin or weak spots rendering it not entirely satisfactory for certain uses, such, for example, as a base for stencils. The hand operations employed in making yoshino paper are slow and tedious resulting in a paper procurable only in small sheets and which can only be sold at a relatively high price. Various efforts have been made to manufacture tissue paper of this general sort by machinery but these attempts have been abortive.

The aim of the present invention is to provide an improved process for economically manufacturing a light weight, long fibered, non-hydrated paper of extremely good quality, and of a uniform and even weight, texture and thickness throughout. By proceeding in accordance with the present invention, an extremely fine quality of paper may be made in a continuous sheet of any desired length at a relatively low cost. The resultant paper has many advantages over yoshino paper, among which may be mentioned that it is more uniform and even in texture and, for all practical purposes, is lintless.

In the accompanying drawing:

Figure 1 is a top plan view of a machine, shown more or less diagrammatically, and which may be advantageously used when carrying out a portion of my improved process;

Fig. 2 is a side view thereof; and

Fig. 3 is a detail view, the same being a longitudinal section through the head box and the breast roll end of the Fourdrinier wire.

In carrying out the improved process, vegetable fibers of the Musa family, especially of the banana species and more particularly, and by preference, fibers of *Musa textilis* are employed. *Musa textilis*, in the raw stock, is composed of structural fibers of pure cellulose encrusted with ligno material and held together by gums and waxes. The structural fibers from such stock are more or less uniform in length, the length of the fibers varying from about 4 to 7 millimeters and there being no minute fibers which will produce lint in the finished paper. These fibers are relatively cylindrical and have tapered or pointed ends and have little or no tendency to curl or twist so that they will not become entangled or matted but, on the other hand, they will remain separated from one another when suspended in a large volume of water. I have found, by experimentation, that ordinary fibers used for producing paper are not suitable for this type of tissue. Fibers like linen and cotton tend to twist together in the process thereby forming bundles which give a clotty effect in the finished paper. Fibers like wood (as bleached sulphite) are too short and, therefore, give a lint to the finished paper which is undesirable.

The fibers, having been selected, are separated by chemically digesting the stock and then stirring the same without mechanical pressure so as to prevent hydration of the fibers or change in the physical characteristics of the structural fibers, there being substantially no shredding, flattening, fraying, or breaking of the individual fibers. By preference, during the digesting operation, the stock is subjected to a chemical action which is very drastic in order to dissolve and remove practically all of the gum and resinous substances and the ligno or encrusting constituents from the fibers so that the structural fibers may be then fully separated by a mere stirring action in solution and without pressure or hydration. While the conditions under which the stock is digested may be varied somewhat, I have found that by proceeding as follows the desired results are obtained, it being understood that while I describe the preferred conditions, the invention is not specifically limited thereto except as pointed

out in the accompanying claims. The raw stock is put into a rotating boiler and cooked in a very strong alkaline solution, such as caustic soda, for a long duration of time and under high pressure and at a temperature of about 320° F. The caustic ratio of one pound of sodium hydroxide to two and one-half pounds of dry stock is found very satisfactory as it is strong enough to dissolve the gummy and resinous material and still not too strong to affect or destroy the characteristics of the structural fiber. Preferably, the caustic liquor for the cook is approximately 7% sodium hydroxide. The pressure for the cook is preferably at least one hundred pounds per square inch above atmosphere, and the duration of the cook is preferably twenty-four hours at least. This drastic action is very much in excess of the usual treatment given stock prior to this invention, the alkaline strength of the cook being four or five times that heretofore employed.

The digesting operation having been completed, the stock is drained, and then the drained, cooked stock is thoroughly washed and the fibers are separated by subjecting them to a mere stirring operation in solution in such manner that the fibers are not subjected to any mechanical pressure and, therefore appreciable hydration thereof is avoided. The de-fibering and washing operations may be carried out in any suitable machine or machines. If desired, a beater, such as a Hollander, may be employed, not as a beater but as a stirrer. In such case, the beater roll is so adjusted with respect to the bed plate that the stock is not subjected to any mechanical pressure. It may be said here that, when the stock is subjected to pressure, the characteristics of the fibers change, and the fibers become hard and relatively stiff. Heretofore, in the manufacture of usual paper, high pressure was applied to the stock by the beater roll for a relatively long period of time. The beater may be provided with a suitable washing mechanism, such as the usual cylindrical washer, by means of which the chemicals used in the digesting operation, the suspended or dissolved gummy or resinous substances, and all other impurities are removed from the fibers. In actual operation, the complete separation of the fibers takes about five minutes, but the machine is continued in operation for a considerably longer period of time in order that the stock may be thoroughly washed free of all foreign matter and impurities. After the stock has been thoroughly washed, it is in condition to be formed into a web.

In forming the fibers into a web of paper, the fibers are suspended in an extremely large proportion of water, and the dilute suspension thus formed is made to flow freely and rapidly through a transverse moving screen leaving the fibers deposited on the screen. The dilute suspension most desirably contains about one pound of dry fiber to twenty-five tons of water; that is, it has a consistency expressed as .002%. While I found it possible, with less desirable results, to use a consistency as high as .012% it will be recognized that even in this case the suspension is properly characterized as "dilute" to distinguish it from ordinary paper-making suspensions, whose consistency is of an entirely different order, being between .2% and .5%.

This highly diluted, non-hydrated stock is supplied to a traveling, upwardly inclined portion of a wire or screen; the water flows freely and rapidly with an avoidance of eddy currents through the wire and through the web of fibers deposited on the wire, and the fibers are deposited evenly on the wire in a web without any rolling or rippling effects, whereby a paper web of any desired length and of uniform and homogeneous texture throughout and free of clots may be had. These results are not possible with Fourdrinier machines as heretofore made, as it has been and is the usual practice to horizontally arrange the wire or to decline it at the desired angle from the breast roll end. With such an arrangement, where the stock is greatly diluted, a rolling effect is produced, it being observed that the stock is flowed onto the wire in the direction of the movement of the wire. It is also of importance to note that, if the fibers were hydrated, the character of the web formed on the screen would be such as to prevent the water from flowing rapidly and freely through the screen and the web so that the desired results could not be obtained. By proceeding in accordance with the present invention, wherein the fibers are not hydrated, a very high dilution may be used, as the character of the web formed upon the wire is such as to not appreciably retard the free and rapid flow of the water through the screen and the web as the latter is formed thereon.

In the accompanying drawing, there is shown, more or less diagrammatically and for illustrative purposes only, an improved machine on which the step of forming the web may be advantageously carried out. The machine has certain elements and instrumentalities which are of old and well-known constructions and which, therefore, are not shown in detail and need not be explicitly described. In accordance with the present invention, the Fourdrinier wire W at the wet or breast roll end of the machine is sharply inclined upwardly and rearwardly, as at 9, and this transverse portion 9 forms, so to speak, a perforated, inclined and movable wall of a box or pond in which is maintained a predetermined level of the highly diluted stock so that, as the wire moves upwardly, the water from the box flows rapidly, under the force of gravity only, through the wire, and the fibers are deposited on the wire in an even and uniform manner without rolling or rippling. The Fourdrinier wire is preferably of a relatively coarse mesh, say fifty meshes per square inch, and, at the front or wet end of the machine, passes over a breast roll 10. At the delivery end of the machine, the wire passes about a suitable couch roll 11. The return portion of the wire may be guided by suitable idlers 12. The upper or working run of the Fourdrinier wire is supported by table or tube rolls 13 which are supported by a frame having an upwardly inclined portion 14 at the breast roll end of the machine and a longer, downwardly inclined portion 15 extending to the delivery end of the machine. Preferably, the inclined portion 9 of the Fourdrinier wire has an angle of approximately 45° to the horizontal plane.

Immediately behind the breast roll and below the sharply inclined front portion of the Fourdrinier wire is positioned a save-all 21 into which the water flowing through the Fourdrinier wire is adapted to drop. Adjacent the delivery end of the machine, and positioned beneath the upper run of the Fourdrinier wire, are a plurality of suction boxes 22 which are maintained under a partial vacuum so that the greater part of the water remaining in the wet sheet is sucked out. These suction boxes may be of any suitable number, and, as they may be of an old and well-known construction, they are shown diagram-

matically only. The machine is, of course, provided with the usual pressers and driers, but as these form no part of the present invention, they are not disclosed.

Located at the forward end of the Fourdrinier wire is a head box or pond B which is in open communication with the inclined portion 9 of the Fourdrinier wire. The box may have a pair of rearwardly extending side walls 30 which are spaced apart a distance less than the width of the wire, and the rear edges 30' of these side walls are inclined correspondingly to the inclination of the wire. Any suitable means may be employed for preventing the diluted stock from flowing laterally between the side walls 30 and the Fourdrinier wire, rubber rulers 31 being shown for this purpose. Instead of such rulers, the usual "deckle straps" may be used. The space between the side walls 30 may be provided with an elevated bottom 32 which is located immediately above the breast roll. The rear edge of this bottom extends into close proximity to the Fourdrinier wire. The box may be provided with a transversely extending underflow dam or baffle 34. It may also be provided with a mixing roll R.

In the present illustrative disclosure, there is shown a mixing box M discharging into the head box. This box may be in the form of a relatively long inclined trough provided with baffles 35. The water and stock may be supplied to the mixing box in any suitable way, as by means of sluices or troughs, but, by way of illustration, I have shown a pipe 36 which may be used for delivering water to the upper end of the mixing vat, and a pipe 37 which may be used for delivering the stock, partially diluted, to the top of the mixing box. The water from the save-all is, of course, returned to the head box.

The operation of the machine will be clear from the foregoing description taken in connection with the accompanying drawing. It is observed, however, that a body of highly diluted stock is maintained in the head box and the water flows rapidly through the inclined portion of the Fourdrinier wire while the fibers are deposited on the wire in the form of a web the thickness of which may be determined by the speed of the wire. The web may be of unlimited length as compared to its width. The water flows from the head box through the wire very rapidly and freely with an avoidance of eddy currents so that an even distribution of the fibers on the screen is assured. The fibers extend in all directions so that the paper has no grain and, therefore, it is of equal strength and equal absorbency in all directions.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the language used in the following claims is intended to cover all of the generic and specific features of the invention herein described and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

I claim as my invention:

1. In the process of manufacturing paper having the characteristics described, digesting stock having long fibers devoid of twisting tendencies to an extent where the fibers may be subsequently separated without pressure, separating the digested fibers without mechanical pressure or hydration, suspending the fibers in an extremely large proportion of water, and depositing the fibers on a traveling meshed sheet-forming screen while permitting the water to flow rapidly and freely through the screen.

2. In the process of manufacturing paper having the characteristics described, digesting stock having long fibers devoid of twisting tendencies to an extent where the fibers may be subsequently separated without pressure, separating the digested fibers without mechanical pressure or appreciable hydration, suspending the fibers in an extremely large proportion of water, the consistency being no more than .025%, and depositing the fibers on a traveling meshed sheet-forming screen without rolling action.

3. In the process of manufacturing paper having the characteristics described, subjecting stock of the Musa family to a digesting operation to an extent where the fibers may be subsequently separated without pressure, separating the fibers in solution without mechanical pressure or hydration, suspending the separated non-hydrated fibers in a large proportion of water, and depositing the fibers on a traveling transverse sheet-forming screen without rolling action while permitting the water to flow rapidly through the screen.

4. In the process of manufacturing paper having the characteristics described, digesting stock having long fibers devoid of twisting tendencies to an extent where the fibers may be subsequently separated without pressure, separating the digested fibers without mechanical pressure or hydration, highly diluting the non-hydrated stock, and maintaining a body of the highly diluted stock against the upper surface of an upwardly travelling inclined portion of a Fourdrinier wire whereby the non-hydrated fibers are deposited on the wire in a web while the water flows freely and rapidly through the wire and the web as it is formed thereon.

5. In the process of manufacturing paper having the characteristics described, chemically digesting fibers of *Musa textilis* to an extent where the fibers may be subsequently separated without pressure, washing the digested stock and separating the fibers by a stirring action in solution without mechanical pressure or hydration, suspending the separated fibers in a large proportion of water, the consistency being .012% or less, and maintaining a body of dilute stock in solution against the upper surface of an upwardly traveling inclined portion of a Fourdrinier wire whereby the fibers are deposited on the wire and the water flows through the wire.

6. In the process of manufacturing paper having the characteristics described, cooking stock having long, narrow fibers devoid of twisting tendencies in a strong cooking solution at a pressure of at least one hundred pounds per square inch and at a temperature of approximately 320° F. for a duration of approximately twenty-four hours, washing and defibering the cooked stock without applying pressure thereto, diluting the stock to an extremely low consistency, and depositing the stock on a traveling meshed wire to form a sheet.

7. In the process of manufacturing paper having the characteristics described from stock of the Musa genus, cooking the stock in a strong cooking solution for a long duration of time and under high pressure, washing the cooked stock

and defibering the same without hydration thereof, diluting the defibered stock to a consistency of .025% or less, and depositing the stock on a traveling meshed sheet-forming member without rolling action.

8. In the process of manufacturing paper having the characteristics described, digesting stock having long fibers devoid of twisting tendencies to an extent where the fibers may be subsequently separated without pressure, and separating the digested fibers by a stirring action in solution without mechanical pressure or hydration.

9. In the process of manufacturing paper having the characteristics described, subjecting fibers of the banana species to a drastic chemical digesting operation to an extent where the fibers may be subsequently separated without pressure, and then separating the fibers in solution without mechanical pressure or hydration.

10. In the process of manufacturing paper having the characteristics described, chemically digesting fibers of *Musa textilis* to an extent where the fibers may be subsequently separated without pressure, and washing the digested stock and separating the fibers by a stirring action in solution without mechanical pressure or hydration.

11. In the process of manufacturing paper having the characteristics described from stock of the Musa genus, cooking the stock in a strong alkaline solution for a long period of time and under high pressure and temperature, washing the cooked stock, and defibering the stock without hydration thereof.

12. In the process of manufacturing paper having the characteristics described, cooking stock having long, narrow fibers devoid of twisting tendencies in a strong alkaline solution at a pressure of at least one hundred pounds per square inch and for a duration of time of at least twenty-four hours, and washing and defibering the cooked stock without applying pressure thereto.

13. In the process of manufacturing paper having the characteristics described, cooking stock having long, narrow fibers devoid of twisting tendencies in a strong alkaline solution at a pressure of at least one hundred pounds per square inch and at a temperature of substantially 320° F. for a duration of approximately twenty-four hours, washing the stock, and defibering the cooked stock without applying appreciable pressure thereto.

14. In the process of manufacturing paper having the characteristics described, cooking stock having long, narrow fibers substantially devoid of twisting tendencies at a pressure of at least one hundred pounds per square inch and at a temperature of at least 320° F. for a duration of substantially twenty-four hours in a solution of substantially seven percent sodium hydroxide, there being a caustic ratio of one pound of sodium hydroxide to approximately two and one-half pounds of dry stock, washing the stock, and defibering the cooked stock without applying appreciable pressure thereto so as to avoid hydration.

15. In the process of manufacturing paper having the characteristics described, suspending the separated non-hydrated fibers in an extremely large proportion of water, and depositing the fibers on a traveling meshed sheet-forming screen while permitting the water to flow rapidly through the screen.

16. In the process of manufacturing paper having the characteristics described, suspending the separated fibers in an extremely large proportion of water, the consistency being no more than 0.25%, and depositing the fibers on a traveling meshed sheet-forming screen without rolling action.

17. In the process of manufacturing paper having the characteristics described, suspending separated long, narrow fibers substantially devoid of twisting tendencies in a large proportion of water, the consistency being .012% or less, and depositing the fibers on a traveling meshed sheet-forming screen without rolling action while permitting the water to flow rapidly through the screen.

18. In the process of manufacturing paper having the characteristics described, suspending the separated fibers in a large proportion of water, the consistency being no more than .025% and maintaining a body of dilute stock in solution against the upper surface of an upwardly traveling inclined portion of a Fourdrinier wire whereby the fibers are deposited on the wire and the water flows rapidly through the wire.

19. In the process of manufacturing paper having the characteristics described, suspending the separated fibers of *Musa textilis* in a large proportion of water the consistency being approximately .002% and maintaining a body of dilute stock in solution against the upper surface of an upwardly traveling inclined portion of a Fourdrinier wire whereby the fibers are deposited on the wire and the water flows rapidly through the wire.

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