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PROCESS FOR NON-SHRINKING FIBROUS MATERIALS

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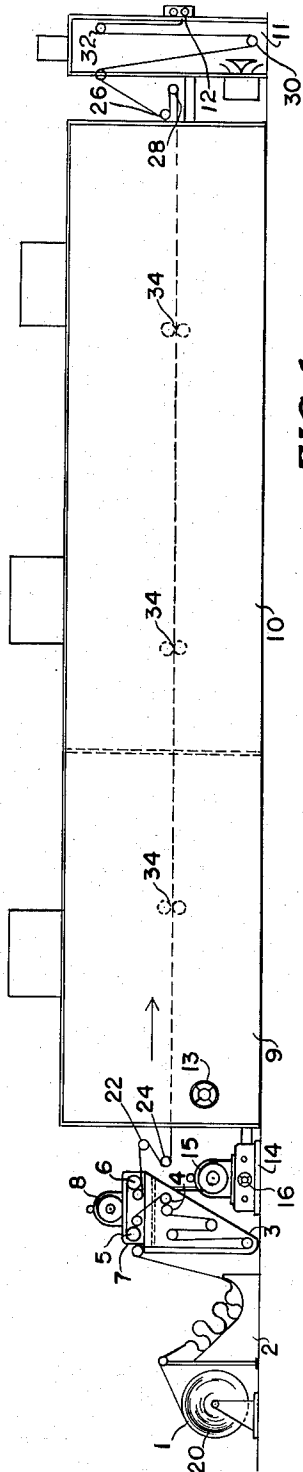


FIG. 1.

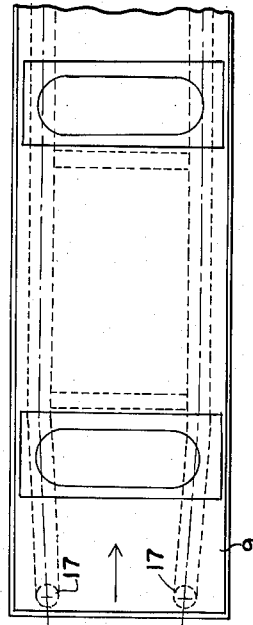


FIG. 3.

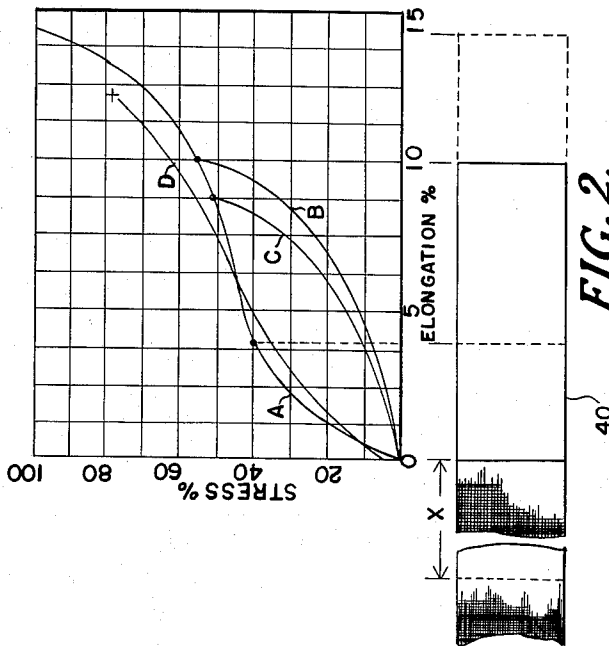


FIG. 2.

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PROCESS FOR NON-SHRINKING FIBROUS MATERIALS

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This invention relates to non-shrinking fibrous materials and processes of producing the same. More specifically, it is concerned with treating dyed or undyed yarns, threads and cords to render them non-shrinking and to improve the other physical properties thereof.

The use of synthetic resins to prevent shrinkage in woven materials and to render them crease-resistant has been known for some time. In such processes the woven materials are greatly weakened by the embrittlement and tendering of the fibers or yarns. The tensile strength is lowered as much as 35% to 50% and the results in the abrasion test (Taber) lowered as such as 30% to 55%. As to crease resistance, the specimens frequently show a return of 20° to 60° when bent at 180° upon itself. The material is weakened at the point of flexure and this becomes marked on repeated bending. From these tests it is apparent that improvements in the use of these synthetic resins are necessary.

In regard to the shrinkage of fibrous materials, particularly that of the woven type, many ways and means have been proposed to prevent this fault, but with little success. These attempts have resulted in most cases in lowering the physical properties of the material itself and giving the same what is known as a bad "hand" or stiffening. It has also been proposed to compress the fibrous material on the warp component under steamed conditions upon itself to compensate for the inherent shrinkage. While this process has been extensively used, yet it actually consumes additional fibrous material in weight proportional to the shrinkage and increases the cost and results in a thicker material. This material also has the disadvantage that under tension it pulls out or becomes extended, especially when wet. It might be well to point out that many factors enter into the shrinkage of material as will be seen, namely, the physical properties of the material, the construction of weave involving twist of yarns and the finishing processes. These factors are true whether the yarns are of staple or filament manufacture, however, the staple yarns show more shrinkage in the woven materials than do filaments. This fact is probably due to a higher twist in the yarn and fiber slipage than would be the case in the filament yarn and is considered to be as much as 15% to 25% more than the woven material constructed from the filament yarn. In this connection the twist, usually referred to as turns per inch (t.p.i.), plays an important role in the yarns and woven materials on account of their helix angles. A high helix angle exerts a kind of pseudo-elasticity or contraction, especially when said materials are wet. This condition causes the yarns to swell and this swelling causes further shrinkage in the material. With repeated washing and drying the material further shrinks. This

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condition is possibly due to a "ratcheting effect" upon the interlaced cross-overs of the yarns and the peripheral fibers or filaments of the yarns trying to accommodate themselves to a new set of imposed conditions. In this respect, the yarns that are less hygroscopic are not so prone to swell as the hygroscopic. Therefore, there is less shrinkage in the material for a given construction. However, a too low helix angle or low twist may invite shrinkage as there is not enough compression upon the fibers or filaments to stabilize them when swollen. This factor also depends on the physical properties of the yarns for a given construction.

It is known that when staple cotton fibers have been treated under tension with certain bonding agents up to the ultimate breaking subpoint of the thread or cord, that the increase in tensile strength is about 75% greater. However, there is little or no elastic return when plotted on the stress-strain curve and the thread or cord presents quite a stiffened condition. Therefore, it is apparent such a process is unsuited for textile purposes and is satisfactory only for preparing a highly stabilized, stiff article of manufacture. On the contrary, fibrous materials for the textile industry must be pliable, elastic and resilient in order to possess a good "hand" and to be durable. These qualities can be shown by appropriate tests, such as determined on stress-strain-elasticity curves, the flexometer and abrasion (Taber) test. In this connection it may be pointed out that individual cellulosic wool and silk fibers have elongations ranging from about 2% to possibly 30%. For instance, the elongation of some of the more common fibers are:

	Percent
Cotton	4 to 9
Viscose rayon (highly stretched)	4 to 7
Viscose rayon (tire cord)	9 to 12
Viscose rayon (normal)	14 to 18
Cuprammonium rayon	15 to 20
Silk	20 to 25
Wool	20 to 25
Nylon	15 to 25
Acetate rayon (highly stretched)	3 to 6
Acetate rayon (normal)	15 to 20

From these values of elongation it can be stated that the true elastic limit or yield point of these materials may represent only 12% to possibly 30% of their elongation. Nylon is an exception since it has an elastic return exceeding these values and up to 100% or unity. These fibers have been considered physically as individual structures, but when they are twisted or made into yarns, threads, cords, and woven materials, there are other physical changes brought about which changes their properties for the particular item. For instance, if one constructs yarns, threads and cords from normal twisted cotton fibers and tests made thereon, it is immediately revealed by the stress-strain-elasticity curves that many changes have taken place.

It is an object of this invention to produce non-shrinkable fibrous materials in the form of yarns, threads, cords, woven materials and the like having improved physical properties including greater tensile strength, wear resistance and crease resistance.

A more specific object is to produce non-shrinkable cellulosic fibrous materials having such improved properties.

Another object of the invention is to prepare woven fibrous materials which are chemically resistant and easily

processed and having greater protection against crocking or bleeding when such materials are dyed.

A further object is to produce woven fibrous materials of increased tear resistance.

Yet another object is to prepare fibrous materials, e.g., work, play and sports clothes in substantially non-shrinkable form and having high chemical, wear, crease and tear resistance and good water-repellency.

A still further object is to prepare threads, yarns, tire cords, shroud lines, fishing lines, ropes and the like having improved stress and strain resistance.

Still further objects and the entire scope of applicability of the present invention will become apparent from the detailed description given hereinafter; it should be understood, however, that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

It has now been found that these objects can be attained by impregnating a fibrous material with a synthetic resin solution or dispersion and subsequently stretching the fibrous material, drying and curing the resin (when a curable resin is employed) while the fibrous material is under tension. The fabric is primarily stretched longitudinally, although for best results it is also stretched laterally with the aid of tenters. The resins should not be of such low melting point as to affect their intended use. The resins can be either thermosetting and/or thermoplastic.

Typical resins include urea-formaldehyde resins (including resin precursors such as dimethylol urea and sesquimethylol urea and alkylated urea-formaldehyde resins, e.g., methylated urea-formaldehyde), phenol formaldehyde resins (including resins where the phenolic component is phenol, cresol, butyl phenol, octyl phenol, etc.), triazine-formaldehyde resins, typical examples of which are shown in Widmer Patent 2,197,357, the entire disclosure of which is hereby incorporated by reference. The preferred triazine-formaldehyde resins are melamine-formaldehyde resins including resin precursors such as dimethylol melamine, trimethylol melamine, hexamethylol melamine and alkylated melamine-formaldehyde resins, e.g., dimethyl trimethylol melamine, trimethylated melamine-formaldehyde resin, etc. Other resins include polyvinyl acetate, polyvinyl chloride, polyvinyl acetate, e.g., polyvinyl butyrate, acrylate esters, e.g., methyl acrylate resin, ethyl acrylate resin and butyl acrylate resin, methacrylate esters, e.g., methyl methacrylate resin, butyl methacrylate resin, glyoxal resins, polyamides, e.g., polymeric hexamethylene adipamide, polymeric cuprolactam, etc., polystyrene, polytetrafluoroethylene, polyacrylonitrile, polymethacrylonitrile, polymeric dimethyl siloxane and polymeric methyl phenyl siloxane. Either homo or copolymers or interpolymers can be employed, or blends thereof.

Generally, there need only be employed as little as 2% to 12% of resin solids based on the fibrous material to be treated, although as much as 15% or 18% or even more of resin can be used.

Preferably, there is used a mixture of a thermosetting resin and a thermoplastic resin. The most preferred mixture is of a partially reacted melamine-formaldehyde resin and an acrylate polymer. The melamine-formaldehyde used is normally at least partially water-soluble and, as previously indicated, can be dimethylol melamine, trimethylol melamine, or a heat-curable or thermosetting alkylated melamine-formaldehyde compounds, specifically methylated melamine-formaldehyde. As the acrylate polymer there can be used polymers of lower alkyl acrylates, including methyl acrylate, ethyl acrylate, n-propyl acrylate, isopropyl acrylate, n-butyl acrylate, isobutyl acrylate, sec-butyl acrylate, etc. or mixtures thereof with each other. There can also be used copolymers of such acrylates with

up to 50% of a different monomeric compound containing a



grouping and which is copolymerizable with the acrylate, e.g., vinyl esters of saturated aliphatic acids, e.g., vinyl acetate, vinyl propionate and vinyl butyrate, styrene, alpha methyl styrene, para methyl styrene, dimethyl styrenes, 2-chlorostyrene, 2,5 dichlorostyrene, fluoro-styrene, cyano styrene, isopropenyl toluene, 2-vinyl pyridine, vinyl thiophene, vinyl fluorene, vinyl chloride, vinyl fluoride, vinyl bromide, vinylidene chloride, acrylonitrile, acrylamide, N-methyl acrylamide, methacrylic acid, methacrylamide, methyl methacrylate, allyl acetate, methylallyl acetate, allyl laurate, etc.

When a mixture of a melamine-formaldehyde and acrylate polymer are employed, they are preferably used in an amount of 2% to 12% of the textile fabric by dry weight. The melamine-formaldehyde is preferably used in an amount of from 1% to 8%, and the acrylate polymer in an amount of 1% to 10% by weight of the textile fabric. Most preferably, the melamine-formaldehyde is used in an amount of 2% to 4%, and the acrylate polymer in an amount of 3% to 8% with the total of the two resins being from 5% to 18%. Usually, the melamine-formaldehyde is used in an amount not greater than the amount of acrylate.

The preferred melamine-formaldehyde resins are Aero-tex M-3 (dimethylated trimethylol melamine), Resloom M-75 (methylated melamine-formaldehyde) and Lanaset (polymethylol melamine). In order to speed up the curing of the curable methylated methylol melamine or other partial melamine-formaldehyde reaction product and to decrease the heating time suitable acid catalysts can be employed in an amount of 0.5% to 10% by weight of the melamine-formaldehyde resin. Typical examples of such catalysts are oxalic acid, methyl acid pyrophosphate, diammonium hydrogen phosphate, phosphoric acid, ammonium chloride, acetic acid, ethyl ammonium phosphate, diammonium phthalate, zinc chloride, etc.

As the acrylate resin there are preferably used the various Rhoplex resins which are alkyl acrylate polymers. They are available as aqueous dispersions of the fully polymerized alkyl acrylate and are colloidal in nature, having a particle size between 0.08 and 0.12 μ mean diameter. Rhoplex MR is believed to be polymeric methyl acrylate and is available as a 50% solids aqueous dispersion. When deposited as a resin film, the film is flexible and elastic, but less so than Rhoplex ER. Rhoplex ER is believed to be an aqueous dispersion (50% solids) of polymeric ethyl acrylate. When deposited as a resin film, the film is soft, elastic, clear, and highly extensible. Rhoplex WN-66 is a 25% solids aqueous dispersion similar in properties to Rhoplex MR.

The compositions of the present invention can be used to treat yarns, threads, cords, woven materials, and other fibrous materials composed substantially or mainly of cellulose or regenerated cellulose, e.g., linen, hemp, jute, ramie, sisal, cellulose acetate rayon, cellulose acetate-propionate rayon, cellulose acetate-butyrate rayon, viscose rayon, cuprammonium rayon, ethyl cellulose and cotton, as well as silk and wool fabrics.

The mixture of resins is normally applied to the textile from an aqueous solution or dispersion. The fibrous material is impregnated with the solution by a 3 bowl mangle or other conventional apparatus so as to have a wet pick-up of about 50% to 100% based on the dry weight of the textile. Drying is then carried out at about 212° F. to 260° F. and curing and polymerization is completed at 260° F. to 375° F. The temperature is maintained for 1 to 30 minutes and the time is inverse to the temperature. The specific temperature depends on the material treated and also the resin employed.

The tension on the textile material during stretching

and curing is preferably between 18% and 75% of the ultimate breaking point and depends on the physical characteristics of the fibrous material and the end result desired.

I have found that using low concentrations of said remains, i.e., resin solids as low as 2% to 12% by weight of the textile permits the textile material to relax and breathe, thus making them pliable, yet strong, and with a good hand. However, these percentages may be higher, e.g., 18% or more, if still greater tensile strength and wear resistance are of importance and the proper resin selected. I have found tensile strengths increased from 10% to 55%, and abrasion resistance increased as much as 400%. Therefore, it is seen that new results have been obtained by taking advantage of the physical change of state of these textile materials by treating them under tension and allowing them to then relax. In this case, immediately after washing said materials and slack drying (relaxing), the materials so processed will contract or shrink to their original count of intended construction without any further dimensional changes. Such textile materials will have a greater tensile strength, resistance to abrasion, creasing and a much increased stabilization of extension than untreated textile materials or textiles treated with resin without the use of tension.

The term "fibrous-set" is used in the specification and claims to describe the condition resulting from impregnating the fibrous materials referred to herein with synthetic resins, drying or drying and curing under tension, and subsequently washing and then drying again. This final washing and drying permits said materials to contract or shrink because, during this process, they are no longer under tension and the physical change of state, such as deformation, elongation, fiber slippage and permanent-set have all taken place. The textile materials will open or breathe and become pliable, as well as contract or shrink to a point representing the actual intended construction count per square inch, thereby indicating unity (100 p.c.) or no further shrinkage.

In the drawings:

Figure 1 is a schematic side elevation of the machine for carrying out the processing of the above-mentioned fibrous materials;

Figure 2 is a graphic representation plotted on a stress-strain curve illustrating the fibrous-set condition of the processed fibrous material as herein described; and

Figure 3 is a top view, looking down on the front end of the machine, and indicating by dotted lines the diverging parallel conveyor tracks of said machine.

Referring more specifically to the drawings, in Figure 1 there is shown a loaded beam 20 on which is wrapped a woven material 1 which passes over to a scray 2 and up into a 3 bowl mangle 3, containing a solution of synthetic resins, e.g., dimethoxy ether of trimethylol melamine and polymerized methyl acrylate. The mangle comprises a series of rollers, as shown, of which rollers 4 are coating and used to squeeze and supply tension to the textile material. From rollers 4 the material moves upward and backward from said solution, having been impregnated and padded, to coating squeeze and tension rollers 5 and across to similar rollers 6 journaled in the housing 7, containing therein a twin variable-speed mechanism of the P.I.V. type. This mechanism permits a positive (no slippage) variable-speed gear ratio between rollers 5 and the power source. This same condition exists relative to rollers 6 and their power source. In this case, the mechanism is driven by a motor 8 mounted on housing 7 by an enclosed silent chain and drives both sets of rollers. On the back of the mechanism are two hand wheels, one for changing the gear ratio of rollers 5 and one for changing the gear ratio of roller 6. Therefore, it is seen by advancing the speed differential of one of these sets of rollers, the material thereon, under tension, would be stretched. For example, when the material being processed is held tightly between the

squeeze and tension rollers 5 rotating at a speed of 60 r.p.m. and rollers 6 are rotating at a speed of 66 r.p.m., the speed differential would be 10% more, increasing the length of the material by 10%, by stretching. The material at this point, having been treated with the synthetic resins, squeezed, stretched and squeezed again, passes over two idler rollers 22 and 24, is now ready to be dried or dried and cured. The material enters the first unit of the drying, curing, and cooling machine, such as drying unit 9, where it may be subjected to a temperature of 212° F. to 260° F., for example. It then passes into curing unit 10 where it is subjected to a temperature of 260° F. to 375° F. for 2 to 12 minutes, depending on the weight of the material and synthetic resin used. Units 9 and 10 may effectively be used as a drying unit for thermoplastic resins by lowering the temperature of curing unit 10 and a higher production obtained, whereas the thermosetting resins usually require a longer specific time for curing. However, the machine may be so proportioned in drying time to that of curing time that it is efficient for the intended purpose. Thus, time and the length of the machine components are reciprocals of each other. The tenter frame of the machine components may be of the pin and/or clip design for good stability of the filling component.

The woven material 1 now passes over two more idler rollers 26 and 28 and up into cooling unit 11 where it is dropped down on idler roller 30, then up over another roller 32 and down the outside between squeeze and tension rollers of coating type 12 to the final washing and drying. It will be noted that the material has been under tension and stretched from rollers 5 through the machine's drying unit, curing unit and cooling unit to rollers 12. The cooling unit serves to cool down the material while still under tension and stretched, somewhat stabilizing it, especially when the thermoplastic resins are used. When the material is washed and dried to clean the same as well as remove some of the uncondensed products therefrom, it will contract or return to its original dimensions by shrinkage to that before being placed under tension or stretching or held at unity. This will be further explained graphically and by examples. Cooling unit 11 may circulate room air at ambient temperatures or the air may be air-cooled, if desired, to a suitable state. Referring to drying unit 9 and curing unit 10, it is known in the art that tenter frames have adjustable means for narrowing or widening the conveyor tracks to suit various widths of material. In this connection it will be noted in Figure 3, by the dotted lines, the diverging parallel conveyor tracks extending back for a short distance as indicated by numerals 17—17. The purpose of this divergence is to expand or stretch the filling component of the material gradually up to the desired width. In this way it will be seen that both the warp and filling components of the material are stretched while being processed in said units. However, it is not necessary to maintain such a condition in cooling unit 11, the material being stabilized at this point. In any case, the filling component of most materials has a shrinkage of only 10% to 30% of the warp component. The conveyor tracks 17—17 may be adjusted or set by the usual hand wheel 13 to proper dimensions. Also shown in drying unit 9 and curing unit 10 are coating rollers 34 at intervals, which serve to stabilize the material while passing through the machine. The rollers 34 may be under varying pressures and adapted to rotate in unison with the machine's speed. The drying and curing machine is equipped with a single variable-speed apparatus 14 for driving the conveyor through the machine and also for driving the coating stabilizing rollers 34, as well as coating squeeze and tension rollers 12, all in unison. This variable-speed apparatus 14 is driven by motor 15 and by an enclosed silent chain. The variable-speed apparatus is also of the P.I.V. type. This variable-speed apparatus permits a variable-speed ratio between the speed

of the motor and the driving speed of the machine itself; thus, by this arrangement, the "lag" or "lead" of the material being processed may be controlled to an exact limit to compensate for too much shrinkage or too much stretching due to drying temperatures or "under-feeding" as well as "over-feeding" the machine and is controlled by hand wheel 16 of apparatus 14. This apparatus also allows the speeding up of the machine for higher production or slowing down for reduced production when the two hand wheels of the twin variable-speed mechanism contained in housing 7 are adjusted to the speed of said machine.

It is to be understood that while the above-described machine may be of the continuous type for treating or processing fibrous materials and the like with synthetic resins, of either the thermoplastic or thermosetting type, or blends thereof, it may be desirable to use the machine as a drying unit in treating with thermosetting resins by lowering the temperature of curing unit 10 as the material is temporarily stabilized dimensionally from drying and move it to other curing units already available in the plant. In this way production may be increased and the cost lowered in processing.

It is desirable to show how fibrous-set is determined in processing fibrous materials with synthetic resins as described in this invention. Referring to Figure 2, a graph is plotted, representing, in a general way, the physical changes of state in fibrous materials when under tension, cured, slack washed (relaxed) and dried in the presence of selected synthetic resins. Underlying the graph there is shown a piece of cotton woven material 40 (low twist), e.g., 30 inches long by 10 inches wide, untreated but framed to these dimensions, representing its intended construction count. Upon washing and drying, suppose the material had "X" shrinkage or 10% in the warp component, as diagrammatically shown by the dotted line from zero to the left. In this case, the material has lost 3 inches of its intended length by shrinkage in the warp component, while the filling component had 2.5% shrinkage of .25 inch, making the net dimensions of the material 27 inches long by 9.75 inches wide, representing a total loss in surface area of 12.3%. (It may be noted the filling component shrinkage is not diagrammatically shown.) Now, if there should be taken an identical material, that is, in construction, frame as mentioned and untreated, stretch said material by tension (stress), e.g., from 0 to 10% elongation (strain), it requires about 58% of its tensile strength to do so, as seen on the stress-strain curve "A," and if stress is continued the material will ultimately break at 14.4% elongation as projected dotted lines of cotton material 40 indicate. As those familiar with stress-strain curves will recognize, at 4% elongation, corresponding to 40% tensile strength, as indicated by the first dot on curve "A," the elastic limit, together with some fiber slippage, is reached and the material will return to 0 repeatedly when stress is removed. From this point on under stress the curve flattens out until it reaches near 10% elongation, 58% of its tensile strength, as stated before, or the third dot on curve "A." At this point the curve goes upward rapidly, denoting a higher orientation, greater crystallization of the molecules in the fiber structure, together with a greater compression upon the fibers, which results in a higher density. However, from the elastic limit, the first dot on the curve, to the ultimate breaking point, deformation and fiber slippage have changed the physical state of the material and it will not return to its original state or back to zero or follow this curve if stress is removed just under the breaking point. This condition termed "permanent-set" is taken advantage of in my invention in combination with the use of synthetic resins. Now, consider the same piece of material in construction and of the same dimensions and frame as before. The material is impregnated or padded with a synthetic resin solution, containing 10% resin

solids, based on the weight of materials. After this is done, the material is run through squeeze and tension rollers, leaving about an 80% pick-up of said solution. The material is then put under tension and is stretched up to 10% elongation, corresponding to the third dot on curve "A," as shown in Figure 2. The material is then dried in this condition at a temperature of 240° F. while progressing through the machine, and then cured in this case at a temperature of 305° F. for 3 minutes. From the curing state, the material is then slack washed (relaxed) in a 0.2% neutral soap solution and rinsed. At this point, and referring to the graph at the third dot, the material is relaxed and will contract by residual elasticity, valence forces and other physical changes along a polytropic curve similar to "B" back to 0. Then, the material is dried at a temperature of 230° F. and conditioned to a moisture regain of about 7%. There is still contraction or a stabilizing phase that takes place. However, the material will not go back further than 0, and where the actual shrinkage "X" of the untreated material began. Therefore, there is no shrinkage dimensionally in either warp or filling components when processed as stated, and the material will remain 30 inches long by 10 inches wide, as originally, together with improved physical properties, as stated. A stress-strain curve "D" is plotted, which represents the processed material as an example above given. It is seen at 0 the material has been stabilized about 5%, which is an advantage but lost about 5% tensile strength at 4% elongation, while at 10% elongation, a gain of 8% in tensile strength is shown. This condition exists to the breaking point, which was about 32%, considerably more than the untreated material. Curve "C" is plotted, which is representative of another piece of cotton material the same as that used in preparing curve "B" and processed as before but, in this instance, the synthetic resin solution contained about 9.5% resin solids. From this fact, it is manifested that it requires more resin solids with less stretching or as the elongation is decreased to achieve the same results. In connection with curve "C," if a stress-strain curve "D" is prepared, it is very similar to that derived from curve "B," denoting that there is an advantage in stretching fibrous materials and treating them while under tension, as described, with lower concentrations of synthetic resins for preventing shrinkage therein, as well as to improve the physical properties. The expression "fibrous-set" refers to the condition resulting from the physical changes brought about in fibrous materials by stretching in combination with synthetic resins from the impregnated state to the final drying as described herein. Of course, it is understood many synthetic resins are prepared with solvents in their solutions, such as the thermoplastics, and it is only necessary to evaporate or drive off these vapors in the dryer to solidify them. There are also others that are water-soluble and, again, it is only necessary to evaporate the water. However, after the evaporation, the resins solidify but become insoluble in water, such as the pre-polymerized methyl methacrylates. The polyvinyl alcohols solidify by the evaporation of their water, but may be again dissolved in water. The thermosetting resins, if in a highly advanced stage, are insoluble in water and most organic solvents, making them highly useful for many purposes after curing.

The term "slack washed (relaxed)" as herein mentioned has reference to subsequent washing of fibrous materials after drying, or drying and curing under tension, wherein said materials are not under any undue tension during washing, and this condition also applies to the final drying. This operation constitutes part of the invention and is a functional component of fibrous-set. The final washing may be carried out at a temperature between 140° F. and 170° F., for example, rinsing carried out at a temperature between 130° F. and 165° F., the material can then be extracted and dried at a temper-

ature between 220° F. and 260° F., depending on the material and synthetic resins being processed.

To further illustrate the invention there are given comparative tests made on untreated, synthetic resin treated fibrous materials and fibrous materials treated with synthetic resin under tension.

In the examples under tension (which are those according to the invention), the fabric was impregnated with the indicated amount of resin in mangle 3, stretched, as indicated, dried while so stretched at 240° F. from 1 to 10 minutes, cured at 305° F. for 3 minutes while under this tension, then washed at 190° F. from 3 to 6 minutes after the tension was released, and then dried at 220° F. for 5 minutes while in the relaxed condition.

From the examples it can be seen that the samples of fabric which were treated with resin and dried and cured under tension were considerably superior to the untreated samples, and were even considerably superior in their properties to the samples which were treated with the same synthetic resins but dried and cured without stretching during these steps. It will be noted that the results with the samples dried and cured under tension were superior even though considerably less resin was employed than those samples employing resins but omitting the stretching during curing and drying. Thus, it is possible to obtain better results while at the same time utilizing less of the costly resins.

In the following Table I the letter "u" stands for the untreated samples, the letter "r" for the samples treated with resin, dried and cured without tension, and the letter "t" for the samples treated with resin, dried and cured under tension.

In Table I the resin solids are expressed in percent by weight of the textile sample.

The percentages of resin solids applied to the 18 speci-

TABLE I

Specimen No.	Material	Resin Solids, Percent Deposited	Stretched, Percent Elongation	Shrinkage, Percent	Tensile Strength, Percent Gain	Abrasion Resistance, Percent Gain
1.	Cotton denim (u)			10.3		
1.	Cotton denim (r)	12		2.2	22	158
1.	Cotton denim (t)	8	10	0	32	165
2.	Cotton denim (r)	13.5		2.4	19	146
2.	Cotton denim (t)	9.5	10	0	29	148
3.	Cotton denim (r)	8		2.9	10	105
3.	Cotton denim (t)	5	8	0	16	72
4.	Cotton H. Twill (u)			10.9		
4.	Cotton H. Twill (r)	12		2.4	18	138
4.	Cotton H. Twill (t)	8	10	0	28	162
5.	Cotton H. Twill (r)	8		3.3	9	78
5.	Cotton H. Twill (t)	5	8	0	12	58
6.	Cotton Sheeting (u)			6		
6.	Cotton Sheeting (r)	8		1.2	12	96
6.	Cotton Sheeting (t)	6	6	0	20	115
7.	Vis. Fil. Rayon Cloth (u)			9.7		
7.	Vis. Fil. Rayon Cloth (r)	8		3.4	13	102
7.	Vis. Fil. Rayon Cloth (t)	5	10	0	22	128
8.	All Wool Shirting (u)			21.3		
8.	All Wool Shirting (r)	8		4.9	11	88
8.	All Wool Shirting (t)	6	18	0	18	94
9.	Vis. Staple Rayon Cloth (u)			11.8		
9.	Vis. Staple Rayon Cloth (r)	8		2.5	18	108
9.	Vis. Staple Rayon Cloth (t)	6	10	0	20	110
10.	Cotton Tire Cord (u)			13.2		
10.	Cotton Tire Cord (r)	12		1.7	34	
10.	Cotton Tire Cord (t)	10	12.5	0	48	
11.	Vis. Fil. Rayon Tire Cord (u)			16.8		
11.	Vis. Fil. Rayon Tire Cord (r)	12		3.1	40	
11.	Vis. Fil. Rayon Tire Cord (t)	10	15	0	55	
12.	Cotton Slide Fastening Tape (u)			8		
12.	Cotton Slide Fastening Tape (r)	10		1.6	29	132
12.	Cotton Slide Fastening Tape (t)	8	8	0	37	142
13.	Rayon Fil. Clothes Lining (u)			14		
13.	Rayon Fil. Clothes Lining (r)	8		3.6	14	105
13.	Rayon Fil. Clothes Lining (t)	6	12	0	18	105
14.	Cotton Sewing Thread (u)			5		
14.	Cotton Sewing Thread (r)	8		1.3	19	
14.	Cotton Sewing Thread (t)	8	5	0	30	138
15.	Cotton Shoe Linings and Cloth (u)			7		
15.	Cotton Shoe Linings and Cloth (r)	8		1.1	11	86
15.	Cotton Shoe Linings and Cloth (t)	6	8	0	17	95
16.	Vis. Fil. Rayon Shoe Cloth (u)			10.3		
16.	Vis. Fil. Rayon Shoe Cloth (r)	8		2.3	16	109
16.	Vis. Fil. Rayon Shoe Cloth (t)	8	8	0	33	154
17.	Cotton Sheeting (u)			6		
17.	Cotton Sheeting (r)	8		1.8	8	72
17.	Cotton Sheeting (t)	6	8	0	18	118
18.	Cotton Shirting (u)			7		
18.	Cotton Shirting (r)	5		2.2	18% loss 4% gain	14% loss 2% loss
18.	Cotton Shirting (t)	2	7	0		

mens of textile materials in the examples using resin alone (r) and resin under tension (t) are as follows:

Specimen No.	Melamine-Formaldehyde	Percent	Acrylate (Rhoplex), Percent	Total, Percent
1 (r)	Aerotex M-3	6	4% MR and 2% ER	12
1 (t)	do	3	2% MR and 3% ER	8
2 (r)	Resloom M-75	7.5	3% MR and 3% ER	13.5
2 (t)	do	3.5	do	9.5
3 (r)	Aerotex M-3	4	2% MR and 2% ER	8
3 (t)	do	2	1% MR and 2% ER	5
4 (r)	do	6	3% MR and 3% ER	12
4 (t)	Resloom M-75	4	2% MR and 2% ER	8
5 (r)	Aerotex M-3	4	2% WN-80 and 2% FRN	8
5 (t)	(None)	0	3% MR and 2% ER	5
6 (r)	Aerotex M-3	3	3% WN-66 and 2% FRN	8
6 (t)	do	2	2% WN-66 and 2% FRN	6
7 (r)	do	4	2% WN-80 and 2% FRN	8
7 (t)	do	2	1% MR and 2% ER	5
8 (r)	Lanaset	4	2% WN-80 and 2% FRN	8
8 (t)	do	3	1% MR and 2% ER	6
9 (r)	Aerotex M-3	5	2% WN-80 and 1% FRN	8
9 (t)	do	3	1% MR and 2% ER	6
10 (r)	do	6	3% WN-80 and 3% FRN	12
10 (t)	do	3	5% MR and 2% ER	10
11 (r)	do	6	4% WN-80 and 2% FRN	12
11 (t)	do	3	5% MR and 2% ER	10
12 (r)	do	5	3% WN-66 and 2% ER	10
12 (t)	do	3	2% MR and 3% ER	8
13 (r)	do	4	2% WN-80 and 2% ER	8
13 (t)	do	3	1% MR and 2% ER	6
14 (r)	do	3	3% WN-80 and 2% ER	8
14 (t)	do	3	2% MR and 3% ER	8
15 (r)	do	3	3% WN-80 and 2% ER	8
15 (t)	do	2	3% WN-80 and 1% FRN	6
16 (r)	do	4	2% WN-80 and 2% ER	8
16 (t)	do	3	3% WN-80 and 2% FRN	8
Polyvinyl Acetate (Merlon), Percent				
17 (r)		0	8% KR	8
17 (t)		0	6% KR	6
18 (r)	Aerotex M-3	5		5
18 (t)	do	2		2

Unless otherwise stated, all parts and percentages are by weight.

I claim:

1. A process of improving the properties of a shrinkable textile material which comprises impregnating the textile material with a synthetic resin composition and drying said impregnated material while it is under tension equivalent to about 18% to 75% of the ultimate breaking strength of the textile material, releasing the tension, slack washing the textile material and thereafter drying the same.

2. A process according to claim 1 wherein the textile material is a cellulosic textile material.

3. A process according to claim 1 wherein the resin is applied in an amount of 2% to 18% by weight of the textile.

4. A process according to claim 1 wherein the synthetic resin is a combination of thermoplastic and thermosetting synthetic resins and the thermosetting resin is cured while the textile material is under tension.

5. A process of improving the properties of a shrinkable textile material which comprises impregnating the textile material with a combination of (1) a curable product of partial reaction of ingredients comprising melamine and formaldehyde, said product being at least partly soluble in water and (2) a film-forming substance comprising a water-insoluble thermoplastic polymer of a lower alkyl acrylate and drying said textile material and curing said melamine-formaldehyde product in intimate contact with the alkyl acrylate polymer while said textile material is under tension equivalent to about 18% to 75% of the ultimate breaking strength of the textile material, releasing the tension, slack washing the textile material and thereafter drying the same.

6. A process according to claim 5 wherein the textile material is a cellulosic textile material.

7. A process according to claim 5 wherein the curable product is a methylol melamine.

8. A process according to claim 5 wherein the curable product is a methylated methylol melamine.

9. A process according to claim 5 wherein the resin is applied in an amount of 2% to 18% by weight of the textile.

10. A process according to claim 9 wherein the melamine-formaldehyde is present in an amount of from

about 1% to 6% and the alkyl acrylate polymer is present in an amount at least about equal to the melamine-formaldehyde.

11. A textile material which is resistant to shrinkage prepared by the process of claim 1.

12. A cellulosic fabric material which is resistant to shrinkage and which is impregnated with the cured product of about 2% to 18% of a combination of (1) a curable product of partial reaction of ingredients comprising melamine and formaldehyde, said product being dispersible in water and (2) a film-forming polymer of a lower alkyl acrylate, said fabric having been dried and said curable product having been cured while the fabric was under a tension equivalent to about 18% to 75% of the ultimate breaking strength of the fabric and said fabric having been released from said tension and thereafter, slack washed and dried.

13. A process according to claim 1 wherein the textile material is wool.

14. A process according to claim 1 wherein the textile material is nylon.

15. A process according to claim 1 wherein the shrinkable textile material is a woven material.

16. A process according to claim 1 wherein the synthetic resin is a combination of thermoplastic and thermosetting synthetic resins, the thermosetting resin is cured while the textile material is under tension and the textile material is selected from the group consisting of cellulosic fabric, nylon, wool and silk.

17. A process of improving the properties of a shrinkable textile material which comprises impregnating the textile material while under tension with a synthetic resin composition and having an elongation ranging from 4% to 18% of said material, drying said impregnated material while it is under tension, releasing said tension and thereafter slack washing and drying said material and thereby shrinking said material to zero of said elongation.

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