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3,623,927

METHOD OF MAKING CROSS-LAPPED SPREAD WEBS

Original Filed Jan. 3, 1967

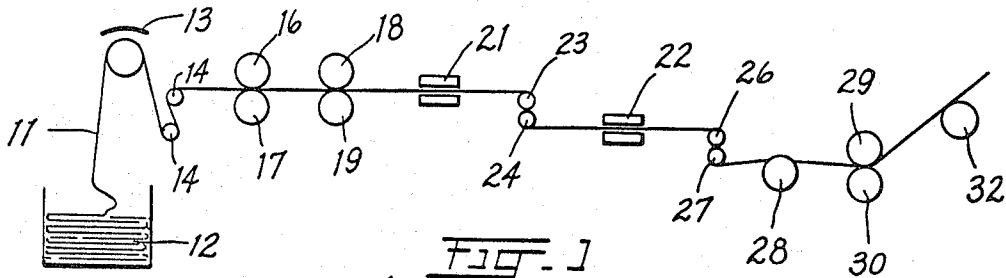


FIG. 1

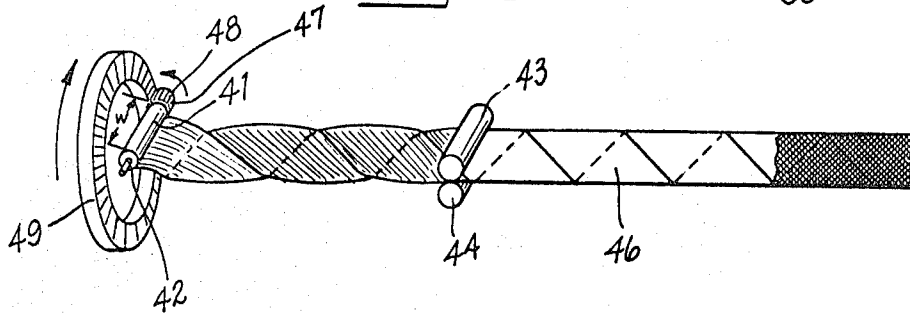


FIG. 2

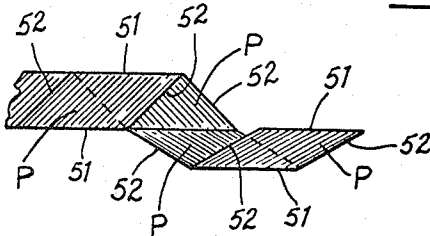


FIG. 3

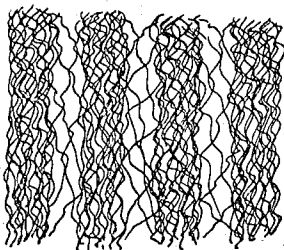


FIG. 5

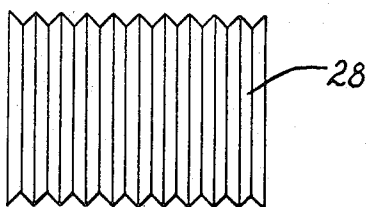


FIG. 6

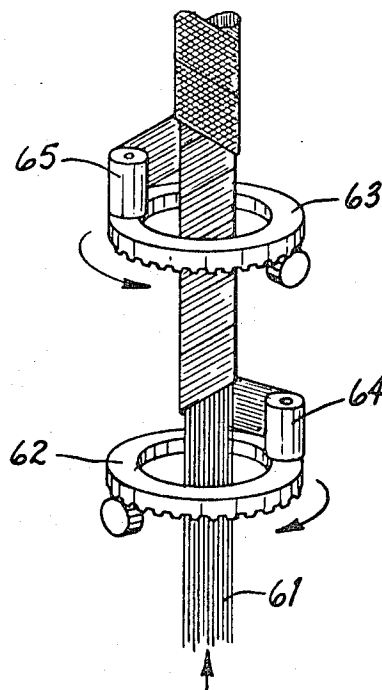


FIG. 4

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3,623,927

METHOD OF MAKING CROSS-LAPPED SPREAD WEBS

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Original application Jan. 3, 1967, Ser. No. 606,984, now
Patent No. 3,515,621, dated June 2, 1970. Divided
and this application July 25, 1969, Ser. No. 871,079
Int. Cl. B32b 5/02, 31/04

U.S. Cl. 156—161

5 Claims

ABSTRACT OF THE DISCLOSURE

Making non-woven fabrics which look like woven cloth
by striating a web of crimped parallel filaments, setting
the striated web, and cross-lapping the striated web.

This application is a divisional application of Ser. No.
606,984, filed Jan. 3, 1967, now Pat. No. 3,515,621.

This invention relates to novel non-woven products
made from spread webs of continuous filaments, and to
processes for the manufacture of such products.

In accordance with one aspect of this invention, I have
produced new and useful non-woven products, having
much of the appearance and strength of a woven fabric,
from tows of continuous filaments. This can be accom-
plished by spreading the tow to form a thin web having
spaced longitudinal striations, of alternating dense and
lean areas, across its width, setting said striations in said
web, cross-lapping the set striated web, and bonding ad-
jacent layers of the cross-lapped structure. The whole
structure can be produced in one continuous operation,
without the need of the discontinuous steps employed in
the manufacture of woven fabrics.

The production of a thin, diaphanous spread web may
be effected in the manner described in the U.S. Pat. No.
3,156,016, by subjecting a crimped tow band, having
crimps in widthwise registry, to a crimp-deregistering
operation followed by a spreading operation. The tow
band may contain, for example, about 5000 to 1,000,000
parallel continuous filaments, and the crimps may be pro-
duced by passing the tow through a stuffer-box crimper,
of conventional type, giving a tow band having ridges
and troughs, formed by aligned crimps in adjacent fila-
ments, extending transversely of the band. In a typical
deregistered, spread lightweight web, all the continuous
filaments run in the same general direction, lengthwise
of the web. However, when one does not look at the
whole of a long length of any particular filament, but
looks instead at the individual crimps thereof, it will be
seen that most portions of the filament do not run in
this general lengthwise direction but, instead, zigzag back
and forth across such general direction. The amplitude
of the crimps is such that, for any particular filament, the
portion of the crimp at one side (hereafter termed the
"crest" of the crimp) overlaps one or more neighboring
filaments while the portion of the crimp at the other side
(hereafter termed the "valley" of the crimp) overlaps
one or more of its neighboring filaments on said other
side. This overlap helps to give the webs their cohesive-
ness. For example, the filaments in the web may have a
crimp whose amplitude (from a median line running in
the same direction as the filament) is in the range of
about $\frac{1}{128}$ to $\frac{3}{16}$ inch, said amplitude being measured
from said median line to the top of a crest, or to the
bottom of a valley. Since there may, for example, be sev-
eral hundred filaments per inch of web width and since
the crimps are not in registry, there will be considerable
overlapping of filaments in the web.

When one turns from an examination of the crimps
and takes a somewhat larger, though still relatively short,

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view of the portion of any particular filament which con-
tains several crimps, and which may be, for example, $\frac{1}{2}$
inch to several inches long, it will be found that these
portions are not perfectly parallel to the longitudinal
direction of the web, but make small angles therewith,
which angles change in direction and magnitude along the
length of the filament; generally these angles are less than
 20° , although for very short portions (e.g. $\frac{1}{2}$ inch long)
the angle may be larger at times.

It is believed that the overlapping of the crimps and
the overlapping, due to the presence of the angularly
disposed short portions, just described, contribute to the
cohesiveness of the web so that, despite its fineness, it
can be readily handled as a unitary structure. The degree
to which the individual filaments meander by virtue of the
presence of said crimps and angularly disposed short por-
tions is not, however, very great; typically, the ratio of the
straightened lengths of the individual filaments to the
lengths of the same filaments in the web is less than about
11/2:1 and, preferably, greater than 1.1:1, e.g. about
1.2:1 to 1.4:1. This ratio may be measured by cutting a
predetermined length of the web, removing the individual
filaments of the cut portion and measuring their lengths
while under a tension just sufficient to remove the crimp;
the results are then expressed as the ratio between the
measured lengths of the individual filaments and said
predetermined cut length.

The striations in the web can be produced by passing
the spread web under tension past a plurality of fila-
ment deflecting elements spaced widthwise of the web,
e.g. by passing the spread web over a rotating roll hav-
ing a series of regularly spaced parallel circumferential
ridges which serve to deflect the longitudinal filaments
widthwise of the band and to thereby increase the con-
centration of the filaments between the ridges. There may
be, for example, about 50 to 500, preferably about 100 to
400, ridges per foot of width of the web, to produce to a
corresponding number of parallel striations in the web.

Striations may also be introduced prior to the spread-
ing operation. For example, in a preferred type of crimp-
deregistering operation, the tow band is subjected to a
differential gripping action during which it passes in con-
tact with a roll having circumferential grooves (e.g. hav-
ing a continuous helical groove or a series of independent
completely parallel grooves); the resulting deregistered
band often shows striations which are generally eliminated
or greatly reduced as the web is air-spread in a series of
stages, particularly when the filaments carry a finish which
permits the filaments to slide over each other easily.
When, however, a more sticky or scoopy finish (such as
certain mineral oil formulations) is employed which in-
hibits migration of filaments from the dense to the lean
bands of the striated material, the striations can persist
through the spreading operation. When the grooves and
ridges of the crimp-deregistering roll are helical, the re-
sulting striations run at a small angle (e.g. 2°) to the pre-
cise lengthwise direction of the web.

In the preferred forms of the invention, the parallel,
dense bands of the striated web are not independent of
each other, but are held together by individual filaments
part of whose length lies within these dense bands and
part of whose length lies in the adjacent lean bands. Some
of these "tying" filaments completely traverse an ad-
jacent lean band, usually at a small angle to the longi-
tudinal direction of the web, so that a single filament ap-
pears in two or more of these parallel dense bands, at
points separated along the length of the web. Others of
these tying filaments do not completely traverse an inter-
vening lean band but, instead, overlap other similar fila-
ments extending from a dense band on the other side of
that lean band; the frictional engagement of these over-

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lapping filaments helps to tie together the dense bands in their spacer relationship.

Typically, the filament density in the dense bands is about 1.5 to 10 times the filament density in the lean bands. There is usually a gradual variation in the filament density from the dense to the lean bands, e.g. a plot of filament densities across the width of the striated web is usually of sinusoidal, rather square-wave, form.

Setting of the striated web is preferably effected by passing the web between heated calender rolls while the filaments of the web are in a heat-plasticizable condition or carry a heat-softened material. For example, when the filaments are of the usual secondary cellulose acetate (containing, for example, about $2\frac{1}{2}$ acetate groups per anhydroglucose unit) the addition of some water to the filaments (as by spraying the web with water or by supplying a water-wet tow to the deregistering and spreading operation) so that the web carries, for example, enough surface water to feel at least damp to the touch, will cause the web to be temporarily plasticized when it is subjected to calender rolls having surface temperatures of, for example, about 250° F. to about the melting point of the fiber. The resulting calendered web is stiffened by this treatment; its filaments are bonded together at spaced contact points; preferably, however, it still retains a soft cloth-like limpness and foldability.

Other setting techniques involve dusting, the striated web with small amounts of a thermoplastic powder (e.g. polyvinyl chloride) or spraying the web with a dispersion (e.g. a latex or solution in volatile solvent) of a thermoplastic material (e.g. an acrylic resin, such as polyethyl acrylate or other vinyl resin such as polyvinyl acetate) or spraying it with a plasticizer (other than the water previously described) such as triacetin or an acetone-water mixture, followed by hot calendering or passage through a heated oven, to bond the fils at spaced contact points.

After the setting step, the striated web is cross-lapped. Various cross-lapping techniques, including those described below with reference to the drawings, may be used. The angle of cross-lapping is preferably about 90° in which case the final product has the appearance of a square-woven fabric. The cross-lapping may be effected so as to produce a structure whose thickness is made up of two or more (e.g. 2, 3, 4 or more) layers of the striated web.

The cross-lapped structure is treated to bond its layers together. This may be effected, for example, by typical saturation techniques (Rando Bonder), spray bonding, etc., commonly used for making non-woven fabrics, as disclosed for example in the *Man-Made Textile Encyclopedia*, edited by J. J. Press, published 1956 by Text Book Publishers, Inc., pp. 485 to 489. The thickness of the resulting bonded structure is typically in the range of about 2 to 10 mils.

Certain aspects of this invention are illustrated in the accompanying drawings in which:

FIG. 1 is a schematic view of the deregistering, spreading, striating and setting operations.

FIG. 2 is a schematic view of one type of cross-lapping operation, in which a wound roll of the spread web is used.

FIG. 3 is a view of the flat cross-lapped material produced in the operation of FIG. 2, partly unfolded to show its structure.

FIG. 4 is a schematic view of the wrapping of sanitary napkins by a cross-lapping operation, using two rolls of spread webs.

FIG. 5 is a plan view of a calendered striated web.

FIG. 6 is a view of a striating roll used in the process of FIG. 1.

In the process illustrated in FIG. 1, the crimped tow band 11 is drawn from a bale 12 through a banding jet 13 in which air is blown at the tow so that it emerges as a flattened band of a width of, for example, 8 inches. This band passes around adjustable stationary tensioning bars

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14 which help to smooth and uniformly pretension it, then into the nip between a pair of rubber-surfaced rolls 16, 17, driven at a constant speed, and horizontally to the nip between a rubber-surfaced roll 18 and a driven grooved steel roll 19, which has helical threads (e.g. 14 threads per inch, the crests of the threads being flat and about $\frac{1}{60}$ inch wide). The tow band, whose crimps have been thus deregistered, then passes through a pair of air spreaders 21 and 22 in each of which air is blown transversely at the tow band, so that it is spread in two stages to a width of say 50 inches. Before entering the second spreader 22, and after leaving that spreader, the tow makes S-wraps about a pair of rolls 23, 24 and a second pair of rolls 26, 27. The lower roll of each of the pairs of rolls herein described is positively driven at a constant speed while the corresponding upper roll is pressed downwardly, by any suitable loading device, so that each upper roll is driven by frictional contact with the tow or web on the lower roll of the pair. Rolls 17, 24 and 26 are driven at about the same linear surface speed while roll 19 is driven at a linear surface speed about $1\frac{1}{2}$ times that of these rolls. After leaving the rolls 26, 27 the web is passed over a grooved striating roll 28 having 10 to 100 grooves/in. then between a pair of driven heated calender rolls 29, 31 to take up roll 32. The roll of material is then cross-lapped by hand so that the striations of the topmost layer cross those of the lower layer at a 90° angle. This is then sprayed with acrylic bonding resins, dried in an oven, and subsequently calendered to achieve intimate bonding of the layers.

In the process illustrated in FIG. 2, one starts with a roll 41 of set striated web material, produced by rolling up the web directly after it has been calendered and cooled. The roll 41 is then mounted so as to unroll the web material in one direction while the axis 42 of the roll 41 is rotating in a plane generally perpendicular to the direction in which the web material is being taken off. After leaving the roll 41, the web material, which is in a generally helical configuration, passes between a pair of rolls 43, 44 which serve to flatten it, producing a flat cross-lapped structure 46 whose striations make angles of about 45° to its edges.

For effecting the simultaneous rotation of the roll 41 about its axis 42 while the axis is itself being rotated, the roll may be mounted on an axle which is journaled for free rotation in bearings 47 carried by gear-toothed pinions 48, the teeth of the pinions being meshed with the teeth of a ring gear 49 which is rotated, by a suitable drive mechanism, in the direction shown by the arrow in FIG. 2. The pull of the driven rolls 43, 44 causes the roll 41 to unwind during the rotation of its axis. When the relative speeds of the rolls 43, 44 and the ring 49 are such that the axis 42 rotates 360° while the surfaces of roll 43 or 44 move a distance equal to twice the width w of the rolled web, the fils of the flat cross-lapped structure 46 will be at an angle of 90° to each other and the structure will be made up of a single striated web folded in a series of overlapping parallelograms P (see FIG. 3), one pair of sides of each parallelogram being along the fold lines 51, which constitute the edges of the flattened structure, and the other pair of sides 52 of each parallelogram (which sides correspond to the edges of the original web) being at 45° to said fold lines. The flattened cross-lapped structure is then bonded and taken up on a roll continuously.

In the process illustrated in FIG. 4, a preformed heavy card silver 61 of parallel staple fibers (which silver is of a weight and absorptive character suitable for a sanitary napkin core) is passed successively through two driven rotatable parallel rings 62 and 63 on each of which a roll 64, 65 of set striated web material is rotatably supported. The rings 62, 63 are rotated in opposite directions at equal angular speeds, their rates of rotation being such, in relation to the speed at which the rope 61 is pulled through said rings, that each layer of web material is

wound at a 45° angle to the axis of the silver. The surface of the resulting structure is then sprayed lightly with a dispersion of an acrylic resin and then flattened by passage through hot calender rolls.

In other aspects of this invention, the cross-lapping techniques illustrated in FIGS. 2 to 4 may be also employed with spread web materials which are not striated but which are of more or less uniform density across their widths.

The filaments used in this invention may be, as previously mentioned, of polyethylene terephthalate or secondary cellulose acetate (of the usual acetyl content, e.g. about 54-55% calculated as acetic acid). It is within the broad scope of this invention to use other filamentary materials such as other polyesters (e.g. the terephthalate esters of other glycols, such as 1,4-dimethylol cyclohexane), linear superpolyamides (such as nylon-6, nylon-6,6, nylon-4, nylon-11, or hexamethylene terephthalamide), melt-blended polyamide-polyester combinations, acrylics such as polyacrylonitrile and acrylonitrile copolymers, modacrylics, olefin polymers and copolymers, e.g. isotactic polypropylene, other organic derivatives of cellulose, such as esters or ethers, such as cellulose triacetate, cellulose propionate cellulose acetate propionate, or the like, rayon (regenerated cellulose), etc. The number of filaments in the starting tow can vary within wide limits, e.g. about 1000 to 1,000,000 preferably about 4000 to 20,000, with a denier per filament of about 1 to 20. The number of crimps per inch in the filaments may be, for example, as high as about 80, but for most products described herein it will be in the range of about 5 to 20, preferably about 8 to 12, crimps per inch. The linear densities of the spread webs may be, for example, within the range of about 1/8 to 1 ounce per square yard, preferably within the range of about 1/4 to 1/2 ounces per square yard. The striation frequency, i.e. the number of lean bands per foot of web width, may be, for example, in the range of about 50 to 500, preferably about 100 to 400.

The foregoing detailed description has been given for clearness of understanding only and no unnecessary limitations are to be understood therefrom. The invention is not limited to the exact details shown and described, for obvious modifications will occur to those skilled in the art. The "Abstract" given above is for the convenience of technical searchers and is not to be used for interpreting the scope of the invention or claims.

What is claimed is:

1. Process for the production of non-woven fabrics which comprises tensioning a band of crimped, substantially parallel continuous filaments to smooth and uniformly pretension the band,

deregistering the crimps of the filaments of the band to form a web,

spreading the web of filaments,

striating the web of crimped parallel filaments to produce alternating dense and lean lengthwise bands therein,

setting the striations in the web,

cross-lapping said web to produce a layered structure, bonding adjacent layers of the cross-lapped striated web to produce a non-woven fabric having the appearance of a woven fabric.

2. Process as in claim 1 in which the striation frequency in said web is about 50 to 500 striations per foot and the density of said web is about 1/8 to 1 ounce per square yard.

3. Process as in claim 1 in which the web has regularly alternating parallel dense and lean bands held together by tying filaments part of whose length lies within these dense bands and part of whose length lies in the adjacent lean bands, some of said tying filaments completely traversing a lean band at a small angle to the longitudinal direction of the web so that such filament appears in a plurality of said dense bands at points separated along the length of the web, and others of said tying filaments incompletely traversing a lean band and overlapping, and in frictional engagement with other similar tying filaments extending from the opposite side of said lean band.

4. Process as in claim 3 wherein the step of spreading comprises air-spreading the deregistered band of said crimped parallel filaments and the step of tensioning comprises passing the spread web under tension past a plurality of filament deflecting elements spaced widthwise of the web.

5. Process as in claim 4 in which said deflecting elements are spaced ridges on a rotating roll having its axis transverse to said web.

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U.S. Cl. X.R.

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