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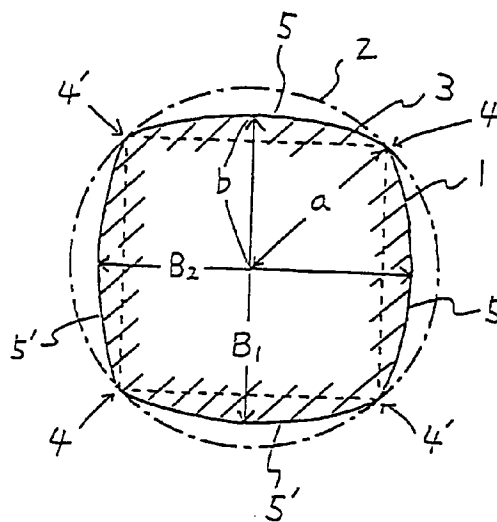
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(54) **STOCKINGS**

(57) In bargain stockings in which the fabrics of leg portions are knitted with elastic covering threads alone, a covering thread constituting the elastic covering threads is a convex quadrilateral elongated fiber thread of polyamide having a square horizontal cross-sectional shape (1) which has four projecting portions (4, 4') and no recessed portions, and which is formed by four outwardly bulging curved sides (5, 5') extending from the four sides of an inscribed square (3) having the projecting portions (4, 4') as its apexes. It is preferably that this thread does not substantially contain titanium oxide, has a thread fineness of 5-12 denier and 2-7 filaments, and is a single elastic covering thread or a double elastic covering thread having a covering twist number of 2200-2800 t/m. Stockings having very high or good transparency, refreshing feeling, glossiness and external appearance which could not be attained by conventional bargain stocking can be obtained, the stockings according to the present invention also having an excellent touch, a high softness, an excellent wearing feeling, excellent fitting characteristics and durability. Therefore, stockings having excellent fitting characteristics, fashionableness, agreeable feeling and high durability can be obtained.

Fig. 1



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DescriptionTechnical field

5 The present invention relates to hosiery produced by knitting substantially exclusively a covered elastic yarn at least the leg portion knitting fabric thereof. Especially it relates to hosiery good in transparency, flat feeling, luster feeling, touch feeling, fitting property, durability, wearing comfort, etc.

Background Art

10 The progress of panty hose in recent years is remarkable, i.e., rapid shift from panty hose produced using the conventional false-twist nylon yarn to panty hose produced using a covered elastic yarn constituted of an elastic polyurethane yarn and a nylon yarn twisted around the elastic polyurethane yarn. The panty hose produced using a covered elastic yarn have gained public favor in the market since they have not only excellent close fitting property due to recovery of the elastic polyurethane yarn after elongation thereof, but also good durability.

15 The panty hose produced using the conventional covered elastic yarn have been produced by alternately knitting the covered elastic yarn and a nylon yarn, but recently for the purposes of obviating weft bar due to alternate course knitting and of achieving higher fitting property, panty hose wherein a leg portion knitting fabric is formed by knitting only a covered elastic yarn, so-called every course panty hose are being marketed. Hereinafter the hosiery wherein a leg portion knitting fabric is formed by knitting only a covered elastic yarn is called "every course hose".

20 In the meantime, since the covered elastic yarn has a structure in which a nylon yarn is twisted around an elastic polyurethane yarn, it is liable to be large in fiber fineness, therefore the hosiery produced using the yarn are disadvantageously poor in transparency, stuffy, large in fabric thickness, etc. as compared with the conventional hosiery produced using a false-twist yarn or a composite fiber. These disadvantages are worse in every course hose, and in addition, every course hose do not have luster feeling and furthermore since the fabric is less uniform, they are poor in flat feeling as a further other large problem.

25 To improve the poor in transparency, stuffy and large in fabric thickness of covered the elastic yarn, it is proposed to use a finer covering yarn or to decrease the count of covering twist.

30 However, if the covering yarn is made thinner, the durability of the hosiery is lowered as a practically unpreferable problem, and if the count of covering twist is decreased, practically unpreferable problems that the durability of hosiery is lowered and that the transparency is lowered are caused. So, these cannot be effective improvement measures, and any other effective improvement measure is desired to be developed.

35 On the other hand, in the case of the covered elastic yarn, the covering performance is important for improving the durability, fabric appearance, color tone, handling touch, etc. of the hosiery obtained, whether the nylon yarn is wound around the elastic polyurethane yarn so as not to expose the elastic polyurethane yarn in surface of the covered elastic yarn and uniformly wound or not.

40 As a technique to improve the covering performance, it is proposed in Japanese Patent Publication (Kokoku) No. 64-3965 (1989), to wind a filament yarn having a non-circular (Y-shaped, T-shaped, X-shaped, U-shaped, H-shaped, L-shaped or E-shaped) cross section of 1.20 to 1.60 in the cross section coefficient as the covering yarn around the elastic polyurethane yarn.

45 Furthermore, as a technique for improving the esthetic value and durability of hosiery, it is proposed in Japanese Laid-open Patent Application (Kokai) No. 2-80635 (1990), to wind a high strength polyamide yarn having a multi-lobed (3-lobed, 5-lobed) type cross section of 1.03 to 1.15 in odd-shape section coefficient as the covering yarn around the elastic polyurethane yarn.

50 However, since the above mentioned filament yarn having a non-circular cross section are very uneven in the cross section of the fiber, the hosiery obtained are remarkably worsened in transparency, luster feeling, flat feeling, touch feeling, etc. as large problems.

55 Therefore, even if these conventional techniques are applied to every course hose, it is difficult to sufficiently improve their transparency, wearing comfort, flat feeling, luster feeling, touch feeling, large in fabric thickness, etc.

The main object of the present invention is to overcome the disadvantages of the above prior arts, and to provide every course hose which is not only excellent in transparency, flat feeling, luster feeling, touch feeling, and wearing comfort not achieved by the conventional every course hose but also good in fitting property, durability, etc., by improving the every course hose produced by knitting substantially exclusively a covered elastic yarn into the leg portion knitting fabric thereof in transparency, flat feeling, luster feeling, large in fabric thickness, wearing comfort, etc.

Disclosure of the invention

The present invention is hosiery, produced by knitting substantially exclusively a covered elastic yarn into at least the leg portion knitting fabric thereof, wherein said covered elastic yarn is formed by winding a polyamide filament yarn

around a core yarn constituted of an elastic yarn, comprising:

the cross section of the polyamide filament yarn is a swollen quadrilateral substantially free from any depression and having four protruding portions, wherein the swollen quadrilateral is formed by four curved sides substantially swelling outside from the respective four sides of an inscribed quadrilateral with the protruding portions as vertexes (hereinafter simply called "a swollen quadrilateral").

The present invention is every course hose produced by knitting substantially exclusively a covered elastic yarn into at least the leg portion knitting fabric thereof, wherein a polyamide filament yarn having a cross section of said specific swollen quadrilateral are used as the covering yarn of the covered elastic yarn, therefore every course hose can have excellent properties which could not be achieved in the conventional every course hose, for example, very good transparency, luster feeling, refreshing feeling, fabric appearance, soft touch, smoothing touch, fitting property, etc., and also excellent wearing comfort and high fashionability.

That is, according to the present invention, the covered elastic yarn are improved in uniformity and transparency, to improve the transparency, luster feeling, touch feeling, fabric appearance, etc. of the hosiery fabric. In addition, at the time of covering, they are better in the adherence of the covering yarn to the elastic yarn as a core yarn, higher in covering performance, less in the separation of the covering yarn from the elastic yarn liable to be caused when a conventional yarn with a round section is used, better in fabric appearance and skin touch feeling, and less in the exposure of the elastic yarn as a core yarn, hence higher in durability.

Furthermore, the frictional coefficient and its variation of the leg portions can be kept at low levels which could not be achieved by the conventional every course hose, and as a result, the hosiery obtained are excellent in smoothing touch when worn, and less in rough feeling when worn, being excellent in skin touch.

Moreover, since the hosiery is produced by knitting substantially exclusively a covered elastic yarn, high fitting power can be easily obtained, and the 60% recovery stress can be kept in an ideal range from 180 to 350 g. At such a high power level, the conventional every course hose is poor in fabric appearance due to shrunken fabric, but in the present invention, since the above mentioned polyamide filament yarn having a cross section of the specific swollen quadrilateral are used as a covering yarn, such effects that covering performance is uniform with less core elastic yarn exposed, that the uneven shrinkage of the knitted fabric is inhibited, that the fabric appearance is prevented from being worsened, and that the processability during knitting and finishing can be improved can be obtained.

Brief description of the drawings

Fig. 1 is a cross sectional view typically showing the cross section of a polyamide filament yarn having a cross section of a swollen quadrilateral, used in a covering yarn of a covered elastic yarn. The symbols in Fig. 1 denote the following: 1 : swollen quadrilateral as cross section of fiber 2 : circumcircle 3 : inscribed quadrilateral 4, 4' : protruding portion 5, 5' : curved side a : distance from the center of circumcircle 3 to the protruding portion 4

b : distance from the center of circumcircle 3 to the centers of curved sides 5

Figs. 2 is a front view of an example of hosiery according to the present invention, and (a) shows a long stocking, while (b) shows panty hose.

Figs. 3 are cross sectional views showing the cross sections of fibers for the covering yarns used in the examples.

Fig. 3 (a) shows a case of the present invention and (b) to (d) show cases not in conformity with the present invention. The symbols of Fig. 3 denote the following: 11 : toe portion 12 : heel portion 13 : leg portion 14 : panty portion 15 : stretchable belt portion

Best mode for carrying out the invention

The hosiery intended in the present invention includes hosiery products such as panty hose, long hosiery and short hosiery.

Fig. 2 (a) illustrates a long stocking which comprises a toe portion 11 and a heel portion 12, and a leg portion 13 refers to the portion which is upper side of a portion corresponding to an ankle immediately above the heel portion 12. At the top end of the leg portion 13, a stretchable belt portion 15 is usually provided.

Fig. 2 (b) illustrates panty hose which comprises a toe portion 11, a leg portion 13, a panty portion 14 and a stretchable belt portion 15, and a pair of right and left stocking portions sewn together in the panty portion 14 and the stretchable belt portion 15.

In the hosiery according to the present invention, it is necessary that at least the leg portion knitting fabric thereof is produced by knitting substantially exclusively a covered elastic yarn, thereby to solve the problem of the weft bar. The leg portion knitting fabric may have a knitted pattern composed of another material or decorated with something like one point mark. The portions other than the leg portion (such as the panty portion) may also be produced by knitting a covered elastic yarn same as the leg portion.

On the contrary, in the case of alternately knitted hosiery produced by alternately knitting a covered elastic yarn and a grey nylon yarn, if the covered elastic yarn specified in the present invention is used, the effect of improving the luster

feeling can be obtained, but the effect of improving the other properties is small. As a result, the hosiery good in fitness, handling touch, touch feeling, quite free from weft bar, and good in skin touch as intended in the present invention cannot be obtained.

The covered elastic yarn can be a single covered elastic yarn (SCY) having a covering yarn singly wound around an elastic yarn, or a double covered elastic yarn (DCY) having two covering yarns doubly wound around an elastic yarn in mutually opposite directions of twist. Single covered elastic yarns are especially preferable in view of higher transparency, smaller in fabric thickness and less stuffy feeling of hosiery.

It is important that the covered elastic yarn used in the present invention comprises a polyamide filament yarn as a covering yarn, wherein the cross section is a swollen quadrilateral substantially free from any depression and having four protruding portions, and formed by four curved sides substantially swelling outside from the respective four sides of an inscribed quadrilateral with the protruding portions as vertexes.

The polyamide filament yarns may be ordinary polyamide fibers such as nylon 6 fibers, nylon 66 fibers and nylon 46 fibers, and above all, nylon 6 fibers especially excellent in transparency and luster feeling are preferable as a covering yarn of every course hose wherein a transparency and luster feeling of the fibers are especially desired.

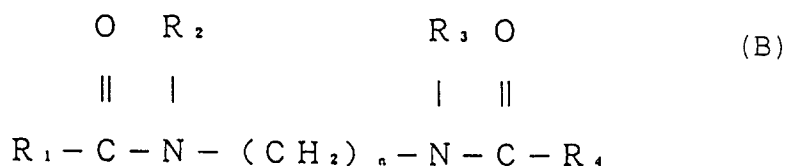
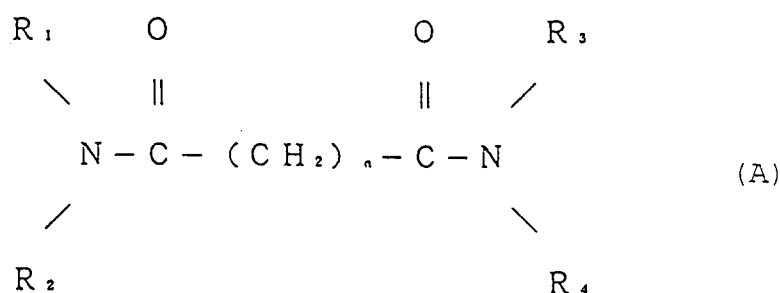
The polyamide is preferably a polyamide substantially consisting of any one polymer component only such as nylon 6, nylon 66 or nylon 46. However, as far as mechanical properties, transparency, etc. are not impaired, a small amount, say, less than about 3 mol% of another polymer component may also be copolymerized. Furthermore, similarly as far as mechanical properties, transparency, etc. are not impaired, a small amount, say, less than about 3 wt% of another polymer may also be blended.

To keep the strength-elongation characteristic of the covering yarn and the durability of every course hose at desired levels, the polyamide has a polymerization degree of preferably 2.5 to 3.5, more preferably 2.6 to 3.3 of relative viscosity in 98% sulfuric acid.

The polyamide may contain, as required, a photo stabilizer, thermal stabilizer, antioxidant, antistatic agent, dyeability improver, etc. as far as they do not impair transparency, but it is preferable for further improving the transparency, touch feeling, color clearness, durability, etc. of every course hose, not to substantially contain any delustering agent such as titanium oxide and pigment.

Titanium oxide is generally contained in polyamide fibers for hosiery as a delustering agent. Especially in the case of fiber with a non-circular cross section such as 3-lobed (Y-shaped) cross section or 5-lobed cross section, since the glittering on the surface of the fiber is very large, it has been considered to be absolutely necessary to add titanium oxide for suppressing the glittering. However, when the fibers having a cross section of a swollen quadrilateral of the present invention are used as the covering yarn, the problem of glittering does not arise, and substantial freedom from titanium oxide is rather effective for improving the transparency, color clearness, strength, etc. of the hosiery. It is preferable that titanium oxide is not substantially contained.

Moreover the polyamide fibers as the covering yarn preferably contain an acid amide compound represented by the following general formula (A) or (B) by 0.01 to 1.0 wt% based on the weight of the polyamide, for further improving the transparency, color clearness, durability, soft touch, etc. of the hosiery, and decreasing the roughness touch due to the unevenness of the knitted ground, and for further improving the soft touch.



where R_1 and R_4 represent, respectively independently, an alkyl group having 10 to 20 carbon atoms; and R_2 and R_3 represent, respectively independently a hydrogen atom, methyl group or ethyl group; and n represents an integer of 1 to 10.

These acid amide compounds can be prepared by the reaction of a dicarboxylic acid with an alkylmonoamine or the reaction of a monocarboxylic acid with an alkylenediamine. Ethylene-bis-stearylamine is a typical compound.

The dicarboxylic acid to be used in the above reaction includes dicarboxylic acids having 2 to 12 carbon atoms such as succinic acid, adipic acid and sebacic acid. The alkylmonoamine includes primary amines having an alkyl group with 10 to 20 carbon atoms such as octadecylamine, methyloctadecylamine and ethyloctadecylamine, and secondary amines in the form of such primary amines further substituted by a methyl group or an ethyl group.

Furthermore, the monocarboxylic acid to be used in the above reaction includes alkylmonocarboxylic acids having 12 to 22 carbon atoms such as lauric acid, palmitic acid and stearic acid. The alkylenediamine includes alkylenediamines having 1 to 10 carbon atoms such as methylenediamine, ethylenediamine, propylenediamine and butylenediamine.

The polyamide filament yarn used as the covering yarn in the covered elastic yarn of the present invention has a cross section of a swollen quadrilateral substantially free from any depression and having four protruding portion, wherein the swollen quadrilateral is formed by four curved sides substantially swelling outside from the respective four sides of an inscribed quadrilateral with the protrusions as vertexes.

Furthermore, it can also be said that the configuration of the swollen quadrilateral is a quadrilateral constituted of four curved sides, and that the four curved sides substantially protrude outward viewed from the center of the quadrilateral and are substantially free from any depression.

The swollen quadrilateral in the present invention can be the configuration typically illustrated in Fig. 1 and Fig. 3 (a). Fig. 1 shows a typical example of the swollen quadrilateral of the present invention. Figs. 3 show cross sectional views of single fibers used as the covering yarns of the examples, and Fig. 3 (a) shows a case of the present invention, and the others show cases not in conformity with the present invention.

In Fig. 1, symbol 1 denotes a cross section of a fiber; 2 (dot-dash line), its circumcircle; and 3 (broken line), its inscribed quadrilateral. The cross section 1 of the fiber has four protruding portions 4 and 4', and the curved sides 5 and 5' connecting the adjacent protruding portions 4 and 4' are substantially swollen outward from the respective sides of the inscribed quadrilateral 3 with the protruding portions 4 and 4' as vertexes.

The curved sides 5 and 5' are substantially swollen from the respective sides of the inscribed quadrilateral 3, and are substantially free from any depression at any intermediate portion of the curved sides 5 and 5'. That is, the outline of the cross section 1 of the fiber exists between the inscribed quadrilateral 3 and the circumcircle 2, and every portion of it is substantially swollen.

On the contrary, if the curved sides 5 and 5' are located outside the circumcircle 2, or located inside the inscribed quadrilateral 3, depressions are formed at the angle portions (corresponding to the protruding portions 4 and 4') or at the intermediate portions of the curved sides 5 and 5'. In this case, the quadrilateral cannot be the swollen quadrilateral of the present invention.

In addition to the above, to keep the quadrilateral swollen, in the case of Fig. 1 where the circumcircle is a real circle and the inscribed quadrilateral is a square, it is preferable that the ratio (b/a) of the distance b from the center of the circumcircle 3 to the centers of the curved sides 5 to the distance a from the center of the circumcircle 3 to the protrusions 4 is 0.80 to 0.96.

The configuration of the cross section of the fibers in the present invention is only required to be substantially free from any depression, and the slight depression which may be caused in the production and processing of the yarn and in the production of hosiery, etc. may be contained if the intended object of the present invention can be achieved.

The swollen quadrilateral specified in the present invention may be not only the configuration of Fig. 1, but also may be a quadrilateral almost ellipsoidal in the circumcircle, and rectangular or parallelogrammatic in the inscribed quadrilateral as far as the configuration conditions specified in the present invention are satisfied. However, to make the effect of transparency, smoothing touch, luster feeling, etc. more remarkable, it is preferable that the inscribed quadrilateral is substantially parallel in two sets of two opposite sides, and especially preferably a square, a rectangle or the configuration similar to them.

Furthermore, it is preferable that the line segments B1 and B2 connecting the centers of the curved sides 5 and 5' facing each other preferably satisfy the relation, $1/2 < B1/B2 < 2/1$, more preferably $1/1.5 \leq B1/B2 \leq 1.5/1$.

The fibers having a cross section of said swollen quadrilateral are more excellent in transparency, luster feeling, smoothing touch, etc. than fibers having a circular cross section. However, the fibers having a conventional odd-shaped cross section with depressions such as four lobed type or three lobed type cannot provide this effect.

The use of fibers with a cross section of said swollen quadrilateral as a covering yarn can improve the transparency, luster feeling, refreshing feeling, fabric appearance, etc. of every course hose. If the fibers having a cross section of the swollen quadrilateral are used for covering, the single fibers can be easily arranged in one layer around the core yarn when covering, and this in combination with the cross section free from any depression gives a large effect in improving transparency, luster feeling, touch feeling, etc., and compared to the conventional every course hose, very excellent

transparency, luster feeling, touch feeling, etc. can be obtained without worsening the other properties required for hosiery such as durability and fitting property.

On the contrary, if the fiber having a conventional odd-shaped cross section with depressions such as 4-lobed type or 3-lobed type are used as the covering yarn, the existence of depressions in the cross section of the fibers worsens the transparency of the hosiery, and the glittering due to reflection and roughness worsens the luster feeling and also soft touch, not allowing the intended object of the present invention to be achieved. Moreover, single fibers having a cross section of 3-lobed type or 5-lobed type are liable to be arranged in two or more layers around the core yarn like fibers having a circular cross section, and in addition, the roughness on the surface of the covered elastic yarn is large, not allowing the intended object of the present invention to be achieved.

The polyamide fibers having a cross section of the swollen quadrilateral specified in the present invention can be obtained by ordinary method of obtaining a desired cross section by controlling a shape of a spinning nozzle of a spinning nozzle plate, a degree of polymerization of a polymer used, etc. For example, a polyamide is melt-spun from a spinning nozzle with cross slits, and in this case, the degree of polymerization (relative viscosity) of the polymer and the dimensions of the slits can be adjusted to obtain the desired cross section. In general, the ratio of slit leg length/slit width is preferably 1 or less.

Furthermore, it is preferable that the polyamide fibers having a cross section of the swollen quadrilateral specified in the present invention is 1.129 to 1.132 g/cm³ in density, 28.0 to 40.0 g/d in initial tensile resistance, 12 to 15% in boil off shrinkage, 6.0 g/d or more in strength, and 45% or less in elongation, in view of further improving the transparency, soft touch, fabric appearance, durability, etc.

If the initial tensile resistance is less than 28.0 g/d as in the case of undrawn yarns spun at a low speed and undrawn yarns spun at a high speed (so-called POY), a formation of the knitted loops in the knitted fabric of every course hose become loose in a tendency to worsen the fabric appearance unpreferably. On the contrary, the tensile modulus of more than 40.0 g/d as in the drawn yarns obtained by drawing the slowly spun undrawn yarns at a high ratio is unpreferable in view of transparency, softness, etc. of the knitted fabric of every course hose.

Furthermore, if the boil off shrinkage exceeds 15% as in the drawn yarns obtained by drawing the slowly spun undrawn yarns at a high ratio, since the shrinkage in the heat treatment processing such as dyeing is too large, the strong tightening by the polyamide yarn wound around the core yarn is liable to make the covered elastic yarn rigid, for further impairing the softness of the fabric, and the knitted loops of the fabric are liable to be deformed or stretched unpreferably when they are formed.

The respective values of the above mentioned initial tensile resistance, strength and elongation are obtained by drawing an elongation-load curve (S-S curve) by measuring fiber samples allowed to stand in an atmosphere of 20°C and 65% RH in free shrinking state, using a Tensilon testing machine in the condition that an initial load of 1/30 g/d, a sample length of 50 cm and a tensile speed of 50 cm/min. The initial tensile resistance is obtained by drawing a tangent for the highest gradient in the rise portion of the S-S curve, and multiplying the stress value at an elongation of 10% by 100/10.

The polyamide fibers having a cross section of the swollen quadrilateral with said physical values can be produced by a high speed direct spinning drawing method of cooling and taking up melt-spun filaments, drawing to 3.0 times or less, heat-treating at 150°C or higher, and winding at 3500 m/min or more.

The polyamide fibers obtained by the above high speed direct spinning drawing method can be expressed as 1.1290 to 1.1320 g/cm³ in density in view of fiber structure, and it is difficult to obtain the polyamide fibers having a cross section of the swollen quadrilateral with these physical values, by any other yarn production method such as low speed spinning, high speed spinning without drawing, or low speed spinning and drawing at a high ratio.

The thickness of the covering yarn used in the present invention is preferably 5 to 12 deniers, especially 5 to 10 deniers when used for single covering, 5 to 10 deniers when used for double covering, for obtaining higher transparency, and excellent durability and wearing feeling. If the yarn thickness is too small, practical durability is liable to be insufficient, and if too large on the contrary, the transparency is liable to be insufficient while the handling touch is liable to be coarse and hard unpreferably.

Moreover, it is preferable for further improving transparency, wearing feeling and durability that the yarn is a multi-filament yarn consisting of 2 to 7 filaments. If the number of filaments is one, the handling touch is liable to be coarse and hard, and the durability is liable to be insufficient. On the contrary, if the number of filaments is 8 or more, transparency and durability are liable to be insufficient unpreferably.

The elastic yarn to be used as the core yarn of the covered elastic yarn can be an elastic polyurethane yarn, an elastic polyamide elastomer yarn, an elastic polyester elastomer yarn, a natural rubber yarn, a synthetic rubber yarn, a butadiene yarn, etc. The yarn preferable for hosiery in view of elastic property, thermal properties, durability, etc. is an elastic polyurethane yarn or an elastic polyamide elastomer yarn. The elastic polyurethane yarn can be obtained by any method of dry spinning, melt spinning or wet spinning.

The thickness of the elastic yarn depends on the application and predetermined tightening pressure of the hosiery, but is generally about 8 to 70 deniers, preferably 10 to 40 deniers. If the thickness is less than 8 deniers, the strength of the yarn is insufficient, and such trouble as breaking of the core yarn is liable to occur during covering and knitting,

and the hosiery is liable to be insufficient in stretchability and durability unpreferably. If the thickness exceeds 70 deniers, the tightening power is so strong as to give a strong pressure feeling, and the decline of transparency and the increase of coarse and hard feeling are liable to be caused unpreferably.

The covered elastic yarn used in the present invention can be produced by winding a covering yarn constituted of plural polyamide filaments having a cross section of the specific swollen quadrilateral, around an elastic yarn in a single layer or double layer by ordinary method.

The count of covering twist of the polyamide filament yarn wound around the core yarn composed of elastic yarns depends on whether the wound layer is single or double. In the case of single covering, the count of covering twist is preferably 2200 to 2800 t/m for further improving the skin touch, durability, fabric appearance, etc. of the hosiery. Even if it is less than 2200 t/m (the same level as in the case of conventional single covered elastic yarn), good hosiery can be obtained, but in view of fabric appearance and the durability in the case of using a covering yarn smaller in thickness, 2200 t/m or more is preferable. On the contrary, if the count of twist exceeds 2800 t/m, the torque by the covering twist and the hardness of the covered elastic yarn itself are liable to impair the fabric appearance and durability unpreferably even though skin touch, transparency and durability are good. To obtain every course hose good in all of skin touch, durability, transparency, fabric appearance, etc., the count of covering twist of the single covered elastic yarn is more preferably 2300 to 2700 t/m.

In the case of double covering, it is preferable for the same viewpoints as above that the count of covering twist for the lower layer is 2200 to 2800 t/m.

In the present invention, the leg portion knitting fabric produced by knitting exclusively a covered elastic yarn can be knitted by an ordinary method of supplying only covered elastic yarns to a knitting machine with two or four yarn feeding ports. In the case of single covered elastic yarns, it is preferable that a single covered elastic yarn with the covering yarn twisted in S direction and a single covered elastic yarn with the covering yarn twisted in Z direction are knitted alternately. The leg portion knitting fabric is produced in this way, to make hosiery.

In the case of such every course hose, since the power level of the hosiery tends to be generally too high, the 60% elongation recovery stress (60% BP) is preferably in a range from 180 to 350 g, more preferably 200 to 300 g.

The 60% BP serves as an indicator of wearing fitting property thereof, and if the value is too low, wrinkles and loosenings are liable to occur unpreferably. If too high on the contrary, the tightening pressure is too high, and tightness and stuffiness are too strong. Furthermore, the knitted fabric shrinks so much as to impair uniform appearance unpreferably.

To set the 60% BP in the above range, it is most effective to optimize the elastic recovery property of the elastic core yarn, and it is also possible to control the constitution of the covered elastic yarn, the formation of knitting, dyeing, finishing, etc. For example, the elastic polymer (an ether polyurethane or an ester polyurethane, etc.) used for the elastic core yarn, its spinning method (melt spinning, dry spinning or wet spinning, etc.), the thickness of the yarn, knit design (number of needles, loop size, etc.) of hosiery, the heat setting conditions (finishing template size, temperature, etc.) can be adjusted for control.

The 60% elongation recovery stress (60% BP) can be obtained by the following method. A hose sample is elongated under a load of 2 kg hooked on one end of the sample, and the elongated sample length is expressed as L1. Then, the hose sample is folded double and set in a constant elongation type tensile testing machine, Model TOM-100E (produced by Shinkoh Communication Industry Co., Ltd.), and elongated up to 75% of L1/2 and recovered, to draw a stress-strain hysteresis curve. From the hysteresis curve of recovery, the stress value at the moment when the sample is recovered to the length of 60% elongation of L1/2 is obtained as 60% BP (g).

Examples

The leg portions of the following hosiery products were evaluated according to the following methods.

Transparency

A hosiery product was put on a human leg model, and the knitted fabric of the leg portion put on the thigh portions was sampled and placed on a color standard white plate (L value: 88.29), to measure the L value (Lw) of the knitted fabric using a color difference meter, $\Sigma 80$ (produced by Nippon Denshoku Kogyo K.K.), and then placed on a color standard black plate (L value: 7.74), to measure the L value (Lb). Using these L values, the transparency is obtained from the following formula. The higher the value, the more excellent the transparency.

$$\text{Transparency} = (Lw - Lb) / (W - B)$$

(where W is the L value of the color standard white plate, and B, the L value of the color standard black plate)

Touch feeling

A hosiery product was put on a human leg model, and the soft touch, refreshing feeling and smoothing touch were relatively evaluated by five inspectors who touched the hosiery product. The following criterion was referred to.

- ⊙ : Very good
- : Good
- △ : Rather poor
- X : Poor

Durability

The bursting strength was measured using a Mullen high-pressure testing machine according to JIS P-8131 Bursting Strength Testing Method. The following criterion was referred to.

- ⊙ : 1.2 kg/cm² or more
- : 1.0 kg/cm² to less than 1.2 kg/cm²
- △ : 0.9 kg/cm² to less than 1.0 kg/cm²
- X : Less than 0.9 kg/cm²

Luster feeling and fabric appearance

The luster feeling and fabric appearance were relatively evaluated with eyes by five inspectors, and the criterion was the same as that for the above touch feeling.

Fitness

Inspectors wore the hosiery product for 8 hours per day for 3 days, and evaluated. The criterion was the same as that for the above touch feeling.

Friction property

The KES friction property was measured in the warp direction of the knitted fabric, and expressed as frictional coefficient (MIU) and frictional coefficient variation (MMD).

Wearing comfort (in midsummer)

To evaluate the wearing comfort in the environment conditions of midsummer, four inspectors who wore hosiery in a 30°C, 65% RH room walked up and down a step for 20 minutes, and evaluated the wearing comfort in reference to the stuffiness they felt. The criterion was the same as that for the above touch feeling.

Example 1

Nylon 6 having a relative viscosity in 98% sulfuric acid of 2.7 and containing no titanium oxide was melt at 270°C, delivered at a rate of 800 m/min from a spinning nozzle plate having delivery ports in the shape of cross-shaped of 0.1 mm in slit width and 0.07 mm in slit length, cooled, oiled, and respectively wound as an undrawn yarn. Subsequently, the yarn was drawn so as to have an elongation of 40 to 45%, to thereby obtain a 10-denier nylon 6 yarn of 5-filament having a cross section as shown in Fig. 3 (a) (No. 1).

Separately, nylon 6 was melt-spun and drawn under the similar conditions as described for No. 1, except that delivery ports in the shape of cross-shaped of 0.2 mm in slit length were used, to thereby obtain a 10-denier nylon 6 yarn of 5-filament as shown in Fig. 3 (b) (No. 2).

For comparison, nylon 6 was melt-spun and drawn under the similar conditions as described for No. 1, except that delivery ports in the shape of Y-shaped or circular were used, to thereby obtain a 10-denier nylon 6 yarn of 5-filaments having a 3-lobed cross section or round cross section (Nos. 3 and 4).

Furthermore, nylon 6 was melt-spun and drawn under the similar conditions as described for No. 1, except that 0.35 wt% of titanium oxide was contained, to thereby obtain a 10-denier nylon 6 yarn 5-filaments having a cross section of a swollen quadrilateral (No. 5).

The cross section coefficients (b/a) of nylon 6 yarns of Nos. 1 and 2 were 0.91 and 0.62 respectively.

A section deformation degree of the nylon 6 yarn (3-lobed cross section) of No. 3 was 1.6. The section deformation degree in this case refers to a value obtained by dividing the radius of the circumcircle by the radius of the inscribed circle.

These nylon 6 yarns (12 t/m in the count of twist) were respectively used as covering yarns, to cover a 20-denier polyether based polyurethane elastic fiber (spandex) used as a core yarn, at a core yarn draft ratio of 3.1 times, at a count of covering twist of 2,300 t/m in S direction or Z direction in a single layer, to prepare S-directed single covered elastic yarns and Z-directed single covered elastic yarns respectively.

The single covered elastic yarns thus obtained were used for knitting panty hose. An S-directed single covered elastic yarn and a Z-directed single covered elastic yarn were alternately supplied into the yarn feeding port of Super 4 knitting machine (400 needles) produced by Nagata Seiki Co., Ltd., to produce panty hose having a leg portion knitting fabric formed by knitting only the covered elastic yarns. The panty hose was then dyed, finished, and set over a pattern plate to produce a panty hose product according to ordinary methods.

The results of evaluation of the leg portion of the panty hose product thus obtained were as shown in Table 1.

As can be seen from the results shown in Table 1, the panty hose according to the present invention (Nos. 1 and 5) were excellent in all the properties of soft touch, cool feeling, slippery feeling, luster feeling and durability. The panty hose of No. 1 containing no titanium oxide was particularly high in transparency.

On the contrary, in the case of a 4-lobed cross section with recesses (recessed quadrilateral) (No. 2), a 3-lobed cross section (No. 3) and a circular cross section (No. 4) were poor in touch feeling and luster feeling. Especially the panty hose having a circular cross section was poor in cool feeling and made the wearers feel stuffy.

Example 2

Nylon 6 having a relative viscosity in 98% sulfuric acid of 2.7 and containing no titanium oxide was melt at 270°C, delivered from a spinning nozzle plate having delivery ports in the shape of cross-shaped of 0.1 mm in slit width and 0.07 mm in slit length, cooled, oiled, taken up by a first godet roller at a rate of 2100 m/min, drawn to 1.8 times to achieve an elongation of 40 to 45%, heat-treated by a 160°C second godet roller, and wound at 4000 m/min, to obtain a 7-denier nylon 6 yarn of 5-filaments having a cross section as shown in Fig. 3 (a) (No. 6).

For comparison, nylon 6 was melt-spun and drawn under the similar conditions as described for No. 1, except that delivery ports in the shape of Y-shaped or circular were used, to thereby obtain a 7-denier nylon 6 yarn of 5-filaments having a 3-lobed cross section or round cross section (Nos. 7 and 8).

Furthermore, nylon 6 was melt-spun and drawn under the similar conditions as described for No. 1, except that 0.35 wt% of titanium oxide was contained, to thereby obtain a 7-denier nylon 6 yarn of 5-filaments having a cross section of a swollen quadrilateral (No. 9).

The cross section coefficient (b/a) of nylon 6 yarns of No. 6 was 0.93 respectively. A section deformation degree of the nylon 6 yarn (3-lobed cross section) of No. 8 was 1.8. The section deformation degree in this case refers to a value obtained by dividing the radius of the circumcircle by the radius of the inscribed circle.

These nylon 6 yarns (12 t/m in the count of twist) were respectively used as covering yarns, to cover a 20-denier polyether polyurethane elastic fiber (spandex) used as a core yarn, at a core yarn draft ratio of 3.1 times, at a count of covering twist of 2,300 t/m in S direction or Z direction in a single layer, to prepare S-directed single covered elastic yarns and Z-directed single covered elastic yarns respectively.

The single covered elastic yarns obtained were used for knitting panty hose. An S-directed single covered elastic yarn and a Z-directed single covered elastic yarn were alternately supplied into the yarn feeding port of Super 4 knitting machine (440 needles) produced by Nagata Seiki Co., Ltd., to produce panty hose having a leg portion knitting fabric formed by knitting only by the covered elastic yarns. The panty hose was then dyed, finished, and set over a pattern plate to produce a panty hose product according to ordinary methods.

The results of evaluation of the leg portion of the panty hose product obtained were as shown in Table 2.

As can be seen from the results shown in Table 2, the panty hose according to the present invention (Nos. 6 and 9) were excellent in all the properties of soft touch, cool feeling, slippery feeling, luster feeling and durability. Especially, the panty hose of No. 6 containing no titanium oxide was particularly high in transparency, etc.

On the contrary, in the case of a 3-lobed cross section (No. 7) and a circular cross section (No. 8) were poor in touch feeling and luster feeling. Especially the panty hose having a circular cross section were poor in cool feeling and made the wearers feel stuffy.

Example 3

The nylon 6 yarn of No. 1 obtained in Example 1, and the nylon 6 yarns of Nos. 6, 7 and 8 obtained in Example 2 were used as covering yarns.

Separately, nylon 6 was melt-spun, cooled, oiled, and wound at 4500 m/min under the similar conditions as described in Example 2, except that neither drawing nor heat treatment was effected, to thereby obtain a 7-denier nylon 6 yarn of 5-filaments of 62% in elongation (No. 10). The cross section coefficient (b/a) of this nylon 6 yarn was 0.92.

Furthermore, nylon 6 was spun by the high speed spinning same as above, to thereby obtain a 7-denier nylon 6 yarn of 5-filaments having a circular section and an elongation of 65% (No. 11).

These nylon 6 yarns of Nos. 1, 6, 7, 8, 10 and 11 were respectively used as covering yarns, to cover a 20-denier polyether polyurethane elastic fiber (spandex) used as a core yarn, at a core yarn draft ratio of 2.9 times, at a count of covering twist of 2,300 t/m in S direction or Z direction in a single layer, to prepare S-directed single covered elastic yarns and Z-directed single covered elastic yarns respectively.

The single covered elastic yarns obtained were used to produce panty hose product under the similar conditions as described in Examples 1 and 2, to evaluate the leg portions. The results were as shown in Table 3.

As can be seen from the results shown in Table 3, the panty hose product of No. 6 corresponding to claims 5 and 6 were especially excellent in all of transparency, fabric appearance, soft touch and durability.

Example 4

The nylon 6 yarn of No. 1 of Example 1 was used as covering yarns, to cover a 15-denier polyether polyurethane elastic fiber (spandex) used as core yarns, at a core yarn draft ratio of 2.9 times, at a count of covering twist of 1900, 2300, 2600 or 2900 t/m in a single layer, for preparing single covered elastic yarns (Nos. 12 to 15).

Separately, nylon 6 having a relative viscosity in 98% sulfuric acid of 2.7, containing no titanium oxide and containing 0.5 wt% of ethylene-bis-stearylamine (EBA) and was melt-spun and then drawn under the similar conditions as described for No. 1 of Example 1, to thereby obtain a 10-denier nylon 6 yarn of 5-filaments having a cross section of a swollen quadrilateral. The nylon 6 yarn was used as a covering yarn, to cover at a count of twist of 2600 t/m as described above, to thereby produce a single covered elastic yarn (No. 16).

The single covered elastic yarns obtained were respectively used to produce panty hose product under the similar condition as described in Example 1, for evaluation. The results were as shown in Table 4.

As can be seen from the results shown in Table 4, all the panty hose obtained were excellent in all of transparency, soft touch, cool feeling, slippery feeling and fabric appearance. Above all, those obtained by covering at a count of twist of 2300 or 2600 t/m (Nos. 13, 14 and 16) were very good in soft touch, cool feeling, slippery feeling and fabric appearance. These properties were also suggested by being small in both frictional coefficient and variation of frictional coefficient, good slipperiness and soft handling touch.

Moreover, the panty hose using the fibers containing an acid amide compound specified in the present invention (No. 16) was especially excellent in transparency.

Example 5

The nylon 6 yarn of No. 1 of Example 1 was used as a covering yarn, to cover a 10-, 15-, 20-, or 30-denier polyether polyurethane elastic fiber (spandex) which was used as a core yarn, at a core yarn draft ratio of 3.0, 2.8, 2.8, or 2.6 times, respectively, at a count of covering twist of 2500 t/m in a single layer, for preparing a single covered elastic yarn (Nos. 17 to 20).

The single covered elastic yarns obtained were respectively used to produce panty hose under the similar conditions as described in Example 1, for evaluation. The results were as shown in Table 5.

As can be seen from the results shown in Table 5, all the panty hose had excellent properties. Above all, in the case of 180 to 350 g in 60% recovery stress (BP) (Nos. 17 to 19) were especially excellent in wearing comfort in the environmental conditions of midsummer.

Example 6

The nylon 6 yarn of No. 1 of Example 2 was used as a covering yarn, to cover a 15-denier polyether polyurethane elastic fiber (spandex) which was used as a core yarn, at a core yarn draft ratio of 3.0 times, at a count of covering twist of 2000 t/m in S direction for the first layer and at a count of twist of 2300 t/m in Z direction for the second layer, to thereby produce a double covered elastic yarn (No. 21).

The double covered elastic yarn thus obtained was used to produce panty hose having a leg portion knitting fabric formed by knitting only the covered elastic yarn using Super 4 knitting machine (400 needles) produced by Nagata Seiki Co., Ltd., and produced a panty hose product under similar condition as described to those in Example 1. The panty hose product had excellent properties as shown below.

Slippery feeling : ◎ Soft touch : ○ Cool feeling : ○ Durability : ◎ Fitting property : ◎

Industrial applicability

The present invention can provide hosiery with very good transparency, cool feeling, luster feeling and fabric appearance not achieved by the conventional every course hose, and excellent also in skin touch, soft handling touch, wearing comfort, fitting property and durability.

Therefore, hosiery products excellent in the fitting property when worn, fashionability, comfort, durability, etc. can be presented.

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Table 1

No.	Covering yarn of covered elastic yarn		Properties of the leg portion knitting fabric of hose					Durability
	Cross-section of fiber	Titanium oxide content (wt%)	Transparency (%)	Touch feeling			Luster feeling	
				Soft touch	Cool feeling	Slippery feeling		
1	Swollen quadrilateral	Fig. 3	0	70	◎-○	◎	◎	◎-○
2 (Comparative example)	Recessed quadrilateral	Fig. 3 (a)	0	63	△	○	○-△	○
3 (Comparative example)	3-lobed type	Fig. 3 (b)	0	57	△	○	×	○
4 (Comparative example)	Circular	Fig. 3 (c)	0	62	△	×	○-△	○
5	Swollen quadrilateral	Fig. 3 (d)	0.35	60	○	◎-○	○	○

Table 2

No.	Covering yarn of covered elastic yarn		Properties of the leg portion knitting fabric of hose						
	Cross-section of fiber	Titanium oxide content (wt%)	Transparency (%)	Touch feeling			Slippery feeling	Luster feeling	Durability
				Soft touch	Cool feeling				
6	Swollen quadrilateral	Fig. 3 (a)	0	73	⊙	⊙	⊙	⊙	⊙
7	3-lobed type	Fig. 3 (c)	0	60	Δ	○	×	Δ	○
8	Circular	Fig. 3 (d)	0	65	Δ	×	○-Δ	Δ	○
9	Swollen quadrilateral	Fig. 3 (a)	0.35	62	○	⊙-○	⊙-○	○	○

Table 3

No.	Covering yarn of covered elastic yarn						Properties of the leg portion knitting fabric of hose				
	Cross-section of fiber		Initial tensile resistance (g/d)	Boil off shrinkage (%)	Strength (g/d)	Density (g/cm ³)	Fabric appearance			Soft touch	Durability
	Transparency						Transparency	Loop deformation	Wet bar		
1	Swollen quadrilateral		49.1	17	5.9	1.134	⊙	○-△	○	⊙-○	⊙-○
6	Swollen quadrilateral		35.2	14	6.4	1.131	⊙	⊙	⊙	⊙	⊙
7 (Comparative example)	3-lobed type		36.1	13	5.7	1.130	△	△	○-△	△	○
8 (Comparative example)	Circular		39.0	14	6.7	1.133	△	○-△	○-△	○	⊙
10	Swollen quadrilateral		13.0	11	4.3	1.127	⊙	△	△	⊙-○	△
11 (Comparative example)	Circular		14.1	11	4.9	1.126	△	△-x	△	△	x

Table 4

No.	Count of covering twist of covered elastic yarn (t/m)	Covering yarn	Properties of the leg portion knitting fabric of hose						
			Trans- parency (wt%)	Touch feeling			Friction properties		Fabric appear- ance
				Soft touch	Cool feel- ing	Slippery feeling	MIU	MMD	
12	1900	0	69	○	○	○	0.21	0.09	○
13	2300	0	71	⊙	⊙	⊙	0.17	0.06	⊙
14	2600	0	72	⊙	⊙	⊙	0.15	0.06	⊙
15	2900	0	70	⊙	○	⊙	0.15	0.07	○-△
16	2600	0.50	75	⊙	⊙	⊙	0.15	0.06	⊙

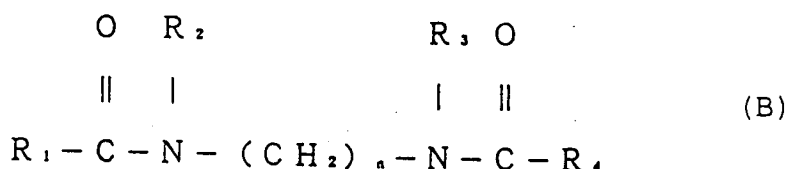
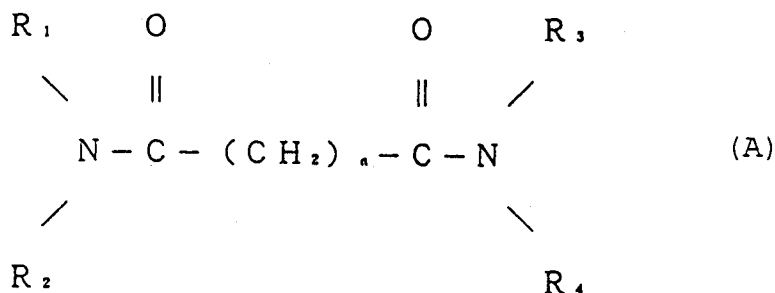
Table 5

No.	Thickness of core yarn (d)	Core yarn draft ratio (times)	Properties of the leg portion knitting fabric of hose			
			Recovery stress 60% BP(g)	Fitness	Slippery feeling	Midsummer wearing com- fort
17	10	3.0	180	○	○	⊙
18	15	2.8	270	⊙	⊙	⊙
19	20	2.8	310	⊙	⊙	⊙
20	30	2.6	390	⊙	⊙	○-△

Claims

- Hosiery produced by knitting substantially exclusively a covered elastic yarn into at least the leg portion knitting fabric thereof, wherein said covered elastic yarn is formed by winding a polyamide filament yarn around a core yarn constituted of an elastic yarn, comprising: the cross section of the polyamide filament yarn is a swollen quadrilateral substantially free from any depression and having four protruding portions, wherein the swollen quadrilateral is formed by four curved sides substantially swelling outside from the respective four sides of an inscribed quadrilateral with the protruding portions as vertexes.
- Hosiery according to claim 1, wherein the ratio (B1/B2) of the lengths of line segments B1 and B2 connecting the centers of the two opposite curved sides of said swollen quadrilateral is $1/2 < B1/B2 < 2/1$.
- Hosiery according to claim 1 or 2, wherein the inscribed quadrilateral of the swollen quadrilateral is substantially a rectangle or square.

4. Hosiery according to claim 1, wherein the polyamide filament yarn is made of a polyamide substantially not containing titanium oxide.
5. Hosiery according to claim 1, wherein the polyamide filament yarn is 1.129 to 1.132 g/cm³ in density, 28.0 to 40.0 g/d in initial tensile resistance, 12 to 15% in boil off shrinkage, and 6.0 g/d or more in strength.
6. Hosiery according to claim 1, wherein the polyamide filament yarn is produced by a high speed direct spinning and drawing method of cooling melt-spun fibers, oiling, taking up, drawing to 3.0 times or less, heat-treating at 150°C or higher and winding at 3500 m/min or more.
7. Hosiery according to claim 1, wherein the covered elastic yarn is a single covered elastic yarn with the covering filament yarn wound around a core yarn constituted of an elastic fiber, in a single layer.
8. Hosiery according to claim 7, wherein the covering filament yarn covers at a count of covering twist of 2200 to 2800 t/m.
9. Hosiery according to claim 7, wherein the covering yarn is 5 to 12 deniers in fineness and the number of filaments of 2 to 7.
10. Hosiery according to claim 1, wherein the covered elastic yarn is a double covered elastic yarn with the covering filament yarn wound around a core yarn constituted of an elastic fiber, in a double layer.
11. Hosiery according to claim 10, wherein the first-layer covering filament yarn covers at a count of covering twist of 2200 to 2800 t/m.
12. Hosiery according to claim 10, wherein the covering filament yarn is 5 to 10 deniers in fineness and the number of filaments of 2 to 7.
13. Hosiery according to claim 1, wherein the polyamide of the covering filament yarn is nylon 6.
14. Hosiery according to claim 1, wherein the polyamide of the covering filament yarn is a polyamide composition containing 0.01 to 1.0 wt% of an acid amide compound represented by the following general formula (A) or (B).



where R₁ and R₄ represent, respectively independently, an alkyl group having 10 to 20 carbon atoms; R₂ and R₃, represent respectively independently, a hydrogen atom, methyl group or ethyl group; and n represents an integer of 1 to 10.

15. Hosiery according to claim 1, wherein the 60% elongation recovery stress of the leg portion knitting fabric of hose is 180 to 350 g.

Fig. 1

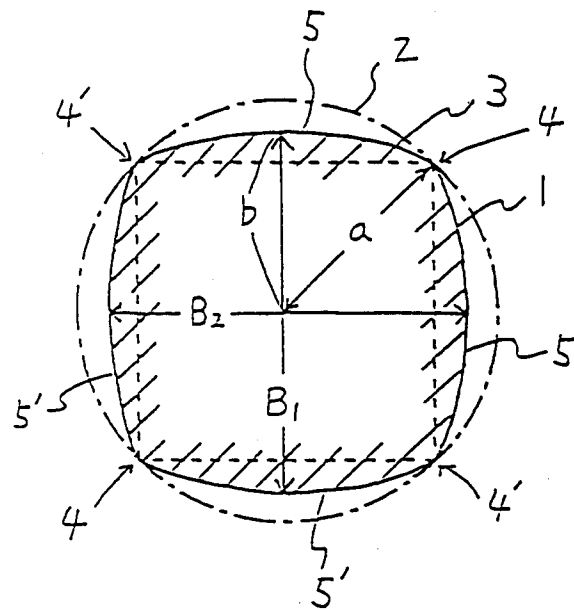


Fig. 2 (a)

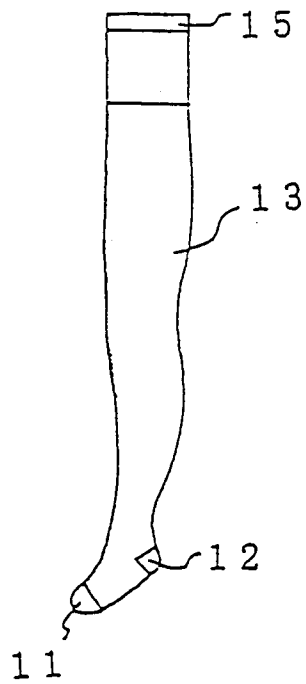


Fig. 2 (b)

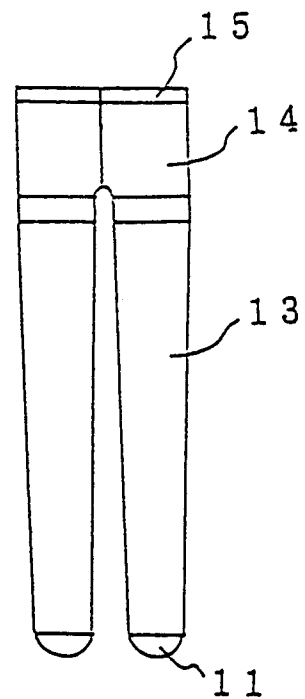


Fig. 3 (a)

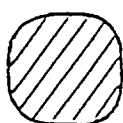


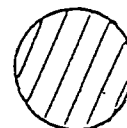
Fig. 3 (b)



Fig. 3 (c)



Fig. 3 (d)



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP95/01825

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl⁶ A41B11/00

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)

Int. Cl⁶ A41B11/00, A41B11/14, D01D5/253, D01F6/90, D02G3/32

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

Jitsuyo Shinan Koho 1911 - 1995

Kokai Jitsuyo Shinan Koho 1971 - 1995

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 58-132113, A (Toray Industries, Inc.), August 6, 1983 (06. 08. 83) (Family: none)	1 - 15
A	US, 4801503, A (E. I. Du Pont de Nemours and Company), January 31, 1989 (31. 01. 89) (Family: none)	1 - 15
A	JP, 1-207433, A (Teijin Ltd.), August 21, 1989 (21. 08. 89), Example 2, page 3 (Family: none)	1 - 15
A	JP, 2-80635, A (Toyobo Co., Ltd.), March 20, 1990 (20. 03. 90) (Family: none)	1 - 15
A	JP, 61-102442, A (Toray Industries, Inc.), May 21, 1989 (21. 05. 89) (Family: none)	1 - 15

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

* Special categories of cited documents:

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Date of the actual completion of the international search

November 28, 1995 (28. 11. 95)

Date of mailing of the international search report

December 19, 1995 (19. 12. 95)

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