Sept. 15, 1970 L. A. RUNTON 3,528,763

PRODUCING STRETCH FABRIC THROUGH USE OF CHEMICAL MODIFIERS AND A PLURALITY OF TENSION ZONES

Filed Aug. 3, 1964 2 Sheets-Sheet 1

Fig. 2

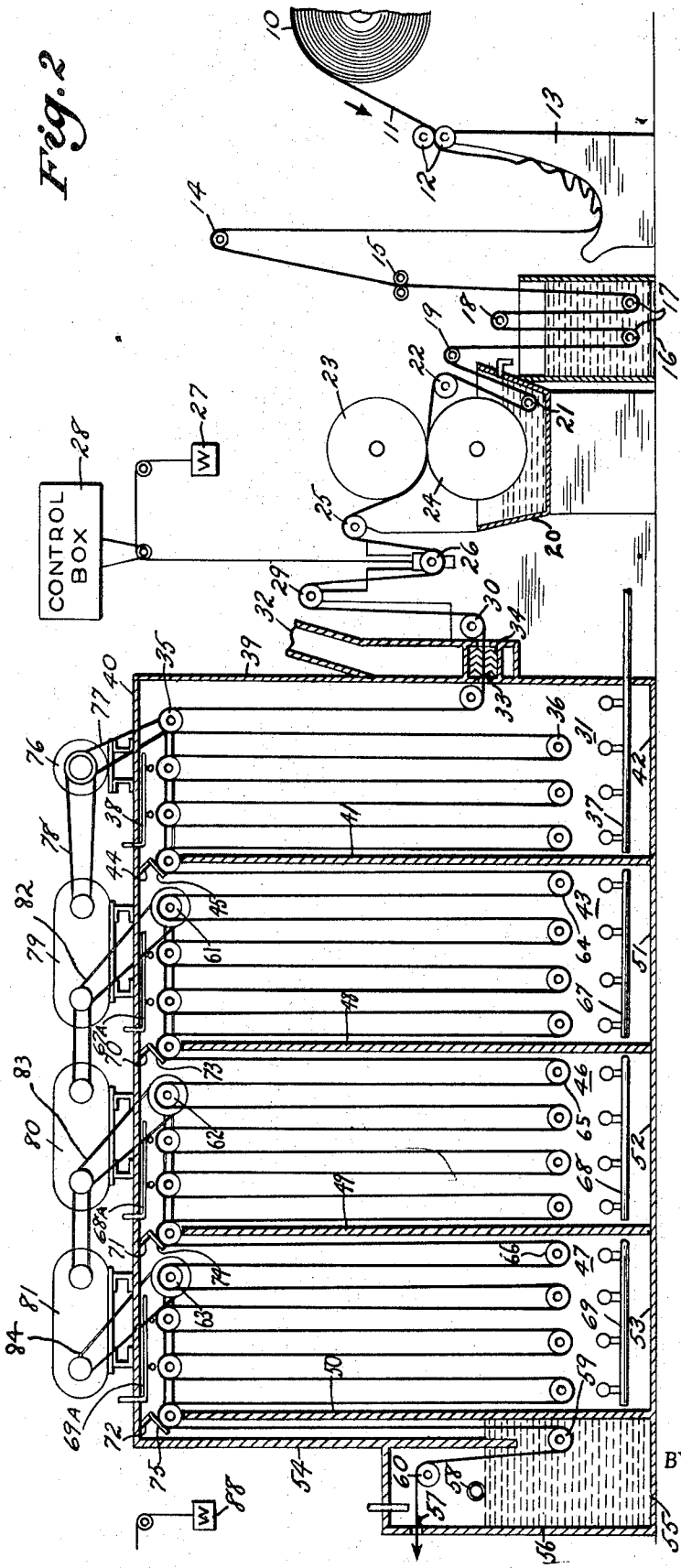
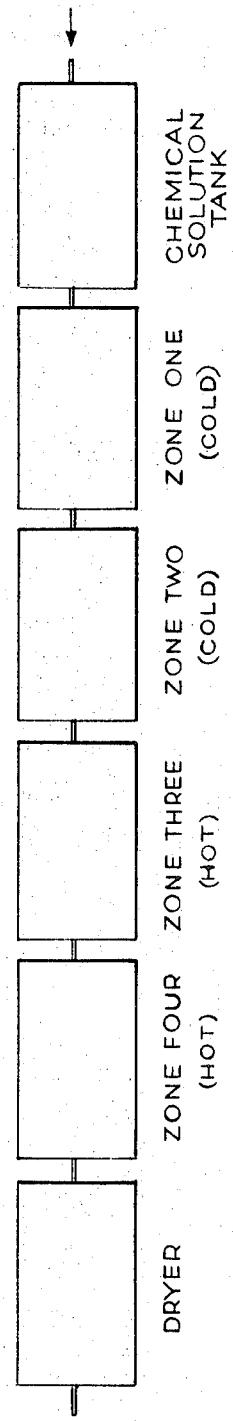


Fig. 1



INVENTOR.
LESLIE A. RUNTON
BY Thomas M. Hammond
ATTORNEY

Sept. 15, 1970 L. A. RUNTON 3,528,763

PRODUCING STRETCH FABRIC THROUGH USE OF CHEMICAL MODIFIERS AND A PLURALITY OF TENSION ZONES

Filed Aug. 3, 1964 2 Sheets-Sheet 2

Fig. 2A

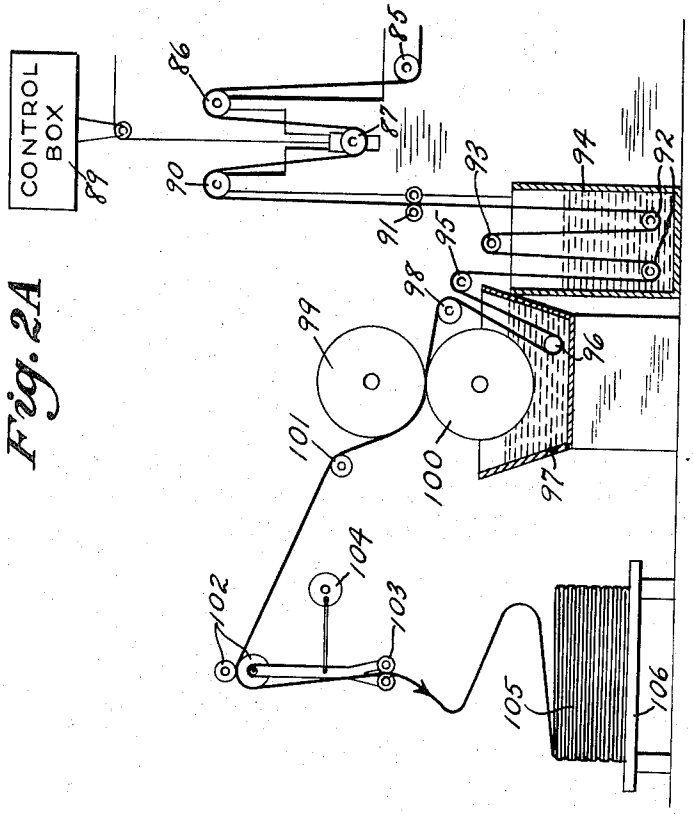
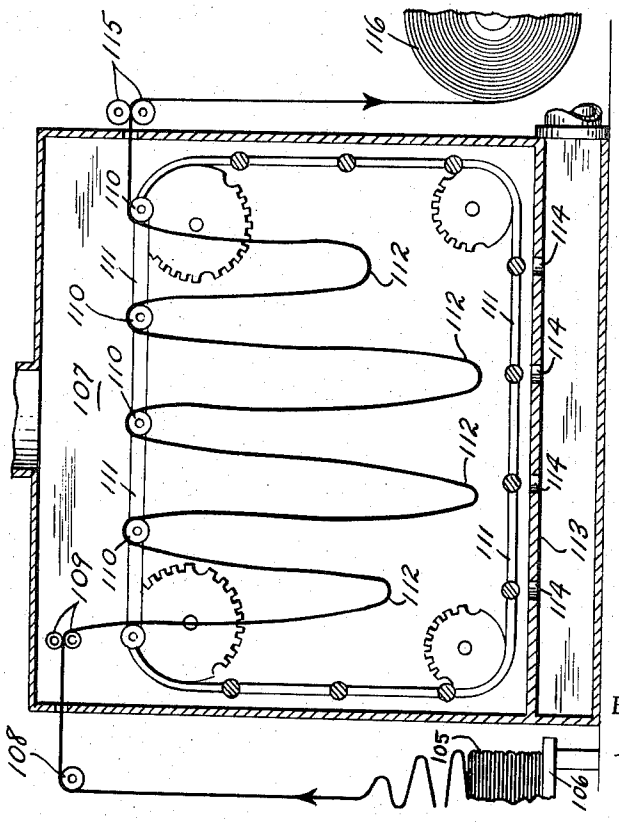


Fig. 3



INVENTOR.
LESLIE A. RUNTON
BY Thomas M. Hammond
ATTORNEY

United States Patent Office 3,528,763 Patented Sept. 15, 1970

3,528,763

PRODUCING STRETCH FABRIC THROUGH USE OF CHEMICAL MODIFIERS AND A PLURALITY OF TENSION ZONES

Leslie A. Runton, Middle Haddam, Conn., assignor to J. P. Stevens & Co., Inc., New York, N.Y., a corporation of Delaware

Filed Aug. 3, 1964, Ser. No. 387,101
Int. Cl. D06m 1/10, 3/06; D06c 3/00
U.S. Cl. 8—125 7 Claims

ABSTRACT OF THE DISCLOSURE

A fabric is treated with a shrinking agent and led through a series of zones under successively increasing warp tension to produce stretch characteristics in the fill direction thereof.

This invention relates to textiles. More particularly, the invention relates to a process and apparatus for the production of stretchable woven fabrics having the ability to stretch and to recover substantially completely after repeated extension throughout the life of the fabrics.

Fabrics having substantially permanent stretch and recovery properties are known. Although these known fabrics have achieved wide commercial acceptance, it is desirable to provide fabrics of this type which have increased stretch while maintaining properties of recovery. Current processes and apparatus are suitable for the production of such fabrics having a stretch factor of just over 20 percent in a filling-wise direction as well as in a warp-wise direction. However, attempts to produce fabrics having much more than 20 percent filling-wise stretch by present methods and apparatus have generally not been successful or result in complete breakdown of the fabric by fiber and/or yarn breakage. On the other hand, the present process and apparatus provide woven fabrics having filling-wise stretch as high as 50 percent and more, as well as substantially complete recoverability from repeated extension throughout the life of the fabrics.

In accordance with the invention there is provided a process for producing woven fabric having stretch characteristics comprising disposing woven fabric having a tension applied to the warp yarns sufficient to straighten the yarns in a warp-wise direction in a treatment zone for a period of time and at a temperature sufficient to cause deformation of the filling yarns in the fabric, conducting the fabric from the first zone to one or more additional zones while increasing the warp tension on the fabric in an amount sufficient to take up any slack which has formed in the warp yarns due to elongation thereof, and maintaining the fabric in the additional zone or zones for a time and at a temperature sufficient to cause further shrinkage of the filling yarns and forming fabric having stretch characteristics.

In the practice of the invention, the instant process can be carried out continuously, semicontinuously, or as a unitary process and the fabric treated in accordance therewith exhibits excellent properties of stretch in a filling-wise direction.

Fabric which can be treated in accordance with this invention varies widely with respect to the materials from which it is made. The fabric can be made from filamentary synthetic materials such as polyamides, polyesters, acrylics, polyolefins and other suitable synthetic filamentary materials. The fabric can also be made from natural fibers such as wool, cellulosics, such as cotton, or proteinaceous material such as silk and the like. If desirable, fabric processed in accordance with the invention can be made of a blend of natural and synthetic fibrous

materials in either the filling and/or the warp yarns. On the other hand, the filling yarns or the warp yarns can be made entirely of one type of fiber. In those cases where fabric which contains a blend of natural and synthetic fibrous materials is processed in accordance with the invention, the blend of fibrous materials is one in which the individual fibrous materials in the blend generally attain stretch characteristics when treated under similar conditions. For example, in order to get maximum benefit of the instant process, fabric containing a blend of polyamide and wool in the filling yarns can have filling stretch properties imparted thereto by application of heat and moisture at a temperature of about 105° C.

Regardless of the particular fibrous material in fabric processed according to the invention, the fabric is woven fabric with the weave being sufficiently open to provide space between neighboring yarns. Moreover, the yarns in the fabric can be in a twisted or untwisted state, depending at least in part on the particular material from which the fabric is made. As an example, where a single continuous filament yarn, such as a polyamide or polyester yarn or the like is being utilized, twist is not necessary. On the other hand, where the yarn is made up of a number of filaments or if it is a spun yarn, at least enough twist is needed to hold the yarn together and to eliminate felting and fiber migration. In this connection where spun yarns are utilized, twist should be normal to 10 percent above normal. On the other hand where a number of continuous filaments are employed to make up a yarn, a producer's twist of approximately one-half turn to one turn is often sufficient to hold the filaments together.

As mentioned hereinabove the process includes disposing the fabric in a series of zones, at least two in number. However, the exact number of zones employed will depend upon the particular fabric being processed. For example, cotton fabric having desirable stretch characteristics is obtained by carrying out the process in an apparatus having four zones. On the other hand, a polyamide fabric having good stretch characteristics can be obtained by using only two zones. The exact number of treatment zones is dependent upon the ability of the fabric being treated to be further elongated in a warp-wise direction without breakage. As with the number of zones, the temperature in each zone varies in accordance with the fiber being processed.

In general, temperatures in a range of about room temperature, that is, about 20° C. to just less than that which will damage the fibrous material present in the fabric being processed are employed in carrying out the process in the various treatment zones. The temperature for a specific fabric being processed is readily determinable.

Deformation of the yarns in accordance with this invention is to be understood to mean both physical and chemical modification thereof, including crimping and the spatial relationship of the filling yarns with respect to each other and with respect to the warp yarns. The physical and chemical deformation is brought about not only by the application of warp tension to fabric being processed, but also by the temperature to which the fabric is subjected and by the optional use of a chemical agent having the ability to modify as, for example, by shrinking the yarns and fibers to which it has been applied by modifying the chemical structure thereof. Moreover, each of these factors aid in setting the yarns in their deformed condition.

Any chemical reagent which is compatible with the fabric being processed and which has the ability to modify, as by shrinking or otherwise, and to set the yarns is suitable for use in the practice of this invention. An

excellent reagent which can be utilized when wool fabric is being processed is monoethanolamine sulphite. Other known wool modifying agents are also suitable. An excellent reagent which can be utilized in the processing of cotton fabric in accordance with the invention is sodium hydroxide. Numerous other reagents are available as will be apparent to those skilled in the art. It is to be noted, however, that the particular reagent being utilized should not have an effect on yarns present in the fabric other than those which are to be modified by the reagent. In this connection, hot water or steam or the application of dry heat itself are also excellent reagents for bringing about deformation and setting. Where a chemical modifying agent is used, it is normally employed in dilute aqueous solutions of about 50 parts water to 1 part chemical, about 2 percent solution.

As mentioned hereinabove, the number of zones through which a fabric is passed will vary depending upon the particular fabric being treated. Wool, for example, can have the desired stretch properties imparted thereto by first treating it with the shrinking agent and then passing it through three zones wherein the temperature is maintained at approximately 105° C. in each zone, and wherein the warp tension of the fabric is increased by about three percent to four percent between the end of the first zone and the end of the second zone and further increased by a like amount between the second and third zones. On the other hand, excellent stretch properties are imparted to a cotton and Dacron blend fabric in a four zone operation wherein the fabric is first padded with sodium hydroxide solution and then conducted through the first zone under slight tension at a temperature of 20° C., then to a second zone wherein the temperature remains at about 20° C. and the tension is increased by about two percent to three percent, then to a third zone wherein the temperature is increased to about 105° C. and the tension is further increased by about an additional two to three percent, and finally to a fourth zone wherein the temperature is maintained at about 105° C. and the tension is further increased by an additional two to three percent. Nylon fabric, however, is susceptible to having stretch properties imparted thereto merely by subjecting it to a temperature of about 140° C., that is, somewhat below the heat setting point thereof, and subsequently subjecting the fabric to an increased tension of about four to six percent at substantially the same temperature in an additional zone.

Tension placed on a fabric being processed in accordance with this invention and which tension is increased as the fabric is led from one zone to another is dependent upon the time and speed with which the fabric is being led from one zone to another of the apparatus. In this case it is to be noted, as mentioned hereinbelow, that the tension is increased by means of a variable speed device, such as a motor or a positive infinitely variable transmission unit which operates rolls or other advancing means in each zone. In order to obtain increased tension, therefore, the variable speed device of the second zone will operate at a speed greater than the motor of the first zone, and the speed of the rolls in each successive zone is increased by an increase in the speed of the variable speed device operating in conjunction with the rolls of that zone. Generally, the surface speed of the rolls in each successive zone is increased by about two to six percent. For example, if a woolen fabric is being processed at the rate of 94 feet per minute through the first zone, the speed in the second zone is increased to about 97 feet per minute, and speed in a third or final zone is increased to about 100 feet per minute. Obviously the surface speed of the rolls in each zone which are advancing the fabric through the zones are, accordingly, increased by a factor of about 3 percent in the case illustrated. Since modification of fibers in a fabric takes place relatively instantaneously once the conditions of temperature and tension are attained in each zone, the time a fabric remains within a particular zone is not critical, so long as the total times in all of the zones when accumulated does not exceed a period which will damage the fabric. For wool, the time factor is about 1 min. 10 sec. The particular total time factor for a specific fabric being processed is readily determinable. Consequently, once the desired conditions of time temperature and tension are attained in a zone, the speed with which the fabric is passed from that zone to the next successive zone can be as great as is practical under normal operating conditions. In this case, as pointed out above, the fabric can be processed as fast as 90 feet per minute and higher, the upper limitation being dependent only upon the ability of the fabric and the machinery to withstand the higher speeds without damage thereto, once each successive zone has been brought to a temperature and the required tension is applied to a fabric being processed therethrough for a sufficient period of time.

After a fabric has been treated to impart the desired amount of stretch thereto, it is generally led into a drying and/or cooling zone. As a practical matter, although a treated fabric can be permitted to cool or dry in air, it is preferred that positive cooling and drying steps be taken in order to complete the setting. Such measures can include optional washing in water or other reagent to remove any excess modifying reagent which may be retained thereon, or the fabric can be passed through an atmosphere of conditioned air in order to lower the temperature thereof. Drying can be carried out at temperatures in a range of 100° C. to 150° C. or less to as high as temperatures just below that which will damage the fabric. Regardless of what positive steps are taken, the fabric, during this cooling and/or drying treatment, is maintained in a substantially completely relaxed condition in order to permit additional shrinkage and/or setting to take place.

In order to more properly understand the instant process and apparatus useful for carrying it out, reference is made to the attached drawings wherein:

FIG. 1 is a schematic view of the process as applied to a cotton and Dacron blend fabric;

FIG. 2 is a sectional elevation showing one form of apparatus for treating a fabric according to the invention;

FIG. 2A is a sectional elevation showing the part of the apparatus which is located after the treatment zones; and,

FIG. 3 is a sectional elevation of a drying and/or cooling means suitable for treatment of a fabric which has been processed in the treatment zones.

Generally, apparatus suitable for carrying out the process comprises means, such as one or more enclosed treatment zones, means for applying tension to fabric while it is advancing through successive treatment zones including means for progressively increasing the tension on the fabric, and means for regulating the temperature of the treatment zones. In addition, a preferred apparatus will include means for applying modifying agent to a fabric which is subsequently passed through the treatment zones, and means for washing the fabric after treatment in the zones as well as means for collecting the fabric after it has been treated and washed. As an optional part of an apparatus a drying means can also be included in carrying out the practice of the invention. Normally the drying means as set forth more fully hereinbelow is located after the washing means through which a fabric passes after it leaves the treatment zones and before collection thereof on a roll or the like.

Referring more particularly to the drawings, in FIG. 1 the schematic view shows a first station wherein a chemical solution such as sodium hydroxide is applied to a cotton and Dacron fabric to be processed. From there, the fabric is conducted into the autoclave forming zone one wherein a tension is applied thereto in a warp-wise direction and the fabric is subjected under slight tension to the action of the sodium hydroxide at a relatively low temperature, that is, about 20° C. From zone one, the fabric is then conducted to zone two where the tension is increased by about two to three percent and the tem-

perature maintained at 20° C. Thereafter, the fabric is led into zone three wherein it is subjected to a further increase of about two to three percent in tension but at a temperature of 105° C. Finally, the fabric is conducted to the fourth treatment zone wherein the tension is further increased by a factor of about two to three percent and the temperature is maintained at about 105° C. The temperature is normally increased and decreased by the addition of hot water or steam and cold water. When steam is used, the apparatus is constructed so that the zones are sufficiently sealed from the atmosphere to allow enough pressure build-up therein to maintain steam in that state. After the fabric has been passed through the four treatment zones, it is then passed into a drying means where drying takes place while the fabric is maintained in a substantially completely relaxed condition. In actual operation, it is to be noted that before drying, a cotton fabric so treated is also passed through a washing step to remove excess sodium hydroxide therefrom.

With reference to FIGS. 2 and 2A of the drawings, there is shown an apparatus for carrying out the present invention by either a unitary, semicontinuous or continuous process. A strip of fabric **11** is fed from a supply roll **10** by feed rolls **12** and into a J-box **13** where it forms a series of loose folds. It is withdrawn from the J-box over a roll **14** and led to a means for applying a modifying agent thereto by introduction between guide rolls **15** and thence to a tank **16** which contains a solution of chemical reagent such as those mentioned hereinabove. The fabric strip **11** then passes in a succession of folds under a set of other rolls **17** and over a roll **18**, the former being immersed in the reagent in tank **16**. From the tank **16** the fabric **11** passes over a roll **19** into a tank **20** around a roll **21** which is submerged in the solution in the tank, thence over a roll **22** to the bite of a pair of squeeze rolls **23** and **24** which remove excess reagent therefrom. A drain returns solution from the tank **20** to the tank **16**. The upper roll **23** of the squeeze rolls is loaded so as to leave a pickup of about 60 to 80 percent of the fabric weight in reagent on the fabric. The lower roll **24** dips into the solution in tank **20**. From the pair of squeeze rolls the fabric passes over a guide roll **25** under a control roll **26** or like means upon which tension is placed by weight **27** regulated through control box **28**. Next the fabric is passed over a guide roll **29** and under a guide roll **30** into the first treatment zone **31** equipped with a vent **32** by way of vestibule **33** which is equipped with a seal **34** to permit entrance of the fabric into the treatment zone without affecting the operating conditions therein and also to minimize the escape of steam if it is to be utilized during the process. The control roll **26** or like means actuates control box **28** which is connected to the drive of the squeeze rolls **23** and **24** in sequence so that the fabric strip entering the treatment zone is maintained under a constant tension in the warp-wise direction.

In the treatment zone **31** the fabric passes around a series of upper rolls **35** and a series of lower rolls **36** or like means in the form of a series of vertical loops. Steam, or cold or hot water is supplied to the zone **31** through supply pipes **37** and **38** equipped with a series of headers or other suitable means.

Treatment zone **31** is enclosed within walls of which end panel **39**, top member **40**, separating partition **41** and base member **42**, are shown. Separating partition **41** forms a common wall with treatment zone **43** and the upper end of partition **41** is formed by panel **44** suspended from top member **40** and equipped with a seal **45** so that as the fabric passes out of zone **31** to zone **43** the conditions within are not changed. Treatment zones **46** and **47**, located downstream from zones **31** and **43** and which next receive the fabric, are enclosed by separating partitions **48**, **49** and **50**, and base members **51**, **52** and **53** respectively. The top member **40** forms a common panel with these zones and with zone **31**. Finally, end panel **54** and base member **55** form part of a tank **56** containing water functioning as a seal at the exit end of the treatment zones through which the fabric next passes. The tank is equipped with an exit vestibule **57** and an overflow pipe **58**. Located in the tank are guide rolls **59**, under which, and **60**, over which, the exiting fabric passes to the vestibule **57**.

Treatment zones **43**, **46** and **47** are all equipped with upper and lower rolls **61**, **62**, **63**, **64**, **65** and **66** respectively or like means, which correspond to rolls **35** and **36** in zone **31**. Zones **43**, **46** and **47** also are equipped with supply pipes and headers **67**, **68** and **69** below, and **67A**, **68A** and **69** above, connected to sources (not shown) to permit entrance of steam or the like into each zone. Moreover panels **70**, **71** and **72** suspended from top member **40** and equipped with seals **73**, **74** and **75** serve to isolate each zone from the preceding and subsequent areas and maintain conditions within each zone. Side panels (not shown) complete the enclosure of the treatment zones and vents (not shown) permit exit of steam or the like therefrom.

Located above top member **40** is a constant speed main driving motor **76** connected to one of upper rolls **35** through a belt drive **77** which passes outside member **40**. Driving motor **76** is also connected through belt drive **78** to means such as variable speed device **79**, located above member **40** and connected to one of the upper rolls **61**. Variable speed device **79** is in turn connected to a like device **80** which is then connected to still another like unit **81** located above zones **46** and **47** respectively. Devices **79**, **80** and **81** are connected to the upper rolls **61**, **62** and **63** by means of belt drives **82**, **83** and **84**.

As fabric leaves the exit vestibule **57**, a guide roll **85** is provided under which the fabric passes and from which it is led over guide roll **86** and thence under a control roll **87** which has tension placed thereon by weight **88** regulated through control box **89** and on its way to the washing means next passes over guide roll **90** and between rolls **91** under a set of other rolls **92** and over a roll **93**, the former being immersed in a washing tank **94**. Passing from tank **94** the fabric is led over roll **95** and under roll **96**, the latter being disposed in a second washing tank **97**, over a roll **98** to the bite of a pair of squeeze rolls **99** and **100** which are adapted to remove the water from the fabric and leave it in only a moistened condition. From the squeeze rolls the fabric is led to collecting means and passes over a guide roll **101** between a pair of rolls **102** and between a pair of reciprocating rolls **103** which reciprocate through a connection to eccentric **104** and is laid in folds **105** below.

The fabric as it is laid in folds on pallet **106** is then transferred to a drying means such as slack loop dryer **107** as shown in FIG. 3. In those instances where the process is being carried out in a continuous or semicontinuous manner, the pallet **106** may be replaced by a J-box or other suitable arrangement (not shown) from which the fabric is withdrawn at a slower speed than the speed with which it is being introduced in the J-box or the like. This is done in order to maintain the fabric in an essentially tensionless state and in order to feed it into the loop dryer in a substantially completely relaxed condition. The fabric is led over a roll **108** and between driven rolls **109** located within the walls of the slack dryer and over a plurality of spaced bars **110** which are continuously advanced by chain **111** so as to form a plurality of fabric loops **112** which hang from the bars **110** in tensionless state. Hot air, or if desirable, cold air is supplied to the slack dryer **107** through passages by way of the floor plate **113** which contains passages **114** to permit the hot or cold air to enter. Accordingly the dryer is maintained at a temperature suitable for removing the remaining liquid from the fabric being dried. In the dryer some additional modification of the fabric takes place although it remains in essentially a smooth condition. Generally a fabric being processed in a dryer can be subjected to a wide temperature range of 100° C. or less to as much as 150° C. until the moisture content of the fabric is substantially com-

pletely removed. The best temperature for drying a particular fabric is readily determinable. If desirable, the temperature may be measured by an infra-red sensing device and controlled by means used in ordinary dryers of this type. From the dryer, the fabric is delivered between rolls **115** and taken up on a roll **116**.

Fabrics treated in accordance with this invention readily lend themselves to a wide variety of uses. For example, since woolen fabrics when treated with the disclosed process possess excellent stretch characteristics, they are useful in the manufacture of garments such as men's and boys' suits, slacks, sport coats, ladies' and children's dress fabrics and sportswear, and the like. Such garments due to treatment in accordance with this invention generally conform to the body of the wearer with a snug fit and because of the stretch characteristics thereof readily expand and contract permitting the wearer to be comfortable while at the same time allowing for freedom of movement. In addition, because of the stretch characteristics of a garment manufactured from material treated in accordance with the invention, flexibility at the elbows and knees overcomes rapid deterioration to the shape of the garment and to the durability of the wearing qualities.

In addition to the garment field, fabrics treated in accordance with the invention, such as for example, nylon fabrics, make excellent furniture coverings and upholstery fabrics which readily conform to the shape of the article to which they are applied. Moreover, due to the excellent stretch properties of all fabrics processed in accordance herewith, stretch and recovery is substantially permanent and results in long fabric life. However, in the case of cotton fabrics recovery is improved by subsequent known processes which will give the cotton a permanent set. Such cotton fabrics are useful in the manufacture of outer garments and denims which are particularly useful in the field of sportswear.

The term "stretch characteristics" as employed throughout this specification and in the appended claims is to be understood to mean that a fabric when treated in accordance with the present invention has the ability to be repeatedly extended and it will return to its non-extended shape upon release of the stretching force applied thereto in order to bring about extension. In this connection, it is to be noted that generally fabrics can be extended or stretched up to about 6 percent of their original width and/or length. In contrast to this, fabrics treated in accordance with the invention exhibit properties of stretch as great as 50 percent and more. Fore example, woolen fabrics processed in accordance with the invention exhibit properties of stretch in a range of 30 to 45 percent in comparison with a stretch factor of about 6 percent exhibited by like woolen fabrics which are not so processed, and in comparison to stretch characteristics of about 20 percent exhibited by woolen fabrics processed in accordance with known procedures for imparting a stretch thereto.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that the same is not limited to the specific embodiments thereof except as defined in the appended claims.

What is claimed is:

1. A process for producing a fabric having stretch characteristics in the fill direction comprising applying to a woven fabric a chemical reagent capable of causing shrinkage of the filling yarns in said fabric by modifying the chemical structure of said filling yarns, disposing said fabric in a first zone under warp tension sufficient to straighten the warp yarns for a period of time and at a temperature sufficient to cause shrinkage of the filling yarns by reaction therewith of said chemical reagent, conducting said fabric from said first zone into at least one additional zone wherein the warp tension on said fabric is increased to remove slack resulting from elongation of the warp yarns and maintaining said fabric therein for a time and at a temperature sufficient to cause further shrinkage of the filling yarns by further reaction of said chemical reagent with said filling yarns, and washing said fabric to remove excess chemical reagent, thereby developing a fabric having stretch characteristics in the fill direction.

2. A process as claimed in claim **1** wherein after said excess is washed from said fabric, the fabric is dried while in a substantially tensionless state.

3. A process as claimed in claim **1** wherein at least one of said zones said fabric is contacted with steam.

4. A process as claimed in claim **2** wherein said fill yarns contain wool and said chemical reagent is monoethanolamine sulphite.

5. A process as claimed in claim **3** wherein said fill yarns contain cotton and said chemical reagent is sodium hydroxide.

6. A process for producing a fabric having stretch characteristics comprising contacting a woven fabric consisting mainly of woolen filling yarns with monoethanolamine sulphite, disposing said fabric in a first zone under warp tension sufficient to straighten the warp yarns for a period of time and at a temperature of about 105° C. in a moist atmosphere to cause deformation of the filling yarns in said fabric, conducting said fabric from said first zone into a second zone and increasing the warp tension on said fabric by an amount sufficient to remove slack therein resulting from elongation of the warp yarns, maintaining said fabric therein for a time and at a temperature of about 105° C. in a moist atmosphere to cause further deformation of the filling yarns, conducting said fabric from said second zone into a third zone and increasing the warp tension thereon in an amount sufficient to remove slack therein resulting from elongation of the warp yarns, maintaining said fabric therein for a time and at a temperature of about 105° C. in a moist atmosphere to cause further deformation of the filling yarns, removing said fabric from the treatment zone, washing excess monoethanolamine sulphite from said fabric and drying said fabric in a substantially completely tensionless state, thereby developing a fabric having stretch characteristics.

7. A process for producing a fabric having stretch characteristics comprising contacting a woven fabric consisting mainly of cotton filling yarns with sodium hydroxide, disposing said fabric in a first zone under warp tension sufficient to straighten the warps for a period of time and at a temperature of about 20° C. to cause deformation of the filling yarns therein, conducting said fabric from said first zone into a second zone and increasing the warp tension thereon by an amount sufficient to remove slack therein resulting from elongation of the warp yarns and maintaining said fabric therein for a time and at a temperature of about 20° C. to cause further deformation of the filling yarns, conducting said fabric from said second zone into a third zone and increasing the warp tension thereon by an amount sufficient to remove slack therein resulting from elongation of the warp yarns and maintaining said fabric therein for a time and at a temperature of about 105° C. in a moist atmosphere to cause further deformation of the filling yarns, conducting said fabric from said third zone to a fourth zone and increasing the warp tension on said fabric by an amount sufficient to remove slack therein resulting from elongation of the warp yarns and maintaining said fabric therein for a time and at a temperature of about 105° C. in a moist atmosphere to cause further deformation of the filling yarns, removing said fabric from the treatment zone, washing excess sodium hydroxide from said fabric and drying said fabric in a substantially completely ten-

sionless state thereby developing a fabric having stretch characteristics.

References Cited

UNITED STATES PATENTS

891,914	6/1908	Cox	26—68
2,824,383	2/1958	Machalek	26—68
3,266,865	8/1966	Runton et al.	8—127.6 X
3,281,205	10/1966	Runton	8—128

FOREIGN PATENTS

148,327 7/1921 Great Britain.

GEORGE F. LESMES, Primary Examiner

J. CANNON, Assistant Examiner

U.S. Cl. X.R.

8—127.6, 130.1, 149.1; 26—54, 68; 28—76