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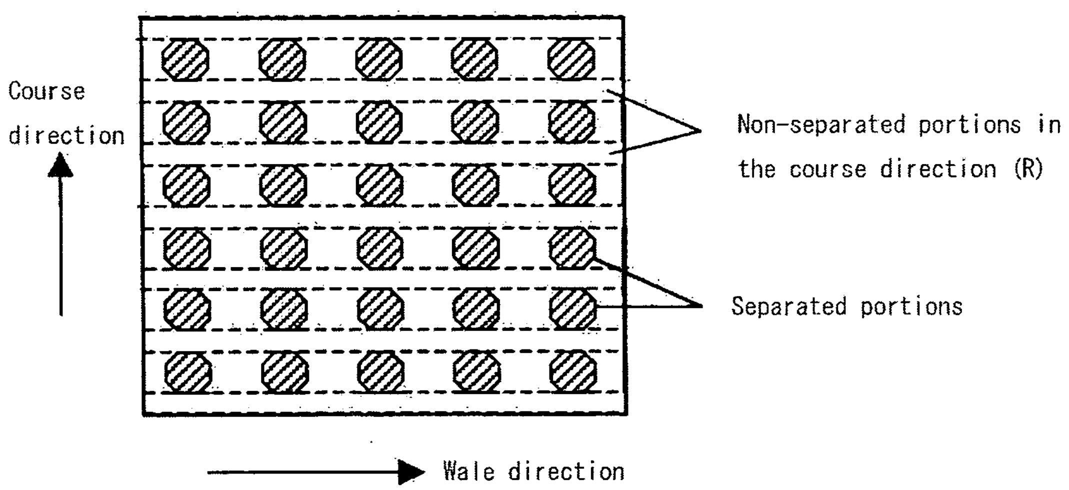
(54) CELLULOSE FIBER BLENDED FABRIC

(57) The present invention provides a fabric which makes the wearer feel comfortable when the wearer is not in a sweating state and does not give a sticky feeling or a steamy feeling to the wearer even when the wearer perspires. The present invention can be achieved by a cellulose fiber-blended fabric, **characterized by** comprising cellulose fibers having a rate of dimensional change upon water absorption of 2% or more. When the fabric of the present invention is applied to sportswear, inner wear, outer wear, and the like, the wearer can obtain a comfortable wear feeling.

[Figure 9]



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Description

Technical Field

[0001] The present invention relates to a special fabric in which fibers undergoing dimension changes during water absorption are blended. More particularly, the present invention provides a fabric which makes the wearer feel comfortable during perspiration prepared by blending cellulose fibers undergoing dimensional changes during water absorption (self-extension upon water absorption or self-shrinkage upon water absorption).

Background Art

[0002] In the case of conventional garments, when the wearer sweats during physical exercise such as sports, the sweat is absorbed by a fabric, which then sticks to the skin, causing a so-called sticky feeling or steamed feeling. Various fabrics have been developed in order to prevent these disadvantages, but the comfort achieved during sweat absorption is limited only by improvements in the fabric structure. In order to eliminate the sticky feeling or steamed feeling, fabrics and garments using fibers which undergo self-extension during sweat absorption (during water absorption) are proposed. For example, by using fibers undergoing self-extension during water absorption, there are proposed a garment having an improved gas permeability during water absorption (refer to Patent Documents 1, 2, and 3), a garment which becomes uneven during sweat absorption (refer to Patent Documents 4 and 5), and the like.
The garments proposed in these Patent Documents do make the wearer feel more comfortable during perspiration than the garments prepared without using a self-extensible yam upon water absorption. However, the fibers used in these garments have substantially no moisture absorbability or water absorbability, and the moisture by insensible perspiration of the body is not absorbed. For this reason, the wearer of such a garment has an uncomfortable feeling even when the wearer is not in a sweating state and also has a sticky feeling or a steamy feeling because it has no sweat absorbability during perspiration. Moreover, it is known that the use of usual cellulose fibers provides comfort to the wearer because they have good moisture absorbability. However, since they provide the wearer a sticky feeling or a steamy feeling during perspiration in physical exercise or the like, a high-performance fabric having, for example, an improved gas permeability during water absorption is further desired. As mentioned above, a fiber which makes the wearer feel comfortable both when the wearer is not in a sweating state and when the wearer perspires is not found at present.

[Patent Document 1] JP-A-2005-163225
[Patent Document 2] JP-A-2005-36374
[Patent Document 3] JP-A-2005-23431
[Patent Document 4] JP-A-2005-146496
[Patent Document 5] JP-A-2006-112009

Disclosure of the Invention

Problems to be Solved by the Invention

[0003] An object of the present invention is to provide a fabric which makes the wearer feel comfortable when the wearer is not in a sweating state and does not give a sticky feeling or a steamy feeling to the wearer even when the wearer perspires.

Means for Solving the Problems

[0004] The present inventors have intensively carried out investigations including wear test and the like for achieving an object, and, as a result, have found that the object can be achieved by a fabric using epoch-making cellulose fibers which undergo dimensional changes during water absorption.
[0005] Specifically, the object of the present invention is achieved by the following cellulose fiber-blended fabric.

(1) A cellulose fiber-blended fabric, characterized by comprising cellulose fibers having a rate of dimensional change upon water absorption of 2% or more.
(2) The cellulose fiber-blended fabric according to (1), characterized by comprising cellulose fibers self-extensible upon water absorption having an extensibility upon water absorption of +3% or more.
(3) The cellulose fiber-blended fabric according to (2), wherein the content of said cellulose fibers is 10 wt% or more.
(4) The cellulose fiber-blended fabric according to (3), wherein the fabric has a tubular knitted structure having a portion in which two or more welt loops and/or tuck loops are successively formed from the cellulose fibers self-

extensible upon water absorption having an extensibility upon water absorption of +3% or more.

(5) The cellulose fiber-blended fabric according to (3), wherein the fabric has a warp knitted structure characterized in that the cellulose fibers self-extensible upon water absorption having an extensibility upon water absorption of +3% or more are looped; the fabric has a swing knitting texture of one to four stitches; and the fabric has a reduction rate of knitted fabric density upon water absorption of 5 to 40%.

(6) The cellulose fiber-blended fabric according to (4) or (5), characterized in that the cellulose fiber self-extensible upon water absorption has been subjected to dipping treatment in an aqueous alkali solution of 20 g/L or more at 20°C or higher for 5 minutes or more.

(7) The cellulose fiber-blended fabric according to (1), characterized by comprising cellulose fibers self-shrinkable upon water absorption having an extensibility upon water absorption of -2% or less.

(8) The cellulose fiber-blended fabric according to (7), characterized in that the fabric is a multilayer fabric with separated portions and non-separated portions repeatedly formed therein, wherein one outer layer and/or an intermediate layer thereof comprises the cellulose fibers self-shrinkable upon water absorption having an extensibility upon water absorption of -2% or less; the other outer layer is formed from fibers non-shrinkable upon water absorption; and the non-separated portions in the course direction are formed from non-shrinkable fibers.

(9) The cellulose fiber-blended fabric according to (7), characterized in that the fabric is a three-dimensional fabric with separated portions and non-separated portions repeatedly formed therein, wherein one outer layer (C) forming the separated portions comprises the cellulose fibers self-shrinkable upon water absorption having an extensibility upon water absorption of -2% or less; the other outer layer (D) comprises fibers non-shrinkable upon water absorption; and the number of courses in (C) is larger than the number of courses in (D).

(10) The cellulose fiber-blended fabric according to (7), characterized in that the cellulose fibers self-shrinkable upon water absorption have a twist coefficient of 8,200 to 35,000.

Advantages of the Invention

[0006] When the fibers of the present invention are used, it is possible to produce a fabric which makes the wearer feel comfortable when the wearer is not in a sweating state and does not give a sticky feeling or a steamy feeling to the wearer even when the wearer perspires. In particular, this fabric can greatly exhibit the effect of moisture absorption and desorption characteristics during physical exercise and shows a big difference in wearing comfort from the garments as disclosed in Patent Documents 1 to 5 proposed until now. Further, since the cellulose fibers can undergo dimensional changes during water absorption (during sweat absorption when the garment is worn) to particularly improve moisture absorption and desorption characteristics, the effect of using the cellulose fibers can be further increased, and particularly a dimensional change effect of the cellulose fibers during water absorption can be obtained even with a small amount of water. For this reason, when the fibers of the present invention are used, it is possible to produce a fabric which makes the wearer feel comfortable when the wearer is not in a sweating state and does not give a sticky feeling or a steamy feeling to the wearer even when the wearer perspires. When a fabric produced using the fibers of the present invention are applied to sportswear, inner wear, outer wear, and the like, the wearer will obtain a comfortable wear feeling.

Brief Description of the Drawings

[0007]

Figure 1 shows an example of knitted texture in a cellulose-blended fabric of the present invention.
Figure 2 shows an example of knitted texture in a cellulose-blended fabric of the present invention.
Figure 3 shows an example of knitted texture in a cellulose-blended fabric of the present invention.
Figure 4 shows an example of knitted texture in a cellulose-blended fabric of the present invention.
Figure 5 shows an example of knitted texture in a cellulose-blended fabric of the present invention.
Figure 6 shows an example of knitted texture in a cellulose-blended fabric of the present invention.
Figure 7 shows an example of knitted texture in a cellulose-blended fabric of the present invention.
Figure 8 shows an example of knitted texture in a cellulose-blended fabric of the present invention.
Figure 9 shows an example of knitted texture in a cellulose-blended fabric of the present invention.
Figure 10 shows an example of knitted texture in a cellulose-blended fabric of the present invention.
Figure 11 shows an example of knitted texture in a cellulose-blended fabric of the present invention.
Figure 12 shows an example of knitted texture in a cellulose-blended fabric of the present invention.
Figure 13 shows an example of knitted texture in a cellulose-blended fabric of the present invention.
Figure 14 shows an example of knitted texture in a cellulose-blended fabric of the present invention.
Figure 15 shows an example of knitted texture in a cellulose-blended fabric of the present invention.
Figure 16 shows an example of knitted texture in a cellulose-blended fabric of the present invention.

Description of Symbols

[0008]

[1] - [8]	Order of knitting
[R]	Texture of non-separated portions provided partially
11	Dial needle
12	Cylinder needle
13	Common fibers
14	Cellulose fibers having a rate of dimensional change of 2% or more upon water absorption
21	Separated portions
22	Non-separated portions
A	One outer layer forming separated portions
B	The other outer layer forming separated portions
C	One outer layer forming separated portions
D	The other outer layer forming separated portions
K	Knit loop
T	Tuck loop
W	Welt loop

Best Mode for Carrying Out the Invention

[0009] Hereinafter, the present invention will be described in detail.
The cellulose fibers in the present invention include cuprammonium rayon, rayon, purified cellulose fibers, bamboo fibers, and cotton, and regenerated cellulose such as cuprammonium rayon and rayon is suitably used. Further, in order to obtain knitted fabrics, filaments and staple fibers (spun yarn) thereof are used. There are used filaments having a size of 11 dt (decitex: hereinafter, the same symbol is used) to 400 dt and staple fibers having a size of 160 S (cotton yam number: hereinafter the same symbol) to 10 S. The filaments and staple fibers can be used as two folded yarns or three folded yarns obtained by twisting them or as a structure obtained by arranging the filaments and staple fibers in parallel, wherein they can be used as a size suitable for textures. Filaments having a size of from 40 dt to 170 dt and staple fibers having a size of about 30 S to 120 S can be easily treated and are preferred.
[0010] The fabric of the present invention is a fabric in which cellulose fibers having a rate of dimensional change upon water absorption of 2% or more are blended. The cellulose fibers having a rate of dimensional change upon water absorption of 2% or more include two types of fibers, cellulose fibers self-extensible upon water absorption and cellulose fibers self-shrinkable upon water absorption. The present inventors have found a method of suitably obtaining cellulose fibers self-extensible upon water absorption and cellulose fibers self-shrinkable upon water absorption, have investigated a fabric structure for making the best use of respective performance, and have attained the present invention.
The cellulose fibers self-extensible upon water absorption refer to cellulose fibers having an extensibility upon water absorption of +2% or more, preferably +3% or more.
The cellulose fibers self-shrinkable upon water absorption refer to cellulose fibers having an extensibility upon water absorption of -2% or less.
[0011] Note that, in the present invention, fibers having a rate of dimensional change upon water absorption of less than 2% are called common fibers. Examples of common fibers include filaments or staple fibers of any fibers such as polyester fibers composed of polyester, polytrimethylene terephthalate, or the like, polyamide fibers, polyurethane fibers, cellulose fibers to which dimensional change performance upon water absorption by alkali treatment or twisting to be mentioned below is not imparted, acetate, and wool. These fibers may have any sectional shape, and may be modified cross-section fibers having a round section, a W-type section, or the like.
In the present invention, the rate of dimensional change upon water absorption is determined by the following methods. In the environment of 20°C and 65% RH, a fiber is measured for the fiber length (A) under a load of 0.05 g/dt (decitex), and then the fiber is dipped in water for 30 seconds. Subsequently, the fiber is taken out of the water and measured for the fiber length (B) after 30 seconds under a load of 0.05 g/dt. The extensibility upon water absorption is determined by the following formula (1). Then, as shown in the following formula (2), the absolute value of the resulting extensibility upon water absorption is defined as the rate of dimensional change upon water absorption.
[0012] Note that, fibers in a fabric are measured for the rate of dimensional change upon water absorption on the same conditions as described above by extracting the fibers from the fabric. At this time, the fiber length to be measured is 30 cm, but when a fiber having a length of 30 cm cannot be extracted from the fabric, a fiber having a length as it is extracted is used for measurement. In this case, in order to determine an exact value, the number of test specimens is appropriately increased for measurement. Also in the case of a composite yam, a blended yam, or a twisted union yam

prepared by combining a plurality of fibers each having a different rate of dimensional change upon water absorption by fluid interweaving such as interlacing, twisting, or the like, fibers are extracted from the fabric and measured for the rate of dimensional change upon water absorption on the same conditions in the state of a composite yam, a blended yam, or a twisted union yam.

$$\text{Extensibility upon water absorption (\%)} = ((B-A)/A) \times 100 \quad (1)$$

$$\text{Rate of dimensional change upon water absorption (\%)} = \text{Absolute value of extensibility upon water absorption} \quad (2)$$

Hereinafter, cellulose fibers self-extensible upon water absorption and the structure of the fabric of the present invention using and these fibers will be described.

[0013] The cellulose fibers self-extensible upon water absorption of the present invention have an extensibility upon water absorption of +2% or more, preferably +3% or more. Cellulose fibers may be converted to self-extensible yarns upon water absorption by treating conventional cellulose fibers in an aqueous alkali solution. Alkali treatment of cellulose fibers is conventionally known. For example, mercerization is the most common treatment process. However, in the present invention, cellulose fibers which extend by 2% or more, preferably 3% or more upon water absorption have been successfully produced by subjecting cellulose fibers to severe alkali treatment contrary to conventional common sense. Specifically, they are obtained by dipping cellulose fibers, for example, in an aqueous solution containing sodium hydroxide in an amount of 20 g/L (liter) or more at 20°C or higher for 5 minutes or more. Control of the extensibility upon water absorption is possible by controlling these conditions. For example, the rate of elongation upon water absorption will be lower as treatment conditions such as alkali concentration, temperature, and time are milder. However, it is difficult to obtain cellulose fibers having an extensibility upon water absorption beyond a certain limit, for example, 20% even when the treatment conditions are too severe. A known alkali treatment agent, for example, alkali metal hydroxides such as sodium hydroxide and potassium hydroxide can be used.

[0014] The alkali concentration is more preferably equivalent to the concentration of an aqueous solution containing an alkali in an amount of from 20 to 200 g/L. Treatment temperature and time are more preferably in the range of from 20 to 110°C and from 5 to 120 minutes, respectively. The above treatment temperature is the highest temperature during treatment. The treatment time is the total time from the time when the treatment temperature exceeds 20°C after charging an alkali to the time when the temperature is lowered to less than 20°C after it reaches the highest temperature and cellulose fibers are treated at the highest temperature. The treatment time may be 5 minutes or more. It is desirable that the cellulose fibers are quickly washed with water and neutralized after discharging cooling water. Any known method of alkali treatment may be used, such as a method in which cellulose fibers are treated with alkali, knitted, and then dyed, or a method in which cellulose fibers before alkali treatment are used to produce a fabric, followed by alkali treatment of the fabric, followed by dyeing. A method of performing alkali treatment after producing a fabric is easy.

[0015] The cellulose fibers self-extensible upon water absorption can also be obtained by a dipping treatment in a strong acid such as acetic acid and malic acid, but the effect to form the cellulose fibers self-extensible upon water absorption is a little smaller than the alkali treatment under the above conditions.

The cellulose fiber-blended fabric of the present invention greatly contributes to wearing comfort because cellulose fibers particularly excellent in moisture absorption and desorption characteristics are used, and this fabric is significantly different in wearing comfort from the fabrics as disclosed in Patent Documents 1 to 5 proposed until now. Specifically, the use of the cellulose fibers self-extensible upon water absorption, which is a significant feature of the cellulose fiber-blended fabric of the present invention, allows cellulose fibers to extend during water absorption (during sweat absorption when the garment is worn) to improve moisture desorption characteristics, thereby capable of increasing the effect of using cellulose fibers.

[0016] The cellulose fibers self-extensible upon water absorption and common fibers can be blended by a method in which common fibers and the cellulose fibers self-extensible upon water absorption are knitted or weaved by arranging in parallel or the like on a knitting machine or a weaving machine, respectively, or a method in which a fabric is produced by using the cellulose fibers self-extensible upon water absorption and common fibers as composite yarns prepared by twisting, composite false twisting, interlacing, or the like. Note that, in some method for preparing a composite yam, extension of the composite yarn may not be obtained satisfactorily during water absorption. In order to avoid this, the feeding amount (feed rate) is designed so that the cellulose fibers self-extensible upon water absorption have a length shorter by 0 to 9% than that of common fibers in the state where a fabric is textured. When the difference of the yarns is larger than 9%, the strength of the composite yam is insufficient, and sufficient fabric strength cannot be obtained. Further, when the cellulose fibers self-extensible upon water absorption are longer, the fiber becomes apparently thicker to reduce the moisture absorption and desorption characteristics, and the object of the present invention may not be achieved.

[0017] Further, the blending ratio of the cellulose fibers self-extensible upon water absorption in the composite yam can be arbitrarily set by considering the effect obtained by the fabric design. The blending ratio of the cellulose fibers self-extensible upon water absorption is preferably from 20 to 80%.

When a fabric such as a knitted fabric and a woven fabric is produced using the cellulose fibers self-extensible upon water absorption of the present invention, it is possible to give various functions which make the wearer feel comfortable during perspiration by the design of a knitted fabric and a woven fabric. For example, the following is an example of a texture where projections are formed by the extension of cellulose fibers in the portions where water is absorbed during perspiration to thereby allow the surface fibers forming the fabric to float to the surface of the fabric: a structure prepared by using a double circular knitting machine in which separated portions, wherein one outer layer containing the cellulose fibers self-extensible upon water absorption is partially separated from the other outer layer containing common fibers, and non-separated portions are regularly or irregularly repeated. The structure will allow the cellulose fibers self-extensible upon water absorption to extend during perspiration to thereby develop unevenness in the knitted fabric, which forms a garment in which a sticky feeling is suppressed.

[0018] Further, if the cellulose fibers self-extensible upon water absorption are designed so that knitting loops or weaving yarns which form the fabric are stretched and enlarged during absorption of sweat to reduce the density of the sweat-absorbing portions, it will be possible to produce a garment which does not make the wearer feel a steamy feeling during perspiration by physical exercise or the like. When producing a garment which does not make the wearer feel a steamy feeling, a highly effective garment can be obtained from a knitted fabric rather than a woven fabric. For example, in a circular rib texture, a structure of fibers non-extensible upon water absorption and the cellulose fibers can be produced by a design of arranging them alternately or arranging one cellulose fiber self-extensible upon water absorption in three fibers or the like. As described above, in the present invention, by effectively designing the cellulose fibers self-extensible upon water absorption with a single circular knitting machine, a double circular knitting machine, a single warp knitting machine, a double warp knitting machine, a weaving machine, or the like, it is possible to form unevenness in a fabric or to reduce the density of the stitches or woven yarns which form the fabric of the water-absorptive portions during perspiration by physical exercise or the like. Further, in the case of warp knitting, the effect of the present invention can be suitably achieved by selecting a warp knitted texture, in which sinker loops having longer floating portions are formed by plain cord (two-stitch swing) rather than denbigh (one-stitch swing), satin (three-stitch swing) rather than the plain cord, or the like; the cellulose fibers self-extensible upon water absorption are arranged in these portions; and these are used as one reed.

[0019] Further, when a fabric is produced as a woven fabric, the fabric may be designed so that the cellulose fibers self-extensible upon water absorption extend during perspiration to form unevenness in the fabric and reduce the density of the sweat-absorbing portions by weaving a front layer and a back layer as a texture in which warp yarns or weft yarns have long floating portions such as twill or satin or as a double weave and providing a connecting portion every several tens of yarns in the weft direction and in the warp direction. In these fabrics, the cellulose fibers self-extensible upon water absorption need not necessarily be exposed to a surface. For example, it is also possible to design a fabric as a three-layer structure in which the cellulose fibers self-extensible upon water absorption are arranged in an intermediate layer and the cellulose fibers self-extensible upon water absorption in the intermediate layer are stretched during perspiration to extrude common fibers in an outer layer to form unevenness or reduce the density.

[0020] Thus, when the cellulose fibers self-extensible upon water absorption are used, it is possible to produce a garment which makes the wearer feel comfortable during perspiration by physical exercise or the like. However, cellulose fibers having an extensibility upon water absorption of less than +2% show only a small change of fabric structure, and it is impossible to produce a garment which makes the wearer feel comfortable during perspiration by physical exercise or the like.

[0021] The cellulose fiber-blended fabric according to the present invention preferably contains 10% or more of the cellulose fibers self-extensible upon water absorption having an extensibility upon water absorption of +2% or more, preferably +3% or more. When the blending ratio of the cellulose fibers self-extensible upon water absorption is less than 10%, the effect of suppressing a steamy feeling is not exhibited effectively even if the cellulose fibers are stretched during water absorption. A more preferred blending ratio is 15 to 100%, and a knitted fabric made from 100% cellulose fibers self-extensible upon water absorption can exhibit the highest effect of the present invention.

Further, when they are blended with common fibers such as cotton, acrylic, polyester, or nylon, concern about feeling, strength, and the like will be eliminated, allowing the fabric to be developed into various types of clothing.

[0022] Further, any known method may be used as a method for blending the cellulose fibers self-extensible upon water absorption with common fibers, but the effect can be exhibited when the cellulose fibers are arranged so that a texture in the course direction or in the wale direction is formed solely from the cellulose fibers. For example, in the interlock texture of knitting, the effect of the present invention can be exhibited more clearly by using the cellulose fibers self-extensible upon water absorption in two contiguous courses, in which all loops in the course direction are formed from the cellulose fibers self-extensible upon water absorption, and using common fibers such as cotton and acrylic in the courses adjoining the above-mentioned courses. In the case of a texture prepared by using solely one type of fiber in one course like a circular rib texture, the effect of the present invention can be exhibited when the cellulose fibers self-extensible upon water absorption are arbitrarily arranged so that they are blended at a blending ratio of 10% or more.

[0023] Further, the cellulose fiber-blended fabric of the present invention can obtain a particularly high effect when the knitted fabric has portions in which at least two welt loops and/or tuck loops are successively formed from the cellulose fibers self-extensible upon water absorption. Specifically, the fabric preferably has portions in which at least two welt loops and/or tuck loops are successively formed from the above-mentioned cellulose fibers in the course direction (warp direction of the knitted fabric), in the wale direction (weft direction of the knitted fabric), or in the oblique direction, in one needle bed.

Here, the tuck loop and the welt loop refer to the loops included in the three elements of the loops forming a knitted fabric, that is, a knit loop, a tuck loop, and a welt loop. The tuck loop means a texture in which a yam is supplied to a needle but the loop is not knocked over, and the welt loop means a texture in which a yarn is not supplied to a needle. The tuck loop and the welt loop are present substantially linearly or a little bent in a knitted fabric. These loops form a loop structure which is easily extended when the cellulose fibers self-extensible on water absorption absorb water and are extended because these loops are less curved and have no bending point compared with a loop structure like a knit loop which is greatly curved and has a large bending point in the lower portion of the knit loop.

[0024] Therefore, forming a texture of a knitted fabric by the tuck loop and the welt loop makes it possible to form a knitted fabric in which density of the knitted fabric or a filling factor during water absorption is reduced to prevent it from making the wearer feel steamy. In particular, when the fabric has portions in which at least two welt loops and/or tuck loops are successively formed in the course direction, in the wale direction, or in the oblique direction, in one needle bed, a steamy feeling-reducing effect during perspiration will be further increased. Note that, a double circular knitting machine has two needle beds, dial and cylinder, but only one needle bed may be taken into consideration. That is, it may be designed so that only one needle bed texture, the dial side or the cylinder side, has portions in which at least two welt loops and/or tuck loops are successively formed in the course direction, in the wale direction, or in the oblique direction. A single circular knitting machine has only a cylinder needle bed. Therefore, the consideration on designing texture like in the case of a double circular knitting machine is unnecessary, and this machine may be designed so that it has portions in which at least two welt loops and/or tuck loops are successively formed from the cellulose fibers self-extensible upon water absorption.

[0025] Further, any combination of tuck loops and welt loops can be used to form successive tuck loops, successive welt loops, or successive loops by a combination of a tuck loop and a welt loop. For example, any method can be used, which includes: welt loops and tuck loops in the course direction, two successive wales of a welt loop/a welt loop in the wale direction, and two wales of welt loops in the wale direction followed by two successive wales of tuck loops in the course direction thereof. Further, in the case of a so-called plain knitting texture in which knit loops are successively formed over a certain length in the wale direction, the effect of the present invention can be exhibited by forming two or more successive textures to thereby successively form two loops in the oblique direction, in the textures the plain knitting portion being knitted by two divided yam feedings and one course being completed by the two yarn feedings.

[0026] These are illustrated in Figures 1 to 6, wherein [1], [2], and [3] represent the knitting order and the course direction. In practice, this knitting order is repeated to knit a fabric. The weft row represents the wale direction. Although only four wales are indicated in the Figures, a fabric is formed by repeating this texture in practice. Further, K represents a knit texture, T represents a tuck texture, and W represents a welt texture.

Figures 1 and 2 show examples in which welt loops or tuck loops are knitted successively in two courses; Figures 3, 4, and 5 show examples in which welt loops or tuck loops are successively formed in the oblique direction; and Figure 6 shows an example in which a welt loop and a tuck loop are combined. Note that, when a tuck loop or a welt loop is not successively formed, the effect of the present invention will be small.

[0027] When the cellulose-blended fabric of the present invention is a warp knitted fabric, it may be difficult for some textures to employ the feature of the self-extensible fibers upon water absorption efficiently. As a result of intensive investigation to prevent this phenomenon, the present inventors have found that a comfortable warp knitted fabric can be produced by a certain method for designing the warp knitted fabric. Specifically, the object of the present invention has been achieved by forming a knitted fabric comprising cellulose fibers self-extensible upon water absorption, in which the cellulose fibers are looped, and the fabric has a swing knitting texture of one to four stitches.

The looping as described herein refers to a structure in which needle loops (knit loops) are formed. An inlay texture which does not form needle loops is not preferred because deformation when the knitted fabric is worn by the wearer is not recovered, but a so-called loosening phenomenon arises. A structure in which the looping and the inlay are repeated is regarded as a looping texture in the present invention when the inlay is formed in only one course and not formed successively. In this structure, the loosening phenomenon does not arise. However, the case where the inlays are successively formed in two or more courses is not preferred because the loosening easily arises. Further, when a fabric is knitted within the same wale as observed in the chain stitch like 10/01, without forming a swing knitting texture, the effect of the invention is not obtained. When forming such a chain stitch, a fabric is designed so that chain stitches are not formed successively in two or more courses by forming a swing knitting texture once in two courses like 10/01/12/21. Of course, the loop by two-needle stitch is also included in looping.

[0028] Further, it is required that the warp knitted texture formed from the cellulose fibers self-extensible upon water absorption have a swing of one to four stitches. When the swing is increased, the effect of the moisture desorption characteristics by extension upon water absorption of the cellulose fibers is easily produced, but a swing of five or more stitches makes the pack density of the cellulose fibers in a warp knitted fabric too high, producing a phenomenon in which the effect of moisture desorption characteristics is conversely reduced during water absorption. Therefore, a warp knitted texture needs to be designed so that the cellulose fibers extensible upon water absorption are knitted by a swing of one to four stitches. Examples of the design of the warp knitted fabrics include various textures prepared by the following methods for preparing a two-reed tricot in which the cellulose fibers self-extensible upon water absorption are used in the back and common fibers are used in the front: a method in which the texture of the back has a swing which changes with courses but is looped in all the courses, such as 10/12, 10/23, 10/34, 10/45, and 10/12/10/34/32/34, and a method in which the texture of the back has repeated loops and inlays, wherein no inlays are formed successively, such as 12/00, and 12/10/22/10/12/00.

[0029] In the case of a warp knitted fabric comprising the cellulose fibers self-extensible upon water absorption in the present invention, it is difficult to extract cellulose fibers from the warp knitted fabric to measure the extensibility upon water absorption (rate of dimensional change upon water absorption) of the cellulose fibers in many cases except in the case of a texture like the half from which fibers in the back's 10/12 texture can be extracted. For this reason, the present inventors have investigated a measure which can replace the self-extensibility upon water absorption. As a result of the investigation, we have found that a fabric having a reduction rate of knitted fabric density within a predetermined value can make the wearer feel comfortable.

In particular, the following has been found. The reduction rate of knitted fabric density under a small amount of water has a correlation with wearing comfort. In the case where a garment is formed from a knitted fabric having a reduction rate of knitted fabric density in the range of from 5 to 40%, air easily moves into and out of the garment when water in an amount of 50% of the knitted fabric weight is given to the knitted fabric. Further, the moisture absorption and desorption characteristics of the cellulose fibers are sufficiently exhibited by the movement of air, thereby preventing the wearer of the garment from being exposed to high humidity. The warp knitted fabric of the present invention has a reduction rate of knitted fabric density upon water absorption of 5 to 40%, preferably 10 to 30%. When the reduction rate of knitted fabric density is less than 5%, the fabric gives the wearer a steamy feeling and the like during perspiration and makes the wearer feel uncomfortable. This is not preferred. When the reduction rate of knitted fabric density is larger than 40%, the garment shape is excessively changed to spoil a wear feeling and worsen the appearance. This is not preferred.

[0030] The warp knitted fabric which is the cellulose-blended fabric of the present invention preferably contains 10% or more of cellulose fibers self-extensible upon water absorption. The cellulose fibers self-extensible upon water absorption are blended with common fibers by the following methods: a method of subjecting common fibers and the cellulose fibers self-extensible upon water absorption to warping and knitting on separate beams, or a method in which the cellulose fibers self-extensible upon water absorption and common fibers are formed into composite yarns by twisting, composite false twisting, interlacing, or the like, and the composite yarns are subjected to warping on a beam. Further, the warp knitted fabric can be produced by warp knitting machines, such as a single or a double tricot machine and a Raschel loom. The knitted fabric can be formed from any texture, such as a knitted fabric of a denbigh, half, satin, or mesh tone which is produced in one reed or more and a warp knitted fabric of a three-dimensional tone which has connecting yarns inside the warp knitted fabric.

[0031] A conventional dyeing step can be used in a dyeing method of the fabric comprising the cellulose fibers self-extensible upon water absorption of the present invention. Any dyeing machine can be used, such as a cheese dyeing machine and a skein dyeing machine when the cellulose fibers are treated with alkali in a fiber state, and a jet dyeing machine and a winch dyeing machine when the cellulose fibers are treated with alkali in a fabric state. Further, it is also possible to use a continuous alkali treatment machine such as a mercerizing machine which can treat a fabric not batchwise but continuously. In this case, treatment conditions may be set to those of the present invention. The fabric after the alkali treatment is preferably dyed under the dyeing conditions depending on fiber materials. Further, texturing in a knitted fabric state may be performed in any steps including the following steps: a step in which a gray fabric is preset by a pin stenter or the like at a temperature in the range of from 150 to 190°C, followed by scouring, alkali treatment, dyeing, and finishing set, and a step in which a gray fabric is scoured and preset by a pin stenter or the like at a temperature in the range of from 150 to 190°C, followed by dyeing and finishing set. The finishing set is performed at a temperature in the range of from 150 to 190°C, wherein the knitted fabric is finished so that the cellulose fibers which extend upon water absorption after the finishing set do not become wrinkled or stretched. Further, a method of drying the fabric before the finishing set to thereby establish the finishing density is preferred. It is also possible to add a softening agent or a water-absorbing agent as a finishing agent. The addition of the water-absorbing agent is preferred because sweat absorbability is improved. Note that a fiber resin such as a water-absorbing agent can also be added during dyeing.

[0032] Hereinafter, cellulose fibers self-shrinkable upon water absorption and the structure of a fabric of the present invention using the fibers will be described.

The cellulose fibers self-shrinkable upon water absorption according to the present invention have an extensibility upon water absorption of -2% or less. The cellulose fibers having an extensibility upon water absorption of -2% or less is obtained by preparing twist yarns having a twist coefficient of 8,200 to 35,000.

A fabric structure for achieving the object of the present invention has been intensively investigated using the cellulose fibers, the investigation including wear tests. As a result, the following conclusion has been obtained: when the fabric is formed as a tubular knitted fabric having two to three layers, wherein fibers which shrink by absorbing sweat during perspiration by physical exercise or the like are used in one outer layer or in an intermediate layer of the tubular knitted fabric having two to three layers and fibers which show small shrinkage during sweat absorption are used in the other outer layer, there will be obtained a fabric structure, in which, when the fabric is dry, it is flat; when it absorbs sweat, fibers in one outer layer of the fabric shrink during sweat absorption to allow the other outer layer to float to form projections because the other outer layer is composed of fibers having a small shrinkage; and when the fabric is dried after the sweat absorption, it returns to a flat state. When a garment is sewed using the side in which the projections are formed as the skin side, the wearer will feel comfortable even during perspiration. As a result of various investigations to achieve this function, it has been found that this function can be achieved by specifying a knitted fabric structure and a material.

[0033] Specifically, in order to develop the effect of the present invention, the fabric is preferably a two-layer tubular knitted fabric with separated portions and non-separated portions repeatedly formed therein, wherein one outer layer comprises cellulose fibers self-shrinkable upon water absorption; the other outer layer is formed from fibers non-shrinkable upon water absorption; and the non-separated portions in the course direction are formed from fibers non-shrinkable upon water absorption. Here, the fibers non-shrinkable upon water absorption refer to fibers having an extensibility upon water absorption of more than -2% and include the above-mentioned common fibers and fibers self-extensible upon water absorption. Sectional views of such tubular knitted fabrics are shown in Figures 7 and 8.

Figure 7 shows a schematic representation of the cross section of the tubular knitted fabric when it is dry, and Figure 8 shows the same when it absorbs sweat. The tubular knitted fabric comprises separated portions 21 and non-separated portions 22 repeatedly formed therein, wherein one outer layer (A) comprises cellulose fibers self-shrinkable upon water absorption, and the other outer layer (B) is formed from fibers non-shrinkable upon water absorption. When it is dry (Figure 7), the surface of the fabric is flat, but when it absorbs sweat (Figure 8), the cellulose fibers self-shrinkable upon water absorption which form (A) shrink to allow the fibers which form the other outer layer (B) in the separated portions 21 to float to form projections.

[0034] The separated portions and the non-separated portions may be repeated regularly or irregularly, and various textures and structures which can be produced with a tubular knitting machine can be selected to form these portions. Note that, unlike the three-dimensional knitted fabric of a different structure to be described below, the range of the course ratio of both outer layers, (A)/(B), is not particularly limited in the tubular knitted fabric of the present structure, but it is preferably substantially: (A)/(B) =1, in order to keep the surface of the fabric flat when it is dry.

Further, as a three-layer tubular knitted fabric which can develop the effect of the present invention, the fabric is preferably a three-layer tubular knitted fabric with separated portions and non-separated portions repeatedly formed therein, wherein one outer layer and/or an intermediated layer comprises cellulose fibers self-shrinkable upon water absorption; the other outer layer is formed from fibers non-shrinkable upon water absorption; and non-separated portions in the course direction is formed from fibers non-shrinkable upon water absorption.

[0035] The separated portions which are partially separated in the multilayer tubular knitted fabric of two to three layers according to the present invention may have any shape in the form of a spot having an area such as a round, elliptic, rectangular, rhombic, or star shape and may also have any arrangement such as a checkered, ascending, or irregular arrangement. The effect of the unevenness of the fabric during perspiration will be reduced when the size of the separated portion is too small or too large. In the case of a spot having an area such as a round or rectangular shape, both the major axis and the minor axis are preferably in the range of from 2 to 15 mm, most preferably from 3 to 12 mm. In the case of a continuous shape with a certain width, the width is preferably in the range of from 2 to 15 mm, most preferably from 3 to 12 mm.

The wearer has a sticky feeling during perspiration when the total area of the separated portions in which projections are formed during sweat absorption is too small or too large. For this reason, the total area obtained by adding individual areas of the projections on the side where the projections are formed during sweat absorption is preferably in the range of from 20 to 90% of the surface of the fabric when it is dry. It is more preferably from 30 to 80%, most preferably from 35 to 75%. The total area in these ranges will provide a comfortable garment which does not give a sticky feeling to the wearer even when he perspires.

[0036] The separated portions in the tubular knitted fabric having two to three layers of the present invention have any shape as described above. It is required that non-separated portions be formed so as to surround separated portions and the separated portions and the non-separated portion be formed repeatedly.

Figure 9 shows an example of the structure of separated portions and non-separated portions of the tubular knitted fabric. Although the non-separated portions in the wale direction (the warp direction of the circular knitted fabric) need not be linearly continuous, the non-separated portions in the course direction (weft direction of the tubular knitted fabric) are designed to be linearly continuous and formed from non-shrinkable fibers. Specifically, although the non-separated portions in the wale direction may contain cellulose fibers self-shrinkable upon water absorption, the non-separated portions in the course direction are formed only from fibers non-shrinkable upon water absorption. The width of the non-separated portions in the wale direction is not particularly limited. The width of the non-separated portions in the course direction is preferably in the range of from 1 to 15 mm because, when it is too narrow or too wide, the effect of reducing stickiness will be decreased during perspiration. The width is more preferably in the range of from 2 to 12 mm, most preferably from 3 to 10 mm. An object of the present invention can be sufficiently achieved by the width in these ranges. The width not only suppresses stickiness during sweat absorption but also allows reduction in the blending ratio of the cellulose fibers having a twist coefficient of 8,200 to 35,000. Since these fibers have a high cost, it is possible to reduce the cost of the tubular knitted fabric. Note that the width of the non-separated portions is determined by measuring the minimum width of the non-separated portions in the course direction.

[0037] As an example of specific methods for producing the two-layer tubular knitted fabric according to the present invention, in the case of using a double tubular knitting machine, there is mentioned a method in which one outer layer is knitted by plain knitting, and the other outer layer is knitted by plain knitting which has a connecting portion of the two-layers of front and back for every several wales, the connecting portion having a knit or tuck texture. A structure in which the cellulose fibers self-shrinkable upon water absorption are contained in one outer layer is designed for knitting. In order to provide non-separated portions as connecting portions which partially connect both the outer layers in these textures, it is necessary to use fibers non-shrinkable upon water absorption to form a non-separated portion for every several courses by connecting the outer layers by knitting with both the dial and the cylinder in the case of a double tubular knitting machine. Thus, the separated portions and the non-separated portions are repeatedly formed in the course direction and in the wale direction, which allows projections in the form of a spot having an area such as a round or rectangular form to be formed during sweat absorption.

[0038] In the case of using a double tubular knitting machine, examples of specific methods for producing the three-layer tubular knitted fabric according to the present invention include the following methods: a method in which the front layer and the back layer are knitted by plain knitting, and an intermediate layer is knitted as welt, wherein these layers are connected by providing one connecting portion for every several wales by knitting or tucking with both the dial and cylinder using any fibers or all yarns which form these three layers; and a method in which one outer layer knitted by plain knitting is integrated with an intermediate layer by plating, and the other outer layer is knitted by plain knitting, wherein these layers are connected by knitting or tucking with any fibers forming the same. Further, there is also mentioned a method in which an intermediate layer is knitted by plating as welt, and the cellulose fibers self-shrinkable upon water absorption are arranged in one outer layer and in the intermediate layer. In the case of the tubular knitting as described above, when these layers are connected by providing one connecting portion for every several wales by knitting with both the dial and the cylinder using the fibers non-shrinkable upon water absorption, the non-separated portions are formed in the course direction and in the wale direction, which allows to form projections in the form of a spot having an area such as a round or rectangular form during sweat absorption.

[0039] The cellulose fibers self-shrinkable upon water absorption according to the present invention are twisted so that they have a twist coefficient of 8,200 to 35,000. The cellulose fibers can exhibit the function of shrinkage during sweat absorption because they are twisted so as to have a twist coefficient of 8,200 to 35,000. A twist coefficient of less than 8,200 is not preferred because the function as an object of the present invention cannot be exhibited. A twist coefficient of more than 35,000 is not preferred because production of a tubular knitted fabric becomes difficult and needs high cost. Therefore, the twist coefficient may be in the range of from 8,200 to 35,000, preferably from 11,000 to 30,000.

In the present invention, the cellulose fibers self-shrinkable upon water absorption are preferably blended in an amount of 5% by weight or more of the whole multilayer tubular knitted fabric. The blending rate of less than 5% by weight is not preferred because the formation of projections in the tubular knitted fabric during sweat absorption according to the present invention is slight, and it is difficult to achieve an object of the present invention. The blending rate of more than 50% by weight is also not preferred because the shrinkage of the whole tubular knitted fabric during sweat absorption is enlarged and the size of the garment is varied. Any known method can be used for blending the cellulose fibers self-shrinkable upon water absorption, such as a method of blending by the arrangement of fibers and a method of preparing a twisted union yam with common fibers.

[0040] When the total area of the portions in which projections are formed during sweat absorption is too small or too large, the fabric will make the wearer feel sticky during perspiration. Therefore, the total area obtained by totaling individual areas of the projections on the side where they are formed during sweat absorption is preferably in the range of from 20 to 90% of the fabric surface when it is dry. It is more preferably from 30 to 80%, most preferably from 35 to 75%. The total area in these ranges will provide a comfortable garment which does not give a sticky feeling to the wearer even when the wearer perspires.

The knitted fabric density of the multilayer tubular knitted fabric having two to three layers in the present invention can be set arbitrarily.

In the dyeing method of the tubular knitted fabric having two to three layers of the present invention, a conventional dyeing step can be used, and dyeing conditions are set depending on fiber materials to be used. Any known dyeing machine can be used such as a jet dyeing machine and a winch dyeing machine. Further, a water-absorbing agent is preferably added in order to increase the water absorbability. Any dyeing step can be employed, and examples of the dyeing step include a method in which a gray fabric is charged into a dyeing machine, scoured, and dyed, followed by undergoing finishing set which serves also as finishing treatment such as water absorption treatment, and a method in which a gray fabric is subjected to wet relaxation and presetting, followed by dyeing and final setting which serves also as finishing treatment.

[0041] Figures 10 and 11 show other preferred embodiments in addition to the embodiments as described above, in which the cellulose fibers self-shrinkable upon water absorption are used to partially separate s fabric to form a three-dimensional fabric having an air space between both outer layers.

Figure 10 shows a schematic representation of the cross section of the three-dimensional knitted fabric when it is dry, and Figure 11 shows the same when it absorbs sweat. The three-dimensional knitted fabric comprises separated portions 21 and non-separated portions 22 repeatedly formed therein, wherein one outer layer (C) comprises cellulose fibers self-shrinkable upon water absorption, and the other outer layer (D) is formed from fibers non-shrinkable upon water absorption. The fabric differs from the above-mentioned structure in that the fabric surface has projections when it is dry (Figure 10). This is obtained by knitting so that the number of courses in (C) is larger than the number of courses in (D). Since the fabric surface has projections when the fabric is dry, the thickness of the fabric is increased, and the presence of the air space makes the wearer feel warm. The cellulose fibers self-shrinkable upon water absorption which form (C) shrink during sweat absorption (Figure 11) to make the projections in the separated portions 21 smaller, which reduces the thickness of the fabric and the air space to thereby increase heat dissipation. When it dries after sweat absorption, the projection will revert again and return to the original thickness.

[0042] That is, the wearer feel warm when the wearer does not perspire, and when the wearer perspires, the fabric dissipates heat to prevent excess sweat to thereby prevent reduction of motor function. Thus, a comfortable fabric can be obtained.

Specifically, an object of the present invention can be achieved by a three-dimensional fabric with separated portions and non-separated portions repeatedly formed therein, characterized in that one outer layer (C) forming the separated portions comprises cellulose fibers self-shrinkable upon water absorption; the other outer layer (D) comprises fibers non-shrinkable upon water absorption; and the number of courses in (C) is larger than the number of courses in (D).

Furthermore, the three-dimensional fabric of the present invention has a structure in which one outer layer (C) forming the separated portions apparently floats to form projections, and also has a structure in which the separated portions and non-separated portions in which both outer layers are connected are repeated regularly or irregularly. These structures can be selected from various textures and structures which can be produced with a tubular knitting machine. The fabric may have a texture in which the outer layer comprising the cellulose fibers self-shrinkable upon water absorption shrink during sweat absorption to reduce the density and reduce the height of the projections (reduce the thickness of the fabric).

[0043] The separated portions which are partially separated in such a three-dimensional fabric may have any shape in the form of a spot having an area such as a round, elliptic, rectangular, rhombic, or star shape and may also have any arrangement such as a checkered, ascending, or irregular arrangement. The effect of the unevenness of the fabric during sweat absorption will be reduced when the size of the separated portions is too small or too large. In the case of a spot having an area such as a round or rectangular shape, both the major axis and the minor axis are preferably in the range of from 2 to 15 mm, most preferably from 3 to 12 mm. In the case of a continuous shape with a certain width, the width is preferably in the range of from 2 to 15 mm, most preferably from 3 to 12 mm.

Further, the effect of the thickness reduction during perspiration will be small when the total area of the separated portions in the three-dimensional fabric is too small. Therefore, the total area is preferably 20% or more of the surface of the tubular knitted fabric. It is more preferably 30% or more, most preferably 40% or more. When the total area is within these ranges, the effect of the thickness reduction during perspiration will be large to thereby increase the amount of heat dissipation, and a comfortable garment will be obtained in which the effect of suppressing perspiration can be expected.

[0044] The separated portions in the three-dimensional fabric of the present invention have any shape as described above. It is required that non-separated portions be formed so as to surround separated portions, and the separated portions and the non-separated portions be formed repeatedly. The non-separated portions may be formed solely from any fiber contained in the separated portions, may be formed by knitting these fibers, or may be formed with yarns different from those of the separated portions. For example, the non-separated portions in the wale direction may comprise the cellulose fibers self-shrinkable upon water absorption, and the non-separated portions in the course direction can be formed only from fibers non-shrinkable upon water absorption. Any knitting texture can be used as long as the texture is knitted using both the needle beds of the cylinder and the dial of a tubular knitting machine, such as circular rib and interlock. Further, when the non-separated portions comprises a larger amount of fibers non-shrinkable upon water absorption, the blending ratio of the cellulose fibers in the three-dimensional fabric can be lower, and the resulting knitted fabric will be advantageous in cost aspect and fastness.

[0045] In the three-dimensional fabric of the present invention, the ratio of the number of courses in (C) and (D), (C) /(D), is preferably in the range of from 1.1 to 5.0, more preferably from 2.0 to 4.0. When the ratio of the number of courses is 1.1 or more, the projections are easily developed in the usual state where sweat is not absorbed, and the effect by the thickness reduction of the projections during sweat absorption can be sufficiently exhibited. Further, when the ratio of the number of courses is 5.0 or less, the projections in the usual state may be easily formed beautifully; the effect of the thickness reduction of the projections during sweat absorption is clear; and the ratio is preferred in terms of productivity. Note that when the number of courses of the outer layers of the separated portions is not the same between wales, the largest number of courses is defined as the number of courses. Further, the number of courses is determined by measuring only knit loops and neither tuck loops nor welt loops are not counted as the number of courses. However, this is applied to the case when the size of the knit loops of both outer layers is almost the same, and when the sizes of the knit loops of both outer layers differ, the sizes are converted to the same size for both outer layers and the converted size is used for calculation. For example, when the size of the knit loop of one outer layer (C) is a size half the size of the other outer layer (D), (C)x2 is treated mathematically as (C). Note that the size of the knit loop is determined by the knitting length forming the separated portions.

[0046] In the three-dimensional fabric of the present invention, one outer layer (C) forming the separated portions may comprise the cellulose fibers self-shrinkable upon water absorption, which may be knitted with fibers non-shrinkable upon water absorption. As the knitting method, the following methods can be used: a method in which the cellulose fibers self-shrinkable upon water absorption are alternately knitted with fibers non-shrinkable upon water absorption, and a method in which the cellulose fibers self-shrinkable upon water absorption are knitted with fibers non-shrinkable upon water absorption by plated stitch. The blending ratio of the cellulose fibers self-shrinkable upon water absorption is preferably 15% by weight or more. When it is less than 15% by weight, the thickness reduction of the projections will be small during sweat absorption. This is not preferred. Most preferably, the blending ratio is 20% by weight or more. Further, the other outer layer (D) forming the separated portions is mainly formed from fibers non-shrinkable upon water absorption, but it is also possible to contain a small amount of the cellulose fibers self-shrinkable upon water absorption. The blending ratio of the cellulose fibers self-shrinkable upon water absorption is preferably less than 5% by weight. The blending ratio of 5% or more is not preferred because the effect of the thickness reduction of the projections during sweat absorption is small. The separated portions are preferably formed only from the fibers non-shrinkable upon water absorption.

[0047] Further, the blending ratio of the cellulose fibers having a twist coefficient of 8,200 to 35,000 in the whole three-dimensional fabric is preferably in the range of from 5 to 50% by weight, more preferably from 10 to 30% by weight. When it is less than 5% by weight, thickness reduction of the projections in a tubular knitted fabric during sweat absorption of the present invention is slight, and when it is more than 50% by weight, shrinkage during sweat absorption of the whole three-dimensional fabric is increased and the size of the garment is varied. These are not preferred. Any known method of blending the cellulose fiber having a twist coefficient of 8,200 to 35,000 can be used, including a method of blending by the arrangement of fibers and a blending method by forming composite yarns with non-shrinkable yarns. The three-dimensional fabric according to the present invention can be produced using a tubular knitting machine, and the density of the tubular knitted fabric can be arbitrarily set.

[0048] As an example of specific methods for producing the three-dimensional fabric according to the present invention, there is mentioned a texture in which a double tubular knitting machine is used; the cellulose fibers self-shrinkable upon water absorption are partially used in the plain knitting portions of the cylinder; and the number of courses of the separated portions of the cylinder is more than the number of courses of the dial. In this case, it is possible to use the cellulose fibers self-shrinkable upon water absorption alone or to knit the cellulose fibers together with common fibers such polyester and nylon by plated stitch. Further, the non-separated portions are required between the separated portions. By providing the non-separated portions, the separated portions and the non-separated portions are formed in the course direction and in the wale direction repeatedly. This allows formation of projections in the form of a spot having an area in the three-dimensional fabric so that the thickness of the projections during sweat absorption is decreased and a heat dissipation effect can be enhanced.

[0049] A conventional dyeing step can be used for dyeing the three-dimensional fabric of the present invention. Dyeing conditions are set depending on fiber materials to be used. Any dyeing machine can be used such as a jet dyeing machine and a winch dyeing machine. Further, a water-absorbing agent is preferably added in order to increase the water absorbability. Any dyeing step can be employed, and examples of the dyeing step include a method in which a gray fabric is charged into a dyeing machine, scoured, and dyed, followed by undergoing finishing set which serves also as finishing treatment such as water absorption treatment, and a method in which a gray fabric is subjected to wet relaxation and presetting, followed by dyeing and finish setting which serves also as finishing treatment. However, cautions are required for setting width or length in the finish setting. It is necessary to finish so that the projections which are formed by the outer layer comprising the cellulose fibers self-shrinkable upon water absorption may be maintained.

Examples

[0050] Hereinafter, the present invention will be described in detail with reference to Examples. Of course, the present invention is not limited to these.
The evaluation values in Examples were measured by the following methods.

(1) Wearing comfort

[0051] Sports shirts were sewn using the fabrics in Examples. The wearers exercised until they sweated. Organoleptic evaluation of the wearing comfort of the shirts was carried out by ten test subjects, and the average of the evaluation results was defined as wearing comfort.
The garments were graded on the following scales, in which those included in scale 2 or higher are actually satisfactory.

5 : The garment gives the wearer a very comfortable feeling with no sticky feeling and steamy feeling even during perspiration.
4 : The garment gives the wearer no sticky feeling and steamy feeling during perspiration.
3 : The garment gives the wearer a comfortable feeling with a little sticky feeling during perspiration.
2 : The garment gives the wearer some sticky feeling and steamy feeling during perspiration.
1 : The garment gives the wearer a very uncomfortable feeling with a significantly sticky feeling and steamy feeling during perspiration.

(2) Twist coefficient

[0052] The twist coefficient of the cellulose fibers was determined by the following.

$$\text{Twist coefficient} = (\text{fineness})^{0.5} \times \text{count of twist} \quad (\text{unit: count of twist/m})$$

(3) Manufacturability of tubular knitted fabric

[0053] The knittability of the twisted cellulose fibers was evaluated during the production of tubular knitted fabrics.
The twisted cellulose fibers were graded on the following scales, in which those included in scale 3 or higher can be subjected to route production, and those having a higher scale are preferred.

5 : Tubular knitted fabrics can be produced satisfactorily.
4 : Acceptable fabrics can be produced although kinky threads and the like occur a little.
3 : Acceptable fabrics can be produced although problems such as thread breakage occur slightly.
2 : Problems such as thread breakage occur, and unacceptable fabrics are formed although tubular knitted fabrics can be produced.
1 : It is difficult to produce tubular knitted fabrics due to the occurrence of kinky threads and thread breakage.

(4) Reduction rate of knitted fabric density

[0054] The density (course/inch x wale/inch) (E) of a dry sample is measured under the environment of 20°C and 65% RH. Subsequently, water having a weight of 50% of the weight of a warp knitted fabric is allowed to be absorbed into the sample; the density (course/inch x wale/inch) (F) upon water absorption is measured; and the reduction rate of knitted fabric density is determined by following formula (2). Further, when the density increases, that is, (F)<(E), the results are indicated by - (minus).

$$\text{Reduction rate of knitted fabric density (\%)} = ((F-E)/E) \times 100 \qquad (2)$$

(5) Formability of projections in dry fabrics

[0055] Formability of projections in the outer layer in a dry state was evaluated by the appearance using the three-dimensional fabrics obtained in Examples.
The fabrics were graded on the following scales, in which those included in scale 2 or higher have projections formed therein, and those having a higher scale have larger thickness.

5 : Projections are projecting distinctly.
4 : Projections are formed quite clearly.
3 : The formation of projections can be distinguished immediately.
2 : Projections are formed a little.
1 : Projections are not formed, and the fabric is almost flat.

(6) Thickness reduction of projections during sweat absorption

[0056] The three-dimensional fabrics obtained in Examples were allowed to absorb 100% by weight of water, and the thickness reduction of the projections of the outer layer during water absorption was evaluated by appearance.
The knitted fabrics were graded on the following scales, in which the thickness reduction of the projections was observed in the fabrics graded on scale 2 or higher. Those included in higher scales show larger reduction, and the effect of the present invention is observed.

5 : These knitted fabrics are substantially flat.
4 : Thickness reduction of projections is large, and projections remain slightly.
3 : It is possible to distinguish that the thickness of projections is reduced.
2 : Although the thickness of projections is reduced a little, it is not clearly observable.
1 : Thickness reduction of projections is hardly observable.

Example 1

[0057] A circular rib texture was knitted with a 28-gauge tubular knitting machine by arranging common fibers and cellulose fibers so that they are alternately knitted. In this knitting, two-heater false-twisted yarns of polyester fibers with 84 dt/36 f were used as common fibers, and cuprammonium rayon fibers with 84 dt/45 f were used as cellulose fibers. In this case, the cuprammonium rayon fibers used are conventional cuprammonium rayon fibers which are not treated with alkali.

[0058] The knitted gray fabric was fed into a jet dyeing machine and scoured at 80°C for 20 minutes, and water was drained from the machine. Then, the scoured fabric was subjected to alkali treatment at a concentration of sodium hydroxide of 60 g/L at 30°C for 20 minutes. Subsequently, only the polyester fibers were dyed at 130°C. Since the dyed knitted fabric had unevenness, it was dried using a short loop dryer and then subjected to finishing set with a pin stenter at 170°C for 60 seconds by extending it to such an extent that the wrinkles of the knitted fabric can be eliminated. Note that during the dyeing a water-absorbing agent was added to the bath.
The cuprammonium rayon fiber of the resulting knitted fabric was extracted and measured for the extensibility upon water absorption. It was found to be +5.8%. In addition, the resulting knitted fabric was subjected to the wear comfort test during perspiration by physical exercise. The results of the wear test are shown in Table 1.

Examples 2 to 8

[0059] Alkali treatment conditions and the type of cellulose fibers were changed from those employed in Example 1, and cellulose fibers having a different extensibility upon water absorption were produced. The wearing comfort of the knitted fabric using these fibers was evaluated, and the results are shown in Table 1.

Example 9

[0060] Polyester fiber raw yarns with 56 dt/24 f as common fibers were used as warp yarns, and polyester fiber raw yarns with 56 dt/24 f as common fibers and rayon fibers with 67 dt/24 f were alternately used as weft yarns to weave a fabric with a 3/1-satin texture.
The woven gray fabric was fed into a jet dyeing machine and scoured at 80°C for 20 minutes, and water was drained from the machine. Then, the scoured fabric was subjected to alkali treatment at a concentration of sodium hydroxide of 50 g/L at 50°C for 25 minutes. Subsequently, only the polyester fibers were dyed at 130°C. Since the dyed woven fabric

had unevenness, it was dried using a short loop dryer and then subjected to finishing set with a pin stenter at 180°C for 60 seconds by extending it to such an extent that the wrinkles of the woven fabric can be eliminated. Note that during the finishing set a water-absorbing agent was added.
The cuprammonium rayon fiber of the resulting woven fabric was extracted and measured for the extensibility upon water absorption. It was found to be +9.3%.
In addition, the resulting knitted fabric was subjected to the wear comfort test during perspiration in physical exercise. The results of the wear test are shown in Table 1.

Example 10

[0061] An interlock texture was knitted with a 22-gauge tubular knitting machine using cuprammonium rayon spun yarns with 1/64 Nm (wool count). The cuprammonium rayon spun yarns used were conventional cuprammonium rayon spun yarns which were not treated with alkali. The knitted gray fabric was fed into a jet dyeing machine and scoured at 80°C for 20 minutes, and water was drained from the machine. Then, the scoured fabric was subjected to alkali treatment at a concentration of sodium hydroxide of 60 g/L at 30°C for 20 minutes. Subsequently, the cuprammonium rayon spun yarns were dyed with a reactive dye. The resulting fabric was dried using a short loop dryer and then subjected to finishing set with a pin stenter at 170°C for 60 seconds by extending it to such an extent that the wrinkles of the knitted fabric can be eliminated. Note that during the finishing set a water-absorbing agent was added.
The cuprammonium rayon fiber yam of the resulting woven fabric was extracted and measured for the extensibility upon water absorption. It was found to be +4.7%.
In addition, the resulting knitted fabric was subjected to the wear comfort test during perspiration by physical exercise. The results of the wear test are shown in Table 1.

Example 11

[0062] Cuprammonium rayon fibers with 56 dt/30 f were interlaced with polyester yarns of W-type cross section with 56 dt/30 f before false twisting, using an interlace nozzle MK-2 manufactured by Awa Spindle Corporation, wherein the number of interlacing points was 80/m. Subsequently, composite yarns were made on an experimental basis by one-heater false twisting using a nip belt type false twisting machine Mach 33H manufactured by TMT Machinery Inc. under the conditions of a texturizing speed of 300 m/min, a first heater temperature of 200°C, a twister belt angle of 95°, and a stretch ratio of 0.984. The crimp stretchability of these composite yarns was 12.1 %. A circular rib fabric was knitted with a 28-gauge tubular knitting machine by arranging these composite yarns and polyester fibers with 84 dt/36 f as common fibers so that they are alternately knitted. The fabric was subjected to dyeing under the following conditions. The composite yam was extracted from the fabric and measured for the extensibility upon water absorption. It was found to be +5.3%.

[0063] The knitted gray fabric was fed into a jet dyeing machine and scoured at 80°C for 20 minutes, and water was drained from the machine. Then, the scoured fabric was subjected to alkali treatment at a concentration of sodium hydroxide of 60 g/L at 30°C for 20 minutes. Subsequently, only the polyester fibers were dyed at 130°C. Since the dyed knitted fabric had unevenness, it was dried using a short loop dryer and then subjected to finishing set with a pin stenter at 170°C for 60 seconds by extending it to such an extent that the wrinkles of the knitted fabric can be eliminated.
The resulting knitted fabric was subjected to the wear comfort test during perspiration by physical exercise. The results of the wear test are shown in Table 1.

Example 12

[0064] Highly oriented, unstretched nylon 66 yarns with 70 dt/34 f were false twisted using a disk friction type false twisting machine ATF-21 manufactured by TMT Machinery Inc. under the conditions of a texturizing speed of 400 m/min, a first heater temperature of 200°C, a number of urethane disks of 5, and a stretch ratio of 1.260. The resulting one-heater false-twisted yarns were false twisted with cuprammonium rayon fibers with 56 dt/30 f, and then the false-twisted yarns were interlaced using an interlace nozzle P-142 manufactured by Heberlein Company to form composite yarns, wherein the number of interlacing points was 80 per meter. The crimp stretchability of these composite yarns was 71.8%. A circular rib fabric was knitted with a 28-gauge tubular knitting machine by arranging these composite yarns and two-heater false-twisted yarns of polyester fibers with 84 dt/36 f as common fibers so that they were alternately knitted. The resulting fabric was subjected to dyeing under the following conditions. The composite yam was extracted from the fabric and measured for the extensibility upon water absorption. It was found to be +4.6%.

[0065] The knitted gray fabric was fed into a jet dyeing machine and scoured at 80°C for 20 minutes, and water was drained from the machine. Then, the scoured fabric was subjected to alkali treatment at a concentration of sodium hydroxide of 50 g/L at 40°C for 20 minutes. Subsequently, only the nylon fibers were dyed at 98°C. Since the dyed

knitted fabric had unevenness, it was dried using a short loop dryer and then subjected to finishing set with a pin stenter at 170°C for 60 seconds by extending it to such an extent that the wrinkles of the knitted fabric can be eliminated.
The resulting knitted fabric was subjected to the wear comfort test during perspiration in physical exercise. The results of the wear test are shown in Table 1.

Example 13

[0066] Textures shown in Figure 12 were knitted with a 28-gauge single tubular knitting machine so that common fibers were arranged in texture 1 and cellulose fibers were arranged in texture 2. Three courses of texture 1 were knitted, and then three courses of texture 2 were knitted. In this knitting, two-heater false-twisted yarns of polyester fibers with 167 dt/f were used as common fibers, and cuprammonium rayon fibers with 84 dt/45 f were used as cellulose fibers. In this case, the cuprammonium rayon fibers used are conventional cuprammonium rayon fibers which are not treated with alkali.

[0067] The knitted gray fabric was fed into a jet dyeing machine and scoured at 80°C for 20 minutes, and water was drained from the machine. Then, the scoured fabric was subjected to alkali treatment at a concentration of sodium hydroxide of 50 g/L at 30°C for 20 minutes. Subsequently, only the polyester fibers were dyed at 130°C. Since the dyed knitted fabric had unevenness, it was dried using a short loop dryer and then subjected to finishing set with a pin stenter at 170°C for 60 seconds by extending it to such an extent that wrinkles of the knitted fabric can be eliminated. Note that during the dyeing a water-absorbing agent was added to the jet dyeing machine. The resulting knitted fabric had a structure in which welt loops were successively formed in the course direction.
The cuprammonium rayon fiber of the resulting knitted fabric was extracted and measured for the extensibility upon water absorption. It was found to be +5.7%.
The resulting knitted fabric was used to sew T-shirts to perform the wear test. The results of the wear test are shown in Table 2.

Examples 14 to 17

[0068] The blending ratio of the cellulose fibers was changed by changing the size of polyester texturized yarns or the yarn arrangement during knitting, and the consecutive number of welt loops was also changed, from those employed in Example 13. Then, knitted fabrics were made on an experimental basis. The wearing comfort of the resulting knitted fabrics was evaluated, and the results are shown in Table 2.

Example 18

[0069] Textures shown in Figure 13 were knitted with a 22-gauge double tubular knitting machine so that common fibers were arranged in texture 1 and composite yarns containing cellulose fibers were arranged in textures 2 and 3. Textures 1 to 2 were repeatedly knitted four times, and then textures 1 and 3 were repeatedly knitted four times. Such knitting was repeated to form a knitted fabric. In this knitting, two-heater false-twisted yarns of polyester fibers with 84 dt/72 f were used as common fibers and composite yarns obtained by false twisting conventional cuprammonium rayon fibers with 56 dt/30 f which were not treated with alkali together with polyester yarns of W-type cross section with 56 dt/30 f at 180°C were used as the composite yarns containing the cellulose fibers, for knitting a gray fabric. The knitted gray fabric was fed into a jet dyeing machine and scoured at 80°C for 20 minutes, and water was drained from the machine. Then, the scoured fabric was subjected to alkali treatment at a concentration of sodium hydroxide of 50 g/L at 30°C for 20 minutes. Subsequently, only the polyester fibers were dyed at 130°C. Since the dyed knitted fabric had unevenness, it was dried using a short loop dryer and then subjected to finishing set with a pin stenter at 170°C for 60 seconds by extending it to such an extent that wrinkles of the knitted fabric can be eliminated. Note that during the dyeing a water-absorbing agent was added to the jet dyeing machine. The resulting knitted fabric had a structure in which tuck loops were successively formed in the course direction.
The cuprammonium rayon fiber of the resulting knitted fabric was extracted and measured for the extensibility upon water absorption. It was found to be +5.7%.
The resulting knitted fabric was used to sew T-shirts to perform the wear test. The results of the wear test are shown in Table 2.

Example 19

[0070] When a half texture was knitted with a 28-gauge single tricot knitting machine, polyester yarns of W-type cross section with 56 dt/30 f were arranged in the front as common fibers; cuprammonium rayon fibers with 56 dt/30 f were arranged in the back as cellulose fibers; and the texture was knitted with the "all-in threading" in which the yarns are threaded through all needles. In this case, the cuprammonium rayon fibers used are conventional cuprammonium rayon fibers which are not treated with alkali.

[0071] The knitted gray fabric was fed into a jet dyeing machine and scoured at 80°C for 20 minutes, and water was drained from the machine. Then, the scoured fabric was subjected to alkali treatment at a concentration of sodium hydroxide of 50 g/L at 30°C for 20 minutes. Subsequently, the polyester fibers and the cuprammonium rayon fibers were dyed. Since the dyed knitted fabric had unevenness, it was dried using a short loop dryer and then subjected to finishing set with a pin stenter at 170°C for 60 seconds by extending it to such an extent that wrinkles of the knitted fabric can be eliminated. Note that, during the jet dyeing, a water-absorbing agent was added to the jet dyeing machine.

The resulting warp knitted fabric was measured for the reduction rate of knitted fabric density. It was found to be 17.8%. The cuprammonium rayon fiber of the resulting knitted fabric was extracted and measured for the extensibility upon water absorption. It was found to be +5.8%.

Further, the resulting knitted fabric was used to sew T-shirts to perform the wear test. The results of the wear test are shown in Table 3.

Examples 20 to 22

[0072] A warp knitted fabric was produced by changing the texture in Example 19 in which the amount of the swing of cellulose fibers, the blending ratio, and looping were changed. The wearing comfort of the resulting knitted fabric was evaluated. The results are shown in Table 3.

Example 23

[0073] Textures shown in Figure 14 were knitted with a 28-gauge tubular knitting machine. Two-heater false-twisted yarns of polyester fibers with 84 dt/36 f were used for texture 1 as common fibers, and cuprammonium rayon fibers with 84 dt/45 f having a twist coefficient of 18,000 were used for texture 2. Textures 1 to 2 were repeatedly ten times, and then texture R in non-separated portions (as shown in Figure 9) was knitted so that a finished width of 4 mm is obtained using two-heater false-twisted yarns of polyester fibers with 56 dt/24 f which are non-shrinkable yarns.

[0074] The knitted gray fabric was fed into a jet dyeing machine and scoured at 80°C for 20 minutes. Subsequently, only the polyester fibers were dyed at 130°C. Since the dyed knitted fabric had unevenness due to the presence of the above-described widths, it was subjected to tentering set with a pin stenter at 170°C for 60 seconds by extending it to such an extent that the projections are extended.

The resulting knitted fabric was used to sew T-shirts, which were subjected to the wear comfort test during perspiration by physical exercise.

The results of the wear test are shown in Table 4.

Examples 24 to 27, Comparative Example 2

[0075] Warp knitted fabrics were produced by using cellulose fibers in which the twist coefficient is changed as shown in Table 4 or by changing the width of non-separated portions, from those in Example 23, and the resulting knitted fabrics were evaluated.

Example 28

[0076] Textures shown in Figure 15 were knitted with a 28-gauge tubular knitting machine. Two-heater false-twisted yarns of polyester fibers with 84 dt/36 f were used for texture 1 as common fibers. The yarns were used as the main portion of a plain knitting texture and partially connected to the cylinder side with a tuck texture. Plated stitch of two-heater false-twisted yarns of polyester fibers with 56 dt/24 f as common fibers and cuprammonium rayon fibers with 84 dt/45 f having a twist coefficient of 18,000 was used for texture 2. Textures 1 to 2 were repeatedly ten times, and then texture R of non-separated portions (as shown in Figure 9) was knitted so that a finished width of 5 mm is obtained in a circular rib texture using two-heater false-twisted yarns of polyester fibers with 56 dt/24 f as common fibers.

[0077] The knitted gray fabric was fed into a jet dyeing machine and scoured at 80°C for 20 minutes. Subsequently, only the polyester fibers were dyed at 130°C. Since the dyed knitted fabric had unevenness due to the presence of the above-described widths, it was subjected to tentering set with a pin stenter at 170°C for 60 seconds by extending it to such an extent that the unevenness is extended.

The resulting knitted fabric was used to sew T-shirts, which were subjected to the wear comfort test during perspiration by physical exercise.

The results of the wear test are shown in Table 4.

Example 29

[0078] Textures shown in Figure 16 were knitted with a 28-gauge tubular knitting machine. Two-heater false-twisted yarns of polyester fibers with 84 dt/36 f were used for textures [1], [2], [4], [5], [6], and [8] as common fibers. Cuprammonium rayon fibers with 56 dt/30 f having a twist coefficient of 25,000 and two-heater false-twisted yarns of polyester fibers with 56 dt/24 f as common fibers were used for textures [3] and [7]. These were adjusted with plated stitch so that the knitted fabric surface is formed from polyester fibers with 56 dt/24 f. Textures [1] to [4] were repeated four times, and then textures [5] to [8] were repeatedly knitted four times. The projections in (C) portions were formed by [3], [4], [7], and [8] which form the separated portions and (D) portions in the other outer layer were formed by [1], [2], [5], and [6] so that the ratio of the number of courses, (C)/(D), is 2.0.

[0079] The knitted gray fabric was fed into a jet dyeing machine and scoured at 80°C for 20 minutes. Subsequently, only the polyester fibers were dyed at 130°C. Further, a water-absorbing processing agent was added during the dyeing to proceed dyeing while imparting water absorbability to the knitted fabric. Since the dyed knitted fabric had unevenness due to the presence of the widths, it was dried with a short loop dryer and then set with a pin stenter at 170°C for 60 seconds while tentering it by 10% of the width of the dried fabric.
The resulting knitted fabric was a three-dimensional tubular knitted fabric in which projections were developed in the outer layer portions (C) knitted in the cylinder side, and the thickness of the projections were reduced by sweat absorption. The results of the performance test of the three-dimensional tubular knitted fabrics are shown in Table 5.

Examples 30 to 34

[0080] Three-dimensional tubular knitted fabrics were produced by changing the ratio of the number of courses of both outer layers, (C)/(D), by changing the number of knitting in [3], [4], [7], and [8] from those in Example 29, and these fabrics were evaluated. The results are shown in Table 5.

[0081]

[Table 1]

Sample	Cellulose fibers	Alkali concentration (g/L)	Treatment temperature (°C)	Treatment time (min)	Extensibility upon water absorption (%)	Wearing comfort
Ex. 1	Cuprammonium rayon	60	30	20	5.8	4
Ex. 2	Cuprammonium rayon	40	30	20	5.4	4
Ex. 3	Cuprammonium rayon	20	30	20	3.8	2
Ex. 4	Cuprammonium rayon	80	30	20	6.7	4
Ex. 5	Cuprammonium rayon	60	20	20	5.6	4
Ex. 6	Cuprammonium rayon	20	20	20	3.7	2
Ex. 7	Cuprammonium rayon	60	30	5	4.2	3
Ex. 8	Cuprammonium rayon	20	20	5	3.2	2
Ex. 9	Rayon	50	50	25	9.3	5
Ex. 10	Cuprammonium rayon spun yam	60	30	20	4.7	3
Ex. 11	Cuprammonium rayon	60	30	20	5.3	4

(continued)

Sample	Cellulose fibers	Alkali concentration (g/L)	Treatment temperature (°C)	Treatment time (min)	Extensibility upon water absorption (%)	Wearing comfort
Ex. 12	Cuprammonium rayon	50	40	20	4.6	3
Comp. Ex. 1	Cuprammonium rayon	Untreated	Untreated	Untreated	1.9	1

[0082]

[Table 2]

Sample	Cellulose fibers	Extensibility upon water absorption (%)	Blending ratio of cellulose fibers (%)	Consecutive number of tuck loops and welt loops	Wearing comfort
Ex. 13	Cuprammonium rayon	5.7	33	3	5
Ex. 14	Cuprammonium rayon	5.7	10	3	3
Ex. 15	Cuprammonium rayon	5.7	15	3	4
Ex. 16	Cuprammonium rayon	5.7	66	3	5
Ex. 17	Cuprammonium rayon	5.7	100	3	5
Ex. 18	Cuprammonium rayon	5.7	33	4	4

[0083]

[Table 3]

Sample	Texture and threading of front (middle)	Texture and threading of back	Blending ratio of cellulose fibers (%)	Reduction rate of knitted fabric density (%)	Wearing comfort
Ex. 19	10/23 all-in	12/10 all-in	43	17.8	5
Ex. 20	10/12 all-in	23/10 all-in	57	29.1	4
Ex. 21	10/12 all-in	45/10 all-in	67	38.9	3
Ex. 22	10/23 all-in	12/00 all-in	37	13.2	4

[0084]

[Table 4]

Sample	Cellulose fibers		Width of non-separated portion in the course direction (mm)	Manufacturability of knitted fabrics	Wearing comfort
	Twist coefficient	Extensibility upon water absorption (%)			
Ex. 23	18000	-3.0	4	5	5
Ex. 24	8200	-2.1	4	5	3
Ex. 25	11000	-2.5	4	5	4
Ex. 26	24000	-3.6	4	5	5
Ex. 27	35000	-4.4	4	3	5
Ex. 28	18000	-3.0	5	5	5
Comp. Ex. 2	5500	-0.9	4	5	1

[0085]

[Table 5]

Sample	Cellulose fibers		Ratio of the number of courses of both outer layers (C)/(D)	Manufacturability of fabrics	Formability of projections in dry fabrics	Thickness reduction of projections during sweat absorption
	Twist coefficient	Extensibility upon water absorption (%)				
Ex. 29	20000	-3.2	2.0	5	3	3
Ex. 30	20000	-3.2	1.5	5	2	2
Ex. 31	20000	-3.2	3.0	4	5	5
Ex. 32	20000	-3.2	4.0	3	5	4
Ex. 33	20000	-3.0	5.0	2	4	4
Ex. 34	20000	-3.0	6.0	2	4	2

Industrial Applicability

[0086] When a fabric is produced using the fibers according to the present invention, it is possible to produce a garment which makes the wearer feel comfortable when the wearer is not in a sweating state and does not give a sticky feeling or a steamy feeling to the wearer even when the wearer perspires, and the wearer can obtain a comfortable wear feeling in a garment such as sportswear, inner wear, and outer wear.

Claims

1. A cellulose fiber-blended fabric, **characterized by** comprising cellulose fibers having a rate of dimensional change upon water absorption of 2% or more.

2. The cellulose fiber-blended fabric according to claim 1, **characterized by** comprising cellulose fibers self-extensible upon water absorption having an extensibility upon water absorption of +3% or more.

3. The cellulose fiber-blended fabric according to claim 2, wherein the content of said cellulose fibers is 10 wt% or more.

4. The cellulose fiber-blended fabric according to claim 3, wherein the fabric has a tubular knitted structure having a portion in which two or more welt loops and/or tuck loops are successively formed from the cellulose fibers self-extensible upon water absorption having an extensibility upon water absorption of +3% or more.

5. The cellulose fiber-blended fabric according to claim 3, wherein the fabric has a warp knitted structure **characterized in that** the cellulose fibers self-extensible upon water absorption having an extensibility upon water absorption of +3% or more are looped; the fabric has a swing knitting texture of one to four stitches; and the fabric has a reduction rate of knitted fabric density upon water absorption of 5 to 40%.

6. The cellulose fiber-blended fabric according to claim 4 or 5, **characterized in that** the cellulose fiber self-extensible upon water absorption has been subjected to dipping treatment in an aqueous alkali solution of 20 g/L or more at 20°C or higher for 5 minutes or more.

7. The cellulose fiber-blended fabric according to claim 1, **characterized by** comprising cellulose fibers self-shrinkable upon water absorption having an extensibility upon water absorption of -2% or less.

8. The cellulose fiber-blended fabric according to claim 7, **characterized in that** the fabric is a multilayer fabric with separated portions and non-separated portions repeatedly formed therein, wherein one outer layer and/or an intermediate layer thereof comprises the cellulose fibers self-shrinkable upon water absorption having an extensibility upon water absorption of -2% or less; the other outer layer is formed from fibers non-shrinkable upon water absorption; and the non-separated portions in the course direction are formed from non-shrinkable fibers.

9. The cellulose fiber-blended fabric according to claim 7, **characterized in that** the fabric is a three-dimensional fabric with separated portions and non-separated portions repeatedly formed therein, wherein one outer layer (C) forming the separated portions comprises the cellulose fibers self-shrinkable upon water absorption having an extensibility upon water absorption of -2% or less; the other outer layer (D) comprises fibers non-shrinkable upon water absorption; and the number of courses in (C) is larger than the number of courses in (D).

10. The cellulose fiber-blended fabric according to claim 7, **characterized in that** the cellulose fibers self-shrinkable upon water absorption have a twist coefficient of 8,200 to 35,000.

[Figure 1]

[3]	KKKK
[2]	KWKW
[1]	KWKW

[Figure 2]

[3]	KKKK
[2]	KTKT
[1]	KTKT

[Figure 3]

[2]	WKWK
[1]	KWKW

[Figure 4]

[2]	TKTK
[1]	KTKT

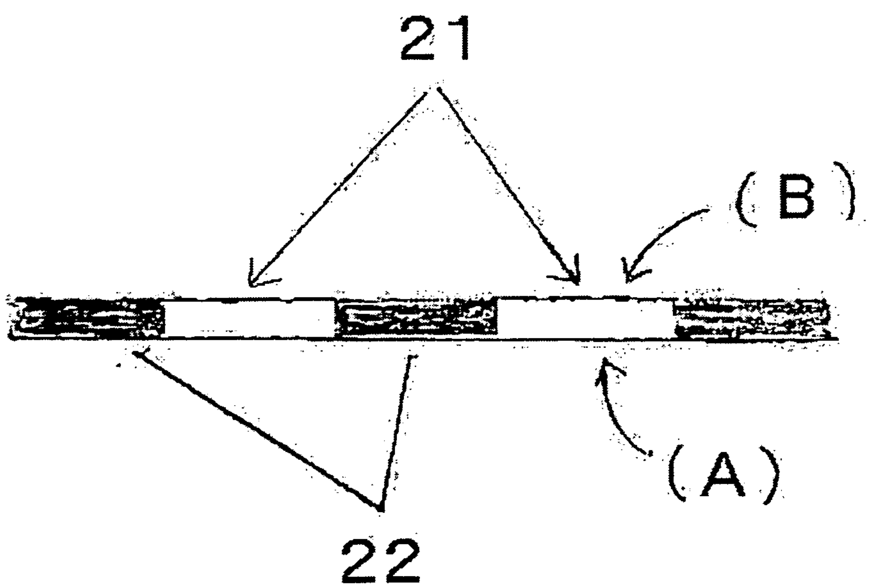
[Figure 5]

[3] KKKK
[2] WWKK
[1] KKWW

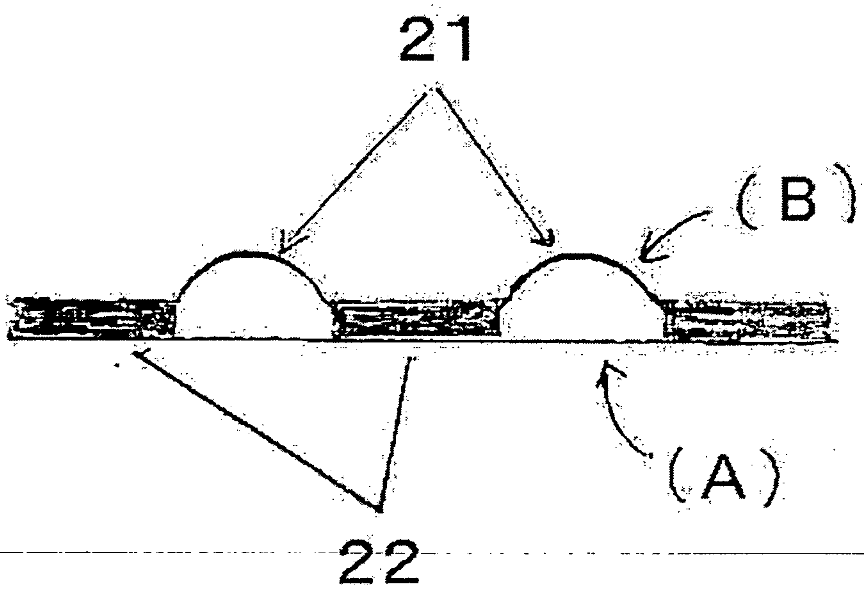
[Figure 6]

[3] KKKK
[2] KWKW
[1] KTKT

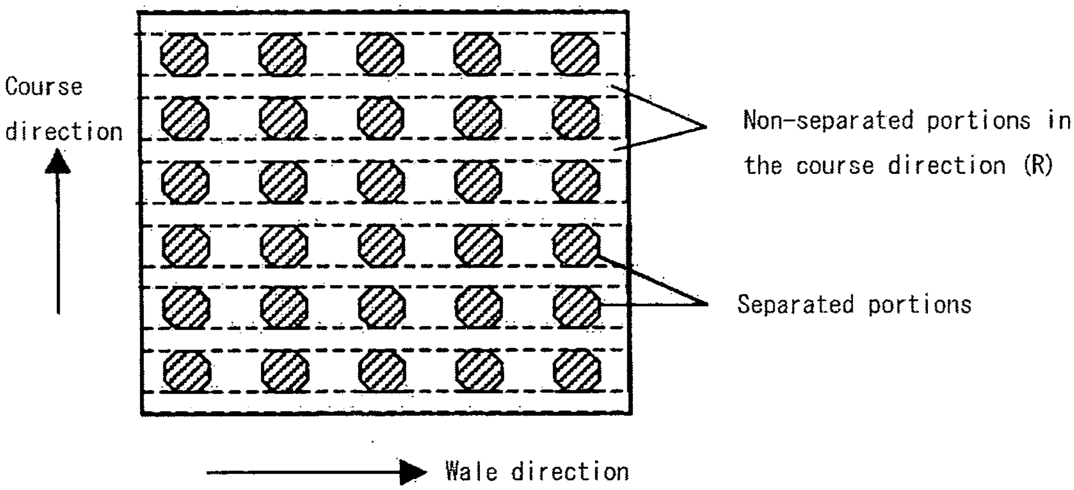
[Figure 7]



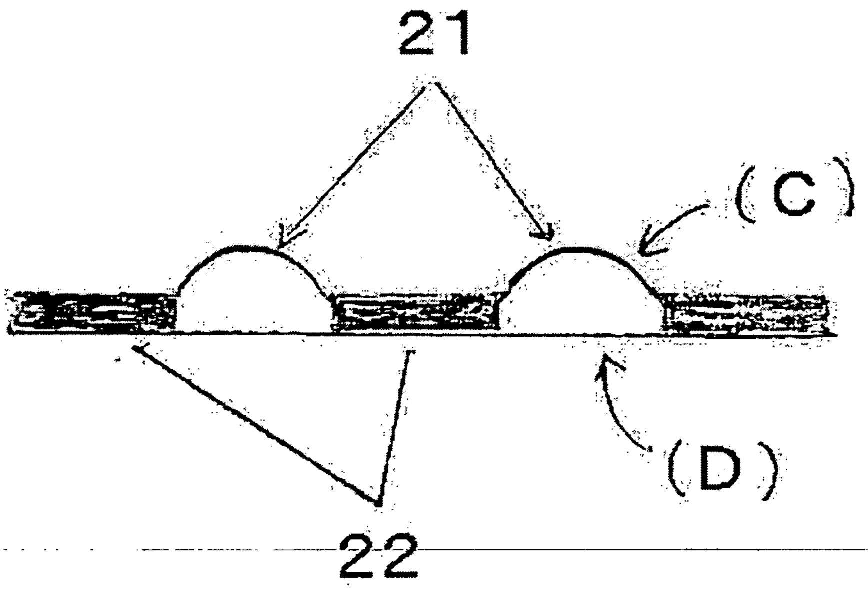
[Figure 8]



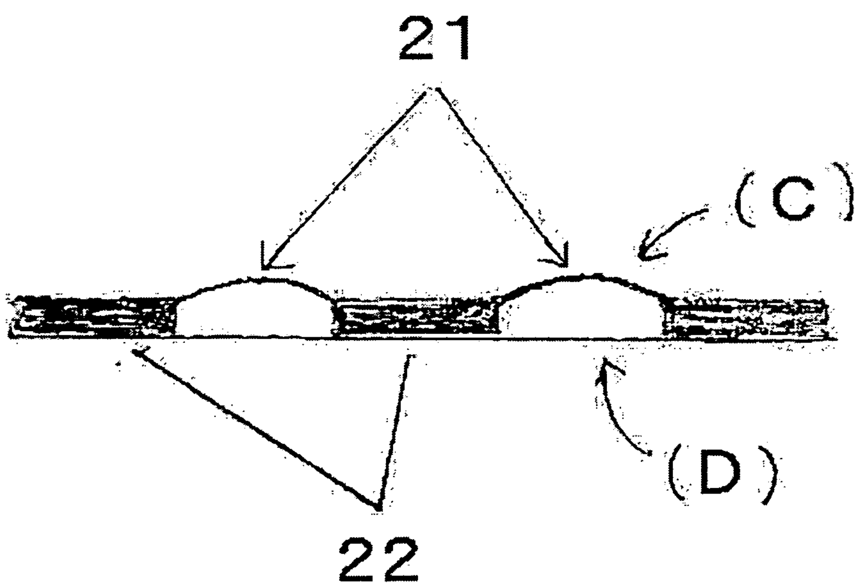
[Figure 9]



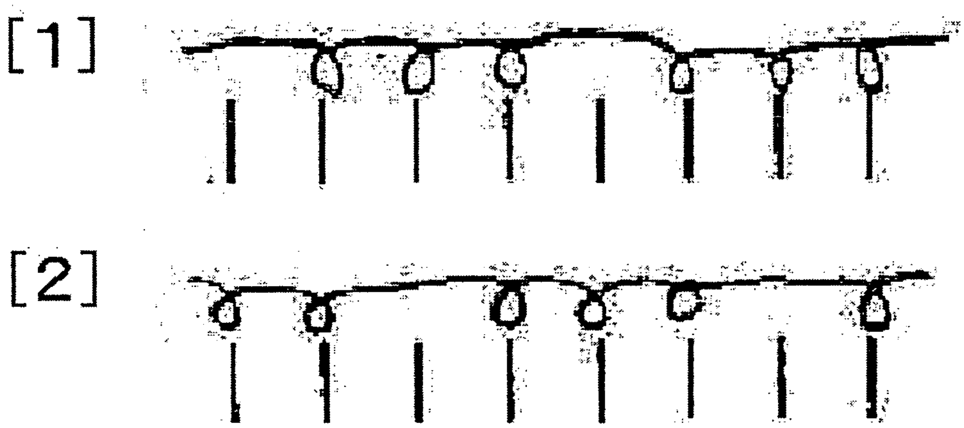
[Figure 10]



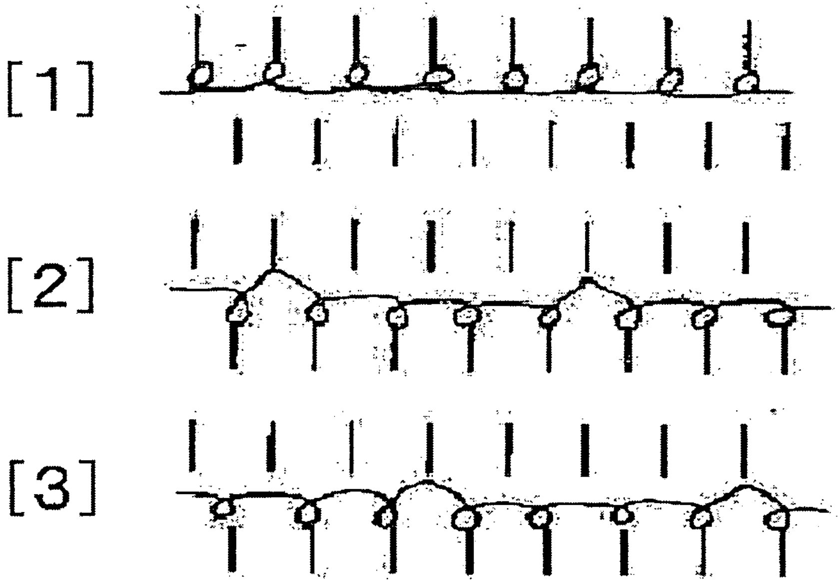
[Figure 11]



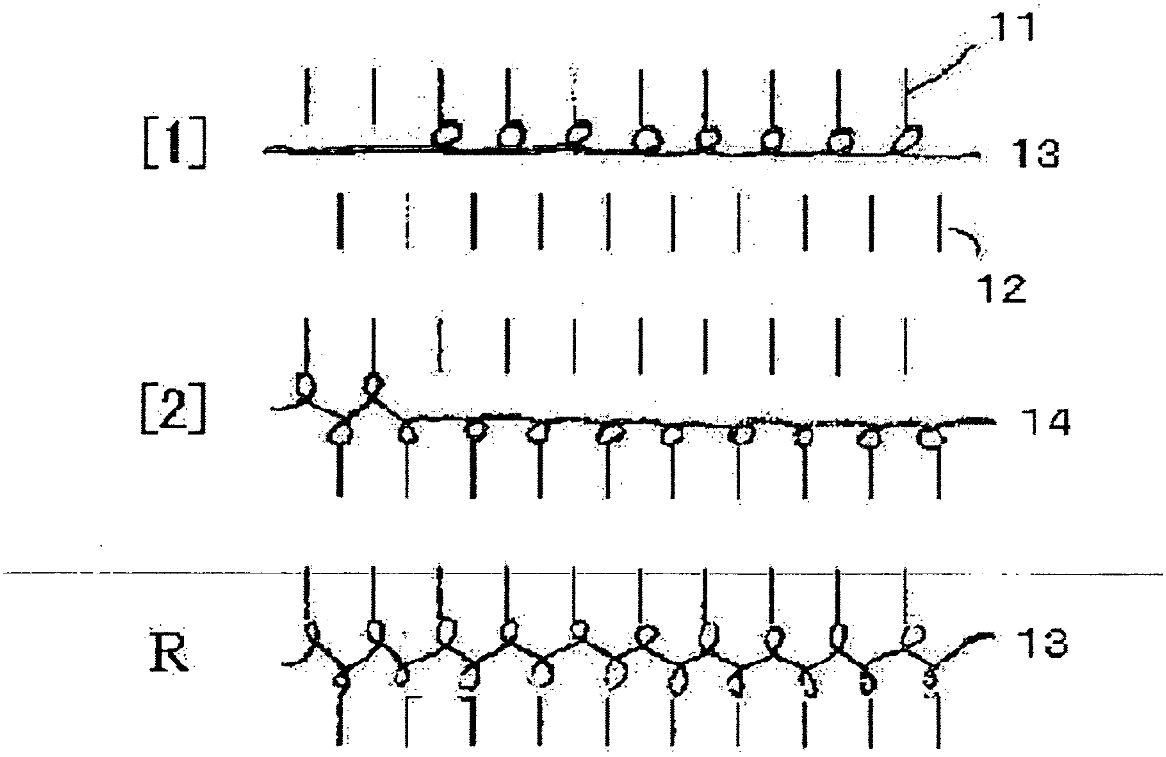
[Figure 12]



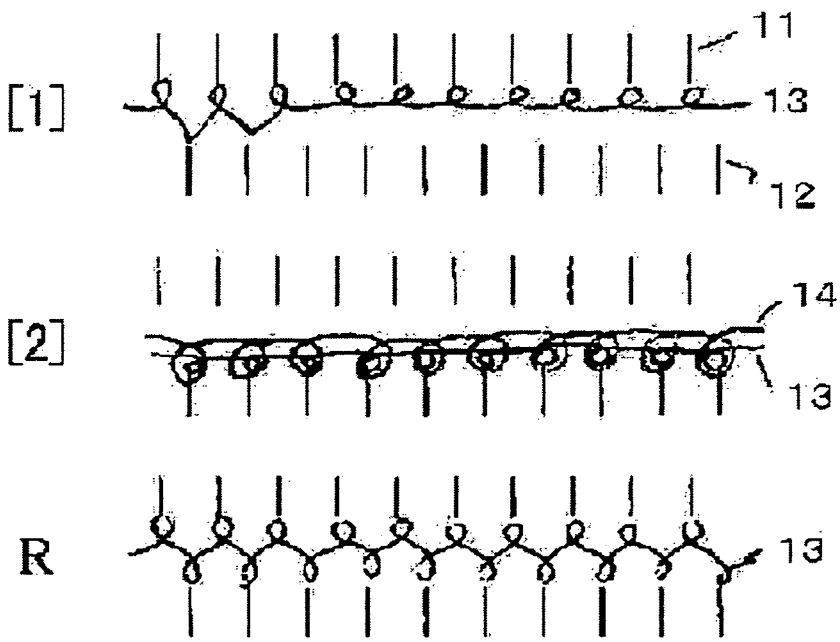
[Figure 13]



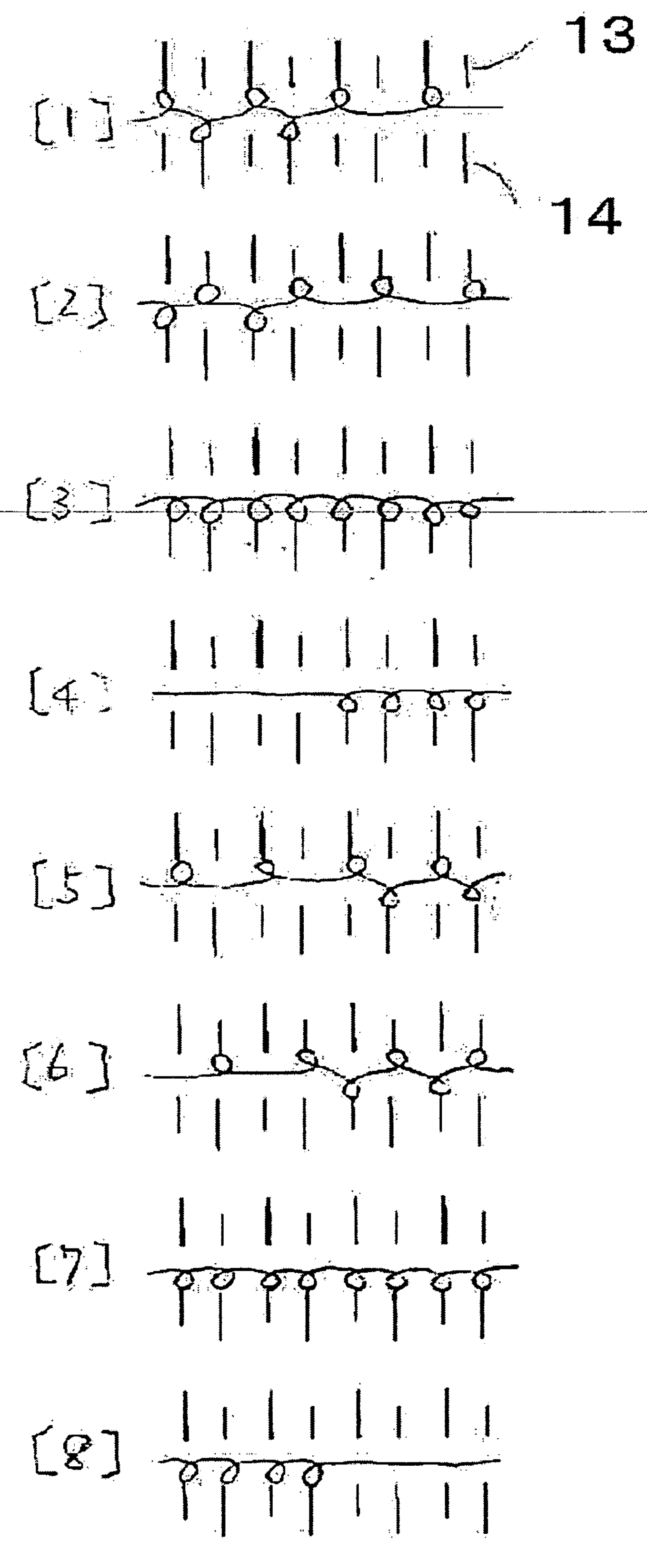
[Figure 14]



[Figure 15]



[Figure 16]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/051227

A. CLASSIFICATION OF SUBJECT MATTER
D06M11/38(2006.01)i, *D02G3/26*(2006.01)i, *D04B1/00*(2006.01)i, *D04B21/00*(2006.01)i, *D06M11/00*(2006.01)i, *D06M101/06*(2006.01)n

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D06M11/00-11/84, D02G1/00-3/48, D02J1/00-13/00, D04B1/00-1/28, 21/00-21/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2007
Kokai Jitsuyo Shinan Koho	1971-2007	Toroku Jitsuyo Shinan Koho	1994-2007

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPIL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2006-9204 A (Toho Tenakkusu Kabushiki Kaisha), 12 January, 2006 (12.01.06), Par. Nos. [0012], [0021] (Family: none)	1-3 4-6
X Y	JP 57-183429 A (Kao Soap Co., Ltd.), 11 November, 1982 (11.11.82), Claims; page 1, lower right column & GB 2078811 A & DE 3124292 A & FR 2485046 A	1,7,10 8,9
Y	JP 2005-163225 A (Teijin Fibers Ltd.), 23 June, 2005 (23.06.05), Par. No. [0022] & EP 1640488 A & US 2006/223400 A1	4-6,8,9

☐ Further documents are listed in the continuation of Box C.
☐ See patent family annex.

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
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Date of the actual completion of the international search	Date of mailing of the international search report
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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2005163225 A **[0002]**
- JP 2005036374 A **[0002]**
- JP 2005023431 A **[0002]**
- JP 2005146496 A **[0002]**
- JP 2006112009 A **[0002]**