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COMPLETE SPECIFICATION

Process for improving Textile Material consisting at least partly of Cellulosic Fibres

We, RADUNER & Co. A.—G., a Swiss Body Corporate, of Horn (Thurgau), Switzerland, do hereby declare the invention, for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

It is known that cellulosic textile material finishing effects such as wash and wear properties, dry and wet crease recovery, dimensional stability and so on may be imparted by crosslinking. The main disadvantage of such processes lies in the fact that high losses of the tensile strength are caused if good effects are to be achieved, such losses sometimes reaching 60% or more of the original tensile strength. Losses of a similar or an even higher magnitude are observed in abrasion and tearing strengths.

Common practice is to pad improving agents on to textile material, squeeze it and dry it at least partly, and finally to crosslink, as a rule by subjecting to a heat treatment. In other cases crosslinking is effected when the textile material is still in a swollen state.

It has been proposed to subject the textile material during the crosslinking step to tension, for instance by stretching it in the case of textile fabrics in tenter frames, the stretching being carried out by pulling the fabric from end to end, i.e. lengthwise, or at both selvages, i.e. weftwise. Such a process is for instance described in the US specification 2,977,665.

As the figures listed there show, improvements of the tensile strength are generally speaking below 10%.

Many tests carried out in textile finishing mills have shown that processes based on stretching fabris by conventional methods in the presence of crosslinking agents, if applied in the mill, do not offer advantages which would make their application seem worth while. The reason for this is related to the fact that conventional stretching processes, which for instance consist in stretching a fabric in the direction of the filling (which usually is the weaker direction and hence would profit most from a decrease of tensile losses) by pulling it at both selvages, hardly ever produce a stretching action which is uniform over the whole length of the yarn system to be stretched due to the inevitable lack of uniformity of individual yarns (which results in a varying degree of stretching) on the one hand, and due to the easily detectable differences in the degree of stretching from the selvages to the middle of the fabrics on the other hand (the degree of stretching is higher near the selvages than in the middle) and finally it is impossible to stretch by such methods to an extent which could result in a more than marginal decrease of tensile losses.

As the degree of stretching is extremely important for the improvement of the tensile strength and as there is a lower limit below which no appreciable improvement at all is obtained, the only effect achieved under these conditions may be a more uniform tensile strength of the fabric components, the weaker components being more stretched and hence showing less loss of tensile strength after crosslinking than the formerly stronger parts, which had been hardly affected by the stretching process and thus exhibit a normal loss of strength. This also may explain why in laboratory trials where tests are made with shorter strips of fabrics, much better results are obtained than in the mill.

It has also been proposed to emboss and crosslink cellulose fabrics by passing them through a calender in which a heated metal bowl engraved with the pattern works against a relatively soft bowl built up of paper or cotton on a metal centre. In this prior process however the bowls compress the fabric between

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them and the stretching produced is not uniform or limited to one set of yarns, *i.e.* warp or filling.

According to the present invention finishing effects based on the crosslinking of cellulose are obtained on textile material at least partly consisting of cellulosic fibres with substantially reduced losses of mechanical properties, particularly reduced losses of the tensile and tearing strength, by producing on such textile material, preferably when it is in an at least slightly swollen state, a rearrangement of the yarns and fibres thereof by means of uniform stretching of at least 30%, preferably more than 50%, of the extension at break of said textile material in the stretched direction, the stretching being carried out in small to infinitely small areas as defined hereinunder by exerting mechanical pull between points which are at a small to infinitely small distance from each other, as defined hereinunder, said stretching being carried out prior to crosslinking the cellulose fibres present in said textile material.

Stretching in small to infinitely small areas means stretching in very small increments, *i.e.* by dividing the stretching area in a large number of small or even infinitely small areas which are stretched virtually simultaneously, and within which the stretching is uniform, as opposed to subjecting large areas to stretching by pulling between distant points, for instance between selvedges of a fabric.

Stretching between points which are at small to infinitely small distances from each other means dividing the distances between points at which a pulling force is exerted, *i.e.* the length of yarn which is being stretched at any given time, into a large number of small to infinitely small lengths of yarn between points at small to infinitely small distances at which a pulling force is active, the degree of stretching being virtually the same for all small to infinitely small stretching lengths, as opposed to conventional methods where stretching is effected by pulling between distance points, for instance between the selvedges of a fabric, where the stretching distance would be equivalent with the width of the fabric, *i.e.* the length of individual filling yarns.

A substantially irreversible rearrangement of the yarns and fibres thus is produced by stretching said textile material not as usual by mechanically pulling between distant points, for instance between selvedges of a fabric, but by pulling in very small areas, *i.e.* by dividing the stretching area into small or even infinitely small areas, within which the stretching is uniform ("microlength stretching"). Such treatments producing small-area stretching may for example consist in causing the textile material to form curves of small length perpendicular to its original dimensions measured in that plane remaining substantially unchanged, or the stretching being carried out by pressing said textile material between two elastic bodies or one elastic and one inelastic or less elastic body such as bowls, belts, blankets or plates in such a way that the increase of surface area produced by pressing elastic bodies against each other or against less elastic bodies causes the interlined textile material to be stretched in the desired direction or directions (one or both bodies may have surface structures), or finally by causing the textile material to be stretched by treatments between bowls or other bodies having differing surface speeds, said textile material after having been stretched in the manner described in all cases being subjected to a crosslinking treatment.

The process according to the invention makes it possible (as opposed to known processes applying tension) to stretch not only in the presence of crosslinking agents, i.e. immediately prior to or during crosslinking, but without any additional step during, after or prior to known treatments such as washing, bleaching, dying or caustic treatments. Afterwards the textile material may be dried (preferably keeping the dimensions obtained by stretching in the stretched direction) and then crosslinked conventionally by padding in the crosslinking solution, drying (again virtually keeping the dimensions obtained by micro-length stretching) and curing. This is in many cases an advantage, since stretching during crosslinking i.e. in presence of the crosslinking agent, is known to result in a stiff and boardy hand. Micro-length stretching according to the invention may, however, also be carried out in presence of the crosslinking agent, i.e. immediately prior to crosslinking. In every case substantially better mechanical properties, particularly better tensile and tearing strength are obtained.

The process is applicable to textile material such as yarns or fabrics consisting at least partly of cellulosic fibres.

The elongation resulting from the mechanical treatment and the rearrangement caused thereby are irreversible in the sense that the elongation caused is not reduced completely after a standard wash at 60°C. if compared with the dimensions of an unstretched, similarly washed sample. "Remaining extension" means the length increase measured after removing mechanical deformation (if there are) between ~~mars~~ marks applied prior to stretching in the stretching direction.

To carry out micro-length stretching, continuous or semicontinuous processes may be applied, making use for instance of devices described below: Stretching in width:

Pairs of bowls or plates with surface structures arranged at a small distance from each other, running nearly parallel to the length direction, such surface structures for instance consisting of ridges in one surface alternating

with grooves in the other and *vice versa*. The depth of penetration i.e. the degree to which the fabrics are diverted from their original plane (in a right angle to that plane i.e. into the third dimension) depends upon the distance apart of the cooperating bowls or plates and may be used to adjust the degree of stretching. Another way of effecting micro-length stretching consists in using bowls or plates with a hard surface provided with surface structures as described above, particularly grooves running in an angle of at least 45° to the stretching direction, into which the textile material to be stretched is pressed by means of bowls, plates, belts or ~~blanket~~ having an elastic surface or consisting of elastic material.

To effect micro-length stretching in the running direction of fabrics or yarns the same devices as mentioned above may be used, the surface structure in this case running nearly parallel to the width of the sheet material, i.e. at an angle of 45—90° to the running direction. On the other hand devices may be used which consist of one or more bodies such as bowls or endless belts made of elastic material, which produce stretch in micro-length by making use of different surface speeds. To assure controlled micro-length stretching and to avoid non-uniform stretching it is preferable to have the textile material at the places where micro-length stretching is to take place firmly held between two bodies (one of which preferably has a relatively high friction coefficient towards the textile material). Finally, microlength stretching may be achieved by pressing the textile material between two bodies, one of which has a hard, the other a relatively elastic surface. The resulting surface increase causes the interlined fabric to be stretched in micro-length fashion.

If micro-length stretching is to be obtained in both directions, devices such as these mentioned above may be combined or used in succession.

In the case of woven fabrics it was found that particularly high degrees of stretching may be obtained with a higher safety margin if the direction of stretching is not fully parallel to the yarn system to be stretched, but at a small angle (usually lower than 30°).

The selection of the most suitable method for stretching depends in each case on the material to be stretched, the stretching direction and the effects to be obtained.

Stretching may be effected at room temperature or at elevated temperatures. The textile material may be dry or preferably at least slightly swollen, it may contain known finishing agents, dyestuffs, crosslinking agents or other finishing chemicals, particularly such which influence inter-fibre friction.

In many cases it was found to be advantageous to effect micro-length stretching not in one, but in several steps, i.e. to repeat the stretching treatment. Between such stretching steps the textile material may be subjected to known finishing treatments or mechanical processing.

The following indications may give some information on what stretching conditions are suitable for obtaining satisfactory effects:

The conditions applied during micro-length stretching, which determine the degree of stretching (depth of penetration or height of deviation of alternating parts of the fabric from its original plane and pressure if pressing between solid bodies is used as stretching means) should be so adjusted to obtain an extension of the textile material in the direction to be stretched of at least 30%, preferably more than 50%, of what the extension is when the same material is subjected in the same device to conditions under which it tears not only in one, but in many micro-length stretching areas. Generally speaking, it may also be said that the reduction of the extension at break (measured conventionally using strips) caused by micro-length stretching, determined by measuring the extension at break immediately prior to and immediately after microlength stretching (without intermediate crosslinking treatment or other treatments affecting extension at break) should be at least 30%, preferably 50% or higher, if a substantial improvement of the tensile strength after crosslinking (as compared to material crosslinked conventionally in more or less slack state) is to be obtained.

To increase the dimensional stability of textile material treated according to the present invention, wet treatments may be carried out after crosslinking in known manner, the material may be mechanically shrunk, or crosslinking may be carried out in several steps according to the process described in our Patent Specification No. 998,385, by first cross-linking under tension and then stabilising the dimensions obtained by a second crosslinking treatment.

If the dimension increase brought about by the stretching process for some reason is undesirable, known treatments, (mechanical or chemical shrinking treatments generally speaking) resulting in a decrease of dimensions in one or both directions may be applied prior to or after micro-length stretching, i.e. one may either reduce an increase of the dimensions caused by stretching by subsequent shrinking treatments or stretch textile material which had been shrunk previosly, restoring for instance by stretching the dimensions the material had prior to shrinking.

Micro-length stretching may as mentioned above be applied to yarns or textile fabrics to the full extent or incrementally at any stage of textile processing or carried out (or be completed) during the crosslinking step, i.e. it may proceed in steps, stretching not being done in one but in several steps, which

if desired may be separated by a lapse of time and processing treatments. The same or different mechanical means may be used in different steps. It has for instance been found that less mechanical pull is required to obtain a givn degree of elongation if the same material had been subjected to stretching to a similar extent at an earlier stage.

As mentioned earlier, micro-length stretching may be preferably applied to cellulosic textile material which is in an at least slightly swollen state. One may for instance subject the material to micro-length stretching after or during the usual wet treatments preceding crosslinking (bleaching, dyeing and mercerising) without intermediate drying, *i.e.* in the presence of agents having a swelling action on cellulose fibres such as water, caustic soda, acids or salt solutions.

If micro-length stretching does not form part of the crosslinking treatment, but is applied exclusively at an earlier stage, then it is important either to avoid treatments between micro-length stretching and crosslinking which could affect the rearrangement of yarns and fibres brought about by micro-length stretching or to repeat micro-length stretching.

At any stage, particularly immediately prior to causing the crosslinking agent to react with cellulose, the textile material may be subjected to conventional mechanical deformation such as embossing between plain or engraved bowls, which may be heated or cold, and the mechanical deformation may if desired be rendered fast to washing by the crosslinking step.

The term crosslinking as it is used throughout the present application includes the formation of all kinds of bonds between adjacent macromolecular chains.

As examples for crosslinking agents are mentioned.

Thermosetting resins of the reactant type (applied in the form of precondensates or components) obtainable from nitrogeneous compounds containing amidic nitrogen (—CO—NH—) and mono- or polyfunctional carbonyl compounds, particularly aldehydes (examples: reaction products from formaldehyde, glyoxal or acrolein and urea, cyclic alkylene ureas, ureins, triazones, or other heterocyclic compounds containing —NH—CO—NH— groups): monomeric or polymeric crosslinking agents reacting through aldehyde groups, particularly aldehydes of low molecular weight such as these mentioned above, applied in free form or as derivatives such as acetals, enol ethers, polymers, which under the crosslinking conditions used are *per se* capable of cross linking cellulose or giving off compounds capable of doing so; di- or polyfunctional crosslinking agents containing epoxy-, isocyanate-, vinylsulfo- or other vinyl compounds capable of reacting with at least two cellulosic hydroxy groups; halogen compounds such as polyhalides, halohydrins, dicarboxylic acids in free form or in the form of derivatives; di- or polyfunctional "onium" compounds (sulphonium, phosphonium and oxonium); reaction products of two carbonyl compounds such as ketones with aldehydes of low molecular weight (in particular oxy-methyl substituted ketones), all the compounds mentioned being brought to reaction preferably in presence of suitable agents having a rate-increasing action (acid, basic, potentially acid or basic catalysts, radical producing compounds and radiation), and if desired also in the presence of known agents having a light to strong swelling action or influencing interfibre-friction, known finishing agents, dyestuffs and pigments.

Crosslinking reactions caused by exposing the prestretched textile material to physical/chemical influences such as heat treatments, irradiation (high energy radiation), by substitution reactions, graft polymer formation, formation of polymers *in situ* or deposition of polymers within the fibre, are within the scope of the present application if such crosslinking treatments *per se* increase the elasticity of the cellulosic fibres (in dry state) and decrease its extensibility.

If the crosslinking agent applied is a chemical compound, it may be applied as usual from solutions, dispersions or emulsions or from gas phase, crosslinking taking place after or during evaporation of voltatile solvents (e.g. water), i.e. in an unswollen or only slightly swollen state of the cellulose or in presence of swelling agents, i.e. when the cellulose is in a swollen state. In both cases suitable catalytic agents may be used as mentioned above to increase the rate of the reaction.

As mentioned earlier, micro-length stretching may—if it has not been completely carried out earlier—be effected or completed immediately prior to crosslinking. It is also possible to cause after a preliminary micro-length stretching treatment only partial crosslinking, i.e. a low degree of crosslinking, and to effect further crosslinking at a later stage, for instance after the material has been subjected to further stretching.

After the cellulose has been crosslinked, stretching treatments are of no use or even harmful. On the other hand known finishing treatments such as washing, padding-on of finishing agents, softeners, pigments, compressive shrinkage treatments and of course making-up may be carried out as usual.

If particularly high creasing angles are desired or for other reasons a second crosslinking treatment may be effected after first crosslinking the stretched material under relatively mild conditions as to the concentration of the crosslinking agent and crosslinking conditions according to the sequence of steps outlined in our Patent Specification No. 998,385.

Examples

All testing results are listed in table I. In all cases micro-length stretching resulted in an extension of more than 50% (usually 60—80%) of the extension at break.

1a) A cotton poplin, which had been singed desized, bleached and mercerised, was in wet state subjected to the following micro-length stretching treatment in weft direction (the weft yarns were weaker than the warp yarns), which resulted in a degree of stretching and hence an increase in the width of 9%: the poplin was led across curved expander rolls of the customary type to keep it wide and ~~increased~~, and then passed between two mating metal bowls which on their surfaces had grooves alternating with ridges, the ridges of one bowl penetrating into the grooves of the other (without touching it) to a predetermined depth. The pitch of the ridges per inch was 0.177 (5.6 teeth/"), the penetration was set to give a degree of stretching of 9%. After passing between the grooved bowls, the poplin had about the same width as before, but it had in warp direction grooves alternating with ridges which when pulled out to flatten the surface gave a width of 98 cm. The fabric was then dried to that width.

The poplin then was subjected to a cross-linking treatment by padding in a bath containing 160 grams/litre of dimethylolpropylene urea, 14 grams/litre of zinc nitrate and 30 grams/litre of a polyethylene softener, drying (the width of 98 cm obtained by micro-length stretching was again maintained) and curing at 150°C for 4 minutes.

1b) The same poplin fabric for comparison purposes was crosslinked as described above without previous micro-length stretching, the finished width being 90 cm.

2a) a light-weight cotton fabric (percale) was singed, desized, bleached, mercirised and dyed and then without drying subjected to micro-length stretching as described in example 1a, the degree of stretching being 11%. After drying to a width of 100.5 cm it was cross-linked by padding in a solution of 120 g/l formalin (36% formaldehyde by weight), 24 g/l of a metal salt catalyst, viz. zinc nitrate and 30 g/l of a polyethylene softener, drying to 100 cm width, and curing for 4 minutes at 130°C. To remove unreacted formaldehyde and the catalyst, the fabric was rinsed in slack state.

2b) The same fabric was treated as described in example 2a, but prior to micro-length stretching the angle between warp and filling yarns was changed to 75° by known means, the direction of stretching thus not being completely parallel to the weft yarns. The degree of stretching was 11.5% (width 100.5 cm. formerly 90 cm). During subsequent drying the right angle between warp and filling yarns was restored. The fabric was then cross-linked as described in example 2a.

2c) The fabric mentioned in example 2a was crosslinked as described without having been subjected to micro-length stretching.

3a) A cotton poplin was subjected to micro-length stretching as described in example 1a after the usual pretreatments, the degree of stretching being 9.5% (width increase from 90 cm to 98.5 cm). After drying to the same width the poplin was slack mercerised (dimensions in ~~warp~~ direction unchanged, with decrease 8.5%. Sodium hydroxide 25° ~~Be)~~. After neutralising, rinsing and drying to 91 cm the cotton was crosslinked as described (~~dimethylolpropylene urea as described~~ in example 1a).

3b) The same poplin was after the pretreatments mentioned in example 3a subjected to micro-length stretching, drying and slack mercerisation as described above, subjected to a second micro-length stretching treatment in presence of caustic soda, i.e. in a highly swollen state. The width increase was 5%, ~~which was 5%~~, which was maintained during subsequent neutralising, rinsing, drying and crosslinking treatments (dimethylolpropylene urea as described in example 1a).

3c). The same poplin was after the pretreatment slack mercerised (shrinkage 8% in weft direction), neutralised and rinsed; it was then subjected to micro-length stretching in swollen state using the method described in example 1a (width increase 9%), dried to the maximum width obtained and crosslinked as in the preceding examples.

3d) The same poplin after being pretreated was slack mercerised as described in example 3c, but after being neutralised it was dried to the maximum width obtained and then padded in the crosslinking bath mentioned in example 1a. In wet state (i.e. in presence of the unreacted crosslinking agent) the fabric was then subjected to micro-length stretching as described in example 1a, dried to the maximum width obtained (degree of stretching 10%) and crosslinked under the conditions given in example 1a.

3e) The same poplin was treated as described in example 3c, but micro-length stretching took place prior to neutralisation. The width increase obtained after flattening the fabric (pulling out the groove/ridge structure which had formed during micro-length stretching) during drying was 9%. The fabric was then dried and crosslinked as described in example 3d (i.e. applying a second micro-length stretching treatment in presence of the crosslinking agent).

3f) The poplin mentioned in examples 3a—3d was crosslinked as described after being pretreated without any micro-length stretching treatment (finished width 90cm).

4a) A light-weight cotton fabric ("cambric") after singeing, the desizing, mercerizing and bleaching was padded in dry state in 140 g/l of formalin (36% formaldehyde by weight),

24 g/l of a metal salt catalyst, viz. zinc chloride, and 30 g/l of a non-ionic softener, viz. an aqueous dispersion of polyethylene, and without drying subjected to micro-length stretching in weft direction as described in example 1a. The width increase was 10 cm (from 90 cm to 100 cm), which was virtually maintained during subsequent drying (width 100.25). Crosslinking was effected by heating to 135°C for 4 minutes. The cotton fabric then was rinsed in slack state first in an alkaline, then in a neutral bath and dried (width 97 cm) and subsequently compressively shrunk by mechanical means.

4b) The same cotton fabric as in example 4a after having pretreated was not subjected to micro-length stretching, but to stretching by conventional means according to US Patent 2 977 665, i.e. it was stretched during crosslinking by pulling at both selvages in a tenter frame. The maximum width which could be obtained without tearing off the selvages or damaging the fabric otherwise, was 95 cm (starting width 90 cm). The crosslinking agent and the curing temperature was exactly the same as in the process according to example 4a.

4c) The same cotton fabric was crosslinked as described in example 4a, but without any stretching treatment (finished width 90 cm).

5a) A cotton fabric (percale) was subjected to micro-length stretching in weft direction as described in example 1a after it had been pretreated as usual. Prior to the stretching treatment 30 g/l of a cross-linkable polyacrylate (Primal HA 8, Rohm & Haas, Philadelphia, USA) had been padded on to the fabric, i.e. stretching took place in presence of water and an agent increasing inter-fibre friction. "Primal" is a Registered Trade Mark. Micro-length stretching resulted in a width increase after drying to the maximum width obtainable of 10 cm (from 90 cm to 100 cm). The fabric then was crosslinked with 140 g/l dimethylol-propylene urea in presence of 14 g/l zinc nitrate and 30 g/l anionic softener viz. Ceramin F (Sandoz A.G. Basle) at 150°C for 4 minutes. "Ceramin" is a Registered Trade Mark.

5b) To the same fabric the crosslinking formulation given in example 5a was applied, and the fabric was then subjected to a microlength stretching treatment in weft direction in presence of 40% water per weight of the fabric. The width obtained and maintained during drying and curing was 98.5 cm.

5c) The same percale was padded in the crosslinking bath mentioned in example 5a and then subjected not to micro-length stretching, but to stretching over the whole width during crosslinking according to US Patent 2 977 665. The maximum width obtainable without tearing off selvages was 95 cm.

6). A cotton poplin after being pretreated as usual was subjected to a micro-length stretching treatment as described in example 1a, followed by crosslinking. Two lengths of the fabric were however run through the grooved rollers simultaneously one on top of the other. The production rate in the stretching step thus was doubled.

7) The cotton poplin mentioned in example 1a was subjected to micro-length stretching as follows: the fabric was in wet state pressed between one grooved bowl (pitch of grooves as stated in example 1a) and an endless rubber belt which by tensioning was pressed against the grooved bowl and hence penetrated into its grooves. The resulting degree of stretching was 8%. The stretching treatment was followed by crosslinking.

8a) A cotton broadcloth was pretreated as usual and then subjected in wet state to micro-length stretching as described in example 1a. The width increase was 10.5 cm (from 84 cm to 94.5 cm). The fabric was then crosslinked in swollen state by padding in 120 g/l of Mykon Lubricant PB in sulfuric acid, batching, storing for 16 hours at room temperature, rinsing, neutralising and drying. "Mykon" is a Registered Trade Mark.

8b) The same fabric was treated as described in example 8a, but micro-length stretching took place only immediately after padding on the crosslinking solution. The fabric was then flattened by stretching slightly, batched, stored, neutralised and dried as in example 8a.

8c) The same fabric was crosslinked in swollen state as described in example 8a, but without any stretching treatment.

9a) A cotton fabric was pretreated as usual, then subjected to micro-length stretching as described in example 1a in wet state, and subsequently crosslinked in wet state according to example 1 of the British Patent Specification 894 195. Still in wet state, it was subjected to a second micro-length stretching treatment and crosslinked in dry state as described in example 1a.

9b) The same poplin was crosslinked first in wet state, then in dry state as described in example 9a, but without any micro-length stretching.

10a) A cotton broadcloth after the customary pretreatment in wet state was subjected to micro-length stretching as described in example 1a and dried (maintaining the maximum width obtained). It was then crosslinked by applying 200 g/l of an acetal of formaldehyde (Quaker Reactant 16) and 25 g/l of magnesium chloride and curing at 140°C for 5 minutes. The fabric then was washed in rope form without tension, top softened and dried.

10b) The same broadcloth was pretreated as usual and then padded in a triazinone crosslinking agent (Fixapret TN, Badische Anilin & Sodafabrik, Ludwigshafen, Germany, 140 g/l), 12 g/l magnesium chloride and 20 g/l of an anionactive softener, viz.

Cerol WB (Sandoz A.G. Basle). "Fixapret" nand "Cerol" are Registered Trade Marks. The fabric was then in wet state subjected to micro-length stretching as described in example 1a and dried, the width thereby being increased by 13.3% (from 90 cm to 102 cm), curing was effected at 140° for 4 minutes. The fabric was then rinsed and dried.

10c) The same broadcloth was crosslinked with Quaker Reactant 16 as described in example 10a, but without any stretching treatment.

11) A cotton poplin after the usual pretreatments was subjected to micro-length stretching as described in example 1a in wet state, dyed, again subjected to micro-length stretching and dried again to the maximum width obtained by micro-length stretching.

The width increased from 90 to 98 cm. The fabric was crosslinked by applying 140 g/l dimethylolethylene urea, 14 g/l magnesium nitrate and 25 g/l of a polyethylene softener, drying to the width previously obtained and curing for 3 minutes at 150°C.

11b) The same poplin was pretreated, dyed and crosslinked as described in example 11a but without any micro-length stretching.

TABLE I

Example	Fabric	Cross-linking agent	Stretching Treatment	Tensile Strength (loss in %)[1]	Tearing Strength[2]	Flex abrasion[3]	Creasing Angles[4]	Wash & Wear Rating[5]	Area Increase[6]
1a)	Cotton Poplin	DMPU	m.l. (f)	19,5 (20.5%)			250°	4	7.5%
1b)	do.	do.	none	13,5 (45%)			255°	4	—
2a)	Cotton Percale	Formal-dehyde	m.l. (f)	8,5) (39%)			285°	4 (1,0)	10%
2b)	do.	do.	do.	10,0 (29%)			280°	4 (0,5)	10,5%
2c)	do.	do.	none	5,5 (61%)			285°	4 (1,0)	—
3a)	Cotton Poplin	DMPU	m.l. (f)	16,0 (22%)	700	550	250°	4—5 (0)	—
3b)	do.	do.	do.	18,0 (12%)	750	500	245°	4—5 (0,5)	5%
3c)	do.	do.	do.	15,5 (24%)	800	550	250°	4—5 (0,5)	2%
3d)	do.	do.	do.	15,5 (24%)	750	500	255°	4—5 (0,5)	3%
3e)	do.	do.	do.	19,0 (7,5%)	700	550	255°	4—5 (0,5)	4%
3f)	do.	do.	none	13,0 (36%)	550	350	230°	4—5 (0,5)	—

Example	Fabric	Cross-linking Agent	Stretching Treatment	Tensile Strength (loss in %)[1]	Tearing Strength[2]	Flex Abrasion[3]	Creasing Angles[4]	Wash & Wear Rating[5]	Area Increase[6]
4a)	Cotton cambric	Formal-dehyde	m.l. (f)	8,5 (35%)	350		280°	4 (0,5)	8%
4b)	do.	do.	accord. to USP 2 977 665[7]	6,0 (55%)	250		275°	4 (0,5)	4%
4c)	do.	do.	none	5,5 (60%)	200		275°	4 (0,5)	—
5a)	Cotton Percale	DMPU	m.l. (f)	12,0 (11%)	550		260°	3—4	10%
5b)	do.	do.	do.	9,5 (30%)	400		250°	3—4	8%
5c)	do.	do.	according to U.S.P. 2977665	7,5 (45%)	300		245°	3—4	4%
6)	Cotton Poplin	DMPU	m.l. (f)	19,0 (20,5%)	800		250°	4	7%
7)	Cotton Poplin	DMPU	m.l. (f)	19,5 (20,0%)	750		255°	4	8%
8a)	Cotton	wet cross-linking	m.l. (f)	12,0 (15%)				3—4	
8b)	do.	do.	do.	11,5 (18%)				3—4	

Example	Fabric	Cross-linking Agent	Stretching Treatment	Tensile Strength (loss in %)[1]	Tearing Strength[2]	Flex Abrasion[3]	Creasing Angles[4]	Wash & Wear Rating[5]	Area Increase[6]
8c)	Cotton	Wet Cross-linking	none	9,0 (35%)				3—4	
9a)	Cotton Percale	Wet Cross-linking + Dry Cross-linking	m.l. (f)	18,0 (27%)			260°	4—5	
9b)	do.	do.	none	11,0 (55%)			255°	4—5	
10a)	Cotton Broad-Cloth	Acetal	m.l. (f)	17,0 (20%)					
10b)	do.	Triazinone	do.	18,0 (15%)					
10c)	do.	Acetal	none	14,5 (35%)					
11a)	Cotton Poplin	DMEU	m.l. (f)	24,5 (9,0%)		500	275°	4 (0,75)	
11b)	do.	do.	none	15,5 (41,5%)		500	280°	4 (0,5)	

[1] Tensile Strength : Determined in stretched ~~direction~~ direction (*), strips 1" wide, 4" long. Figures mean kilograms. In parenthesis: loss of tensile strength in stretched direction caused by treatment.

[2] Tearing Strength : Elmendorf Tearing Strength Tester. Values given for stretched direction only (*).

[3] Abrasion Resistance : Stoll Quartermaster ~~Abrader~~ Abrasier, flex abrasion (load 3 lbs.), values given for stretched direction only (*).

[4] Creasing angles : Sum of warp and filling creasing angles determined according to ASTM D 1255—60 T.

[5] Wash & Wear rating : Determined according to AATCC Tentative Test Method 88—1961 T. In parenthesis shrinkage due to washing in stretched direction (*).

[6] Area increase : Increase of area due to stretching treatment, area of unstretched sample = 100%.

[7] USP 2 977 665 : Process for increasing dimensional stability at improved tensile strength, characterized by crosslinking under tension, i.e. stretching in presence of crosslinking agents, no micro-length stretching.

m.l. (f) : micro-length stretching in filling direction.

(*) of course determined in the same direction in the case of unstretched samples.

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WHAT WE CLAIM IS—

1. Process for achieving finishing effects such as crease resistance, wash and wear properties and dimensional stability with substantially reduced loss of mechanical properties, such as tensile strength and tearing strength, on textile material at least partly consisting of cellulosic fibres, characterised by producing on such textile material, preferably when it is in an at least slightly swollen state, a rearrangement of the yarns and fibres thereof by uniformly stretching said material by at least 30%, preferably more than 50%, of its extension at break in the stretched direction, the stretching being carried out in small to infinitely small areas as defined herein by exerting mechanical pull between points which are at a small to infinitely small distance from each other as defined herein and then crosslinking the cellulose fibre material.

2. Process according to Claim 1, characterised by stretching in small areas by deflecting textile sheet material from its plane whilst virtually holding its original dimensions, stretching in the direction to be stretched being carried out in small to infinitely small areas and resulting in a degree of stretching of at least 50% of the extension at break of said material in the stretching direction, and by then flattening said textile sheet material again prior to crosslinking, preferably by pulling out the deflections from its original plane until said textile sheet material is virtually flat.

3. Process according to either preceding claim, characterised by stretching by treatments between rotating bowls or plates which preferably have different elasticity and frictional properties, the more elastic bowl or plate which also has a higher friction coefficient, being deformed under pressure and thereby increasing its surface and hence stretching the interlined fabric.

4. Process according to any preceding claim, characterised by stretching in small to infinitely small areas between rotating bodies such as bowls and belts which have different surface speeds and preferably different coefficients of friction.

5. Process according to Claim 1 and any one of Claims 2 to 4, characterised by stretching in at least one direction prior to applying to the textile material crosslinking agents, said textile material being if desired subjected to additional stretching treatments after applying crosslinking agents, but prior to crosslinking, the dimensions obtained by the last stretching step being virtually kept until crosslinking has been effected.

6. Process according to any preceding Claim, characterised by stretching in small to infinitely small areas incrementally in several steps or by repeating stretching steps, carrying out if desired known finishing treatments between stretching steps and stretching for the last time immediately prior to or after applying the crosslinking agent to the textile material.

7. Process according to any preceding claim, characterised by stretching textile fabrics not parallel to, but at a preferably small angle to the yarns to be stretched, the stretch preferably acting predominantly in the direction of the weaker yarns.

8. Process according to any preceding claim, characterised by stretching in at least one step when the fibre material is in a slightly to strongly swollen state, the same swelling agents if desired being used to shrink the textile material prior to or after stretching.

9. Process according to any preceding claim, characterised by reducing at least partly the area increase caused by stretching, by subjecting the textile material to mechanical and/or chemical shrinking treatments prior to and/or after stretching steps.

10. Process according to any preceding claim, characterised by crosslinking only partly after stretching, and completing the crosslinking treatment at a later stage, if desired after subjecting the textile material to known treatments or after making-up operations.

11. Process according to any preceding claim, characterised by mechanically deforming the textile material after the last stretching step, and if desired rendering the mechanical deformation fast to washing by crosslinking.

12. Process according to Claim 1 for achieving finishing effects on textile materials at least partly consisting of cellulosic fibres as set forth in any one of the examples herein.

13. Textile materials at least partly consisting of cellulosic fibres produced according to the process claimed in any preceding claim.

For the Applicants,
F. J. CLEVELAND & COMPANY,
Chartered Patent Agents,
Lincolns Inn Chambers,
Chancery Lane, London, W.C.2.

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F J Cleveland