Dec. 8, 1953 J. HAMILTON ET AL 2,661,520

SHRINKAGE METHOD FOR KNITTED FABRICS

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FIG. 1a.

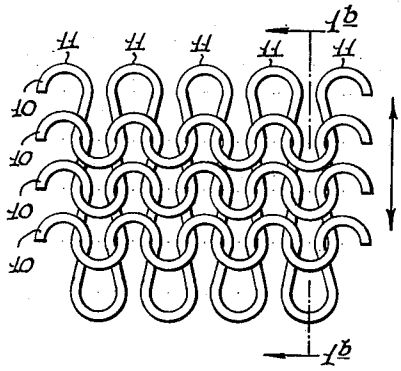


FIG. 1b.

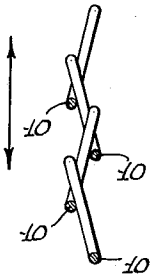


FIG. 4a.

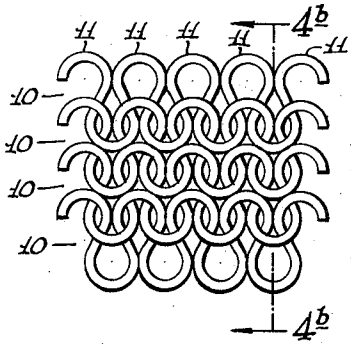


FIG. 4b.

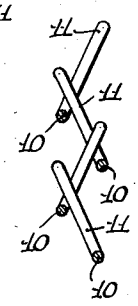


FIG. 2a.

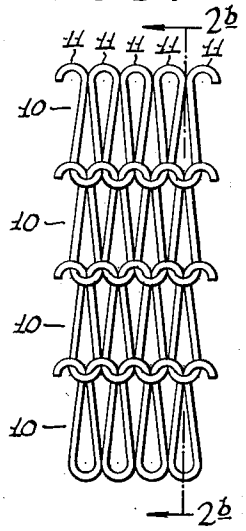


FIG. 2b.

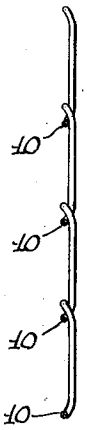


FIG. 5.

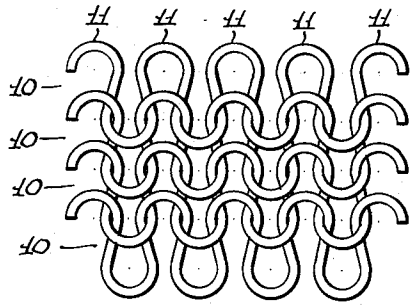


FIG. 3a.

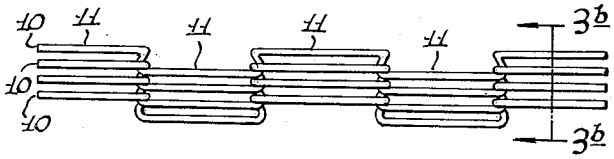
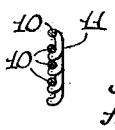


FIG. 3b.



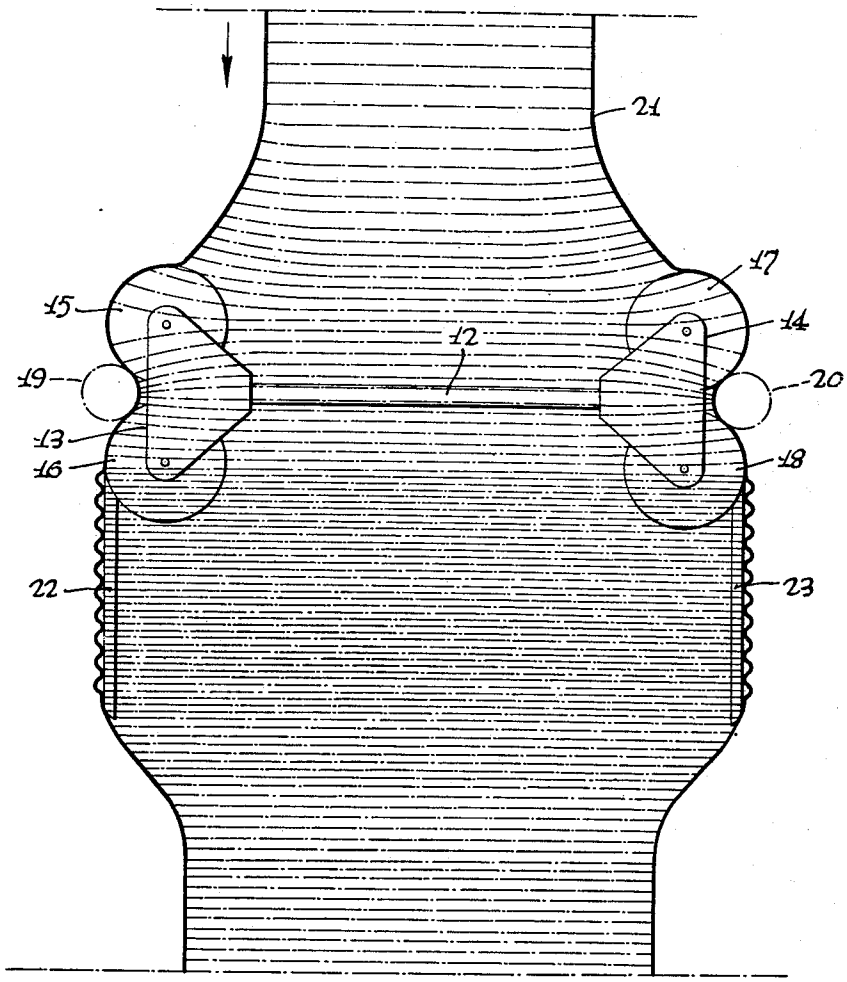
Inventors:
John Hamilton &
Arthur A. Meder, Jr.
by his Attorneys
Howson & Howson

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FIG. 6.



Inventors:
John Hamilton &
Arthur A. Meder, Jr.
by his Attorneys
Howson & Howson

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FIG. 7.

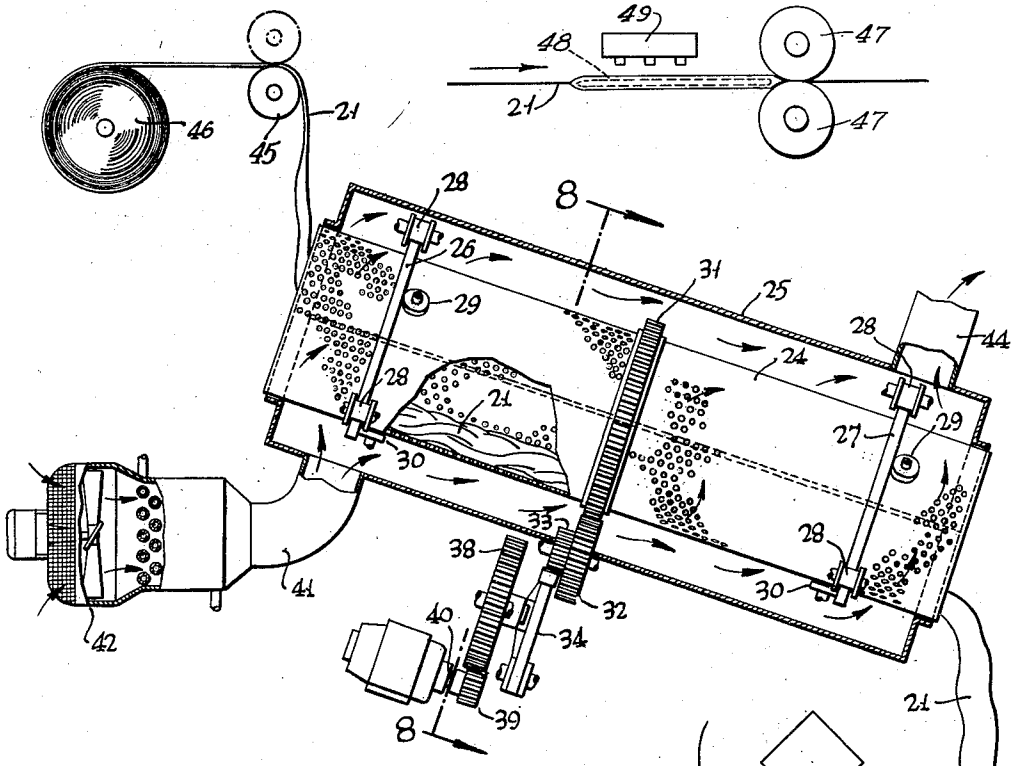


FIG. 9.

FIG. 8.

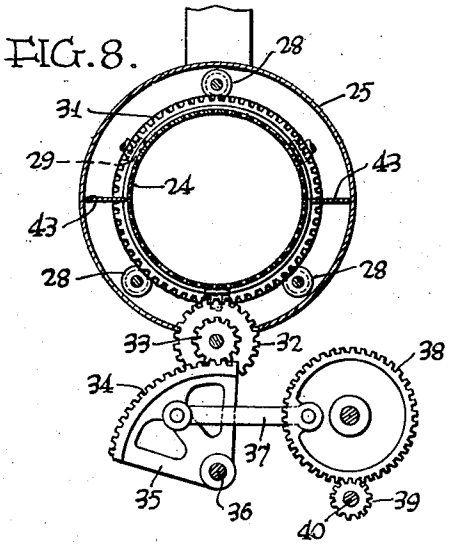
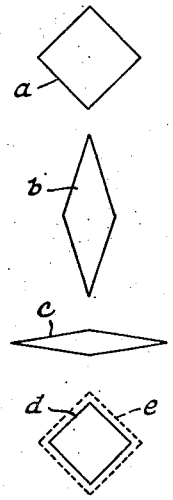


FIG. 10.



Inventors:
John Hamilton &
Arthur A. Meder, Jr.
by his Attorneys
Howson & Howson

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UNITED STATES PATENT OFFICE

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SHRINKAGE METHOD FOR KNITTED FABRICS

John Hamilton, Oakford, and Arthur A. Meder, Jr., Penllyn, Pa., assignors to Proctor & Schwartz, Inc., Philadelphia, Pa., a corporation of Pennsylvania

Application June 19, 1950, Serial No. 168,952

5 Claims. (Cl. 26—18.5)

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This invention relates to treatment of knitted fabrics, and more particularly to treatment of tubular knitted fabrics to prevent or eliminate objectionable shrinkage of garments made therefrom. By a "tubular knitted fabric" is meant one which is knitted in tubular form or one which is knitted in flat form and then converted to tubular form.

Shrinkage has long been a problem in the textile industry, and much effort has been directed toward reduction thereof both in woven and knitted fabrics. The problem has been particularly troublesome in the case of knitted fabrics, and in fact shrinkage has prevented use of such fabrics in many fields.

Referring particularly to knitted fabrics, as they come from the knitting machine such fabrics are subjected to treatment known as "wet processing" which includes scouring, bleaching and dyeing. As the fabric comes from the knitting machine it has some potential fibre shrinkage but this disappears in the wet processing and is of no concern. However, the wet processing subjects the fabric to severe tensional forces lengthwise and produces (1) great distortion of the knitted stitches and (2) slight fibre and yarn stretch. We have discovered that later shrinkage of a garment made from such fabric is due primarily to the stitch distortion, and secondarily to the fibre or yarn stretch. While the latter factor is greater in wool fabric than in cotton fabric, it is always of much lesser effect than the stitch distortion which is the primary cause of shrinkage. With the stitch distortion present the fabric is increased in length and decreased in width; that is to say the fabric is stretched. Laundering of a garment made from such fabric causes shortening and widening of the garment.

The degree of stretch of the fabric depends upon the type and weight of the fabric, and also the type and condition of the machinery used in wet processing. In some instances, the stretch may be very great, for example as much as 40%.

The present invention has for its principal object the provision of a simple, efficient and inexpensive method of treatment of knitted fabric, especially tubular knitted fabric, to eliminate objectionable shrinkage thereof.

Another object of the invention is to provide such a method which is applicable to all kinds of knitted fabrics composed of either natural or synthetic fibres, or mixtures thereof.

In accordance with the present invention, a knitted fabric is treated in a manner to bring about a "normal" condition of the fabric. As

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used in this specification and in the appended claims, the word "normal" means a condition in which the fabric has zero potential shrinkage both lengthwise and widthwise. This may be said to be a "zero-zero" condition, and it is the condition which would exist if a fabric were simply washed. In this condition of the fabric, the stitches have a certain shape and size, and the fabric has certain dimensions. The departure from this condition is what permits shrinkage. As the fabric goes through the wet processing, during which it is in a soft, wet and very elastic state, the stitches are elongated longitudinally and narrowed widthwise due to the tensional forces acting longitudinally or lengthwise of the fabric. Thus the stitches are distorted from their normal shape and size, and the fabric as a whole is distorted accordingly, being stretched longitudinally and narrowed transversely or widthwise. Upon ordinary drying and other usual treatment such as calendering, the fabric remains in a distorted condition. As the fabric dries the stitches acquire a distorted "set," because ordinary treatment does not cause or allow the fabric to become normal.

In order effectively to eliminate shrinkage of garments made from knitted fabric, it is necessary to convert the fabric and its component stitches or loops substantially to the "normal" condition prior to the making of garments therefrom. We have discovered that this result can be achieved by a simple method which involves, as its principal step, mechanical collapsing of the stitches in any suitable manner. Where the fabric is treated as it comes from the wet processing, the mechanical collapsing of the stitches is effective to prevent them from acquiring the above-mentioned distorted "set." Thus if the collapsing action takes place while the wet fabric is being dried, the yarns are caused to "flow" freely or slide over one another and the stitches are caused to assume their normal shape. Where the fabric is not treated immediately after the wet processing and the fabric is dried, the stitches will have acquired the distorted "set" but the treatment according to the present invention will undo the "set" and will cause the stitches to assume substantially their normal shape. In such case if there is insufficient moisture in the fabric for highly effective treatment, the fabric may be moistened prior to the treatment, as by steaming it or subjecting it to a fine water spray. Then the mechanical collapsing of the stitches and simultaneous drying will bring about the desired result. While the moisture content of the fabric may vary widely, experiments have indicated that

a moisture content of about 15% of the weight of the fabric is preferable. However, the invention may be practiced with any condition of the fabric except a bone dry condition.

The mechanical collapsing of the stitches is more readily carried out transversely or widthwise of the fabric, and for this reason it is preferred to expand the fabric widthwise as a preliminary to the stitch collapsing treatment. The purpose of the widthwise expansion is to change the distortion of the stitches from a lengthwise distortion to a widthwise distortion, so that the subsequent stitch collapsing treatment will be more effective.

Most knitted fabrics are calendered after having been dried from the wet condition in which they come from the wet processing. Since calendering is a stretching operation, it may also contribute to objectionable shrinkage. A further feature of the present invention resides in the compensating for calender stretch by carrying out the stitch collapsing treatment to such an extent that the fabric is "fulled" or condensed in its general plane, that is the fabric is narrower and shorter than normal. Then the calendering of the fabric expands the fabric to normal size.

Reference is now made to the accompanying drawings, wherein:

Figs. 1A and 1B are face and edge views, respectively, of a portion of a knitted fabric in normal condition, the double head arrow indicating the longitudinal or lengthwise direction;

Figs. 2A and 2B are similar views of the same portion of the fabric after wet processing thereof and prior to treatment in accordance with the present invention;

Figs. 3A and 3B are similar views of the same portion of the fabric upon subjection thereof to widthwise expansion, which step is preferably included as a part of the treatment prior to the main step involving stitch collapsing;

Figs. 4A and 4B are face and edge views of the same portion of the fabric after it has been subjected to the stitch collapsing treatment to such an extent that the fabric is "fulled," i. e. narrower and shorter than normal;

Fig. 5 is a view of the same portion of the fabric after calendering thereof, it being then substantially normal;

Fig. 6 is a diagrammatic illustration of a device which may be employed to expand the fabric;

Fig. 7 is a diagrammatic or generalized illustration of an apparatus which may be employed for the stitch-collapsing treatment;

Fig. 8 is a cross-sectional view taken along line 8—8 of Fig. 7;

Fig. 9 is a view illustrating the calendering step; and

Fig. 10 is an illustration supplemental to a description hereinafter of a specific example.

Referring more particularly to the drawings, in Figs. 1A and 1B the fabric is shown in the normal condition, the yarns 10 being disposed so that the stitches 11 have a certain size and shape, and the fabric being substantially free of any tension or stretch which can permit shrinkage.

Figs. 2A and 2B show the condition of the same fabric after the wet processing. It will be noted that the stitches or loops 11 are elongated lengthwise or longitudinally of the fabric and they are narrowed widthwise. Due to this condition of the stitches, the fabric as a whole is stretched lengthwise and is narrowed widthwise. As mentioned above, drying of the fabric in this condition will cause the stitches to acquire a distorted "set" which is not corrected by ordinary treatment of the fabric, such as calendering, etc. As previously pointed out, it is this condition of the fabric which is largely responsible for shrinkage. The secondary causes of shrinkage correct themselves and are relatively unimportant.

In the preferred embodiment of the novel method of the present invention, the fabric is subjected to widthwise expansion to an extent to produce generally the condition illustrated in Figs. 3A and 3B. In this condition, the stitches are elongated and distorted widthwise, and the fabric is shortened lengthwise. This expansion is a course condensing action as is apparent from Fig. 3A. This expansion step may be performed by causing the tubular fabric to pass over a spreader device capable of expanding the fabric to the desired extent. Preferably, the spreader is of the "push-off" type, i. e. one having driven rollers or wheels which engage the outside of the tubular fabric adjacent the expanding elements of the spreader so as to push the fabric from the spreading device. Such a device is generally shown in Fig. 6.

The widthwise expansion of the fabric, as depicted in Figs. 3A and 3B, is effective to change from lengthwise distortion of the stitches to widthwise distortion thereof, so as better to condition the fabric for the subsequent stitch collapsing treatment.

Referring to Fig. 6, the spreading device shown comprises a transverse member 12 carrying supports 13 and 14 at its opposite ends, said supports in turn carrying wheels or rollers 15, 16 and 17, 18 which are freely rotatable on the supports. A pair of power driven wheels or rollers 19 and 20 are arranged as shown to support the spreader and to move the tubular knitted fabric 21 over and from the spreader. The wheels 15, 16 and 17, 18 seat within flanges (not shown) on the wheels 19, 20. A pair of members 22 and 23 have straight parallel sections extending from wheels 16 and 18 substantially tangent thereto. The members 22 and 23 have curved sections (not visible) extending in peripheral grooves of the wheels 16 and 18 and secured to the supports 13 and 14. The members 22 and 23 are stationary and there is sufficient clearance between them and the wheels 16 and 18 so as not to interfere with free rotation of said wheels.

The tubular knitted fabric 21 moves in the direction of the arrow over the spreader wheels and between those wheels and the driving wheels, as illustrated. As the fabric approaches the spreading device, it is in the longitudinally stretched condition shown in Fig. 2A. As it is drawn over the wheels 15 and 17 by the propelling wheels 19 and 20, it is spread or expanded widthwise to the desired extent. As it leaves the wheels 15, 17, the fabric is pushed by wheels 19, 20 over the wheels 16, 18 and onto the members 22, 23. During this action, the courses are straightened and condensed, and as the fabric leaves the spreading device, it is in the condition illustrated in Fig. 3A.

Following the expansion step above described, the fabric is subjected to the stitch collapsing treatment to an extent to produce the condition shown in Figs. 4A and 4B. In this condition, the fabric is "fulled" or condensed relative to the normal condition shown in Fig. 1. The stitches

are substantially normal in shape and size, but there is substantial overlapping and close intermingling of the stitches, the fabric being narrower and shorter than normal. Compared to the condition of Figs. 1A and 1B, the weight per unit area and the thickness of the fabric material are increased.

The mechanical collapsing of the stitches may be effected by subjecting the fabric to agitation which will produce the desired stitch-collapsing action. While any suitable apparatus may be employed for this purpose, a particular form of apparatus which may be employed is shown in Figs. 7 and 8. A foraminous cylindrical shell **24**, open at both ends, is supported for rotary movement about its longitudinal axis within a stationary casing or housing **25** which is also of tubular form and has end openings to accommodate the shell **24**. The shell **24** and the surrounding casing **25** are inclined to the horizontal at a suitable angle for a reason which will presently appear. In the specific embodiment illustrated, the shell **24** has flanges **26** and **27** which may be in the form of rings permanently secured to the shell, for example by being welded thereto. As shown in Fig. 8, each of these flanges engages three flanged rollers **28** which are mounted on stationary studs suitably supported within the stationary casing **25**. To relieve strain on the said rollers, each of the flanges **26** and **27** also engages rollers **29**, **30** disposed as shown in Fig. 7 and mounted on stationary studs suitably supported within the casing **25**.

Centrally of the tubular shell **24**, there is provided a ring gear **31** which surrounds the shell and is suitably secured thereto. The ring gear meshes with a gear **32** which is on a common shaft with a smaller gear **33**. The latter meshes with a gear segment **34** (Fig. 8) carried by a wheel segment **35** which is mounted on a rotary shaft **36**. A link **37** interconnects the wheel segment **35** with a crank wheel **38** provided with gear teeth to mesh with a driving pinion **39** on the shaft of a driving motor **40**. By this arrangement, the shell **24** is oscillated about its axis through a predetermined arc.

Heated air is supplied to the casing **25** through an inlet conduit **41** from a source **42** which may comprise an air blower and air heating means. The purpose of this is to dry a fabric passing through the foraminous shell **24**, as described below. As shown in Fig. 8, baffles **43** are provided in casing **25** so that all of the air will pass through the foraminous shell **24**. The air is exhausted through conduit **44**.

In operation, the fabric **21** may be fed vertically downward into the upper end of shell **24**. In the specific illustration, the fabric is shown being fed by means of a roll **45** from a wound roll **46**. As the shell **24** oscillates, the fabric moves by gravity through the inclined shell, and as it does so it is tumbled or agitated. The particular action in this case is a continual falling of one portion of the fabric onto another, so that there is repeated collapsing of the stitches. As it moves through the shell **24**, the fabric is subjected to the drying effect of the heated air so that it is being dried at the same time that it is being agitated. The stitch-collapsing action thus produced converts the stitches substantially to their normal shape and size as previously described, and causes fulling of the fabric so that it emerges from shell **24** in the condition shown in Figs. 4A and 4B.

Following the above-described treatment, the fabric is calendered in the usual way. As shown in Fig. 9, in the usual calendering operation, the tubular knitted fabric **21** passes over a frame or spreader **48** which flattens and smooths the fabric just before it passes between the pressing or calendering rolls **47**. Usually steam is applied to the fabric as it passes over the spreader **48**, as by means of a steam box **49**. As the fabric passes over the spreader **48** and between the calendering rolls **47**, it is expanded both widthwise and lengthwise. The calendering operation is effective to remove the fulling completely or partially, as desired, and to convert the fabric substantially to the condition shown in Fig. 5. It should be noted that the previous fulling action is in anticipation of the stretching produced by calendering, and the fabric is actually calendered up to size. After calendering, the fabric as a whole is normal and has substantially zero-zero shrinkage.

It should be noted further that while the expansion step of Figs. 3A and 3B is preferred for the reason hereinbefore set forth, this step is not absolutely necessary as the stitch-collapsing treatment alone will suffice but it takes a greater length of time without the expansion step.

In the practice of the invention, it is readily possible to determine the extent of treatment necessary to produce the normal condition of the fabric. For a certain fabric from a particular mill and processed in a particular bleachery, a wash test of a sample after wet processing will show the amount or percentage of potential shrinkage. Such a test merely involves washing the sample, and measuring its width and length before and after washing.

By way of example, the following data is given with respect to actual treatment of a particular fabric according to the preferred form of the present invention. The following may be more readily understood with the aid of Fig. 10 which shows a series of illustrations representing a marked figure on the fabric.

The fabric treated was 1 x 1 rib with a tight stitch, which was knitted on a knitting machine having a 10" diameter head.

After bleaching in the usual wet processing, the width of the tubular fabric in flat form was 8¾". From a wash test of a sample, it was determined that zero width for this fabric was 11¼", and that the fabric had been stretched longitudinally 17%. By "zero width" is meant the width of the fabric which it should have for substantially zero shrinkage, i. e. the width prevailing after shrinkage of the bleached fabric by the wash test. The test showed that a 17% reduction from the stretched condition represented normal length. The normal condition is represented at *a* in Fig. 10, while the stretched condition is represented at *b*.

The bleached fabric which had been stretched 17% and which had a width in flat form of 8¾" was passed over a course condensing spreader of the type illustrated in Fig. 6, the spreader width being 20". After spreading, the fabric was reduced in length by 30%. This condition of the fabric is represented at *c* in Fig. 10.

The fabric was then subjected to the stitch-collapsing treatment above described, and when dry its width in flat form was 11" and its length reduction was 22% of its stretched length after bleaching. This condition is represented at *d* in Fig. 10. It should be noted that at this point the fabric was actually smaller in size than the zero

condition indicated by the wash test as above mentioned.

The fabric was then calendered and folded in the usual manner, in the course of which treatment it was passed over a calender spreader with a 12" width and a folder spreader of 11½" width.

The cold width of the fabric after calendering was 11¼", and the cold length reduction was 16%. This condition is represented at *e* in Fig. 10. It will be noted that the fabric was then substantially in the zero shrinkage condition determined by the above-mentioned wash testing of a sample after bleaching.

Following the above-described treatment, the fabric was subjected to a wash test to determine its condition from the standpoint of shrinkage. It was found that the fabric had a widthwise shrinkage of about 1% and a lengthwise shrinkage of about 2%. These figures indicated that the fabric had substantially zero-zero shrinkage, since the low percentages indicated are insignificant from a practical standpoint.

The method of treating knitted fabric according to this invention as hereinbefore described, is not only highly efficient in substantially eliminating shrinkage but it is extremely simple and inexpensive.

While a preferred embodiment of the invention has been described, it will be understood that the invention is not limited thereto but may be practiced with such variations as may occur to those skilled in the art. For example, the invention contemplates any suitable treatment of the fabric which will effect the stitch-collapsing action, and is not limited to the specific treatment described.

We claim:

1. A method of treating wet or moist stretched knitted fabric whereof the stitches are distorted from normal shape, which method comprises mechanically collapsing the stitches from their distorted condition to an extent to condense the fabric both lengthwise and widthwise and cause substantial overlapping and close intermingling of the stitches, thus reducing the fabric to smaller-than-normal size, drying the fabric concomitantly with the stitch collapsing action, and calendering the fabric to finish the same and to expand the fabric to its normal size.

2. A method of treating wet or moist longitudinally-stretched knitted fabric whereof the stitches are elongated longitudinally and distorted from normal shape, which method comprises expanding the fabric widthwise to an extent to distort the stitches widthwise, mechanically collapsing the stitches from their distorted condition to an extent to condense the fabric both lengthwise and widthwise and cause substantial overlapping and close intermingling of the stitches, thus reducing the fabric to smaller-than-normal size, and calendering the fabric to finish the same and to expand the fabric to its normal size.

3. A method of treating wet or moist longitudinally-stretched knitted fabric whereof the stitches are elongated longitudinally and distorted from normal shape, which method comprises expanding the fabric widthwise to an extent to distort the stitches widthwise, mechanically collapsing the stitches from their distorted condition to an extent to condense the fabric both lengthwise and widthwise and cause substantial overlapping and close intermingling of the stitches, thus reducing the fabric to smaller-than-normal size, drying the fabric concomitantly with the stitch collapsing action, and calendering the fabric to finish the same and to expand the fabric to its normal size.

4. A method of treating wet or moist stretched knitted fabric whereof the stitches are distorted from normal shape, which method comprises subjecting the fabric to agitation effective to collapse the stitches from their distorted condition, continuing such agitation until the fabric is condensed both lengthwise and widthwise and the stitches are caused to be overlapped and closely intermingled, thus reducing the fabric to smaller-than-normal size, drying the fabric concomitantly with the stitch collapsing action, and calendering the fabric to finish the same and to expand the fabric to its normal size.

5. A method of treating wet or moist longitudinally-stretched knitted fabric whereof the stitches are elongated longitudinally and distorted from normal shape, which method comprises expanding the fabric widthwise to an extent to distort the stitches widthwise, subjecting the fabric to agitation effective to collapse the stitches from their distorted condition, continuing such agitation until the fabric is condensed both lengthwise and widthwise and the stitches are caused to be overlapped and closely intermingled, thus reducing the fabric to smaller-than-normal size, drying the fabric concomitantly with the stitch collapsing action, and calendering the fabric to finish the same and to expand the fabric to its normal size.

JOHN HAMILTON.
ARTHUR A. MEDER, JR.

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