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A. BARTOVICS ET AL

2,815,558

PILE FABRICS AND METHOD OF PILE FABRIC TREATMENT

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2 Sheets-Sheet 1

Fig. 1

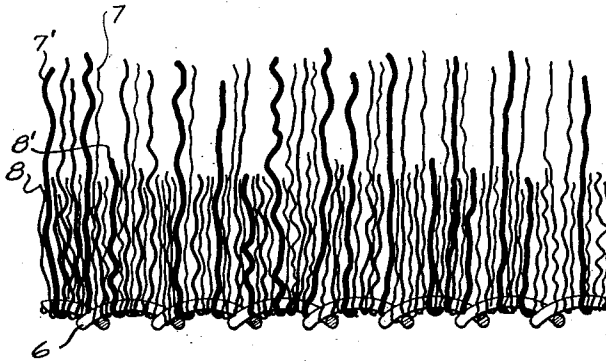


Fig. 2

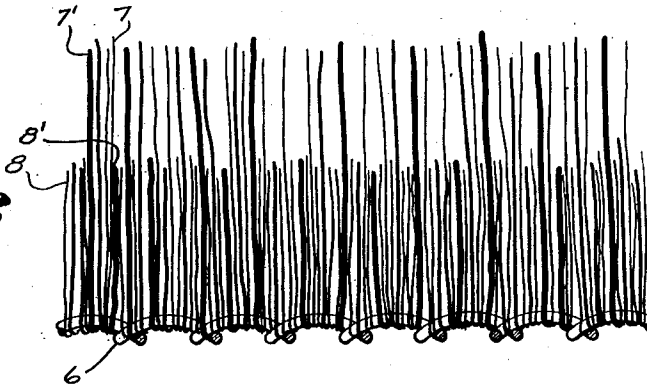
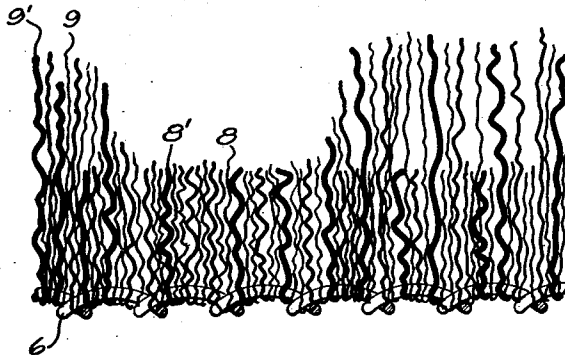


Fig. 3



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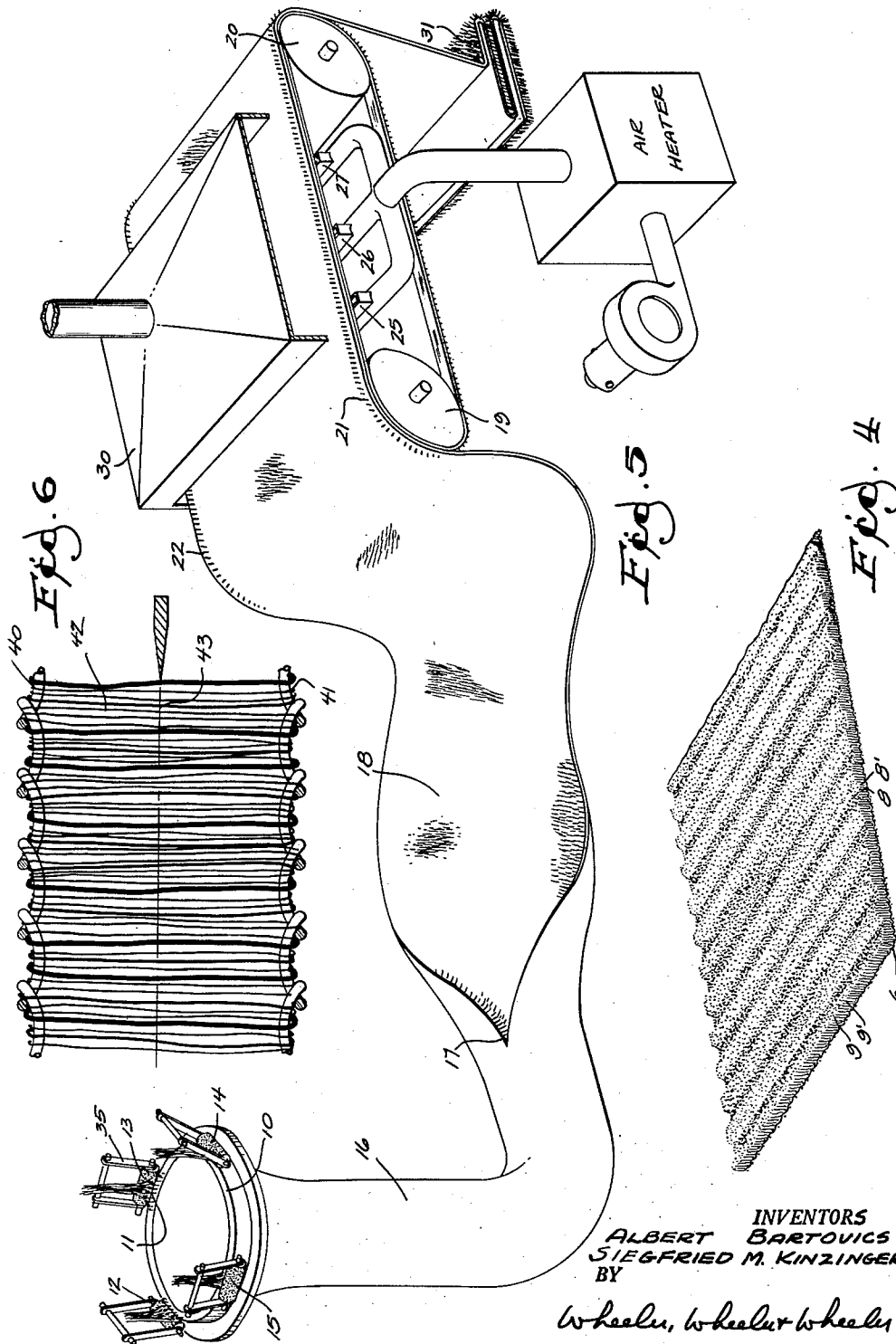
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1

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PILE FABRICS AND METHOD OF PILE FABRIC TREATMENT

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This invention relates to improvements in pile fabrics and method of pile fabric treatment.

More particularly stated, the invention relates to the provision of an improved pile for pile fabrics not only because of the selection and dispersion throughout the pile of the fabric of synthetic fibers having differing reaction to special heat or deorientation treatments after the fabric has been knitted or woven, but also because of the selection and dispersion through the pile of the fabric of fibers of differing denier and length.

The object of the invention is to provide a pile fabric having novel characteristics as to appearance, wearing quality, and density.

A further feature of the invention is the provision of a pile for a pile fabric wherein a pattern may be worked out in a predetermined succession of pile fibers having differing deniers, differing lengths, differing shrinkage characteristics, or differing response to treatment after fabrication.

One of the additional features of the pile fabric product of the invention is the remarkable density of the portion of the pile closest to the base fabric, and in those products where such density in the surface of the pile is desirable it is practicable to shear the pile so as to expose a novel, densely interengaged, fibre zone unmatched by any natural fur.

In the drawings:

Fig. 1 shows a section through the new pile fabric, the various long and short pile fibers and large diameter and small diameter pile fibers being shown in moderately or extremely shrunk or deoriented condition.

Fig. 2 is a section similar to that shown in Fig. 1, but showing the pile fibers in the physical condition which they exhibit prior to deorientation.

Fig. 3 shows a section through a pile fabric which has been deoriented and in which a pattern of short and long fibers has provided a top surface exhibiting ridges or wales.

Fig. 4 is a perspective of a piece of yard goods made in accord with the disclosure in Fig. 3, and exhibiting the surface pattern thereof.

Fig. 5 is a diagrammatic view of the successive stages of manufacture of pile fabric in accord with this invention.

Fig. 6 shows diagrammatically a textile or rug type pile fabric as it is taken from the machines and sheared along a median line between the spaced textile base fabrics.

Synthetic fibers used in accord with this invention are of the type which are "oriented" at the time of their manufacture. For instance, if produced by extrusion processes they are elongated and "set" in such molecular arrangement that subsequent treatment such as that hereinafter described will deorient them and cause them to shrink, curl or kink to a remarkable degree. Such fibers include those which are sold under such designations as nylon, Dacron, Orlon, Acrilan, dynel and Vinyon and many others.

Some of the synthetic fibers with which pile fabrics

2

are made are heat sensitive at differing temperatures, some of which temperatures are fairly low. Some of the fibers react with a relaxation of an oriented fiber when heat in various forms is applied to the pile fibers of the fabric. Shrinkage can be relied upon to occur in predeterminable degree according to the manner in which the heat is applied and according to the intensity of the heat.

It has been established, for instance, that in a pile fabric as it is delivered from knitting machines, the fabric may have a pile height of approximately $\frac{3}{4}$ " and with a particular heat or deorientation treatment the pile height may be reduced to $\frac{1}{2}$ " or less on the average. At the same time the density of the pile of the fabric is increased very effectively and the fibers will have become somewhat stiffened and set in their positions. This gives a more highly resilient and mat resisting pile. The pile fabric of the invention here described has been developed through the use of pile fibers having differing deniers while all of the pile fibers used in the particular fabric are of the same characteristics in other respects, for instance, a pile fabric produced upon a knitting machine in the usual manner is, according to the instant invention, made up with fibers for the pile comprising dynel closely approximately $1\frac{1}{2}$ " in length so that the resulting pile is approximately $\frac{3}{4}$ " in depth. However, instead of using pile fibers which are all of the same denier, a certain proportion, for instance 25.0 percent of the fibers are 12 denier, 50 percent are of 6 denier and the remainder of 3 denier. After the fabric has been taken from the knitting machines the fabric is treated as described below.

The application of heat in the carrying out of this invention has also been found to be very effectively accomplished where the heat is applied in the presence of water or in a medium which is water solvent. A particular treatment subjected the pile fabric in an autoclave (closed system) wherein the water was brought to a temperature above the boiling point. Where dynel is to be treated, as in our present example, the temperature is raised to 250 degrees for a period of 10 minutes. It has been found that a fairly wide range of time for the heat treatment is effective.

"Finishing" of pile fabric in recent years has been accomplished through the use of a machine called an "electrifier." This has a large revoluble roll transversely positioned across the path of the fabric which passes under and against the roll while supported by a belt or shoe. The roll may be heated and its surface is usually provided with grooves extending length-wise or helically along the roll whereby a certain amount of beating, combing and "ironing" of the fabric or its pile may be effected. Combing is specially accomplished where the "trailing" margin of the groove is abrupt and is serrated. One example of an electrifier is shown in U. S. Patent 2,477,448 to Friedman July 26, 1949. In the natural fur industry such a machine was known previously as a fur conditioning machine; but in the finishing of knitted pile fabric, especially that made with a pile of synthetic fibers, the term "electrifier" is practically universally used, even though electricity is only used to motivate the roll rotation, or to heat the roll. Static electricity is purely incidental.

It will be noted that where, at first glance the unelectrified, but heat treated pile may appear slightly damaged by the high heat used, the electrification will remove all evidence of damage and the pile will appear "stylishly" shaggy. The shagginess is due to the irregularity in length of the pile fibers, the differing deniers of the mixed fibers, and the irregularity with which the differing fibers react to the heat treatment.

The dynel pile treated as above prescribed results in a fur-like product in which the under fur is dense and cer-

tain of the pile fibers of larger denier stand up more straightly with a certain degree of similarity to guard hairs as found in natural fur. In any event, the heavier denier fibers react differently to a specific treatment than do the small lighter deniers and where the pile fibers are mixed, the similarity to natural fur is striking.

It will be understood that the treatment of fibers above described is not accompanied by shearing action or electrification, although either of these may be used where particular appearances and characteristics may be desired.

A different result may be obtained involving an almost fundamental difference in appearance and "feel" of the pile fabric product where pile fibers selected for the fabrication of the product differ not only in denier but also in length, and care is used with respect to the degree of heat and time of subjection to the heat treatment. Here the longer fibers respond somewhat differently from the shorter fibers with resulting novel characteristic of appearance since the longer fibers extending beyond the shorter fibers are less protected by neighboring fibers and receive a more direct application of heat.

Fig. 2 shows knitted pile fabric comprising a base fabric 6, long, small denier pile fibers 7, long, larger denier fibers 7', short, small denier fibers 8 and short, larger denier fibers 8'. It will be understood that the proportions of long, short, or small denier, large denier fibers may be changed to accomplish any of the many variations in texture and appearance which may be desired in the resulting product.

After the fabric has been knitted, it is subjected to any one of the various treatments described below, with the result shown in Fig. 1, where it will be seen that the various lengths and various deniers of pile fibers have been shrunk, kinked, or curled, each of the differing types of fibers having reacted in its own way to the treatment.

Fig. 5 shows diagrammatically the cylinder 10 of a pile fabric knitting machine with its needles 11 working through card clothing of the rolls of a plurality of carding heads at 12, 13, 14 and 15. The resulting pile fabric in tubular form at 16 is slit at 17 so that the inner pile surface 18 is exposed. The wide strip of fabric is then passed to the equivalent of a "tenter frame," in this case comprising spaced belts running over pulleys 19 and 20. Each belt is provided with a row of pins shown at 21 and 22 upon which the margins of the fabric are impaled.

The belts are held apart by flanges of the pulleys (not shown) so that the fabric is laterally stretched between the pins and the fabric is held in longitudinal tension as it progressively rides onto the pins adjacent pulley 19.

While the fabric is carried in tension it passes over hot air jets projected by nozzles diagrammatically shown at 25, 26, 27. These are fed with hot air as indicated in Fig. 5. Above the fabric a vented hood 30 tends to confine the heated air which is forced through the fabric so as to control the heat as to time of heat treatment, gauged according to the speed of rotation of the pulleys and the number of feet per minute of fabric travel under the hood, or over the air jets.

Where there is reason to protect the base fabric from the heat of the jets of hot air the jets may be applied to the pile surface rather than to apply the jets through the base fabric from "below." In such case the jets are directed at different angles to disturb the pile kinetically, thus assuring complete distribution of the heated air throughout the pile.

After the fabric has been subjected to the heat treatment it is piled at 31 in readiness for such subsequent treatment as may be desired, as for instance, electrification which will straighten the outer ends of some of the longer fibers.

The surface of the untreated pile is shaggy and has an "unfinished" appearance, as may be well imagined since an untreated pile made of carefully selected lengths of identical deniers and identical materials will have a mused

and uncombed appearance if it has not been sheared or electrified.

The shaggy pile fabric of the instant example is treated immediately as shown in Fig. 5 by stretching it on a tenter frame below which is a battery of devices to project heated air against and through the fabric. The streams of heated air are powerfully projected so that the pile is agitated and "opened up" whereby to expose substantially all of the pile fibers to the effect of the heat.

If the base fabric be a knitted cotton yarn, the only effect on the back of the fabric will be that which results from the shrinkage and constriction of the pile fibers which are intertwined with the individual base loops, but if the base fabric is made of shrinkable synthetic fibers or yarns, there will be a considerable stabilization of the base fabric.

It is to the pile of the fabric, however, that this invention is primarily directed, and it will be found that hot air temperatures approaching the softening point of the synthetic fibers in the pile may be used up to certain time limits with beneficial results, as explained below.

Where a pattern is desired in the pile of the fabric either by reason of length or denier of pile fibers, the synthetic fibers supplied to the knitting machine may be controlled either by dispersal of the differing deniers or differing lengths of the fibers fed to the carding heads, or by working the pile fibers into the knitted base fabric through separate carding heads at controlled intervals.

Diagrammatically, Fig. 5 shows the four carding heads, one or more of which may be so adjustably mounted as at 35 so that the particular type of fiber to be fed to the needles by that head may be withdrawn from the needles at the will of the operator or in response to an automatic pattern control device (not shown). Thus as the tubular fabric is produced by the knitting machine the pile may show intermittent ridges or wales in which a particular denier or length of pile fiber appears, or is missing. Such an irregular or regular pattern as is made by the pile of this new fabric is accentuated or modified by the treatment or intensity or duration of the heat treatment disclosed herein. An example of this is shown in Figs. 3 and 4. The long pile fibers 9 and 9' are fed or not fed intermittently, or the fibers of a particular denier are fed or not fed at intervals by the particular carding head with which they may be individually supplied.

In referring to the treatment by hot air, steam or an autoclave, above, it will be understood that these are merely two of the acceptable ways in which heat treatment may be applied to the pile fabric having differing deniers and differing lengths. The same general result has been achieved in the development of this invention by subjecting the pile fabric to high temperatures, for instance, 250 to 300° in an inert water soluble medium having a high boiling point. Such a medium is found in higher alcohols of which glycerin and the various glycols are the best known. When using these media, an open vessel may be used so that the process is carried out at atmospheric pressure with less practical difficulties from the production standpoint. When the fabric is passed through a glycol bath the excess glycol may be removed by a squeeze roll above the bath, whereupon the fabric may be passed through a wash bath containing water which removes any remaining glycol and the fabric again passes through a squeeze roll onto a tenter frame. Finally an oven dries the fabric.

The following are some examples of actual test runs wherein various types of fibers are referred to. Some of them have a low softening point as for instance Vinyon, saran, shrinkable Dacron, shrinkable Orlon, or dynel. Fibers of higher temperature softening point would be Vicara, nylon, Orlon, or Dacron.

Example 1

An equal mixture of 6 and 12 denier dynel was used to make up the pile of pile fabric having a knitted base

5

comprising cotton yarn. The product was placed in an autoclave in the presence of water. The temperature was raised to 255° F. The time during which the fabrics were subjected to that temperature was twenty minutes. After treatment the fabric was cooled in cold water. There was some shrinkage and tightening of the stitch in the fabric itself, but it was less than 10%, while the pile height of the fiber had been reduced by about 30%.

Example 2

A knitted base fabric of dynel was provided with a pile comprising a mixture of 12 and 24 denier dynel. The fabric was introduced into a closed system autoclave with live steam supplied, and held five minutes at a temperature of 255° F. Again an approximate shrinkage of pile to the extent of 100% as that term is used in referring to shrinkage of synthetic fibers, and the finished sample had great density and remarkable fur-like appearance.

Example 3

Pile fabric wherein the pile comprised dynel in 6 denier and blends of 6 and 12 denier nylon were immersed into tri-ethylene glycol at a temperature of 260° F. for a period of two minutes in an open vessel. After removal and washing the pile of these fabrics had shrunk so as to substantially remove the orientation length in the case of dynel, while the nylon fibers did not shrink. Again a fur-like fabric was obtained with guard hair effects.

It thus appears that where synthetic fibers of differing characteristics as for instance, nylon and dynel are treated as above described, the characteristics of the resulting product are quite different from the product obtained from previously known processes.

The texture of the fur-like product under the instant invention is very different from that heretofore obtained, and the visual appearance is subject to wide variations according to the percent of relatively shrinkable or relatively light deniers comprising the pile.

One of the very beneficial results of heat treatment of these heterogeneous synthetic pile fibers is the improved density of the "under fur," that next to the base fabric. Not only do the fibers interengage because of the kinking and shrinkage, but the heavier denier fibers help to support the smaller denier fibers. This has been found to be so pronounced that new fabric made according to the instant invention has found new markets in the fields where synthetic pile fabrics had been rejected heretofore. For instance the heat treated heterogeneous pile does not "break" when the base fabric is folded. It does not expose the base fabric under these conditions and is therefore equal to or better than natural fur in most cases. Use for footwear, collar and cuff purposes are examples of new adaptability.

It is also practicable to obtain a shaggy irregular or patterned pile surface in textile pile fabric manufacture. As shown in Fig. 6 the spaced base fabrics 40 and 41 with the pile 42 extending between them may be sheared along a median line 43 to provide the separate yard goods areas of rug or other textile products. If the pile as thus woven is made up of differing synthetic fibers and differing deniers, the heat treatment or deorientation will produce the shaggy irregular or patterned product, even though the shearing action along the median line is at that point in the process, smooth and plane.

We claim:

1. The method of making a pile fabric which includes the manufacture of a continuous base fabric, the inter-twining of pile fibers with said base fabric in continuous

6

process concurrent with said manufacture of the base fabric, providing pile fibers of differing deorientation characteristics for said continuous process, and finally deorienting said pile fibers at predetermined temperatures.

2. The method of making a pile fabric which includes the continuous manufacture of base fabric by continuous fabrication process to form the fabric in a web and concurrently feeding oriented fibers of differing deorientation characteristics into the web at controlled intervals and the subsequent deorientation of said pile fibers.

3. The method of claim 2 including the feeding of said pile fibers into the web in separate spaced feeding operations through separate heads concurrently, said feeding heads being supplied with fibers of differing deorientation characteristics.

4. The method of claim 3 including the withdrawal of certain of said feed operations through certain of said heads at intervals.

5. A pile fabric including a base fabric and synthetic originally oriented pile fibers of differing deniers, said pile fibers being deoriented, in situ, in the fabric.

6. A pile fabric including a base fabric and synthetic originally oriented pile fibers of differing lengths, said pile fibers being deoriented, in situ, in the fabric.

7. A pile fabric including base fabric and pile fibers, said base and pile comprising originally oriented synthetic fibers, the individual pile fibers having differing deorientation characteristics, the base and pile being deoriented, in situ.

8. The fabric of claim 7 wherein the pile fibers are of differing deniers.

9. The fabric of claim 7 wherein the pile fibers are of differing lengths.

10. The fabric of claim 7 wherein the pile fibers are of differing deniers and of differing lengths.

11. As a new article of manufacture an improved irregularly surfaced pile fabric comprising a base fabric, pile fibers intertwined with the base fabric and extending therefrom to provide a pile, said pile fibers being composed of synthetic differently deorientable materials deoriented, in situ, in the fabric.

12. As a new article of manufacture an improved irregularly surfaced pile fabric comprising a base fabric, pile fibers intertwined with the base fabric and extending therefrom to provide a pile, said pile being composed of synthetic deorientable fibers of differing deniers deoriented, in situ, in the fabric.

13. As a new article of manufacture an improved pattern surfaced pile fabric comprising a base fabric, pile fibers intertwined with the base fabric and extending therefrom to provide a pile, said pile fibers being composed of a plurality of types of synthetic differently deorientable materials each of said different types being arranged in a pattern and deoriented, in situ, in the fabric.

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