PROCESS FOR MAKING ARTIFICIAL LEATHER FROM LAPPED FIBROUS STRUCTURES

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1 Claim

ABSTRACT OF THE DISCLOSURE

Making stratified lapped fibrous structures such as crossed-lapped webs, or yarns, which have layers of different fibers by, for example, feeding a web having side-by-side bands of different fibers to a cross-lapping device.

This application is a divisional of United States application Ser. No. 606,982 filed Jan. 3, 1967, now abandoned.

This invention relates to the production of lapped fibrous structures.

In accordance with one aspect of this invention, I produce lapped structures which, in cross-section, have a predetermined non-uniform distribution of fibers by providing a fibrous web having a predetermined non-uniform distribution of the fibers across the width of the web, andlapping the web. Surprisingly, I have found, for example, that by otherwise ordinary cross-lapping techniques I can produce a lapped batting, relatively thin in relation to its surface area, having one surface of one fiber and its other surface of a different fiber, by feeding a thin web made of side-by-side relatively flat zones of the two fibers.

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

FIG. 1 is a top view of a cross-laying operation;

FIG. 2 is a side view of the operation shown in FIG. 1;

FIG. 3 is a schematic perspective view of a device for making a cross-lapped structure from staple fibers;

FIG. 4 is a schematic perspective view of the spreading and cross-lapping of a tow band;

FIG. 5 is a schematic perspective view of the formation of a yarn of predetermined fiber distribution; and

FIG. 6 is a schematic perspective view of a device for making a crimped tow band having a predetermined non-uniform distribution of fibers.

The effect may be understood by a consideration of FIGS. 1 and 2 showing a web 11 of three side-by-side layers of different fibers (labelled A, B, and C) being fed to a cross-lapping zone 12 where they are traversed back and forth by a head 13 over an apron 14 while the resulting cross-lapped batting 16 is taken off continuously in a direction (indicated by the arrow) transverse to the traversing direction. In the usual cross-lapping process, producing a batting whose thickness is made up of several layers (e.g. 6 to 12 or more layers) of the fibrous web, I have observed that while the initially formed layer lies relatively flat on the apron, after the process has been running for a short time, each new layer is laid down at what is, in effect, a slant angle (greatly exaggerated in FIG. 2) to the upper and lower faces of the batting with one edge 18 of the web appearing at the bottom face of the batting and the opposite edge 19 of the web appearing at the top face of the same batting, as shown in simplified form in FIG. 2. By using a plurality of parallel wide bands side-by-side in the web, I thus form a corresponding series of thin parallel strata in the batting.

In another aspect, helical lapping is used, with one edge of the banded web forming the outside surface of the lapped structure and the opposite edge being buried in the interior of the structure. In a preferred form of this aspect of the invention, the helical lapping is employed for the production of yarns or other funicular structures (such as slivers), which, in transverse cross-section, have a predetermined radially non-uniform distribution of the different fibers. In this way, yarns having a core which is predominantly of one fiber and a covering which is predominantly of a different fiber may be obtained. The relative proportions of the two fibers may be varied widely so as to vary the characteristics of the final sliver or yarn product; thus, the ratio of the proportion of that fiber which predominates in the surface to the proportion of the fiber which predominates in the core may be in the range of 99:1 to 1:99, e.g. 5:95, 10:90, 50:50, 70:30, 90:10 or 95:5.

The reference herein to "different" fibers is intended to include fibers differing in any attribute. Thus, the fibers may differ only in denier, or in cross-section, or in degree of crimp, or in staple length, or in color, or in the material of which they are made. For a certain purpose, for example, for the preparation of battings having different resistances to bending in opposite directions, the fibers should differ in stiffness; for example, one face of the batting may be composed predominantly of fibers of greater stiffness than those of the other face. Such increased stiffness may be attained, for example, by using fibers of heavier denier or fibers of non-circular cross-section (e.g. of cruciform, triangular, trilobal, "H" or other cross-section while fibers of circular cross-section may predominate at the other face), or fibers of inherently stiffer material (e.g. of polyethylene terphthalate which is stiffer than nylon-6 or nylon-66). The "different" fibers may be blends of fibers; for example, one fiber blend may differ from the other only in the proportions of its components; thus, one band of the web may contain an 80:20 blend of two fibers and the adjacent band of different fibers may be composed of a 50:50 blend of the same two fibers.

Typical staple webs may be produced on conventional web-forming devices as, for example, Garroon or air lay machines such as Rando Webber (see Man-Made Textile Encyclopedia, edited by J. J. Press, pub. 1956 by Text Book Publishers, Inc., pp. 484-5). The fibers may be crimped or uncrimped and may, for example, have the length of conventional staple fibers, e.g. about 3/2 to 6 inches. The different types of staple fibers may be fed in side-by-side bands of loose fibers to the carding device, thrown loosely into segmented feed hoppers. Two laps of different staple fibers may be formed on a picker and these laps fed side-by-side to the web-forming device. A wide picker lap of one fiber may be split lengthwise to form a number of narrower laps, each of which can be fed to the web-forming device side-by-side with one or more similarly produced narrow laps of different fibers. When an air laying machine is employed, it may be divided lengthwise by thin baffles which will serve to substantially separate the different fibers during their simultaneous passage through the machine.

Webs of continuous filaments having bands of different fibers may be produced by laying a plurality of multi-filament tow of the different fibers side-by-side in contact with each other and, preferably, treating the assem-
3 bly to cause the edges of each of these tows to adhere to the adjacent tow so that the assembly can be handled as a single large tow (containing, for example, about 5000 to 1,000,000 continuous filaments). One technique for effecting such adheses is to feed the smaller tow bands together to a crimping device such as a stuffing box crimper of conventional type where not only are the tow bands crimped per inch, but the fibers at the edges overlapped and intermingled sufficiently to cause the bands to adhere together. In the manufacture of a particularly suitable type of cross-lapped structure, the resulting cramped tow band, having crimps in wide-side registry (i.e. in which the cramped fibers, which run lengthwise of the band, have their aligned peaks and valleys extending as ridges and troughs transversely of the band) is subjected to a crimp-deregressing operation followed by a spreading operation, as described, for example, in the French Pat. No. 1,418,403 (South African 64/5472) to produce a lightweight web which is then cross-lapped to form the batting. In a typical light-weight web produced in this manner, 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 portions of the filament, in particular the 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 coherent character. In the particular embodiment hereinafter described, 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 15/32 to 9/16 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 several 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, view of the portion of any particular filament which contains such a trough, it will be seen that the filaments, which are inclined to twist, 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 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 portions is not, however, very great; typically, the ratio of the straightened lengths of the individual filaments to the portions of the filament which contains such a trough is less than about 1½:1 and, preferably, greater than 1.1:1, e.g. about 1.2:1 to 1.4:1. The ratio may be measured by cutting a predetermined length of the web, removing the individual filaments of the cut portion and measuring the results. The results are then expressed as the ratio between the measured lengths of the individual filaments and said predetermined cut length.

It is also within the scope of the invention to use a combination of continuous and staple fibers. For example, to a single cross-lapping device there may be fed a coherent web of continuous filaments, as described above, alongside of (or partially or completely overlapped by) a web of staple fibers.

Typically, the fibers will have a denier within the range of about 1 to 25. When crimped they may have, for example, about 5 to 50 or more (e.g. about 8 to 16) crimps per inch, the crimp material being a proteinaceous edge or any elongation such substances as polymers (e.g. the terephthalate esters of ethylene glycol or other glycols such as dimethyl cyclohexane), linear superpolyamides (such as nylon-6, nylon 6.6, nylon-4, nylon-11, or hexamethylene terephthalamide), melt-blended polyamide-polyester combina-

nions, acrylics such as polyacrylonitrile and acrylonitril copolymers, modacrylics, olefinic polymers and copolymers, e.g. isotactic polypropylene, rubber spandex, rub-

ber, organic derivatives of cellulose, such as esters or others, for example secondary cellulose acetate, cellulose tricarbonate, cellulose propionate, cellulose acetate propionate, or the like, rayon (regenerated cellulose), con-

jugate-spun (e.g. bi-component) fibers such as fibers contain-
ing parallel adherent components of nylon and poly-
ester or of cellulose tricarbonate and saponified or unsaponi-
fied cellulose acetate, glass, metal, metal foil laminated to plastic such as cellulose acetate or polylethylene ter-

epthalate. Carded from inextricable natural fibers such as cotton, wool, silk, linen, or ramie or other fibers or filamentary material capable of forming a cohesive web may also be used.

As indicated previously, for some purposes each band of fibers may be composed of a blend of fibers. Thus, in the manufacture of a dense batting such as is used as a base in artificial leather, it is desirable to blend a shrinkable fiber with a fiber stable under the conditions of treatment. For example, fibers which shrink when heat is subsequently applied to the web, whether from a source of polypropylene or polystyrene (or cold drawn polyester fibers) may be intimately blended with fibers (such as heat-set polyester fibers which are stable) under the same heat-treatment.

The batting or the individual webs may be given other treatments to improve the cohesiveness of the batting or change its characteristics. The batting, or the individual webs, may be sprayed with adhesive, the batting may be quilted by stitching, treated to adhere its fibers (as by heat-sealing or solvent-sealing) along a predetermined pattern, needled, calendared or otherwise bonded. For the manufacture of artificial leather, needling (preferably followed by a heat-shrinking treatment, par-
ticularly when using a fiber blend as described above) is a desirable treatment. In the needling operation, the bat-
ing is generally passed through a needle loom equipped with the usual barbed needles which reciprocate perpen-
dicularly to the face of the batting and serve to move portions of the filaments from each web layer upward or downward so that these portions intermingle with fila-
ments of neighboring webs. The batting is advantageously given several passes through the needle loom and is turned over after each pass. Because of the crimp in the continuous filaments, the filaments can often undergo considerable extension into adjacent layers without ex-

eriting a substantial contracting effect on the whole bat-

ting. The needle looms used may be those commercially employed in the needle punching of staple fiber battings.

The batting may be given one or more coatings. Thus, for the manufacture of artificial leather, the needlel bat-

ting, which may for example be .025" to .060" thick, may be impregnated with a rubbery material, preferably a synthetic rubber such as a rubbery polyurethane, which may be made from a polyisocyanate and a polyester or polyl-

ymer; a polymer of a butadiene and another mono-

mer, e.g. acrylonitrile, styrene, vinyl pyridine, methyl methacrylate, or a homopolymer of butadiene or isoprene or chloroprene; or a rubbery ethylene-propylene copoly-

mer, etc. Preferably, the rubbery polymer is deposited in
the needled structure in such a fashion that the resulting material remains porous, preferably microporous. This may be done in any known manner, as by the use of blowing or foam-forming agents or by the use of rubber lattices followed by coagulation, e.g. with an aqueous solution of an acid such as acetic acid or of a salt as calcium chloride, or by inclusion of a teachable material such as finely divided sodium chloride which is later extracted from the deposited polymer with water. Advantageously, the rubber is vulcanized as by the inclusion of suitable known cross-linking agents therein, followed by curing. Thereafter, a thin coating 2–40 mils, e.g. 8 mils, thick, of a tough polymer such as polyethylene acrylate, polyvinyl chloride, or a polyurethane like the like, is applied.

The invention finds its greatest utility in the production of battings or other cross-lapped structures made up of 5 or more cross-lapped layers (e.g. 3 to 40 layers). Such multilayered structures can be produced, as is well known, by controlling the speed of lateral movement of the cross-lapped structure in relation to the frequency of traverse and the width of the web fed to the cross-lapping zone. Thus, to produce a structure made up of n layers, the cross-lapped structure will be moved laterally and continuously, during each back and forth traverse cycle, a distance equal to \( W/n \) where \( W \) is equal to the width of the web fed to the cross-lapping zone. Generally, the webs will have widths of the order of about 24 to 180 inches.

The following examples are given to illustrate this invention further:

**EXAMPLE 1**

In this example, there is employed a Saco-Lowell card 26 (FIG. 3) fitted with garnett clothing and comprising a driven endless feed belt 27 to which staple fibers are continuously supplied (e.g. as a uniform sheet such as a "lap") produced by a picker device), a driven rotating cylinder 28 carrying toodshed garnett cloth, and a device 29 for removing a web 31 (shown in broken lines) of aligned staple fibers from the cylinder 28 and for feeding this web to a cross-lapping device of conventional construction (e.g. a cross-laying machine) of the "canvass back" type having an upwardly inclined driven belt 32 for transporting the web to another driven belt 33 from which the web passes to an oscillating structure 34 pivoted at the top and having a pair of driven belts 36, 37 engaging opposite faces of the web and serving to transport the web to a longitudinally moving apron 38 (a driven endless belt) on which the web is traversed back and forth by the movement of the oscillating structure.

Over \( 5/6 \) of the width of the feed belt 27 there are fed white staple fibers, while over the remaining \( 1/6 \) there are fed blue staple fibers, so that there are two distinct bands of fibers side-by-side on that belt. Both the white and the colored fibers may be, for example, cellulose acetate staple fibers of 3 d.p.f. and 11/2 inch fiber length. The resulting web taken off the cylinder has substantially the same two bands as the material supplied to the cylinder, while the final cross-lapped bathing is blue on one side and white on the other with a distinct interface between the blue layer and the white layer. In one embodiment, the web 31 may have a weight of about 1/2 ounce per square yard, while the cross-lapped bathing 39 may have a weight of about six ounces per square yard (thus, the bathing cross-section is made up of about 12 thicknesses of the web); such a web may be made by adjusting the rate of movement of the apron in relation to the frequency of traverse so that the apron is driven over the width of the web for each back and forth traverse cycle.

**EXAMPLE 2**

A crimped draw tow band varying in denier per filament (d.p.f.) across its width is produced by feeding five different sub-tows, here designated, from left to right, as V, W, X, Y, and Z (of uncrimped continuous filaments of undrawn polyethylene terephthalate of circular filament cross-section) side-by-side through guides 40 and around the concave side of a curved bar 41 (of circular cross-section) which serves to converge the sub-tows, then through a conventional finish, in tank 42, over another bar 43, to a drawing section 44 having two pairs of positively driven rolls (pair 46 and pair 47) the second pair (47) being driven at a multilateral of the sides 46 of the first pair (46) (e.g. about 4 times the surface speed of the first pair). The reach of tow between the pairs of rolls passes over a convergence guide 48 whose tow-engageing surface is displaced above or below the plane line joining the nips of the pairs of rolls 46, 47; the yarn-engaging surface of this guide 48 is concave (when viewed in a cross-section taken in a vertical plane transverse to the general path of the tow) so that the drawing tension exerted by the roll pair 47 forces the sub-tows together in controlled manner, giving a controlled intertwining of filaments at the edges of adjacent sub-tows. The drawn tow band is then fed into a conventional stuffer box crimper, whose exit and entrance are each \( 1\frac{1}{4} \) inches wide, where it is mechanically crimped, and it is then baled.

In one specific example nine undrawn sub-tows are used, all of the same total denier, having the following undrawn deniers per filament: for the three sub-tows closest to one edge of the two band, 6 d.p.f.; for the three sub-tows making up the center portion of the tow band, 12 d.p.f.; and for the three sub-tows closest to the other edge of the tow band, 20 d.p.f.; so that in the drawn tow band having a total denier of, for example, 128,000, there are side-by-side bands (somewhat intermingled at the edges of said bands) of about \( 1\frac{1}{4}, 3 \) and 5 d.p.f. filament.

The resulting crimped tow band, in which the crimps are in registry, extending across the width of the tow band, (and having, for example, 10 crimps per inch and 35% crimp), is passed through a tow opening and air-spreading system as illustrated in FIG. 4 of the drawing (and of the type disclosed in French Patent 1,418,403) to form a diaphanous spread web 49 which is continuously delivered to a cross-lapping apparatus comprising a reciprocating cross-laying chute 50 (provided at the top) and an apron on which is preferably a continuously endless belt 50a on which the cross-lapped batting forms at the rate of feed of the web, the frequency of reciprocation of the chute and the speed of the belt are correlated so that there is produced a batting weighing about 12 ounces per square yard. This batting is then passed through a needle- punching machine of conventional design in which it is subjected to a series of needles rapidly reciprocated perpendicularly to the face of the batting so as to bring fibers from one layer of the web into adjacent layers in a direction perpendicular to said face. The batting is passed through the needlezone a number of times, and is turned over at each pass, until a total of 800 punches per square inch has been made from each side of the batting. The resulting needleweb has substantially greater resistance to bending in one direction than in the opposite direction.

The needlebed is immersed in a tank containing butyl rubber latex plus curing agents. The bath is removed from the tank by squeegee, the pressure of whose pressure is adjusted to allow the bath to pick up 80% of the rubber. The impregnated batt is treated to coagulate the latex and is then passed through a curing oven. The firmly bound micro-porous batt is then sueded by a wide endless belt made of 100 grit sandpaper. The sueding of both sides of the batt results in an even thickness. That face of the batt where the convex bending resistance is highest is then coated with a solution of polyurethane, of known type, to deposit a microporous abrasion-resistant coating thereon.

In a typical tow opening and spreading system shown in FIG. 4, the tow band 51 is drawn from the bale 52 through a banding jet 53 in which air is blown at the tow so that it emerges as a flattened band of a width of, for
The face of the batt where the convex bending resistance is higher can be determined by comparing the resistance of the batt to bending first in a direction to make one face convex (and the other face correspondingly concave) and then in the direction to make the other face convex.

The preferred polyhydroxy compound to be used in the formation of the polyurethane is a low molecular weight polymer having hydroxyl end groups and containing three poly(tetramethylene ether) blocks per molecule; this low molecular weight polymer may be made by reacting 3 moles of dry poly(tetramethylene ether) glycol having an average molecular weight of about 1000 with two moles of 2,4-tolylenediisocyanate in a manner well known to the art.

**EXAMPLE 4**

This example illustrates the production of covered or core yarns. In the manner described in Example 1, there is produced a web 71 comprising a narrow longitudinal band 72 of one fiber and a much wider portion of another fiber on a driven endless belt 74 tilted upward at a small angle. Resting on the belt 74 is a driven roll-up roll 76 rotating in the direction shown by the arrow around its axis 77 and driven (as through a belt and pulley arrangement 78) by a motor 79. The axis of the roll 76 is oblique (i.e. neither transverse nor parallel) to the direction of movement of the web 71, making an angle α, preferably an angle of ±45° or less, to the direction of movement of the web. The rolled-up fibers are continuously drawn off in the general direction of the axis of the roll-up roll 76 by the action of a driven rotating silver drum 81 of the conventional type. In the embodiment shown in FIG. 5, substantially all the fibers marked B (of band 72) will be on the outside of the resulting sliver. If the sliver is taken off the opposite side of the belt 71 (with the angle of roll 76 changed appropriately) the fibers marked B will be on the inside of the resulting sliver.

In one construction, the fibers marked B are cotton staple fibers, while the fibers marked A are 11/4 d.p.f. drawn polyethylene terephthalate fibers of 1/8 inch length to form a non-pilling high strength yarn having a strong polyester core and a non-pilling cotton face which can accept the usual cotton dyes. The bands 72, 73 here may also be of such width as to supply equal weights of the two staple fibers.

It is to be understood that the foregoing detailed description by way of example is given without limitation and that variations may be made therein without departing from the spirit of our invention. 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. In the process for making a drawn tow band by drawing sub-tows of continuous filaments in side-by-side contact in a drawing zone to produce a tow band having its subtows cohered together by filament intermingling at their edges, the improvement which comprises supplying to said drawing zone sub-tows of different filaments in a predetermined arrangement of said sub-tows whereby to produce a drawn tow band having a predetermined non-uniform distribution of different filaments across its width, mechanically crimping the drawn tow band, de-registering the crimps in adjacent filaments, spreading the crimped de-registered tow band to produce a cohesive web having a predetermined non-uniform distribution of said different filaments across its width, said distribution being substantially uniform longitudinally of said web, cross-lapping said web to produce a batt whose cross-section has a predetermined non-uniform distribution of said filaments, needling said batt and impregnating said batt to deposit a microporous rubbery material therein.
and coating the impregnated batting with an abrasion-resistant surface layer to form an artificial leather.

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