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METHOD AND APPARATUS FOR MODIFYING TEXTILE FABRICS

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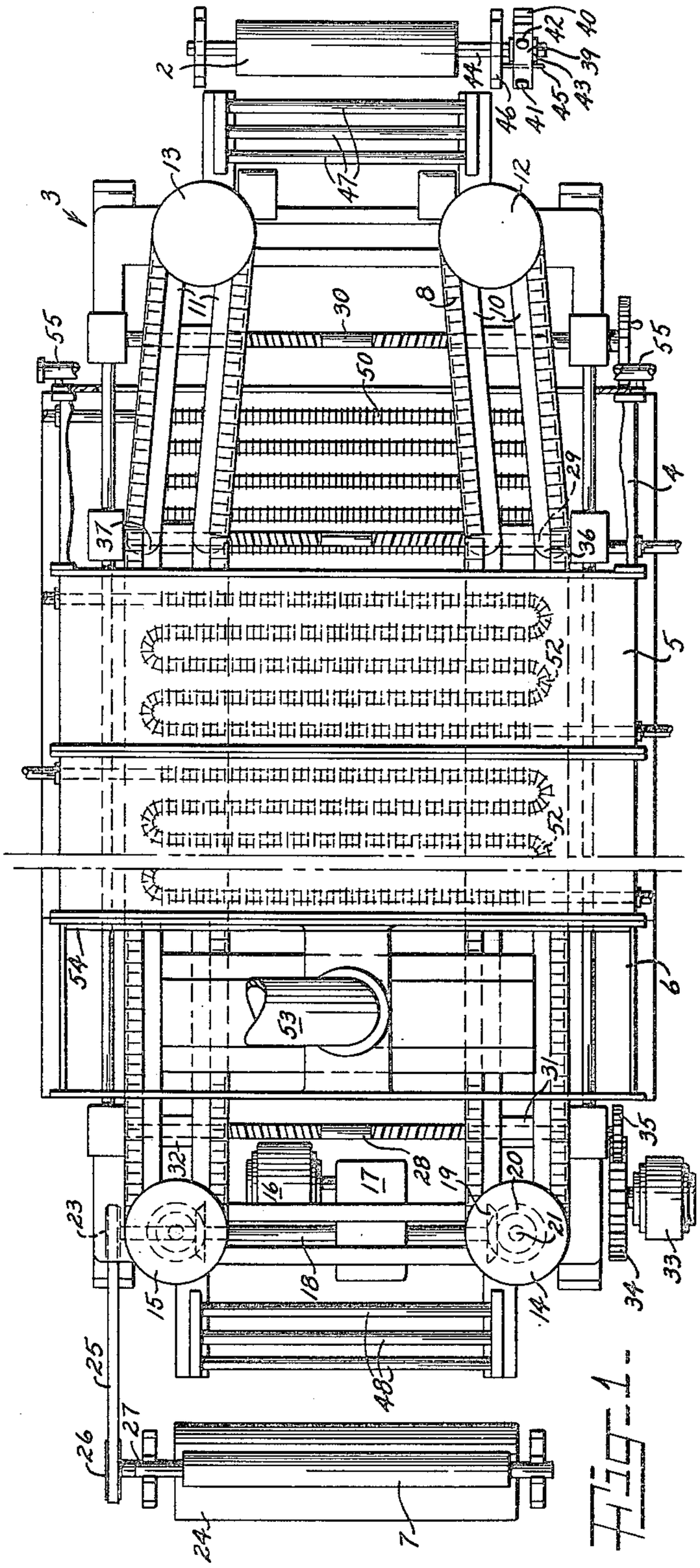

FIG. 1.

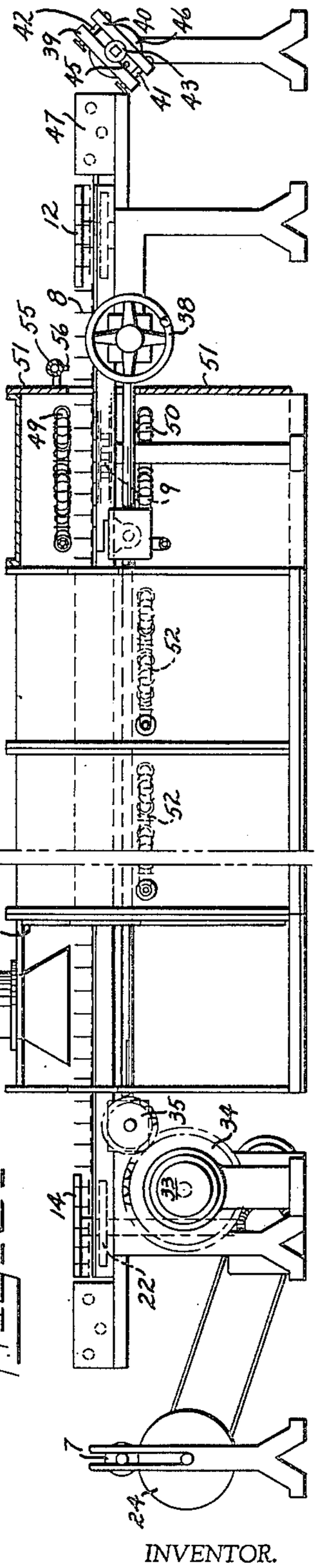

FIG. 2.

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METHOD AND APPARATUS FOR MODIFYING TEXTILE FABRICS

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This invention relates to a method and apparatus for modifying textile fabrics made of yarns containing thermoplastic filaments or fibers, such as those of vinyl polymers. The invention contemplates applying a combination of stretching and heating steps to such textile fabrics continuously to impart thereto improved characteristics adapting them particularly for certain uses for which the unmodified fabrics would be unsuitable. The invention also contemplates the apparatus adapted to modify the fabrics in the desired fashion.

In the drawing, illustrative of the invention,

Figure 1 is a plan view of one form of device for practicing the invention with one section of the housing broken away and a heating coil removed to clarify the showing, and

Figure 2 is an elevation, partially in cross-section, of the device of Figure 1.

In accordance with the invention, a fabric composed of yarns of thermoplastic filaments and fibers, or of yarns containing a substantial proportion of such thermoplastic material, is brought into a condition of longitudinal and transverse tension while continuously moving it through a path. While the fabric is maintained in the condition of longitudinal and transverse tension or simultaneously with the attainment of that condition, its temperature is raised to the softening point by application of heat, preferably to both surfaces thereof, as it continuously moves past a designated point of the path. As the fabric continues through its path, the temperature is maintained by additional heating means along the path so that its effect can be uniformly distributed throughout the fabric. Shortly thereafter, the temperature of the fabric is reduced to a point below its softening point to set the structure.

The application of heat at the first stage may be termed "preheating" and it should be sufficiently vigorous so that at least the outer filaments or fibers in the yarns of the fabric attain the softening temperature of the material of which they are constituted by the time, or, in some cases explained hereinafter, considerably after, they approach the end of this heating stage. At the same time, this heating should preferably not be so drastic as to cause coalescence of the filaments or fibers to any substantial extent.

At their softening point, the thermoplastic filaments and fibers tend to shrink or, if restrained, to tauten. The magnitude of these effects depends upon the particular nature of the filamentary material and the extent of stretching employed during their original manufacture by extrusion through spinnerettes into setting media as well as the time and intensity of heating of the fabric in accordance with the invention.

The longitudinal tension may be applied to the fabric prior to the application of the transverse tension thereto. Where the longitudinal tension is applied first, the transverse tension may be produced in the fabric by stretching it to its full width under the given conditions of longitudinal tension or to any greater extent short of rupture. This transverse tension may also be produced by permitting the fabric to shrink to a reduced width as a result of the heating of the longitudinally tensioned fabric. The longitudinal tension may be varied—in fact it may be eliminated entirely or a certain amount of longitudinal slack may be introduced into the fabric as it enters the path of treatment and the longitudinal tension may in this case be introduced simultaneously with the transverse tension by shrinkage during the pre-heating stage.

By variation of the longitudinal and transverse tensions, the fabric can be shortened, narrowed, lengthened, widened, or both shortened and narrowed or widened; or it can be both lengthened and narrowed or widened; or it can be modified by the heat without substantial alteration of dimensions. Taking an open mesh fabric as an example, one may subject it to any combination of increase or decrease of length or width and obtain a corresponding change in the shape of the openings, thereby converting a single fabric into several each having a distinctive pattern of mesh. Where the dimensions are altered by shrinkage, a heavier, stiffer product is obtained, whereas alteration by increase in dimensions yields a somewhat attenuated fabric of comparatively less stiffness for a corresponding extent of heating. By varying the time of heating during the softened condition, considerable variation in the product may be obtained. The heating may be just sufficient to effect the desired change of dimensions by shrinkage or stretching with a minimum of coalescence of the filaments and fibers in the individual yarns and a minimum of tacking together of the yarns before the fabric is set, in which case a modified fabric having a maximum pliability is obtained. On the other hand, the heating may be increased to tack the yarns together to produce a non-slip fabric, or to produce in addition any desired coalescence of the filaments and fibers in the in-

dividual yarns, which increases the stiffness and reduces the pliability of the fabric.

In those cases where one or more of the dimensions are to be either increased or decreased by stretching or shrinkage respectively it is preferable to apply the pre-heating to the fabric well before it approaches its final dimensions. In this way, the dimensions are caused to change gradually more or less in direct proportion to the extent of heating and softening. The stretching to a larger dimension, therefore, is not accompanied by excessive tensions since the softening relaxes the internal stresses in the filaments. On the other hand, when reducing the size of the fabric, the shrinkage tendencies are permitted to cause a change in dimensions only gradually so that they take up the slack that would otherwise occur upon the reduction of distances between the fabric tensioning and restraining elements. In this latter case, the tendency to form irregularities over the surface of the fabric by sudden irregular and uncontrolled shrinkage is minimized. In both cases (stretching and shrinking), the application of heat to effect softening simultaneously and gradually with the change of distances between the fabric restraining or constraining elements results in a more uniform and rapid distribution of the heat within the yarns of the fabric. This is accomplished, in the former case, by virtue of the fact that in the stretching of the fabric, and especially when the stretching along one dimension follows that along the other, a certain amount of sliding of the yarns upon one another is obtained at their points of intercrossing. This slipping action between the several yarns at their points of intercrossing, taking place as it does during the stage of pre-heating, allows the heat to make direct contact with the points of crossing of the yarns which would otherwise not be directly exposed were the heating to take place while the fabric is in a static condition, whether stretched or unstretched. In the case of shrinkage, sagging of the fabric is reduced so that special forms and shapes of heating elements need not be used in order to account for variations in extent of sagging at various points along the path.

The stage of pre-heating is immediately followed by a heating stage in which the temperature of the fabric is maintained while it is still in the stretched or shrunk condition in which all slack is absent so that opportunity is afforded for the desired amount of tacking of the yarns or coalescence of the filaments and fibers of the individual yarns to occur. During this stage of heating, opportunity is also afforded for the equalization and distribution across and along the fabric of heat and any internal stresses set up thereby. Thereafter, the fabric continuously moves into a cooling stage, where it is caused to set while still restrained in the stretched or shrunk condition with all slack removed and from which stage the fabric proceeds continuously to a suitable take-up device.

While any form of apparatus may be employed to perform the method, Figures 1 and 2 show a preferred form of apparatus capable of efficiently performing the method.

As shown in Figures 1 and 2, the fabric may be withdrawn from a suitable supply roll 2 to the narrowed entrance of a tentering frame 3. The tentering frame extends through several housings 4 and 5 for the heating means past the cooling means 6 and delivers the fabric to suitable take-up means 7.

Any suitable form of tentering device may be employed, such as those having the pin or clip type of tenterhooks. That shown in the drawing represents a clip type of tenter, the clips being shown diagrammatically at 8. As shown, the clips, carried by chains 9 are caused to follow suitable guideways 10 and 11 and proceed about two pairs of cam disks 12, 13 and 14, 15 the former pair opening and closing the clips to engage the fabric as it enters the device and the latter pair releasing the clips from engagement with the fabric as it leaves the device, in known manner. A motor 16, through a reduction gear 17, serves to drive a shaft 18 which, through bevel gears such as 19 and 20, and a vertical shaft 21, drives sprockets such as 22 which are concentric with the cam disks and drive the chains carrying the clips around their guideways. This shaft 18 also has a pulley 23 for driving a winding drum 24 for the take-up roll 7 through a suitable belt 25, pulley 26, and its shaft 27.

Suitable means are provided for adjusting the distance between adjacent courses of the tentering chains. For example, the right- and left-hand screws 28, 29 and 30 operating in threaded blocks, such as 31 and 32, for supporting the guideways 10 and 11 for the chains, may be driven, when adjustment is desired, by motor 33 through suitable gears 34 and 35.

The guides 10 and 11 may be provided with swivel joints at 36 and 37 which permits the tenter chains to be brought closer to each other where the fabric is to enter the device and it is desired to increase the width of the fabric or farther apart where it is desired to decrease the width of the fabric. The right- and left-hand screw 30 may be connected to the motor 33 for operation in unison with the other right- and left-hand screws and it may also be provided with a hand means 38 for independently narrowing or spreading it.

The supply roll 2 should be provided with a suitable drag device. As shown, this comprises a pair of blocks 39 and 40 adapted to be clamped with any degree of compression by means of suitable screws 41 and 42 and having bearing surfaces adapted to press against the collar 43 mounted on the square trunnion 44 of the feed roll. A pin 45 may be mounted on the stationary frame 46 in such a manner as to extend between the two blocks in order to prevent rotation of the blocks. By adjusting the clamping pressure, or reducing it to a negligible amount any degree of tension or slack may be placed upon the fabric as it enters the tentering device, thereby stretching or letting slack into the fabric longitudinally. In order to distribute the fabric in a flat plane to the tentering device as it enters the tentering, it may be interlaced through the rotatable bars 47 just before it enters the clips of the tenter. Similar bars 48 may be placed at the other end of the tenter.

Two radiators or heating coils 49 and 50, one above and one below the plane of the fabric in the device, may be provided for heating the fabric while it is still undergoing transverse stretching where a fabric of increased width is being made, or while the distance between the two guideways is being narrowed where a fabric of reduced width is being made. This system constitutes the stage of pre-heating and the amount of heating surface at this point is correlated with the temperature of the heating fluid within the coils, such as hot water or steam, and with the rate of travel of the fabric therethrough

to impart to the fabric as it leaves this portion of the device or at any desired position before it leaves this portion, a state or condition of incipient softening. The temperature needed to effect this condition depends upon the particular material of which the fabric is composed, a temperature in the neighborhood of 150° F. or upward being satisfactory for fabric of copolymers of vinyl chloride and vinyl acetate. The front face 51 of the housing is preferably entirely closed except for a slit and apertures permitting the fabric and the tenter chain mechanism to extend therethrough. If desired, a similar partition may be placed between the pre-heating portion of the housing and the next inclosure though this is not essential. This second heating portion 5 consists of a suitable heating coil 52 or plurality of such coils extending horizontally beneath the plane of the fabric. The housing 5 of this section of the device may comprise a single housing shell or a plurality of such shells as shown, no partitions being necessary to be provided between the several shells.

Beyond and adjacent to the last heating section 5, a cooling section 6, open to the surrounding atmosphere, is provided into which a duct 53 may introduce a blast of cold air, forced thereto by a suitable pump (not shown). A partition 54 is provided to separate the cooling section 6 from the adjacent heating housing 5, this partition being provided with a suitable slit and with apertures to accommodate the fabric and the tenter chains traveling therethrough.

For certain purposes, it may be desirable to moisten the fabric before or after it enters the pre-heating section. For this purpose a pipe 55 with distributing spray nozzles 56 may extend across the tenter. It may be supplied with cold or hot water, steam, or other liquids. Alternatively, a padder or quetsch may be inserted between roll 2 and bars 47.

While heating coils 50 and 52 are shown as heating sources, others may be substituted. For example, heated air or steam may be blown or sprayed directly upon fabric. Alternatively infrared or high frequency induction may be employed, or any of these several heating devices may be employed in combination such as open steaming in the pre-heating stage and steam coils in the second heating stage.

The invention is applicable to all sorts of woven, knitted or braided fabrics and has the effect of imparting to the fabric any desired stiffness and yet leaving it highly elastic. The treatment may be sufficient, as stated previously to tack the yarns of the fabric together so that a fabric of non-slipping character may be obtained. After treatment, the fabric may be flexed into any desired shape, which it retains until released, when it returns substantially to its original shape, flat or otherwise. The heating steps of the treatment causes a certain amount of coalescence of the thermoplastic filaments and fibers of the yarns. This may be especially pronounced at the surface in which case the fabric is characterized by a marked reduction of porosity and an increase in translucency and in hardness. In addition, the interstices of the fabric becomes more open where stretching is involved, and less open where shrinkage is permitted, apparently as a result of a tendency of the yarn to be reduced in cross-section by stretching of the fabric and enlarged in cross-section by shrinkage and to be set in either condition by the subsequent cooling.

These various properties make the finished fabric particularly valuable for use in ladies hose, shoes, hats, handbags, and other novelties. It yields particularly interesting effects with open mesh fabrics.

The elasticity resulting from the process renders the fabric capable of being readily fabricated and the stiffness enables the fabric to retain its shape. The appearance of the fabric is pleasing and decorative, its surface may be made highly resistant to wear and not only presents few minute interstices between filaments or fibers to catch dirt or dust, but also is readily cleaned by brushing or washing. When the copolymers of vinyl chloride and vinyl acetate constitute the thermoplastic material of which the filaments or fibers are formed, the fabrics also have the property of repelling moisture and being unaffected in shape and strength thereby.

While preferred embodiments of the invention have been shown, it is to be understood that changes and variations may be made without departing from the spirit and scope of the invention as defined by the appended claims.

What I claim is:

1. In a method of modifying a fabric comprising yarns containing thermoplastic material, the steps of engaging spaced points along the boundaries of said fabric while continuously moving said fabric in a longitudinal path, bringing the points of engagement of the fabric without releasing the fabric into effective separation distances defining the desired final dimensions of the fabric along a portion of its path, heating said fabric to its softening point along said portion of the path to effect partial coalescence of the yarns thereof and to cause said fabric to attain the desired final dimensions, and subsequently setting said fabric while maintaining it without slack in said final-dimension condition by reducing its temperature below the softening point.

2. In a method of modifying a fabric comprising yarns containing thermoplastic material, the steps of engaging spaced points along the boundaries of said fabric while continuously moving said fabric in a longitudinal path, gradually altering the distance between the points of engagement without releasing the fabric to effective separation distances defining the desired final dimensions of the fabric along a portion of the path, heating said fabric to its softening point along said portion of the path to effect partial coalescence of the yarns thereof and to cause said fabric to attain the desired final dimensions, and subsequently setting said fabric while maintaining it without slack in said final-dimension condition by reducing its temperature below the softening point.

3. In a method of modifying a fabric comprising yarns containing thermoplastic material, the steps of engaging spaced points along the boundaries of said fabric while continuously moving said fabric in a longitudinal path, altering the distance between the points of engagement without releasing the fabric to effective separation distances defining the desired final dimensions of the fabric along a portion of the path, heating said fabric to its softening point along said portion of the path to effect partial coalescence of the yarns thereof and to cause the fabric to attain the desired final dimensions, continuing to heat the fabric to maintain it in the softened and final-dimension condition to permit equalization of internal stresses and uniform distribution of heat effects, and subsequently setting said fabric while maintaining it without slack in said final-

dimension condition by reducing its temperature below the softening point.

4. In a method of modifying an open-mesh fabric comprising yarns containing vinyl resin filamentary material, the steps of engaging spaced points along the boundaries of said fabric while continuously moving said fabric in a longitudinal path, altering the distance between points of engagement without releasing the fabric to effective separation distances defining the desired final dimensions of the fabric along a portion of the path, heating said fabric to its softening point along said portion of the path to effect partial coalescence of the yarns thereof and to cause said fabric to attain the desired final-dimensions, continuing to heat the fabric to maintain it in the softened and final-dimension condition to permit equalization of internal stresses and uniform distribution of heat effects, and subsequently setting said fabric while maintaining it without slack in said final-dimension condition by reducing its temperature below the softening point.

5. In a method of modifying a fabric comprising yarns containing thermoplastic material, the steps of engaging spaced points along the boundaries of said fabric while continuously moving said fabric in a longitudinal path, increasing the distance between the points of engagement without releasing the fabric to effective separation distances defining the desired final dimensions of the fabric along a portion of the path, heating said fabric to the softening point along said portion of the path to effect partial coalescence of the yarns thereof and to cause said fabric to attain the desired final-dimensions, and subsequently setting said fabric while maintaining it without slack in said final-dimension condition by reducing the temperature below the softening point.

6. In a method of modifying a fabric comprising yarns containing thermoplastic material, the steps of engaging spaced points along the boundaries of said fabric while continuously moving said fabric in a longitudinal path, decreasing the distance between the points of engagement without releasing the fabric to effective separation distances defining the desired final dimensions of the fabric along a portion of the path, heating said fabric to the softening point along said portion of the path to effect partial coalescence of the yarns thereof and to cause said fabric to shrink and to take up slack to attain the desired final-dimensions, and subsequently setting said fabric while maintaining it without slack in said final-dimension condition by reducing its temperature below the softening point.

7. In a method of modifying a fabric comprising yarns containing thermoplastic material, the steps of continuously stretching said fabric and heating said fabric to effect partial coalescence of the yarns thereof, and reducing the temperature of said fabric below the softening point while it is in the stretched condition.

8. In a method of modifying a fabric comprising yarns containing thermoplastic material, the steps of continuously stretching said fabric, heating said fabric simultaneously with said stretching to a condition of softening, maintaining the fabric in the softened and stretched condition to effect partial coalescence of the yarns thereof and subsequently reducing the temperature of said fabric below its softening point while maintaining it in the stretched condition to set it.

9. In a method of modifying a fabric comprising yarns containing thermoplastic material, the steps of continuously stretching said fabric longitudinally, then additionally stretching said fabric transversely while simultaneously heating said fabric to a condition of softening, maintaining the fabric in the softened and stretched condition to effect partial coalescence of the yarns thereof, and subsequently reducing the temperature of said fabric below the softening point while maintaining it in the stretched condition to set it.

10. In a method of modifying an open-mesh fabric comprising yarns containing a vinyl resin, the steps of continuously stretching said fabric, heating said fabric simultaneously with said stretching to a condition of softening to impart the desired shape of the mesh, maintaining the fabric in a softened and stretched condition to effect partial coalescence of the yarns thereof and subsequently reducing the temperature of said fabric below its softening point while maintaining it in a stretched condition to set it.

11. In a method of modifying an open-mesh fabric comprising yarns containing a vinyl resin, the steps of continuously stretching said fabric longitudinally, then additionally stretching said fabric transversely while simultaneously heating said fabric to a condition of softening, maintaining the fabric in the softened and stretched condition to effect partial coalescence of the yarns thereof, and subsequently reducing the temperature of said fabric below its softening point while maintaining it in the stretched condition to set it.

12. In apparatus for treating a fabric, means for continuously moving said fabric longitudinally in a path, means for stretching said fabric along a portion of said path and means for maintaining it in stretched condition along a second portion of said path, means adjacent said stretching means for heating said fabric as it passes therethrough and means for reducing the temperature of said stretched fabric below its softening point as it passes beyond said heating means.

13. In apparatus for treating a fabric, means for continuously moving said fabric longitudinally in a path, means for stretching said fabric along a portion of said path and means for maintaining it in stretched condition along a second portion of said path, means for heating said fabric adjacent a portion of said path, said heating means comprising a portion arranged adjacent said stretching means to effect heating of said fabric as it is being stretched, and means beyond said heating means for cooling said stretched fabric.

14. In apparatus for treating a fabric, means for continuously moving said fabric longitudinally in a path, means for longitudinally tensioning said fabric while it moves in said path, means along a portion of said path for stretching said fabric transversely, means for maintaining said fabric in longitudinally and transversely stretched condition along a second portion of said path, means adjacent said stretching means for heating said fabric as it passes therethrough and means for cooling said stretched fabric as it passes beyond said heating means.

15. In apparatus for treating a fabric, means for continuously moving said fabric longitudinally in a path, means for longitudinally tensioning said fabric while it moves in said path, means along a portion of said path for stretching said fabric transversely, means for maintaining said fabric in stretched condition along a second portion of said path, means for heating said fabric adjacent a portion of said path, said heating

means comprising a portion arranged adjacent said stretching means to effect heating of said fabric as it is being stretched, and means beyond said heating means for cooling said stretched fabric.

16. In apparatus for treating a fabric, a tentering device, a supply roll for feeding a fabric to said device, means for longitudinally tensioning said fabric in said device, heating means disposed adjacent a portion of the fabric path in said device, and cooling means adjacent another portion of said fabric path.

17. In apparatus for treating a fabric, a tentering device, a supply roll for feeding a fabric to said device, means for longitudinally tensioning said fabric in said device, heating means disposed adjacent the fabric path in said device, a portion of said heating means being arranged adjacent the width altering portion of the fabric path in said device and cooling means adjacent another portion of said fabric path beyond said heating means.

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