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2,991,537

METHOD OF MAKING FELT-LIKE FABRIC

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Fig. 1

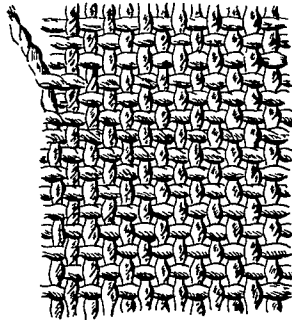


Fig. 3

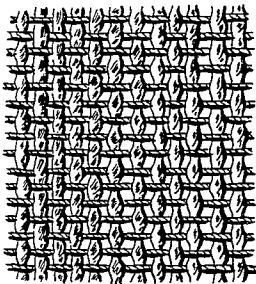


Fig. 4

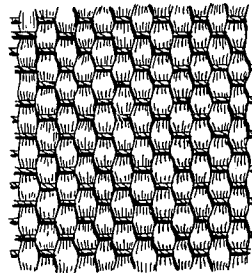


Fig. 2

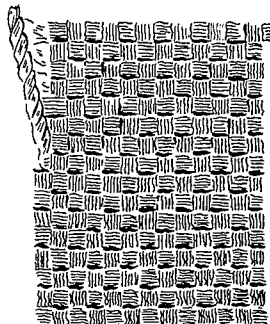
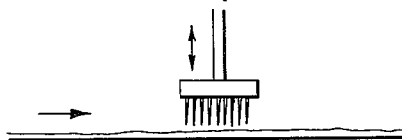


Fig. 5



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1

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METHOD OF MAKING FELT-LIKE FABRIC

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1 Claim. (Cl. 28—72.2)

This invention relates to a process of finishing fabrics and products produced thereby. More particularly it is concerned with a process for fulling fabrics and with a novel fabric made from a yarn spun from epithelialless fiber.

By the term "epithelialless fiber" as used herein is meant a staple or general fiber of natural or synthetic origin which lacks the epithelial scales of wool. Thus a "yarn spun from epithelialless fiber" is a yarn containing non-wool components.

The fulling phenomenon, i.e., the displacement and intermingling of the fibers in a woven or knitted fabric, has been known to be possible only with fabric containing epithelial fibers such as wool. The fulling procedure has involved intermittent mechanical compression as by beating or twisting and shrinking under the influence of heat and moisture. At least partly due to the epithelial nature of the individual fiber the intermittent stimuli cause the fiber in the yarn to creep toward its root end. This creeping results in a random fiber arrangement within the fabric which may hide the weave pattern.

It is an object of the present invention to provide a novel fulling process.

Another object is to provide a process for the fulling of a fabric produced from a yarn spun from epithelialless fiber.

Another object is to provide a process for the fulling of a fabric produced from a yarn spun from a man-made fiber.

A further object is to provide a novel fulled fabric produced from a yarn spun from epithelialless fiber.

These and other objects will become apparent in the course of the following specification and claims.

In accordance with the present invention woven and knitted fabric spun from staple yarn is fullled by a multiple needling. By "multiple needling" is meant subjecting the fabric to recurrent piercing and withdrawing of a needle to be described hereinafter until migration of fibers into adjacent or crossing yarns within the weave is attained.

The invention will be more readily understood by reference to the drawing.

FIGURE 1 is an illustration of an open plain weave of a low twist, high denier yarn.

FIGURE 2 illustrates the fabric of FIGURE 1 after fulling in accordance with the present invention.

FIGURE 3 illustrates a relatively tight weave as compared with that of FIGURE 1 wherein uneven spacing of the warp yarn has occurred.

FIGURE 4 illustrates the effect obtained upon subjecting the fabric of FIGURE 3 to the process of the present invention.

FIGURE 5 is a side view of a fabric passing under a needle bank.

The following examples are cited to illustrate the invention. They are not intended to limit it in any manner.

Example I

A yarn is spun in the woolen system from polyethylene terephthalate staple, an epithelialless fiber. The fiber is 7 denier per filament and 2½ inches long. A 3-ply cord Z twisted 3 times per inch of approximately 12,000 total

2

denier is formed from the yarn. A plain weave fabric having 7 ends per inch and 7 picks per inch is woven from this cord. It is shown in FIGURE 1. A sample 20 inches wide is fed into a standard needle loom, such as that made by the James Hunter Machine Company of North Adams, Massachusetts. This loom is 36" wide and has a bank of 1440 equidistantly spaced steel needles. These needles, a preferred type, are prepared by etching standard size No. 25 needles (purchased from The Torrington Company of Torrington, Connecticut, and commonly designated as 15x18x25x3½, regular barb) for two 3½ hour periods by immersion in concentrated hydrochloric acid (38% in water). Before use they are washed and dried. The etching removes the sharp protrusions of the barbs and leaves notches. The needle board is adjusted above the fabric so that the notches penetrate through the fabric in each stroke of the needle-bank reciprocation. The bank is raised and lowered 250 times per minute. The fabric is moved past the needles 0.285 inch at each cycle (a complete lowering and subsequent raising). The needled fabric is refeed to the loom 49 times. It is turned over (i.e., reversed by a 180° rotation on its long axis) on each feeding. The needles penetrate the fabric approximately 7,000 times per square inch in the 50 passes through the loom. The needled fabric as shown in FIGURE 2 has the appearance of being tightly woven. It has a smoother, nappier surface, and exhibits increased body over the original sample. The fabric shrinks about 10% in each direction while the yarn diameter is increased sufficiently to close the openings which result from weaving. When a single yarn is pulled from an edge of the fabric, it tends to be constrained due to its fibrous interconnection with neighboring and crossing yarns as illustrated in FIGURE 2. This fibrous interconnection is the result of fiber migration which has occurred to fibers in adjacent yarn as a result of the fulling phenomenon. The needled fabric is especially useful as a filter medium for dilute alkaline solutions because of its high resistance to abrasion and chemical attack.

Example II

A Shetland tweed type of fabric with a 2 x 2 twill construction and having a weave count of 32 x 30 is woven from a yarn containing a stock blend of 20% wool and 80% 3 denier, 2½ inch length polyacrylonitrile staple. The fiber is spun into an 18/2 cotton count yarn. The singles have a Z twist of 11 turns per inch and are plied with an S twist of 10 turns per inch. A portion of the yarn is dyed brown before weaving, so that the woven fabric consists of a pattern of brown and white. A sample of this fabric 20 inches wide is fed through a standard needle loom equipped and operated as described in Example I except that the fabric is fed through the loom only 25 times. This produces a total needling of about 3,500 times per square inch of fabric surface. The needled fabric possesses more covering power, is softer and has more nap than the original sample. It is also bulkier, its thickness having increased from 0.026 inch to 0.032 inch. The intermigration of colored and white fibers produces a pleasant blending which tones down the sharp pattern contrasts.

Example III

The Shetland tweed of Example II is subjected to 40 passes in the loom of Example I, the needles being round in cross section and having a maximum diameter of 0.035 inch on their working section. The vertical oscillation of the needle board is so adjusted that the needle passes through the fabric. This is a penetration of 5600 times per square inch. The needled fabric is similar in appearance to that produced in Example II.

3

Example IV

A woman's sweater is knitted on a 12-cut circular knitting machine from a yarn of polyacrylonitrile staple. The fiber is spun into a 2/24 worsted count yarn from 3 denier staple, 2½" long. The singles are twisted 10 turns Z to the inch. The ply contains 6½ turns S to the inch. The sweater is dyed yellow. It is then fed to the needle loom as equipped and operated in Example I for a total of 28 passes. The sweater is turned inside out after each pass. This is a total needling of about 3800 times per square inch. The covering power of the needled sweater is increased so that whereas when ultra violet light is directed at the samples the original sweater transmits 6.3% of the light while the needled sweater transmits only 0.4% as recorded on a photoelectric cell. The needled sweater is fulled despite the fact that the yarn from which it is knitted is spun from epithelialless staple. It has a softer hand, greater bulk and is less sleazy as compared with its condition before needling.

Example V

A plain woven fabric is made with a filling of a 5000 total denier 2 ply nylon yarn (spun from 6 denier staple 2½ inches long, the plies containing 7 turns per inch) and a warp of an 8000 total denier 2 ply polyethylene terephthalate yarn (spun from 6 denier staple 2½ inches long, the plies containing 5 turns per inch). The ends of the fabric are joined by interweaving to form an endless belt. The fabric is teaseled on one side. Because of the nature of the weave, irregularity in the spacing of the polyethylene terephthalate warp occurs. The effect is illustrated in FIGURE 3. The fabric is fed into the needle loom of Example I. It is passed through the loom 25 times with the needles always entering the teaseled side. A total needling of about 3500 times per square inch is obtained. The needled fabric as shown in FIGURE 4 exhibits equal spacing of yarns in both the warp and the filling. Irregularity of weave as existed in the original sample is often encountered in preparing leno and similar open-weave fabrics as well as open-knit fabrics. As a result of the needle-punching operation, the irregularly spaced warp yarns migrate, i.e., the fabric is pulled, to produce a regular weave pattern without disturbing the regular pattern of the filling yarns. It is also observed that the needling improves the surface smoothness on the unteased side by making the fabric more nappy and by increasing the diameter of both warp and filling yarns. The surface uniformity and body of such a fabric render it particularly useful as a paper-maker's felt since it contains insufficient pattern to mark the paper. The example illustrates a fulled fabric wherein different yarns, both spun from epithelialless staple, are employed as warp and filling.

Example VI

A typical woven woolen suiting fabric of 100% wool is fed to the needle loom equipped as described in Example I. It is subjected to about 4,000 needlings per square inch. Instead of passing the fabric repeatedly through, it is held in the loom for about 5 minutes. The needled fabric shows improved covering power over the unneedled sample by virtue of the fulling. In addition the thickness of the fabric increases from 0.091 inch to 0.127 inch thereby increasing the bulk.

Example VII

The loom of Example I is equipped with unetched standard size No. 25 needles. The process of Example VI is repeated, the barbs passing through the fabric on each penetration cycle. A multiple rending of the fabric occurs without fulling.

Example VIII

The needling technique of Example VI is applied to a 2 x 2 twill. The yarn which has an 8 turn per inch Z

4

twist is 100% polyester (polyethylene glycol terephthalate) spun from a 2 inch, 2.4 denier staple to an 8/1 cotton count. The equipment of Example I is employed. However the needle board is so adjusted that the needle notches do not enter the fabric surface. Thus the needling is performed with the smooth surface of an etched needle of small diameter. About 1700 needlings per square inch are made. Observations as to count, bulk and thickness follow:

	Weave Count	Bulk		Thickness (cm.)	
		A.S.T.M. ¹	B.S.I. ²	A.S.T.M.	B.S.I.
Control.....	58 x 40	2.41	3.72	0.094	0.145
Needled.....	58 x 42	2.60	3.88	0.104	0.155

¹ 3.4 pounds/in.².² 5 grams/cm.².

A fiber migration due to fulling resulting in increased covering power is noted.

Example IX

A yarn of polyacrylonitrile fiber having a cotton count of 42/2 is spun from staple of which half is 1.5 denier, 1.5 inch length and half is 4.5 denier, 2.5 inch length. The yarn is given a Z twist of 7 turns per inch. It is woven into a 2 x 2 twill. The fabric is subjected to the equipment and technique of Example VIII. Observations are as follows:

	Weave Count	Bulk		Thickness (cm.)	
		A.S.T.M. ¹	B.S.I. ¹	A.S.T.M.	B.S.I.
Control.....	53 x 53	2.71	2.93	0.098	0.041
Needled.....	54 x 55	2.93	3.64	0.041	0.045

¹ As in Example VIII.

Improved covering power is observed due to fiber migration.

The fabric may be needled in accordance with the present invention on one or both sides, singly or in multilayers. In multilayer treatment it is desirable to separate the layers at intervals to prevent vertical interlocking and achieve optimum results. It is not necessary that the entire fabric be subjected to the needling technique. Thus a narrow edging can be applied to a weave in accordance with the present invention to prevent unravelling. Furthermore the needling technique can be employed to create novel and artistic fabric designs and effects. The process is particularly valuable in making endless belts by joining, i.e., an interweaving of two ends of the same fabric followed by fulling to strengthen the join. Such a fabric can be used under tension as for instance as a paper-maker's felt.

The shape of the needle is not critical. It may have a round, flat, elliptical, square, rectangular, hexagonal, triangular, or the like, cross section. The end must be sufficiently pointed and the diameter sufficiently small to permit piercing of the fabric without rending of the yarn structure. The needle from which the needle used in Example I is prepared has a round sharp point increasing to an equilateral triangular cross section. Before etching the triangular cross section has an effective altitude of 39 mils, and contains 9 barbs, staggered evenly, 3 on an edge, the first barb being about 0.25 inch from the tip while the last is 1 inch from the tip. The working end of the needle is about 1.1 inches in length. It is preferred that the working end length be sufficient to at least pass completely through the fabric thickness. However, some fulling at the surface can be accomplished with less than complete penetration. The maximum permissible needle diameter (which may vary along the shank) before rending occurs will depend primarily upon the nature of the

yarn from which the fabric is woven. Usually needles having a cross-sectional dimension of about 40 mills give satisfactory results. Needles of smaller diameter are preferred. Such needles of small diameter can be obtained by dissolving away (etching) fine commercially available needles in acid. The lower limit upon needle diameter is governed solely by the needle strength required. Satisfactory results are obtained with a smooth surface needle. It is preferred however to employ a needle with a notched surface. The preferred needle is described in detail in United States application 427,465, filed May 4, 1954, in the name of Herbert G. Lauterbach, now Patent No. 2,857,650 dated October 28, 1958. These may be conveniently prepared by etching barbed needles. A barbed needle, etched until its barbs are removed, leaving notches, has been found eminently suited. Such needles may be prepared by etching a high quality hardened steel needle in acid. The period required to remove the barbs will depend upon the needle diameter, the size of the barbs, the acid strength and the like. As a guide, the needles of Example I are preferably etched with hydrochloric acid (38% in water) for at least about 5 hours before the barbs are removed. Etching for a longer period as in the example, reduces the over-all needle diameter. The deleterious effect of barbed needles is demonstrated in Example VII above.

The fabrics to which the process of this invention may be applied comprise those knitted or woven from yarns (preferably those spun from staple) of natural fibers (e.g., wool, mohair, cotton, fur, hair, jute, ramie, hemp, silk, sisal, regenerated cellulose, asbestos, protein, glass, and the like), or synthetic fibers (e.g., cellulose acetate, polyesters such as polyethylene glycol terephthalate, polyamides such as polyhexamethylene adipamide, and polycaprolactam, polytetrafluoroethylene, polyvinyl fibers such as polyacrylonitrile and copolymers including terpolymers of acrylonitrile with vinyl pyrrolidone, vinyl chloride, vinyl acetate, vinyl pyridine, or other monomers, copolymers of vinyl chloride and vinyl acetate, copolymers of vinylidene chloride and vinyl chloride, and the like); or they may be blends of natural and/or synthetic fibers, including stock blends, end-and-end blends, pick-and-pick blends, ply blends, and blends wherein the warp and filling yarns may be the same or different, natural and/or synthetic and/or a blend of natural and synthetic fibers.

Fabrics subjected to the needling of the present invention may be finished by teaseling, brushing or the like either before or after the step of needling. Where the nature of the fiber is such as to permit chemical or thermal shrinkage, a needling step may be performed prior to and/or after shrinking. For example, a fabric woven from polyethylene terephthalate fibers having an inherent shrinkage in boiling water of 30% in length may be needled followed by shrinking. Where a nap is raised prior to the needling, the needling step may cause a decrease in bulk, especially if the needle is introduced into the surface bearing the nap.

While it is illustrated by Example VI above that the fulling process of the present invention is applicable to fabrics made from wool yarn, it is particularly valuable in its application to fabrics from yarn spun from epithelial-

less fiber as defined hereinbefore. Thus it is possible to produce an entire novel class of fulled fabrics from both natural and synthetic yarns.

The amount of needling required to attain the "fulling" phenomenon will vary with the denier of the yarn, the size of the staple from which the yarn is spun, the twist of the yarn, the tightness of the woven pattern, the character of the needles employed and the like. In general the needling is continued until a visible migration occurs. A simple test to indicate migration in a woven fabric is by attempting to pull away an end warp yarn. If fulling has occurred, a web of minute fibers will be visible between the yarn pulled away and the body of the fabric. In general, fabrics from yarns of longer staple and looser twist will tend to full more readily under any set of conditions. While no exact limits can be set due to the many variables, a needling of at least about 1500 penetrations per square inch is considered a minimum for most fabrics. Many more penetrations can be made and in fact are often preferred. Neither needle speed nor length has been observed to have any critical effect.

Among the effects which may be obtained by the process of the present invention are the removal of fabric wrinkles, the improvement of fabric hand, increases in fabric bulk, covering power, stiffness, body, the improvement of fabric uniformity, surface levelness and nap. The process permits fabrics of wool yarn to be fulled while being increased in bulk. It provides a method of fulling fabrics made from yarn spun from man-made fibers. It permits the strengthening of joins to an extent impossible to attain by interweaving.

Typical examples of industrial uses for the products of this invention include filter fabrics for both gas and liquid filtrations, papermaker's felts, polishing fabrics, blankets, conveyor beltings, roll coverings, sanforizing blankets, upholstery fabrics, draperies, boot linings and the like. Examples of household uses are apparel, such as sweaters, suitings, hosiery, overcoatings, underwear, shirting and blouse fabrics, headwear and the like.

Many modifications will be apparent to those skilled in the art from a reading of the above without a departure from the inventive concept.

This application is a division of application Serial No. 415,196, filed March 10, 1954, by George Leslie Moler.

The claimed invention:

A method of making felt-like fabric composed entirely of synthetic fibers and which fabric exhibits the strength and resistance to change of shape of a fabric made of natural fibers, said method comprising the steps of providing a woven fabric in which both the weft and warp are made up of yarns, the fibers of which are composed entirely of synthetic fibers, mechanically needling said woven fabric to move a substantial portion of said fibers loosely into interlocking engagement with adjacent fibers of other yarns to provide a woven fabric wherein a substantial portion of the fibers are interlocked whereby a fabric is produced which is stable as to shape and having the physical characteristics of a wool fabric, and subjecting the fibers while in the said locked condition to a shrinking treatment.

No reference cited.