Aug. 18, 1964 N. L. SELTZER 3,145,132

WOVEN STRETCHABLE FABRICS

Filed Aug. 2, 1961

2 Sheets-Sheet 1

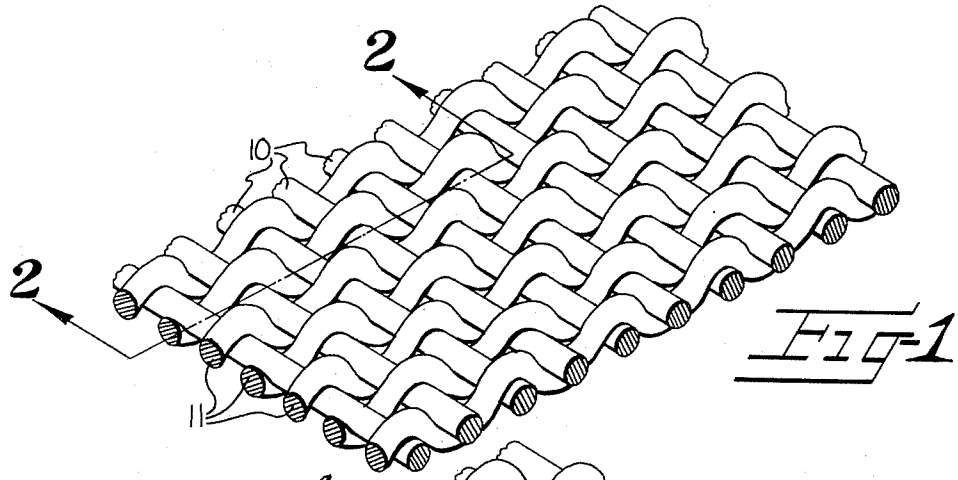


Fig-1

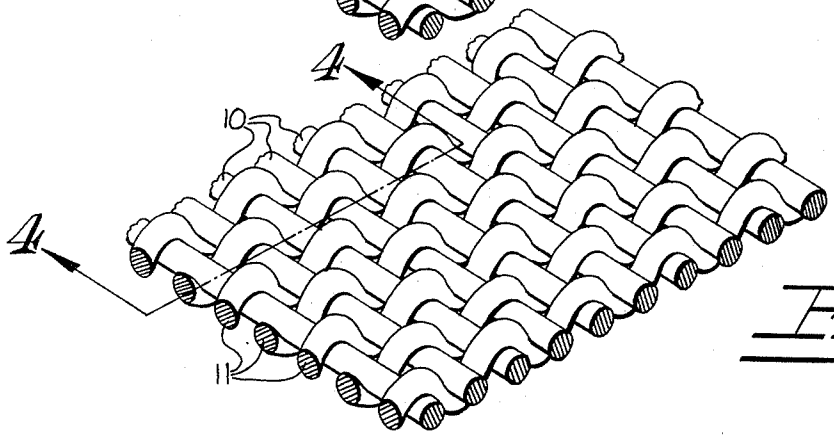


Fig-3

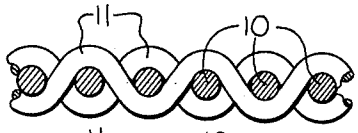


Fig-2

Fig-4



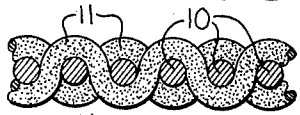
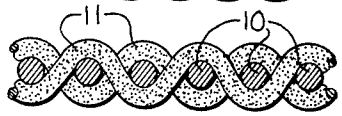


Fig-5

Fig-6



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WOVEN STRETCHABLE FABRICS

Filed Aug. 2, 1961 2 Sheets-Sheet 2

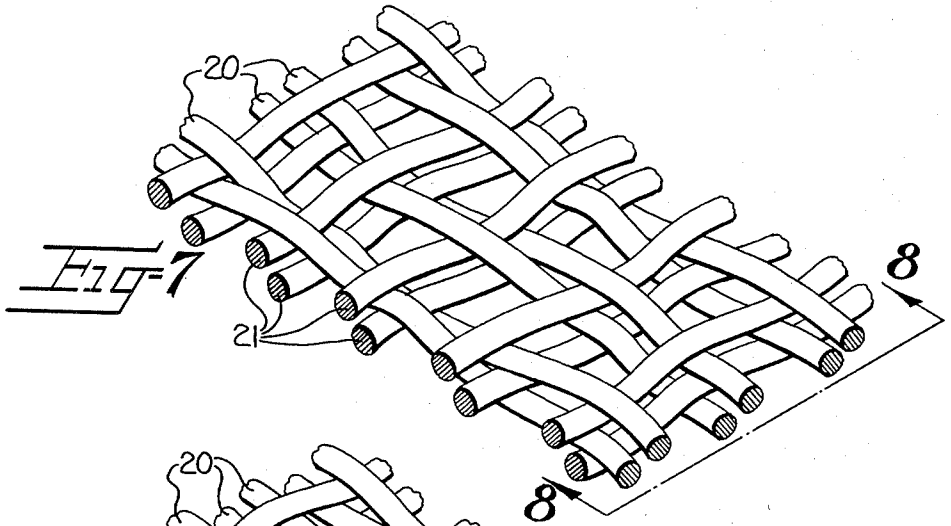


Fig-7

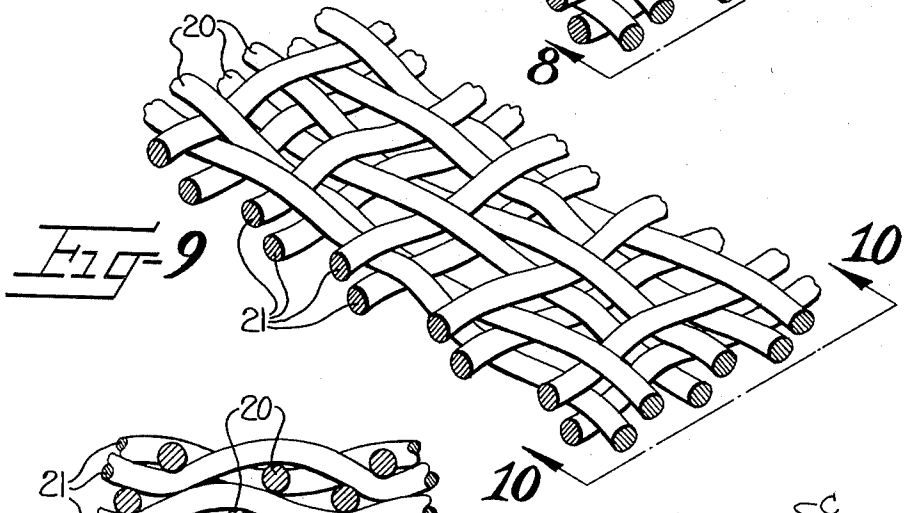


Fig-9

Fig-8

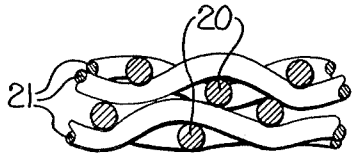


Fig-10

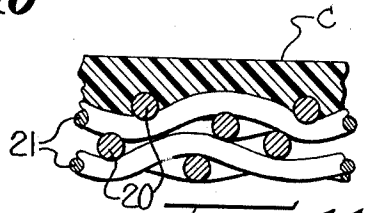


Fig-11

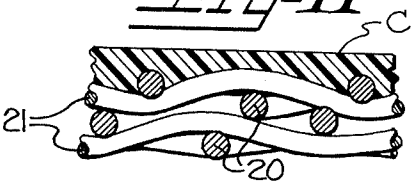


Fig-12

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3,145,132

WOVEN STRETCHABLE FABRICS

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13 Claims. (Cl. 161—90)

This invention relates generally to woven stretchable fabrics which are particularly adapted to be treated with a stabilizing material in the nature of an impregnation or coating, with the resulting fabrics having many enhanced and novel characteristics over prior art fabrics.

There are two general types of stabilizing treatments that are applicable to this invention. In the first, the fabric is impregnated with a relatively minor amount of material such as resins or other fabric modifiers consisting essentially of thermosetting resins and cross-linking reactants to impart wrinkle-resistance, crease recoverability, dimensional stability, and quick-drying properties to textiles such as apparel fabrics. Such finishes, in which the outward physical appearance of the fabric is essentially unaltered, have attained considerable commercial success as "wash and wear" finishes.

The second type of stabilizing treatment involves the use of a relatively large amount of resin to coat or cover the fabric, frequently obscuring the weave, so that the fabric serves as a matrix or base for a coating of a generally elastomeric or thermoplastic resin. Such applications are familiar as upholstery material, luggage covering, and many other uses.

Prior art fabrics utilizing either type of stabilizing treatment suffer from at least two drawbacks. Either type of application results in a decrease in the tear strength of the fabric and either application decreases the inherent toughness of the fabric. In the case of "wash and wear" type finishes, these drawbacks are directly traceable to the stabilization treatment immobilizing the yarns to a large degree and reducing their natural resiliency, which prevents the yarns from "giving" under certain stress conditions, particularly large or exaggerated stresses. The decrease in these qualities has the serious consequence of definitely limiting the field of utility of these two types of treatment. The decreased tear strength and toughness resulting from such treatment frequently necessitates the use of a stronger initial base fabric than is really needed—i.e., in order to meet a certain commercial standard of tear strength and toughness after treatment, the hitherto inevitable loss of a part of those valuable properties has been compensated for by overdesigning the base fabric—that is, by selecting a base fabric with tear strength and toughness substantially in excess of the tear strength and toughness expected after conventional treatment. This is obviously an undesirable and uneconomical expedient.

In prior art treatment of the first type, for example where a thermosetting resin is used, the thermosetting resin applied is generally of a non-extensible nature, and it is applied to a woven fabric with very modest extensibility. The application of a stress to such a treated fabric, therefore, means a decreased tear strength, as well as lack of recovery, because there is no provision in the fabric for any appreciable degree of coaction between fabric yarns and resin.

In prior art treatment of the second type, a thermoplastic coating is applied which is potentially capable of considerably greater elongation than the elongation of commercial base fabrics. Stress or deformation of such coated fabrics results in the pulling or tearing away of the elongatable coating from the yarns, with loss of product utility. Again, there is no provision in prior art woven base fabrics for coaction between coating and

base fabric, so that coating and fabric can work together as a unitary structure.

I am aware that efforts have been made to overcome these objections by the use of stretchable base fabrics such as knitted goods, or crepe weaves. However, knitted fabrics are notoriously unstable, having a tendency to stretch almost without restriction. For example, in finishing knitted goods, a pull on the fabric in the direction of feed results in difficulty in controlling the stretch thereof as well as causing a narrowing or "pull in" of the width thereof. Therefore, the processing of suitable knitted fabrics in resin application is normally difficult or impossible. Thus, the problems attendant to controlling the stretchability of knitted fabrics have limited the market and use thereof. Furthermore, the fact that suitable knitted fabrics, per yard, are generally more expensive than woven fabrics has further contributed to the limited use thereof. Crepe fabrics have likewise a definite instability, and additionally have a pebbled surface which demands repeated coatings before a smooth finish is obtained.

Moreover, in treatments of the first or "wash and wear" type, no treatment can make the fabric appear otherwise than as a knitted fabric or a crepe fabric, which limits the use of these materials. Furthermore, in the case of knitted fabrics provided with thermoplastic coatings, the surface of the coating does not normally attain the desired smoothness, but continues to exhibit a somewhat roughened or non-uniform appearance.

It is the essence of this invention that I have found that it is possible to so design, produce, and finish a woven base fabric as to enable it to coact with a stabilizing treatment of either the first or second type, whereby the defects of prior art fabrics are overcome. Not only do the treated fabrics of my invention possess an enhanced toughness and tear strength over similarly treated prior art woven fabrics, but they also show both an increased degree of recovery of the original state, and a definitely increased speed of such recovery, upon the release of applied stress. This is particularly important in the apparel field, where garments may be fashioned with the desirable characteristics of "wash and wear" properties combined with an easy yield to and quick recovery from stretching, bending, and deformation in general. These results, so far as I am aware, are not attainable in prior art fabrics.

It is a primary object of this invention to provide a woven base fabric, having considerable stretchability, and which is particularly adapted to be impregnated or coated with stabilizing materials of the types described, and wherein the base fabrics and stabilizing materials coact and work together as a unitary structure to provide stabilized stretchable fabrics of enhanced toughness and tear strength, and wherein the fabrics exhibit both an increased degree of recoverability, as well as speed of recoverability following any stretching thereof.

It is a more specific object as one aspect of this invention, to provide woven "wash and wear" type fabrics which have for the first time the important characteristic of a wide range of stretchability, as well as enhanced tear strength, toughness, and quick recoverability from stretching, even at high elongation, to thus permit such fabrics to be readily utilized in the apparel field, wherein these properties contribute materially to the comfort, wearability, and life of the garment.

Briefly, the foregoing objects are accomplished by suitably interweaving normally non-stretchable warp and weft yarns formed of staple fibers, such as cotton, to provide a woven fabric of the desired dimensions. This woven fabric is then suitably treated, as by a strong contracting and swelling agent, to reduce the dimensions

of the fabric in at least one direction while simultaneously imparting crimp to the yarns in this direction, thus making the fabric stretchable. The fabric is then treated with a stabilizing material while in this contracted condition to resiliently maintain the yarns in their crimped condition, thus imparting quick recoverability to the fabric to return the fabric to unstretched condition following any stretching thereof.

The type of stretchable base fabric with which the present invention is primarily concerned is one in which the mesh or distance between the interwoven yarns is relatively small and the cover factor is at least eight or more. Also, the yarns utilized are preferably made from cellulosic and water-swellable fibers and of a non-stretchable nature, such as cotton, rayon, or blends or mixtures thereof and are within the range of from 12/1 to 50/1. Further, the yarns which extend in the stretchable direction have a twist multiple within the range of from 3.5 to 7. The sum of warp and filling yarns per inch may vary within the range of from 60 to 160 and the base fabric may be stretched within the range of from 15 to 50 percent with a stretch of approximately 30 percent being preferred.

The term "non-stretchable" yarns, as used herein, is directed to those yarns such as cotton and rayon which are normally non-heat-shrinkable and which inherently have little stretchability and to distinguish these yarns from those yarns of a true stretchable nature, such as texturized nylon, stretchable yarns, rubber, or the like.

The term "wash and wear" finish or treatment, as used herein, is to define those stabilizing materials consisting essentially of thermosetting resins and/or cross-linking reactants which impart the desired characteristics to the fabric, with the outward physical appearance of the fabric being essentially unaltered.

Some of the objects of the invention having been stated, other objects will appear as the description proceeds, when taken in connection with the accompanying drawings, in which—

FIGURE 1 is a greatly enlarged isometric view of a small portion of one type of woven fabric which may be rendered stretchable and then have a "wash and wear finish" applied, illustrating the appearance of the interwoven warp and weft yarns before the fabric is reduced in size;

FIGURE 2 is an enlarged vertical sectional view taken substantially along the line **2—2** in FIGURE 1 and illustrating the spaced apart relationship of one group of yarns and the manner in which the yarns of the other group are sinuously interwoven therewith;

FIGURE 3 is an isometric view of the fabric shown in FIGURE 1 and illustrating its appearance after the dimensions thereof have been reduced in one direction;

FIGURE 4 is an enlarged vertical sectional view taken substantially along the line **4—4** in FIGURE 3 and illustrating the manner in which the yarns of one group are drawn closer together and the sinuosity of the yarns in the other group is increased;

FIGURE 5 is a view similar to FIGURE 4 with the speckles on the yarns representing a relatively light-weight stabilizing treatment of thermosetting material applied thereto to resiliently maintain the fabric in the unstretched condition;

FIGURE 6 is a view similar to FIGURE 5 but showing the relationship of the yarns when the thermosetting treated fabric is stretched to substantially its outermost limit;

FIGURE 7 is a view similar to FIGURE 1 except showing a modified form of woven fabric which may be rendered stretchable and then coated with a relatively heavy-weight film of thermoplastic resin, illustrating the appearance of the interwoven warp and weft yarns before the fabric is reduced in size;

FIGURE 8 is an enlarged vertical sectional view taken substantially along the line **8—8** in FIGURE 7 and illustrating the spaced apart relationship of one group of yarns and the manner in which the yarns of the other group are sinuously interwoven therewith;

FIGURE 9 is a view similar to FIGURE 7, but illustrating its appearance after the dimensions thereof have been reduced in one direction;

FIGURE 10 is an enlarged vertical sectional view taken substantially along the line **10—10** in FIGURE 9 and illustrating the manner in which the yarns of one group are drawn closer together and the sinuosity of the yarns in the other group is increased;

FIGURE 11 is a view similar to FIGURE 10 and illustrating a relatively heavy coating or film of thermoplastic resin such as vinyl applied to one face of the fabric and the coating acting to resiliently maintain the fabric in unstretched condition; and

FIGURE 12 is a view similar to FIGURE 11, but showing the relationship of the yarns when the fabric is stretched to substantially its outermost limit.

Stretchable woven fabrics of varying constructions may be produced in accordance with the present invention, with the desired end uses of the fabrics determining the size and manner in which the yarns are interwoven. Generally, the fabric is woven with a somewhat open-mesh to provide sufficient space for at least one group of yarns to be moved closer together to effect a reduction of the dimension of the fabric in this direction. However, the yarns do not have to be spaced so far apart that the fabric appears to be open mesh when viewed with the unaided eye. The openness of the weave should be sufficient, however, to prevent an undue crowding together of the yarns as the fabric is contracted, thereby preventing buckling, wrinkling or the like of the type which is characteristic of crepe fabrics.

While the amount of stretchability of the fabric will in large part be controlled by the yarn spacing and the ability of at least one of the groups of yarns to contract, the yarn size, the number of yarns per inch and the weave of the fabric also exert an influence on the stretchability thereof. The woven stretchable fabric of the present invention is not substantially increased in thickness by the contraction thereof and has no visible crinkles or wrinkles so that the resulting fabric may have a "wash and wear" finish applied thereto or be coated with thermoplastic type resins by any of the known methods.

The stretchable "wash and wear" fabrics may be used to make stretchable fitted sheets for beds and cribs, mattress ticking, shirts, dresses, uniforms, pajamas, shorts, or heavier clothing, such as blue jeans and the like and outerwear, such as raincoats, jackets and the like. The stretchable fabrics which are coated with thermoplastic material may be used as household and automotive upholstery material, waterproof articles of clothing, shoes, luggage, wall coverings, boat covers, girdles, brassieres, and the like wherever recoverability and conformability are desired.

A general description of the preferred method of producing the stretchable "wash and wear" type fabric and the coated type fabric will be given first, and then specific examples will be set forth. It is believed that with the general description and specific examples, those skilled in the art will be able to readily adapt the teachings of the present invention to a wide range of stretchable fabrics without departing from the spirit of the invention.

In forming the base fabric, groups of warp and filling yarns may be interwoven in a plain weave, a sateen weave or any other desired weave as long as the spacing between the yarns is sufficient to allow the fabric to be reduced in at least one dimension following the weaving operation. After the fabric is woven, its dimension is reduced in at least one direction by any suitable means, such as by wetting the fabric in the presence of a strong swelling and contracting agent, such as caustic soda, to contract the fabric and impart increased sinuosity and crimp to the

yarns. Also, the fabric may be reduced by mechanical means in which at least one group of the yarns is moved closer together to impart crimp to the yarns running in the opposite direction.

While the fabric is in at least partially reduced or contracted condition, the desired stabilizing material is applied thereto to resiliently maintain the fabric in its contracted condition. The thus treated fabric may then be stretched or elongated, in the direction in which it has previously been contracted, within the range of from 15 to 50 percent, with the stabilizing material serving to quickly return the fabric to its contracted relaxed condition more quickly following the release of stresses thereon.

There are a number of different types of "wash and wear" finishes available which may be utilized to resiliently maintain the stretchable fabric in its relaxed contracted condition and the type of finish used will depend, to a large degree, upon the end use of the stretchable fabric. These "wash and wear" finishes, as stated earlier, consist essentially of thermosetting resins and/or cross-linking reactants and are normally applied to the fabric by impregnation without essentially altering the outward physical appearance of the fabric. Suitable thermosetting resins for this purpose are triazone, urea formaldehyde, melamine formaldehyde, etc. Examples of suitable cross-linking reactants are epichlorohydrin, formaldehyde, and divinyl sulfone.

For obtaining a relatively heavy coating on the fabric, resins such as a thermoplastic type vinyl or polyurethane may be applied to one face of the fabric to provide a stretchable water repellent or impervious material in which the base fabric provides a stretchable carrier or support for the relatively heavy coating.

In testing both types of treated fabrics produced in accordance with the present invention, it has been generally found that the amount the fabric recovers after elongation, particularly high elongation, is increased. Also, when the stretchable fabric is provided with a "wash and wear" finish of the first type, the tear strength is unexpectedly higher than the tear strength of a similarly treated non-stretchable fabric. Furthermore, when the stretchable fabric is treated with a "wash and wear" finish or coated with thermoplastic material, the "snap back" or rate of recoverability of the fabric is greater than the rate of recoverability of the untreated fabric.

The yarns which extend in the non-stretchable direction of the fabric are preferably formed of twisted staple fibers which are generally given a normal amount of twist, and the yarns which extend in the stretchable direction of the fabric may be twisted with a twist multiple of from 3.5 to 7, which is calculated in the usual manner by dividing the square root of the yarn size into the turns per inch of the yarn. Since the amount of twist in the yarns will effect, to some extent, the surface smoothness of the stretchable fabric, it is preferred that the yarns which extend in the stretchable direction have a twist multiple no greater than seven to avoid the obtaining of crepe yarns which result in a pebbled surface on the fabric.

In order to more clearly illustrate the invention, the following examples disclose specific stretchable fabrics which have been given both types of stabilizing treatments. Also, the results of various tests conducted on these fabrics are set forth in the examples. It is to be understood that the following examples are merely given as illustrations which may be followed to produce certain types of woven stretchable fabrics and that other types of stretchable fabrics may be produced by varying the constructions thereof or the type of stabilizing materials applied, as desired.

WASH AND WEAR

Referring to FIGURES 1 through 6, there is shown a woven fabric of the type which is suitably treated with a thermosetting resin or cross-linking reactant after it has been woven and then rendered stretchable in one direction. In weaving the fabric shown in FIGURES 1 and 2, a plain weave is utilized to interweave the warp yarns, indicated at **10**, and the filling or weft yarns, indicated at **11**. The warp yarns **10** are formed of cotton staple fibers which are processed to produce a yarn having a cotton count size of 31.5/1 and a normal twist multiple of 4.2. In weaving the grey fabric shown in FIGURE 1, 92 warp yarns per inch are utilized and the fabric is woven 50 inches wide.

The filling yarns **11** are formed of cotton staple fibers which are processed to produce a yarn having a cotton count size of 30/1 and a twist multiple of 6.5. The grey fabric shown in FIGURE 1 contains 60 filling yarns per inch. The cover factor of this grey fabric is calculated in the usual manner by dividing the square root of the yarn size into the number of yarns per inch in the fabric. Thus, the warpwise cover factor is 16.7 and the filling wise cover factor is 10.9.

The grey fabric shown in FIGURE 1 is then subjected to a causticizing, scouring and bleaching process which results in a fillingwise contraction and reduction of the fabric to produce a stretchable fabric such as that illustrated in FIGURE 3. Furthermore, the caustic treatment causes the yarns to shorten, thereby increasing the twist or turns per inch. It will be noted as shown in FIGURES 3 and 4 that the sinuosity of the filling yarns **11** has been increased to thus impart considerable crimp to the yarns. Also, the causticizing process has caused the filling yarns to draw the warp yarns **10** closer together. The processed fabric has 105 warp yarns per inch and 58 filling yarns per inch with a warpwise cover factor of 18.9 and a fillingwise cover factor of 10.6.

The process for causticizing, scouring and bleaching the fabric is preferably continuous with the fabric being pulled forward warpwise, which further aids in increasing the sinuosity of the filling yarns. The process includes subjecting the grey fabric to an open-width saturation of from 100 to 110 pick up percent based on dry weight of the fabric in a sodium hydroxide (NaOH) concentration of 26° Tw. at a temperature of from 95 to 105 degrees F. The fabric is then steamed in a J tube for 30 minutes at a temperature of from 200 to 220 degrees F., washed and then continuously subjected to the conventional scouring and bleaching process. The causticized, scoured and bleached fabric is finished 43 inches wide and is stretchable in a fillingwise direction.

The stretchable fabric (FIGURES 3 and 4) is then further treated by applying blueing and optical brighteners, drying, padding on a low-chlorine-retentive triazone type thermosetting resin containing approximately eight percent active resin in the bath, appropriate metal salt catalysts, softeners and hand-builders, 68 percent of which are picked up at 85 degrees F. The thermosetting resin treated fabric is then dried on a tenter frame at 275 degrees F., calendered and heat-cured at 325 degrees F. for 90 seconds, and wound into suitable bolts or rolls with a fabric width of 44½ inches.

Tests have been conducted on the causticized, scoured and bleached stretchable fabric before the resin finish is applied thereto and tests have also been conducted on the resin finished fabric.

In testing the stretchable fabric shown in FIGURES 3 and 4, prior to its being subjected to a resin treatment, it has been found that it will stretch 30 percent in a fillingwise direction at break. Also, it will recover a relatively low percentage of the amount stretched, particularly when elongated or stretched near its upper limit. Thus, the amount of stretch recovery of the causticized, scoured and bleached fabric is relatively low.

The following chart indicates the percentages of stretch

of the base fabric when various forces are applied in a fillingwise direction:

Stretch in Response to Force

Force, lb./in.	Percent stretch
5	19.7
10	22.9
15	24.9
20	26.9

The stretch recovery of the causticized, scoured and bleached fabric has been calculated by stretching fabric strips in a fillingwise direction, new ones each time, to various distances ranging from 10 to 90 percent of their total elongation at break, relaxing the strip for two minutes and then determining the percentage of stretch recovered during this period. This test was conducted on an Instron Tester with the "C" cell set at 20 pound load, the cross head speed being 5"/minute, the chart speed being 10"/minute. The following chart gives the results found:

Stretch		Recovery	
Inches Per 5"	Percent of Stretch	Inches Recovered	Percent of Stretch Recovered
0.15	3.0	.135	90.0
0.45	9.0	.365	81.1
0.75	15.0	.500	66.6
1.05	21.0	.415	44.3
1.35	27.0	.360	26.8

In testing the stretchable thermosetting resin finished fabric (FIGURES 5 and 6), it has been found that it will stretch 24 percent in a fillingwise direction at break, and that it will recover a relatively high percentage of the amount stretched. For example, the following chart indicates the percentage of stretch of the fabric when various forces are applied in a fillingwise direction:

Stretch in Response to Force

Force lb./in.	Percent stretch
5	16.8
10	19.3
15	21.2
20	23.0

The results of the stretch recovery test of the stretchable resin finished fabric are listed in the chart below:

Stretch		Recovery	
Inches Per 5"	Percent of Stretch	Inches Recovered	Percent of Stretch Recovered
0.36	7.2	.36	100.0
0.60	12.0	.545	91.1
0.72	14.4	.600	85.7
0.84	16.8	.650	74.2
1.08	21.6	.690	63.1

A comparison of the stretch recovery characteristics of the stretchable resin finished fabric with those of the stretchable fabric before the resin finish is applied thereto reveals that the resin finished fabric quickly recovers a greater percent. Also, the percentage of filling stretch at break (30 compared to 24 percent) is not greatly reduced, and the ability to stretch in response to given forces is not substantially reduced by the resin finish, particularly when the higher forces are applied.

The filling toughness of the resin finished stretchable fabric has also been determined by multiplying the fillingwise tensile strength (26.9 lbs.) by the percent of filling stretch at break (24), and then dividing this product by two. This calculation results in a filling toughness of 323 in the resin finished stretchable fabric.

The filling toughness of a standard prior art resin treated non-stretchable "wash and wear" type broadcloth fabric having the same construction as the stretchable resin treated fabric of the present invention has been determined to be 172 based on a fillingwise tensile strength of 30.8 and a filling stretch at break of 11.2.

In comparing the filling toughness figures, it is apparent that the stretchable "wash and wear" fabric of the present invention has almost twice as much toughness. This contributes materially to increasing the life and wearability of the fabric.

The tear strength of the aforementioned prior art "wash and wear" fabric has been found to be 3.03 lbs. in a warpwise direction and 1.53 lbs. in a fillingwise direction. The tear strength of the resin treated stretchable fabric of the present invention is 3.42 lbs. in a warpwise direction and 2.59 lbs. in a fillingwise direction. It should be noted that the tear strength in both directions has been considerably increased, with the fillingwise tear strength exhibiting a 70 percent increase.

Modulus of elasticity tests have also been conducted on these two fabrics. The prior art "wash and wear" fabric had a modulus of 4.48 as compared to 2.96 for the stretchable fabric of this invention. The substantially lower modulus figure of the instant invention is thus indicative of a much greater compliance of the fabric to yielding under stress conditions.

Although the conventional "wash and wear" fabric and the stretchable "wash and wear" fabric of the present invention have substantially the same appearance to the eye, and fabric of the present invention is much more desirable because of its ability to readily stretch and yield, its ability to recover quickly, its markedly increased tear strength and its greatly enhanced filling toughness.

COATED FABRIC

Referring to FIGURES 7 through 12, there is shown a woven fabric of the type which is adapted to be coated with a thermoplastic resin after it has been rendered stretchable in one direction. In weaving the fabric shown in FIGURES 7 and 8, a special type of open weave is utilized to interweave the warp yarns indicated at **20**, and the filling yarns, indicated at **21**. The weave pattern is shown in the following draft form diagram, in which the horizontal rows of squares represent picks of filling yarns **21** and the vertical rows represent the manipulation of warp yarns **20**.

		X	
X	X	X	
	X		
	X	X	X
			X
X	X		X
X			
X		X	X

The warp yarns **20** are formed of cotton staple fibers which are processed to produce a yarn having a cotton count of 22/1 and a normal twist multiple of 4.2. In weaving the grey fabric shown in FIGURES 7 and 8, 80 warp yarns per inch are utilized and the fabric is woven 76 inches wide. The filling yarns **21** are formed of cotton staple fibers which are processed to produce a yarn having a cotton count size of 30/1 and a twist multiple of 6.5, with the fabric having 60 filling yarns per inch. The cover factor is 17 in the warpwise direction and 10.9 in the fillingwise direction.

The grey fabric shown in FIGURES 7 and 8 is then subjected to a continuous causticizing and bleaching process similar to that previously described, which results in a fillingwise reduction of the fabric to render the fabric stretchable fillingwise, as illustrated in FIGURES 9 and

10. The fabric is finished 57½ inches wide with 2.01 running yards per pound. The fabric contains 100 warp yarns per inch and 64 filling yarns per inch, with a warpwise cover factor of 21.3 and a fillingwise cover factor of 11.7.

The stretchable fabric is then given a thermoplastic coating of vinyl resin on one face thereof (FIGURES 11 and 12) which reduces the running yards per pound of the fabric to 0.58. The coating, indicated at C, is then cured or dried and the stretchable coated fabric is wound into suitable bolts or rolls.

In testing the stretchable fabric prior to being coated, it has been found that it will stretch 39.6 percent in a fillingwise direction at break, stretches varying amounts in response to various amounts of force being applied thereto, and will quickly recover only a relatively low percentage of the amount stretched, particularly when elongated or stretched near its upper limit.

The following chart is representative of the percentages of stretch of the uncoated fabric when various forces are applied in a fillingwise direction:

Stretch in Response to Force

Force, lb./in.	Percent stretch
5	21.0
10	25.4
15	28.0
20	30.1

The stretch recovery of the uncoated fabric has been calculated in a similar manner as previously explained. The following chart gives the results found:

Stretch		Recovery	
Inches Per 5″	Percent of Stretch	Inches Recovered	Percent of Stretch Recovered
0.20	4.0	.100	50.0
0.62	12.4	.484	75.0
1.03	20.6	.745	74.5
1.24	24.8	.695	57.3
1.44	28.8	.780	53.7
1.65	33.0	.590	35.9
1.85	37.0	.310	16.9

In testing the stretchable vinyl coated fabric (FIGURES 11 and 12), it has been found that it has increased stretch (44 percent) as compared to the uncoated fabric (39.6 percent), and that it will quickly recover a relatively high percentage of the amounts stretched. For example, the following chart indicates the percentages of stretch of the fabric when various forces are applied in a fillingwise direction:

Stretch in Response to Force

Force, lb./in.	Percent stretch
5	11.1
10	20.7
15	28.2
20	33.5

The results of the stretch recovery test of the stretchable vinyl coated fabric are listed in the chart below:

Stretch		Recovery	
Inches Per 5″	Percent of Stretch	Inches Recovered	Percent of Stretch Recovered
0.22	4.4	.165	72.5
0.66	13.2	.575	88.5
1.10	22.0	.865	79.3
1.54	30.8	1.160	74.3
1.98	39.6	1.415	71.2

A comparison of the stretch recovery characteristics of the stretchable vinyl coated fabric with those of the stretchable uncoated fabric reveals that the vinyl coated fabric quickly recovers a much greater percentage. Also, the filling stretch at break is greater after the vinyl coating is applied (44 compared to 39.6) and the ability to stretch in response to given forces is not substantially reduced, particularly when the higher forces are applied.

The filling toughness of the vinyl coated stretchable fabric has also been determined by multiplying the fillingwise tensile strength (78) by the percent of filling stretch at break (4) and then dividing the product by 2. This calculation results in a filling toughness of 1716 in the coated stretchable fabric.

The uncoated stretchable fabric has a fillingwise tensile strength of 32.4, and the percent of filling stretch at break is 39.6. Thus, the filling toughness of this uncoated fabric is 642. Comparing this figure with the toughness (1716) of the coated fabric, it is apparent that the coated fabric has almost triple the toughness thereof.

In summation, it is apparent that the woven fabrics of this invention exhibit not only an ability to readily stretch and yield under stresses, but after being treated with a coating or "wash and wear" finish have an enhanced toughness and tear strength over prior art woven fabrics. Furthermore, these treated fabrics have an increased degree of recovery or "snap back," even at high elongation, and an increased speed of such recovery upon the release of applied stress.

It is evident that these fabric characteristics have been obtained in a most economical manner which contributes materially to the earlier enumerated varied uses thereof.

In the drawings and specification, there have been set forth several embodiments of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being defined in the claims.

I claim:

1. A woven stretchable fabric having relatively quick recoverability comprising interwoven groups of non-stretchable warp and filling yarns imparting a relatively smooth appearance to the fabric, the number of yarns per inch and the size of the yarns being sufficient to provide a cover factor of at least eight in the direction of each of said groups of yarns, and at least one group of said yarns being normally non-heat-shrinkable and having a twist multiple within the range of from 3.5 to 7 and following a sufficiently sinuous path that the fabric will stretch within the range of from 15 to 50 percent in a direction corresponding to said one group of yarns and recover therefrom, and a stabilizing material having been applied to the fabric and resiliently maintaining the fabric in non-stretched condition while still allowing the fabric to be stretched within its above-recited range of stretchability and for quickening the recovery therefrom, said stabilizing material being selected from the group consisting of thermosetting resins and cross-linking reactants.

2. A fabric according to claim 1 wherein said one group of yarns following said sinuous path are filling yarns and wherein the fabric will stretch approximately 30 percent in a fillingwise direction.

3. A woven stretchable fabric having relatively quick recoverability comprising interwoven groups of cellulosic warp and filling yarns imparting a relatively smooth appearance to the fabric, the number of yarns per inch and the size of the yarns being sufficient to provide a cover factor of at least eight in the direction of each of said groups of yarns, and at least one group of said yarns having a twist multiple within the range of from 3.5 to 7 and following a sufficiently sinuous path that the fabric will stretch within the range of from 15 to 50 percent in a direction corresponding to said one group of yarns and recover therefrom, and a stabilizing material having been applied to the fabric and resiliently maintaining the fabric in non-stretched condition while still allowing the fabric to be stretched within its above-recited range of stretchability and for quickening the recovery therefrom, said stabilizing material being selected from the group consist-

ing of thermosetting resins and cross-linking reactants which impart desired "wash and wear" finish characteristics to the fabric with the outward physical appearance of the fabric being essentially unaltered.

4. A woven stretchable fabric having relatively quick recoverability comprising interwoven groups of cellulosic warp and filling yarns imparting a relatively smooth appearance to the fabric, the number of yarns per inch and the size of the yarns being sufficient to provide a cover factor of at least eight in the direction of each of said groups of yarns, and at least one group of said yarns having a twist multiple within the range of from 3.5 to 7 and following a sufficiently sinuous path that the fabric will stretch within the range of from 15 to 50 percent in a direction corresponding to said one group of yarns and recover therefrom, and a stabilizing material having been applied to the fabric and resiliently maintaining the fabric in non-stretched condition while still allowing the fabric to be stretched within its above-recited range of stretchability and for quickening the recovery therefrom, said stabilizing material consisting essentially of thermosetting resins and cross-linking reactants which impart desired "wash and wear" finish characteristics to the fabric with the outward physical appearance of the fabric being essentially unaltered.

5. A woven essentially cellulosic fabric having a relatively smooth appearance and characterized by the combination of substantial stretchability and recoverability with a high degree of dimensional stability, said fabric comprising two groups of yarns interwoven with each other, the yarns in one of said groups being disposed in a sinuous path with the sinuosity thereof, together with the number of yarns per inch, the size, twist and weaving of such group of yarns, providing stretchability and recoverability in the fabric, the fabric being stretchable within a range of 15 to 50 percent in the longitudinal direction of said one group of yarns, and said fabric having a stabilizing material applied thereto resiliently maintaining the fabric in non-stretched condition while permitting stretchability within the above range and also quickening the recoverability of the fabric, said stabilizing material being selected from the group consisting of thermosetting resins and cross-linking reactants to include those which impart "wash and wear" finish characteristics to the fabric with the outward physical appearance of the fabric being essentially unaltered.

6. A fabric according to claim 5 wherein said one group of yarns are filling yarns and wherein the fabric will stretch approximately 30 percent in a fillingwise direction.

7. A woven fabric having a relatively smooth appearance and characterized by the combination of substantial stretchability and recoverability with a high degree of dimensional stability, said fabric comprising two groups of non-stretchable yarns interwoven with each other, the yarns in one of said groups being normally non-heat shrinkable and disposed in a sinuous path with the sinuosity thereof, together with the number of yarns per inch, the size, twist and weaving of such group of yarns, providing stretchability and recoverability in the fabric, the fabric being stretchable within a range of 15 to 50 percent in the longitudinal direction of said one group of yarns, and said fabric having a stabilizing material applied thereto resiliently maintaining the fabric in non-stretched condition while permitting stretchability within the above range and also quickening the recoverability of the fabric, said stabilizing material being selected from the group consisting of thermosetting resins and cross-linking reactants to include those which impart "wash and wear" finish characteristics to the fabric with the outward physical appearance of the fabric being essentially unaltered.

8. A fabric according to claim 7 wherein said one group of yarns are filling yarns.

9. A woven cellulosic fabric having a relatively smooth appearance and characterized by the combination of substantial stretchability and recoverability with a high degree of dimensional stability, said fabric comprising two groups of yarns interwoven with each other, the yarns in one of said groups being disposed in a sinuous path with the sinuosity thereof, together with the number of yarns per inch, the size, twist and weaving of such group of yarns, providing stretchability and recoverability in the fabric, the fabric being stretchable approximately 30 percent in the longitudinal direction of said one group of yarns, and said fabric having a stabilizing material applied thereto resiliently maintaining the fabric in non-stretched condition while permitting said stretchability and also quickening the recoverability of the fabric, said stabilizing material being selected from the group consisting of thermosetting resins and cross-linking reactants to include those which impart desired "wash and wear" finish characteristics to the fabric with the outward physical appearance of the fabric being essentially unaltered.

10. A woven fabric having a relatively smooth appearance and characterized by the combination of substantial stretchability and recoverability with a high degree of dimensional stability, said fabric comprising two groups of non-stretchable yarns interwoven with each other, the yarns in one of said groups being normally non-heat shrinkable and disposed in a sinuous path with the sinuosity thereof, together with the number of yarns per inch, the size, twist and weaving of such group of yarns, providing stretchability and recoverability in the fabric, the fabric being stretchable within a range of 15 to 50 percent in the longitudinal direction of said one group of yarns, and said fabric having a stabilizing material applied thereto resiliently maintaining the fabric in non-stretched condition while permitting stretchability within the above range and also quickening the recoverability of the fabric, said stabilizing material consisting essentially of thermosetting resins and cross-linking reactants which impart "wash and wear" finish characteristics to the fabric with the outward physical appearance of the fabric being essentially unaltered.

11. A woven essentially cellulosic fabric having a relatively smooth appearance and characterized by the combination of substantial stretchability and recoverability with a high degree of dimensional stability, said fabric comprising two groups of yarns interwoven with each other, the yarns in one of said groups being disposed in a sinuous path with the sinuosity thereof, together with the number of yarns per inch, the size, twist and weaving of such group of yarns, providing stretchability and recoverability in the fabric, the fabric being stretchable within a range of 15 to 50 percent in the longitudinal direction of said one group of yarns, and said fabric having a stabilizing material applied thereto resiliently maintaining the fabric in non-stretched condition while permitting stretchability within the above range and also quickening the recoverability of the fabric, said stabilizing material consisting essentially of thermosetting resins and cross-linking reactants which impart "wash and wear" finish characteristics to the fabric with the outward physical appearance of the fabric being essentially unaltered.

12. A woven apparel fabric having a stabilizing material applied thereto, said fabric being characterized by the combination of substantial stretchability and recoverability with a high degree of dimensional stability, said fabric comprising two interwoven groups of yarns consisting essentially of cellulosic fibers, at least one group of said yarns in said fabric being characterized by rapid elongating compliance with applied stress and a rapid and substantial recovery after release of said stress, the fabric in the direction of said one group of yarns having at least about 24 percent extension at breaking elongation and a two-minute recovery of at least about 75 percent of its elongation when the fabric has been elongated to about one-half of its breaking elongation, said fabric having a cover factor of at least about 8 in the direction of each of said groups of yarns, and said stabilizing material being

selected from the group consisting of thermosetting resins and reactants which cross-link with cellulose.

13. A fabric according to claim 12 wherein said yarns consist essentially of cotton fibers and said one group of yarns are filling yarns.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,145,132 August 18, 1964

Norman L. Seltzer

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 8, line 30, for "and" read -- the --; column 10, line 9, for "(4)" read -- (44) --.

Signed and sealed this 15th day of December 1964.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents