APPARATUS FOR PRODUCING FRESHRUNK FABRICS

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INVENTOR.

CARLETON S. FRANCIS, JR.

BY Howson & Howson

ATTORNEYS
The invention relates in general to textiles and, in particular, to an apparatus for stabilizing the structure and form of fabrics.

In the conventional method of knitting and weaving fabrics, the yarns are subjected to tension. This is done to secure proper operation of the knitting and weaving machines and to secure uniformity in the finished product. The fibres and yarns constituting the fabric in its unfinished state (i.e., in greige goods) are in a condition of stress or stretch, and hence tend to shrink under any circumstances that permit facilitate movement and contraction of the fibres.

Fabrics made in such a manner exhibit the tendency to shrink when subjected to wet treatment such as may be encountered in finishing operations. However, by the conventional methods of handling fabrics, part or all of the shrinkage so acquired may be offset or lost through mechanical strain and stretch that the fabric encounters in passing through these operations. Consequently, when the goods are again wet out, such as in laundering, they will again exhibit the tendency to shrink either in the warp direction or filling direction or both, dependent on the degree of stretch present after finishing. The tendency to shrink will continue until the stretched condition of both the warp and filling threads has been relieved or until a balanced state of weaving contraction is obtained.

It has been proposed to provide a method of treatment that will shrink the fabric in both directions, in a manner analogous to the shrinkage otherwise occurring in the laundering, washing or other cleaning process. This method is predicated upon the determination that the causes of shrinkage in a fabric subjected to full laundry treatment are mostly mechanical in effect. The process is, therefore, adapted to mechanically rearrange the fibres and to alter the crimp in the yarns of the fabric to the same extent that these fibres would rearrange themselves and the yarn be crimped if subjected to full laundry washing.

Basically, this process comprises the steps of detarning the change in dimension that will take place in the fabric when it is subjected to washing, then mechanically shrinking the fabric down to the dimensions so indicated, and finally completing the finishing operation without disturbing these dimensions.

Moreover, prior methods of shrinking fabrics have never been entirely successful when the fabric has been composed in whole or in part of artificial fibres, in particular of cut staple rayon. Owing to the swelling and shrinking which artificial filaments undergo on being wetted and dried, fabrics made of such filaments do not retain the condition produced by the preshrinking operation. However, even with fabrics made of natural fibres, such as cotton, the prior methods of preshrinking have not given results which were entirely permanent.

Furthermore, the stresses which fabrics undergo during wear and laundering frequently produce objectionable distortions even though such fabrics have been preshrunk by prior methods. Therefore, it is desirable to provide fabrics which are characterized by having a substantial permanent resistance to distortions of all types in order to preserve a desired structure, form and character in the textile.

On the other hand, it is frequently desired to impart to fabrics a predetermined structure or shape designed to enhance its general utility or to render the textile adapted for some special uses. For example, it is desirable to provide a fabric having a predetermined and definite residual shrinkage so that the fabric will maintain its shape and structure during wear and laundering.

Accordingly, it is a general object of the present invention to provide an apparatus for producing a stabilized textile having a predetermined structure which is permanent.

It is another object to provide an apparatus for setting and fixing the dimensions of fabrics in a predetermined manner.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

In the practice of the invention, the permanently preshrunk fabrics are made by mechanically shrinking a fabric containing thermoplastic fibres, fixing the shrink structure by heating the thermoplastic fibres to render them tacky while the fabric is in its shrink condition to effect a substantially permanent adhesion of fibres in the fabric. The present invention provides an apparatus for shrinking a textile web containing thermoplastic fibres comprising, in combination, means for shrinking a fabric, means for applying heat and pressure to said shrunk fabric sufficient to render the thermoplastic fibres tacky, and means for cooling said web to render the tacky material non-tacky. The fabrics to be treated in the present apparatus contain thermoplastic yarns or fibres and may be prepared.
from a mixture of two types of fibres in accordance with the process disclosed in the co-pending U. S. applications Serial No. 157,018, filed August 2, 1937, and Serial No. 201,851, filed April 13, 1938. The shrinkage of the fabric may be partial or complete or to any predetermined amount, and may be effected on woven, knitted, netted or other fabrics in one or more dimensions. The expression "shrinking" is intended to include all physical or mechanical changes in fibre size, length and crimp and changes in yarn length, crimp and displacement in fabrics which produce a decrease in dimension or contraction in the fabric.

The invention accordingly comprises an apparatus having the elements and the relations of elements not only as hereinafter described and the scope of the application of which will be exemplified in the claims.

For a more complete understanding of the nature and objects of the invention, reference should be had to the accompanying drawing in which:

Fig. 1 is a diagrammatical representation of suitable means for carrying out one embodiment of the process of the invention;

Fig. 2 is a cross-sectional elevation of a fabric before and after shrinkage in the process of the invention; and

Fig. 3 is a cross-section of a fabric after shrinkage in one dimension in accordance with one embodiment of the invention.

For the non-adhesive textile fibre there may be used any suitable naturale fibres of textile-making length of the type that will not be rendered tacky at the temperatures employed to render the thermoplastic fibres tacky. Examples of which are given in my parent co-pending U. S. application Serial No. 310,533 filed December 22, 1939.

The potentially adhesive fibre may comprise any thermoplastic synthetic resinous material or thermoplastic non-fibrous cellulosic material capable of being formed into fibres which have an inherent tackiness upon heating to a temperature below that at which the textile fibres are damaged or rendered tacky and which are not tacky at room temperature, examples of which are given in my parent application above identified.

The fabrics treated in the apparatus of the invention are preferably fabricated from yarns comprising at least two dissimilar types of fibres at least one of which type is potentially adhesive. The mixing of the dissimilar fibres may be carried out in a suitable manner such as blending at least two types of fibres before and/or during carding, combing, drafting, but before completion of the spinning of the fibres into a singles yarn. Thus the two types of fibres may be mixed and fed together into a carding machine, or slivers are made from each type independently and the slivers combined by drafting and spinning into a yarn. Alternatively, a yarn containing the potentially adhesive fibre may be twisted or doubled with another yarn of similar type or with a yarn not containing potentially adhesive fibres.

The apparatus is particularly adapted for permanently controlling or fixing a shrunk condition in a fabric comprising yarns made from non-adhesive and potentially adhesive fibres mixed together before the completion of the spinning of the yarn. However, in its broad aspects the apparatus of the invention is applicable for per-

manently fixing the structures and form of fabrics after they have been modified by shrinking.

It is to be understood that the invention is not limited to any particular means for carrying out the shrinking of the present process. Suitable means for carrying out the shrinking operation involved in the present invention are shown in U. S. Patents Nos. 1,982,720, 1,988,376, 2,021,978, and 2,052,948. By way of illustration, but not by way of limiting the invention, the following methods may be employed for shrinking fabrics in accordance with the present invention:

A. Stretching a moistened fabric in one dimension while permitting or controlling the shrinkage in another dimension. In this embodiment a woven fabric is subjected to moisture and preferably a suitable activating agent and then after stretched in the direction of one of its constituent sets of yarns, either warp or weft, while leaving the other set free from tension or under a limited tension and drying the fabric while maintaining the tension on the one set of yarns. The stretching of the one set of yarns causes a contraction and increased crinkle or undulation of the yarns in the other set. The shrinking is carried out while the thermoplastic fibres are in a tacky condition and the adhesive material is rendered non-tacky while the one set of yarns is maintained under tension and increased crinkle or shrink structure is rendered substantially permanent by the adhesion of the fibres in the fabric. This method can be used for shrinking knitted fabrics in one dimension.

B. By moistening and stretching the moist fabric in one dimension while permitting or controlling the shrinkage of the fabric in the other dimension whereby the unstretched yarns acquire additional crinkle, drying the fabric while under tension, again moistening the fabric while free of tension to cause a swelling of the yarns and a consequent shrinkage of the first stretched yarns, and again drying the fabric under pressure, but free of tension. In this embodiment the potentially adhesive fibres are preferably rendered tacky during or after the final drying step. By this method the fabric can be permanently shrunk in two dimensions.

C. By moistening a fabric, mechanically compressing the moistened and preferably activated fabric in one dimension whereby the yarns acquire additional crinkle, moistening the fabric under pressure while drying the fabric, the activation of the potentially adhesive fibres may take place before, during or after the drying step, and the reactivation of the fabric may take place after the drying by cooling while the fabric is maintained in the pre-shrink condition. One embodiment of suitable means for carrying out the shrinking in this process is disclosed in U. S. Patent No. 1,861,422.

D. By moistening a fabric while maintaining one yarn system under tension and permitting or controlling the shrinking of the other yarn system, that is, by permitting the other yarns to crinkle, thereafter mechanically compressing the yarn system previously maintained under tension to shrink that system by increasing the yarn crinkle or undulation. One embodiment of suitable means for carrying out the shrinking in this process is disclosed in U. S. Patent No. 1,861,423. The activation of the potentially adhesive fibres may be effected before, during or after the drying step and the deactivation of the fabric after the drying of the fabric.

In the mechanical shrinking treatments de-
scribed above a chemical swelling agent may be employed in place of or in addition to water and such agent may be used to facilitate rendering the thermoplastic fibres tacky by heating.

The shrunk structure and form given the fabric by the shrinking treatment just described may be rendered permanent and the textile material stabilized by activating the thermoplastic fibres to render them tacky before, during or after shrinking the fabric, preferably squeezing the fibres together as by pressing, and deactivating the fabric while in the shrunk condition and form to effect a substantially permanent adhesion between the fibres and to set the yarn relationships.

The thermoplastic fibres are rendered tacky by use of hot or hot water or by contact with hot surface, with or without the addition of a solvent or plasticizer, and with or without the use of pressure.

While the fibres are in an adhesive condition, the fabric preferably is subjected to a squeezing or compacting treatment to further the adhesion of the accelerated fibres at their points of contact as by passing the fabric between pressure rollers. The squeezing may be effected by the means employed for mechanically shrinking fabrics as described heretofore.

Deactivation may be accomplished by heating to a higher temperature, as in the case of a heat-convertible resin fibre, or by cooling, as in the case of a thermoplastic resin or cellulose derivative fibre.

A plasticizer advantageously may be applied to the thermoplastic fibres and/or to the fabric before the activation of the fibres as described in my parent co-pending application Serial No. 310,933, filed December 22, 1939.

The activation of the thermoplastic fibres takes place preferably before the shrinking operation occurs and the fabrics are subjected to the shrinking operations while the thermoplastic fibres are in an activated condition. The deactivation of the adhesive or adhesive fibres takes place while the fabric is maintained in the shrunk condition. If the fabric is shrunk in the tensions, the deactivation of the adhesive or of the adhesive fibres preferably takes place after the completion of both shrinking operations while the fabric is in a relaxed state or under controlled tension. The shrunk structure should not be placed under distorting tensions during the deactivation treatment. For instance, if the deactivation is to take place by heating or cooling, the fabric may be passed over a heated or cooled drum in the manner just described or over a series of rollers which are heated or cooled by known means.

The properties of the finished product depend upon various factors, such as the nature and proportion of thermoplastic fibres; the extent of the activation thereof; and the tacky condition of the fibres during squeezing or pressing and the nature of the deactivation and the extent of shrinking. The extent of activation may be varied considerably, depending upon the relative proportions of the types of fibres, the properties of the thermoplastic fibres, and the extent of the activation. The thermoplastic fibres may be rendered superficially adhesive; or rendered plastic and tacky without losing their fibrous form; or made to lose their fibrous structure and form an adhesive. The tacky thermoplastic fibres will cohere to each other and adhere to the other fibres to fix the position thereof to give a product having increased tensile strength and lower stretch and shrinkage. If the activation is such as to form an adhesive, the adhesive will cause the other fibres to be permanently adhered and the shrunk structure permanently set.

While a knitted fabric has, of course, only one yarn system, it may be shrunk in a manner similar to a woven fabric by one or more of the methods just described which are appropriate thereof and the present invention is not to include fixing the shrunk structure of both woven and knitted fabrics.

Referring to the Figure 1, a dry fabric containing thermoplastic fibres is passed between the pressure rolls and subjected to tension between the rolls and the calender to cause a weaving contraction to take place in the direction of the filling. While the fabric is held to a desired width by means of a suitable tenter frame P, there is applied to it moisture and a plasticizer by means of sprays 4 and 4'. The plasticizer is any suitable substance which is miscible with the thermoplastic fibres and capable of reducing the temperature at which such fibres become tacky upon heating. The fabric containing moisture and plasticizer is now passed over the calender 3 which is heated a temperature sufficient to render the thermoplastic fibres tacky. While the fibres are in a plastic and tacky condition the fabric is shrunk by passing it between the applicator roll 7 and the heated ironer 8 which is curved to conform to the areal surface of the applicator roll 7 and fed between an endless blanket moving in surface contact with a heated rotating drum. Between the calender 3 and the ironer 8 the fabric may again be moistened with steam to keep the yarns pliable if necessary. Shrinking in a warpswise direction is effected as the fabric passes over the curved surface of the blanket passing about the roll 7. In passing between the blanket 5 and heated drum 6, the fabric is subjected to heat and pressure whereby the resin fibres are rendered tacky and the weaving contraction permanently set.

As the fabric emerges from the blanket and the drum, it is cooled by traverse through the air around rolls 10 and 11 or preferably through the cooling chamber 12 through which cold air is passed. The cooling of the fabric renders the thermoplastic material non-tacky, thus creating a strong and substantially permanent adhesion between the fibres in the fabric and permanently setting the weaving contraction. Additional pressure may be obtained on the blanket by use of one or more pressure rolls such as roll 9.

While the plasticizer may be allowed to remain in the fabric if it is of a non-volatile type, it is desirable in most cases to remove the plasticizer thereby elevating the temperature at which the resin can again be rendered tacky. For this purpose the fabric is passed from the roll through a solvent 13. From the solvent 12, the fabric is passed to a heated dryer (not shown) of conventional type for the purpose of evaporating the residual solvent. It is desirable in most cases, however, to pass the fabric through a second shrinking apparatus similar to the first apparatus employed as described above and shown in Fig. 1 to correct any slight distortions in the weaving contraction created by passing the fabric through the solvent 12. When the
solvent 12 is selected so that it has no swelling action upon any of the fibres in the fabric, little or no distortions will occur during the extraction of the plasticiser so that the second shrinking step just described may be dispensed with. The shrunk fabric may be passed to a reel or may be subjected to any conventional finishing treatments.

While the fabric is in the shrunk condition, such as that shown in Fig. 3 or in the lower view of Fig. 2, the deactivation of the previously activated adhesive fibres causes the component fibres of the yarn to adhere to each other. This adherence of the fibres renders permanent the crinkle imparted to the yarn by the shrinking operation and anchors the yarn to each other in their new relationship. The shrunk condition thus rendered permanent by the deactivation need not be the ultimate shrinking contraction produced by repeated launderings, but may be a shrunk condition intermediate between that of the untreated fabric and that of the ultimate shrinking after laundering. This effect is not obtainable by the use of the shrinking operation alone, but only by the use of the combination of the shrinking with the setting operation of the present invention.

Accordingly, the present invention provides, inter alia, apparatus such that a fabric may be shrunk to a predetermined but not necessarily the ultimate shrunk condition, and such shrunk condition rendered permanent so that the fabric neither shrinks nor expands to any substantial extent upon laundering, dry cleaning or wearing. Thus, the present invention provides an apparatus for setting and fixing the dimensions of fabrics in a predetermined manner and for establishing a predetermined and residual shrinkage in textiles and these results may be obtained in fabrics made from artificial filaments, in particular, cut staple rayon, as well as in fabrics made from natural fibres.

The effect of the combined shrinking and setting operations of the present invention may be illustrated by reference to Figs. 2 and 3 of the drawing. The untreated fabric may be represented by the upper view of Fig. 2 in which the warp yarns 15 and the weft yarns 16 show only a slight undulation and the yarns are relatively distant from one another, giving the fabric a loose, porous appearance. When the fabric is shrunk in one dimension only, for example, by stretching the warp yarns of a pre-moltened fabric, while permitting or controlling the widthwise contraction, there is produced a product as shown in Fig. 3, in which the warp yarns 15 lie substantially in the same plane, while the weft yarns are given an increased crinkle and a decreased over-all length. If the fabric shown in Fig. 3 be subjected to warpswise shrinking as by mechanically compressing the warp yarns longitudinally by any suitable method, the warp yarns are given an increased crinkle, thus bringing the weft yarns closer to each other. As a result of the longitudinal contraction in the warp and weft yarns, the final product will have the structure illustrated in the lower view of Fig. 2 in which both layers of yarns have a substantial crinkle and the yarns lie relatively close together in contrast to the untreated fabric.

Since certain changes in the apparatus and in carrying out the above process, and certain modifications in the article which embody the invention of this and the parent application may be made without departing from its scope, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

This application is a division of my co-pending U. S. application, Serial No. 310,533 filed December 22, 1899, now U. S. Patent No. 2,310,809. No claim is made to the process of shrinking and stabilizing fabrics or the articles so produced in this application since that subject matter is claimed in said co-pending application.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. Apparatus for shrinking a textile web containing thermoplastic fibres comprising, in combination, means for advancing a textile web in a warpswise direction, means for applying a swelling agent to said web, means for stretching said web warpswise sufficient to increase the crinkle in the weft yarns, means for heating said web sufficient to render said thermoplastic fibres tacky, means for shrinking said web warpswise by applying compression parallel to the surface of the web, and means for applying pressure to the compressed web.

2. Apparatus for shrinking a textile web containing thermoplastic fibres comprising, in combination, a pair of pressure rollers, a heated calender, means to subject a web passing between said pressure rollers and said calender to longitudinal tension, means to hold said web to a definite width, means to apply a liquid to said web while held by said last means, means to mechanically shrink the web after passage over said calender, means to subject the said shrunk fabric to heat and pressure, and means to cool said shrunk fabric.

3. Apparatus for shrinking a textile web containing thermoplastic fibres comprising, in combination, a pair of pressure rollers, a heated calender adapted with said pressure rollers to subject a web passing between said pressure rollers and said calender to longitudinal tension, means to hold said web to a definite width, means to apply a liquid to said web while held by said last means, means to mechanically shrink the web after passage over said calender, and means to subject the fabric while it is in a shrunk condition to heat and pressure.

4. Apparatus for shrinking a textile web containing thermoplastic fibres, comprising, in combination, means for advancing a textile web in a warpswise and weftswise direction, means for stretching said web warpswise sufficient to increase the crinkle in the weft yarns, means for shrinking the web warpswise by applying compression parallel to the surface of the web, and means for heating the web sufficiently to render said thermoplastic fibres tacky, and means, in addition to said warpswise shrinking means, to subject the fabric to pressure after said warpswise shrinking and while said fibres are in a tacky condition to cause the tacky material to bind fibres in said product.

5. In an apparatus for shrinking a textile web containing thermoplastic fibres, the combination of, means for shrinking a fabric warpswise and weftswise, means for applying heat to said fabric prior to said warpswise shrinking sufficient to render the thermoplastic fibres tacky, and means, in addition to said warpswise shrinking means, for applying pressure to said fabric after said warpswise shrinking and while said thermoplastic fibres are tacky to cause the tacky material to bind fibres in said product.
6. In an apparatus for shrinking a textile web containing thermoplastic fibres, the combination of, means for shrinking a fabric weftwise and warpwise, means for applying heat to said fabric prior to warpwise shrinking sufficient to render the thermoplastic fibres tacky, means, in addition to said warpwise shrinking means, for applying pressure to said fabric after said warpwise shrinking and while said thermoplastic fibres are tacky to cause the tacky material to bind fibres in said product, and means for cooling said web to render the thermoplastic material non-tacky.

7. In an apparatus for shrinking a textile web containing thermoplastic fibres, the combination of, means for moistening a fabric, means for shrinking a fabric weftwise and warpwise, means for applying heat to said fabric prior to said warpwise shrinking sufficient to render the thermoplastic fibres tacky, and means, in addition to said warpwise shrinking means, for applying pressure to said fabric after said warpwise shrinking and while said thermoplastic fibres are tacky to cause the tacky material to bind fibres in said product.

CARLETON S. FRANCIS, Jr.