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MANUFACTURE OF PAPER OF ORGANIC HYDROPHOBIC FIBERS

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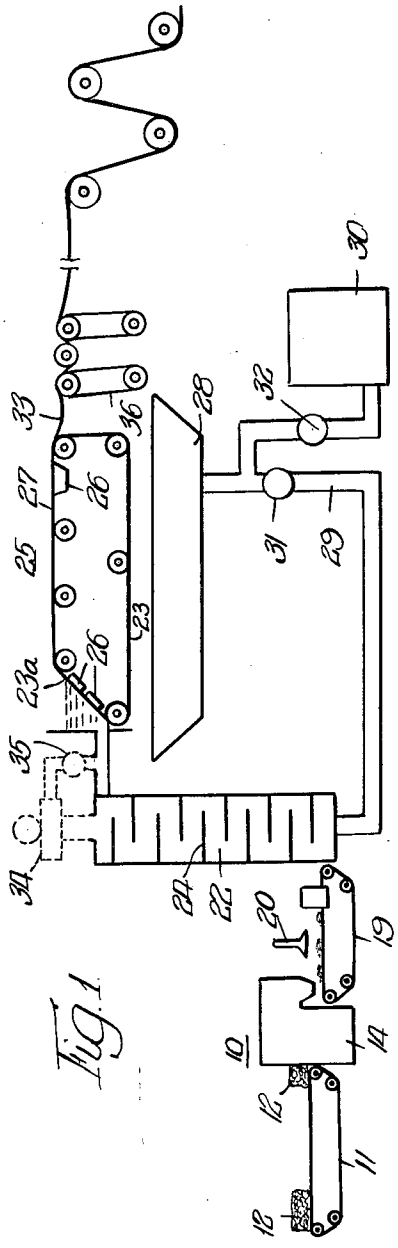


Fig. 1

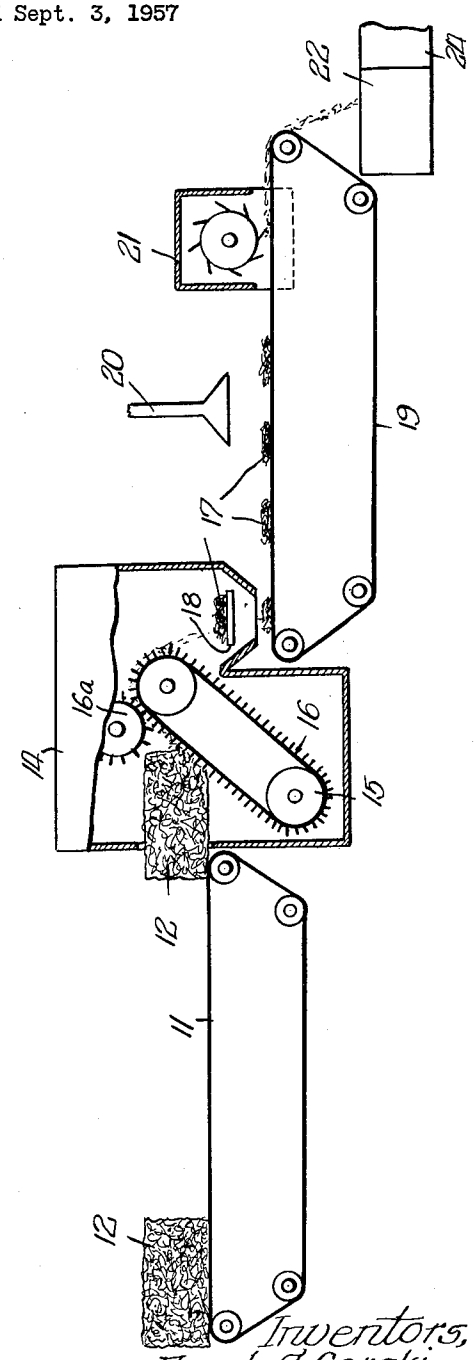


Fig. 2

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MANUFACTURE OF PAPER OF ORGANIC HYDROPHOBIC FIBERS

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Continuation of application Ser. No. 681,518, Sept. 3, 1957. This application June 22, 1959, Ser. No. 822,073
2 Claims. (Cl. 162—157)

This invention pertains to paper and its manufacture and in particular to paper comprised in part or wholly of relatively long fibers.

This application is a continuation of our co-pending application Serial No. 681,518 filed September 3, 1957, for Manufacture of Cellulosic Products (now abandoned).

In manufacturing paper comprised in part or wholly of relatively long fibers, in particular those of the hydrophobic non-bonding type, it has been found that the conventional methods used heretofore are unsatisfactory in many respects. Accordingly it has been necessary to invent and develop new techniques, methods, and means for handling and treating such fibers in order to achieve satisfactory results.

These fibers are generally expensive as compared to the ordinary short fibers which are normally used in the manufacture of paper. Therefore, it is desirable to have a system for manufacturing paper which will permit accurate control of the rate that these long fibers are fed into the paper stock suspension. Furthermore, if an upset should occur in the system necessitating a shutdown, it is desirable that the system permit instantaneous cut-off of the long fiber feed so as to avoid expensive recovery of the long fiber material. The system should also permit the rate of feed of the long fibers to be readily varied in order to change from one type of paper to another or from one basis weight to another, particularly where the paper being produced is comprised of both long and short fibers.

It has been found necessary to treat many types of long fibers with a wetting agent in order to obtain a homogeneous dispersion of the fibers in water to form the paper stock. This is especially true in the case of hydrophobic fibers. At the same time it has been found undesirable to use agitators and beaters which were heretofore used to disperse the fibrous material because of the entrainment of air and foam caused by these devices, particularly where a wetting agent was used. The conventional methods of beating and refining would also cause entanglement and cutting of the long fibers. Therefore, it has been necessary to develop and invent new techniques and methods for dispersing these long fibers in a stock slurry.

The characteristics of these fibers also require that the concentration of the slurry be considerably more dilute than heretofore necessary in the manufacture of short fiber papers. Thus the quantities of liquid involved are increased considerably due to the low consistency so that the conventional stock system is inadequate. This is particularly true of the tanks used in the conventional systems in which the woodpulp and stock are treated and stored. Therefore, it has been found desirable when working with the long fibers to eliminate the traditional "batch" operations and in their place use a continuous type operation which would eliminate the large storage facilities heretofore necessary.

It is an object of the invention to provide an improved system and process for preparing and forming long fibered materials into paper which is novel.

Another object of the invention is to provide a process and system for the manufacture of paper which is a continuous operation.

A still further object of the invention is to provide a system for manufacturing paper that will permit accurate control over and immediate response to the rate at which the fibrous materials are fed into the stock suspension.

A still further object of the invention is to provide a system that is economical and simple in construction and operation.

A still further object of the invention is to provide a process and system for manufacturing paper that is particularly adapted to the manufacture of paper comprised at least in part of long fibers.

These objects and still further objects will be apparent upon development of the specification with reference to the following drawing.

In the drawing:

FIGURE 1 is a diagrammatic illustration of the system embodied in the invention.

FIGURE 2 is a diagrammatic illustration of a part of the system in detail.

It has been found that paper comprised in part or wholly of certain types of long fibers will have certain qualities not present in ordinary types of paper and will permit new uses not heretofore possible. However, these fibers, as was mentioned previously, present many problems if processed according to the traditional methods of making paper. The long fibers to which this invention is especially adapted may be divided into three categories: hydrophobic nonbonding fibers; hydrophilic nonbonding fibers; and hydrophilic bonding fibers. Some of the fibers which are included in these three categories are listed in the following table:

Hydrophobic Nonbonding Fibers	Hydrophilic Nonbonding Fibers	Hydrophilic Bonding Fibers (Hydrated)
Polyamides.	Alginates.	Jute.
Acrylics.	Regenerated Cellulose.	Hemp.
Polyesters.	Viscose.	Ramie.
Polyvinyl chlorides.	Polyvinyl Alcohol.	Cotton.
Polyacryonitrile.	Cellulose Acetate.	Abaca.
Tetrafluoroethylene.	Polyvinyl Acetate.	Flax.
Polyethylenes.	Triacetate.	Asbestos.
Metallic Fibers.	Cupro-ammonium.	Sisal.
Glass and Mineral Fiber.	Protein Fibers (Animal or Synthetic).	Special Synthetics (capable of being hydrated or fibrillated).
Vinylidene chloride.	Cotton (nonhydrated).	

The fibers listed above are generally used in the form of relatively long fibers as opposed to the short fibers normally used in the manufacture of paper, such as those obtained from the sulphite or kraft chemical processes or from groundwood.

By relatively long, is meant any fiber having a minimum length of ⅛ of an inch. Many of these fibers, however, are much longer than the ⅛ inch minimum and are in lengths up to 1½ inch, particularly the synthetics which may be formed in any desired length. It should also be pointed out that these fibers have been formed into papers ranging from 3 to 250 pound basis weights, and it is contemplated that papers outside of this range could be formed, according to the method described herein. (Basis weight per ream 24" x 36"—500 sheets.)

The invention can now best be described by referring to the drawing in which there is shown a dry fiber feed system generally noted by the numeral **10**. By dry fiber feed is meant a system or method for handling the long fibers in which they are not suspended in water as a slurry. In other words, the fibers are in a relatively dry environment during this stage of the paper making operation as apposed to the stock-water slurry normally used in the manufacture of paper. However, this concept of dry fiber feed contemplates moist fibers in which there is no discrete amount of water present in a continuous

phase, as contrasted to a slurry, as well as those fibers which are "bone" dry.

As shown in the drawing, the dry fiber feed system includes a conveyor 11 on which the raw fibrous material is fed in bales 12, or the like, to a picker 14. The bales 12 that are shown in the drawing are merely an example of one form in which the fiber material may be fed into the system as will be apparent later on. The picker 14 is provided with a continuous belt or chain 15 to which is secured the picker members 16 which tear the fibers in the form of loose clumps from the bale 12. The picker may also be provided with a drum 16*a* having a plurality of spikes extending therefrom which co-operate with the picker members 16 to prevent any hard clumps of fibers from being passed into the system. The fiber clumps 17 are deposited on the weighing platform 18 until there is a predetermined weight of material thereon. At that time the fiber clump 17 is deposited on a second conveyor belt 19. It can now be seen that the rate at which dry fiber is supplied may be readily varied by adjusting the various elements of the dry feed system. This provides quick and effective control over the basis weight and fiber content in the paper web being produced.

If it should be necessary to treat the fiber clumps with a wetting agent or the like, as will be explained more fully later on, they are then carried under a spraying apparatus 20. The clumps are then carried forward into a second picker 21 which serves to separate the individual fibers still further as shown in the drawing, possibly to the extent of a continuous mass of loosely associated fibers. The fibers are then carried forward and dumped into the flume 22 which is a part of the stock system used for the manufacture of paper comprised of long fibers and will be described later on.

The dry fiber feed system as presently described is merely an example of one way in which it may be carried out. The fibers may be supplied in the form of continuous filaments in which event, instead of a picker, it would be necessary to provide cutting means for severing the fibers into appropriate lengths. Other variations, such as spray or extrusion manufacture of long fiber, at the point of dry feed addition may be desirable or necessary, depending upon the nature of the fibrous material and the results to be achieved. In any event by using a dry system as opposed to a wet system for supplying these long fibers, certain advantages are obtained. For example, once the fibers are placed into a liquid medium for treatment and preparation, it is extremely difficult and expensive to recover the fibers if an upset should require the system to shut down. This is particularly important in the case of these long fibers because they are very expensive as compared to the ordinary short fibers such as woodpulp. A still further advantage is that if these long fibers were to be suspended in water according to the conventional methods, large vats or tanks would be required. Furthermore, many of the long fibers, particularly the synthetics, are difficult to keep in suspension, some having a tendency to settle out and others tending to float to the top of a stock-water suspension. These tendencies make it extremely difficult to maintain an accurate rate of feed of fiber from a tank or the like in which the fiber is suspended in water. We have discovered such problems are not encountered in the dry feed system.

With the dry feed system the ratio of long fiber to other stock furnish constituents may be very quickly and precisely varied without upsetting other process variables. For example, in prior art systems the long fiber is supplied in a slurry with the result that variations in the amount of fiber supplied will upset the consistency of the total furnished, the drainage rates and other process conditions. The flexibility of the dry fiber system is especially valuable in making specialty products where only small quantities of a given product specification may be produced at a given time. The process may thus be

changed quickly and economically from one product specification to another without upsetting continuous operation of the paper machine.

As was mentioned previously, it may be desirable to treat the fibers with a wetting agent, particularly the hydrophobic fibers, in order that they may be dispersed in water to form a stock slurry. The hydrophobic fibers are resistant to wetting by water and have an affinity for any entrained air which further interferes with wetting. Therefore the term "wetting agent" refers to chemical substances which cause the release of the entrained air attached to the fibers and uniform wetting contact between the fibers and the liquid. At the same time it is necessary that the wetting agent be of a non-foaming type or at least produce a minimum of foam, as will be seen later on. Large quantities of foam will interfere with the operation of the web forming apparatus and furthermore the fibrous material will become entrapped in the foam and suspended therein rather than in the water, which is obviously undesirable. The preferred wetting agents which are particularly suitable for the practice of the invention are the non-ionic types such as polyoxyethylene alcohols; polyether alcohols; polyoxyethylene ethers; polyoxyethylene thioethers; alkylphenol ethylene oxide condensates; polyoxypropylene and polyoxyethylene condensates; polyoxyethylene fatty acid esters; amino fatty acid esters; alkoxypolyglycol fatty acid esters and fatty amide condensates. These general classes of wetting agents are examples of compounds that are particularly adapted for this use but are in no way to be construed as a limitation.

It has been found that the wetting agent concentration depends upon the quantity of water into which the fibers are to be dispersed and does not depend upon the amount of fibers involved. The concentration necessary also depends upon the type of fiber involved because some fibers such as polyesters are more resistant to wetting than others. The general range of wetting agent concentration that has been found suitable for dispersing fibers is ¾ to 2 parts by weight of wetting agent to 100,000 parts by weight of water. One part per 100,000 parts seems optimum for most types of fiber although there are certain notable exceptions such as polyesters where up to 2 parts of wetting agent per 100,000 parts of water is desirable. Although the amount of wetting agent used depends upon the amount of water involved as has been mentioned, all or part of this may be added by treating the fibers with the wetting agent during the dry feed operation as was described previously. However, this is a matter of choice or design and in some systems it will be found preferable to add the wetting agent directly into the water rather than onto the fibers.

Dry fibers which have been pretreated with various surface active agents may be used in conjunction with the process already described. Such pretreated dry fibers are commercially available and form no part of the present invention. However, even with such pretreated dry fiber, the wetting agent techniques previously described herein are highly desirable. It has been found for flexible operation within a range of consistencies that the pretreatment alone is inadequate and that the addition of wetting agents may be necessary.

It may also be desirable in certain instances to add an antifoaming agent to eliminate any foam caused by the wetting agent or entrained air in the system. An example of the antifoaming agents suitable for this use that are presently available commercially are the silicones which are particularly efficient in this respect.

Referring now to the drawing, there is shown a flume 22 through which the stock slurry flows to the paper making machine. Dry fibers, as was described previously, are incorporated into the slurry or liquid while it is in the flume 22. The flume 22 is provided with a series of alternating baffles 24 which cause sufficient

agitation and turbulence in the system to adequately disperse the dry fibers but at the same time minimize any tendency to form foam or entrain air in the slurry.

It has been found in the manufacture of paper from long fibers that it is desirable to use an extremely dilute stock suspension in order to obtain high quality paper. The consistency of these dilute suspensions is in the general range of .01 percent to .05 percent, which is considerably less than that used in the manufacture of ordinary paper from short fibers. The optimum consistency appears to be .02 percent, although certain types of fiber may be exceptions to this value. In general, the longer the fiber, the higher should be the degree of dilution to achieve a well formed sheet. In the conventional systems used for manufacturing paper from short fiber stock the stock is stored and treated in one or more vats or storage tanks. In the manufacture of long fiber paper it would be necessary to provide extremely large and consequently expensive vats and tanks in order to accommodate the dilute suspensions and the resulting large volumes of liquid involved. Agitating equipment customarily used in such tanks consumes substantial amounts of power and at times causes air bubbles to be attached to the long fibers, thus aggravating the problem of fiber stratification. By using dry fiber feed systems as previously described in conjunction with the open flume, the use of tanks and the like can be limited to those needed for the conventional short fiber constituents of the stock furnish.

It can now be seen that, by using the continuous system, the contact time between the fibers and the water will be relatively short as compared to the conventional batch systems. This shortening of the contact time will aid in maintaining a homogenous suspension and preventing stratification of the fibrous materials.

Referring back to the drawing, it can be seen that the stock suspension passes through the flume 22 and onto the web forming movable wire 23 of a Fourdrinier papermaking machine 25. The machine includes an inclined wire type headbox 23*a* which has been found particularly suitable for this use because it can most efficiently handle the large volumes of low consistency stock involved in this operation. However, other types of web forming apparatus such as a cylinder machine, a conventional Fourdrinier, or a pressure forming machine may be use, where the formation is not critical or where a very light basis weight paper is being formed.

Because of the large volumes of liquid involved at a relatively low consistency it may be necessary to provide means for increasing and controlling the rate of liquid or white water removal. This can be done by any suitable means such as the vacuum boxes 26, although this is a matter of choice and it is not necessary to the practice of the invention. After the white water is drained from the web 27, it drains downwardly into the wire pit 28. The white water from the pit may be recirculated into the flume by the fan pump 31 through the conduit 29 as shown in the drawing.

It is also necessary to provide means for incorporating cellulose or other short fibers in combination with the long fibers previously described. In this case, the cellulose slurry is stored at a relatively high consistency in the tank 30 where it may be fed into the conduit 29 or pit 28 by the pump 32 at the rate desired. It should be noted that the consistencies previously suggested were for the long fiber content in the stock only. In other words, if a 50 percent long fiber and 50 percent short fiber paper were being formed, the actual consistency of the stock at the previously suggested optimum level of .02 percent long fiber would be .04 percent total fiber content. After the web has been formed, it will then be couched as at 33 onto felts 36. The web may then be transfered onto other apparatus necessary for the finishing of the paper such as that shown in the copending application Serial No. 681,693 (now abandoned), filed September 3, 1957, and assigned to the same assignee. As shown in the drawing, the web may be pressed, dried, and wound on a reel in the manner well known in the art.

An added refinement which may be incorporated into the system for aiding the dispersion of the long fibers is an air removal device. This device 34 may be of any suitable type comprising a vacuum chest which removes the entrained air from the stock as illustrated, for example, in the U.S. patent to De Cew No. 1,853,849. The pump 35 supplies the stock-water to the wire 23 at the desired rate and pressure, and other means (not shown) maintains the vacuum within the chest. In this manner the dispersion of the long fibers, particularly the synthetics, to which air bubbles tend to attach, would be enhanced so as to insure a homogeneous suspension. However, the use of an air removal device in this instance is a matter of choice and is not necessary to the practice of the invention.

Although certain values, elements, and the like, have been specified in the description, it is to be understood that these are merely by way of example and are in no manner to be construed as a limitation. It is obvious that certain modifications may be made within the scope of the claims without departing from the spirit of the invention.

What is claimed is:

1. In the method for manufacturing a fibrous web composed substantially completely or organic hydrophobic fibers, the steps which comprise flowing a stream of water, continuously adding dry hydrophobic fibers of lengths between ⅛ inch and 1½ inches and adding a wetting agent for said fibers to the surface of said stream of water to form a slurry, the fibers being so added in an amount so that the consistency of the slurry is between .01 percent and .05 percent, agitating the flowing stream so as to thoroughly disperse the fibers in the stream and to cause the wetting agent to remove air bubbles from the fibers, thereupon directly after said agitation passing the slurry onto a moving foraminous draining support so as to form a web of the fibers on the support, and continuously collecting the water draining through said support and moving it to said flowing stream for addition of wetting agent and fibers as aforesaid.

2. In a method for manufacturing a fibrous web composed substantially completely of organic hydrophobic fibers, the steps which comprise flowing a stream of water, adding a wetting agent for said fibers to said flowing stream in amount so that there is a concentration of ¾ to two parts by weight of wetting agent to 100,000 parts by weight of water, subsequently and continuously adding the dry hydrophobic fibers of lengths between ⅛ inch and 1½ inches to the surface of said flowing stream to form a slurry and in an amount so that the consistency of the slurry is between .01 percent and .05 percent, agitating the flowing stream containing said fibers and said wetting agent so as to thoroughly disperse the fibers in the stream and cause the wetting agent to remove air bubbles from the fibers by passing the stream over a plurality of baffles and then subsequently passing the stream through a pump, thereafter directly passing said stream after passage through said pump onto a moving foraminous liquid draining support so as to form a web of fibers on the support, and continuously collecting the water draining through said support and moving it to said flowing stream for addition of wetting agent and fibers as aforesaid.

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