Nov. 12, 1968 J. H. DUSENBURY ETAL 3,409,960

STRETCH FABRIC PROCESS EMPLOYING EXTERNAL COMPACTING FORCES

Filed Nov. 24, 1964 2 Sheets-Sheet 1

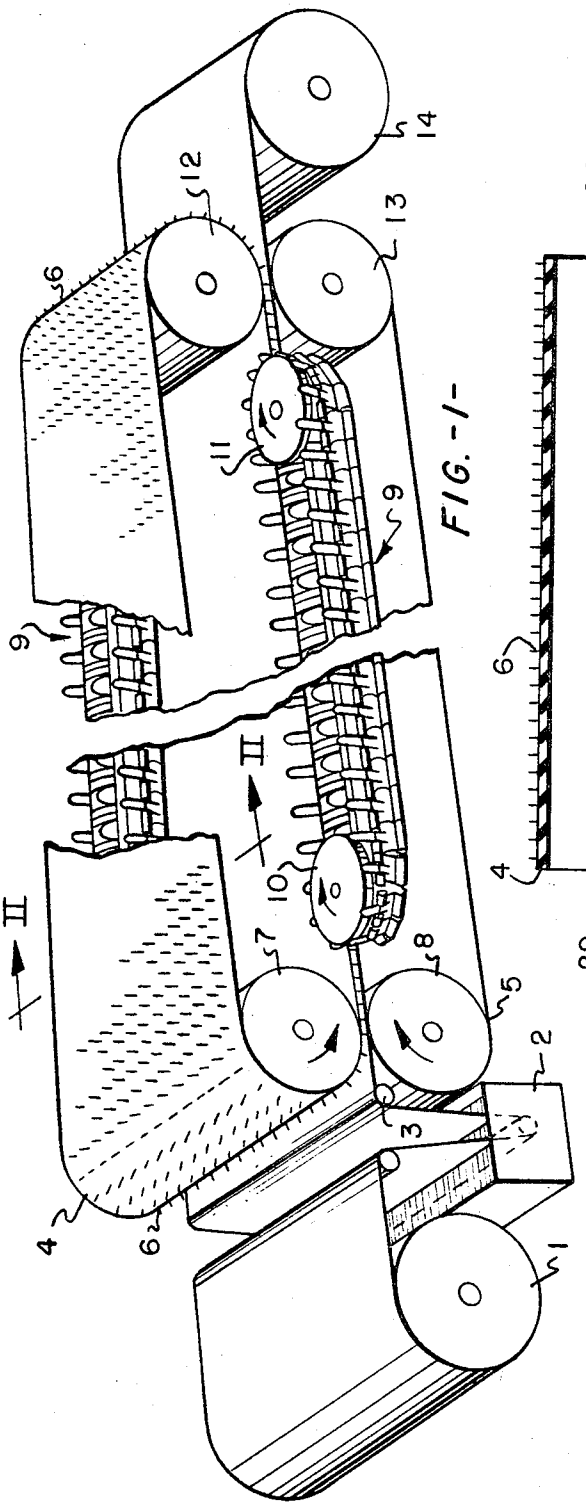


FIG. -1-

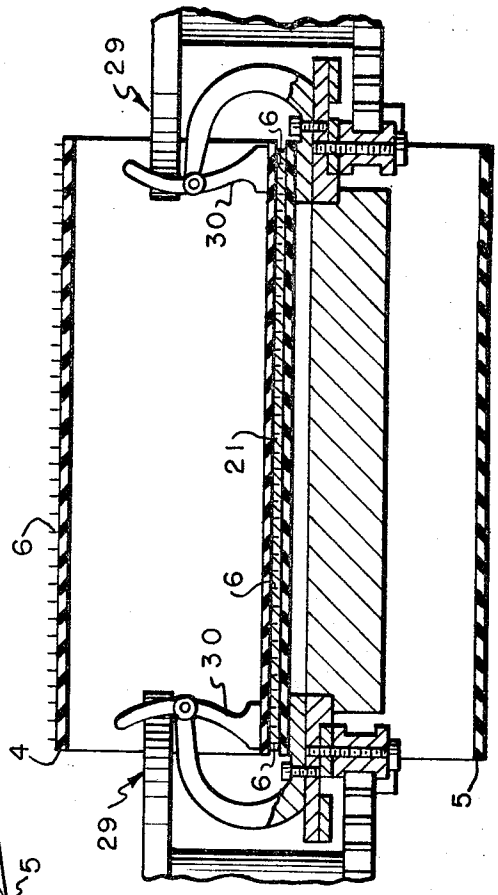


FIG. -2-

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STRETCH FABRIC PROCESS EMPLOYING EXTERNAL COMPACTING FORCES

Filed Nov. 24, 1964 2 Sheets-Sheet 2

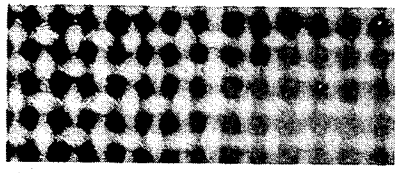


FIG.-3-

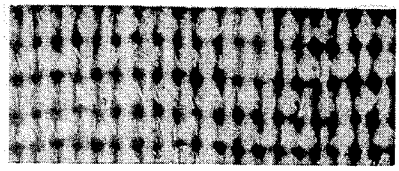


FIG.-4-

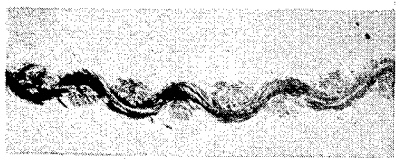


FIG.-5-

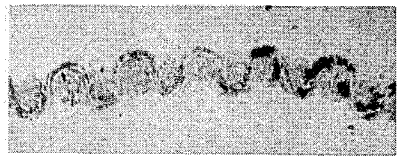


FIG.-6-

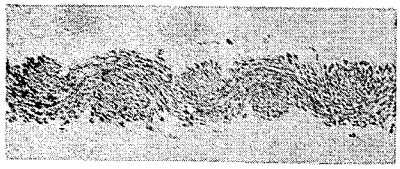


FIG.-7-

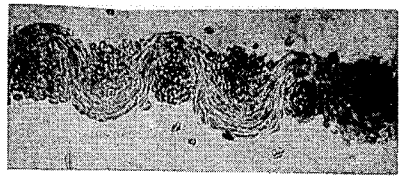


FIG.-8-

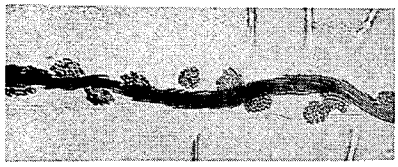


FIG.-9-

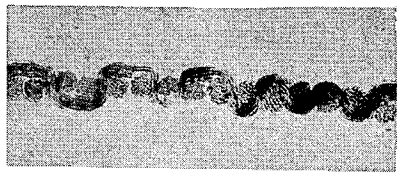


FIG.-10-

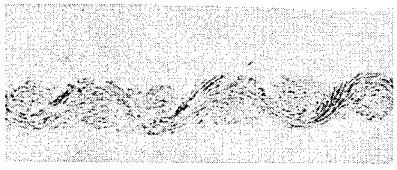


FIG.-11-

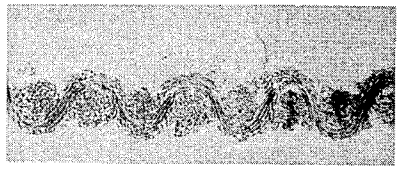


FIG.-12-

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3,409,960

STRETCH FABRIC PROCESS EMPLOYING EXTERNAL COMPACTING FORCES

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Filed Nov. 24, 1964, Ser. No. 413,570
2 Claims. (Cl. 28—76)

This invention relates to stretch sheet material and more specifically to stretch fabrics having elastic characteristics.

In general, elastic effects are produced in a sheet material such as a fabric either by preparing fabrics from elastic yarns or by compacting performed fabrics prepared from yarns having no prior stretch characteristics. The term compacting should not be confused with shrinking as shrinking does not allow for subsequent recovery of fabric dimensions. Stretch yarns are commonly prepared by employing an elastomeric component as a core about which non-elastic fibers are spun. A second means for producing stretch yarn is by compacting or crimping the yarns or the staple fibers employed in the preparation of the yarns. Methods which are commonly employed for the preparation of such noncore spun stretch yarns are gear crimping, knit-unknit methods, edge-crimping, belt crimping, blowing methods and twist-set-untwist methods.

While stretch fabrics may be prepared from the stretch yarns produced according to any of the aforementioned processes, great care must be exercised in the preparation of the stretch fabrics to insure that the elastic characteristics of the yarns are not lost in the subsequent knitting or weaving operations. It is therefore often desirable to produce stretch characteristics in preformed fabrics. Stretch fabrics produced in the piece are now being prepared according to U.S. Patents Nos. 3,077,655, 2,765,513 and 2,765,514. The first of these patented processes involves a combination of factors among which are fabric construction, chemical treatments and mechanical action. In its most general terms the process set forth in U.S. Patent No. 3,077,655 involves the preparation of a loosely constructed fabric from high twist wool yarns, immerison of the fabric in a reducing agent followed by agitation of the fabric between vibrating members whereby the fabric is alternately compacted and released thereby permitting the high twist yarns to contract and create a stretch fabric having elastic characteristics in both the warp and filling direction. Another process for the preparation of stretch fabric is embodied in U.S. Patents Nos. 2,765,513 and 2,765,514. The process set forth in these two patents involve the compacting of a fabric in the direction of the warp yarns by the passage of the fabric into a machine consisting of two rolls and a blade. The blade is in close proximity to the upper roll to form a primary feed nip. A fabric entering the apparatus between the blade and a smooth compounded upper roll assumes the speed of that roll. The fabric then passes from this primary nip to a second nip formed by the two rolls themselves. The lower roll possessing a higher coefficient of friction than the top roll and traveling at a slower speed than the top roll takes control of the fabric from the top roll because the fabric is being fed into the apparatus at a faster rate by the first nip and is being taken away at a slower rate. At the second nip the column of fabric supported between the nip is under a state of warpwise compression and a fabric having elastic characteristics in the direction of the warp yarns alone is created.

Stretched fabric developed in the piece according to the methods heretofore known have resulted in a product having a certain degree of stretch. It is found that in general these fabrics are limited to less than 25% extensibility in either the warp direction or the filling direction. The reason for this low degree of stretch is due to the fact that compacting in the direction of the warp yarns of a preformed fabric is limited by the necessity that in most fabrics the warp yarns must be of high twist construction and under tension during weaving operation, both these high twist and high tension characteristics tending to restrict the degree to which a fabric may be compacted in the direction of the warp yarns. When a fabric is compacted by relying upon the internal contractions inherent in high twist yarns by subjecting a preformed fabric prepared from high twist yarns to agitation, the yarns themselves will provide a limiting factor to the degree of compaction which may be obtained. A second limiting factor to the degree of stretch obtainable from internal yarn contractions is that the agitated fabric held in an untensioned state will buckle badly if extensive contraction is induced within the yarns.

It is therefore an object of this invention to provide by means of external forces a sheet material having stretch characteristics in excess of 25%.

It is another object of this invention to provide a fabric having stretch characteristics in the direction of the filling yarns without noticeable buckling of the fabric.

It is a further object of this invention to provide a process for the preparation of a fabric having stretch characteristics in the direction of the filling yarns by application of external forces.

It is an additional object of this invention to provide a process for the preparation of a fabric having stretch characteristics in the direction of the filling yarns from preformed fabrics.

In accordance with this invention it has now been discovered that a stretch sheet material may be developed in the piece by securing a nonelastometric sheet material in a preselected configuration, subjecting the sheet material to multidirectional sheet contacting mechanical compacting forces applied uniformly across the sheet and fixing the sheet material in its compacted configuration. The sheet material may be sheet materials such as for instance, paper, nonwoven fabrics, woven fabrics, knitted fabrics and the like. In the event that the sheet material is a woven fabric, stretch characteristics may be produced in both the warp and fill yarn directions by securing a preformed woven fabric, having a construction which may be compacted, in a preselected configuration and preferably a wrinkle-free configuration, subjecting the fabric to external mechanical fabric contacting compacting forces applied uniformly across the fabric in the warp and fill yarn directions and fixing the fabric in its compacted configuration. It should be understood that the preselected configuration may be a configuration designed to produce either a substantially flat fabric surface or a textured fabric surface, that is to say, pebble effects and the like. Preferably a fabric having stretch characteristics in the fill yarn direction is prepared by securing a fabric of a construction which may be compacted in the fill yarn direction in a wrinkle-free configuration, subjecting the fabric to external mechanical fabric contacting compacting forces in the fill yarn direction and fixing the fabric in its compacted configuration.

A better understanding of the invention may be had from a discussion of the drawings:

FIGURE 1 is a broken schematic illustration of one means for securing a preformed fabric in wrinkle free configuration and compacting by means of external forces.

FIGURE 2 is a cross sectional view of the apparatus of FIGURE 1 taken along the line II—II.

FIGURE 3 is an enlarged photograph of a polyester

worsted fabric prior to compacting by means of external forces.

FIGURE 4 is an enlarged photograph of a polyester worsted fabric subsequent to compacting by means of external forces.

FIGURE 5 is an enlarged (twenty power) cross sectional photograph of the fabric of FIGURE 3.

FIGURE 6 is an enlarged (twenty power) cross sectional photograph of the fabric of FIGURE 4.

FIGURE 7 is an enlarged (fifty power) cross sectional photograph of a cotton fabric prior to compacting.

FIGURE 8 is an enlarged (fifty power) cross sectional photograph of a cotton fabric subsequent to compacting by means of external forces.

FIGURE 9 is an enlarged (fifty power) cross sectional photograph of a polyester fabric made from filament yarns prior to compacting.

FIGURE 10 is an enlarged (fifty power) cross sectional photograph of a polyester fabric made from filament yarns subsequent to compacting by means of external forces.

FIGURE 11 is an enlarged (fifty power) cross sectional photograph of a polyester-cotton fabric prior to compacting.

FIGURE 12 is an enlarged (fifty power) cross sectional photograph of a polyester-cotton fabric subsequent to compacting by means of external forces.

Turning to FIGURE 1 of the drawings, a keratinous fiber containing fabric of open weave construction **1** is passed into a reducing agent containing pad bath **2**. It should be understood that the keratinous fiber containing fabric has been selected for purposes of illustration and should not be considered a limiting feature in this invention. The treated fabric is then passed over suitable guine roll **3** into the nip formed by the contacting of an upper continuous belt member **4** and a lower continuous belt member **5**. Each of the continuous belt members **4** and **5** are extensible belts made of suitable elastomeric polymeric materials. Upper belt member **4** contains needle members **6** mounted in the outer face of belt member **4**. Upper continuous belt member **4** and lower continuous belt member **5** are driven by means of drive rolls **7** and **8**, respectively. Upper belt member **4** and lower belt member **5** are held in a fully expanded configuration when in the vicinity of drive rolls **7** and **8** respectively by means of continuous inwardly progressing tenter clip assemblies **9** disposed on either side of continuous belt members **4** and **5**. The individual tenter clip members of tenter clip assemblies **9** upon passing drive roll members **10** secures the edge portions of upper continuous belt member **4** and lower continuous belt member **5** so as to hold belt members **4** and **5** in an expanded configuration. The individual tenter clips of tenter clip assemblies **9** continue to progress inwardly thereby permitting reduction in width of both upper continuous belt member **4** and lower continuous belt member **5** until the individual tenter clips release continuous belt members **4** and **5** in the vicinity of idler roll members **11**. Fabric **1** which is passed into the nip between continuous belt members **4** and **5** is firmly secured by means of needle mmebers **6** which project from upper continuous belt member **4** as the fabric **1** progresses in the direction of travel of continuous belt members **4** and **5**. Fabric **1** is forced to compact substantially to the same degree as continuous belt members **4** and **5** are allowed to contract for reason of the inwardly directed paths of the individual tenter clips which secure the edges of continuous belt members **4** and **5**. When fabric **1** leaves the nip between continuous belt members **4** and **5**, the fabric has been compacted to that degree which belt members **4** and **5** were allowed to contract, that is to say, fabric **1** has been substantially compacted to the same degree as the belt contraction which exists between drive roll **7** and idler roll **12** and drive roll **8** and idler roll **13**. It should be understood that sufficient tension is maintained on upper continuous belt member **4** by means of proper spacing of drive roll member **7** and idler roll member **12** so that continuous belt member **4** is maintained in either its expanded or contracted configuration even though continuous belt member **4** is not secured by tenter clip members throughout the entire length. A similar tensioning is, of course, provided for lower continuous belt member **5** by means of proper placement of drive roll member **8** and idler roll member **13**. Fabric **1** in its compacted state may be wound on a suitable takeup roll **14**. The compacted fabric may then be set in its compacted configuration by means of a decating operation or any other operation which is suitable for oxidation of reducing agent treated keratinous fibers so as to reform or restore a substantial proportion of the cystine linkages originally present and reform or restore a substantial proportion of the hydrogen bonds originally present.

The exact functioning of the tenter clip assembly may be better understood by turning to FIGURE 2 of the drawings. As may be seen in FIGURE 2 which is a cross section of FIGURE 1 of the drawings, taken along the line II—II, individual tenter clip members **30** of tenter clip assemblies **29** secure the edge portions of upper continuous belt member **4** and lower continuous belt member **5**, individual tenter clip members **30** also serving to force pin members **6** of upper continuous belt member **4** into the fabric **21** which is being compacted. It should be understood that if it is desired to exert compacting forces in both the warp and filling directions that the apparatus may be modified so as to allow the belt members to contract in a warpwise direction as well as in a fillingwise direction. The mechanical features of the individual tenter clips **30** have not been dealt with in detail as such tenter clips are items of commerce and readily available from manufacturers such as for instance Edward Parkinson Manufacturing Company, Inc., of Esmond, R.I.

Fabrics which are suitable for compacting according to the process described herein are any fabrics which are prepared with a reeded out construction, that is to say, any fabrics which have a construction such as will admit compacting along the direction of the filling yarns. Specific textile materials which may be employed in the construction of such fabrics are any textile materials which will lend themselves to a setting operation subsequent to or simultaneously with a compacting operation. As previously mentioned the setting operation may be any of the setting operations well known to the art such as for instance, the use of a reducing agent setting operation for yarns containing keratinous fibers; the use of cross-linking agents in the setting of cellulosic type yarn and the use of heat-setting mediums for thermoplastic yarns; the selection of the particular setting medium being employed depending, of course, upon the type of fiber present to the greatest degree in the yarn or the percentage of fibers of a particular nature coupled with the ability of such fibers to retain a permanent set.

The yarns employed in the fabrics suitable for compacting according to the process described herein are both high and low twist yarns. It should be understood, however, that the process of this invention lends itself to the preparation of stretch fabrics from fabrics containing yarns of lower twist multiple than may be employed in processes which require internally generated compacting forces. When stretch fabrics are prepared by means of internally generated compacting forces such as in the process described in U.S. Patent No. 3,077,655, worsted wool yarns having a twist multiple in excess of about 2.6 must be employed. When stretch fabrics are prepared according to the process set forth herein, however, worsted wool yarns having a twist multiple of less than about 2.6 may be satisfactorily employed. Correspondingly, low twist woolen system yarns may also be satisfactorily employed, that is to say, woolen system yarns having a twist multiple of less than about 8 and preferably from about 5 to about 8 may be employed. Twist multiple is a term common to the textile industry and may be defined as

turns per inch divided by the square root of the yarn count.

The following specific examples for the preparation of the stretch fabrics of this invention are given for the purpose of illustration and should not be considered as limiting the spirit or scope of this invention:

EXAMPLE I

An all wool fabric having 35 ends per inch and 29 picks per inch and having a warp and filling yarn count of 4.6 woolen run was passed into a reducing agent bath comprising an aqueous solution of sodium borohydride at a concentration of about 2% by weight. The reducing agent treated fabric is then passed through a set of squeeze rolls and then into the nip formed by contacting two continuous belt members, the belt members being in an expanded condition at the point of receiving the reducing agent treated fabric. The continuous belt members are then allowed to laterally contract thereby exerting external compacting forces on the reducing agent treated fabric and causing the fabric to compact to a degree which is substantially identical to the degree of contraction of the belt members. The fabric is then wound upon a decating roll and subjected to a twenty minute aging operation at a temperature about 80° F. The fabric is then dried in a Fleissner drier (relaxed drum drier) at 200° F. After drying the fabric is semi-decated with a cycle of steam breakthrough plus a ten second steaming followed by two minutes vacuum pumping. The wool fabric, set in its compacted configuration, is found to have a substantial degree of stretch along the direction of the fill yarns. The stretch fabric is found to have 46 ends per inch and 23 picks per inch.

EXAMPLE II

A 55% polyester, 45% worsted wool fabric having 49 ends per inch and 43 picks per inch and a worsted warp yarn count of 20/1 and a worsted filling yarn count of 20/1 is fed into the nip formed by contacting two continuous belt members, each of the two belt members being in an expanded configuration upon initial contact with the fabric. The continuous belt members are then allowed to laterally contract about 40% thereby compacting the fabric to about the same degree as the contraction of the belt members. Simultaneous to the compacting operation the polyester/worsted wool fabric is subjected to a heat treatment at temperatures approaching a suitable thermal transition point of the polyester fibers. The compacted fabric upon emerging from the nip of the continuous belt members is found to have 40% stretch when subjected to a load of two pounds per inch of fabric sample width and an unrecovered stretch of 3.9%, the unrecovered stretch being reported on the basis of percentage of the original length after being held five minutes at 30% extension and allowed to recover five minutes after unloading.

EXAMPLE III

A 100% cotton fabric having 76 ends per inch and 70 picks per inch is fed into the nip formed by a pair of continuous belt members, the belt members being in an expanded state at their initial point of contact with the fabric. The continuous belt members are then allowed to contract laterally about 35%, the degree of contraction of the belt members approximately corresponding to the degree of compaction which is obtained in the cotton fabric. The cotton fabric is then set in its compacted configuration by treatment with a dihydroxy dimethylol ethyleneurea cross-linking agent. The final product is found to have 35% stretch under a load of two pounds per inch of sample width and to have a 5.6% unrecovered stretch, the unrecovered stretch being reported at percent of original length after being held five minutes at 30% extension and allowed to recover five minutes after unloading.

EXAMPLE IV

A polyester continuous filament yarn having 144 ends per inch and 100 picks per inch and having a 40 denier yarn count in both the warp and filling directions is subjected to the same processing operation as set forth in Example II. The finished product is found to have 227 ends per inch and 99 picks per inch and to have a 34% stretch at a load of two pounds per inch of sample width with 8.0% unrecovered stretch, the unrecovered stretch being reported as percent of original length after five minutes at 30% extension and allowed to recover five minutes after unloading.

EXAMPLE V

A 65% polyester, 35% cotton fabric having 92 ends per inch and 76 picks per inch and a yarn count (cotton system) of 50/1 in both the warp and filling direction is processed according to the procedure set forth in Example II. The finished product is found to have 121 ends per inch, 74 picks per inch and to have a stretch of 35% under a load of two pounds per inch of sample width with an unrecovered stretch of 5.4%. The unrecovered stretch is reported as percent of original length after being held five minutes at 30% extension and allowed to recover five minutes after unloading.

EXAMPLE VI

A fabric having a fiber content of 65% polyester and 35% cotton and a construction of 87 ends per inch and 67 picks per inch is processed according to the procedure set forth in Example II, the lateral contraction of the belt members being about 42%. The fabric having a yarn count in the cotton system of 40/1 in both the warp and filling directions is a fabric having 113 ends per inch, 62 picks per inch and a stretch of 42% under a load of two pounds per inch of sample width, the unrecovered stretch being 5.8%. The unrecovered stretch is reported as percent of original length after being held five minutes at 30% extension and allowed to recover five minutes after unloading.

EXAMPLE VII

A fabric having a fiber content of 65% polyester/35% rayon and having a fabric construction of 64 ends per inch and 60 picks per inch with a yarn count on the cotton system of 20/1 in both the warp and filling direction is processed according to the procedure set forth in Example II. The final product is found to be a fabric having 90 ends per inch, 56 picks per inch and a stretch of 30% a load at two points per inch of sample width. The unrecovered stretch is found to be 5.5%, unrecovered stretch being reported as percent of original length after being held five minutes at 30% extension and allowed to recover five minutes after unloading.

The determination of elasticity in the finished product as reported in the foregoing examples was determined by cutting test specimens 2 inches by 24 inches with the longer length being parallel to the stretch direction. The upper end of the test specimen is then secured to a clamp member while the lower end of the test specimen is subjected to a load of four pounds (two pounds per inch). The specimen is then exercised by cycling three times between a zero load and a two pounds load at approximately five seconds per cycle. The increase in length is then recorded within 30 seconds after the completion of the fourth loading cycle. The increase in length over the initial length multiplied by 100 is then recorded as the percent stretch.

The extent to which a fabric has been compacted and correspondingly given stretch characteristics is readily discernible from a review of FIGURES 3 through 12 which are enlarged photographs of fabrics and fabric cross sections prior to compacting and subsequent to compacting operations. The cross sections in each of FIGURES 3 through 12 are cross sections made by cutting through the warp yarns. The increase in both frequency

and amplitude of the filling yarns may be seen in each set of fabric cross sections subsequent to compacting. It is important to note that the finished stretch fabric prepared according to the process of this invention may be a fabric having low twist yarns, the low twist yarns, of course, having greater bulk and resulting in a fabric having a superior hand than fabrics prepared from the high twist yarns which are necessary in the preparation of fabrics compacted by internal forces. While the stretch fabrics of this invention may be prepared from either high or low twist yarns, it is an important feature of the present invention that stretch fabrics may be prepared from yarns having insufficient twist to produce internal compacting forces.

We claim:

1. A method for impairing stretch characteristics to a woven fabric having an open weave comprising the steps of securing said fabric in a preselected configuration, reducing the width of the fabric to produce a stretch in the fill direction in excess of 25% by sequentially applying external forces on the edges of said fabric in the fill direction, maintaining the body of said fabric in wrinkle-free condition while applying said external forces and setting said fabric in its reduced configuration.

2. A method for imparting stretch characteristics to a woven fabric having an open weave comprising the steps of: securing said fabric in a preselected configuration, sequentially applying a plurality of external compacting forces on said fabric to reduce the width thereof, maintaining said fabric in a wrinkle-free condition while applying said external compacting forces and setting said fabric in its compacted configuration.

References Cited

UNITED STATES PATENTS

2,021,975	11/1935	Wrigley et al.	26—18.6
1,971,211	8/1934	Cluett	26—18.6
2,618,012	11/1952	Milnes.	
2,674,023	4/1954	Foley	26—57
2,849,781	9/1958	Rosen	26—18.6
2,979,131	4/1961	Benton.	
3,100,925	8/1963	Messinger	26—18.6
3,316,610	5/1967	Manock	28—76 XR

FOREIGN PATENTS

16,595	1911	Great Britain.

ROBERT R. MACKEY, *Primary Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,409,960 November 12, 1968

Joseph H. Dusenbury et al.

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 16, "performed" should read -- preformed --. Column 3, line 35, "guine" should read -- guide --; line 61, "mmebers" should read -- members --. Column 6, line 49, "points" should read -- pounds --; line 62, "pounds" should read -- pound --. Column 7, line 16, "impairing" should read -- imparting --.

Signed and sealed this 10th day of March 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents