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PROCESS FOR PREPARING SMOOTH SURFACE FABRICS

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Fig. 1.

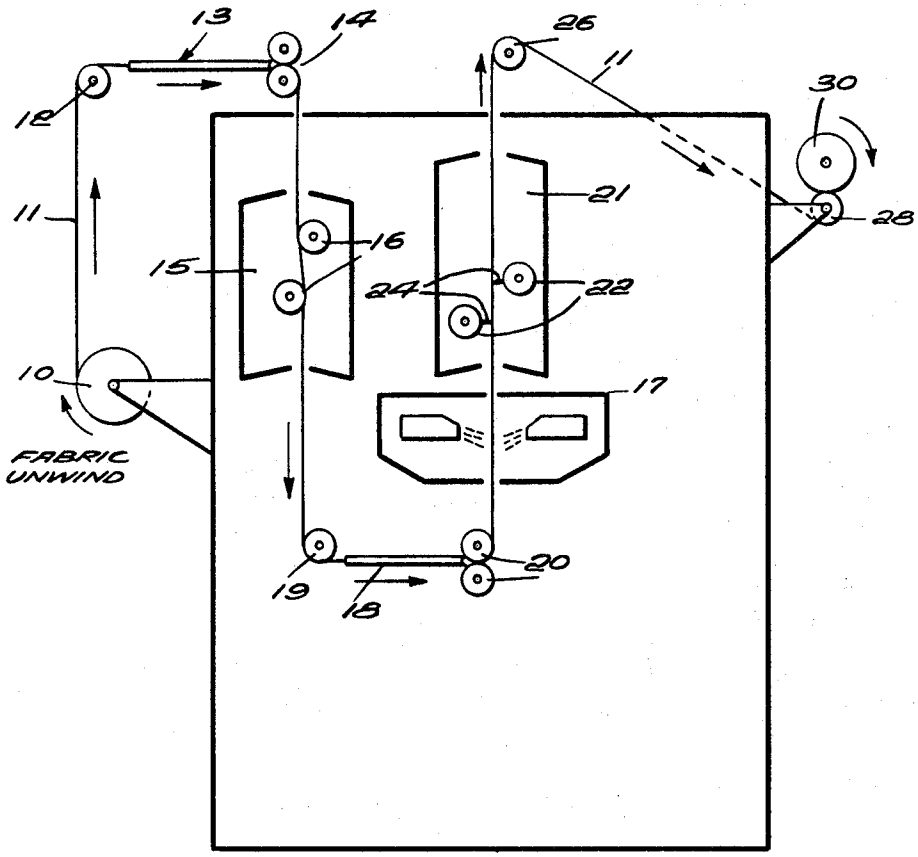
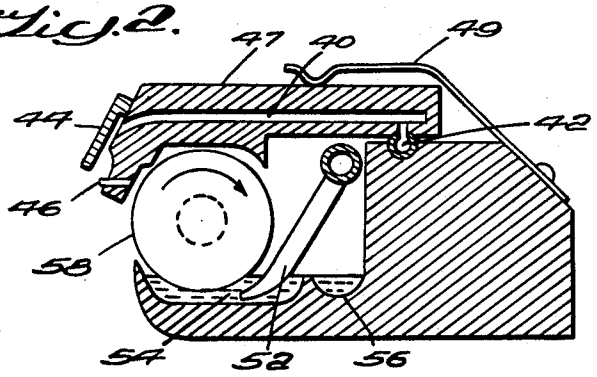


Fig. 2.



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PROCESS FOR PREPARING SMOOTH SURFACE FABRICS

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5 Claims. (Cl. 8—130.1)

ABSTRACT OF THE DISCLOSURE

A process for preparing smooth fabric from fuzzy fabric, in particular by bonding the free ends of staple fibers protruding from the surface of the fabric. The process comprising applying (preferably in mist form) a swelling agent to the fuzz of free fibers, and steaming the treated fabric to cause the fibers to become plastic and adhesive. The fuzz or free fiber portions have been or are subsequently pressed to the fabric surface (e.g., by mechanically aligning them); preferably this is done before and after the applying and steaming.

This application is a continuation-in-part application of application Ser. No. 375,339, filed June 15, 1964, now abandoned.

This invention relates to the production of fabrics for apparel purposes and is particularly concerned with fabrics of synthetic fibers having a clear surface substantially free from fuzz.

Yarns and fabrics made from staple fibers, whether natural or synthetic, are always fuzzy. In the case of cellulosic fibers such as cotton, linen or rayon, the fuzz can be removed easily by singeing without damage to the aesthetic properties of the fabrics. Wool fabrics can be fulled to shrink the fabrics and reduce the fuzz to produce a smooth surface nap on the fabric.

With synthetic fibers such as polyacrylic, polyamide or polyester fibers, neither of the above processes will satisfactorily remove the fuzz. Singeing will fuse the protruding fibers and form small balls which are irritating to the skin when garments of these fabrics are worn. Furthermore, the synthetic fibers will not felt like wool so fulling is not effective fo eliminating fuzz.

It is therefore an object of the present invention to produce fabrics from synthetic staple fibers which are substantially free from fuzz and which retain their pleasant aesthetic properties. Another object of this invention is to produce fuzz-free fabrics from stable fibers spun from acrylonitrile polymers or copolymers.

These objects are accomplished in the present invention by treating woven or knit fabrics or non-woven sheet structures made from staple fibers of acrylonitrile polymer or copolymer, with steam, orienting the fibers on the surface of the fabric, treating with swelling agents for the fibers, steam treating the fabric with the swelling agent in place, and mechanically orienting the free ends of fibers. In this fashion, the fibers are caused to collapse and the adhere to the surface of the fabric, exposing its weave and resulting in a smooth appearance.

The treatment of acrylonitrile fabrics with solvents or swelling agents to produce various results is shown in, for example, the U.S. patent to Miller, No. 3,053,609, British Patent 842,857, Belgian Patent 625,563 (and its French counterpart 1,340,057), and the coassigned pending U.S. patent application Ser. No. 135,316, filed Aug. 31, 1961. The method of formation and application of a solvent or swelling agent mist as disclosed in copending

Ser. No. 135,316 as well as the apparatus therein can be employed in the present invention. Consequently for details of that nature, reference may be made to that application. Other apparatus and misting procedures can be used if desired and the Grammer sprayer, described below and in U.S. Patent 1,592,100 to Grammer, is presently preferred for misting purposes.

In the present invention the objects are achieved by causing the surface structure (fuzz) to collapse to the fabric surface in such a way as to be difficult to observe in the finished product. For this purpose only the surface fibers are treated with the swelling agent or solvent and the main body of the fabric remains substantially untreated.

In carrying out the process, the fabrics containing free fiber ends or fuzz are treated with a mist of the fiber swelling agent or of the solution of the swelling agent such that when steam is thereafter applied, the swelling agent softens and plasticizes the free fibers so that they become plastic and adhesive. It is important to use an effective concentration of fiber swelling agent that is misted onto the fabric, and to apply the proper amount of the mist. The concentrations and amounts of the swelling agents employed will vary with the solubility of that agent in the carrier solvent, if any is employed, as well as temperature conditions that may be involved and the instrinsic effectiveness of the swelling agent being used on the fabric being treated. If the mist is applied as a solution, some evaporation of solvent usually occurs which increases the concentration of the active agent. Furthermore, when the misted fabrics are steamed, the fiber swelling agent can be diluted somewhat. With these general consideration in mind, a concentration of swelling agent in carrier solvent and a rate of mist application are chosen such that about 1.0 to 5.0 grams of swelling agent is applied per square yard of fabric being treated. This quantity of mist application may be achieved by applying a solution of the swelling agent at the highest concentration possible, though lower concentrations can be used as well.

The swelling agent mist can be generated and applied in accordance with known techniques, for example using atomizing jets, or other apparatus such as that shown in Feldermann, U.S. Patents 2,022,415 and 2,591,057, or the Grammer sprayer mentioned hereinbefore. The Feldermann apparatus produces a mist by centrifugal force, the solution being thrown from a disk rotating at high speed. The resulting small mist particles, about 10 to 60 microns in diameter, are blown onto the surface of the fabric by a flow of air of about 100 or 200 to about 600 feet per minute, preferably 300 to 500 feet per minute, which allows the mist particles to settle almost exclusively on the free fiber ends comprising the fuzz on the surface of the fabrics. It is to be noted that it is not desirable to permit any substantial amount of the mist to reach the inner surface of the fabric, and the fine size of the particles of mist can aid in achieving that object.

The preferred apparatus for supplying the mist is the Grammer sprayer manufactured by the Acme Gear and Machine Co. of Philadelphia and described in U.S. Patent 1,592.100.

FIGURE I is a schematic drawing showing one arrangement of equipment employed in practicing the present invention.

FIGURE II is a cross section of a nozzle of the Grammer sprayer that can be used with this invention.

Referring to FIGURE I, the numeral **10** indicates a supply roll of fabric **11** to be treated. The fabric **11** passes from a roll **12** over a conventional spreader **13** used to assure that there are no wrinkles or creases in the fabric. From the spreader, the fabric is advanced by pull rolls **14** to a chamber **15** where it passes over align-

ment cells **16**. These cells emit steam and also serve to press the surface fuzz onto the fabric surface, orienting these fibers in the lengthwise direction of the fabric. The fabric is then advanced to a chamber **17** where the mist is applied. If desired, the fabric can be passed over another spreader **18** between rolls **19** and **20** just before entering chamber **17**. Mist is applied to fabric **11** in chamber **17** on the outside surface of the fabric, which then passes to an activation chamber **21**. In chamber **21**, steam from steam cells **22** is applied to the fabric to activate the fiber solvent. Cells **22** are provided with lips **24**, and the fabric may be kept in contact with those lips to press the fuzz onto the fabric surface. Such lips may be simple projections of the slot opening from which the steam issues. The fabric **11** is then passed over a roll **26** to a wind-up station composed, in the embodiment shown, of a drive roll **28** and wind-up roll **30**.

FIGURE II shows a nozzle that can be employed to provide the mist that is applied to the fabric. The nozzle has a channel **40** through which air is passed from air inlet **42** from a source (not shown). The air passing out of channel **40** contacts a plate **44** and is deflected across the end of a capillary tube **46**. The top plate member **47** is detachable, and a spring **49** is provided to keep it in place. Liquid is supplied to the unit through a supply line **52** terminating in a liquid basin or trough **54** provided with an overflow trough **56**. A roll **58** is rotatably mounted to pick up liquid from the basin **54** and carry it to capillary tube **46** from which it is atomized by the stream of air passing by its outer end. Obviously a number of such nozzles will be employed to facilitate misting a substantial fabric width.

Typical swelling agents that can be used in the present invention include ethylene carbonate, propylene carbonate, dimethyl sulfoxide, tetramethylene sulfone, dimethylformamide, dimethyl acetamide, gamma-butyrolactone, trimethylene carbonate, sodium thiocyanate, lithium thiocyanate, lithium iodide, sodium iodide, calcium thiocyanate, potassium thiocyanate, calcium bromide, zinc chloride, lithium bromide, magnesium thiocyanate, cupric chloride, magnesium chloride, ferric chloride, ferrous bromide, cadmium iodide, barium chloride, and cobaltous iodide. Mixtures of ethylene carbonate and propylene carbonate are preferred. As noted, these agents may be applied as solutions, with the carrier liquid being determined largely by solubility, economic and like considerations. Such carrier liquids (or solvents) as water, acetone or other organic liquid essentially inert to the fabric under the conditions of operation may be used. The presently preferred practice in treating acrylic fabrics is to use a mixture of ethylene carbonate and propylene carbonate without water or other solvent.

After misting, the treated fabric is steamed which heats the fabric and apparently activates the swelling agent causing further collapse of the fuzz and its adhesion to other fibers. This is conveniently accomplished by passing the fabric over a slot having steel lips and from which steam issues as noted above in describing the drawing. Steaming can also be accomplished in other ways, for example by passing the misted fabric through an atmosphere of steam obtained by boiling water. Ordinary saturated steam at 100° C. can be used as well as steam of any degree of superheat or quality. Superheated steam at about 190° C. is preferred. Of course the steam used must not be at temperature so high that it adversely affects the fabric being treated. Steaming generally is practiced for a period below about one minute, and generally is applied for a fraction of a second, for example about 0.01 to 0.2 second. Moreover, the steaming operation should be applied promptly after misting has occurred for the best and most reproducible results.

The third essential operation in the practice of the invention comprises mechanically aligning and straightening the free fiber ends or fuzz. This can be done before or after misting but is preferably done before and after misting as described in conjunction with FIGURE I above. A preferred method of mechanically straightening and aligning the fuzz is accomplished in conjunction with steaming operations. By use of a steam slot for steaming operations, the slot having raised shoulders or the like, with the fabric being passed across the slot while firmly contacting those edges, a brushing-like action occurs. The steam serves to soften and plasticize while drag over the surface further aligns the fiber ends. Other methods can also be used. The alignment of the fibers in this manner together with their collapse to the surface of the fabric imparts the clean look to acrylonitrile polymer fabrics characteristic of this invention.

The textile materials which may be treated in accordance with this invention may include woven, knitted and non-woven fabrics. The woven fabrics may be woolen spun, cotton spun or worsted spun; the kitted fabrics may be warp knitted or circular knitted jersey, and the like. Since the resulting product has a smooth, clean-look finish, fabrics for summer wear are particularly suited to processing by this invention.

The composition of the staple fibers making up the textile materials which may be treated according to this invention include those prepared from polyacrylonitrile, copolymers of acrylonitrile with other monomers such as vinyl acetate, vinyl chloride, methyl acrylate, vinyl pyridine, and sodium styrene sulfonate terpolymers of acrylonitrile/methyl acrylate/sodium styrene sulfonate made in accordance with U.S. Patent 2,837,501. Other related materials also can be similarly treated, and in any event the composition should be at least 70 percent polyacrylonitrile.

In a preferred application of this invention, fabrics of acrylonitrile polymer are treated with a mist of a mixture of ethylene carbonate and propylene carbonate. A solvent carrier such as acetone or water can be used but has disadvantages as compared to the above mixture. Ethylene carbonate alone may tend to crystallize in the misting apparatus because of the cooling and evaporative action of the air and the addition of propylene carbonate avoids this difficulty. The concentration of these carbonates in the solution applied can vary from about 5% to 100% depending upon the amount of solvent that is allowed to evaporate before the fabric is steamed after being misted or during steaming, and the time and temperature achieved during steaming. The preferred mixture is composed, by weight, of about 75 parts of ethylene carbonate and 25 parts of propylene carbonate.

As indicated, it is necessary to use a proper concentration of swelling agent at each fabric temperature for the best results. Too high an amount of swelling agent can destroy the fabric. A suitable concentration for each agent can be determined by dipping pieces of fabric in solutions having different concentrations of swelling agent and then steaming at atmospheric pressure. The degree of shrinking accomplished on the fiber ends is noted for each concentration and the concentration at which incipient solution of the fibers begin is also noted. The results of such tests using ethylene carbonate are shown in Table I for 60 second steaming. Constant temperature is achieved in these tests by employing steam for a fixed period of time.

TABLE I

Concentration (in water):	Percent shrinkage
10% ethylene carbonate	9
25% ethylene carbonate	34
30% ethylene carbonate	56
35% ethylene carbonate	66
40% ethylene carbonate	71
45% ethylene carbonate	71
50% ethylene carbonate	72
55% ethylene carbonate	Dissolves

Concentrations for some other fiber swelling agents were as shown in Table II. At higher concentrations, fibers

were dissolved. However, in practice the steam dilutes the swelling agent so that limited fiber solution occurs.

TABLE II

Fiber swelling agents:	Concentration, percent
Butyrolactone	60 to 65
Sodium thiocyanate	40 to 45
Tetramethylene sulfone	70 to 75
Dimethylsulfoxide	90 to 95

The invention will be described further by means of the following specific examples in which the details are given for purposes of illustration.

Example I

A fiber of 1.5 denier per filament is spun from a terpolymer of 93.6% acrylonitrile, 6.0% methyl acrylate and 0.4% sodium styrenesulfonate. The fiber, after drawing and crimping, is cut to 1.5 inch staple. This is carded on a cotton system card and spun to a 20/1 cc. yarn having a twist of 13.4 Z turns per inch. This yarn is knit into a jersey fabric weighing 4 ounces per square yarn.

The fabric produced is treated by placing it on a pin tenter frame and passing it over a misting machine, known as Model No. OTVT "Web-Wetter," sold by Walton Laboratories, Inc., Irvington, N.J., using a 75/25 parts by weight ethylene carbonate/propylene carbonate mixture. Then the fabric is passed over a steam slot. The fibers are thus permanently set and adhesively attached to the surface of the fabric.

Highly magnified photographs of the fabric before treatment were taken and clearly show the fuzz on the surface. A similar picture of the fabric after treatment shows that the fuzz is cemented down.

Example II

Untreated fabric made as in Example I is passed through the apparatus shown in FIGURE I. After being spread, it is steamed as it passes over the alignment cells **16**. These steam cells and those mentioned below are covered with a fabric preferably woven from a high-melting polyamide fiber. The steam passes through this fabric, and the fabric being treated rubs against the covering fabric giving better orientation of the surface fibers. The fuzz is pressed down against the fabric in this operation. The fabric then passes through a mist of 75 parts ethylene carbonate and 25 parts propylene carbonate formed in a Grammer sprayer. The mist particles settle almost exclusively upon the surface fibers.

The fabric next passes to chamber **21** over activation steam cells **24**. The slots of these cells are also cloth covered but steel lips on the cells are not covered. This heats the ethylene carbonate/propylene carbonate on the fuzz. It also adds condensed moisture so that a solvent or swelling action takes place, and the surface fibers become highly plastic and adhesive and under the pressure of the lips of the steam cells these fibers adhere to other fibers in the fabric surface. The resulting treated fabric is free of fuzz and has a clean, clear surface appearance.

In this experiment the pick-up roll in the nozzle is rotated at a speed of 100 r.p.m. giving an average spray rate of 1.8 grams of spray mixture per minute per inch of fabric width. The fabric travels at a speed of 25 yards per minute. The air pressure is 3 pounds per sq. inch and the steam used is superheated to 190° C.

By running a large number of experiments in which the fabric speed, spray pick-up roll speed and solvent application rate were varied over wide ranges, a mathematical expression was developed which shows the relation among these variables. This expression

$$S=R/36\times F$$

where S=solvent spray rate in gm./in./min.; R=solvent application rate in gm./sq. yd.; F=fabric speed in yds./min.; S is determined by the speed of the pick-up roll.

Fabrics can be given a heavy or a light treatment according to the demands of a particular fabric by varying the pick-up roll speed of the sprayer and also by the speed at which the fabric itself is run. Steam pressure and temperature and air pressure can be varied to suit fabric speed.

In other tests of the invention, similarly satisfactory results are achieved. While the invention has been described with respect to specific details, it should be evident that changes can be made without departing from its scope.

What is claimed is:

1. A method of preparing a smooth fabric from a fuzzy jersey fabric formed from synthetic staple fibers of acrylonitrile polymer having at least a 70% acrylonitrile content and up to 30% of other monomer copolymerized herewith comprising:

(1) applying to the fuzz of said fabric a chemical swelling agent mist for said fuzz which is capable of softening and plasticizing said fuzz so that said fuzz becomes plastic and adhesive, said mist being in the form of particles about 10 to 60 microns in diameter deposited onto the surface of said fabric by a flow of air about 100 to about 600 feet per minute and allowing said mist particles to settle almost exclusively on said fuzz on the surface of said fabric,

(2) steaming the chemical swelling agent treated fabric with steam at temperature about 100° C. to 190° C. for a period below about one minute which render said fuzz adhesive, and

(3) pressing the adhesive steam-heated fuzz to the fabric surface by passing the fabric in firm contact with a smooth surface which provides a brushing-like action to said fuzz and permanently sets and adhesively attaches said fuzz to the fabric surface so that the fabric surface becomes smooth and essentially free of protruding fuzz fibers.

2. The method of claim **1** in which the fuzz is pressed against the fabric surface in the direction of weave or stitch of the fabric.

3. The method of claim **1** comprising the additional step in which the fabric fuzz is aligned by pressing it, with a brushing-like action, to the fabric surface, and steamed, prior to the deposition of the chemical swelling agent on the fuzz in step (1) of claim **1**.

4. The method of claim **3** in which the chemical swelling agent comprises a carbonate and the steam employed is superheated.

5. The method of claim **4** in which the carbonate is a mixture of ethylene carbonate and propylene carbonate.

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