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(54) **LYOCELL FABRICS AND THEIR TREATMENT**

BEHANDLUNG VON LYOCELL-GEWEBEN

TISSUS LYOCELLULAIRES ET LEUR TRAITEMENT

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Description**Field of the invention**

5 **[0001]** This invention relates to the treatment of fabrics and has particular reference to the treatment of fabrics consisting of or containing lyocell fibre.

[0002] Lyocell fibre is a cellulosic fibre formed in a process in which cellulose is dissolved in an aqueous organic solvent without the formation of a derivative and is subsequently solvent-spun.

10 **[0003]** Cellulosic fibres are formed into fabrics in a number of different ways. Typically, staple lyocell fibre is spun or twisted to form yarns, which are then converted into fabrics by weaving or knitting. The yarns may be formed entirely of lyocell fibres and the fabrics may be formed entirely of lyocell yarns. However, it is possible to produce blended yarns containing less than 100% lyocell - the remaining fibre may be cotton or polyester or any other suitable fibre. Similarly, the fabric can be produced from a mixture of yarns some of which may be 100% lyocell fibre yarns or blended yarns, the remaining yarns can then be either blends or completely different fibres such as polyester or cotton. Furthermore, the yarns may be formed of continuous filament lyocell.

15 **[0004]** Typically, lyocell fabrics, by which is meant herein fabrics at least partly formed of yarns containing or consisting exclusively of lyocell fibres, are known for their flexible drape or handle. It is also known, however, that lyocell fabrics do have a tendency to crease when being wet processed (for example in dyeing or in the enzymatic treatments used to produce the so-called "peach-skin" effect on lyocell fabrics).

Disclosure of the Invention

[0005] A process has now been discovered which permits the treatment of lyocell fabrics so as to reduce the creasing effect during wet processing and which is capable of forming fabrics having a softer feel.

25 **[0006]** By the present invention there is provided a method of inducing set in a fabric formed of yarns, at least some of the fibres in at least some of the yarns being lyocell fibres, characterised in that it includes the steps of:

30 (i) maintaining the fabric in a form in which it is free to shrink;

(ii) contacting the fabric while in said form with a water-miscible swelling agent so that (a) the lyocell fibres swell in diameter without substantial dissolution and (b) the fabric shrinks;

35 (iii) diluting the swelling agent with water under conditions such that (a) the fibres shrink in diameter and (b) the yarns become set in the relative positions one to another which the yarns attained during the fabric shrinkage caused in step (ii); and

(iv) drying the fabric.

40 **[0007]** Any suitable swelling agent may be used. The preferred swelling agent comprises an alkali such as sodium hydroxide or lithium hydroxide or potassium hydroxide or ammonia. Alternatively, the swelling agent may comprise a bicarbonate of an alkali metal such as sodium bicarbonate. Alternatively, although this is less preferred, other swelling agents such as aqueous tertiary amine oxides, typically aqueous N-methylmorpholine N-oxide, may be used as the swelling agent.

45 **[0008]** The fabric may be maintained in a state free to shrink by being in woven piece-form. Alternatively, if the fabric is in the form of a garment, the fabric can be placed around a dummy or other cylindrical member so that the fabric does not have any sharp corners.

[0009] Once the fabric has been treated with a swelling agent such as sodium hydroxide, it is then treated with water so as to dilute the effect of the swelling agent (e.g. sodium hydroxide). Subsequently, the fabric may be dried for manufacture into garments and subsequent wet processing such as dyeing. Alternatively, the fabric may go straight from the diluting step into a dyeing or other wet processing finishing process.

[0010] Preferably the fabric is a woven fabric, but the fabric may alternatively be a knitted fabric, for example a knitted single jersey fabric, for which the setting process may reduce curl in the fabric. The fabric may alternatively be a nonwoven fabric, for example a hydroentangled or needle-punched or bonded nonwoven fabric.

55 **[0011]** Typically, the swelling agent may comprise sodium hydroxide at a concentration in water in the range 3 to 10 per cent, preferably in the range 5 to 9 per cent, further preferably in the range 7 to 8 per cent, by weight. The swelling agent may be at ambient temperature or at elevated or reduced temperature. The swelling agent should not dissolve the lyocell fibres to such an extent that their structure is destroyed. Higher concentrations of swelling agent increase

the dissolution of the cellulose and it is preferred that the cellulose should not be dissolved to a substantial extent, for example 10 per cent.

[0012] The fabric may be processed continuously in piece-form by being passed through a shrinking bath containing the swelling agent and then through an aqueous diluting bath.

[0013] It has been found that the method produces fabrics which are very much less affected by creasing and which in particular do not suffer as much or subsequent wet processing from the formation of lines during such wet processing, for example dyeing processes.

[0014] By the method of the present invention it is possible to provide a dyed fabric comprising yarn comprising lyocell fibre, said fabric having a structure produced by the steps of:-

- (i) swelling the lyocell fibre-containing yarns of an undyed fabric in a substantially unrestrained condition by an amount in excess of that occurring when fabric is exposed to wet processing such as dyeing conditions,
- (ii) exposing said swollen fabric to the diluting effects of water, whereby said fabric is permitted to relax whilst in an unrestrained condition, and
- (iii) subsequently dyeing said fabric under wet processing conditions.

[0015] By the method of the present invention it is further possible to provide a lyocell fabric which has a uniform separation of fibres, said uniform separation having been obtained by pre-swelling the lyocell fibres in said fabric in an unrestrained condition and setting said pre-swollen fabric.

[0016] By exposing said fabric in a substantially unrestrained condition to the swelling agent the lyocell fibres and yarns containing them in said fabric are caused to swell without destroying their structure. On diluting the swelling agent with water the fabric has the position of the swollen yarns within said fabric set in position.

[0017] Within the scope of the method of the present invention is a method of processing lyocell fabric containing lyocell fibres which comprises the steps of:-

- (i) passing said fabric in a substantially unrestrained condition through a swelling agent which causes the lyocell fibres to swell in diameter by an amount greater than any swelling of said fibres during wet processing in stage (iii) below; then
- (ii) passing said fabric through a water-containing bath so as to dilute the effect of said swelling agent;
- (iii) subsequently wet processing said fabric, there optionally being a drying stage after said diluting stage (ii) but before said wet processing stage (iii); and
- (iv) drying said wet processed fabric.

[0018] The fabric material subjected to the subsequent wet processing may have been made up into the form of garments prior to the subsequent wet processing if it was not in such form prior to pre-swelling.

[0019] Fabrics of lyocell fibre, whether said fabrics comprise 100 per cent lyocell fibre or a lesser amount of lyocell fibre, have proved to be extremely popular. Much effort has been invested in developing novel treatments for lyocell fabrics, in particularly treatments to produce a so-called "peach-skin" effect on the fabric. These types of treatments typically involve extensive wet processing of lyocell fabrics. It has been found that the wet processing conditions must be very carefully chosen to avoid excessive creasing of lyocell fabrics and the formation of lines on dyed lyocell fabrics resulting from an optical effect relating to dye up-take in creased regions of the fabric or garments. The present invention provides a method of producing fabrics and treating fabrics which reduces this effect.

[0020] Essentially, according to the invention the material, in fabric form, is treated with a swelling agent, typically sodium hydroxide, so as to cause swelling of the lyocell fibre in the fabric. The amount of sodium hydroxide is so chosen as to result in a swelling in excess of that which occurs during normal wet processing of the fabric but not so high as to destroy the fibres by excessive dissolution. It has been found that, if lyocell fabric is swollen with a swelling agent such as sodium hydroxide and the swelling agent is then diluted, the fabric takes on a set whereby the yarns in the fabric are fixed in a position relative to one another, which reduces the creasing in subsequent wet processing.

[0021] It is a feature of the treatment with the swelling agent that the fabric as a whole shrinks during the swelling process. Because the fabric is in an unrestrained condition this shrinkage can occur. By an unrestrained or substantially unrestrained condition as used herein is meant a condition in which shrinkage of the fabric is permitted. In other words the fabric, although under a small amount of tension in some cases, can still shrink. The shrinkage is believed to result from the lyocell fibres forming a crimp along their length. When the fabric having swollen lyocell-containing yarn is washed with water as a diluting agent, the effect of the swelling agent is removed. This means that the fibres shrink. However, the fabric itself does not expand to its original condition so that the fibres and yarns within the fabric are in a relatively spaced state.

[0022] It has been found that when this fabric is subsequently wet processed, for example during dyeing or enzymatic treatment, the fabric does not produce creases or a crease-dyed effect to anywhere near the extent found hitherto.

Description of drawings**[0023]**

- Fig. 1 is a schematic view of an apparatus for carrying out the method of the present invention.
- Fig. 2 is a photograph of a fabric treated by the method of the invention and of an untreated fabric after each had been squashed by hand into a ball whilst in the wet state, released and then left to dry.
- Fig 3 is a graph correlating force required for wet crease pull out with caustic soda concentration for a fabric treatment by the method of the invention for bathwise treatment and pad treatment.

[0024] By way of example, embodiments of the present invention will now be described with reference to Fig. 1 of the accompanying drawings.

[0025] Referring to Fig. 1, this shows a fabric 1 passing around a roller 2 and through the nip of a pair of rollers 3 and being pushed down into a bath 4 containing 7 per cent by weight aqueous sodium hydroxide solution 5 at room temperature. The fabric runs around a pair of rollers 6,7 and up through the nip of a pair of rollers 8. The fabric then passes around guide rollers 9 and 10 before being passed through a bath 11 containing water 12. The fabric then passes through the nip of a pair of rollers 13 before passing around a guide 14 for subsequent processing. In practice, the rollers 3 run more quickly than the rollers 8. This means that the fabric passing through the bath 5 is in a substantially unrestrained condition, so that it can shrink as it passes through the sodium hydroxide solution. This causes the lyocell fibres in the fabric to swell. The fabric is then passed through the bath 11, being pulled by the rollers 13 in a substantially unrestrained condition, so as to dilute the sodium hydroxide by passing the swollen fabric through the bath 11. This causes the lyocell fibres to shrink in diameter but the fabric itself does not increase in length, thus forming a slightly looser fabric which can be subsequently processed in wet processing, so as to give less creasing and less creased dyeing.

[0026] Optionally, the fabric at point 15 can go direct to wet processing such as piece dyeing and/or enzyme treatment. Alternatively, the fabric at point 15 can be dried and made into garments prior to wet processing.

[0027] Rather than treating the fabric as fabric in continuous lengths, it is possible to take lyocell fabric straight from the woven condition, to form it into garments such as skirts and then to put the skirts through the process of swelling and diluting whilst the skirts are on mannequins or dummies or other cylinders. The fabric need not be kept completely flat as such but it does have to be in an unrestrained condition, sufficiently unrestrained to permit the fibres to swell and the fabric to shrink during the swelling process.

[0028] By way of a comparative test, two samples of fabric formed of 100 per cent woven lyocell were prepared. Each sample was a 3X1 twill at a weight of 170 g/m². Each sample was constructed from 45ends/cm in the warp of 50 number metric yarn and 23 picks in the weft of 34 number metric yarn.

[0029] The first sample of fabric was immersed in a solution of 80 g/litre sodium hydroxide in water (8% by weight sodium hydroxide). The sample was then washed and dyed with a reactive dye in an alkaline solution containing 3g/litre sodium hydroxide (0.3% by weight sodium hydroxide). The treatment in 8% sodium hydroxide was at room temperature. The fabric was then subjected to a wet softness test.

[0030] The actual test comprised a bending length test. In this test a wet strip of fabric is pushed up an incline of 45° until the end of the strip of fabric passes the upper end of the incline. Initially, the fabric maintains the 45° angle until eventually the weight of the fabric over the end of the incline causes the fabric to bend. A measure of the length of the fabric which has passed the end of the incline gives an indication of the softness of the fabric. Clearly the softer the fabric, the smaller the amount which can support itself beyond the end of the incline before bending.

[0031] In the case of wet dyed fabric which has been treated with 8% sodium hydroxide as set out above, 2cm of fabric passed the end before the fabric bent. In a comparative example which was treated identically in dyeing, but which had not been given the 8% sodium hydroxide treatment, 5.5 cm of the wet fabric had to pass the end of the incline before the fabric bent under its own weight.

[0032] It is clear from the above results that the invention is capable of producing a fabric having a much softer handle when wet. This is in comparison to the techniques described in published PCT Application WO95/24524, which requires fabric to be treated with a cellulase to produce a softening of the mercerised lyocell.

[0033] The preferred range for the sodium hydroxide concentration in the pre-treatment and swelling step is 3% to 10% by weight. As the sodium hydroxide concentration increases, the amount of cellulose dissolved increases and at 10% by weight sodium hydroxide 8% of the cellulose is dissolved. This is about the maximum acceptable for this technique, and the preferred range of 7 to 8% sodium hydroxide gives the optimum combination of improved softness together with a reduction in crease marking and damage marking, whilst having acceptably low levels of cellulose dissolved.

[0034] The invention is of further particular interest in the treatment of non-woven fabrics. Firstly, the swelling treatment and subsequent dilution treatment 'sets' the structure of the nonwoven fabric so that the fabric is stronger in

subsequent wet processing such as dyeing and the fibres in the fabric are less likely to fall out. Although the nonwoven fabric is stronger, it is still softer compared to nonwoven fabrics which have not been given the swelling technique of the present invention. The nonwoven fabric is preferably a hydroentangled fabric.

[0035] The softness of the fabric is particularly noticeable when the fabric is wet. Two pieces of lyocell fabric were produced, one treated in accordance with the method of the invention by preswelling the fabric with aqueous sodium hydroxide whilst free to shrink and then setting the fabric by diluting the effect of the sodium hydroxide with water, the other not being given the treatment of the invention. The two pieces of fabric were then dried and compared. The pieces of fabrics and the processing prior to and including the treatment according to the invention were chosen so that in the dried state the pieces of fabric had virtually identical feel to the hand. On being picked up in each hand and squashed into a ball, the two pieces of fabric felt the same in the dry state. When the fabrics were rewetted and again squashed by hand into a ball, the wet untreated sample felt hard compared to the wet treated sample. When the two wet samples were dropped onto a test bench so that the samples were free to lay flat, the untreated sample retained many creases, but the treated sample in accordance with the invention fell into an almost smooth sheet,

[0036] The different appearance of the sample treated in accordance with the method of the invention as compared with the untreated sample after the wet fabric in each case (after scouring) had been crumpled by hand by being squashed into a ball and released and the fabric had then been left to dry is illustrated in Figure 2 of the drawings. The left hand piece (treated sample) is smooth whereas the right-hand piece (untreated sample) is crumpled and creased. In Figure 2, the two samples are undyed, the left-hand sample having been relaxed in 8wt% soda (sodium hydroxide solution), washed and scoured, the right-hand sample having merely been relaxed in hot water and scoured. It can be seen that the difference in properties has a very material effect during wet processing of the fabric, i.e. during the dyeing process or during subsequent washing at home of garments made from such fabrics. Because the untreated sample readily creases there is enhanced abrasion of the fabric samples along the ridges formed by the peaks of the creases. As lyocell is a fibre which has a tendency to fibrillate, this wet abrasion gives rise to greater fibrillation along the lines of the creases than in the bulk of the fabric. This fibrillation produces a large number of minute fibrils which have a whiter effect optically when the fabric is subsequently dried. In effect what has happened is that fibrillation has been concentrated along the lines of the creases and these very fine fibrils reflect light in a different way to the lesser fibrillated fibre forming the main part of the fabric and garment. Thus, the garments appear to have crease lines in them when they have been washed. This can occur during the wet processing or dyeing or can occur subsequently during washing of the garments.

[0037] Thus, although the handle of the dry fabrics is little different whether the method of the invention has been used or not, and although the handle of the wet fabric is of little significance to the wearer of the eventual garments (with few exceptions clothes are worn dry and if they become wet in use it is unlikely that the user would notice the difference in handle between one wet garment and another compared to the difference between dry and wet garments), the use of the invention means that fabrics can be processed with much less chance of crease marks appearing during dyeing and with much less chance of crease marks appearing during the home washing process. Furthermore, if the fabric samples shown in Figure 2 are merely dried, then the sample on the left tends to dry much flatter whereas the sample on the right tends to dry with the creases built in. It is, therefore, easier to maintain garments processed from fabric produced in accordance with the invention than otherwise.

[0038] Scientifically, this effect can be correlated to the force required for wet crease pull-out. In Table I below this force is correlated with caustic soda concentration in the solution of sodium hydroxide used to treat the fabric in the method of the invention, both in bathwise treatment and in pad treatment.

TABLE 1

Caustic Conc	Force for Wet Crease		Pullout	
	Bend Length (cm) Bathwise	Bend Length (cm) Pad	(Flex Rigidity)* (mg.cm) Bathwise	(Flex Rigidity)* (mg.cm) Pad
0	5.5	5.5	1040	1040
5	4	4.5	400	570
10	4.5	4.5	570	570
20	4	3.5	400	268
40	4	3.5	400	268
80	2	3	50	169

*from ASTM method D1388 'Stiffness of Fabrics', 1975, fabric wt per unit area taken as 50mg/cm²

TABLE 1 (continued)

Caustic Conc g/l	Force for Wet Crease		Pullout	
	Bend Length (cm) Bathwise	Bend Length (cm) Pad	(Flex Rigidity)* (mg.cm) Bathwise	(Flex Rigidity)* (mg.cm) Pad
110	2	2	50	50
160	1.5	2	21	50
240	1.5	1.5	21	21

*from ASTM method D1388 'Stiffness of Fabrics', 1975, fabric wt per unit area taken as 50mg/cm²

[0039] For ease of understanding, the information in Table 1 is reproduced graphically in Figure 3 of the drawings, the force for bend straightening (mg.cm) being plotted along the y-axis and the caustic soda concentration in g/l being plotted along the x axis. In the Figure the data for bathwise treatment are shown as diamond-shaped points and the data for pad treatment are shown as square-shaped points. It can be seen that there is a significant force reduction down to about 80g/l (=8% by weight) caustic soda. It is best to keep the caustic level below that at which too much Lyocell is dissolved in the caustic soda, thus about 7-8% by weight is the preferred concentration.

Claims

1. A method of inducing set in a fabric formed of yarns, at least some of the fibres in at least some of the yarns being lyocell fibres, **characterised in that** it includes the steps of:

(i) maintaining the fabric in a form in which it is free to shrink;

(ii) contacting the fabric while in said form with a water-miscible swelling agent so that (a) the lyocell fibres swell in diameter without substantial dissolution and (b) the fabric shrinks;

(iii) diluting the swelling agent with water under conditions such that (a) the fibres shrink in diameter and (b) the yarns become set in the relative positions one to another which the yarns attained during the fabric shrinkage caused in step (ii); and

(iv) drying the fabric.

2. A method according to claim 1, **characterised in that** the fabric is subjected to further wet processing between step (iii) and step (iv), none of said further wet processing causing the lyocell fibre to swell as much as in step (ii).

3. A method according to claim 2, **characterised in that** the fabric is dried subsequent to step (iii) but prior to said further wet processing.

4. A method according to of claim 2 or claim 3, **characterised in that** the further wet processing comprises a dyeing step.

5. A method according to any one of the preceding claims, **characterised in that** the swelling agent is aqueous sodium hydroxide of 3 to 10 percent by weight concentration.

6. A method according to claim 5, **characterised in that** the swelling agent is aqueous sodium hydroxide of 5 to 9 percent by weight concentration.

7. A method according to claim 6, **characterised in that** the swelling agent is aqueous sodium hydroxide of 7 to 8 percent by weight concentration.

8. A method according to any one of the preceding claims, **characterised in that** the fabric is either (a) in woven piece form or (b) in garment form so held as not to have any sharp comers.

9. A method according to any one of claims 1 to 7, **characterised in that** the fabric is in continuous piece form.

Patentansprüche

1. Verfahren zum Fixieren einer aus Fäden gebildeten Ware, wobei es sich zumindest in einem Teil der Fäden bei den Fasern zumindest zum Teil um Lyocellfasern handelt, **dadurch gekennzeichnet, daß** man
 - (i) die Ware ungebunden führt,
 - (ii) die Ware in dieser ungebundenen Form mit einem wassermischbaren Quellmittel so in Berührung bringt, daß (a) die Lyocellfasern zwar anschwellen, sich aber im wesentlichen nicht auflösen, und (b) die Ware schrumpft,
 - (iii) das Quellmittel mit Wasser so verdünnt, daß (a) die Fasern im Durchmesser schrumpfen und (b) die Fäden in den bei der in Schritt (ii) herbeigeführten Warenschrumpfung gegeneinander eingenommenen Stellungen fixiert werden, und
 - (iv) die Ware trocknet.
2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, daß** man die Ware zwischen Schritt (iii) und Schritt (iv) einer weiteren Naßbehandlung unterzieht, bei der die Lyocellfasern jedoch nicht so stark wie in Schritt (ii) anschwellen dürfen.
3. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, daß** man die Ware nach Schritt (iii), aber vor der weiteren Naßbehandlung trocknet.
4. Verfahren nach Anspruch 2 oder 3, **dadurch gekennzeichnet, daß** die weitere Naßbehandlung eine Färbung umfaßt.
5. Verfahren nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, daß** man als Quellmittel eine 3 bis 10 gew.-%ige Natronlauge einsetzt.
6. Verfahren nach Anspruch 5, **dadurch gekennzeichnet, daß** man als Quellmittel eine 5 bis 9 gew.-%ige Natronlauge einsetzt.
7. Verfahren nach Anspruch 6, **dadurch gekennzeichnet, daß** man als Quellmittel eine 7 bis 8 gew.-%ige Natronlauge einsetzt.
8. Verfahren nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, daß** man als Ware entweder (a) eine Webware oder (b) ein nicht scharfkantig gehaltenes Kleidungsstück einsetzt.
9. Verfahren nach einem der Ansprüche 1 bis 7, **dadurch gekennzeichnet, daß** die Ware bahnförmig vorliegt.

Revendications

1. Procédé pour amorcer la prise dans un tissu formé de fils, certaines des fibres au moins dans certains des fils au moins étant des fibres de lyocell, **caractérisé en ce qu'il** comprend les étapes consistant à:
 - (i) maintenir le tissu sous une forme dans laquelle il soit libre de rétrécir ;
 - (ii) mettre en contact le tissu, pendant qu'il est sous ladite forme, avec un agent gonflant miscible avec l'eau, de manière (a) à ce que les fibres de lyocell aient un diamètre qui gonfle sans dissolution substantielle et (b) à ce que le tissu rétrécisse ;
 - (iii) diluer l'agent gonflant avec de l'eau dans des conditions telles (a) que les fibres aient un diamètre qui rétrécisse et (b) que les fils se prennent dans les positions relatives qu'adoptent les fils, les uns par rapport

aux autres, pendant le rétrécissement du tissu provoqué dans l'étape (ii) ; et

(iv) sécher le tissu.

- 5 **2.** Procédé selon la revendication 1, **caractérisé en ce que** le tissu est soumis à une mise en oeuvre humide ultérieure, entre l'étape (iii) et l'étape (iv), aucune de ces étapes de mise en oeuvre humide ultérieure ne provoquant autant de gonflement de la fibre de lyocell que dans l'étape (ii).
- 10 **3.** Procédé selon la revendication 2, **caractérisé en ce que** le tissu est séché après l'étape (iii), mais avant ladite mise en oeuvre humide ultérieure.
- 4.** Procédé selon la revendication 2 ou la revendication 3, **caractérisé en ce que** la mise en oeuvre humide ultérieure comprend une étape de teinture.
- 15 **5.** Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'agent gonflant est de l'hydroxyde de sodium aqueux de concentration 3 à 10 pour cent en poids.
- 6.** Procédé selon la revendication 5, **caractérisé en ce que** l'agent gonflant est de l'hydroxyde de sodium aqueux de concentration 5 à 9 pour cent en poids.
- 20 **7.** Procédé selon la revendication 6, **caractérisé en ce que** l'agent gonflant est de l'hydroxyde de sodium aqueux de concentration 7 à 8 pour cent en poids.
- 8.** Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le tissu est soit (a) sous forme de morceau tissé, soit (b) sous forme de vêtement, maintenu de manière à ne pas présenter d'angle aigu.
- 25 **9.** Procédé selon l'une quelconque des revendications 1 à 7, **caractérisé en ce que** le tissu est sous forme de morceau continu.

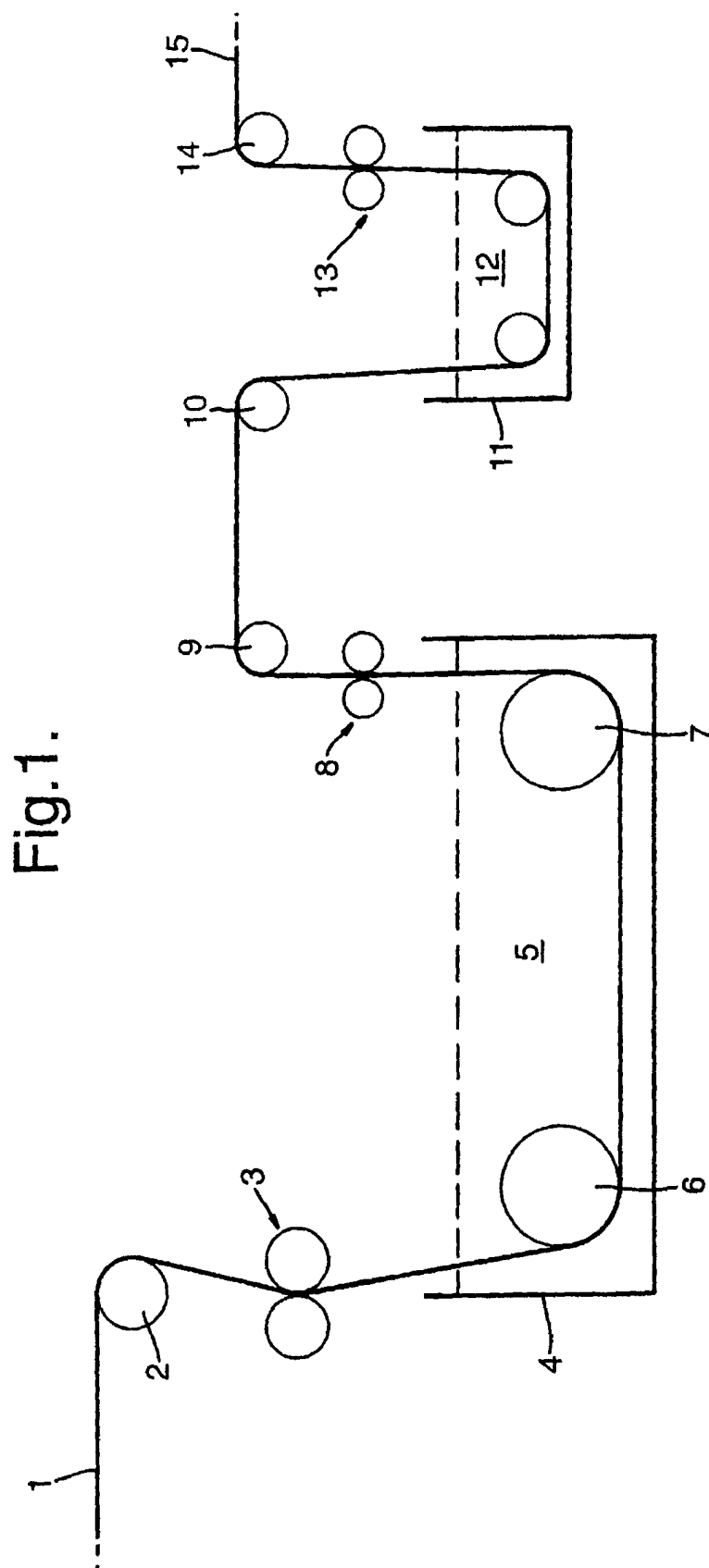


Fig.1.

Fig.2.

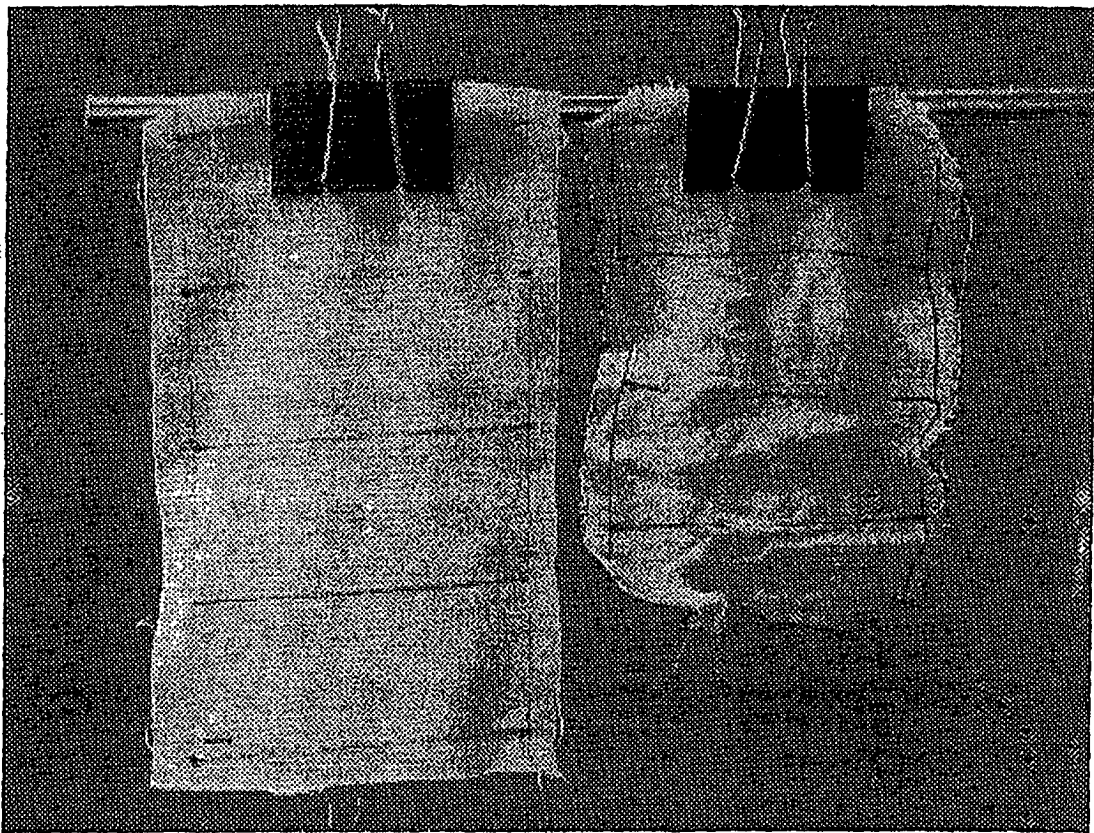


Fig.3.

