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(54) Process for the production of non-woven cotton fabrics having a patterned structure.

(57) A web of gray cotton fibers is entangled by passing it under a series of low pressure liquid jets which are oscillated in a direction transverse to the direction of travel of the web. The entangled web is then subjected to a cotton bleaching step, and then dried, to produce a coherent nonwoven fabric that requires no resin binder.

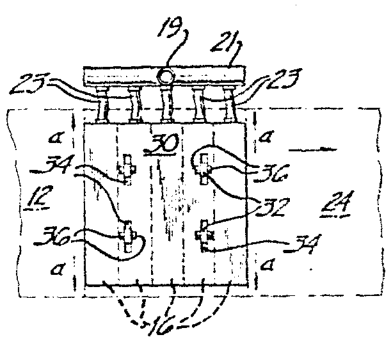

FIG-10

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TITLE MODIFIED see front page

Cotton Patterned Fabric

The invention relates to a process for the production of nonwoven fabrics made from cotton, and to the nonwoven cotton fabrics that are made thereby.

Background of the Invention

Nonwoven fabrics that are made by the fluid rearrangement of fibers have been in commercial use for some time. For instance, Kalwaites, in U.S. Patent Nos. 2,862,251, 3,033,721, 3,931,436, and 3,769,659, and Griswold in U.S. Patent Nos. 3,081,515 and 3,025,585, describe various processes for producing nonwoven fabrics by the fluid rearrangement of a fibrous web to which resin binder is added after the fluid rearrangement to form a useful, coherent, nonwoven fabric. Still other nonwoven fabrics are made by forming a web of fibers and treating it with high pressure jets to entangle the fibers and produce a strong fabric that does not require the addition of binder to be self-supporting and useful for many purposes. Such a technique is described by Evans, in U.S. Patent No. 3,485,706.

In the processes taught by Kalwaites and Griswold, resin binder is added to the rearranged fabric to produce a commercially useful nonwoven fabric. With the Evans process, although binder need not be added, high pressure water jets are used to produce the nonwoven fabric. The present invention is based upon the discovery of a process whereby cotton fibers can be fluid rearranged to produce useful nonwoven fabrics, without the necessity for the use of any resin binder, and yet the fluid rearrangement takes place at relatively low pressures. Thus, the process of the invention can be carried out using relatively inexpensive and uncomplicated equipment.

Brief Summary of the Invention

The invention provides a process wherein an array of gray cotton fibers is carried on a foraminous belt under a series of water sprays or jets, wherein the water sprays or jets are maintained under low frequency oscillation, whereby the cotton fibers are rearranged by the water to form a coherent web of patterned gray cotton fibers. This coherent web, preferably without drying, is then treated to conventional cotton bleaching techniques, and is then dried, to produce a strong, coherent cotton nonwoven fabric. The invention also provides the nonwoven cotton fabric that is produced by the process of the invention.

The Prior Art

Bunting et al., in U.S. Patent Nos. 3,493,462, 3,508,308, and 3,620,903, describe a process for producing lightweight, nonpatterned, nonwoven fabrics, by treating an array of fibers to essentially columnar streams of liquid jetted from orifices under high pressure. The jet streams may be rapidly oscillated, which oscillation is done for the purpose of producing a smooth fabric surface and to enhance the nonpatterned structure of the nonwoven fabric.

Brief Description of the Drawings

Fig. 1 is a schematic view in elevation of an arrangement of apparatus suitable for carrying out the process of the invention;

Figs. 2 through 5 are photomacrographs, originally taken at 10X, of the nonwoven fabric of Example 1 of this application;

Figs. 6 through 9 are photomacrographs, originally taken at 10X, of the nonwoven fabric of Example 2 of this application; and

Fig. 10 is a top plan view of the manifold section looking in the direction of the arrows 10-10 of Fig. 1.

Detailed Description Of The Invention

Referring to Figs. 1 and 10, a carded web 12 of gray cotton fibers is produced by a card 10, and is then passed onto a liquid pervious support member or forming belt, such as an endless woven belt 14. The belt 14 carries the web 12 of fibers under a series of manifolds 16 that are arranged in rows disposed transversely across the path of travel of the belt 14 (i.e., they are disposed in the cross direction). On the manifolds 16 are mounted spray heads or orifice strips for ejecting liquid 18 under moderate pressure down onto the carded web 12 of cotton fibers supported on the belt 14. The liquid is provided from a source (not shown) of pressurized water, through a main water duct 19, to a common supply manifold 21, and through flexible hoses 23 into each manifold 16. The manifolds 16 are constructed and adapted so that they can be oscillated transversely to the path of travel of the web 12 (see the arrows "a" in Fig. 10, which show the direction of oscillation), with the frequency of oscillation being, for instance, from about 1 to about 5 oscillations per second. There may be a vacuum duct 20 attached to conventional vacuum means (not shown) pulling a vacuum of, for example, up to 5 to 10 inches of mercury beneath the belt 14, with vacuum slots 22 being positioned directly under each manifold 16. The cotton fibers in the web 12 are rearranged by the liquid jets or spray 18 as the liquid impinges upon and passes through the fibrous web 12 and then through the belt 14. The rearranged fibrous web 24 can be de-watered, as by passing it through a pair of squeeze rolls 28, and it is then carried to a conventional windup 26, still in the wet state, for subsequent bleaching. The rearranged fibrous web 24 is preferably kept wet until it has been bleached, in order to impart sufficient strength to the web 24 so that it can be handled. The rearranged fibrous web is then bleached by conventional cotton bleaching procedures, and is then rinsed and dried, to produce the cotton patterned nonwoven fabric of the invention.

The process of the invention is employed with gray cotton staple fibers. While other fibers can be blended with the cotton, the gray cotton must comprise at least a major proportion of the web to be employed in the process of the invention. As used herein, "gray cotton" refers to cotton that has not been bleached or scoured.

The cotton feed web can be formed by carding, air-laying, or other convenional web-forming procedure. Typical feed web weights are from about 25 to about 200 grams per square meter.

If desired, a reinforcing web such as a scrim or a reticulated plastic netting can be used. Typically, the carded cotton fiber feed web is laid down on top of the reinforcing web prior to the liquid rearranging.

The liquid pervious support member or forming belt that is employed to carry the array of cotton fibers under the water spray can be a conventional plain weave belt woven of polyester monofilament, bronze, or other conventional materials. The belts will usually have from 35 to 75 per cent open area. Such belts are conventionally made from monofilaments having a filament count of from about 11 to about 236 filaments per 10 centimeters (about 3 to 60 filaments per inch) in both directions.

The water that is jetted or sprayed onto the fibers can be provided at relatively low pressure, for instance, from about 100 to about 600 psi (that is, from about 700 to about 4,000 kpa). The water spray can be provided in the form of essentially columnar jets, if desired, but can also be employed in the form of sprays with a relatively wide angle of divergence, for instance, up to about 10 degrees.

The exact number of spray heads per unit width has not been found to be narrowly critical. However, a much wider spacing can be used than is customarily employed with the technique of Evans (U.S. Patent No. 3,485,706). When using columnar jets having diameters of from about 3 to 10 mils, the usual spacing is from about 2 to about 10 jets per inch. When using spray jets instead of columnar jets, about one-half to two per inch are typical. (Closer spacing would be difficult because of the size of the spray heads.)

The number of rows of jets (i.e., the number of jets in the machine direction or direction of travel of the forming belt) has not been found to be narrowly critical. Typically, there will be from about 10 to about 30 rows when spray jets are used, and from about 8 to about 20 rows when columnar jets are used.

For the conditions indicated above (i.e., typical web weights, jet liquid pressures, jet spacings, and rows of jets), the usual speed of the forming belt is from about 5 to about 20 meters per minute.

A major point of novelty of this invention is the provision of means to impart transverse oscillation to the jets. Such oscillation can be effected by mounting the manifolds 16 in such a way that they are transversely moveable (as by using roller bearings or linear bearings), and employing a driven crank-shaft, rotating cams, eccentrically mounted rotating circular disks, or other conventional oscillation-imparting means (not shown), to engage the manifolds and oscillate them. The manifolds can be oscillated either together (in phase with each other) or independently (out of phase with each other).

In the embodiment schematically shown in the drawings, the manifolds 16 are ganged, and are suspended from a stationary mounting plate 30. Upstanding projections or lugs 32 attached to the ganged manifolds 16 extend through slots 34 in the stationary mounting plate 30. Roller bearings 36 mounted on the lugs 32 ride on the mounting plate 30 as the ganged manifolds 16 oscillate.

The oscillation used is a relatively low frequency oscillation, e.g., from about 75 to about 200 cycles per minute. The amplitude of the oscillation is not narrowly critical, and it can vary, for instance, from about 5 millimeters to about 50 millimeters.

The rearranged web is subjected to a conventional cotton bleaching process (which is illustrated below in the examples), and is then dried as by passing it over a set of steam cans.

The examples below illustrate the practice of the invention.

Example 1

A carded web of gray cotton having a weight of 50 grams per square meter was laid down onto a single layer of woven cotton gauze. The gauze was a plain weave scrim having a warp thread count of 17 per inch and a weft thread count of 13 per inch, and weighed 15 grams per square meter. The double layer web was then passed onto a woven belt having the following description:

The belt was a plain weave belt woven of polyester monofilaments. The warp and weft threads had diameters of 500 microns, and the thread counts were 40 warp threads per centimeter and 10 weft threads per centimeter.

The belt carrying the web of carded cotton plus scrim was passed under a series of manifolds at a speed of 10 meters per minute. The manifolds contained spray nozzles that were 55 millimeters apart (center-to-center) in the cross direction, and there were 8 rows of nozzles in the machine direction. The spray nozzles used were designed to deliver solid streams of water through orifices having diameters of about 8 mils.

The belt was 15 millimeters under the tips of the nozzles. Water was sprayed through the nozzles at a pressure of 3500 kpa. As the web was carried under the nozzles, the manifolds in which the nozzles were mounted were vibrated at a frequency of 120 cycles per minute and an amplitude of 37 millimeters. Vacuum slots under the belt below each row of nozzles pulled a vacuum of about 5 inches of mercury. The fabric was passed through the apparatus 10 times. The web was de-watered by passing it through a pair of squeeze rolls, was collected on a windup while still wet, and was then bleached under the following conditions:

The fabric is rolled onto a perforated spindle and is then placed in a bleaching kier. The fabric is wet out with hot water and then drained. The kier is then filled (to a level above the cloth) with an aqueous solution containing caustic soda, soda ash, and soap, and allowed to circulate. Hydrogen peroxide is added and the kier is sealed and heated to 120°C., where it is kept for 20 minutes. The kier is then cooled, drained, and rinsed twice with cold water. Dilute acetic acid is added to a pH of 6.5 - 7.0, and then two more rinses are made. If the pH of the final rinse is 6.5 - 7.0, the cloth is removed and dried.

Photomacrographs of this fabric are shown in Figs. 2 - 5. Figs. 2 and 3 were made with incident light and Figs. 4 and 5 were made with transmitted light. Figs. 2 and 4 show the top side of the fabric and Figs. 3 and 5 show the bottom or belt side (i.e., the side that was next to the belt during the rearranging).

Example 2

By a procedure analogous to that described in Example 1, a cotton patterned fabric was made from a web of carded gray cotton having a basis weight of 50 grams per square meter. The forming belt was the same as that described in Example 1. The processing conditions were as follows:

Belt speed - 10 meters per minute
Spray pressure 3500 kpa
Manifold Oscillation
    2 cycles per second
    3.7 centimeter amplitude

The wet, rearranged fabric was bleached and dried by a procedure analogous to that of Example 1. Photomacrographs of the fabric are shown in Figs. 6-9. As with Example 1, the photomacrographs were taken both with incident light and with transmitted light, and both the top and belt sides are shown.

The fabrics described in this application are useful as bandages, sponges, swabs, primary dressings, secondary dressings, prepping swabs, and other absorbent products.

Examples 3 and 4

By a procedure analogous to that described in Example 1, a gauze reinforced fabric was made from a web of gray cotton having a weight of 50 grams per square meter and the scrim described in Example 1. Instead of using spray nozzles, the water was jetted through the holes in an orifice strip, the holes being designed to produce essentially columnar jets. The holes had diameters of 0.007 inch, and there were four holes per inch. There were 12 rows of nozzles. Only one pass through the apparatus was used. The processing conditions were the following:

Belt speed - 10 meters per minute
Jet pressure - 3500 kpa
Manifold oscillation - 2.67 cycles per second
3.1 centimeter amplitude

The webs were dewatered, bleached, and dried as described in Example 1.

The procedure was repeated, but without using the gauze reinforcement. Typical tensile properties of both the gauze-reinforced and the non-reinforced fabrics are the following:

Tensile Strengths

	Non-Reinforced	Gauze-Reinforced
MD Dry	13.7 Newtons, minimum	27.5 and 19.6 N., min.
MD Wet	15.7 N., min.	27.5 N., min.
CD Dry	4.7 N., min.	10.3 and 8.3 N., min.
CD Wet	4.9 N., min.	12.7 N., min.

The tensile tests were carried out on an Instron tensile tester. Sample size was 25 x 130 mm. The initial distance between the jaws was 100 mm. The crosshead speed was set at 200 mm/minute.

With the gauze-reinforced samples, there are two peaks in the stress/strain curve. The higher numbers are the tensile strengths of the gauze reinforcement; the lower are the tensile strengths of the entangled cotton.

What Is Claimed Is:

1. Process for producing a nonwoven fabric which comprises:

(a) supporting a layer comprising gray cotton fibers which are in mechanical engagement with each other but which are capable of movement under applied liquid forces, on a liquid pervious support member adapted to move in a predetermined direction and on which fiber movement in directions both in and at an angle to the plane of said layer is permitted in response to applied liquid forces;

(b) moving the supported layer in said predetermined direction through a fiber rearranging zone within which streams of liquid are projected directly onto said layer, wherein said streams are oscillated in a direction transverse to said predetermined direction;

(c) permitting said streams of liquid to pass through said layer and said support member to effect movement of said fibers to form a layer that resembles the negative image of said liquid pervious support member, and to effect sufficient interlocking of said fibers that said layer becomes self-supporting; and

(d) subjecting the self-supporting fibrous web product of step (c) to a cotton bleaching step, thereby producing a coherent nonwoven fabric.

2. Process of claim 1 wherein the frequency of oscillation of said streams is from about 75 to about 200 cycles per minute, and the amplitude of said oscillation is from about 5 to about 50 millimeters.

3. The process of claim 1 or claim 2 wherein said streams are columnar jets spaced at least 0.8 millimeter apart, center-to-center.

4. The process of any one of claims 1 to 3 wherein the streams of liquid are under a pressure of about 100 to 600 psi.

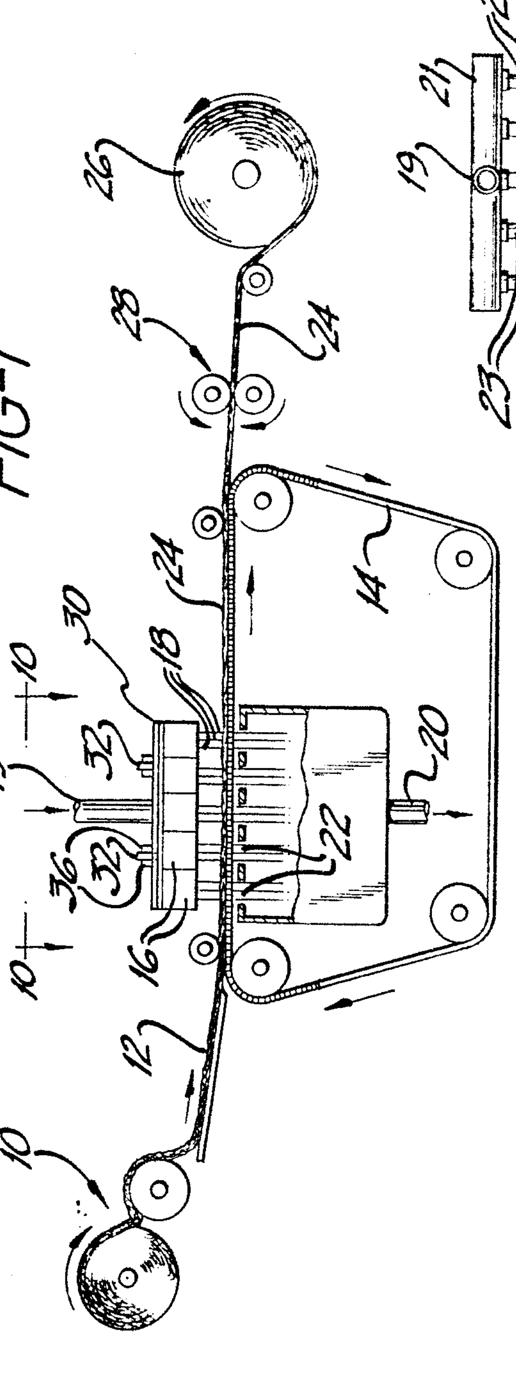

FIG-1

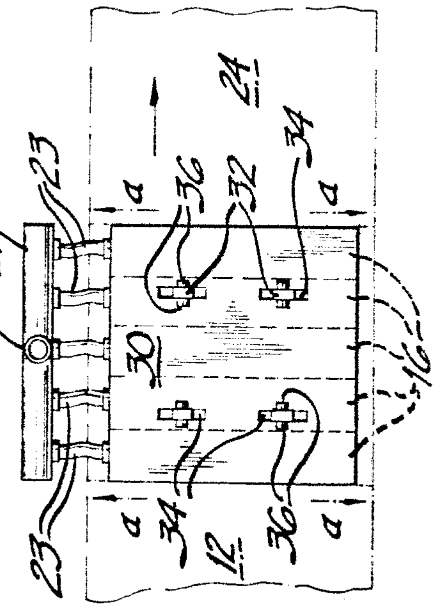

FIG-10

FIG-2

FIG-3

FIG-4

FIG-5

FIG-6

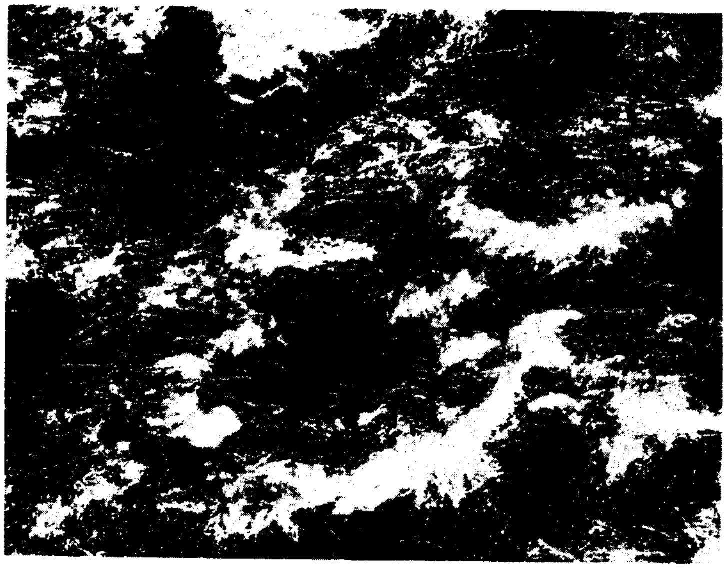

FIG-7

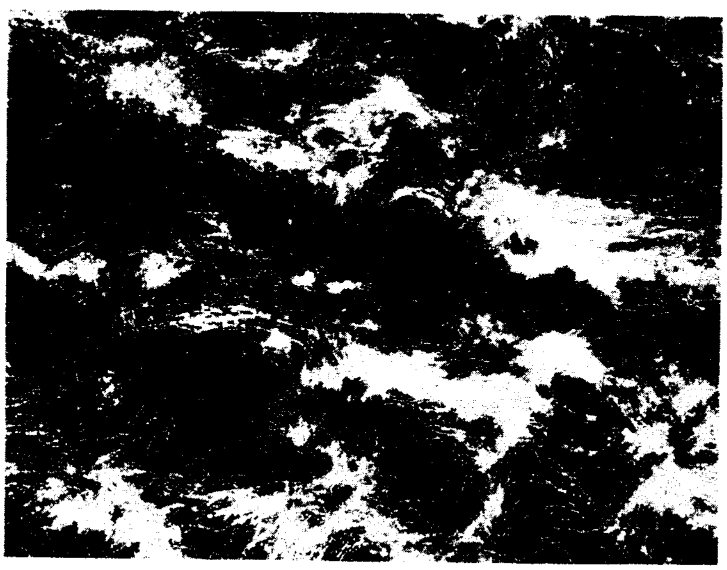

FIG-8

FIG-9