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METHOD AND APPARATUS FOR MANUFACTURING NON-WOVEN FABRICS

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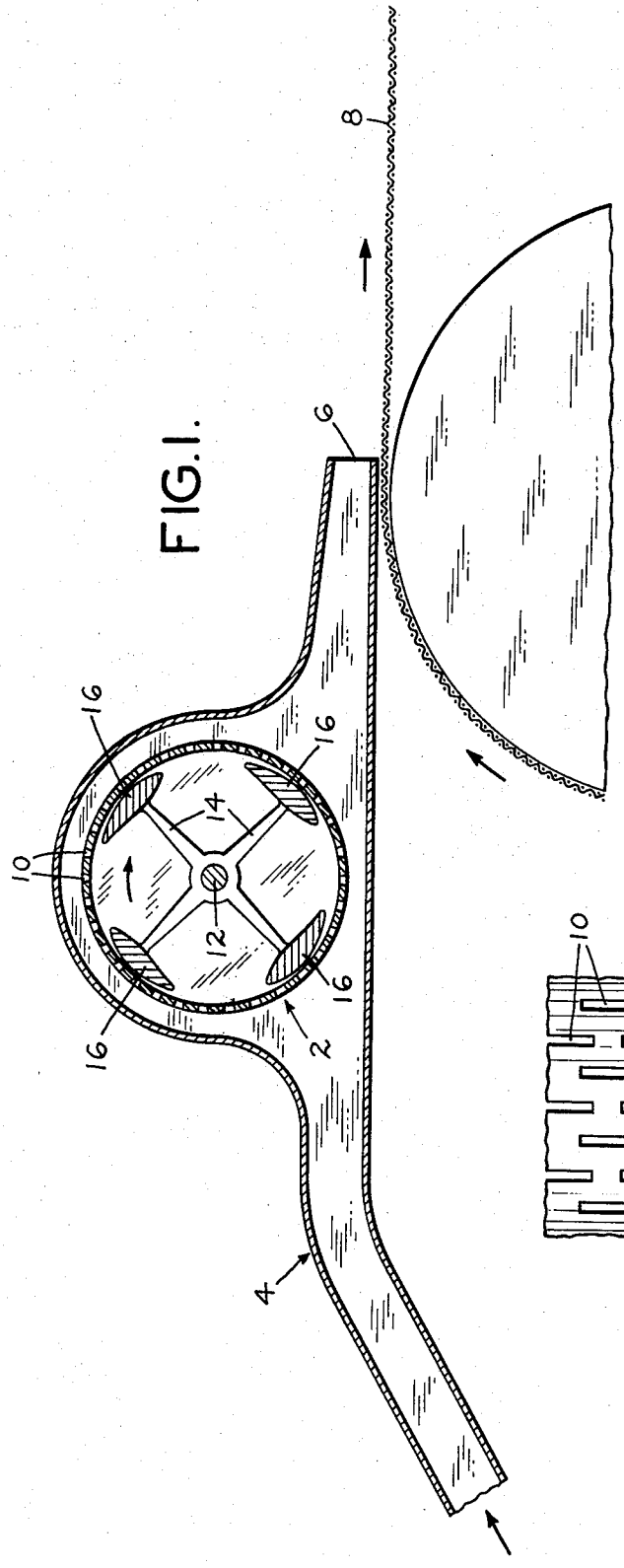

FIG. 1.

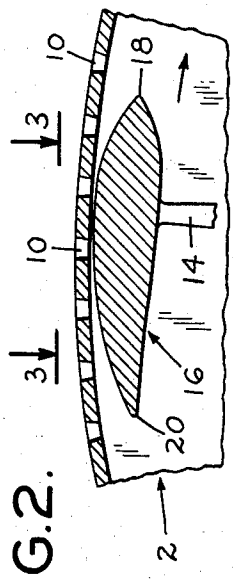

FIG. 2.

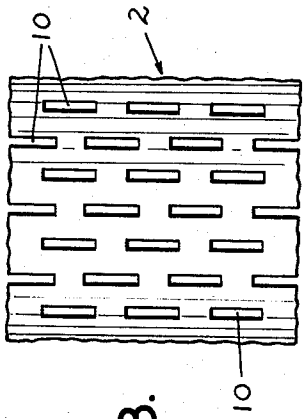

FIG. 3.

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METHOD AND APPARATUS FOR MANUFACTURING NON-WOVEN FABRICS

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Continuation-in-part of abandoned application Ser. No. 840,921, July 11, 1969. This application Dec. 8, 1971, Ser. No. 205,955

Claims priority, application Germany, July 15, 1968, P 17 61 853.0

Int. Cl. D21f *11/00*

U.S. Cl. 162—216 8 Claims

ABSTRACT OF THE DISCLOSURE

Non-woven fabrics are prepared on a paper machine from aqueous dispersions of relatively long synthetic fibers which are separated from each other in an axially slotted, cylindrical drum by means of a rotary agitator carrying airfoil sections on arms radially extending from a drive shaft. The airfoil sections sweeping the apertured, stationary wall of the drum produce cyclic pressure changes in the liquid within the drum which loosen any fiber bundles present. As the loosened bundles are discharged from the drum through the slots which flare outwardly at a small angle, the fiber bundles are fully broken up, and a dispersion substantially free from bundles reaches the paper machine. The dwell time in the drum can be held to a minimum to avoid the formation of new bundles by the agitator.

This application is a continuation-in-part of our copending application Ser. No. 840,921, filed on July 11, 1969, and now abandoned.

This invention relates to the manufacture of non-woven fabrics on a paper-making type of machine, and more particularly to a method and apparatus for dispersing synthetic fibers in an aqueous liquid prior to application of the fiber dispersion or stock to a screen.

It is common practice to produce paper from a dispersion or stock essentially consisting of an aqueous liquid and dispersed cellulose fibers and the like. The fibers employed have a length not exceeding 6 millimeters and are readily dispersed in the aqueous liquid by agitating a mixture of the fibers and the liquid.

When staple fibers of synthetic material are substituted for the cellulose, a non-woven fabric is obtained on the screen of a paper making machine in an analogous manner. The mechanical strength of the fabric is closely related to the fiber length under otherwise comparable conditions, and it is desirable that the synthetic fibers employed have a length of at least 10 mm., and preferably greater.

When an attempt is made to disperse such longer fibers in the conventional paper-making operation, it is found that the longer fibers tend to agglomerate in bundles, nodules, knots, or the like, and that the agglomerates grow rather than being broken up when the aqueous carrier liquid is agitated. When a stock containing agglomerated fibers is fed to the screen of a paper-making type of machine, the strength of the web so produced varies greatly over its width and length, and the web surface shows projections and depressions due to the fiber agglomerates.

The only practical method available heretofore for producing webs of relatively long synthetic fibers on a paper-making machine resided in the use of stock of extremely low consistency, that is, the weight of fibers per unit volume of water had to be extremely small if the fibers were to be dispersed successfully in the liquid without

forming aggregates such as bundles. Fibers up to a length of 12 mm. have been made into non-woven fabrics in this manner, but the method is costly because of the large amount of water to be removed from the fibers deposited on the screen, and it has not been possible to apply the method to fibers longer than 12 mm.

Non-woven fabrics can be prepared from fibers 20 mm. long or longer by the so-called Japan paper method which requires hand dipping, and such fabrics have been found to have superior strength and other characteristics comparable with those of woven or knitted fabrics, such as hand, softness, and drape. Manual production of non-woven fabrics, however, is economically unsound.

The primary object of this invention is a method for uniformly dispersing long fibers in water or an aqueous liquid essentially consisting of water to form a stock suitable for processing on a paper-making or paper-making type of machine.

Another object is the provision of apparatus for performing the method.

According to the method of the invention, fibers longer than 10 mm., and preferably longer than 20 mm. are dispersed in water to form a slurry of relatively high consistency. The slurry is confined by a wall formed with a multiplicity of slots and subjected to alternating pressure and suction waves until any fiber bundles present in the slurry are loosened. The resulting mixture of water, individual fibers, and loosened fiber bundles is passed in respective streams through the slots. Each slot is of elongated cross section transverse to the direction of flow of the mixture, and the width of the cross section increases in that direction. The mixture discharged from the slots is transferred to the screen of a paper-making type of machine for conversion to non-woven fabric in the usual manner. The mixture discharged from the conduit is found to be substantially free from fiber bundles and other fiber agglomerates, and the non-woven fabric ultimately produced on the paper-making type of equipment is found to have the desirable properties of fabric prepared manually from fibers of equal length.

The apparatus employed for performing the method may include a drum whose circumferential wall is formed with apertures flaring in a direction outward of the drum. An axially elongated airfoil member having a leading axial edge and a trailing axial edge is moved along the inner face of the wall in a circular path by a rotor. The aqueous fiber stock containing fiber bundles is introduced into the drum, and the material discharged outwardly from the apertures is removed toward the paper-making machine.

Other features, additional objects, and many of the attendant advantages of this invention will readily be appreciated as the same becomes better understood by reference to the following detailed description of a preferred embodiment when considered in connection with the appended drawing in which:

FIG. 1 shows a stock run-on line of a paper-making type of machine equipped with apparatus of the instant invention in elevational section;

FIG. 2 shows a portion of the apparatus of FIG. 1 on a larger scale; and

FIG. 3 is a fragmentary plan view of a drum in the apparatus of FIG. 1, as viewed in the direction of the arrows 3, 3 in FIG. 2.

Referring initially to FIG. 1, there is shown a cylindrical drum 2 arranged in stock run-on 4 in a fixed position. A slurry of fibers and water enters the run-on as indicated by an arrow, passes the drum 2, and is discharged from an orifice 6 on the wire or screen 8 of a paper-making or paper-making type of machine, which may be conventional in itself and has not been shown otherwise.

The circumferential wall of the drum **2** has axially elongated slots **10** which flare in a radially outward direction at an angle too small to permit realistic representation on the scale of the drawing, the angle preferably being not substantially greater than 7°. Thus, each slots **10** forms an aperture or conduit of elongated cross section narrowing from the exterior to the interior of the drum as the stock is drawn into the drum **2**, and widening outwardly as the stock is forced out of the drum, as hereinafter described. A rotor **14** having four radial spokes, is mounted coaxially in the drum **2** on a drive shaft **12** which is actuated by means not shown. An air foil section, elongated axially of the drum **2**, is mounted on the end of each spoke radially remote from the shaft **12**.

As is best seen in FIG. 3, the rounded edge **18** of the airfoil section is the leading edge as the section is moved by the shaft **13** in a circular path closely adjacent the inner face of the circumferential drum wall. The sharp edge **20** of the section trails.

During operation of the apparatus, the shaft **12** and the airfoil sections **16** mounted thereon may be rotated at a speed of 1000 r.p.m. while a stock or slurry of water and fibers is introduced into the run-on **4** at a pressure sufficient to produce the desired non-woven fabric on the screen **8**.

The trailing edges **20** of the air foils cause suction waves as they pass the inner orifices of the slots **10** whereby the stock of water and fibers is drawn into the drum **2**. Similarly, pressure waves are generated by the leading edges **18** and cause discharge of fiber-bearing liquid streams through the slots **10** outward of the drum **2**.

The cyclic pressure and suction waves are transmitted by the liquid to the fibrous material confined in the drum **2**, and causes fiber aggregates initially present or generated in the drum by the agitating effect of the rotor **14** to be loosened and partly separated into individual fibers. The material entering the slots **10** under the pressure action of the airfoil sections **16** is a mixture of water, individual fibers, and loosened fiber bundles.

The slots **10** are dimensioned so that they are about 2 to 6 times as long as the fibers to be dispersed, and have a width, at their narrow end, which is 20 to 30 times the diameter of the fibers. Thus the individual fibers can pass through the slots without being longitudinally oriented in the direction of flow. The dwell time of the fibers in the drum is very short because the slots do not seriously interfere with outward flow of the stock in the form of streams whose principal dimensions are in the direction of radial outward flow and in the direction of elongation of the slots.

As the longitudinal, spacedly opposite faces of the drum in each slot diverge outwardly of the drum **2**, the discharged mixture of water, fibers, and loosened fiber bundles is expanded transversely of its direction of flow, and the transverse forces exerted by the diverging streams of liquid on the loosened fiber bundles cause disintegration of the latter.

The acute angle at which the longitudinal slot walls diverge outward of the drum **2** must be chosen carefully for the greatest disrupting effect of the flowing liquid on the fiber bundles. At the high flow rates practical for industrial applications, it should be very small, and not greater than 7° to avoid turbulence in the slots **10** which would produce the opposite of the desired effect. For the same reason, the slots must be narrow as compared to their length.

Apparatus of this invention has been operated successfully to disperse synthetic staple fibers 20 mm. long and longer in relatively little water to produce stock of a consistency much higher than permissible heretofore with fibers only 12 mm. long or shorter which were to be converted to a non-woven fabric on a paper-making machine or paper-making type of machine.

Rather than mounting the drum **2** and rotor **14** in the run-on of a paper-making type of machine, they may also be mounted in the stock make-up tank. They may also be utilized on a stock system in which the stock or slurry of fibers and water is fed directly into the drum **2** and discharged from the drum **2** through the slots **10** into the run-on **4**.

If the direction of stock flow and the inclination of the slot walls are reversed in the last-mentioned variation of this invention, a slurry or mixture of water, fibers, and fiber bundles may be fed to the modified drum through the inwardly flaring slots, whereby fiber bundles are disintegrated in the slots under the forces partly generated by the airfoil sections, and discharged from the drum directly into the run-on without again passing through the slots. In such an arrangement, the formation of nodules and other agglomerations by the rotor **14** is unavoidable, and such agglomerations are not broken up by subsequent passage through conduits of elongated cross section which widen in the direction of flow.

The length of the slots must not be smaller than the length of the fibers to be processed, that is, not less than 20 mm. for fibers 20 mm. long, but it preferably is at least twice the fiber length or not less than 20 mm. for fibers 10 mm. long or longer, and not less than 40 mm. for fibers having a length of 20 mm. to which this invention is uniquely applicable.

While the drum **2** illustrated and described above is provided with slots **10** of a uniform cross section which is elongated in the direction of the drum axis, the orientation of the slots **10** is not critical. The slots may be elongated circumferentially or at any desired angle to a plane through the drum axis. They may be arranged in a uniform pattern, as shown in FIG. 2, or they may be distributed at random over the drum wall.

It should be understood, therefore, that the foregoing disclosure relates only to a preferred embodiment of the invention, and that it is intended to cover all changes and modifications of the example of the invention herein chosen for the purpose of the disclosure which do not constitute departure from the spirit and scope of the invention set forth in the appended claims.

We claim:

1. A method of dispersing fibers longer than 10 mm. in stock water prior to converting said fibers to non-woven fabric on a screen of a paper-making type of machine which comprises:

(a) dispersing said fibers in water to form a slurry, respective pluralities of fibers in said slurry constituting bundles;

(b) confining said slurry behind a wall formed with a multiplicity of slots;

(c) subjecting the confined slurry to alternating pressure and suction waves until the fibers of said bundles are partly separated;

(d) passing the resulting mixture of water, individual fibers, and partly separated bundles of fibers through said wall in a multiplicity of respective streams flowing through said slots and being discharged therefrom,

(1) said slots being shaped to cause each passing stream to expand in said slots transversely to the direction of flow,

(2) the rate of flow and the rate of expansion of each stream in said slots being sufficient to cause further separation of the fibers in said bundles; and

(e) transferring the mixture discharged from said slots to said screen.

2. A method as set forth in claim **1**, wherein said fibers are longer than 20 mm., each slot is of elongated cross section transverse to said direction, the length of said cross section being twice to six times the length of said fibers.

3. A method as set forth in claim 2, wherein the width of said cross section is at least 20 times the diameter of each fiber.

4. An apparatus for separating fibers of fiber bundles in an aqueous fiber stock comprising:

(a) a drum having an axis and a circumferential wall about said axis,

(1) said wall being of circular cross section at right angles to said axis, and

(2) being formed with a multiplicity of apertures extending therethrough in a radial direction, said apertures flaring radially outward of said drum;

(b) an axially elongated airfoil member having a leading axial edge and a trailing axial edge;

(c) rotor means for moving said airfoil member along the inner face of said wall in a circular path about said axis;

(d) means for introducing said stock into said drum; and

(e) means for removing material radially outwardly discharged from said apertures.

5. An apparatus as set forth in claim 4, wherein said apertures are slots elongated at right angles to said radial direction and having a length of not less than 20 mm.

6. An apparatus as set forth in claim 5, wherein said length is at least 40 mm.

7. An apparatus as set forth in claim 5, wherein respective spacedly opposite faces of said wall bound each slot, said faces extending longitudinally of said slot and diverging in a radially outward direction.

8. An apparatus as set forth in claim 7, wherein said faces diverge at an angle not substantially greater than 7°.

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