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SHRINKPROOFING WOOL BY MECHANICAL TREATMENT

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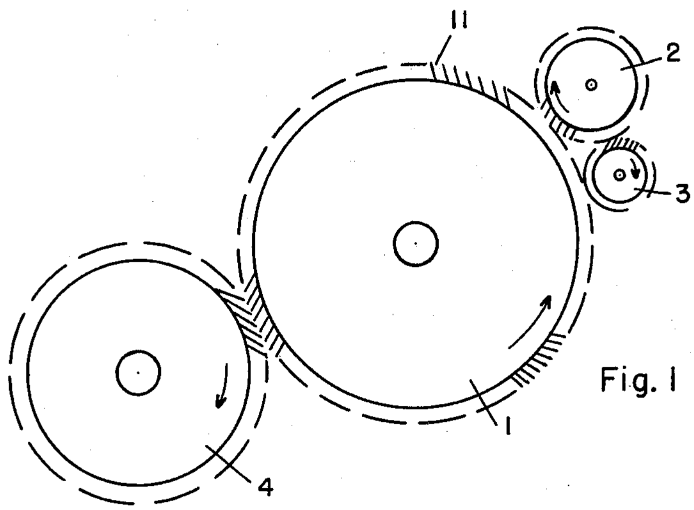

Fig. 1

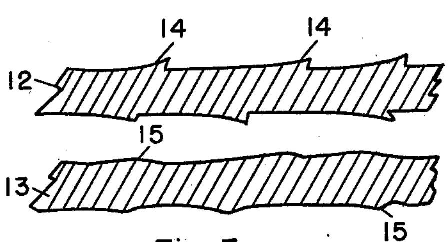

Fig. 3

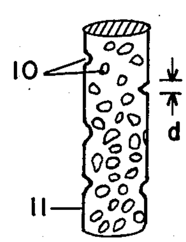

Fig. 2

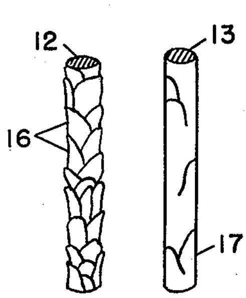

Fig. 4

T.J. COE

INVENTOR

By T. A. Seegrist

ATTORNEY

United States Patent Office

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SHRINKPROOFING WOOL BY MECHANICAL TREATMENT

Thompson J. Coe, Albany, Calif., assignor to the United States of America as represented by the Secretary of Agriculture

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1 Claim. (Cl. 19—98)

(Granted under Title 35, U.S. Code (1952), sec. 266)

A non-exclusive, irrevocable, royalty-free license in the invention herein described, throughout the world for all purposes of the United States Government, with the power to grant sublicenses for such purposes, is hereby granted to the Government of the United States of America.

This invention relates to and has as its principal object the provision of novel processes for shrinkproofing wool by a mechanical treatment of the wool fibers. Further objects and advantages of the invention will be evident from the description herein taken in connection with the annexed drawing.

In the drawing:

Fig. 1 is a diagrammatic view of a carding machine for carrying out the process of the invention.

Fig. 2 illustrates, on anp enlarged scale, an individual card wire.

Fig. 3 illustrates, on a greatly enlarged scale, the cross-sectional structure of wool fibers before and after treatment in accordance with the invention.

Fig. 4 illustrates, on a greatly enlarged scale, the outward appearance of wool fibers before and after treatment in accordance with the invention.

It is well known that when wool textiles are subjected to laundering or similar textile operations wherein they are subjected to rubbing action in an aqueous medium, considerable shrinkage of the textile occurs. The degree of shrinkage is accentuated by such factors as increased degree of agitation, use of hotter soap solution, more alkaline conditions in the washing medium, etc. The shrinkage of wool is generally attributed to the characteristic scale structure of the individual fibers. These scales are arranged on the fibers much as are the shingles on a roof, to give a crude analogy. As a result when the fabric is subjected to rubbing, twisting, and other mechanical forces as encountered in laundering, the individual fibrous elements move within the textile structure. These movements are irreversible because of the shingle-like arrangement of the scales which permit of motion in one direction but not the other. The net result is that the fabric is smaller in area because it has become more dense and compact. The shrinkage of wool fabrics is generally referred to as felting shrinkage because of this compacting effect.

In accordance with the present invention, wool is rendered essentially shrinkproof by a mechanical treatment of the fibers. Thus in applying the invention, the wool fibers are mechanically treated to effectuate a de-scaling of the fibers. The expression de-scaling is used herein to mean a smoothing of the fibers by a rounding off of the sharp projections of the scale tips and/or by actual removal of scales. By this de-scaling operation the ability of the fibers to move in preferential directions during laundering is destroyed and as a net result, fabrics made from the treated fibers are essentially shrinkproof when subjected to laundering.

The de-scaling procedure of the invention essentially involves drawing the wool fibers, in wet or dry condition, over wires, the sides of which are provided with minute cutting edges or teeth. These teeth are so dimensioned that they selectively engage the scale structure and effectuate a smoothing of the fiber by a cutting or abrading action without damaging the fiber itself. The net result of this treatment is that the treated fibers can be fabricated by conventional means into textiles which have substantially reduced shrinkage after laundering as compared to fabrics made from untreated wool. It is also to be noted that the de-scaling procedure of the invention removes only a small amount of material from the fibers so there is substantially no loss of wool in the process. Moreover, since the process of the invention does not involve addition of extraneous materials, fabrics made from the treated fibers have the same hand as those made from native, untreated wool.

As noted above, a critical factor in the de-scaling wires lies in the dimensions of the tooth structure. A coarsely toothed structure such as one which is visibly roughtened by acid etching or abrading with relatively coarse grits cannot be used because it will cut the fibers to pieces and thus be totally inoperative. A polished structure also will be of no utility because it will not engage the minute projections of the scales from the fiber surface. An operative element is one provided with a microscopically dimensional tooth structure. Such a structure will appear to the naked eye as a polished surface but microscopic examination will reveal the toothed structure so proportioned as to selectively engage the scales without damaging the fibers. The numerical dimensions of the tooth structure may be varied depending on the characteristics of the fiber to be treated. For example, wool fibers of larger diameter will require a greater distance between adjacent teeth as compared with fibers of fine diameter. In general, structures provided with a toothed surface wherein the adjacent teeth are separated by a distance on the order of 0.001 to 0.05 mm. may be employed.

The element provided with the microscopically fine toothed structure over which the fibers are drawn may be any rod or similar metallic structure. Usually it is most convenient and effective to card or comb the fibers with carding or combing devices wherein the wires thereof are provided with the desired finely toothed surface. The wires may be treated in various ways to form the finely toothed structure. For example, a conventional card or comb may be blasted with an air stream containing very fine abrasive grit, for example, grit sizes 200 to 600. These grits are of very fine particle size—comparable with jeweler's rouge—and entirely unlike grits used in grinding operations. Impact of the grit particles produces minute pits on the bristles, the diameter of the pits being on the same order as the size of the particles, that is, about 0.001 to 0.05 mm. The grit-blasted wires are not visibly roughened but require microscopic examination to detect the pitting. Cards or combs provided with such minutely toothed wires are totally different in their function from conventional carding or combing devices wherein the wires are deliberately made as smooth and polished as possible. Thus the conventional devices will merely disentangle, straighten and parallelize the fibers whereas the grit-blasted devices will not only accomplish these functions but will also de-scale the fibers as previously explained.

The invention is further explained below having reference to the annexed drawing:

Referring now to Fig. 1, therein is illustrated several components of a carding train including main cylinder **1**, worker **2**, stripper **3**, and doffer **4**. The wire bristles of one or more of these cylinders are provided with fine teeth as explained below. The wool to be treated is fed onto main cylinder **1** by conventional means whereby it is worked by cylinder **2**. Stripper **3** returns the worked fiber to main cylinder **1**. Doffer **4** removes the fiber and transfers it to the next set of carding cylinders. In the figure, only one set of worker and stripper rolls is illustrated merely for simplifying the drawing. In actual practice the usual 3 or 4 sets would be employed.

Fig. 2 illustrates, on an exaggerated scale, a portion of one of the card wires **11**, the side of which is provided with minute pits **10**, produced by blasting the wire with very fine grit as described above. The diameter (*d*) of the pits is on the order of 0.001 to 0.05 mm.

Reference is now made to Figs. 3 and 4 which illustrate, on a greatly enlarged scale, the structure of wool fibers before and after treatment in accordance with the invention. In Fig. 3 the untreated fiber, **12**, and the treated fiber, **13**, are shown in cross-section. In the untreated fiber, **12**, the surface exhibits the sharp scale tips **14** whereas in the treated fiber, **13**, these projections are smoothly rounded off as at **15**. In Fig. 4 is shown the untreated fiber **12** typically covered with the scales **16**. The treated fiber **13** has only a few residual scales **17** and these have rounded edges as shown at **15** in Fig. 3.

Although the process of the invention is particularly adapted for the treatment of wool, it can be applied for the de-scaling of any other fibers which are normally scaly, for example mohair.

The invention is further demonstrated by the following illustrative examples:

Example I

Several hand cards were obtained. Each of these cards consisted of a wooden base provided with a handle and a multitude of fine spring steel wires protruding out of the base. The wires of one pair of cards were grit-blasted with Carborundum (silicon carbide) grit No. 600; another pair was blasted with Carborundum grit No. 400 and a third pair was blasted with Carborundum grit No. 240.

Each of several samples of wool was carded with one pair of the cards treated as described above. In each case the wool was carded by brushing the cards together so that the teeth barely touch one another to alternately draw the fibers through the wires of each card. Carding in each case was for 5 minutes. Portions of each sample were similarly carded with cards having conventional, i.e., highly polished, wires to provide controls.

All six samples of carded wool were then subjected to tests to determine their differential friction characteristics. In this test the force required to draw a single fiber over a surface is measured. The test is then repeated drawing the fiber in the opposite direction. From these measurements the coefficient of friction in each direction is calculated. The difference between the two values is the differential friction. With a highly scaled fiber this figure will be high because the drag with the scales will be much less than the drag against the scales. With a non-scaly fiber, the differential friction will be low because the drag in each direction will be essentially the same. It is evident that the described test provides a useful measure of the scaliness of fibers. The results obtained are tabulated below wherein the differential friction values are each the average of tests on seven randomly selected individual fibers from each batch.

Sample	Grit used in blasting card wires, No.	Diameter of grit particles, mm.	Differential friction	Improvement over control, Percent
1	600	0.02	0.10	41
Control			0.17	
2	400	0.04	0.09	44
Control			0.16	
3	240	0.05	0.07	36
Control			0.11	

Example II

A single lot of wood (Beltsville top) was divided into four batches.

Two batches of the wool were given a resin treatment to mask the scale structure of the fibers. (A) One batch was impregnated in an ethyl acetate solution of 5% diglycidyl ether of glycerol and 5% of polyamide (condensation product of diethylene triamine and heat-dimerized unsaturated fat acid). (B) The other batch was impregnated in an ethyl acetate solution containing 3% diglycidyl ether of 2,2-bis (parahydroxyphenyl) propane and 2% of the polyamide described above. Both batches of impregnated fibers were then heated at 125° C. for one-half hour to cure the polyepoxide-polyamide resin on the fibers.

(C) The third batch of the wool was de-scaled by hand carding for 10 minutes with cards prepared, as described in Example I, by blasting with No. 400 grit.

(D) The fourth batch of wool was carded with cards having conventional polished wires to provide a control.

All the batches of wool fibers were then subjected to measurements to determine their differential friction values as described in Example I.

The results are tabulated below wherein the figures given are the averages for ten individual fibers from each batch.

Sample	Treatment	Differential friction	Improvement over control, Percent
A	Resin coated	0.05	33
B	do	0.05	33
C	De-scaled in accordance with invention.	0.02	78
D	None (control)	0.09	

Having thus described the invention, what is claimed is:

The process for the treatment of wool in order to improve its shrinkage properties which comprises carding wool fibers with card wires, the side of which are provided with a finely pitted surface to selectively engage the scale formations on the fibers and smooth the fibers without causing excessive fiber damage, the pits in the card wires having diameters on the order of 0.001 to 0.05 mm.

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