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(54) APPARATUS AND METHOD FOR HYDROENHANCING FABRIC

VORRICHTUNG UND VERFAHREN FÜR WASSERBEHANDLUNG VON GEWEBEN

MACHINE ET PROCEDE D'HYDROEMBELLISSEMENT DE TISSU

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(73) Proprietor: **INTERNATIONAL PAPER COMPANY**
Purchase New York 10577 (US)

(72) Inventors:
- **STERNLIEB, Herschel**
  Brunswick, ME 04011 (US)
- **SIEGEL, Jodie, M.**
  Watertown, MA 02172 (US)
- **GREENWAY, John, Michael**
  Westwood, MA 02090 (US)

(74) Representative:
Kearney, Kevin David Nicholas et al
KILBURN & STRODE
30 John Street
London, WC1N 2DD (GB)

(56) References cited:
EP-A- 0 099 639
EP-A- 0 177 277
AU-A- 0 287 821
CA-A- 0 739 652
US-A- 3 747 161
US-A- 3 917 785

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Description

Field of Invention

This invention generally relates to a textile finishing process for upgrading the quality of woven and knit fabrics. More particularly, it is concerned with a hydroentangling process which enhances woven and knit fabrics through use of dynamic fluid jets to entangle and cause fabric yarns to bloom. Fabrics produced by the method of the invention have enhanced surface finish and improved characteristics such as cover, abrasion resistance, drape, stability as well as reduced air permeability, wrinkle recovery, seam slippage, and edge fray.

Background Art

The quality of a woven or knit fabric can be measured by various properties, such as, the yarn count, thread count, abrasion resistance, cover, weight, yarn bulk, yarn bloom, torque resistance, wrinkle recovery, drape and hand.

Yarn count is the numerical designation given to indicate yarn size and is the relationship of length to weight.

Thread count in woven or knit fabrics, respectively, defines the number of ends and picks, and wales and courses per inch of fabric. For example, the count of cloth is indicated by enumerating first the number of warp ends per cm (inch), then the number of filling picks per cm (inch). Thus, 27 x 28 (68 x 72) defines a fabric having 27 (68) warp ends and 28 (72) filling picks per cm (inch).

Abrasion resistance is the ability of a fabric to withstand loss of appearance, utility, pile or surface through destructive action of surface wear and rubbing.

Cover is the degree to which underlying structure in a fabric is concealed by surface material. A measure of cover is provided by fabric air permeability, that is, the ease with which air passes through the fabric. Permeability measures fundamental fabric qualities and characteristics such as filtration and cover.

Yarn bloom is a measure of the opening and spread of fibers in yarn.

Fabric weight is measured in weight per unit area, for example, the number of grams per square meter (ounces per square yard).

Torque of fabric refers to that characteristic which tends to make it turn on itself as a result of twisting. It is desirable to remove or diminish torque in fabrics. For example, fabrics used in vertical blinds should have no torque, since such torque will make the fabric twist when hanging in a strip.

Wrinkle recovery is the property of a fabric which enables it to recover from folding deformations.

Hand refers to tactile fabric properties such as softness and drapability.

It is known in the prior art to employ hydroentangling processes in the production of nonwoven materials. In conventional hydroentangling processes, webs of nonwoven fibers are treated with high pressure fluids while supported on apertured patterning screens. Typically, the patterning screen is provided on a drum or continuous planar conveyor which traverses pressurized fluid jets to entangle the web into cohesive ordered fiber groups and configurations corresponding to open areas in the screen. Entanglement is effected by action of the fluid jets which cause fibers in the web to migrate to open areas in the screen, entangle and intertwine.

Prior art hydroentangling processes for producing patterned nonwoven fabrics are represented by U.S. Patent Nos. 3,485,706 and 3,498,874, respectively, to Evans and Evans et al., and U.S. Patent Nos. 3,873,255 and 3,917,785 to Kalwaites.

Hydroentangling technology has also been employed by the art to enhance woven and knit fabrics. In such applications warp and pick fibers in fabrics are hydroentangled at cross-over points to effect enhancement in fabric cover. However, conventional processes have not proved entirely satisfactory in yielding uniform fabric enhancement. The art has also failed to develop apparatus and process line technology which achieves production line efficiencies.

Australian Patent Specification 287821 to Bunting et al. is representative of the state of the art. Bunting impacts high speed columnar fluid streams on fabrics supported on coarse porous members. Preferred parameters employed in the Bunting process, described in the Specification Example Nos. XV - XVII, include 0.84 mm (20 mesh) and 0.59 mm (30 mesh) support screens, fluid pressure of 10340 kPa (1500 psi), and jet orifices having 0.18 mm (0.007 inch) diameters on 1.27 mm (0.050 inch) centers. Fabrics are processed employing multiple hydroentangling passes in which the fabric is reoriented on a bias direction with respect to the process direction in order to effect uniform entanglement. Data set forth in the Examples evidences a modest enhancement in fabric cover and stability.

Another approach of art is represented by European Patent Application 0 177 277 to Willbanks which is directed to hydropatterning technology. Willbanks impinges high velocity fluids onto woven, knitted and bonded fabrics for decorative effects. Patterning is effected by redistributing yarn tension within the fabric - yarns are selectively compacted, loosened and opened - to impart relief structure to the fabric.

Fabric enhancement of limited extent is obtained in Willbanks as a secondary product of the patterning process. However, Willbanks fails to suggest or teach a hydroentangling process that can be employed to uniformly enhance fabric characteristics. See Willbanks Example 4, page 40.

There is a need in the art for an improved woven textile hydroenhancing process which is commercially viable. It will be appreciated that fabric enhancement offers aesthetic and functional advantages which have application in a wide diversity of fabrics. Hydroenhancement improves fabric cover through dynamic fluid entanglement and bulking of fabric yarns for improved fabric stability. These results are advantageously obtained without requirement of conventional fabric finishing processes.

The art also requires apparatus of uncomplex design for hydroenhancing textile materials. Commercial production requires apparatus for continuous fabric hydroenhancing and inline drying of such fabrics under controlled conditions to yield fabrics of uniform specifications.

Accordingly, it is a broad object of the invention to provide an improved textile hydroenhancing process and related apparatus for production of a variety of novel woven and knit fabrics having improved characteristics which advance the art.

A more specific object of the invention is to provide a hydroenhancing process for enhancement of fabrics made of spun and spun/filament yarn.

Another object of the invention is to provide a hydroenhancing process having application for the fabrication of novel composite and layered fabrics.

A further object of the invention is to provide a hydroenhancing production line apparatus which is less complex and improved over the prior art.

Disclosure of the Invention

In the present invention, these purposes, as well as others which will be apparent, are achieved generally by providing an apparatus and a related method for hydroenhancing woven and knit fabrics through dynamic fluid action. A hydroenhancing module is employed in the invention in which the fabric is supported on a member and impacted with a fluid curtain under controlled process energies. Enhancement of the fabric is effected by entanglement and intertwining of yarn fibers at cross-over points in the fabric weave or knit. Fabrics enhanced in accordance with the invention have a uniform finish and improved characteristics, such as, edge fray, drape, stability, wrinkle recovery, abrasion resistance, fabric weight and thickness.

According to the present invention a method for enhancing and finishing woven or knitted textile fabrics having yarns which intersect at cross-over points, wherein the fabric is supported on a support member, conveyed in a machine direction through a production line, and impacted with liquid, is characterised in that the fabric is made from spun and/or spun filament yarn fibres having dtex and lengths in the range of 0.333 to 17.8 dtex (0.3 to 16.0 denier) and 1.27 to 20.3 centimetres (0.5 - 8 inches) respectively, and yarn counts in the range of 1180 to 7.4 TEX (0.5s to 80s) and in that the method comprises uniformly and continuously impacting at least one side of the fabric with a continuous curtain of fluid which impacts the fabric with an energy in the range of 5.7×10^5 to 11.5×10^6 joule/kg (0.1 - 2.0 hp-hr/lb), thereby effecting entanglement of the yarns at their cross-over points.

The continuous curtain of fluid is preferably provided by an array of closely spaced liquid jets which emanate from jet orifices.

The conveying speed is preferably from .0508 to 2.54 m/sec (10 to 500 fpm), the jet pressure is preferably from 1,379 to 20,685 kpa (200 to 3000 psi), the jets are preferably columnar, the jet orifices preferably have a diameter of 0.0127 to 0.254 cm (0.005 to 0.010 inches), and preferably centre-to-centre spacing of 0.043 to 0.086 cm (0.017 to 0.034 inches).

The jets are preferably spaced approximately 1.27 cm (0.5 inches) from the support member.

The support member is preferably liquid pervious and includes open areas of 17-40% and has a fine mesh pattern which permits fluid passage without imparting a patterned effect to the fabric.

The support preferably includes a fine mesh screen arranged in offset relation to the machine direction.

The array of jets is preferably provided by a plurality of parallel manifolds spaced approximately 20.3 cm (8 inches) apart.

In one preferred embodiment the pressure is approximately 10,340 kPa (1500 psi), the jet orifice diameter is approximately 0.0127 cm (0.005 inches), the centre-to-centre spacing of the jet orifices provides approximately 24 jets per cm (60 jets per inch), and the fabric is impacted with a cumulative energy of approximately 2.64×10^6 joule/kg (0.46 hp-hr/lb).

Following enhancement, the fabric is advanced to a tenter frame which dries the fabric to a specified width under tension to produce a uniform fabric finish.

Advantage in the invention apparatus is obtained by provision of a continuous process line of uncomplex design. First and second enhancement stations are provided which include a plurality of cross-directionally ("CD") aligned and spaced manifolds.

In a preferred arrangement columnar jet nozzles having orifice diameters of approximately 0.0127 cm (0.005 inches) with center-to center spacings of approximately 0.043 cm (.017 inches) are mounted approximately 1.27 cm (.5 inches) from the screens. At the process energies of the invention, this spacing arrangement provides a curtain of fluid which yields a uniform fabric enhancement. Use of fluid pervious support members which are oriented in offset relation, preferably 45°, effectively limits jet streaks and eliminates reed markings in processed fabrics.

Optimum fabric enhancement results are obtained in fabrics including fibers with dtex and staple lengths in the range of 0.555 to 6.66 dtex (0.5 to 6.0 denier), and 1.27 cm to 12.7 cm (0.5 to 5 inches), respectively, and yarn counts in the range of 1180 to 11.8 Tex (.5s to 50s). Preferred yarn spinning systems of the invention fabrics include open end cotton spun, wrap spun, open end wool spun and friction spun.

The fabric preferably includes low denier, short length fibres and loosely twisted yarns.

The liquid jets are preferably aligned in a cross-direction relative to the machine direction, and each liquid jet has an axis substantially perpendicular to the fabric.

In a preferred form of the invention the method effects enhancement of the yarns in interstitial open areas defined by the cross-over points in the fabric weave, and the fabric demonstrates a reduction in air permeability in the range of 10 to 90% after enhancement.

In one embodiment the fabric is a woven polyester fabric and the fabric includes 2.22 dtex (2 denier), 4.8 cm (1.9 inch) polyester fibre, open-end cotton spun yarn having a yarn number of 34.7 Tex (17s) and count of 19 x 9 per cm (49 x 23 per inch), and the method yields an approximately 48% reduction in air permeability in the fabric after enhancement.

In another embodiment the fabric is a woven acrylic fabric and the fabric includes 3.33 dtex (3 denier), 3.8 cm (1.5 inch) fibre, open-end cotton warp yarn having a yarn number of 65.7 Tex (9s), 11 ends per cm (28 per inch), and a 3.33 dtex (3 denier), 7.6 cm (3 inch) acrylic fibre, open-end wool spun fill yarn having a number of 147.6 Tex (4s), 6.3 picks per cm (16 per inch), and the method yields an approximately 36% reduction in air permeability in the fabric after enhancement.

In another embodiment the fabric is an acrylic wrap spun fabric and the fabric includes 3.33 dtex (3 denier), 7.6 cm (3 inch) acrylic fibre, wrap spun with 111 dtex (100 denier) textured polyester yarn having a yarn number of 147.6 Tex (4s) and count of 5.5 x 6.3 per cm (14 x 16 per inch), and the method yields an approximately 65% reduction in air permeability in the fabric after enhancement.

In another embodiment the fabric is a woven acrylic fabric and the fabric includes 3.33 dtex (3 denier), 3.8 cm (1.5 inch) acrylic fibre, open-end cotton spun warp yarn having a yarn number of 65.7 Tex (9s), 11 ends per cm (28 per inch), and a 3.33 dtex (3 denier), 7.62 cm (3 inch) acrylic fibre, hollow wrap spun fill yarn, 2.4 twists per cm (6 per inch) having a number of 147.6 Tex (4s), 6.3 picks per cm (16 per inch), and the method yields an approximately 48% reduction in air permeability in the fabric after enhancement.

In another embodiment the fabric is a woven acrylic fabric and the fabric includes 3.33 dtex (3 denier), 3.8 cm (1.5 inch) acrylic fibre, open-end wool spun warp yarn having a yarn number of 147.6 Tex (4s), 5.5 ends per cm (14 per inch), and a 3.33 dtex (3 denier), 7.6 cm (3 inch) acrylic fibre, open-end wool spun fill yarn having a yarn number of 227 Tex (2.6s), 6.3 picks per cm (16 per inch), and the method yields an approximate 48% reduction in air permeability in the fabric after enhancement.

In another embodiment the fabric is a woven fabric and the fabric includes 80% wool/20% nylon in a 2 x 1 twill weave, and the method yields an approximately 49.5% reduction in air permeability in the fabric after enhancement.

In another embodiment the fabric is a 53% polyester/47% cotton fabric and the fabric includes a 3 x 1 twill weave, a thread count of 47 ends/cm x 14.9 picks/cm (120 ends/inch x 38 picks/inch), and the method yields an approximately 50.6% reduction in air permeability in the fabric after enhancement.

In another embodiment the fabric is a 50% polyester/50% cotton doubleknit fabric and the fabric includes wrap spun yarn with 111 dtex (100 denier) polyester wrap, and the process yields an approximately 16% reduction in air permeability in the fabric after enhancement.

The invention also extends to apparatus for enhancing and finishing woven or knitted textile fabrics having spun and/or spun filament yarns which intersect at cross-over points, the apparatus including a fabric support member, and means for providing a plurality of liquid jet streams which impact the fabric, characterised in that the apparatus comprises:

means for conveying the supported fabric in a machine direction;
means for uniformly impacting the conveyed fabric with a continuous curtain of fluid comprising a plurality of densely spaced liquid jets aligned in a cross-direction relative to the machine direction, said liquid jets emanating from a plurality of densely spaced jet orifices as a continuous curtain of fluid;
said curtain of fluid coacting with the support member to entangle fabric yarns at their cross-over points.

The jets are preferably columnar, and the jet orifices preferably have diameters and centre-to-centre spacings of 0.0127 to 0.254 cm (0.005 to 0.010 inches) and 0.043 to 0.086 cm (0.017 to 0.034 inches) respectively.

The jets are preferably approximately 1.27 cm (0.5 inches) from the support member.

The support member is preferably liquid pervious and includes open areas of 17-40% and has a fine mesh pattern which permits fluid passage without imparting a patterned effect to the fabric.

The support preferably includes a fine mesh screen arranged in offset relation to the machine direction.

The jets are preferably provided by a plurality of parallel manifolds spaced approximately 20.32 cm (8 inches) apart.

The jet orifice diameter is preferably approximately 0.0127 cm (0.005 inches) and the centre-to-centre spacing of the jet orifices (32) is approximately 24/cm (60/inch).

The liquid jets each preferably have an axis substantially perpendicular to the fabric.

The invention also extends to a uniformly enhanced woven or knit textile fabric made by supporting the fabric on a support member and impacting the fabric with a plurality of liquid jet streams, characterised in that the fabric includes spun and/or spun filament yarns which intersect at cross-over points to define interstitial open areas, said yarns including fibres having dtex and lengths in the range of 0.333 to 17.8 dtex (0.3 to 16.0 denier) and 1.27 to 20.32 cms (0.5 to 8 inches), respectively, wherein said yarns are fluid entangled in said interstitial open areas, by application of a continuous curtain of non-compressible fluid energy in the range of 5.7 x 10^5 to 11.5 x 10^6 joule/kg (0.1 to 2.0 hp-hr/lb).

The fabric preferably includes low denier, short length fibres and loosely twisted yarns.

In a preferred form of the invention a uniformly enhanced woven or knit textile demonstrates a substantial improvement in at least two of air permeability, abrasion resistance, tensile strength, edge fray, seam slippage, wrinkle recovery, torque resistance, and fabric weight.

The invention also extends to a method for enhancing and hydrobonding woven or knit fabric materials having spun and/or spun filament yarns which intersect at cross-over points characterised in that it comprises:

napping first and second surfaces of the fabric to raise surface fibres thereof, and
arranging said first and second fabric surfaces on the support member in opposing and overlying layered relation, wherein the fabric is impacted with a continuous curtain of fluid with an energy in the range 5.7 x 10^5 to 11.5 x 10^6 joule/Kg to effect entanglement of said raised fibres in said first and second surfaces to bond the fabric.

The invention also extends to a method for hydrobonding woven or knit fabric materials to form a composite textile fabric, the fabric including spun and/or spun filament yarns in a structured pattern including yarns which intersect at cross-over points, the method comprising the steps of:

napping first and second surfaces of the fabric to raise surface fibres thereof,
arranging said first and second surfaces in opposing and overlying layered relation,
supporting the layered fabric on a support member, and
traversing one side of said layered fabric with a first continuous curtain of fluid for sufficient duration to effect entanglement of said raised surface fibres in said first and second surfaces,
said curtain of fluid impacting the fabric with an energy in the range 5.7 x 10^5 to 11.5 x 10^6 joule/Kg (0.1 and 2.0 hp-hr/lb).

Preferably the conveying speed is from .0508 to 2.54 m/sec (10 to 500 fpm), jet pressure is from 1,379 to 20,685 kpa (200 to 3000 psi), and the jets are columnar, the jet orifices having a diameter of 0.0127 to 0.254 cm (0.005 to 0.010 inches), and centre-to-centre spacing of 0.043 to 0.086 cm (0.017 to 0.034 inches).

The fabric is preferably treated on both sides.

The fabric preferably includes low denier, short length fibres and loosely twisted yarns.

The invention also extends to an enhanced composite woven or knit textile fabric characterised in that the fabric includes first and second napped surfaces which have raised surface fibres, said napped surfaces being arranged in overlying and opposed relation, and in which the said raised surface fibres in said first and second surfaces are entangled.

Other objects, features and advantages of the present invention will be apparent when the detailed description of the preferred embodiments of the invention are considered in conjunction with the drawings which should be construed in an illustrative and not limiting sense as follows:

Brief Description of the Drawings

Fig. 1 is a schematic view of a production line including a weft straightener, flat and drum hydroenhancing modules, and tenter frame, for the hydroenhancement of woven and knit fabrics in accordance with the invention;
Figs. 2A and B are photographs at 10X magnification of 14 x 11.4 90° mesh/cm (36x29 90° mesh/inch) and 16x16 45° mesh/cm (40x40 45° mesh/inch) plain weave support members, respectively, employed in the flat and drum enhancing modules of Fig. 1;

Figs. 3A and B are photomicrographs at 10X magnification of a fine polyester woven fabric before and after hydroenhancement in accordance with the invention;

Figs. 4A and B are photomicrographs at 16X magnification of the control and processed fabric of Figs. 3A and B;

Figs. 5A and B are photomicrographs at 10X magnification of a control and hydroenhanced woven acrylic fabric;

Figs. 6A and B are photomicrographs at 10X magnification of a control and hydroenhanced acrylic fabric woven of wrap spun yarn;

Figs. 7A and B are photomicrographs at 10X magnification of a control and hydroenhanced acrylic fabric woven of wrap spun yarn;

Figs. 8A and B are photomicrographs at 10X magnification of a control and hydroenhanced acrylic fabric including open end wool spun yarn;

Figs. 9A and B are photomicrographs at 16X magnification of a control and hydroenhanced wool nylon (80/20%) fabric;

Figs. 10A and B are photomicrographs at 16X magnification of a control and hydroenhanced spun/filament polyester/cotton twill fabric;

Figs. 11A and B are photomicrographs at 16X magnification of a control and hydroenhanced doubleknit fabric;

Figs. 12A and B are front and back side photomicrographs at 16X magnification of a control wall covering fabric;

Figs. 13A and B are front and back side photomicrographs at 16X magnification of the wall covering fabric of Figs. 12A and B hydroenhanced in accordance with the invention;

Figs. 14A and 14B are photomacrographs at 0.09X magnification of a control and hydroenhanced acrylic fabric strips, the fabric of Figs. 7A and B, showing the reduction in fabric torque achieved in the invention process;

Figs. 15 A-C are photomacrographs at 0.23X magnification, respectively, of the woven acrylic fabrics of Figs. 5, 7 and 8, comprised of wrap spun and open end wool spun yarns, showing washability and wrinkle characteristics of control and processed fabrics;

Fig. 16 is a schematic view of an alternative production line apparatus for the hydroenhancement of woven and knit fabrics in accordance with the invention; and

Fig. 17 illustrates a composite fabric including napped fabric components which are bonded into an integral structure employing the hydroenhancing process of the invention.

Best Mode Of Carrying out The Invention

With further reference to the drawings, Fig. 1 illustrates a preferred embodiment of a production line of the invention, generally designated 10, for hydroenhancement of a fabric 12 including spun and/or spun/filament yarns. The line includes a conventional weft straightener 14, flat and drum enhancing modules 16, 18, and a tenter frame 20.

Modules 16, 18 effect two sided enhancement of the fabric through fluid entanglement and bulking of fabric yarns. Such entanglement is imparted to the fabric in areas of yarn cross-over or intersection. Control of process energies and provision of a uniform curtain of fluid produces fabrics having a uniform finish and improved characteristics including, edge fray, torque, wrinkle recovery, drape, stability, abrasion resistance, fabric weight and thickness.

Method and Mechanism of the Enhancing Modules

Fabric is advanced through the weft straightener 14 which aligns the fabric weft prior to processing in enhancement modules 16, 18. Following hydroenhancement, the fabric is advanced to the tenter frame 20, which is of conventional design, where it is dried under tension to produce a uniform fabric of specified width.

Module 16 includes a first support member 22 which is supported on an endless conveyor means including rollers 24 and drive means (not shown) for rotation of the rollers. Preferred line speeds for the conveyor are in the range of 0.0508 to 2.54 m/sec (10 to 500 ft/min). Line speeds are adjusted in accordance with process energy requirements which vary as a function of fabric type and weight.

Support member 22, which preferably has a flat configuration, includes closely spaced fluid pervious open areas 26. A preferred support member 22, shown in Fig. 2A, is a 14.2 x 11.4 90° mesh/cm (36x29 90° mesh/inch) plain weave having a 23.7% open area, fabricated of polyester warp and shute round wire. Support member 22 is a tight seamless weave which is not subject to angular displacement or snag. Specifications for the screen, which is manufactured by Albany International, Appleton Wire Division, P.O. Box 1939, Appleton, Wisconsin 54913 are set forth in Table I.

TABLE I

Support Screen Specifications		
Property	14.2x11.4 90° mesh/cm 36x29 90° mesh/inch) flat mesh	16x16 45° mesh/cm (40x40 45° mesh/inch) drum mesh
Wire	polyester	stainless steel
Warp wire	0.4 mm (.0157 inches)	0.25 mm (0.010 inches)
Shute wire	0.4 mm (.0157 inches)	0.25 mm (0.010 inches)
Weave type	plain	plain
Open area	23.7%	36%

Module 16 also includes an arrangement of parallel and spaced manifolds 30 oriented in a cross-direction ("CD") relative to movement of the fabric 12. The manifolds which are spaced approximately 20.3 cm (8 inches) apart each include a plurality of closely aligned and spaced columnar jet orifices 32 which are spaced approximately 1.27 cm (.5 inches) from the support member 22.

The jet orifices have diameters and center-to-center spacings in the range of 0.0127 to 0.0254 cm (.005 to .010 inches) and 0.043 to 0.086 cm (.017 to .034 inches), respectively, and are designed to impact the fabric with fluid jets 28 at pressures in the range of 1379 to 20685 kPa (200 to 3000 psi). Preferred orifices have diameters of approximately 0.0127 cm (.005 inches) with center-to-center spacings of approximately 0.043 cm (.017 inches).

This arrangement of fluid jets 28 provides a curtain of fluid entangling streams which yield optimum enhancement in the fabric. Energy input to the fabric is cumulative along the line and preferably set at approximately the same level in modules 16, 18 (two stage system) to impart uniform enhancement to top and bottom surfaces of the fabric. Effective first stage enhancement of fabric yarn is achieved at an energy output in the range of 5.7×10^5 to 11.5×10^6 Joule/Kg (.1 to 2.0 hp-hr/lb).

Following the first stage enhancement, the fabric i advanced to module 18 which enhances the other side of the fabric. Module 18 includes a second support member 34 of cylindrical configuration which is supported on a drum. The member 34 includes closely spaced fluid pervious open areas 36 which comprise approximately 36% of the screen area. A preferred support member 34, shown in Fig. 2B, is a 16x16 45° mesh/cm (40x40 45° mesh/inch) stainless steel screen, manufactured by Appleton Wire, having the specifications set forth in Table I.

Module 18 functions in the same manner as the planar module 16. Manifolds 30 and jet orifices 32 are provided which have substantially the same specifications as in the first stage enhancement module. Fluid energy to the fabric of at least 2.9×10^6 Joule/Kg (0.5 hp-hr/lb) and preferably in the range of 5.7×10^5 to 11.5×10^6 Joule/Kg (.1 to 2.0 hp-hr/lb) effects second stage enhancement.

Conventional weaving processes impart reed marks to fabrics. Illustrations of such markings are shown in Figs. 3A and 4A which are photomicrographs at 10X and 16X magnification of a polyester LIBBEY brand fabric style no. S/x-A805 (see Table II). Reed marks in Figs. 3A and 4A are designated by the letter "R".

The invention overcomes this defect in conventional weaving processes through use of a single and preferably two stage hydroenhancement process. Advantage is obtained in the invention process by orienting the drum support member 34 in offset relation, preferably 45°, relative to machine direction ("MD") of the hydroenhancing line. See Figs. 2A and B.

Support members 22 and 34 are preferably provided with fine mesh open areas which are dimensioned to effect fluid passage through the members without imparting a patterned effect to the fabric. The preferred members have an effective open area for fluid passage in the range of 17 - 40%.

Comparison of the control and processed polyester fabric of Figs. 3A, B and 4A, B illustrates the advantages obtained through use of the enhancement process. Reed marks R in control polyester fabric are essentially eliminated through enhancement of the fabric. The offset screen arrangement is also effective in diminishing linear jet streak markings associated with the enhancement process.

Examples I-XIII

Figs. 3 - 15 illustrate representative woven and knit fabrics enhanced in accordance with the method of the invention, employing test conditions which simulate the line of Fig. 1. Table II sets fort specifications for the fabrics illustrated in the drawings.

As in the Fig. 1 line, the test manifolds 30 were spaced approximately 20.3 cm (8 inches) apart in modules 16, 18, and provided with densely packed columnar jet orifices 32 of approximately 23.6/cm (60/inch). Orifices 32 each had a diameter of 0.0127cm (0.005 inches) and were spaced approximately 1.27cm (.5 inches) from the first and second support members 22, 34.

The process line of Fig. 1 includes enhancement modules 16, 18 which, respectively, are provided with six manifolds. In the Examples, modules 16, 18 were each fitted with two manifolds 34. To simulate line conditions, the fabrics were advanced through multiple runs on the line. Three processing runs in each two manifold module was deemed to be equivalent to a six manifold module.

Fabrics were hydroenhanced at process pressures of approximately 10340 kPa (1500 psi). Line speed and cumulative energy output to the modules were respectively maintained at approximately 0.15m/sec (30 fpm) and 2.64 x 10^6 Joule/Kg (0.46 hp-hr/lb). Adjustments in the line speed and fluid pressure were made to accommodate differences in fabric weight for uniform processing and to maintain the preferred energy level.

Fabrics processed in the Examples exhibited marked enhancement in aesthetic appearance and quality including, characteristics such as cover, bloom, abrasion resistance, drape, stability, and reduction in seam slippage, and edge fray.

Tables III - XI set forth data for fabrics enhanced in accordance with invention on the test process line. Standard testing procedures of The American Society for Testing and Materials (ASTM) were employed to test control and processed characteristics of fabrics. Data set forth in the Tables was generated in accordance with the following ASTM standards:

Fabric Characteristic	ASTM Standard
Weight	D3776-79
Thickness	D1777-64 (Ames Tester)
Tensile Load	D1682-64 (1975) (Cut strip/grab)
Elongation	D1682-64 (1975)
Air Permeability	D737-75 (1980) (Frazier)
Thread Count	D3775-79
Ball Burst	D3787-80A
Seam Slippage	D4159-82
Tongue Tear	D2261-71
Wrinkle Recovery	D1295-67 (1972)
Abrasion Resistance	D3884-80
Pilling	D3514-81

Washability tests were conducted in accordance with the following procedure. Weight measurements ("before wash") were taken of control and processed fabric samples each having a dimension of 21.6 cm x 27.9 cm (8.5"x11") (21.6 cm (8.5") fill direction and 27.9 cm (11") warp direction). The samples were then washed and dried in conventional washer and dryers three consecutive times and "after wash" measurements were taken. The percent weight loss of the pre and post wash samples was determined in accordance the following formula:

$$\% \text{ weight loss} = D/B \times 100$$

where, B = before wash sample weight; A = after wash sample weight; and D = B-A.

Photcmicrographs of the fabrics, Figs. 4-15, illustrate the enhancement in fabric cover obtained in the invention. Attention is directed to open areas in the unprocessed fabrics, photographs designated A, these areas are of reduced size in the processed fabrics in the photographs designated B. Hydroenhancement caused fabric yarns to bloom and entangle at cross-over points, filling in open areas to improve cover and reduce air permeability in the fabrics.

Figs. 12 and 13 are photomicrographs of a HYTEX brand wall covering fabric, manufactured by Hytex, Inc, Randolph, Massachusetts. A multi-textured surface appearance of the fabric is provided by yarns which are woven through discrete areas of the front fabric surface. Free floating weave stitches, designated by the letter "S" in Figs. 12B and 13B, are formed on the backside of the fabric.

Hydroenhancement of HYTEX wall covering fabric secured the free-floating stitches S to the fabric backside enhancing fabric stability and cover. See Figs. 12B, 13B. In wall covering applications, fabric enhancement and associated stabilizing effects reduces or eliminates the need for adhesive backcoatings. Enhancement of the fabric also limits wicking of wall cover application adhesives through the fabric. Further advantage is obtained when enhanced fabrics are used in acoustic applications; elimination of backcoating reduces sound reflection and furthers efficient transmission of sound through the fabric.

TABLE II

Fabric Specifications

Fiber Brand and Style Designation	Figure(s)
NOMEX S/x-A805*	3A,B, 4A,B
Fiber : 2.22 dtex (2 denier) - 4.8 cm (1.9 inch)	
Yarn : Open end cotton spun 34.7 Tex (17s)	
LIBBEY S/022**	5A,B
Warp:	
Fiber: 3.33 dtex (3denier) - 3.8cm (1.5 inch) acrylic	
Yarn : Open end cotton spun 65.6 Tex (9s) 11 ends per cm (28 ends per inch)	
Fill:	
Fiber: 3.33 dtex (3 denier) - 7.6 cm (3 inch) acrylic	
Yarn : Open end wool spun 147.6 Tex (4s) 5.5, 6.3 or 7.1 picks per cm (14, 16 or 18 picks per inch)	
LIBBEY S/x-1160	6A,B
Fiber: 3.33 dtex (3 denier) - 7.6 cm (3 inch) acrylic	
Yarn : Wrap spun w/100 den textured polyester 147.6 Tex (4s) 5.5ends x 6.3 picks per cm (14 ends x 16 picks per inch)	
LIBBEY S/406	7A,B, 14A,B
Warp:	
Fiber: 3.33 dtex (3 denier) - 3.8 cm (1.5 inch) acrylic	
Yarn : Open end cotton spun 65.6 Tex (9s) 11 ends per cm (28 ends per inch)	
Fill:	
Fiber: 3.33 dtex (3 denier) - 7.6 cm (3 inch) acrylic	
Yarn : Hollow spun 2.4 twists/cm 6 twists/inch 147.6 Tex (4s) 5.5, 6.3 or 7.1 picks /cm (14, 16 or 18 picks per inch)	

Table II, continued

LIBBEY S/152 8A,B

Warp:

Fiber: 3.33 dtex (3 denier) - 6.35 cm (2.5 inch) acrylic

Yarn : Open end cotton spun 147.6 Tex (4s) 5.5 ends/cm (14 ends per inch)

Fill:

Fiber: 3.33 dtex (3 denier) - 7.6 cm (3 inch) acrylic

Yarn : Open end wool spun 227 Tex (2.6s) 5.5, 6.3 or 7.1 picks/cm (14, 16 or 18 picks per inch)

Guilford Wool/Nylon 9A,B

80% wool/20% nylon

Polyester/cotton (53/47) 10A,B

Weight: 339 g/m^2 (10 ounces/yd^2)

Yarn : Spun Filament

Weave : 3x1 Twill

Thread Count: 47.2 x 14.2/cm (120x38/inch)

50% Polyester/50% cotton Doubleknit 11A,B

Yarn: wrap spun with 111 dtex (100 denier) polyester wrap

HYTEX Wall covering*** 12, 13

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*LIBBEY is a trademark of W. S. Libbey Co., One Mill Street, Lewiston, ME 04240.
**NOMEX is a trademark of E.I. Du Pont de Nemours and Company, Wilmington, Del.
***HYTEX is a trademark of Hytex, Inc., Randolph, MA.

TABLE III

	Nomex A805 - Fig. 4		
	Control	Processed	% Change
Weight g/m^2 (gsy)	233 (195)	236 (197)	+1.0
Thickness mm (mils)	1.07 (42)	1.07 (42)	0
Air Perm. m^3/m^2/min (ft^3/ft^2/min)	100 (331)	47 (156)	-52.9
Strip Tensile Kg/cm (lbs/in)			
warp	20.54 (115)	23.57 (132)	+14.8
fill	10.54 (59)	8.39 (47)	-20.3
Elongation %			

TABLE III (continued)

	Nomex A805 - Fig. 4		
	Control	Processed	% Change
warp	48	50	+4.2
fill	62	71	+14.5

TABLE IV

	022/6075 (16 ppi) - Fig. 5		
	Control	Processed	% Change
Weight g/m^2 (gsy)	189 (158)	197 (165)	+ 4.4
Thickness mm (mils)	1.2 (48)	1.2 (49)	+ 2.1
Air Perm. m^3/m^2/min (ft^3/ft^2 min)	123 (406)	78.7 (259)	-36.2
Strip Tensile Kg/cm (lbs/in)			
warp	6.07 (34)	6.43 (36)	+ 5.9
fill	6.61 (37)	5.54 (31)	-16.2
Elongation (%)			
warp	33	27	-18.2
fill	27	28	+ 3.7
Seam Slippage Kg/cm (lbs/in)			
warp	0.89 (5)	10.71 (60)	+1100.0
fill	1.25 (7)	9.82 (55)	+ 685.7
Tongue Tear Kg (lbs)			
warp	8.1 (18)	4.5 (10)	-44.4
fill	9.5 (21)	3.6 (8)	-61.9
Wt. Loss In Wash (%)	37	5	-86.5
Wrinkle Recovery* (recovery angle)	123°	138°	+12.2

* Under ASTM test standards (D1295-67) improvements in the wrinkle recovery of a fabric are indicated by an increase in the recovery angle.

TABLE V

	Libbey S/x-1160 - Fig. 6		
	Control	Processed	% Change
Weight g/m^2 (gsy)	175.6 (146.8)	191.4 (160.2)	9.1
Thickness mm (mils)	0.97 (38.1)	1.34 (52.7)	38.3
Air Perm. m^3/m^2/min (ft^3/ft^2 min)	139 (457.2)	57 (188.5)	-58.8
Grab Tensile Kg/cm (lbs/in)			
warp	14.32 (80.2)	15.95 (89.3)	11.4
fill	18.75 (105.0)	19.89 (111.4)	6.1
Elongation (%)			
warp	30.0	34.0	13.3
fill	32.0	46.0	43.8
Ball Burst Kg (lbs)	86 (190)	71 (157)	-17.4

TABLE VI

	406/6075 (16 ppi) - Fig. 7		
	Control	Processed	% Change
Weight g/m^2 (gsy)	190 (159)	199 (166)	+ 4.4

TABLE VI (continued)

	406/6075 (16 ppi) - Fig. 7		
	Control	Processed	% Change
Thickness mm (mils)	1.2 (48)	1.27 (50)	+ 4.2
Air Perm. $m^3/m^2/min$ (ft^3/ft^2 min)	107 (351)	56 (184)	-47.6
Strip Tensile Kg/cm (lbs/in)			
warp	7.5 (42)	6.43 (36)	-14.3
fill	11.79 (66)	10.36 (58)	-12.1
Elongation (%)			
warp	23	31	+34.8
fill	49	33	-32.7
Seam Slippage Kg (lbs)			
warp	13 (29)	16.2 (36)	+89.5
fill	9.5 (21)	34.2 (76)	+ 261.9
Tongue Tear Kg (lbs)			
warp	10.4 (23)	8.1 (18)	-21.7
fill	8.6 (19)	6.8 (15)	- 1.1
Wt. Loss In Wash (%)	28	4	-85.7
Wrinkle Recovery (recovery angle)	140°	148°	+ 5.7

TABLE VII

152/6076 (16 ppi)- Fig. 8			
	Control	Processed	% Change
Weight g/m^2 (gsy)	276 (231)	307 (257)	+11.3
Thickness mm (mils)	6.58 (259)	6.04 (238)	- 8.1
Air Perm. $m^3/m^2/min$ ($ft^3/ft^2/min$)	62 (204)	32 (106)	-48.0
Strip Tensile Kg/cm (lbs/in)			
warp	8.57 (48)	10.36 (58)	+20.8
fill	10.0 (56)	12.86 (72)	+28.6
Elongation (%)			
warp	33	33	0
fill	34	39	+14.7
Seam Slippage Kg (lbs)			
warp	29 (64)	36.5 (81)	+26.6
fill	35 (78)	50.4 (112)	+43.6
Tongue Tear Kg (lbs)			
warp	9.5 (21)	8.1 (18)	-14.3
fill	7.7 (17)	6.8 (15)	-11.8
Wt. Loss In Wash (%)	--	--	----
Wrinkle Recovery (recovery angle)	117°	136°	+16.2

TABLE VIII

Guilford Wool (80% wool/20% nylon) - Fig. 9			
	Control	Process	% Change
Air Perm. $m^3/m^2/min$ ($ft^3/ft^2/min$)	74 (243)	44.5 (147)	-39.5

TABLE IXA

Spun/Filament - Bottom Weights - Fig. 10

	Sample #1 Control	Sample #1 Proc	Sample #2 Control	Sample #2 Proc
Weight g/m^2 (gsy)	310 (259.2)	329 (275.4)	287 (240.3)	297 (248.4)
Thickness mm (mils)	1.0 (39.7)	0.99 (39.2)	0.89 35.0	0.90 (35.3)
Strip Tensiles Kg/cm (lbs./in.)				
Warp	36.63 (206.98)	36.97 (208.87)	34.6 (195.50)	35.55 (200.86)
Fill	15.14 (85.55)	9.95 (56.23)	14.9 (84.21)	12.77 (71.83)
Normalized Tensiles Kg/cm (lbs./in.)				
Warp	1.41 (7.98)	1.34 (7.58)	1.42 (8.05)	1.43 (8.09)
Fill	0.58 (3.30)	0.36 (2.04)	0.62 (3.54)	0.51 (2.89)
Elongation (%)				
Warp	42.0	55.3	36.5	39.1
Fill	23.6	25.6	24.0	20.0
Air Perm. m^3/m^2/min ($ft.^3/ft.^2$/min)	15.4 (50.9)	8.3 (27.3)	13.2 (43.5)	8.7 (28.8)
Thread Count wxf/cm (wxf/inch)	47.2 x 15.7 (120 x 40)	47.2 x 16.1 (120 x 41)	47.2 x 17.8 (120 x 45)	47.2 x 17.8 (120 x 45)
Mullen Burst Kg (lbs.)	72.5 (161.2)	99.9 (222.2)	84.2 (187.2)	103 (228.8)
Normalized Burst Kg/g x 10^2 (lbs./g x 10^2)	28.2 (62.2)	36.6 (80.7)	35.3 (77.9)	41.8 (92.1)

TABLE IXA (contd.)

Spun/Filament - Bottom Weights - Fig. 10

	Sample #3 Control	Sample #3 Proc	Sample #4 Control	Sample #4 Proc
Weight g/m^2 (gsy)	342.3 (286.2)	355.5 (297.2)	319.7 (267.3)	335.9 (280.8)
Thickness mm (mils)	1.12 (44.2)	1.05 (41.5)	1.01 (40.0)	0.96 (38.0)
Strip Tensiles Kg/cm (lbs./in.)				
Warp	32.40 (183.09)	33.62 (189.95)	36.54 (206.43)	36.79 (207.87)
Fill	14.31 (80.88)	11.69 (83.01)	14.19 (80.16)	14.54 (82.14)
Normalized Tensiles Kg/cm (lbs./in.)				
Warp	1.13 (6.40)	1.13 (6.39)	1.35 (7.65)	1.31 (7.40)
Fill	0.50 (2.83)	0.49 (2.79)	0.53 (3.03)	0.52 (2.93)
Elongation (%)				
Warp	40.9	43.5	46.1	51.2
Fill	23.5	20.3	22.9	22.4
Air Perm. m^3/m^2/min (ft.^{3}/ft.^{2}/min)	13.9 (45.8)	6.6 (21.8)	15.6 (51.4)	7.7 (25.4)
Thread Count wxf/cm (wxf/inch)	47.2 x 15 (120 x 38)	47.2 x 16.5 120 x 42	47.2 x 16.5 120 x 42	47.2 x 17 120 x 43
Mullen Burst Kg (lbs.)	72.4 (161.0)	98 (217.8)	92.2 (205.0)	109 (242.2)
Normalized Burst Kg/g x 10^2 (lbs./g x 10^2)	25.5 (56.2)	33.2 (73.3)	34.8 (76.7)	39.0 (86.3)

TABLE IXB

Abrasion -- Spun Filament-Bottom Weights - Fig. 10					
ASTM Standard - Twill side up; 500 cycles; 500 g weight; H-18 wheels					
Sample	Weight Before(g)	Weight After(g)	Weight Loss(g)	% Loss	% Improvement
1C	3.32	3.02	0.30	9.0	
1P	3.36	3.13	0.23	6.9	23%
2C	4.64	4.16	0.48	10.4	
2P	4.83	4.57	0.26	5.4	48%
3C	4.73	4.47	0.26	5.5	
3P	4.91	5.13	0.22	4.5	18%
4C	4.47	4.18	0.29	6.5	
4P	4.71	4.53	0.18	3.8	41%

TABLE X

	Doubleknit - Fig. 11		
	Control	Processed	% Change
Air Perm. m^3/m^2/min (Ft^3/ft^2 min)	34.4 (113.1)	28.9 (95.1)	-15.9
Abrasion	1.0	0.6	-40.0
ASTM (D-3884-80): 250 Cycles, H-18 wheel			
Pilling (1-5 rating)	4.3	4.3	0
ASTM (D-3914-81): 300 cycles			

Figs. 14A, B are photomacrographs of control and processed acrylic vertical blind fabric, manufactured by W.S. Libbey, style designation S/406. Enhancement of the fabric reduces fabric torque which is particularly advantageous in vertical blind applications. The torque reduction test of Figs. 14A, B employed fabric strips 213 cm (84") long and 8.9 cm (3.5") wide, which were suspended vertically without restraint. Torque was measured with reference to the angle of fabric twist from a flat support surface. As can be seen in the photographs, a torque of 90° in the unprocessed fabric, Fig. 14A, was eliminated in the enhancement process.

Figs. 15A-C are macrophotographs of control and processed acrylic fabrics, LIBBEY style nos. 022, 406 and 152, respectively, which were tested for washability. Unprocessed fabrics exhibited excessive fraying and destruction, in contrast to the enhanced fabrics which exhibit limited fraying and yarn (weight) loss. Table XI sets forth washability test weight loss data.

TABLE XI

022, 406, 152 - Figs. 15A-C		
Percent Weight Loss (3 wash/dry cycles)		
Sample	Control	Processed
022	36.5	5.0
406	28.0	4.0
152	28.1	7.2

Fig. 16 illustrates an alternative embodiment of the invention apparatus, generally designated 40. The apparatus, includes a plurality of drums 42a-d over which a fabric 44 is advanced for enhancement processing. Specifically, the fabric 44 traverses the line in a sinuous path under and over the drums 42 in succession. Rollers 46 are provided at opposite ends of the line adjacent drums 42a and d to support the fabric. Any or all of the drums can be rotated by a suitable motor drive (not shown) to advance the fabric on the line.

A plurality of manifolds 48 are provided in groups, Fig. 16 illustrates groups of four, which are respectively spaced from each of the drums 42a-d. An arrangement of manifold groups at 90° intervals on the sinuous fabric path successively positions the manifolds in spaced relation with respect to opposing surfaces of the fabric. Each manifold 48 impinges columnar fluid jets 50, such as water, against the fabric. Fluid supply 52 supplies fluid to the manifolds 48 which is collected in liquid sump 54 during processing for recirculation via line 56 to the manifolds.

The support drums 42 may be porous or non-porous. It will be recognized that advantage is obtained through use of drums which include perforated support surfaces. Open areas in the support surfaces facilitate recirculation of the fluid employed in the enhancement process.

Further advantage is obtained, as previously set forth in discussion of the first embodiment, through use of support surfaces having a fine mesh open area pattern which facilitates fluid passage. Offset arrangement of the support member orientations, for example at 45° offset orientation as shown in Fig. 2, limits process water streak and weave reed marks in the enhanced fabric.

Enhancement is a function of energy which is imparted to the fabric. Preferred energy levels for enhancement in accordance with the invention are in the range of 5.7×10^5 to 11.5×10^6 Joule/Kg (.1 to 2.0 hp-hr/lb). Variables which determine process energy levels include line speed, the amount and velocity of liquid which impinges on the fabric, and fabric weight and characteristics.

Fluid velocity and pressure are determined in part by the characteristics of the fluid orifices, for example, columnar versus fan jet configuration, and arrangement and spacing from the process line. It is a feature of the invention to impinge a curtain of fluid on a process line to impart an energy flux of approximately 2.64×10^6 Joule/Kg (0.46 hp-hr/lb) to the fabric. Preferred specifications for orifice type and arrangement are set forth in description of the embodiment of Fig. 1. Briefly, the jet orifices are closely spaced with center-to-center spacings of approximately 0.043 cm (0.017 inches) and are spaced 1.27 cm (0.5 inches) from the support members. Orifice diameters of 0.0127 cm (.005 inches) and densities of 23.6 per manifold cm (60 per manifold inch) eject columnar fluid jets which form a uniform fluid curtain.

The following Examples are representative of the results obtained on the process line illustrated in Fig. 17.

Example XIV

A plain woven 100% polyester fabric comprised of friction spun yarns having the following specifications was processed in accordance with the invention: count of 6.3 x 3.9 yarns/cm^2 (16 x 10 yarns/in^2), weight of 271 g/m^2 (8 ounces/yd^2), an abrasion resistance of 500 grams (measured by 50 cycles of a CS17 abrasicn test wheel) and an air permeability of 141 m^3/m^2/min (465 ft^3/ft^2/min).

The fabric was processed on a test line to simulate a speed of 1.5 m/sec (300 ft/min) on process apparatus including four drums 42 and eighteen nozzles 16 at a pressure of approximately 10340 kPa (1500 psi). Energy output to the fabric at these process parameters was approximately 2.64×10^6 Joules/Kg (.46 hp-hr/lb). Table XII sets forth control and processed characteristics of the fabric.

TABLE XII

100% Polyester Friction Spun Fabric		
Fabric Characteristic	Control	Processed
Count yarns/cm^2 (yarns/in.^{2})	6.3x3.9 (16x10)	6.7x3.9 (17x10)
Weight g/m^2 (ounces/yd.^{2})	271 (8)	278 (8.2)
Abrasion resistance (cycles)	50	85
Air permeability m^3/m^2/min (ft^{3}ft^2/min.)	141 (465)	55 (181)

Examples XV and XVI

The process conditions of Example XIV were employed to process a plain woven cotton osnaburg and plain woven polyester ring spun fabrics yielding the results set forth in Tables XIV and XV.

TABLE XV

Plain Woven Cotton Osnaburg		
Fabric Characteristic	Control	Processed
Count yarns/cm^2 (yarns/in.^{2})	12.6x10.2 (32x26)	12.6x12.6 (32x32)
Abrasion resistance (cycles)	140	344

TABLE XV (continued)

Plain Woven Cotton Osnaburg		
Fabric Characteristic	Control	Processed
Air permeability $m^3/m^2/min$ ($ft^3/ft^2/min.$)	216 (710)	36.5 (120)

TABLE XIV

Plain Woven Polyester Ring Spun Yarn		
Fabric Characteristic	Control	Processed
Count yarns/cm^2 (yarns/$in.^2$)	17.3x11.0 (44x28)	18.9x12.6 (48x32)
Abrasion resistance (cycles)	100	225
Air permeability $m^3/m^2/min$ ($ft.^3/ft^2/min.$)	77 (252)	19 (63)

Fabrics processed in Examples XIV-XVI are characterized by a substantial reduction in air permeability and increase in abrasion resistance. Process energy levels in these Examples were approximately 2.64 x 10^6 Joule/Kg (.46 hp-hr/lb). It has been discovered that there is a correlation between process energy and enhancement. Increased energy levels yield optimum enhancement effects.

The foregoing Examples illustrate applications of the hydroenhancing process of the invention for upgrading the quality of single ply woven and knit fabrics.

In an alternative application of the hydroenhancing process of the invention, fabric strata are hydrobonded into integral composite fabric. Fig. 17 illustrates a composite flannel fabric 60 including fabric layers 62, 64. Hydrobonding of the layers is effected by first napping opposing surfaces 62a, 64a of each of the layers to raise surface fibers. The opposing surfaces 62a, 64a are then arranged in overlying relation and processed on the production line of the invention. See Figs. 1 and 16. Enhancement of the layers 62, 64 effects entanglement of fibers in the napped surfaces and bonding of the layers to form a integral composite fabric 60. Exterior surfaces 62b, 64b are also enhanced in the process yielding improvements in cover and quality in the composite fabric.

Napped surfaces 62a, 64a are provided by use of conventional mechanical napping apparatus. Such apparatus include cylinders covered with metal points or teasel burrs which abrade fabric surfaces.

Advantageously, composite fabric 60 is manufactured without requirement of conventional laminating adhesives. As a result, the composite fabric breaths and has improved tactile characteristics than obtained in prior art laminated ccnposites. It will be recognized that such composite fabrics have diverse applications in fields such as apparel and footwear.

Optimum enhancement (in single and multi-ply fabrics) is a function of energy. Preferred results are obtained at energy levels of approximately 2.64 x 10^6 Joule/Kg (.46 hp-hr/lb). Energy requirements will of course vary for different fabrics as will process conditions required to achieve optimum energy levels. In general, process speeds, nozzle configuration and spacing may be varied to obtain preferred process energy levels.

Enhanced fabrics of the invention are preferably fabricated of yarns including fibers having dtex and lengths, respectively, in the ranges of 0.333 to 11.1 dtex (0.3 to 10.0 denier) and 1.27 to 15.24 cm (0.5 to 6.0 inches), and yarn counts of 1180 to 7.4 Tex (.5s to 80s). Optimum enhancement is obtained in fabrics having fiber dtex in the range of 0.555 to 6.66 dtex (.5 to 6 denier), staple fibers of 1.27 to 15.24 cm (.5 to 6.0 inches), and yarn counts in the range of 1180 to 11.8 Tex (.5s to 50s). Experimentation indicates that preferred enhancement results are obtained in fabrics including low denier, short lengths fibers, and loosely twisted yarns.

The invention advances the art by recognizing that superior fabric enhancement can be obtained under controlled process conditions and energy levels. Heretofore, the art has not recognized the advantages and the extent to which hydroenhancement can be employed to upgrade fabric quality. It is submitted that the results achieved in the invention reflect a substantial and surprising contribution to the art.

Numerous modifications are possible in light of the above disclosure. For example, although the preferred process and apparatus employ fluid pervious support members, non-porous support members are within the scope of the invention. Similarly, Figs. 1 and 16 respectively illustrate two and four stage enhancement process lines. System configurations which include one or more modules having flat, drum or other support member configuration may be employed in the invention.

It will be recognized that the process of the invention has wide application for the production of a diversity of enhanced fabrics. Thus, the Examples are not intended to limit the invention.

Finally, although the disclosed enhancement process employs columnar jet orifices to provide a fluid curtain, other apparatus may be employed for this purpose. Attention is directed to = US Patent No. 4995151 entitled "Apparatus and Method for Hydropatterning Fabric" dated February 26, 1991 assigned to International Paper Company, the assignee of the present case which discloses a divergent jet fluid entangling apparatus for use in hydropatterning woven and nonwoven textile fabrics.

Therefore, although the invention has been described with reference to certain preferred embodiments, it will be appreciated that other hydroentangling apparatus and processes may be devised, which are nevertheless within the scope and spirit of the invention as defined in the claims appended hereto.

Claims

1. A method for enhancing and finishing woven or knitted textile fabrics having yarns which intersect at cross-over points, wherein the fabric is supported on a support member (22, 34, 42), conveyed in a machine direction through a production line, and impacted with liquid, characterised in that the fabric is made from spun and/or spun filament yarn fibres having dtex and lengths in the range of 0.333 to 17.8 dtex (0.3 to 16.0 denier) and 1.27 to 20.3 centimetres (0.5 - 8 inches) respectively, and yarn counts in the range of 1180 to 7.4 TEX (0.5s to 80s) and in that the method comprises uniformly and continuously impacting at least one side of the fabric with a continuous curtain of fluid which impacts the fabric with an energy in the range of 5.7 x 10^5 to 11.5 x 10^6 joule/kg (0.1 - 2.0 hp-hr/lb), thereby effecting entanglement of the yarns at their cross over points.

2. A method as claimed in Claim 1 characterised in that the continuous curtain of fluid is provided by an array of closely spaced liquid jets (28, 50) which emanate from jet orifices (32).

3. A method as claimed in Claim 2 characterised in that the conveying speed is from .0508 to 2.54 m/sec (10 to 500 fpm), jet pressure is from 1,379 to 20,685 kpa (200 to 3000 psi), the jets (28, 50) are columnar, the jet orifices (32) have a diameter of 0.0127 to 0.0254 cm (0.005 to 0.010 inches), and centre-to-centre spacing of 0.043 to 0.086 cm (0.017 to 0.034 inches).

4. A method as claimed in Claim 2 or Claim 3 characterised in that the jets (28) are spaced approximately 1.27 cm (0.5 inches) from the support member.

5. A method as claimed in any one of Claims 1 to 4 characterised in that the support member (22, 34) is liquid pervious and includes open areas (26, 36) of 17-40% and has a fine mesh pattern which permits fluid passage without imparting a patterned effect to the fabric.

6. A method as claimed in Claim 5 characterised in that the support includes a fine mesh screen (34) arranged in offset relation to the machine direction.

7. A method as claimed in any one of Claims 1 to 6 characterised in that the fabric (12, 44) is treated on both sides.

8. A method as claimed in any one of Claims 2 to 7 characterised in that the array of jets (28, 50) is provided by a plurality of parallel manifolds (30, 48) spaced approximately 20.3 cm (8 inches) apart.

9. A method as claimed in any one of Claims 2 to 8 characterised in that the pressure is approximately 10,340 kps (1500 psi), the jet orifice diameter is approximately 0.0127 cm (0.005 inches), the centre-to-centre spacing of the jet orifices (32) provides approximately 24 jets per cm (60 jets per inch), and the fabric is impacted with a cumulative energy of approximately 2.64 x 10^6 joule/kg (0.46 hp-hr/lb).

10. A method as claimed in any one of Claims 1 to 9 characterised in that the fabric (12, 44) includes low denier, short length fibres and loosely twisted yarns.

11. A method as claimed in any one of Claims 2 to 10 characterised in that the liquid jets (28, 50) are aligned in a cross-direction relative to the machine direction, and each liquid jet (28, 50) has an axis substantially perpendicular to the fabric.

12. A method as claimed in any one of Claims 1 to 11 further characterised in that it comprises the step of drying the impacted fabric.

13. A method as claimed in any one of Claims 1 to 12 further characterised in that it comprises the step of drying the

impacted fabric to a specified width under tension.

14. A method as claimed in any one of Claims 1 to 13 characterised in that the method effects enhancement of the yarns in interstitial open areas defined by the cross-over points in the fabric weave, and the fabric demonstrates a reduction in air permeability in the range of 10 to 90% after enhancement.

15. A method as claimed in any one of Claims 1 to 13 characterised in that the fabric is a woven polyester fabric and the fabric includes 2.22 dtex (2 denier), 4.8 cm (1.9 inch) polyester fibre, open-end cotton spun yarn having a yarn number of 34.7 Tex (17s) and count of 19.2 x 9 per cm (49 x 23 per inch), and the method yields an approximately 48% reduction in air permeability in the fabric after enhancement.

16. A method as claimed in any one of Claims 1 to 13 characterised in that the fabric is a woven acrylic fabric and the fabric includes 3.33 dtex (3 denier), 3.8 cm (1.5 inch) fibre, open-end cotton warp yarn having a yarn number of 65.7 Tex (9s), 11 ends per cm (28 per inch), and a 3.33 dtex (3 denier), 7.6 cm (3 inch) acrylic fibre, open-end wool spun fill yarn having a number of 147.6 Tex (4s), 6.3 picks per cm (16 per inch), and the method yields an approximately 36% reduction in air permeability in the fabric after enhancement.

17. A method as claimed in any one of Claims 1 to 13 characterised in that the fabric is an acrylic wrap spun fabric and the fabric includes 3.33 dtex (3 denier), 7.6 cm (3 inch) acrylic fibre, wrap spun with 111 dtex (100 denier) textured polyester yarn having a yarn number of 147.6 Tex (4s) and count of 5.5 x 6.3 per cm (14 x 16 per inch), and the method yields an approximately 65% reduction in air permeability in the fabric after enhancement.

18. A method as claimed in any one of Claims 1 to 13 characterised in that the fabric is a woven acrylic fabric and the fabric includes 3.33 dtex (3 denier), 3.8 cm (1.5 inch) acrylic fibre, open-end cotton spun warp yarn having a yarn number of 65.7 Tex (9s), 11 ends per cm (28 per inch), and a 3.33 dtex (3 denier), 7.62 cm (3 inch) acrylic fibre, hollow wrap spun fill yarn, 2.4 twists per cm (6 per inch) having a number of 147.6 Tex (4s), 6.3 picks per cm (16 per inch), and the method yields an approximately 48% reduction in air permeability in the fabric after enhancement.

19. A method as claimed in any one of Claims 1 to 3 characterised in that the fabric is a woven acrylic fabric and the fabric includes 3.33 dtex (3 denier), 3.8 cm (1.5 inch) acrylic fibre, open-end wool spun warp yarn having a yarn number of 147.6 Tex (4s), 5.5 ends per cm (14 per inch), and a 3.33 dtex (3 denier), 7.6 cm (3 inch) acrylic fibre, open-end wool spun fill yarn having a yarn number of 227 Tex (2.6s), 6.3 picks per cm (16 per inch), and the method yields an approximate 48% reduction in air permeability in the fabric after enhancement.

20. A method as claimed in any one of Claims 1 to 13 characterised in that the fabric is a woven fabric and the fabric includes 80% wool/20% nylon in a 2 x 1 twill weave, and the method yields an approximately 49.5% reduction in air permeability in the fabric after enhancement.

21. A method as claimed in any one of Claims 1 to 13 characterised in that the fabric is a 53% polyester/47% cotton fabric and the fabric includes a 3 x 1 twill weave, a thread count of 47 ends/cm x 14.9 picks/cm (120 ends/inch x 38 picks/inch), and the method yields an approximately 50.6% reduction in air permeability in the fabric after enhancement.

22. A method as claimed in any one of Claims 1 to 13 characterised in that the fabric is a 50% polyester/50% cotton doubleknit fabric and the fabric includes wrap spun yarn with 111 dtex (100 denier) polyester wrap, and the process yields an approximately 16% reduction in air permeability in the fabric after enhancement.

23. A method as claimed in any one of Claims 1 to 13 characterised in that the yarn is open end cotton spun.

24. A method as claimed in any one of Claims 1 to 13 characterised in that the yarn is wrap spun.

25. A method as claimed in any one of Claims 1 to 13 characterised in that the yarn is open end wool spun.

26. Apparatus for enhancing and finishing woven or knitted textile fabrics having spun and/or spun filament yarns which intersect at cross-over points, the apparatus including a fabric support member (22, 34, 42), and means for providing a plurality of liquid jet streams (28, 50) which impact the fabric (12, 44), characterised in that the apparatus comprises:

means for conveying (24) the supported fabric in a machine direction;
means for uniformly impacting the conveyed fabric with a continuous curtain of fluid comprising a plurality of densely spaced liquid jets (28, 50) aligned in a cross-direction relative to the machine direction, said liquid jets (28, 50) emanating from a plurality of densely spaced jet orifices (32) as a continuous curtain of fluid;
said curtain of fluid coacting with the support member to entangle fabric yarns at their cross-over points.

27. An apparatus as claimed in Claim 26 characterised in that the jets (28, 50) are columnar, and the jet orifices (32) have diameters and centre-to-centre spacings of 0.0127 to 0.0254 cm (0.005 to 0.010 inches) and 0.043 to 0.086 cm (0.017 to 0.034 inches) respectively.

28. An apparatus as claimed in Claim 26 or Claim 27 characterised in that the jets (28, 50) are approximately 1.27 cm (0.5 inches) from the support member (22, 34).

29. An apparatus as claimed in Claim 26, 27 or 28 characterised in that the support member (22, 34, 44) is liquid pervious and includes open areas (26, 36) of 17-40% and has a fine mesh pattern which permits fluid passage without imparting a patterned effect to the fabric (12, 44).

30. An apparatus as claimed in Claim 29 characterised in that the support includes a fine mesh screen (34) arranged in offset relation to the machine direction.

31. An apparatus as claimed in any one of Claims 26 to 30 characterised in that the jets (28, 50) are provided by a plurality of parallel manifolds (30, 48) spaced approximately 20.32 cm (8 inches) apart.

32. An apparatus as claimed in any one of Claims 26 to 31 characterised in that the jet orifice diameter is approximately 0.0127 cm (0.005 inches) and the centre-to-centre spacing of the jet orifices (32) is approximately 24/cm (60/inch).

33. An apparatus as claimed in any one of Claims 26 to 32 characterised in that the liquid jets (28, 50) each have an axis substantially perpendicular to the fabric (12, 44).

34. A uniformly enhanced woven or knit textile fabric made by supporting the fabric on a support member (22, 34, 42) and impacting the fabric (12, 44) with a plurality of liquid jet streams (28, 50), characterised in that the fabric includes spun and/or spun filament yarns which intersect at cross-over points to define interstitial open areas, said yarns including fibres having dtex and lengths in the range of 0.333 to 17.8 dtex (0.3 to 16.0 denier) and 1.27 to 20.32 cms (0.5 to 8 inches), respectively, wherein said yarns are fluid entangled in said interstitial open areas, by application of a continuous curtain of non-compressible fluid energy in the range of 5.7 x 10^5 to 11.5 x 10^6 joule/kg (0.1 to 2.0 hp-hr/lb).

35. A uniformly enhanced fabric as claimed in Claim 34 characterised in that the fabric includes low denier, short length fibres and loosely twisted yarns.

36. A uniformly enhanced woven or knit textile fabric as claimed in Claim 34 or Claim 35 characterised in that the enhanced fabric demonstrates a substantial improvement in at least two of air permeability, abrasion resistance, tensile strength, edge fray, seam slippage, wrinkle recovery, torque resistance, and fabric weight.

37. A method for enhancing and hydrobonding woven or knit fabric materials having spun and/or spun filament yarns which intersect at crossover points characterised in that it comprises:

napping first and second surfaces (62a, 64a) of the fabric to raise surface fibres thereof, and
arranging said first and second fabric surfaces on the support member (22, 34, 42) in opposing and overlying layered relation,
wherein the fabric (60) is impacted with a continuous curtain of fluid with an energy in the range 5.7 x 10^5 to 11.5 x 10^6 joule/Kg (0.1 to 2.0 hp-hr/lb) to effect entanglement of said raised fibres in said first and second surfaces (62a, 64a) to bond the fabric (60).

38. A method for hydrobonding woven or knit fabric materials to form a composite textile fabric, the fabric including spun and/or spun filament yarns in a structured pattern including yarns which intersect at cross-over points, the method comprising the steps of:

napping first and second surfaces (62a, 64a) of the fabric to raise surface fibres thereof,
arranging said first and second surfaces in opposing and overlying layered relation,
supporting the layered fabric on a support member (22, 34, 42), and
traversing one side of said layered fabric with a first continuous curtain of fluid for sufficient duration to effect entanglement of said raised surface fibres in said first and second surfaces,
said curtain of fluid impacting the fabric with an energy in the range 5.7 x 10^5 to 11.5 x 10^6 joule/Kg (0.1 to 2.0 hp-hr/lb).

39. A method as claimed in Claim 37 or Claim 38 characterised in that the method of Claims 1 and 2 is used and in that the conveying speed is from .0508 to 2.54 m/sec (10 to 500 fpm), jet pressure is from 1,379 to 20,685 kpa (200 to 3000 psi), and the jets (28, 50) are columnar, the jet orifices (32) having a diameter of 0.0127 to 0.0254 cm (0.005 to 0.010 inches), and centre-to-centre spacing of 0.043 to 0.086 cm (0.017 to 0.034 inches).

40. A method as claimed in Claim 37, 38 or 39 characterised in that the fabric (60) is treated on both sides.

41. A method as claimed in any one of Claims 37 to 40 characterised in that the fabric (60) includes low denier, short length fibres and loosely twisted yarns.

42. An enhanced composite woven or knit textile fabric as claimed in Claim 34, 35 or 36 characterised in that the fabric includes first and second napped surfaces (62a, 64) which have raised surface fibres, said napped surfaces being arranged in overlying and opposed relation, and in which the said raised surface fibres in said first and second surfaces are entangled.

Patentansprüche

1. Verfahren zur Verstärkung und Veredlung von Web- oder Maschenwaren, die Garne aufweisen, welche sich an Überkreuzungspunkten schneiden, wobei die Ware auf einem Stützelement (22, 34, 42) getragen wird, in einer Bearbeitungsrichtung durch eine Produktionslinie transportiert wird und mit Flüssigkeit beaufschlagt wird, dadurch gekennzeichnet, daß die Ware aus Spinnfasern und/oder gesponnenen Filamentgarnfasern gefertigt ist, die dtex und Längen im Bereich von 0,333 bis 17,8 dtex (0,3 bis 16,0 Denier) bzw. 1,27 bis 20,3 Zentimetern (0,5 - 8 Zoll) sowie Garnfeinheiten im Bereich von 1180 bis 7,4 TEX (0,5s bis 80s) aufweisen, und daß das Verfahren die gleichmäßige und kontinuierliche Beaufschlagung mindestens einer Seite der Ware mit einem kontinuierlichen Fluidvorhang umfaßt, welcher die Ware mit einer Energie im Bereich von 5,7 x 10^5 bis 11,5 x 10^6 Joule/kg (0,1 - 2,0 hp-hr/lb) beaufschlagt und hierdurch eine Verschlingung der Garne an ihren Überkreuzungspunkten bewirkt.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß der kontinuierliche Fluidvorhang von einen Bereich eng beabstandeter Flüssigkeitsstrahlen (28, 50) geschaffen wird, die aus Düsenöffnungen (32) ausströmen.

3. Verfahren nach Anspruch 2, dadurch gekennzeichnet, daß die Transportgeschwindigkeit 0,0508 bis 2,54 m/s (10 bis 500 fpm) beträgt, der Strahldruck 1.379 bis 20.685 kPa (200 bis 3000 psi) beträgt, die Strahlen (28, 50) säulenförmig sind, die Düsenöffnungen (32) einen Durchmesser von 0,0127 bis 0,0254 cm (0,005 bis 0,010 Zoll) und einen Mittenabstand von 0,043 bis 0,086 cm (0,017 bis 0,034 Zoll) aufweisen.

4. Verfahren nach Anspruch 2 oder Anspruch 3, dadurch gekennzeichnet, daß die Strahlen (28) etwa 1,27 cm (0,5 Zoll) vom Stützelement beabstandet sind.

5. Verfahren nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß das Stützelement (22, 34) flüssigkeitsdurchlässig ist und offene Bereiche (26, 36) von 17-40% umfaßt und ein feinmaschiges Muster aufweist, das einen Durchtritt von Fluid erlaubt, ohne der Ware eine Musterwirkung zu verleihen.

6. Verfahren nach Anspruch 5, dadurch gekennzeichnet, daß die Stütze ein feinmaschiges Sieb (34) umfaßt, das in einer versetzten Beziehung zur Bearbeitungsrichtung angeordnet ist.

7. Verfahren nach einem der Ansprüche 1 bis 6, dadurch gekennzeichnet, daß die Ware (12, 44) beidseitig behandelt wird.

8. Verfahren nach einem der Ansprüche 2 bis 7, dadurch gekennzeichnet, daß der Bereich von Strahlen (28, 50) von einer Mehrzahl paralleler Verteiler (30, 48) bereitgestellt wird, die etwa 20,3 cm (8 Zoll) voneinander beabstandet sind.

9. Verfahren nach einem der Ansprüche 2 bis 8, dadurch gekennzeichnet, daß der Druck etwa 10.340 kPa (1500 psi) beträgt, der Düsenöffnungsdurchmesser etwa 0,0127 cm (0,005 Zoll) ist, der Mittenabstand der Düsenöffnungen (32) etwa 24 Strahlen pro cm (60 Strahlen pro Zoll) bereitstellt und die Ware mit einer Summenenergie von etwa 2,64 x 10^6 Joule/kg (0,46 hp-hr/lb) beaufschlagt wird.

10. Verfahren nach einem der Ansprüche 1 bis 9, dadurch gekennzeichnet, daß die Ware (12, 44) kurze Fasern von niedriger Denier und locker gedrehte Garne enthält.

11. Verfahren nach einem der Ansprüche 2 bis 10, dadurch gekennzeichnet, daß die Flüssigkeitsstrahlen (28, 50) in einer Querrichtung bezogen auf die Bearbeitungsrichtung ausgerichtet sind und jeder Flüssigkeitsstrahl (28, 50) eine Achse aufweist, die im wesentlichen senkrecht zur Ware ist.

12. Verfahren nach einem der Ansprüche 1 bis 11, ferner dadurch gekennzeichnet, daß es den Schritt des Trocknens der beaufschlagten Ware umfaßt.

13. Verfahren nach einem der Ansprüche 1 bis 12, ferner dadurch gekennzeichnet, daß es den Schritt des Trocknens der beaufschlagten Ware unter Spannung bis zu einer spezifischen Breite umfaßt.

14. Verfahren nach einem der Ansprüche 1 bis 13, dadurch gekennzeichnet, daß das Verfahren eine Verstärkung der Garne in offenen Zwischenräumen, die von den Überkreuzungspunkten in der Bindung der Ware definiert werden, bewirkt und die Ware nach der Verstärkung eine Verringerung der Luftdurchlässigkeit im Bereich von 10 bis 90% zeigt.

15. Verfahren nach einem der Ansprüche 1 bis 13, dadurch gekennzeichnet, daß die Ware ein Polyestergewebe ist und die Ware 4,8 cm (1,9 Zoll) lange Polyesterfaser von 2,22 dtex (2 Denier), Offen-End-Baumwollspinngarn mit einer Garnfeinheit von 34,7 Tex (17s) und eine Fadenzahl von 19,2 x 9 pro cm (49 x 23 pro Zoll) enthält, und das Verfahren bei der Ware nach der Verstärkung eine ungefähr 48%ige Verringerung der Luftdurchlässigkeit ergibt.

16. Verfahren nach einem der Ansprüche 1 bis 13, dadurch gekennzeichnet, daß die Ware ein Acrylgewebe ist und die Ware 3,8 cm (1,5 Zoll) lange Faser von 3,33 dtex (3 Denier), Offen-End-Baumwollkettgarn mit einer Garnfeinheit von 65,7 Tex (9s), 11 Kettfäden pro cm (28 pro Zoll), und eine 7,6 cm (3 Zoll) lange Acrylfaser von 3,33 dtex (3 Denier), Offen-End-Wollspinn-Schußgarn mit einer Feinheit von 147,6 Tex (4s), 6,3 Schußfäden pro cm (16 pro Zoll), enthält, und das Verfahren bei der Ware nach der Verstärkung eine ungefähr 36%ige Verringerung der Luftdurchlässigkeit ergibt.

17. Verfahren nach einem der Ansprüche 1 bis 13, dadurch gekennzeichnet, daß die Ware eine Acrylumspinnungsware ist und die Ware 7,6 cm (3 Zoll) lange Acrylfaser von 3,33 dtex (3 Denier), umsponnen mit einem texturierten Polyestergarn von 111 dtex (100 Denier), das eine Garnfeinheit von 147,6 Tex (4s) aufweist, und eine Fadenzahl von 5,5 x 6,3 pro cm (14 x 16 pro Zoll) enthält, und das Verfahren bei der Ware nach der Verstärkung eine ungefähr 65%ige Verringerung der Luftdurchlässigkeit ergibt.

18. Verfahren nach einem der Ansprüche 1 bis 13, dadurch gekennzeichnet, daß die Ware ein Acrylgewebe ist und die Ware 3,8 cm (1,5 Zoll) lange Acrylfaser von 3,33 dtex (3 Denier), Offen-End-Baumwollspinn-Kettgarn mit einer Garnfeinheit von 65,7 Tex (9s), 11 Kettfäden pro cm (28 pro Zoll), und eine 7,62 cm (3 Zoll) lange Faser von 3,33 dtex (3 Denier), Hohl-Umspinnungs-Schußgarn, 2,4 Drehungen pro cm (6 pro Zoll), mit einer Feinheit von 147,6 Tex (4s), 6,3 Schußfäden pro cm (16 pro Zoll), enthält, und das Verfahren bei der Ware nach der Verstärkung eine ungefähr 48%ige Verringerung der Luftdurchlässigkeit ergibt.

19. Verfahren nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß die Ware ein Acrylgewebe ist und die Ware 3,8 cm (1,5 Zoll) lange Acrylfaser von 3,33 dtex (3 Denier), Offen-End-Wollspinn-Kettgarn mit einer Garnfeinheit von 147,6 Tex (4s), 5,5 Kettfäden pro cm (14 pro Zoll), und eine 7,6 cm (3 Zoll) lange Acrylfaser von 3,33 dtex (3 Denier), Offen-End-Wollspinn-Schußgarn mit einer Garnfeinheit von 227 Tex (2,6s), 6,3 Schußfäden pro cm (16 pro Zoll), enthält, und das Verfahren bei der Ware nach der Verstärkung eine ungefähr 48%ige Verringerung der Luftdurchlässigkeit ergibt.

20. Verfahren nach einem der Ansprüche 1 bis 13, dadurch gekennzeichnet, daß die Ware ein Gewebe ist und die Ware 80% Wolle/20% Nylon in einer 2 x 1 Köperbindung enthält und das Verfahren bei der Ware nach der Verstärkung eine ungefähr 49,5 %ige Verringerung der Luftdurchlässigkeit ergibt.

21. Verfahren nach einem der Ansprüche 1 bis 13, dadurch gekennzeichnet, daß die Ware eine Ware aus 53% Polyester/47% Baumwolle ist und die Ware eine 3 x 1 Köperbindung, eine Fadenzahl von 47 Kettfäden/cm x 14,9 Schußfäden/cm (120 Kettfäden/Zoll x 38 Schußfäden/Zoll) enthält und das Verfahren bei der Ware nach der Verstärkung eine ungefähr 50,6%ige Verringerung der Luftdurchlässigkeit ergibt.

22. Verfahren nach einem der Ansprüche 1 bis 13, dadurch gekennzeichnet, daß die Ware eine Doppel-Maschenware aus 50% Polyester/50% Baumwolle ist und die Ware Umspinnungsgarn mit einer 111 dtex (100 Denier) Polyester-Umspinnung enthält und das Verfahren bei der Ware nach der Verstärkung eine ungefähr 16%ige Verringerung der Luftdurchlässigkeit ergibt.

23. Verfahren nach einem der Ansprüche 1 bis 13, dadurch gekennzeichnet, daß das Garn offen-end-baumwollgesponnen ist.

24. Verfahren nach einem der Ansprüche 1 bis 13, dadurch gekennzeichnet, daß das Garn umsponnen ist.

25. Verfahren nach einem der Ansprüche 1 bis 13, dadurch gekennzeichnet, daß das Garn offen-end-wollgesponnen ist.

26. Vorrichtung zur Verstärkung und Veredlung von Web- oder Maschenwaren, die Spinnfasergarne und/oder gesponnene Filamentgarne aufweisen, welche sich an Überkreuzungspunkten schneiden, wobei die Vorrichtung ein Warenstützelement (22, 34, 42) und Mittel zur Bereitstellung einer Mehrzahl von Flüssigkeitsstrahlströmen (28, 50) umfaßt, welche die Ware (12, 44) beaufschlagen, dadurch gekennzeichnet, daß die Vorrichtung umfaßt:

Mittel für den Transport (24) der getragenen Ware in einer Bearbeitungsrichtung;
Mittel zur gleichmäßigen Beaufschlagung der transportierten Ware mit einem kontinuierlichen Fluidvorhang, der eine Mehrzahl von eng beabstandeten Flüssigkeitsstrahlen (28, 50) umfaßt, die in einer Querrichtung bezogen auf die Bearbeitungsrichtung ausgerichtet sind, wobei die Flüssigkeitsstrahlen (28, 50) als kontinuierlicher Fluidvorhang aus einer Mehrzahl eng beabstandeter Düsenöffnungen (32) ausströmen;
wobei dieser Fluidvorhang mit dem Stützelement zusammenwirkt, um die Garne der Ware an ihren Überkreuzungspunkten zu verschlingen.

27. Vorrichtung nach Anspruch 26, dadurch gekennzeichnet, daß die Strahlen (28, 50) säulenförmig sind und die Düsenöffnungen (32) Durchmesser und Mittenabstände von 0,0127 bis 0,0254 cm (0,005 bis 0,010 Zoll) bzw. 0,043 bis 0,086 cm (0,017 bis 0,034 Zoll) aufweisen.

28. Vorrichtung nach Anspruch 26 oder Anspruch 27, dadurch gekennzeichnet, daß sich die Strahlen (28, 50) etwa 1,27 cm (0,5 Zoll) vom Stützelement (22, 34) befinden.

29. Vorrichtung nach Anspruch 26, 27 oder 28, dadurch gekennzeichnet, daß das Stützelement (22, 34, 44) flüssigkeitsdurchlässig ist und offene Bereiche (26, 36) von 17-40% umfaßt und ein feinmaschiges Muster aufweist, das einen Durchtritt von Fluid erlaubt, ohne der Ware (12, 44) eine Musterwirkung zu verleihen.

30. Vorrichtung nach Anspruch 29, dadurch gekennzeichnet, daß die Stütze ein feinmaschiges Sieb (34) umfaßt, das in einer versetzten Beziehung zur Bearbeitungsrichtung angeordnet ist.

31. Vorrichtung nach einem der Ansprüche 26 bis 30, dadurch gekennzeichnet, daß die Strahlen (28, 50) von einer Mehrzahl paralleler Verteiler (30, 48) bereitgestellt sind, die etwa 20,32 cm (8 Zoll) voneinander beabstandet sind.

32. Vorrichtung nach einem der Ansprüche 26 bis 31, dadurch gekennzeichnet, daß der Düsenöffnungsdurchmesser etwa 0,0127 cm (0,005 Zoll) ist und der Mittenabstand der Düsenöffnungen (32) etwa 24/cm (60/Zoll) ist.

33. Vorrichtung nach einem der Ansprüche 26 bis 32, dadurch gekennzeichnet, daß die Flüssigkeitsstrahlen (28, 50) jeweils eine Achse aufweisen, die im wesentlichen senkrecht zur Ware (12, 44) ist.

34. Gleichmäßig verstärkte Web- oder Maschenware, erzeugt durch Abstützen der Ware auf einem Stützelement (22, 34, 42) und Beaufschlagen der Ware (12, 44) mit einer Mehrzahl von Flüssigkeitsstrahlströmen (28, 50), dadurch gekennzeichnet, daß die Ware Spinnfasergarne und/oder gesponnene Filamentgarne enthält, welche sich an Überkreuzungspunkten schneiden, um offene Zwischenräume zu definieren, wobei die Garne Fasern enthalten, die dtex und Längen im Bereich von 0,333 bis 17,8 dtex (0,3 bis 16,0 Denier) bzw. 1,27 bis 20,32 Zentimetern (0,5 bis 8 Zoll) aufweisen, wobei die Garne durch Anwendung eines kontinuierlichen Vorhangs aus einem nicht-komprimierbaren Fluid mit einer Energie im Bereich von 5,7 x 10^5 bis 11,5 x 10^6 Joule/kg (0,1 bis 2,0 hp-hr/lb) in den offenen Zwischenräumen fluidverschlungen werden.

35. Gleichmäßig verstärkte Ware nach Anspruch 34, dadurch gekennzeichnet, daß die Ware kurze Fasern von niedriger Denier und locker gedrehte Garne enthält.

36. Gleichmäßig verstärkte Web- oder Maschenware nach Anspruch 34 oder Anspruch 35, dadurch gekennzeichnet, daß die verstärkte Ware eine wesentliche Verbesserung bei mindestens zwei der folgenden Eigenschaften zeigt: Luftdurchlässigkeit, Scheuerfestigkeit, Reißfestigkeit, Kantenausfransen, Nahtverschiebung, Knittererholung, Verdrehfestigkeit und Warengewicht.

37. Verfahren zur Verstärkung und zum Naßverbinden von Web- oder Maschenwarenmaterialien, die Spinnfasergarne und/oder gesponnene Filamentgarne aufweisen, welche sich an Überkreuzungspunkten schneiden, dadurch gekennzeichnet, daß es umfaßt:

das Aufrauhen erster und zweiter Oberflächen (62a, 64a) der Ware, um deren Oberflächenfasern aufzurichten, und
das Anordnen der ersten und zweiten Warenoberflächen auf dem Stützelement (22, 34, 42) in einer gegenüberliegenden und überlagernden geschichteten Beziehung,
wobei die Ware (60) mit einem kontinuierlichen Fluidvorhang mit einer Energie im Bereich von 5,7 x 10^5 bis 11,5 x 10^6 Joule/kg (0,1 bis 2,0 hp-hr/lb) beaufschlagt wird, um eine Verschlingung der aufgerichteten Fasern in den ersten und zweiten Oberflächen (62a, 64a) zu bewirken, um die Ware (60) zu verbinden.

38. Verfahren zum Naßverbinden von Web- oder Maschenwarenmaterialien, um ein Verbundtextilerzeugnis zu bilden, wobei die Ware Spinnfasergarne und/oder gesponnene Filamentgarne in einem Strukturmuster enthält, mit Garnen, die sich an Überkreuzungspunkten schneiden, wobei das Verfahren die folgenden Schritte umfaßt:

das Aufrauhen erster und zweiter Oberflächen (62a, 64a) der Ware, um deren Oberflächen fasern aufzurichten,
das Anordnen der ersten und zweiten Oberflächen in einer gegenüberliegenden und überlagernden geschichteten Beziehung,
das Abstützen der geschichteten Ware auf einem Stützelement (22, 34, 42), und
das Überfahren einer Seite der geschichteten Ware mit einem ersten kontinuierlichen Fluidvorhang für eine genügende Zeit, um eine Verschlingung der aufgerichteten Fasern in den ersten und zweiten Oberflächen zu bewirken,
wobei der Fluidvorhang die Ware mit einer Energie im Bereich von 5,7 x 10^5 bis 11,5 x 10^6 Joule/kg (0,1 bis 2,0 hp-hr/lb) beaufschlagt.

39. Verfahren nach Anspruch 37 oder Anspruch 38, dadurch gekennzeichnet, daß das Verfahren von Anspruch 1 und 2 angewendet wird, und daß die Transportgeschwindigkeit 0,0508 bis 2,54 m/s (10 bis 500 fpm) beträgt, der Strahldruck 1.379 bis 20.685 kPa (200 bis 3000 psi) beträgt, die Strahlen (28, 50) säulenförmig sind, die Düsenöffnungen (32) einen Durchmesser von 0,0127 bis 0,0254 cm (0,005 bis 0,010 Zoll) und einen Mittenabstand von 0,043 bis 0,086 cm (0,017 bis 0,034 Zoll) aufweisen.

40. Verfahren nach Anspruch 37, 38 oder 39, dadurch gekennzeichnet, daß die Ware (60) beidseitig behandelt wird.

41. Verfahren nach einem der Ansprüche 37 bis 40, dadurch gekennzeichnet, daß die Ware (60) kurze Fasern von niedriger Denier und locker gedrehte Garne enthält.

42. Verstärktes Web- oder Maschenwaren-Verbundtextil nach Anspruch 34, 35 oder 36, dadurch gekennzeichnet, daß die Ware erste und zweite aufgerauhte Oberflächen (62a, 64) mit aufgerichteten Oberflächenfasern umfaßt, wobei die aufgerauhten Oberflächen in einer überlagernden und gegenüberliegenden Beziehung angeordnet sind, und wobei die aufgerichteten Oberflächenfasern in den ersten und zweiten Oberflächen verschlungen sind.

Revendications

1. Procédé d'amélioration et d'ennoblissement d'étoffes tissées ou tricotées ayant des fils qui s'entrecroisent à des points de croisement, dans lequel l'étoffe est supportée sur un élément de support (22, 34, 42), acheminée dans un sens machine suivant une ligne de production, et sur laquelle est projetée du liquide, caractérisé en ce que l'étoffe est faite à partir de fibres filées et/ou de fibres de fils continus filés de décitex et de longueurs de l'ordre de 0,333 à 17,8 dtex (0,3 à 16,0 deniers) et de 1,27 à 20,3 centimètres (0,5 à 8 pouces), respectivement, et le titre du fil est de l'ordre de 1180 à 7,4 Tex (0,5 s à 80 s) et en ce que le procédé comprend la projection uniforme et continue, sur au moins une face de l'étoffe, d'un rideau continu de fluide qui frappe l'étoffe avec une énergie de l'ordre de $5,7 \times 10^5$ à $11,5 \times 10^6$ joule/kg (0,1 à 2,0 ch·h/livre), ce qui a pour effet d'enchevêtrer les fils à leurs points de croisement.

2. Procédé suivant la revendication 1, caractérisé en ce que le rideau continu de fluide est créé par une série de jets liquides (28, 50) disposés les uns près des autres qui sortent d'orifices d'éjection (32).

3. Procédé suivant la revendication 2, caractérisé en ce que la vitesse d'acheminement est comprise entre 0,0508 et 2,54 m/s (10 à 500 pieds/min), la pression d'éjection est comprise entre 1379 et 20 685 kPa (200 à 3000 livres/pouce carré), les jets (28, 50) sont colonnaires, les orifices d'éjection (32) ont un diamètre de 0,0127 à 0,254 cm (0,005 à 0,010 pouce), et une distance de centre à centre de 0,043 à 0,086 cm (0,017 à 0,034 pouce).

4. Procédé suivant la revendication 2 ou la revendication 3, caractérisé en ce que les jets (28) sont distants d'approximativement 1,27 cm (0,5 pouce) de l'élément de support.

5. Procédé suivant l'une quelconque des revendications 1 à 4, caractérisé en ce que l'élément de support (22, 34) est perméable aux liquides et comporte entre 17 et 40% de zones ouvertes (26, 36) et a une structure à mailles fines qui permet le passage de fluide sans imprimer un effet de dessin à l'étoffe.

6. Procédé suivant la revendication 5, caractérisé en ce que le support comprend un tamis à mailles fines (34) décalé par rapport au sens machine.

7. Procédé suivant l'une quelconque des revendications 1 à 6, caractérisé en ce que l'étoffe (12, 44) est traitée sur les deux faces.

8. Procédé suivant l'une quelconque des revendications 2 à 7, caractérisé en ce que la série de jets (28, 50) est créée par une pluralité de collecteurs parallèles (30, 48) espacés les uns des autres d'approximativement 20,3 cm (8 pouces).

9. Procédé suivant l'une quelconque des revendication 2 à 8, caractérisé en ce que la pression vaut approximativement 10 340 kPa (1500 livre/pouce carré), le diamètre des orifices d'éjection vaut approximativement 0,0127 cm (0,005 pouce), la distance de centre à centre des orifices d'éjection (32) assure approximativement 24 jets/cm (60 jets/pouce), et l'étoffe est frappée avec une énergie cumulée d'approximativement $2,64 \times 10^6$ joule/kg (0,46 ch·h/livre).

10. Procédé suivant l'une quelconque des revendications 1 à 9, caractérisé en ce que l'étoffe (12, 44) comprend des fils de faible denier, composés de fibres courtes et retordus floches.

11. Procédé suivant l'une quelconque des revendications 2 à 10, caractérisé en ce que les jets liquides (28, 50) sont alignés dans une direction transversale au sens machine, et l'axe de chaque jet liquide (28, 50) est sensiblement perpendiculaire à l'étoffe.

12. Procédé suivant l'une quelconque des revendications 1 à 11, caractérisé en outre en ce qu'il comprend l'étape consistant à sécher l'étoffe frappée.

13. Procédé suivant l'une quelconque des revendications 1 à 12, caractérisé en outre en ce qu'il comprend l'étape consistant à sécher l'étoffe frappée à une largeur déterminée sous tension.

14. Procédé suivant l'une quelconque des revendications 1 à 13, caractérisé en ce que le procédé a pour effet d'améliorer les fils dans des zones ouvertes interstitielles définies par les points de croisement dans l'armure de l'étoffe,

et l'étoffe présente une réduction de la perméabilité à l'air de l'ordre de 10 à 90% après amélioration.

15. Procédé suivant l'une quelconque des revendications 1 à 13, caractérisé en ce que l'étoffe est un tissu de polyester et elle comprend un filé de coton open-end, composé de fibres de polyester de 2,22 dtex (2 deniers) et de 4,8 cm (1,9 pouce), ayant un titre de 34,7 Tex (17 s) et un compte en fils de 19,2 x 9/cm (49 x 23/pouce), et le procédé réduit la perméabilité à l'air de l'étoffe d'approximativement 48% après amélioration.

16. Procédé suivant l'une quelconque des revendications 1 à 13, caractérisé en ce que l'étoffe est un tissu acrylique et elle comprend un fil de chaîne de coton open-end, composé de fibres de 3,33 dtex (3 deniers) et de 3,8 cm (1,5 pouce), ayant un titre de 65,7 Tex (9 s), 11 fils de chaîne/cm (28/pouce), et un filé de trame de laine open-end, composé de fibres acryliques de 3,33 dtex (3 deniers) et 7,6 cm (3 pouces), ayant un titre de 147,6 Tex (4 s), 6,3 duites/cm (16/pouce) et le procédé réduit la perméabilité à l'air de l'étoffe d'approximativement 36% après amélioration.

17. Procédé suivant l'une quelconque des revendications 1 à 13, caractérisé en ce que l'étoffe est une étoffe de filé guipé acrylique et elle comprend un filé, composé de fibres acryliques de 3,33 dtex (3 deniers) et de 7,6 cm (3 pouces), guipé d'un fil de polyester texturé de 111 dtex (100 deniers) et ayant un titre de 147,6 Tex (4 s) et un compte en fils de 5,5 x 6,3/cm (14 x 16/pouce), et le procédé réduit la perméabilité à l'air de l'étoffe d'approximativement 65% après amélioration.

18. Procédé suivant l'une quelconque des revendications 1 à 13, caractérisé en ce que l'étoffe est un tissu acrylique et elle comprend un filé de chaîne de coton open-end, composé de fibres acryliques de 3,33 dtex (3 deniers) et de 3,8 cm (1,5 pouce), ayant un titre de 65,7 Tex (9 s), 11 fils de chaine/cm (28/pouce), et un filé guipé de trame creux, composé de fibres acryliques de 3,33 dtex (3 deniers) et de 7,62 cm (3 pouces), ayant 2,4 torsions/cm (6/pouce), un titre de 147,6 Tex (4 s), 6,3 duites/cm (16/pouce), et le procédé réduit la perméabilité à l'air de l'étoffe d'approximativement 48% après amélioration.

19. Procédé suivant l'une quelconque des revendications 1 à 3, caractérisé en ce que l'étoffe est un tissu acrylique et elle comprend un filé de chaîne de laine open-end, composé de fibres acryliques de 3,33 dtex (3 deniers) et de 3,8 cm (1,5 pouce), ayant un titre de 147,6 Tex (4 s), 5,5 fils de chaîne/cm (14/pouce), et un filé de trame de laine open-end, composé de fibres acryliques de 3,33 dtex (3 deniers) et de 7,6 cm (3 pouces), ayant un titre de 227 Tex (2,6 s), 6,3 duites/cm (16/pouce) et le procédé réduit la perméabilité à l'air de l'étoffe d'approximativement 48% après amélioration.

20. Procédé suivant l'une quelconque des revendications 1 à 13, caractérisé en ce que l'étoffe est un tissu et elle comprend une armure sergé 2 x 1 à 80% laine/20% Nylon, et le procédé réduit la perméabilité à l'air de l'étoffe d'approximativement 49,5% après amélioration.

21. Procédé suivant l'une quelconque des revendications 1 à 13, caractérisé en ce que l'étoffe est une étoffe à 53% polyester/47% coton et elle comprend une armure sergé 3 x 1, un compte en fils de 47 fils de chaîne/cm x 14,9 duites/cm (120 fils de chaîne/pouce x 38 duites/pouce) et le procédé réduit la perméabilité à l'air de l'étoffe d'approximativement 50,6% après amélioration.

22. Procédé suivant l'une quelconque des revendications 1 à 13, caractérisé en ce que l'étoffe est un tricot deux fontures à 50% polyester/50% coton et elle comprend un filé guipé avec une guipure de polyester de 111 dtex (100 deniers) et le procédé réduit la perméabilité à l'air de l'étoffe d'approximativement 16% après amélioration.

23. Procédé suivant l'une quelconque des revendications 1 à 13, caractérisé en ce que le fil est un filé de coton open-end.

24. Procédé suivant l'une quelconque des revendications 1 à 13, caractérisé en ce que le fil est un filé guipé.

25. Procédé suivant l'une quelconque des revendications 1 à 13, caractérisé en ce que le fil est un filé de laine open-end.

26. Appareil destiné à l'amélioration et l'ennoblissement d'étoffes tissées ou tricotées ayant des fils filés et/ou continus filés qui s'entrecroisent à des points de croisement, l'appareil comprenant un élément (22, 34, 42) de support de l'étoffe et un moyen pour fournir une pluralité de courants-jets liquides qui sont projetés sur l'étoffe (12, 44), caractérisé en ce que l'appareil comprend :

un moyen (24) pour acheminer l'étoffe supportée dans un sens machine;
un moyen pour projeter de manière uniforme sur l'étoffe acheminée un rideau continu de fluide comprenant une pluralité de jets liquides (28, 50) disposés très près les uns des autres, alignés dans une direction transversale au sens machine, lesdits jets liquides (28, 50) sortant, sous la forme d'un rideau continu de fluide, d'une pluralité d'orifices d'éjection (32) disposés très près les uns des autres;
ledit rideau de fluide agissant de concert avec l'élément de support pour enchevêtrer les fils de l'étoffe à leurs points de croisement.

27. Appareil suivant la revendication 26, caractérisé en ce que les jets (28, 50) sont colonnaires, et les orifices d'éjection (32) ont des diamètres et des distances de centre à centre de 0,0127 à 0,254 cm (0,005 à 0,010 pouce) et de 0,043 à 0,086 cm (0,017 à 0,034 pouce), respectivement.

28. Appareil suivant la revendication 26 ou la revendication 27, caractérisé en ce que les jets (28, 50) sont distants d'approximativement 1,27 cm (0,5 pouce) de l'élément de support (22, 34).

29. Appareil suivant la revendication 26, 27 ou 28, caractérisé en ce que l'élément de support (22, 34, 44) est perméable aux liquides et comporte entre 17 et 40% de zones ouvertes (26, 36) et a un dessin à mailles fines qui permet le passage de fluide sans imprimer un effet de dessin à l'étoffe (12, 44).

30. Appareil suivant la revendication 29, caractérisé en ce que le support comprend un tamis à mailles fines (34) décalé par rapport au sens machine.

31. Appareil suivant l'une quelconque des revendications 26 à 30, caractérisé en ce que les jets (28, 50) sont créés par une pluralité de collecteurs parallèles (30, 48) distants d'approximativement 20,32 cm (8 pouces).

32. Appareil suivant l'une quelconque des revendications 26 à 31, caractérisé en ce que le diamètre des orifices d'éjection vaut approximativement 0,0127 cm (0,005 pouce) et la distance de centre à centre des orifices d'éjection (32) vaut approximativement 24/cm (60/pouce).

33. Appareil suivant l'une quelconque des revendications 26 à 32, caractérisé en ce que l'axe de chaque jet liquide (28, 50) est sensiblement perpendiculaire à l'étoffe (12, 44).

34. Etoffe tissée ou tricotée améliorée uniformément réalisée en supportant l'étoffe sur un élément de support (22, 34, 42) et en projetant sur l'étoffe (12, 44) une pluralité de courants-jets liquides (28, 50), caractérisée en ce que l'étoffe comprend des fils filés et/ou continus filés qui s'entrecroisent à des points de croisement afin de définir des zones ouvertes interstitielles, lesdits fils comprenant des fibres ayant des dtex et longueurs de l'ordre de 0,333 à 17,8 dtex (0,3 à 16,0 deniers) et de 1,27 à 20,32 cm (0,5 à 8 pouces), respectivement, dans laquelle lesdits fils sont enchevêtrés de manière hydrodynamique dans lesdites zones ouvertes interstitielles par application d'un rideau continu de fluide non compressible avec une énergie de l'ordre de $5,7 \times 10^5$ à $11,5 \times 10^6$ joule/kg (0,1 à 2,0 ch·h/livre).

35. Etoffe améliorée uniformément suivant la revendication 34, caractérisée en ce que l'étoffe comprend des fils de faible denier, composés de fibres courtes et retordus floches.

36. Etoffe tissée ou tricotée améliorée uniformément suivant la revendication 34 ou la revendication 35, caractérisée en ce que l'étoffe améliorée présente au moins deux caractéristiques sensiblement améliorées telles que la perméabilité à l'air, la résistance à l'abrasion, la résistance à la traction, l'effilochement du bord, le glissement de la couture, l'infroissabilité, la résistance à la torsion, et le poids de l'étoffe.

37. Procédé d'amélioration et de liage hydrodynamique d'étoffes tissées ou tricotées ayant des fils filés et/ou continus filés qui s'entrecroisent à des points de croisement, caractérisé en ce qu'il comprend les étapes consistant à :

gratter la première et seconde surfaces (62a, 64a) de l'étoffe afin de redresser les fibres superficielles de ces dernières, et
superposer l'une face à l'autre, sur l'élément de support (22, 34, 42), lesdites première et seconde surfaces de l'étoffe,

dans lequel un rideau continu de fluide est projeté sur l'étoffe (60) avec une énergie de l'ordre de 5,7 x 10^5 à 11,5 x 10^6 joule/kg (0,1 à 2,0 ch·h/livre) afin d'enchevêtrer lesdites fibres redressées dans lesdites première et seconde surfaces (62a, 64a) et d'assembler l'étoffe (60).

38. Procédé de liage hydrodynamique d'étoffes tissées ou tricotées pour former une étoffe composite, l'étoffe comprenant des fils filés et/ou continus filés dans une structure comprenant des fils qui s'entrecroisent à des points de croisement, le procédé comprenant les étapes consistant à :

gratter la première et seconde surfaces (62a, 64a) de l'étoffe afin de redresser les fibres superficielles de ces dernières,
superposer lesdites première et seconde surfaces l'une face à l'autre,
supporter l'étoffe en couches sur un élément de support (22, 34, 42), et
traverser une face de ladite étoffe en couches avec un premier rideau continu de fluide pendant un temps suffisant pour enchevêtrer lesdites fibres superficielles redressées dans lesdites première et seconde surfaces,
ledit rideau de fluide étant projeté sur l'étoffe avec une énergie de l'ordre de 5,7 x 10^5 à 11,5 x 10^6 joule/kg (0,1 à 2,0 ch·h/livre).

39. Procédé suivant la revendication 37 ou la revendication 38, caractérisé en ce que le procédé des revendications 1 et 2 est utilisé et en ce que la vitesse d'acheminement est comprise entre 0,0508 et 2,54 m/s (10 à 500 pieds/min), la pression d'éjection est comprise entre 1379 à 20 685 kPa (200 à 3000 pieds/pouce carré), et les jets (28, 50) sont colonnaires, les orifices d'éjection (32) ayant un diamètre compris entre 0,0127 et 0,0254 cm (0,005 à 0,010 pouce), et une distance de centre à centre comprise entre 0,043 et 0,086 cm (0,017 à 0,034 pouce).

40. Procédé suivant la revendication 37, 38 ou 39, caractérisé en ce que l'étoffe (60) est traitée sur les deux faces.

41. Procédé suivant l'une quelconque des revendications 37 à 40, caractérisé en ce que l'étoffe (60) comprend des fils de faible denier, composés de fibres courtes et retordus floches.

42. Etoffe tissée ou tricotée composite améliorée suivant la revendication 34, 35 ou 36, caractérisé en ce que l'étoffe comprend une première et une seconde surfaces grattées (62a, 64) dont des fibres superficielles sont redressées, lesdites surfaces grattées étant superposées l'une face à l'autre, et dans lesquelles lesdites fibres superficielles redressées dans lesdites première et seconde surfaces sont enchevêtrées.

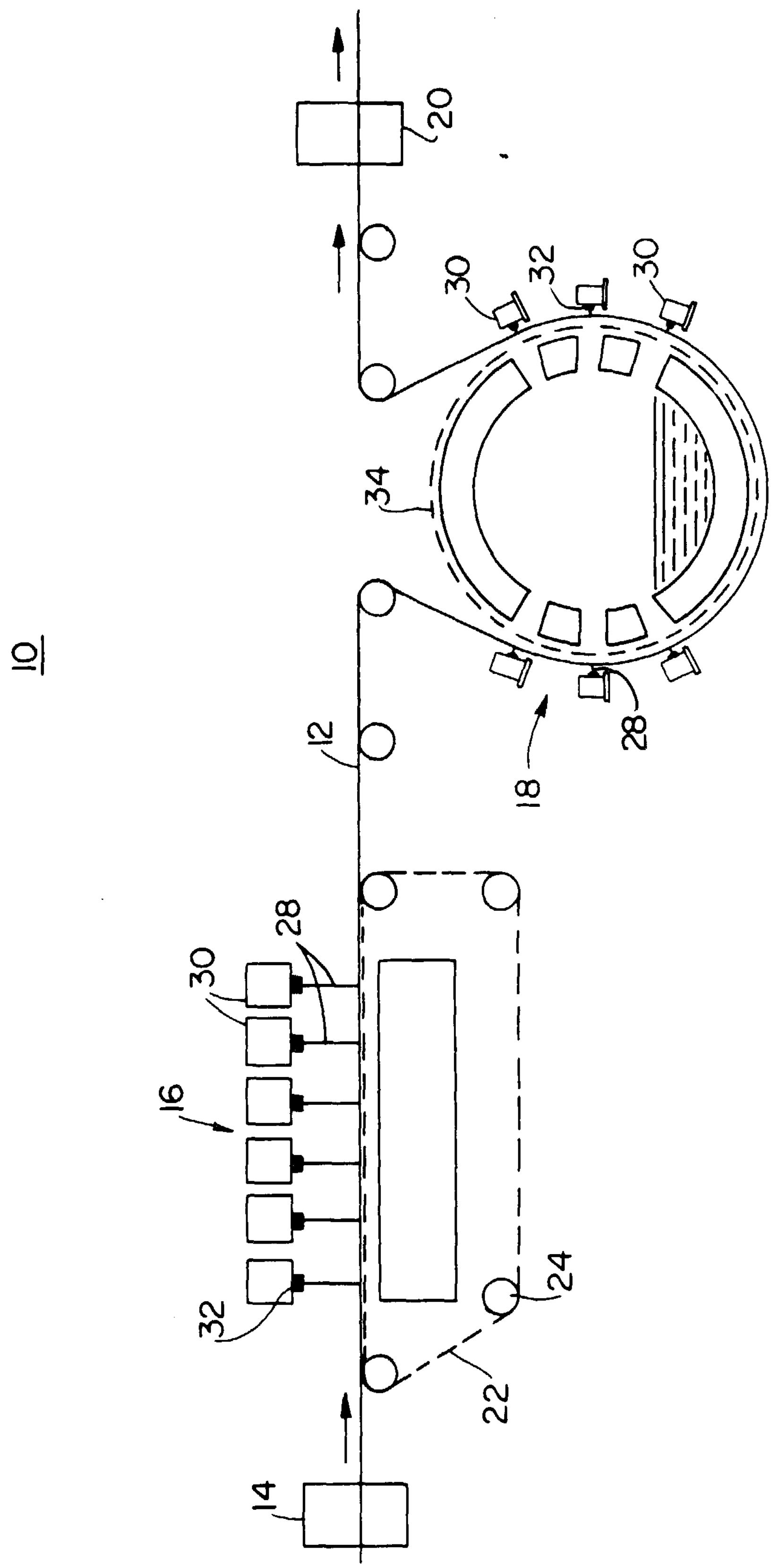

FIG. 1

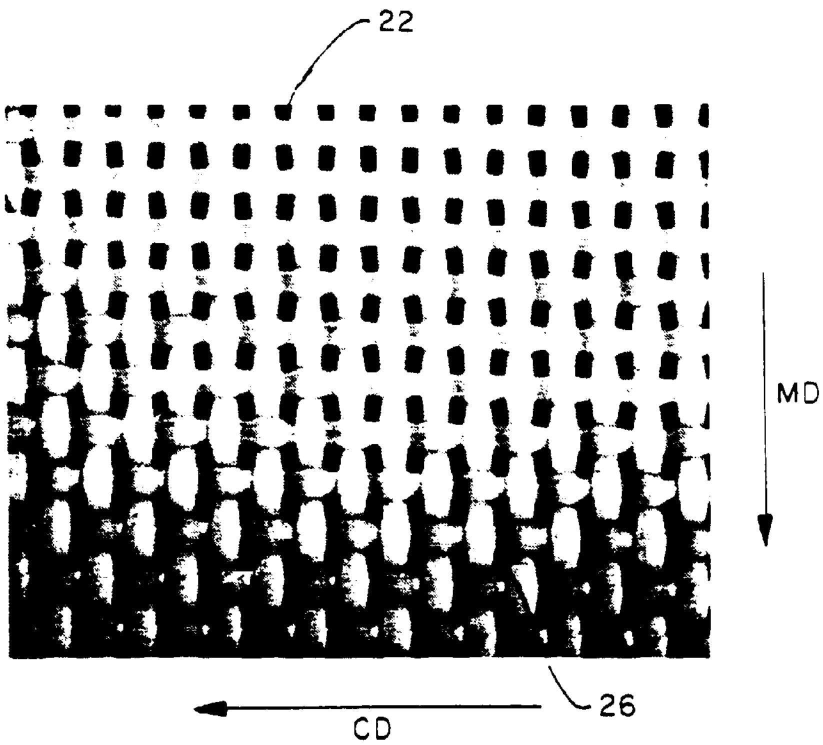

FIG. 2A

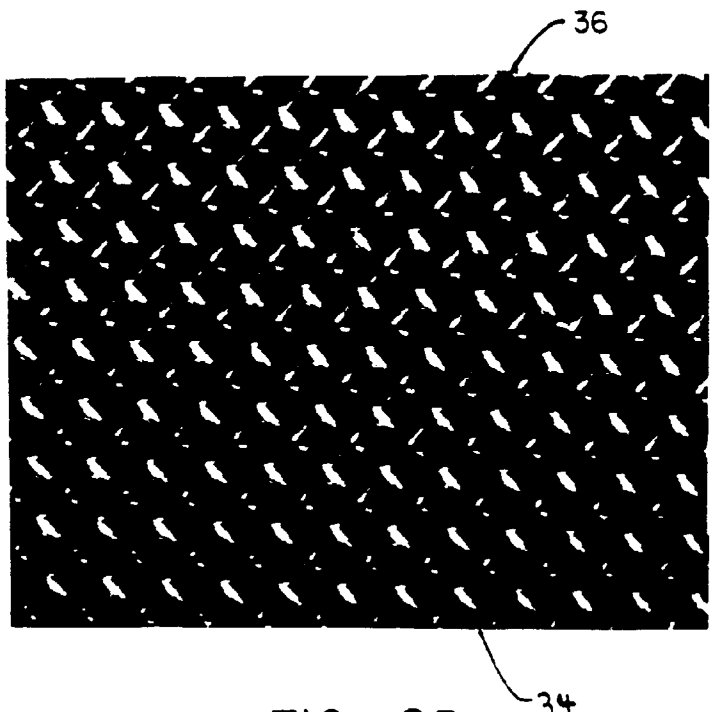

FIG. 2B

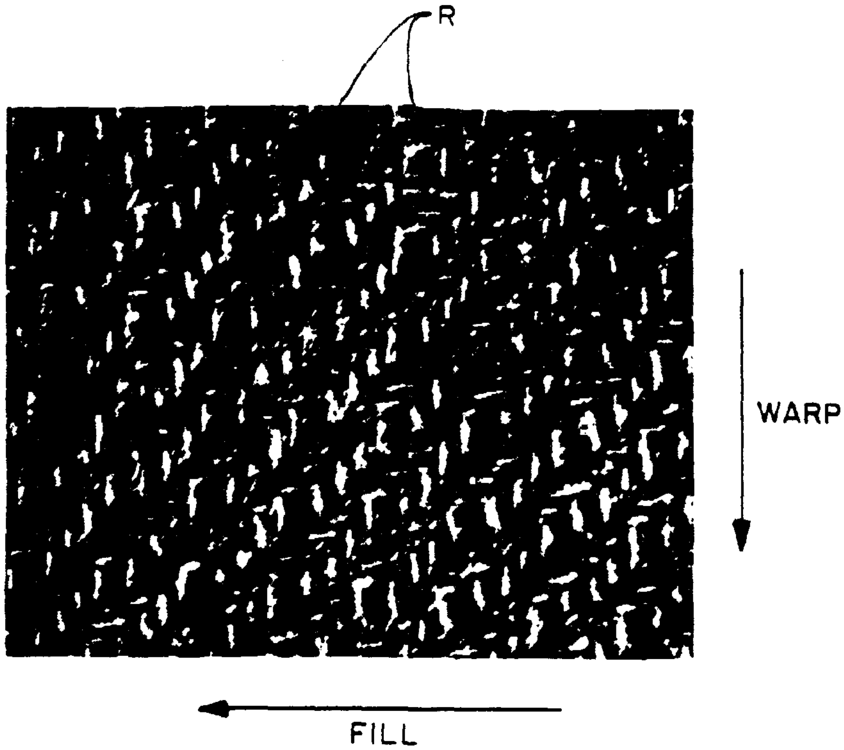

FIG. 3A

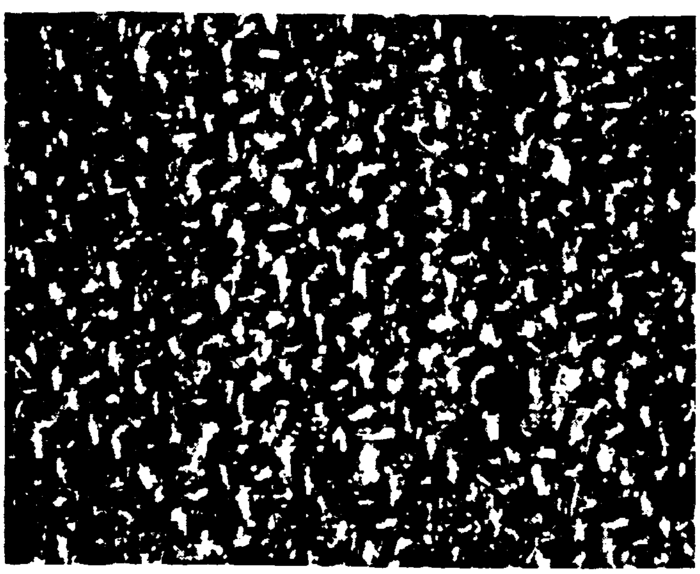

FIG. 3B

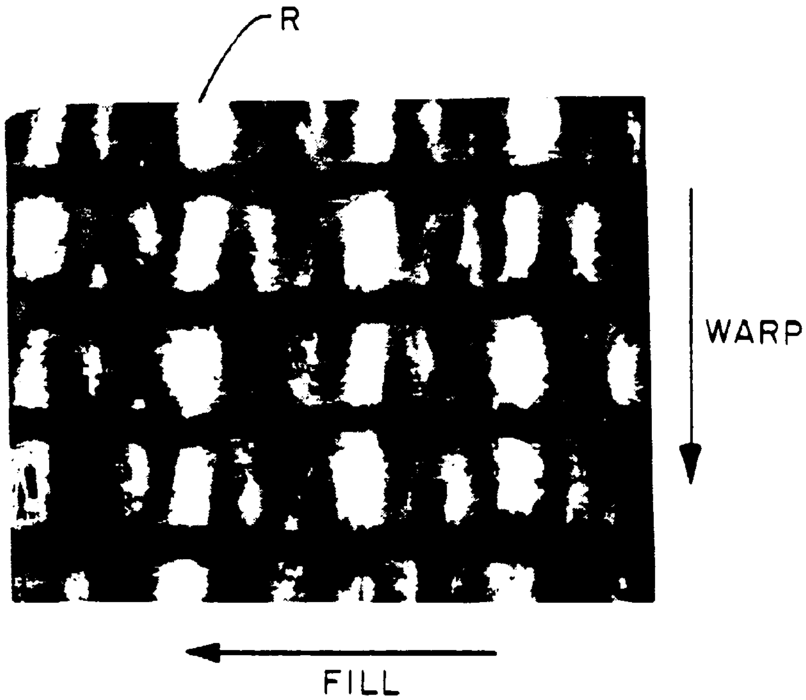

FIG. 4A

FIG. 4B

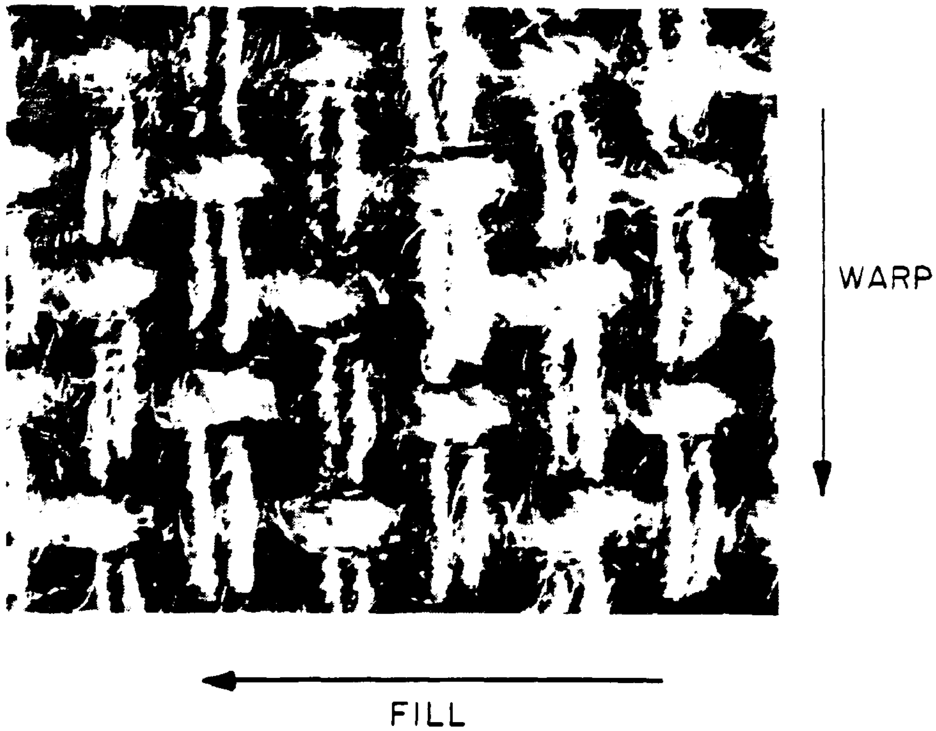

FIG. 5A

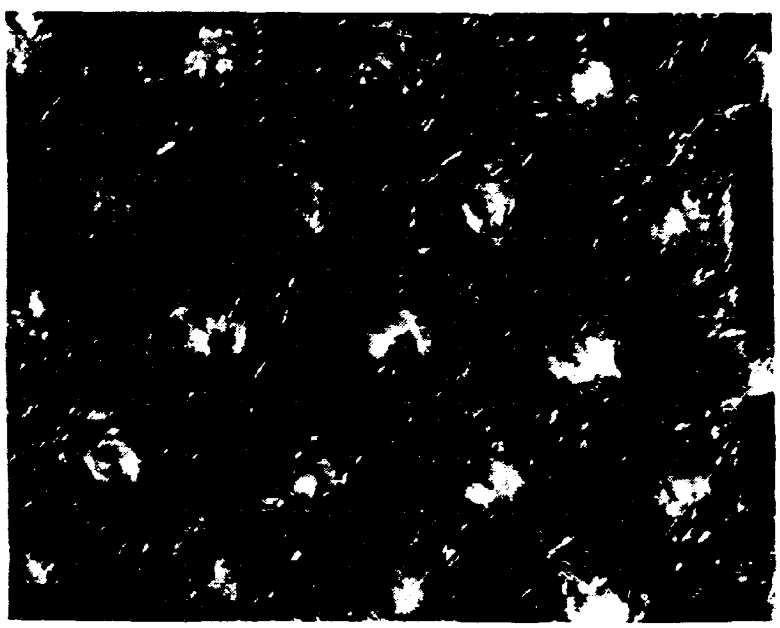

FIG. 5B

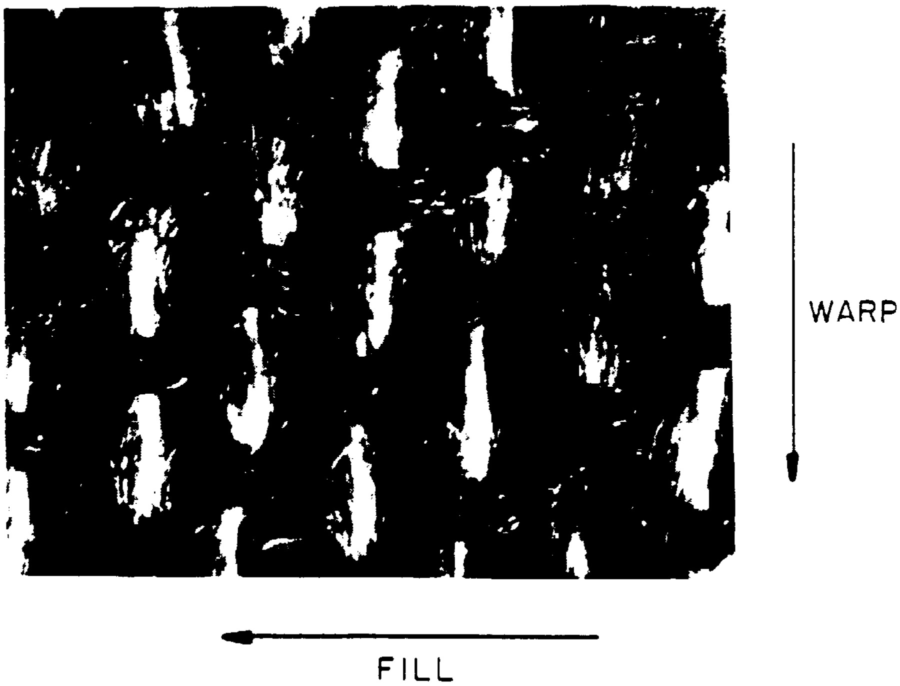

FIG. 6A

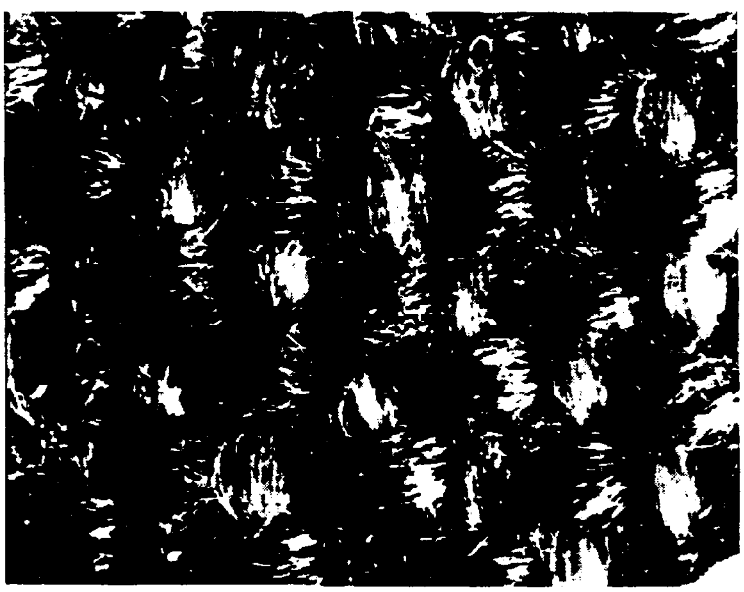

FIG. 6B

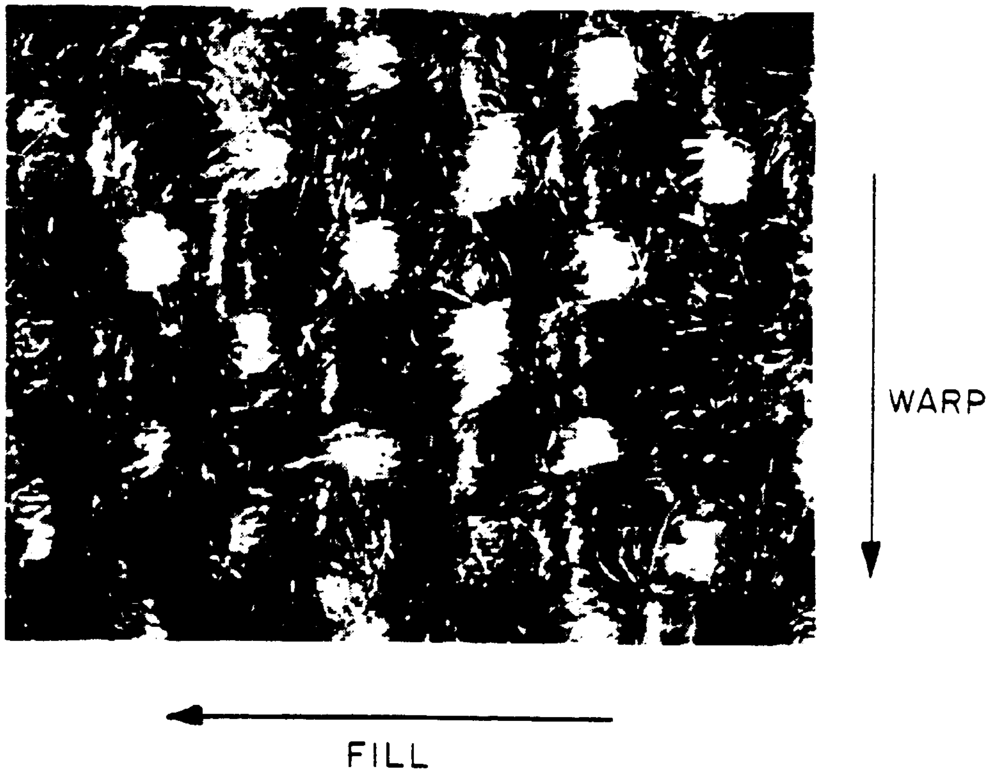

FIG. 7A

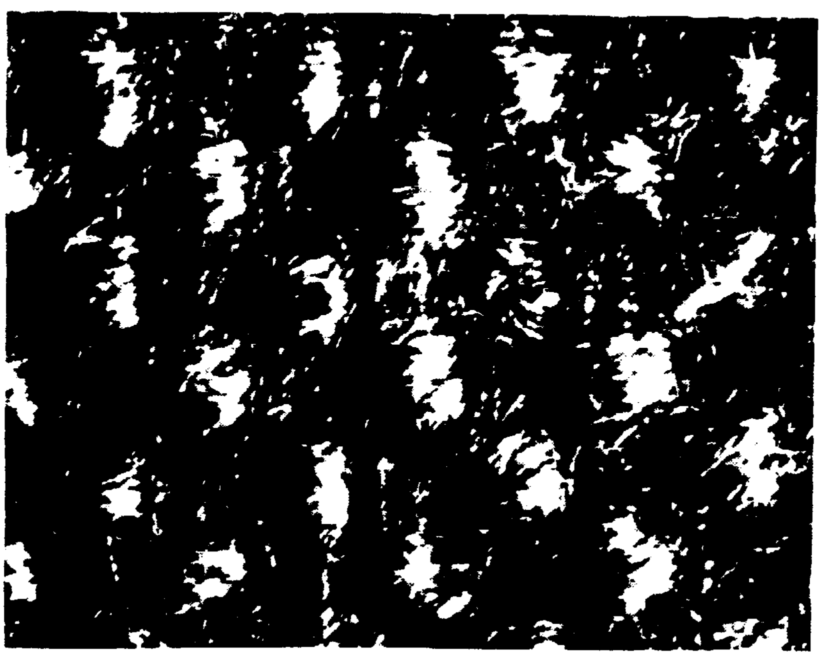

FIG. 7B

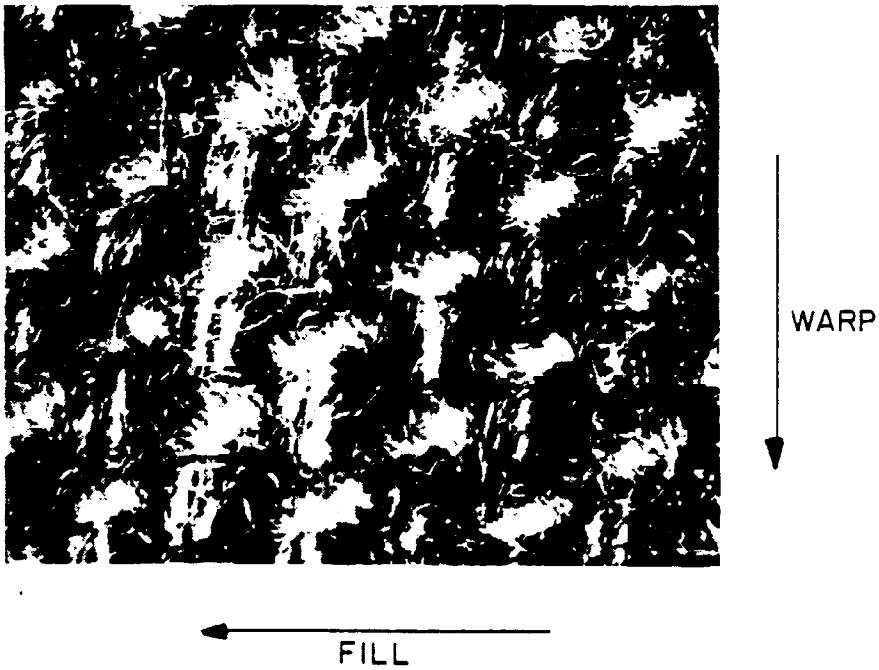

FIG. 8A

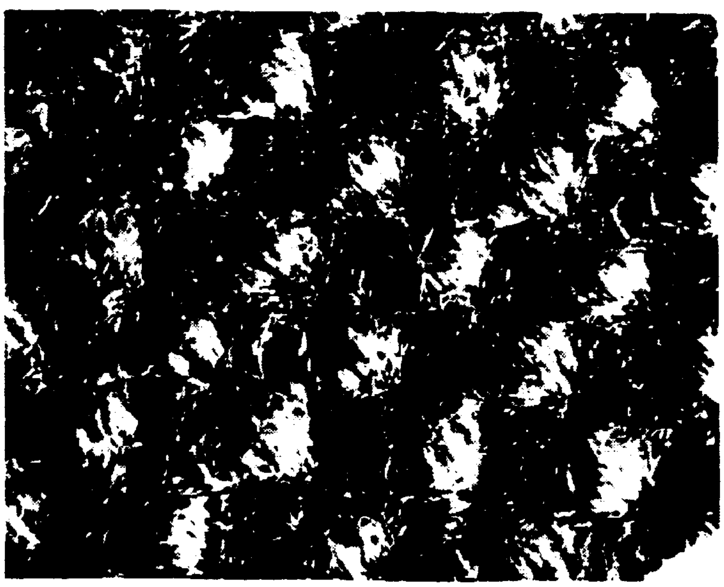

FIG. 8B

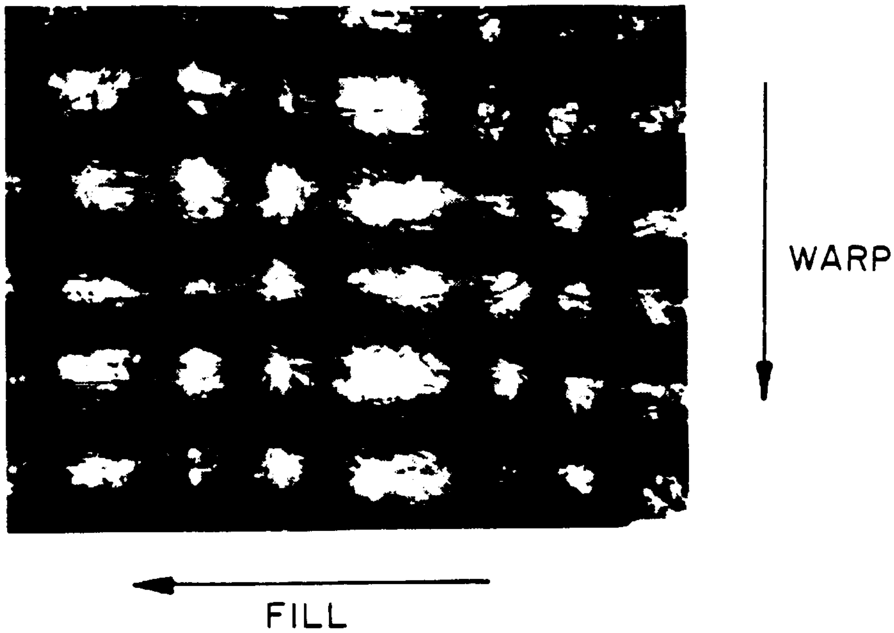

FIG. 9A

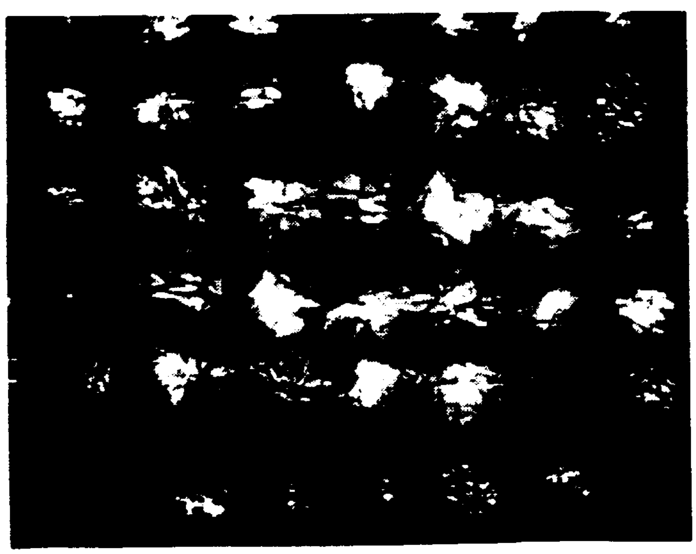

FIG. 9B

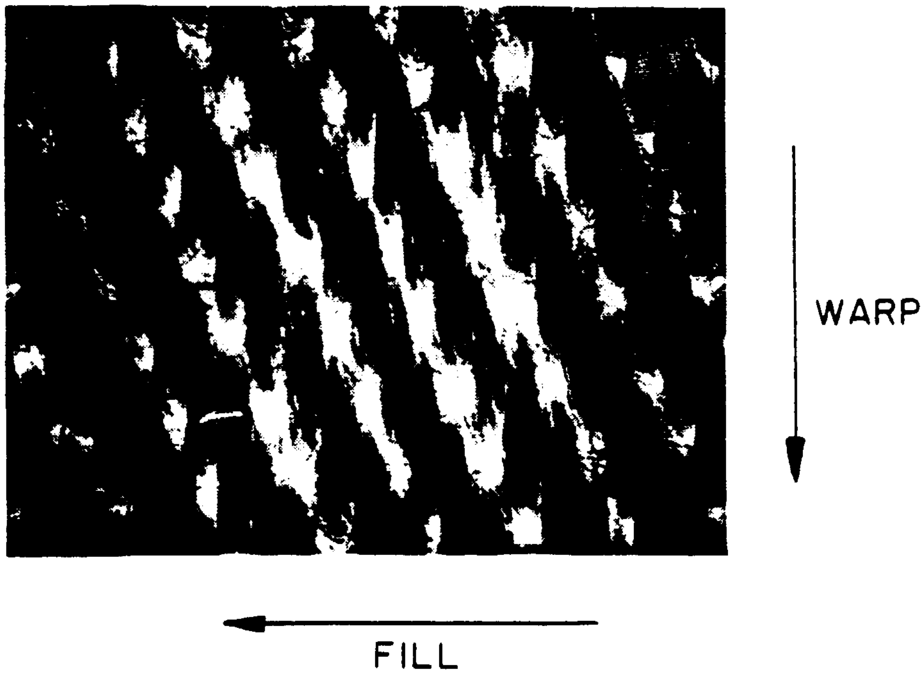

FIG. 10A

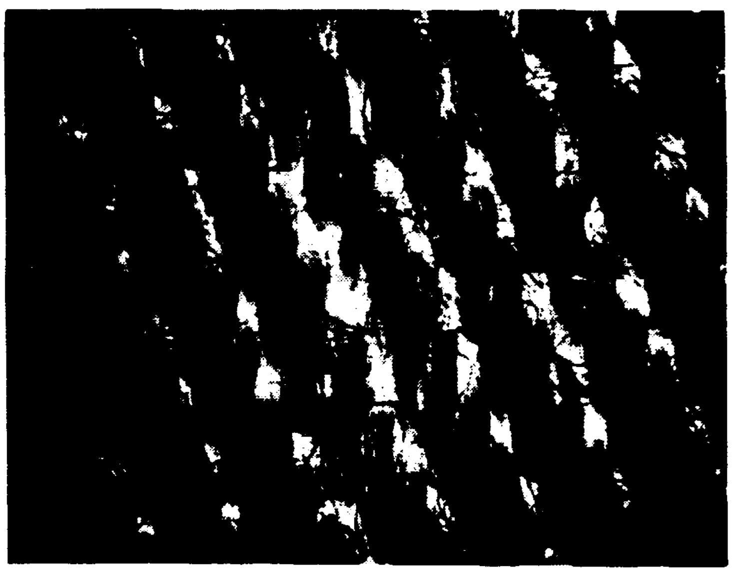

FIG. 10B

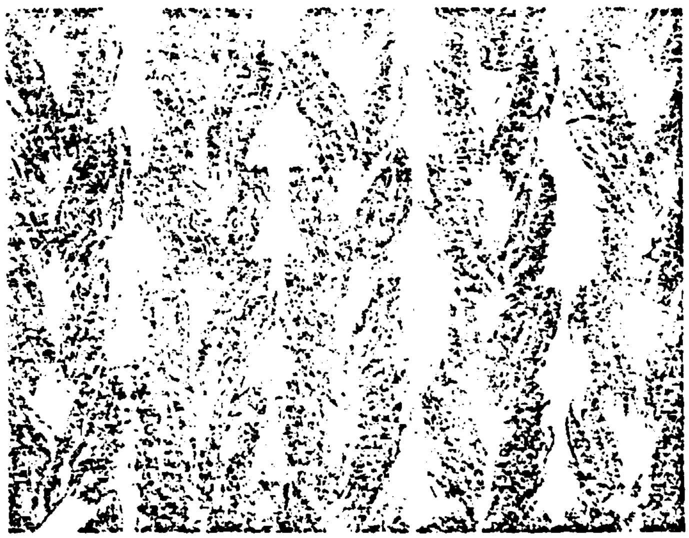

FIG. 11B

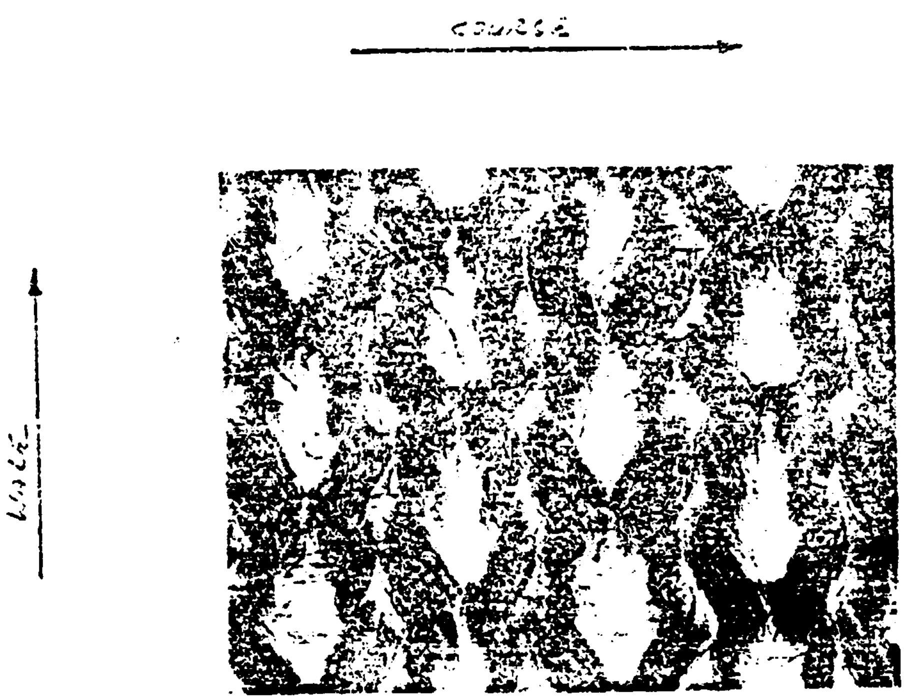

FIG. 11A

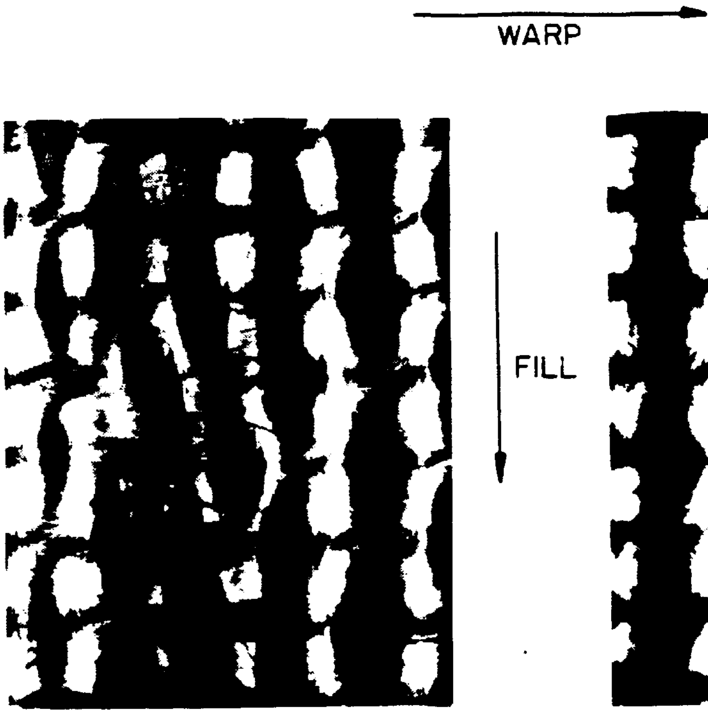

FIG. 12A

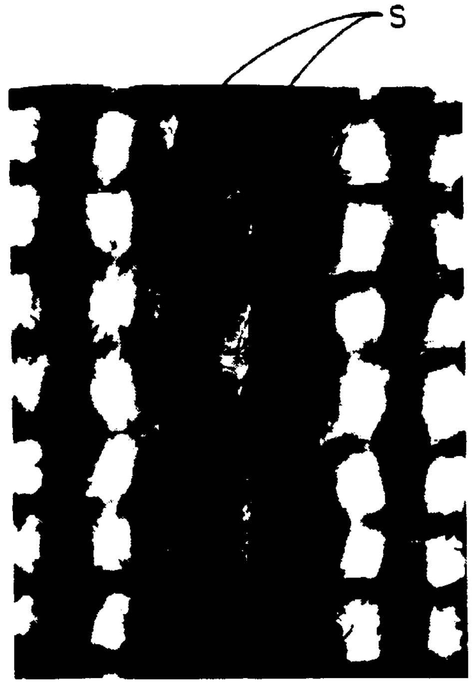

FIG. 12B

FIG. 13A

FIG. 13B

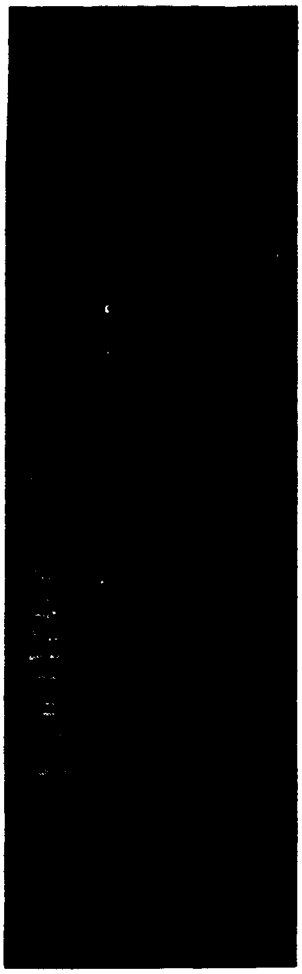

FIG. 14A

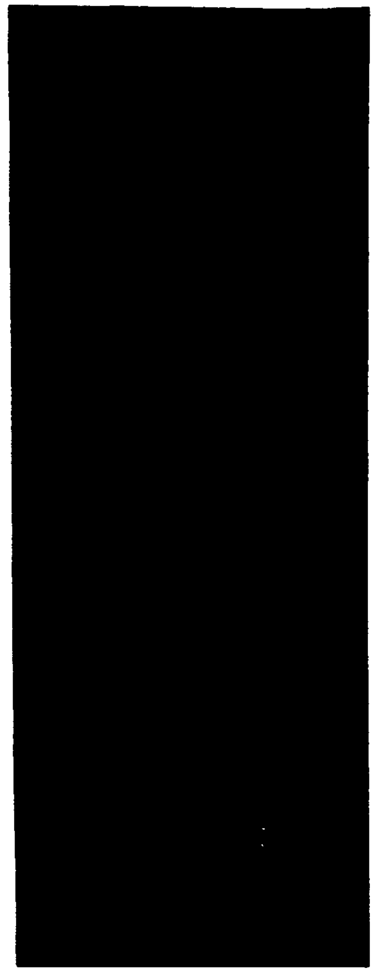

FIG. 14B

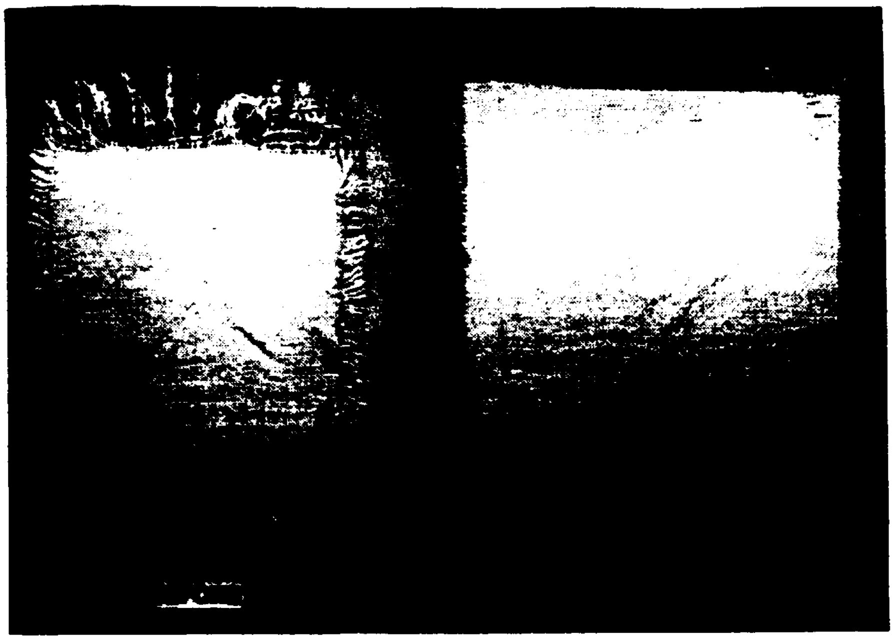

FIG. 15A

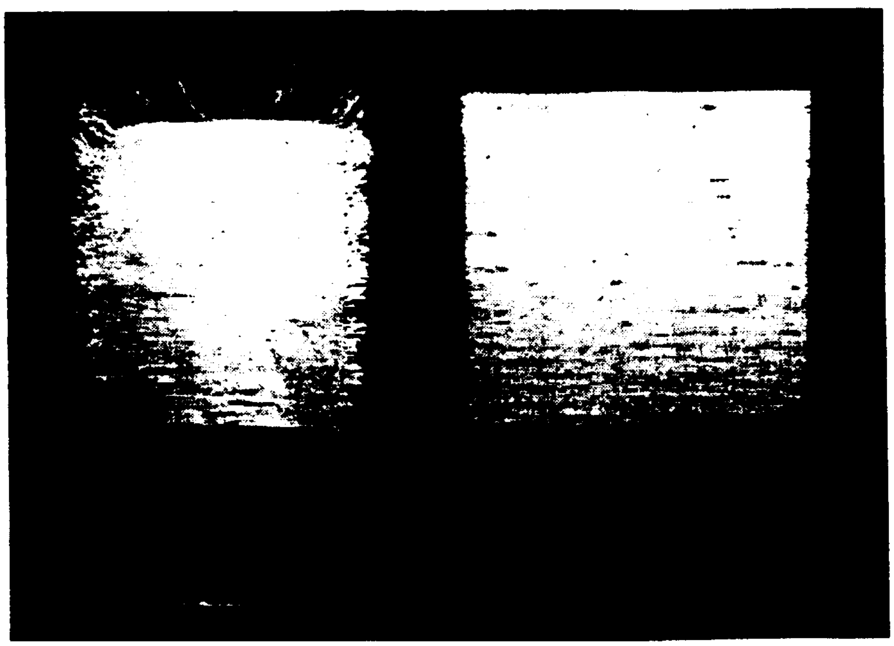

FIG. 15B

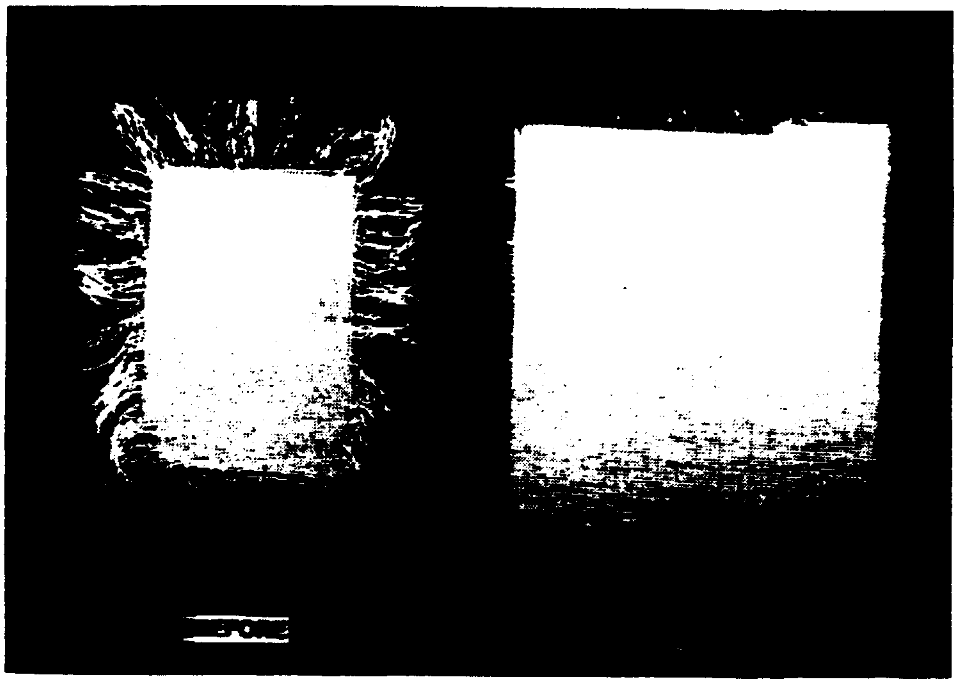

FIG. 15C

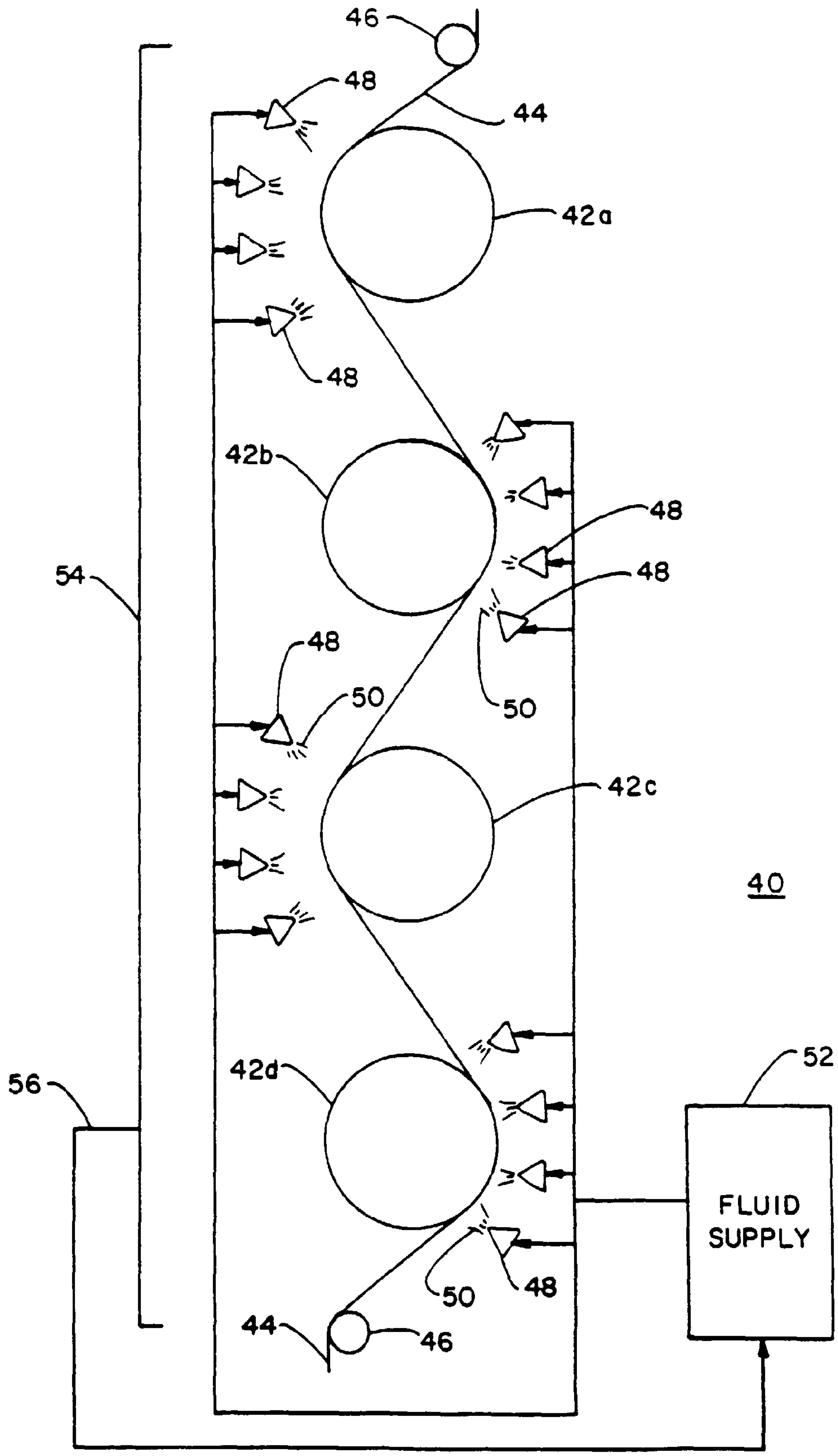
46
48
44
42a
48
42b
48
48
54
48
50
50
42c
40
52
42d
56
FLUID SUPPLY
50
48
44
46

FIG. 16

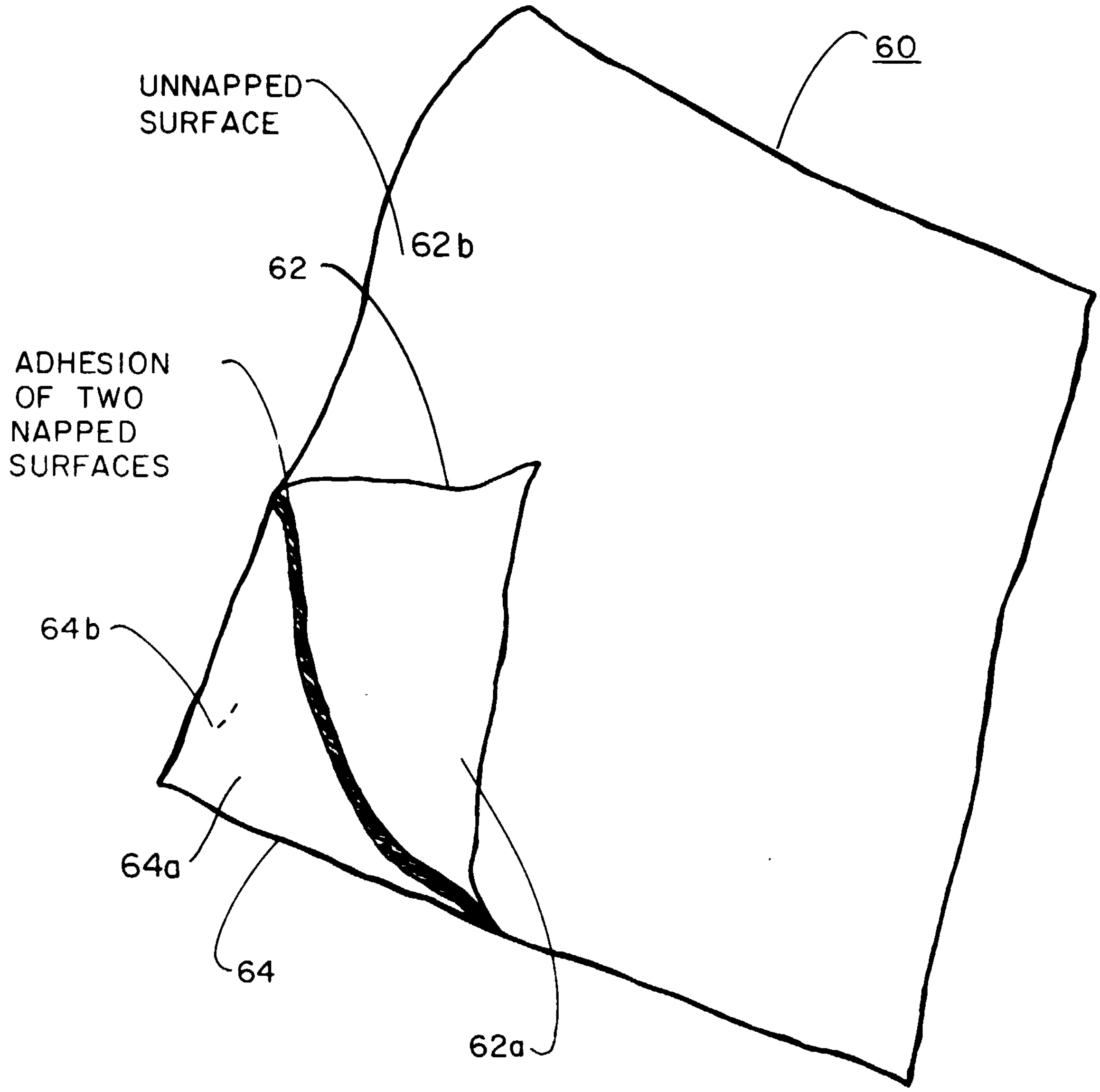
60
UNNAPPED SURFACE
62b
62
ADHESION OF TWO NAPPED SURFACES
64b
64a
64
62a

FIG. 17