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:

<table>
<thead>
<tr>
<th>Hydrophobic Nonbonding Fibers</th>
<th>Hydrophobic Nonbonding Fibers</th>
<th>Hydrophilic Bonding Fibers (Hydrated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyanides</td>
<td>Alginate</td>
<td>Jute, Hemp, Rami, Cotton, Abaca, Fish, Asbestos, Sisal, Special Synthetic</td>
</tr>
<tr>
<td>Acrylics</td>
<td>Regenerated Cellulose</td>
<td></td>
</tr>
<tr>
<td>Polyesters</td>
<td>Viscose</td>
<td></td>
</tr>
<tr>
<td>Polyvinyl chlorides</td>
<td>Polyvinyl Alcohol</td>
<td></td>
</tr>
<tr>
<td>Polyzeryonitrile</td>
<td>Cellulose Acetate, Acetone</td>
<td></td>
</tr>
<tr>
<td>Tetrathioethylenes</td>
<td>Polyvinyl Acetate</td>
<td></td>
</tr>
<tr>
<td>Polychrylthanes</td>
<td>Acetates</td>
<td></td>
</tr>
<tr>
<td>Metallic Fibers</td>
<td>Tricresylphosphate</td>
<td></td>
</tr>
<tr>
<td>Glass and Mineral Fibers</td>
<td>Cupro-ammonium</td>
<td></td>
</tr>
<tr>
<td>Vinylidene chloride</td>
<td>Protea Fibers (Animal) or Synthetic, Cotton (mordanted).</td>
<td></td>
</tr>
</tbody>
</table>

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 3/8 of an inch. Many of these fibers, however, are much longer than the 3/8 inch minimum and are in lengths up to 1 1/2 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 opposed 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 themselves are merely an example of one form in which the fibrous 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 13. The picker may also be provided with a drum or 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 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 furnish, the drainage properties 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 upon forming intimate 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; polyeoxyethylene alcohol condensates; polyeoxypropylene and polyoxyethylene condensates; polyeoxyethylene 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 types of fibers 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 1% 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. 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 fibers are fed 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 is desirable to use a web forming apparatus in which the web is formed, it will then be couched as at 33 onto felts 36. The web may then be transferred onto other apparatus necessary for the finishing of the paper such as that shown in the preceding application Serial No. 681,693 (now abandoned), filed September 5, 1957, and assigned a vacuum chest which removes the entrained air from the stock as illustrated, for example, in the U.S. patent to De Cewe No. 1,853,889. The pump 35 supplies the stock-water to the wire 23 at the desired rate and pressure, and other means (not shown) maintain the vacuum within the chest. In this manner the dispersion of the long fibers, particularly the synthetic, 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 7/8 inch and 3/4 inches and adding a wetting agent and 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 3/4 to 100,000 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 1/4 inch and 1/2 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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