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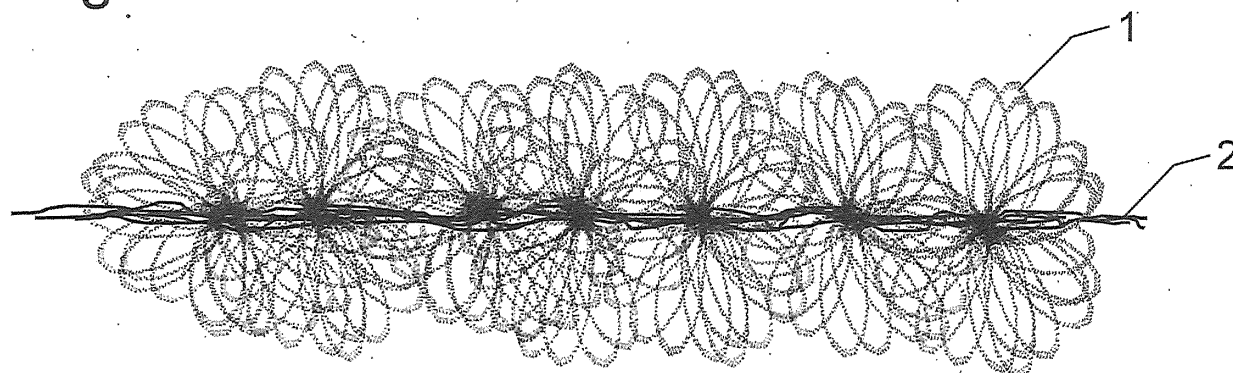
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(54) **BULKY YARN**

(57) The present invention is a bulky yarn having: a sheath yarn (1) that has continuously formed loops without any breakages; and a core yarn (2) that substantially fixes the sheath yarn (1) by being interlaced with the sheath yarn (1). In the bulky yarn, the number of loops protruding from the yarn surface layer by not less than 3.0 mm is in a range of 1-30 loops/mm, the elastic modulus

is not greater than 80 cN/dtex, and the extension recovery rate at the time of 10% extension recovery is not less than 50%. The present invention thus provides a bulky yarn having excellent touch feeling, excellent lightweight and heat retaining properties, and stretchability.

Figure 1



Description

TECHNICAL FIELD

[0001] The present invention relates to a bulky yarn having a large number of loops in the surface layer. The bulky yarn can be applied in a wide variety of fields from clothing to industrial resources applications because the bulky yarn can appeal high heat retaining properties with exhibiting a soft touch feeling.

BACKGROUND ART

[0002] Synthetic fibers made from thermoplastic polymers such as polyesters and polyamides have characteristics that they have good basic characteristics such as mechanical properties and dimensional stability, and are excellent in the balance of such characteristics. Therefore, fiber materials utilizing thermoplastic polymers can have various structural forms by high-order processing in addition to being capable of exhibiting polymer properties and basic performance exhibited by yarn making, and are widely used not only in clothing applications but also in interior decorations, vehicle interior decorations, and industrial applications.

[0003] It is no exaggeration to say that technological innovation related to synthetic fibers has been made based on a motivation for imitating natural materials, and various technical proposals have been made for exhibiting functions originating from natural complex structural forms with synthetic fibers. For example, there are various technical proposals such as the manifestation of unique texture (friction, flexibility) by imitating the cross section of silk, structural coloring typified by morpho butterflies, and water repellent performance seen in leaves of lotus. One of them is an approach to exhibit functions such as soft texture and lightweight and heat retaining properties provided by natural feathers.

[0004] As the natural feathers, a mixture of down balls (in a granular cotton form) collected in a small amount from the chest of waterfowls and feathers (in a fluffy form) is generally used. These materials are rich in the soft texture, easy to follow the body shape, and exhibit excellent lightweight and heat retaining properties owing to their special structural form formed of keratin fibers. For this reason, functions of products including natural feathers as filling have been recognized by even general users, and the natural feathers are widely used in bedclothes and clothing items such as jackets.

[0005] Capture of waterfowls, however, is limited from the viewpoint of nature conservation, and the total production of natural feathers is restricted. Furthermore, due to the recent abnormal weather and occurrence of the plague, there is a problem that the supply of natural feathers largely fluctuates, and is also a problem of price increase and unstable supply. In addition, despite the number of steps for the use of natural feathers, such as collection, screening, disinfection, and degreasing of the feathers, peculiar odor and animal allergy are often at issue. Moreover, from the viewpoint of animal welfare, there is also a movement to eliminate the use of natural feathers in Europe and other countries. For this reason, attention is being paid to a filling material made of synthetic fibers that is capable of stable supply.

[0006] Many filling materials made of synthetic fibers have been proposed from long ago, but there are no filling materials comparable to natural feathers in terms of basic characteristics such as the bulkiness, compression recovery, and soft texture.

[0007] For example, as shown in Patent Documents 1 and 2, by making the fiber aggregate state spherical or radial, the bulkiness derived from the structure is improved.

[0008] Conventionally used yarn processing techniques intended for adding high value to fibers have been generally known to be capable of manufacturing a textured yarn having bulkiness by subjecting the fibers to twisting and then to untwisting, or by mixing one or more kinds of fibers with a fluid processing nozzle or the like, for example. Since such bulky textured yarns are basically made of long fibers, they can be processed into various forms, and can also be applied to a filling material based on the bulkiness and soft texture of the textured yarns.

[0009] In Patent Document 3, of two kinds of fibers used, only one kind of the fibers are supplied to a waist gauge while being swayed, and then the two kinds of fibers are collectively subjected to twisting to form loops in the surface layer by the swayed fibers. After that, the fibers are untwisted by further being abraded with two discs or the like to provide a bulky textured yarn. Indeed, with this technique, there is a possibility of providing a bulky yarn having loops formed by a sheath yarn by adjusting the degree of yarn swaying or the like according to the conventional method.

[0010] Patent Document 4 discloses a technique in which an excessively supplied sheath yarn is fixed by a yarn length difference by injecting compressed air from a direction perpendicular to the traveling yarn within an entangling nozzle, and opening and entangling the fiber. In Patent Document 4, it is possible to provide an entangled yarn having bulkiness in which sheath yarns having a loop shape are present in the surface layer.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

5 **[0011]**

Patent Document 1: Japanese Patent Publication No. 48-7955

Patent Document 2: Japanese Patent Publication No. 51-39134

Patent Document 3: Japanese Patent Laid-open Publication No. 2011-246850

10 Patent Document 4: Japanese Patent Laid-open Publication No. 2012-67430

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

15 **[0012]** Those shown in Patent Documents 1 and 2 cause a foreign body sensation when compressed and are not comparable to natural feathers from the viewpoint of soft texture of natural feathers. In these fiber structures mainly composed of short fibers, the bulkiness and flexibility (compression recovery) of the structure are provided by the mechanical properties and the fineness (thickness) of the fibers used. For this reason, further improvements are required to achieve both the conflicting properties, that is, bulkiness and flexibility, like natural feathers do.

20 **[0013]** In Patent Document 3, in the case where twisting is applied to the loop yarn from which the sheath yarn partially protrudes and the yarn is untwisted while abraded with rubber or the like by a mechanical kneading machine, the protruding loop is partly broken or deteriorated. When the textured yarn is used as a filling material, several to several tens of yarns are finally bundled and filled. Therefore, the deteriorated part (fluff) is remarkably entangled with the sheath yarn of other textured yarns. When this entangled sheath yarn is filled, it causes a foreign body sensation to deteriorate the texture or promotes entanglement, so that the bulkiness may decrease over time.

25 **[0014]** In Patent Document 4, in the case of intermingling the traveling threads in the nozzle, and opening and entangling the fibers, the traveling yarns sway in a very short period to cause entanglement between them. For this reason, small loops influenced by the nozzle shape are naturally excessively formed with high frequency. In addition, since the sheath yarn is randomly entangled with the core yarn, the size of the loops varies in the fiber axis direction, and the yarn is restricted in the bulkiness. Further, the loop yarn formed in the nozzle stays inside the nozzle, and is discharged to the outside of the nozzle by the jet air. For this reason, the size of the loops and the length of the sheath yarns forming the loops vary in the fiber axis direction of the textured yarn to form slack. In this case, particularly a sheath yarn having slack tends to be tangled with another sheath yarn, and there still remain problems such as difficulties in the process passability in the high-order processing and that the portion where the sheath yarns are tangled with each other leads to a foreign body sensation.

30 **[0015]** In the case of using the textured yarns as described in Patent Documents 3 and 4 as the filling material, in addition to the problems relating to bulkiness and texture described above, both ends of the textured yarn are to be fixed for use to suppress entanglement and twist. However, in the textured yarns described in Patent Documents 3 and 4, since the textured yarn itself does not have extensibility, the entangled yarn fixed at a fixed length is in a state of being stretched in the filling material. Therefore, if the design or size is so tight, there are cases where an uncomfortable restraint feeling is produced. In particular, when clothing and the like are produced with the yarns, because elbows, knees, neck, and waist circumference parts that are largely moved need to be designed with a margin, extra spaces are formed. Therefore, there are cases where functions such as heat retaining properties cannot be exhibited sufficiently.

35 **[0016]** For this reason, a bulky yarn that has extremely high bulkiness provided by loops, suppresses entanglement between textured yarns, and has good stretchability is desired.

[0017] An object of the present invention is to provide a bulky yarn suitable for high-performance heat retaining materials.

SOLUTIONS TO THE PROBLEMS

50 **[0018]** The above-mentioned object is achieved by the following means.

- 55 (1) A bulky yarn including: a sheath yarn that has continuously formed loops without any breakages; and a core yarn that substantially fixes the sheath yarn by being interlaced with the sheath yarn, wherein a number of loops protruding from a yarn surface layer by not less than 3.0 mm is in a range of 1 to 30 loops/mm, an elastic modulus is not greater than 80 cN/dtex, and an extension recovery rate at a time of 10% extension recovery is not less than 50%.
- (2) The bulky yarn according to (1), wherein a single yarn fineness of a constituent fiber is not less than 3.0 dtex,

and a single yarn fineness ratio of the sheath yarn to the core yarn (sheath/core) is in a range of 0.5 to 2.5.

(3) The bulky yarn according to (1) or (2), wherein the core yarn is a side-by-side or eccentric core-in-sheath conjugate fiber, and a fiber that constitutes the sheath yarn is a three-dimensional crimped structure yarn having a curvature radius of 2.0 mm to 30.0 mm.

(4) The bulky yarn according to (1) or (2), including: a sheath yarn that has formed loops; and a core yarn that substantially fixes the sheath yarn by being interlaced with the sheath yarn, wherein the sheath yarn has continuously formed loops substantially without any breakages and is a conjugate fiber having a density of less than 1.00 g/cm³.

(5) The bulky yarn according to (4), wherein the sheath yarn has a three-dimensional crimped structure.

(6) The bulky yarn according to (4) or (5), wherein the sheath yarn is an islands-in-sea conjugate fiber having a hollow cross section with a hollow rate of not less than 20%.

(7) The bulky yarn according to (6), wherein an island component in the islands-in-sea conjugate fiber contains a polyolefin and a sea component in the islands-in-sea conjugate fiber contains a polyester.

(8) The bulky yarn according to (1) or (2), including: a sheath yarn that has formed loops and a three-dimensional crimped structure; and a core yarn that substantially fixes the sheath yarn by being interlaced with the sheath yarn, wherein a 10% modulus is less than 1.5 cN/dtex, a fiber extension ratio at load application is not less than 1.1, and a fiber length restoration rate after load application extension is 80 to 100%.

(9) The bulky yarn according to (8), wherein the fiber extension ratio at load application is not less than 1.5, and the fiber length restoration rate after load application extension is 90 to 100%.

(10) The bulky yarn according to any one of (1) to (9), wherein a coefficient of static friction between fibers is not greater than 0.3.

(11) The bulky yarn according to any one of (1) to (10), wherein both the core yarn and the sheath yarn are composed of hollow cross-section fibers with a hollow rate of not less than 20%.

(12) A fiber product including the bulky yarn according to any one of (1) to (11) in at least a part of the fiber product.

EFFECTS OF THE INVENTION

[0019] The bulky yarn of the present invention exhibits an excellent touch feeling without a foreign body sensation, excellent lightweight and heat retaining properties and the like because it has a unique bulky structure in which loops having a three-dimensional crimped form are formed in the surface layer, and thus entanglement between bulky yarns is suppressed. Because the bulky yarn of the present invention also has comfortable stretchability that allows the bulky yarn to extend and deform under low stress, the bulky yarn of the present invention is excellent in adherence as well as a movement following ability which enables flexible extension and deformation in accordance with a movement, and does not produce any unnecessary space. Therefore, the bulky yarn of the present invention can be utilized as a high-performance and lightweight heat retaining material that is excellent in a wearing feeling and heat retaining functions although it is compact.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

Fig. 1 shows a schematic side view of an example of the bulky yarn of the present invention.

Fig. 2 shows a schematic diagram for illustrating a yarn surface measuring method.

Fig. 3 shows a schematic diagram for illustrating a three-dimensional crimped (spiral) structure.

Fig. 4-1 shows a schematic diagram of an example of a cross section of a side-by-side conjugate yarn that constitutes the bulky yarn of the present invention, and Fig. 4-2 shows a schematic diagram of an example of a cross section of an eccentric core-in-sheath conjugate yarn that constitutes the bulky yarn of the present invention.

Fig. 5 shows a schematic diagram of an example of a cross section of a hollow islands-in-sea conjugate yarn that constitutes the bulky yarn of the present invention.

Fig. 6 shows a schematic process diagram schematically showing an example of a method for manufacturing the bulky yarn of the present invention.

Fig. 7 shows a schematic side view for illustrating a suction nozzle used in the method for manufacturing the bulky yarn of the present invention.

Fig. 8 shows a schematic cross-sectional view for illustrating a discharge hole of a hollow cross-section spinneret used in the method for manufacturing the bulky yarn of the present invention.

EMBODIMENTS OF THE INVENTION

[0021] Hereinafter, the present invention will be described in detail together with preferable embodiments.

[0022] The bulky yarn of the present invention is a bulky yarn including: a sheath yarn that has continuously formed loops without any breakages; and a core yarn that substantially fixes the sheath yarn by being interlaced with the sheath yarn, wherein a number of loops protruding from a yarn surface layer by not less than 3.0 mm is in a range of 1 to 30 loops/mm, an elastic modulus is not greater than 80 cN/dtex, and an extension recovery rate at a time of 10% extension recovery is not less than 50%.

[0023] The bulky yarn of the present invention includes a sheath yarn that has formed loops and a core yarn that substantially fixes the sheath yarn by being interlaced with the sheath yarn. In the present invention, the sheath yarn has continuously formed loops without any breakages.

[0024] The bulky yarn of the present invention is suitably made of synthetic fibers from the viewpoint of process passability during bulky processing and making use of the characteristics of the present invention in actual use. The term "synthetic fibers" as used herein refers to fibers made of high molecular weight polymers. Among high molecular weight polymers, melt-moldable thermoplastic polymers are suitably used in the present invention because the fibers used in the present invention can be manufactured in a highly productive melt spinning method.

[0025] Herein, examples of the thermoplastic polymers include melt-moldable polymers such as polyethylene terephthalate or a copolymer thereof, polyethylene naphthalate, polybutylene terephthalate, polytrimethylene terephthalate, polyolefins, polycarbonates, polyacrylates, polyamides, polylactic acids, and thermoplastic polyurethanes.

[0026] Among these thermoplastic polymers, polycondensation polymers typified by polyesters and polyamides are suitable because these polymers are crystalline polymers, have high melting points, and thus do not deteriorate or flatten even when they are heated at relatively high temperature in subsequent processes, a molding process, and actual use.

From the viewpoint of heat resistance, the melting point of the polymer is preferably not less than 165°C.

[0027] From the viewpoint of improving the lightweight properties of the bulky yarn of the present invention, it is more preferably that low density polypropylene, which is a polyolefin, be at least partially used. The molecular weight of polypropylene to be used is suitably high in order to provide, in addition to lightweight properties, anti-flattening properties against compression, and the melt flow rate (MFR), which is an index of the molecular weight of polypropylene, is preferably not greater than 20 g/10 min. The MFR herein is the amount of the resin extruded per 10 minutes measured according to the method described in JIS K 7210: 1999, and the MFR generally tends to decrease as the molecular weight of the resin increases. When the MFR of the polypropylene to be used falls within the above-mentioned range, the bulky yarn is less likely to be flattened by the compression and bending applied to the bulky yarn during use, and can sufficiently withstand the impact undergone during processing. Therefore, the bulky yarn has no problem in process passability. When polypropylene is used in at least a part of the bulky yarn of the present invention, polypropylene containing an antioxidant is particularly preferably used to prevent oxidation and heat generation in the case where the bulky yarn is used in clothing and the like.

[0028] The polymer used in the present invention can contain various additives such as inorganic substances such as titanium oxide, silica, and barium oxide, colorants such as carbon black, dyes, and pigments, flame retardants, fluorescent whitening agents, antioxidants, and ultraviolet absorbers.

[0029] The bulky yarn of the present invention, as illustrated in Fig. 1, includes a sheath yarn (reference sign 1 in Fig. 1) that has formed loops and a core yarn (reference sign 2 in Fig. 1) that substantially fixes the sheath yarn by being interlaced with the sheath yarn.

[0030] The core yarn herein means a filament present within not greater than 0.6 mm from a yarn surface (reference sign 3 in Fig. 2). The yarn surface means a straight line connecting a pair of yarn path guides (reference sign 4 in Fig. 2) when a fixed length of a textured yarn is threaded between the yarn path guides 4. The filament present within a distance not greater than 0.6 mm from the yarn surface (reference sign 5 in Fig. 2) is the core yarn of the present invention, and is a base point of loops. The filament protruding in a loop shape by not less than 3.0 mm from the surface of the yarn is a sheath yarn referred to herein, which is responsible for the bulkiness of the bulky yarn of the present invention. The present invention includes a core yarn that substantially fixes the sheath yarn that has formed loops. The term "substantially fix" as used herein means that the sheath yarn self-stands from the interlacing point between the sheath yarn and the core yarn. The self-standing state refers to a state in which the sheath yarn stands and forms loops in the outer layer direction of the bulky yarn from the interlacing point between the sheath yarn and the core yarn. The interlacing point with the core yarn, that is, the vicinity of the starting point of a loop, is often actually in a state in which filament bundles twine each other and are mixed with each other. Therefore, the point at which the sheath yarn that forms an apex of a loop in a distance of not less than 3.0 mm from the yarn surface intersects with a straight line positioned 0.6 mm from the yarn surface is defined as an interlacing point.

[0031] The interlacing point plays a role of supporting the self standing of the loop formed by the sheath yarn, which is a characteristic of the present invention. The interlacing points are preferably present at a moderate period. From this viewpoint, the number of interlacing points between the sheath yarn and the core yarn in the bulky yarn needs to be 1/mm to 30/mm. When the number falls within the above-mentioned range, the distance between loops is appropriate and thus the stretchability (extension recovery), which is an important element of the present invention, is not impaired. Further from this viewpoint, the number of interlacing points is more preferably in a range of 5/mm to 15/mm to play the

role of fixing the loop and exhibit good stretchability.

[0032] To determine the core yarn and the sheath yarn and continuously measure the number of loops per unit length in the fiber axis direction of the textured yarn, a photoelectric fluff detection device can be utilized. For example, the parts at 0.6 mm and 3.0 mm from the yarn surface are evaluated under the conditions of a yarn speed of 10 m/min and a traveling yarn tension of 0.1 cN/dtex using a photoelectric fluff measuring machine (TORAY FRAY COUNTER).

[0033] The sheath yarn that has loops of the present invention is substantially fixed by the core yarn and has a form protruding toward the outer layer in the cross section of the textured yarn.

[0034] The term "protrusion of a loop" as used herein corresponds to the distance from the surface of the yarn (reference sign 5 in Fig. 2). The distance is determined by two-dimensionally observing the textured yarn threaded in a fixed length on a pair of yarn path guides from one side of the textured yarn, and measuring the distance in the observed image. Ten randomly selected textured yarns are photographed so that the entire loops can be observed, and protrusions of loops at 10 points are photographed in each image. This operation is performed for a total of 10 images, and a total of 100 points are measured in units of millimeters up to the second decimal place. An average value of these numerical values is calculated, and a value obtained by rounding off the value to the first decimal place is taken as the loop size (protrusion) in the present invention.

[0035] According to the studies made by the present inventors, the loop preferably protrudes by a length in the range of not less than 3.0 mm and not greater than 100.0 mm from the surface of the yarn. When the protrusion length falls within the above-mentioned range, combined with the crimped structure of the sheath yarn, the bulkiness and the entanglement suppression effect, that is, the object of the present invention, can be achieved without problem. In consideration of processability of the bulky yarn described below, the protrusion length is more preferably not less than 3.0 mm and not greater than 70.0 mm. In consideration of repeated compression recovery deformation under harsh environments such as the environments of sports clothing, the protrusion length is more preferably not less than 5.0 mm and not greater than 60.0 mm.

[0036] Herein, the loop formed by the sheath yarn protrudes toward the outer layer from the interlacing point on the core yarn as the starting point, and the shape of the loop is preferably a kurunodaru shape (a teardrop shape) rather than an arched shape formed by general entanglement. In the case of the kurunodaru-shaped loop, the loop is substantially fixed at the interlacing point with the core yarn, and thus the loop formed by the sheath yarn returns to its original shape more easily after compressive deformation as compared to the arched loop. In the first place, the kurunodaru shape is preferable to achieve the bulkiness with resilience. The sheath yarn preferably has a three-dimensional crimped structure from the viewpoint of the suppression of entanglement between sheath yarns. It was also found that by adopting this structure, marked bulkiness can be exhibited due to the synergistic effect with the loop shape.

[0037] Meanwhile, the present inventors have found as a result of their investigation that when the loop formed by the sheath yarn is broken halfway or partially deteriorated, the above-mentioned effect tends to decrease. Therefore, it is important that the sheath yarn be not broken halfway in the loop from the viewpoint of simultaneously achieving contradictory properties, that is, bulkiness and suppression of entanglement, which cannot be provided by conventional techniques.

[0038] The breakage can be confirmed by observing 10 points randomly selected from a textured yarn at a magnification enabling the observation from the interlacing point between the core yarn and the sheath yarn to the next interlacing point (the entire loop). The state in which a sheath yarn has continuously formed loops without any breakages in the present invention means that the average of the breakages of a total of 100 sheath yarns obtained by the observation of 10 sheath yarns at 10 observation points is not greater than 0.2. When the average falls within the above-mentioned range, sheath yarns having free yarn ends are substantially not present, and sheath yarns can be present without being entangled with each other. In the case of subjecting a yarn to twisting and then an untwisting step, or intermingling and opening the yarn in a nozzle by strong air injection as in conventional methods, the traveling yarn may be slammed into the inside of the nozzle made of metal at high frequency to be broken or deteriorated. Further, when loops as in the present invention are to be formed, it is necessary to abrade the yarn between rubber discs to untwist the yarn, and thus the sheath yarn is broken or largely deteriorated. Therefore, the broken sheath yarn twines around other sheath yarns or the sheath yarns are tangled with each other to promote the fastener effect, resulting in constraining the structural form and high-order processing of the textured yarn. In the present invention, these problems are largely eliminated and the effect provided by the sheath yarn can be sufficiently exhibited.

[0039] The sheath yarn of the present invention preferably has a three-dimensional crimped structure. The three-dimensional crimped structure herein refers to a single yarn of a filament having a spiral structure as illustrated in Fig. 3. This three-dimensional crimp can be evaluated by picking up 10 or more single yarns at 10 points selected randomly from a textured yarn, and observing each single yarn at a magnification enabling the observation of the crimp form using a digital microscope or the like. In the image, if the single yarn observed has a spirally swirling form, the yarn is judged to have a three-dimensional crimped structure, and if the single yarn has a straight form, the yarn is judged not to have a crimped structure.

[0040] To make the present invention more effective, the curvature radius of the three-dimensional crimp of the sheath

yarn is suitably on the millimeter order (10^{-3} m) size rather than the micrometer order (10^{-6} m) size, which is a size exhibited by a latent crimped yarn obtained by common manufacturing methods such as conventional side-by-side conjugate fibers and hollow fibers. In the present invention, the bulkiness and resilience in the circumferential direction and cross-sectional direction of the textured yarn can be freely controlled by the size of the three-dimensional crimp, and naturally, by utilizing this resilience, the entanglement suppression of the sheath yarns, which is one of the objects of the invention, can also be realized. In particular, when the size of the crimp is on the millimeter order, the bulky yarn is excellent mainly from the viewpoint of the compatibility of bulkiness and compressibility of the sheath yarn, and in addition, the balance between the bulkiness and the suppression of entanglement.

[0041] In the present invention, the curvature radius of the spiral structure is preferably in the range of 2.0 mm to 30.0 mm. The curvature radius of the spiral structure herein is defined as the length corresponding to the radius of a perfect circle inscribed most frequently at two or more points in a curve (reference sign 6 in Fig. 3) formed by the fiber having the spiral structure in the image two-dimensionally observed with a digital microscope or the like by the same method as in the above-mentioned determination of the presence or absence of the three-dimensional crimp. Curvature radii of the total of 100 single yarns are measured to the second decimal place in units of millimeters by picking up 10 or more single yarns at 10 points randomly selected from the textured yarn, and observing each single yarn with a digital microscope or the like at a magnification enabling confirmation of the crimp shape. A simple average of these measured values is calculated, and a value obtained by rounding off the value to the first decimal place is taken as the curvature radius of the three-dimensional crimped structure of the present invention.

[0042] The curvature radius is more preferably 2.0 mm to 20.0 mm. When the curvature radius falls within this range, loops formed by the sheath yarn have crimps like a spring. Therefore, the sheath yarn comes in contact with the core yarn at points while having a moderate repulsion feeling against the compression in the cross-sectional direction of the bulky yarn, and the bulky yarn exhibits very comfortable bulkiness. Further, considering the balance with a loop having a high processability, which will be described later, the curvature radius is particularly preferably in the range of 3.0 mm to 15.0 mm so that the effect of the present invention is well exhibited. Within this range, the bulky yarn has no problem with long-term durability, and the effect of the present invention effectively works when the bulky yarn is applied to clothing to which repeated compression recovery is applied, especially sports clothing that is used under harsh environments.

[0043] What is necessary for the exhibition of this effect is not a two-dimensional bending that can be imparted by mechanical pushing or the like, but the three-dimensional shape and a spiral or similar structure possessed by the single yarn itself. Conventionally, these crimped forms are not applied to sheath yarns because the fastener phenomenon due to the entanglement of the yarns is relatively likely to occur. This is because the fibers mainly used are general latent crimped fibers having fine crimps on the micrometer order. In this case, the fine spiral structures mutually penetrate into each other, sometimes promoting the fastener effect.

[0044] Meanwhile, to achieve the suppression of entanglement between the textured yarns of the present application, the present inventors pushed forward the study focusing on the form of the original yarn. As a result, the present inventors discovered that, in particular, when three-dimensional crimps on the millimeter order are formed in a bulky yarn having loops, a phenomenon completely opposite to the conventional recognition occurs. Such a phenomenon is thought to be caused by the synergistic effect with the structure of loops formed by the sheath yarn because, due to three-dimensional crimps of the sheath yarn, bulky yarns have volumes to exclude each other and entanglement is largely suppressed even when bulky yarns are bundled. That is, the sheath yarn of the bulky yarn of the present invention has a movable space depending on the size of the loop. According to the definition of the present invention, the sheath yarn has a relatively large hemispherical movable space having a radius of not less than 2.0 mm around the fixing point of the loop. In this case, single yarns having a three-dimensional crimp with an overwhelmingly large size relative to the fiber diameter come into contact with each other at points and repel each other so that they can be present independently without entanglement. In a filament having three-dimensional crimps, in addition to the movable space described above, the single yarn itself can further extend like a spring in the fiber axis direction. Therefore, when single yarns cross each other, the crossed part can be easily unwound by vibration. This phenomenon is a phenomenon unique to the structural form, as in the bulky yarn of the present invention, in which a sheath yarn has loops formed several times to several tens of times of the conventional one. Furthermore, the three-dimensional crimp of the sheath yarn works effectively also from the viewpoint of bulkiness, which is the basic characteristic of the present invention. That is, the point contact between the sheath yarns described above produces an effect of repelling each other even within a single textured yarn, maintaining the state of being radially opened in the cross-sectional direction of the textured yarn over time in addition to the initial bulkiness. The conventional simple straight filament is difficult to achieve the behavior like a spring of the radially opened sheath yarn of the present invention. In addition, such a behavior is generated by mutual repulsion of the sheath yarns, and sheath yarns having three-dimensional crimps support each other, thereby achieving the significant suppression of flattening of the sheath yarn.

[0045] The morphological characteristics that the sheath yarn of the present invention has formed loops and a three-dimensional crimped structure can also be seen as a decrease in coefficient of friction. The decrease in coefficient of

friction is an effect provided by the point contact with others, as described above, and is one of the effects exhibited by the bulky yarn having the specific structure of the present invention. According to the investigation by the present inventors, the coefficient of static friction between fibers is preferably not greater than 0.3 in order to suppress entanglement between textured yarns while retaining bulkiness. The coefficient of static friction between fibers is herein measured by a radar type coefficient of friction tester in accordance with JIS L 1015 (2010). In the present invention, unless necessary, processing such as fiber opening is not performed, and the textured yarns is evaluated by arranged in parallel in a cylinder. The coefficient of static friction between fibers is suitably low, more preferably not greater than 0.2, and particularly preferably not greater than 0.1, because the texture is improved as the fiber slides and moves moderately when the bulky yarn of the present invention is processed into a fiber product and compressed.

[0046] The bulky yarn of the present invention has excellent bulkiness, and the yarn that constitutes the bulky yarn suitably has moderate resilience. This resilience can be regarded as the cross-sectional secondary moment of the fiber, and in consideration of the intended effect of the present invention, the single yarn fineness of the constituent synthetic fiber is preferably not less than 3.0 dtex. When used as filling, the bulky yarn is deformed due to repeated compression recovery and the like. Therefore, the constituent filaments preferably have moderate rigidity, and the single yarn fineness is more preferably not less than 6.0 dtex. The fineness herein refers to a value calculated from the obtained fiber diameter, number of filaments, and density, or a value obtained by calculating the weight per 10,000 m from a simple average value obtained by measuring the weight of a unit length of fibers a plurality of times. The substantial upper limit of the single yarn fineness in the present invention is 50.0 dtex.

[0047] The single yarn fineness ratio of the sheath yarn to the core yarn (sheath/core) is preferably in the range of 0.5 to 2.5 from the viewpoint of appealing a more excellent touch feeling with the bulky yarn of the present invention. When the ratio falls within the above-mentioned range, the sheath yarn and the core yarn have finenesses close to each other, and the bulky yarn can be used without foreign body sensation or the like when compressed. A range of the single yarn fineness ratio (sheath/core) enabling efficient bulky processing is 0.7 to 1.5. The above-mentioned range is more preferable in that the effect of the present invention becomes more remarkable. In the bulky yarn of the present invention, various fibers can be combined. However, from the viewpoint of the efficient fluid processing and no foreign body sensation at the time of compression as described above, the core yarn and the sheath yarn are suitably fibers having the same single yarn fineness and the same mechanical properties. Specifically, in the present invention, it is suitable to prepare two or more drums of fibers produced under the same yarn-making conditions and use them in the core yarn and the sheath yarn. In particular, it is preferable that these fibers be made from one kind of (single) resin.

[0048] From the viewpoint of lowering of the coefficient of friction and suppression of entanglement in such a textured yarn, it is preferable that the core yarn have a three-dimensional crimped structure in addition to the sheath yarn. This is because also in the core yarn, when the yarn is in a free state at the interlacing point of the core yarn that substantially fixes the sheath yarn, a space between filaments derived from the three-dimensional crimp of the core yarn is present, and in the case where such a textured yarn has almost no tension, the loop of the sheath yarn can be skidded in a limited space also in the fiber axis direction, and thus the movable space of the sheath yarn expands, making the effect of entanglement suppression and soft texture of the present invention more prominent. Meanwhile, when tension is applied to the textured yarn, the sheath yarn extends, thereby exhibiting an effect in practical use, such as increase of the binding force at the interlacing point, and prevention of the loosening of the loop and the falling off of the sheath yarn. The three-dimensional crimp of the core yarn can also be confirmed from the observation of the core yarn sampled randomly according to the three-dimensional crimp evaluation method of the sheath yarn described above.

[0049] The bulky textured yarn of the present invention needs to have an elastic modulus of not greater than 80 cN/dtex. Herein, the elastic modulus was calculated by obtaining a stress-strain curve of the textured yarn under the conditions shown in JIS L1013 (1999), linearly approximating the initial rising portion of the curve, and finding the slope of the line. This operation was performed on 5 samples for each level, and a simple average value of the obtained results was obtained, and rounded off to the first decimal place to obtain the elastic modulus.

[0050] This elastic modulus represents the rigidity at the time of extension deformation of the textured yarn. When this value is too high, the textured yarn does not flexibly extend and deform. Meanwhile, when the elastic modulus is not greater than 80 cN/dtex, the textured yarn can be flexibly deformed while having an appropriate resistance to the initial deformation force. Therefore, the textured yarn is excellent in movement following ability, which is an object of the present invention. For example, when a jacket is sewed with the yarn, it is naturally suitable to appropriately change the characteristics of the sample depending on to the site. In particular, with respect to the sites around the elbow and the knee that are often moved, the elastic modulus is preferably not greater than 65 cN/dtex. Regarding the site such as neck circumference or waist circumference in which rigidity can be an uncomfortable feeling of oppression, it is particularly preferable to set the elastic modulus to not greater than 55 cN/dtex. The substantial lower limit of the elastic modulus in the present invention is 10 cN/dtex.

[0051] To achieve the object of the present invention, it is an important requirement that the extension recovery rate at 10% extension of the textured yarn is not less than 50%. Herein, the extension recovery rate can be evaluated by a tensile tester used for evaluating the above-mentioned elastic modulus. That is, the textured yarn is extended by 10%

under conditions of a sample length of 20 cm and a tensile speed of 100%/min using a tensile tester, then left to stand for 1 minute, and recovered to the original sample length at the same speed. This operation is repeated 10 times, the stress-strain curve in this operation is recorded, and the length (S0) at 10% extension and the length (S1) at which the stress reaches 0 are obtained to obtain the extension recovery rate by the following formula. The same operation is performed on 5 samples for each level, and a simple average value of the obtained results is obtained, and rounded off to the nearest whole number to obtain the extension recovery rate.

$$\text{Extension recovery rate (\%)} = (S0 - S1) / S0 \times 100$$

[S0: length at 10% extension, S1: length at which the stress reaches 0]

[0052] The bulky yarn of the present invention can exert its effect to the full extent especially when it is applied to a part with high mobility. When the extension recovery rate is not less than 50%, elastic properties and anti-flattening properties at repeated extension recovery are excellent. The distortion applied repeatedly in the application of the bulky textured yarn of the present invention is not greater than 10%, and the textured yarn is suitably excellent in the extension recovery rate in such distortion. Further, from this viewpoint, the higher the extension recovery rate defined herein is, the closer it is to that of rubber elastic deformation, which means that the textured yarn having high extension recovery rate is a material showing excellent stretchability. The substantial upper limit in the present invention is 100%. When the bulky yarn of the present invention is used in general clothing applications such as underwear and outerwear or sleepwear such as bedclothes and pillows, the extension recovery rate is preferably not less than 55%. It is particularly preferable that the extension recovery rate be not less than 70% in sports clothing applications where the use situation is relatively harsh.

[0053] The bulky yarn of the present invention preferably has a breaking strength of 0.5 to 10.0 cN/dtex and a degree of extension of 5 to 700%. Herein, the strength is a value obtained by obtaining a load-extension curve of a textured yarn under the conditions shown in JIS L 1013 (1999), and dividing the load value at break by the initial fineness. The degree of extension is a value obtained by dividing the extension at break by the initial sample length. To satisfy the process passability in high-order processing processes and withstand practical use, the breaking strength of the bulky yarn of the present invention is preferably not less than 0.5 cN/dtex, and the practicable upper limit value is 10.0 cN/dtex. The degree of extension is preferably not less than 5%, and the practicable upper limit value is 700% in consideration of process passability in the post-processing process. The breaking strength and degree of extension can be adjusted by controlling the conditions in the manufacturing process according to the intended application. When the bulky yarn of the present invention is used in general clothing applications such as underwear and outerwear or sleepwear such as bedclothes and pillows, the breaking strength is preferably 0.5 to 4.0 cN/dtex. It is particularly preferable that the breaking strength be 1.0 to 6.0 cN/dtex in sports clothing applications where the use situation is relatively harsh.

[0054] The bulky yarn of the present invention has stretchability. As a result of intensive investigation to exhibit stretchability not achieved in the past, the present inventors have found that by adjusting the properties of the core yarn, comfortable stretchability is exhibited in the processed bulky textured yarn. As a requirement for exhibiting this stretchability, though stretchability is exhibited in principle when the core yarn is excellent in extension recovery, to achieve the object of the present invention, it is suitable to generate the interlacing point between the core yarn and the sheath yarn to such an extent that a loop is formed, which is an important requirement also from the viewpoint of prevention of flattening of the bulky textured yarn. As a result of intensive investigations from such a viewpoint, it was found that the fiber used for the core yarn of the present invention is preferably a side-by-side or eccentric core-in-sheath conjugate fiber, from the viewpoint that the opening properties of the textured yarn in the processing described later are good and the necessary interlacing points are formed.

[0055] As illustrated in Fig. 4 (4-1), the side-by-side conjugate fiber herein refers to a fiber having a structure in which an A polymer (reference sign 7 in Fig. 4) and a B polymer (reference sign 8 in Fig. 4) having different properties are bonded together in the fiber cross section in the direction perpendicular to the fiber axis. As shown in Fig. 4 (4-2), the eccentric core-in-sheath conjugate fiber refers to a fiber having a structure in which the A polymer (reference sign 7 in Fig. 4 (4-2)) is arranged on either the left or the right from the center of gravity and the B polymer (reference sign 8 in Fig. 4 (4-2)) is arranged so as to cover the A polymer in the fiber cross section perpendicular to the fiber axis.

[0056] Both of these fibers exhibit crimps according to the shrinkage difference between the A polymer and the B polymer as well as the fiber diameter. In accordance with the crimps, the stretchability of the present invention is exhibited. The crimps exhibited by the conjugate fiber are generally on the order of micrometers, thereby fixing points suitable for making loops self-stand are formed. It is suitable that in the original yarn stage, the yarn have a relatively flat fiber form, and the yarn exhibit fine crimps after processing for the durability of the bulky textured yarn and the traveling property and the like during processing. Among the conjugate fibers, side-by-side and eccentric core-in-sheath conjugate fibers of high viscosity polyethylene terephthalate/low viscosity polyethylene terephthalate and polybutylene terephthalate/pol-

yethylene terephthalate are more preferable.

[0057] The bulky yarn of the present invention can have high extension characteristics at low stress and exhibit anti-flattening properties, that is, high resilience utilizing the found principle. In this case, it is preferable to use an elastic yarn as the core yarn. Examples of the elastic yarn used for the core yarn include fibers containing as a main component at least polytrimethylene terephthalate, a polybutylene terephthalate copolymer and a thermoplastic polyurethane. In particular, from the viewpoint that a soft touch feeling can be obtained by minimizing the tightening feeling for wearing comfort in the case where a produce made from the yarn is worn in an extended state, the elastic yarn is more preferably a fiber made of a thermoplastic polyurethane or, considering handling properties, a polyester elastomer.

[0058] The characteristic of excellent extension characteristics at low stress can be evaluated by stress at 10% modulus. That is, the 10% modulus indicates the rigidity when 10% strain is applied to the fiber. When the value of the 10% modulus is lower, the fiber can be deformed flexibly from the beginning. Therefore, in the bulky yarn of the present invention, it is preferable that the 10% modulus be less than 1.5 cN/dtex as an index for flexible deformation.

[0059] The term "10% modulus" as used herein refers to the stress when 10% extension strain is applied, and is obtained by obtaining a stress-strain curve of a bulky yarn under conditions shown in JIS L 1013 (1999) and dividing the load at the time of applying 10% strain by the fineness of the core yarn. This operation is performed on 5 samples for each level, and a simple average value of the obtained results is obtained, and rounded off to the first decimal to obtain the 10% modulus.

[0060] When the 10% modulus is high, the bulky yarn is not flexibly extended and deformed. When the stress is less than 1.5 cN/dtex, the bulky yarn can be flexibly deformed from the beginning of deformation. Therefore, when the fiber is applied to clothes or the like, discomfort such as a feeling of oppression and a taut feeling on wear comfort is reduced, and particularly when the fiber is applied to a part of the elbow or the knee where a taut feeling is felt, very comfortable wear comfort is provided. From the viewpoint of extensibility at low stress, it is suitable that the stress required for extension deformation be low, and the 10% modulus is more preferably less than 1.0 cN/dtex, further preferably less than 0.5 cN/dtex. The substantial lower limit of the 10% modulus in the present invention is 0.1 cN/dtex.

[0061] In view of the object of the present invention, for example, when a jacket or the like is designed, it is suitable to change the characteristics of the bulky yarn depending on the site. In conventional techniques, the characteristics are changed merely by adjusting the filling amount or the like. In this case, it is impossible to achieve a packing property and a fitting property for enhancing the heat retention effect while suppressing an unpleasant feeling of oppression caused by stress of extension of the material especially at around the neck, cuffs and elbow. Meanwhile, in the bulky yarn of the present invention, such characteristics can be adjusted by appropriately changing the characteristics of the core yarn. It is possible to manufacture a bulky yarn having extensibility suitable for each site by the manufacturing method described later, and it is possible to sew comfortable products by utilizing the bulky yarn.

[0062] To enhance the extensibility at low stress, it is preferable that the fiber extension ratio at load application be not less than 1.1, and the fiber length restoration rate be 80 to 100%.

[0063] The fiber extension ratio at load application herein can be obtained by applying a predetermined load to a sample taken at a specific length to extend the sample, and calculating the change in the sample length before and after load application extension. That is, 5 m of a bulky yarn is taken using a 1 m/circumference skein, and the taken yarn is hung with one end of the skein hooked. Then, an initial load per sample fineness of 0.03 cN/dtex is applied to the sample to measure the original length (L0) before load application extension. Subsequently, the initial load is removed, and the sample is left to stand for 1 minute with an extension load per sample fineness of 1.5 cN/dtex being applied. Then, the sample length (L1) at load application extension is measured, and the fiber extension ratio at load application is calculated using the formula below. The same operation is performed on 5 samples for each level, and a simple average value of the obtained results is obtained, and rounded off to the first decimal place to obtain the ratio.

$$\text{Extension ratio at load application} = L1/L0$$

[L0: original length before load application extension (cm), L1: length at load application extension (cm)]

[0064] Subsequent to the measurement of the extension ratio at load application, the extension load is removed, and the sample length (L2) after the load application extension with the above-mentioned initial load being applied is measured. Then, the fiber length restoration rate after load application extension is calculated by the following formula. The same operation is performed on 5 samples for each level, and a simple average value of the obtained results is obtained, and rounded off to the nearest whole number to obtain the fiber length restoration rate.

Fiber length restoration rate (%) after load

$$\text{application extension} = (L1 - L2) / (L1 - L0) \times 100$$

[L0: original length before load application extension (cm), L1: length at load application extension (cm), L2: length after load application extension (cm)]

[0065] When the extension ratio at load application is not less than 1.1, the textured yarn can be highly extended. When the fiber length restoration rate is not less than 80%, the textured yarn has excellent shape recoverability after stretching, that is, anti-flattening properties. That is, the higher the extension ratio at load application and the fiber length restoration rate, the closer the deformation of the bulky yarn to the rubber elastic deformation. Thus, a bulky yarn having a high extension ratio at load application and a high fiber length restoration rate is suitable for applications in which relatively high extension deformation and repeated extension recovery are repeated. Therefore, for example, when a textured yarn having the characteristics in the above-mentioned range is used in clothing, the yarn is suitably used in a site where repeated extension recovery is applied, such as the elbow or the knee. In such a case, stress due to tension and the like is not felt and the deformation almost completely recovers, and thus the shape of the clothing is not lost. Furthermore, when the yarn is combined with an outer fabric having stretchability, clothing fitted to the body can be tailored. In this case, a high degree of heat retaining properties due to adherence can be secured, and at the same time, the clothing flexibly deforms in conformity with the individual's body constitution, so that various people can wear the clothing of one size and sewing pattern comfortably.

[0066] When the bulky yarn of the present invention is used for applications in which the tightening feeling needs to be minimized and a soft touch feeling is appealed, including general clothing applications such as underwear and outerwear, nightclothes, clothing for the injured, and clothing for pregnant women, the extension ratio at load application is more preferably not less than 1.5, further preferably not less than 2.0. When the yarn is used as a material excellent in shape recoverability such as a material that recovers to its original form even after being compactly stored, the fiber length restoration rate after load application is more preferably not less than 90%, further preferably not less than 95%.

[0067] In these extension characteristics, the upper limit of the extension is the extension at which the sheath yarn of the bulky yarn is fully extended. Thus, the substantial upper limit of the extension ratio at load application in the present invention is 20.0.

[0068] The fiber used in the present invention is preferably a hollow cross-section fiber. The hollow cross-section fiber is suitable from the viewpoint that, as an advantage of the manufacturing method described later, the three-dimensional crimp size on the millimeter order, which is a preferable form of the sheath yarn, can be controlled relatively freely from a large size to a small size, as well as the viewpoint of the self standing of the loop. That is, in the bulky yarn of the present invention, the self standing of the loop formed by the sheath yarn is responsible for the bulkiness. Self standing of the sheath yarn is achieved by the interlacing point with the core yarn and the rigidity of the sheath yarn. However, considering the anti-flattening properties, it is preferable that the sheath yarn itself be also lightweight. Therefore, specifically, it is suitable that the density (weight per unit volume) of the sheath yarn be lower, and a fiber having a hollow cross section is preferably used. From the viewpoint of the lightweight properties of the sheath yarn, hollow cross-section fibers having a hollow rate of not less than 20% are more preferable. The hollow rate herein is measured in the following manner. A hollow cross-section fiber is cut and then the cut surface is photographed two-dimensionally with an electron microscope (SEM) at a magnification enabling observation of 10 or more fibers. Ten fibers randomly selected from the photographed image are picked up, and the area of the fibers and the hollow portions is measured using image processing software, and the hollow rate is obtained as the area rate. All of the above-mentioned values were measured for 10 images and the average value of 10 images was taken as the hollow rate of the hollow cross-section fiber of the present invention. To easily obtain the hollow rate, the side surface of the fiber is observed with a microscope or the like, and the fiber diameter in terms of round cross section is measured from the image. It is also possible to obtain the hollow rate by calculating the rate of the actually measured fineness (actually measured weight) in the fineness in terms of a solid fiber (converted weight) from the fiber diameter.

[0069] From the viewpoint of lightweight and heat retaining properties, which is an object of the present invention, the bulky yarn preferably has a larger air layer, and the hollow rate is particularly preferably not less than 30%. Within the above-mentioned range, improved lightweight properties can be achieved when a bundle of the textured yarn is held, and the textured yarn is excellent in heat retaining properties because the textured yarn has an air layer having a lower thermal conductivity. The substantial upper limit of the hollow rate in the present invention is 50%.

[0070] The sheath yarn of the bulky yarn of the present invention preferably has a density of less than 1.00 g/cm³. The density of the sheath yarn herein refers to the weight per unit volume of the sheath yarn, which is measured using a density gradient tube by the method according to JIS L 1013: 2010. When the density of the sheath yarn falls within the above-mentioned range, a product having lightweight properties and high comfortability in use is provided when the yarn is used as wadding for clothing and bedding. From the viewpoint of increasing the lightweight properties of the

bulky yarn, the density of the sheath yarn is more preferably not greater than 0.95 g/cm^3 , still more preferably not greater than 0.90 g/cm^3 .

[0071] To provide an unprecedented bulky yarn having lightweight properties, mechanical properties, and a repulsion feeling, the fiber used for the sheath yarn is preferably an islands-in-sea conjugate fiber having a hollow cross section.

The islands-in-sea conjugate fiber herein refers to a conjugate fiber having a cross-sectional structure in which an island component made of a certain polymer is scattered in a sea component made of another polymer. An example of the islands-in-sea conjugate fiber having this hollow cross section is a donut-shaped islands-in-sea conjugate fiber having a hollow portion (9) in the center of the fiber cross section and an island component (10) scattered in a sea component (11), as shown in Fig. 5.

[0072] As described above, due to the air contained in the hollow portion at the center of the cross section of the fiber, in addition to the lightweight properties, the heat insulating effect is obtained by the air layer contained in the hollow portion, thereby heat retaining properties are obtained. Furthermore, in the sea-island structure around the hollow portion, the island component scattered in the sea component disperses the impact such as compression and bending on the bulky yarn. Thus, the sea-island structure reinforces while maintains the flexibility of the sheath yarn, greatly suppresses the flattening, which sometimes causes a problem in a fiber having a high hollow rate, and makes the bulky yarn highly resilient.

[0073] Combinations of polymers used for the island component and the sea component of the islands-in-sea conjugate fiber can be appropriately selected and used from the above-mentioned polymer group. However, among them, it is preferable that the island component be a polyolefin, and the sea component be a polyester from the viewpoint of promoting the weight reduction of the bulky yarn and achieving physical properties that provide sufficient durability for the use as a fiber product. Polyolefins have low density, and thus when they are used for an island component, islands-in-sea conjugate fibers are lightweight. When a polyester is used as a sea component, physical properties such as the degree of strength and extension of the islands-in-sea conjugate fiber become suitable for a fiber product, and the sea component which is a matrix of the islands-in-sea conjugate fiber has crystallinity. Therefore, the yarn becomes resistant to deterioration and flattening in processing and use. In this case, the conjugate ratio of the island/sea is preferably 50/50 to 10/90 from the viewpoint of providing the islands-in-sea conjugate fiber with sufficient characteristics for the use as a fiber product. The conjugate ratio of the island/sea is more preferably 50/50 to 20/80, further preferably 50/50 to 30/70 from the viewpoint of further increasing the proportion of the low density polyolefin of the island component to improve the lightweight properties of the islands-in-sea conjugate fiber.

[0074] The bulky yarn of the present invention can be used in various fiber structures and various fiber products such as fiber winding packages, tows, cut fibers, batting, fiber balls, cords, piles, and woven and nonwoven fabrics. Herein, the fiber products can be used in livingware applications such as general clothing, sports clothing, clothing materials, interior products such as carpets, sofas and curtains, vehicle interior decorations such as car seats, cosmetics, cosmetic masks, wiping cloths, health supplies, as well as environmental/industrial material application such as filters and hazardous substance removal products. In particular, the bulky yarn of the present invention is suitably utilized as a filling material because of the bulkiness and the entanglement suppression effect. In this case, the bulky yarn is preferably used as yarn bundles having several to several tens of fibers or a sheet-shaped material such as a nonwoven fabric because the yarn is filled into an outer fabric. Particularly when the yarn is made into a sheet, the yarn is easily filled into an outer fabric, and it is easy to adjust the filling amount according to the application. Therefore, a thin, lightweight and heat-retentive material is provided, and moreover, there is no worry that the material gets out of the outer fabric, and sewing is unnecessary. Thus, there is no restriction on the form of the fiber product, and a complicated design and the like become possible.

[0075] An example of the method for manufacturing the bulky yarn of the present invention will be described in detail below.

[0076] As the core yarn and the sheath yarn used in the present invention, a synthetic fiber obtained by fiberizing a thermoplastic polymer by a melt spinning method may be used.

[0077] The spinning temperature at the time of spinning the synthetic fiber used in the present invention is a temperature at which the polymer used exhibits fluidity. The temperature at which the fluidity is exhibited varies depending on the molecular weight, but the melting point of the polymer serves as a rough indication, and the spinning temperature may be set at a temperature not greater than the melting point + 60°C . A temperature in the above-mentioned range is preferable because the polymer does not undergo thermal decomposition or the like in the spinning head or the spinning pack, and the molecular weight reduction is suppressed. A range of discharge amount allowing stable discharge is 0.1 g/min/hole to 20.0 g/min/hole per discharge hole. In this case, it is preferable to consider the pressure loss in the discharge hole that can ensure discharge stability. The pressure loss herein is preferably determined in the range of 0.1 MPa to 40 MPa as an index based on the relationship among the melt viscosity of the polymer, the discharge hole diameter and the discharge hole length.

[0078] The molten polymer discharged in this way is cooled and solidified, and is taken up by a roller whose peripheral speed is regulated after application of an oil agent to become a synthetic fiber. This take-up speed may be determined

from the discharge amount and the intended fiber diameter, but in order to stably produce a synthetic fiber, it is preferable to set the take-up speed in the range of 100 to 7000 m/min. From the viewpoint of improving the orientation of the synthetic fiber and improving the mechanical properties, the synthetic fiber may be drawn after being wound up, or may be drawn without being wound up. As the drawing conditions, for example, in a drawing machine having one or more pairs of rollers, as long as a fiber made of a polymer generally showing synthetic fibers capable of melt spinning is used, the fiber is naturally stretched in the fiber axis direction, thermally set, and wound up due to the peripheral speed ratio between the first roller set to a temperature not less than the glass transition temperature and not greater than the melting point and the second roller at a temperature equivalent to the crystallization temperature. In the case of a polymer showing no glass transition, the dynamic viscoelasticity measurement ($\tan \delta$) of the conjugate fiber is carried out, and a temperature not less than the temperature of the peak on the high temperature side of the obtained $\tan \delta$ is selected as the preheating temperature. From the viewpoint of increasing the draw ratio and improving the mechanical properties, it is also a suitable means to apply this drawing step in multiple stages.

[0079] The cross-sectional shape of the synthetic fiber of the present invention is not particularly limited, and by changing the shape of the discharge hole in the spinneret, it is possible to obtain a general round cross section, a triangular cross section, a Y shape, an octagonal shape, a flat shape, and amorphous shapes such as a diverse shape and a hollow shape. The fiber may be made of a single polymer, or may be a conjugate fiber made of two or more kinds of polymers. However, from the viewpoint of exhibiting the three-dimensional crimp of the sheath yarn, which is an important requirement of the present invention, it is preferable to use a hollow cross-section fiber or a side-by-side conjugate fiber in which two types of polymers are bonded together. That is, these fibers exhibit a three-dimensional crimp due to a structural difference in the cross-sectional direction by the heat treatment after yarn making and yarn processing. Therefore, although it is a so-called straight fiber at the time of fluid processing to be described later, a three-dimensional crimp is exhibited by the application of heat treatment after the loop forming step with a sheath yarn. If the fibers are straight at the time of bulky processing, the yarns easily stably travel without causing clogging of a nozzle or the like with the yarn. Furthermore, also in forming the loop of the present invention, the core yarn and the sheath yarn are efficiently swirled, and the loop is formed very uniformly in the fiber axis direction of the textured yarn. By subjecting the textured yarn with loops formed in the outer layer to heat treatment at the crystallization temperature of the polymer as an index, the sheath yarn exhibits a three-dimensional crimp and the bulky yarn of the present invention is provided.

[0080] The three-dimensional crimp of the sheath yarn provides good bulkiness both in the circumferential direction and in the cross-sectional direction of the textured yarn, and is suitably appropriately controlled depending on the required characteristics. From the viewpoint of control of crimp exhibition after the heat treatment, the fiber used in the present invention is more preferably a hollow cross-section fiber. The hollow cross-section fiber has an air layer having a low thermal conductivity at the center of the fiber. Therefore, for example, a fiber material is discharged from a spinneret capable of forming a hollow cross section, and then one side of the material is forcibly cooled with excessive cooling air or the like, or one side of the material is excessively heat-treated with a heating roller or the like at the time of drawing, thereby the difference in structure is generated in the cross-sectional direction of the fiber. In the case of a hollow cross-section fiber, yarn making can be performed by a single spinning machine, and in addition, the size of the three-dimensional crimp can be relatively freely controlled from a large size to a small size by the above-described operation. Therefore, the hollow cross-section fiber is suitably used in the present invention, and from the viewpoint of crimp control by the above-described operation, a hollow cross-section fiber having a hollow rate of not less than 20% is more preferable, and a hollow cross-section fiber having a hollow rate of not less than 30% is particularly preferable.

[0081] In the bulky yarn of the present invention, as a first step, prescribed amounts of core yarn (reference sign 20 in Fig. 6) and sheath yarn (reference sign 21 in Fig. 6) that are described above are supplied by supply rollers (reference sign 19 in Fig. 6) having a nip roller or the like, and the core yarn and the sheath yarn are sucked by means of a suction nozzle (reference sign 12 in Fig. 6) capable of injecting compressed air.

[0082] In the suction nozzle (reference sign 12 in Fig. 6), the flow rate of the compressed air injected from the nozzle may be a flow rate at which the yarn inserted into the nozzle from the supply rollers has the necessary minimum tension and stably travels without yarn swaying or the like between the supply rollers and the nozzle and within the nozzle. Although the optimum amount of the flow rate of the compressed air changes depending on the hole diameter of the suction nozzle used, the airflow rate in the nozzle is not less than 100 m/s as an index of a range in which yarn tension can be provided and a loop to be described later can be smoothly formed. An approximate upper limit of the airflow rate is not greater than 700 m/s. Within this range, the traveling yarn will stably travel within the nozzle without yarn swaying or the like caused by excessively injected compressed air.

[0083] Further, from the viewpoint of preventing intermingling and opening in the nozzle and the viewpoint of uniformly forming loops by a sheath yarn with high productivity, it is preferable that a jet angle (reference sign 22 in Fig. 7) of the compressed air be an angle of a propulsive jet flow that is jetted at an angle less than 60° with respect to the traveling yarn. Naturally, it is not impossible to manufacture the bulky yarn of the present invention by processing with a vertical jet flow which injects a fluid at an angle of 90° to the traveling yarn. However, processing with a propulsive jet flow is preferable from the viewpoint of opening the traveling yarn by jet flow from the vertical direction and suppressing entan-

gument of single yarns in a narrow space inside the nozzle. Due to the propulsive jet flow processing, the formation of arch-shaped small loops which are easily formed at a short period in the case of the vertical jet flow can also be suppressed.

[0084] To form the loops formed by sheath yarns required for the bulky yarn of the present invention, it is suitable that intermingling or opening in the suction nozzle do not occur. From the viewpoint of making a multifilament composed of several to several tens of yarns travel without opening the fibers in the nozzle, it is more preferable that the jet angle of the compressed air be not greater than 45° with respect to the traveling yarn. Furthermore, to form a loop outside the nozzle to be described later, it is suitable that stability and propulsive force of the jet air stream immediately after the nozzle be high. From this viewpoint, the jet angle is particularly preferably not greater than 20° with respect to the traveling yarn.

[0085] Next, as a second step of the present invention, the yarn sucked by the suction nozzle is swirled outside the nozzle to form a loop of the sheath yarn.

[0086] The yarn may be introduced into the suction nozzle in one feed or in two feeds, however, to manufacture the bulky yarn of the present invention, it is suitable to perform processing in two feeds. The term "two-feeds" as used herein means a method in which two or more yarns are supplied into the nozzle at different feed rates (amounts) preliminarily given by a supply roller or the like. In the method, utilizing a turning force by an airflow described later, an excessively supplied yarn (sheath yarn) forms a bulky structure in which a loop is formed in an outer layer. When utilizing this two feeds, it is possible to manufacture a textured yarn having a loop using an interlace processing nozzle or a Taslan processing nozzle that imparts intermingling, opening and entangling effects to the traveling yarn inside the nozzle. However, the yarns processed with these processing nozzles have loops formed at a short period, and in addition, reduced size. Therefore, to manufacture the bulky yarn that satisfies the object of the present invention, many parameters have to be finely controlled, and this is very difficult. There is a possibility that the bulkiness of the textured yarn will be different by the spindle when multi-spindle spinning is carried out, and thus, it is suitable to use a method that utilizes airflow control outside the nozzle as described later from the viewpoint of stability of quality. Regarding this point, the present inventors got an idea of a concept that a loop can be formed by turning two yarns supplied at a position distant from the nozzle without giving any intermingling or opening treatment in the nozzle. As a result of intensive studies from the viewpoint of controlling the airflow injected from the nozzle, the present inventors found a specific phenomenon that the sheath yarn turns while opening when the ratio of the airflow rate to the yarn velocity (airflow rate/yarn velocity) is from 100 to 3000.

[0087] The airflow rate referred to herein is the speed of the airflow injected from the downstream of the suction nozzle accompanying the traveling yarn, and can be controlled by the discharge diameter of the nozzle and the flow rate of the compressed air. The yarn speed can be controlled by the circulating speed of the roller which picks up the textured yarn after the fluid processing nozzle. The turning force of the traveling yarn increases and decreases depending on the speed ratio of the airflow to the yarn. Therefore, in the case of strengthening the interlacing point of the intended bulky yarn, the speed ratio should be approximated to 3000, and conversely in the case of making the interlacing point loose, the speed ratio should be approximated to 100. For the speed ratio, for example, it is also possible to change the interlacing degree of the interlacing point by changing the flow rate of the compressed air intermittently or by changing the speed of the take-up roller. Meanwhile, when the bulky yarn of the present invention is used for applications in which repeated compression recovery deformation such as in filling is imparted, it is preferable to set the airflow rate/yarn speed in the range of 200 to 2000. In particular, in the case of manufacturing a textured yarn used for clothing such as a jacket to which deformation is frequently applied, from the viewpoint of imparting moderate binding and flexibility, it is particularly preferable to set the airflow rate/yarn speed in the range of 400 to 1500.

[0088] A turning point (reference sign 13 in Fig. 6), which is the base point at which the turning force is generated, is a point at which the traveling yarn is separated from the accompanying airflow. Specifically, the turning point is made by just changing the yarn path with a bar guide or the like. The sheath yarn turns around the core yarn to form a loop when the traveling yarn is taken up at a specified speed by a take-up roller (reference sign 15 in Fig. 6) in the traveling direction of the traveling yarn. From the viewpoint of loosening the sheath yarn by the vibration of the sheath yarn based on the space for turning and the diffusion of the airflow injected from the nozzle, it is suitable that the turning point of the traveling yarn be located away from the nozzle discharge port. However, the distance between the nozzle and the turning point suitable for manufacturing the bulky yarn of the present invention varies depending on the rate of the ejected air, and it is preferable that the turning point (reference sign 13 in Fig. 6) be present during a period in which the ejected airflow travels for 1.0×10^{-5} seconds to 1.0×10^{-3} seconds. To form an interlacing point between the core yarn and the sheath yarn at an appropriate period keeping the balance with the diffusion of the airflow, the distance between the nozzle and the turning point is preferably a distance at which the ejected airflow travels for 2.0×10^{-5} seconds to 5.0×10^{-4} seconds.

[0089] By adjusting the turning point, it is also possible to control the period of the interlacing points of the bulky yarn of the present invention. The interlacing points play a role of supporting the self standing of the loop formed by the sheath yarn, which is a characteristic of the present invention, and are suitably present at a certain period. From this viewpoint, it is preferable to adjust the turning point so that 1/mm to 30/mm of the interlacing points of the core yarn and the sheath

yarn are present in the bulky yarn. Within the above-mentioned range, it is preferable because even after the three-dimensional crimp of the sheath yarn is exhibited, the loops are present at a moderate interval. Further from this viewpoint, it is more preferable to adjust the turning point so that 5/mm to 15/mm of interlacing points are present.

[0090] A textured yarn (reference sign 14 in Fig. 6) having the loops formed by the sheath yarn is preferably subjected to heat treatment to fix the shape and exhibit the three-dimensional crimp after once wound up or following bulky processing. In Fig. 6, a processing step of performing heat treatment subsequently to the loop forming step is exemplified.

[0091] The heat treatment (16 in Fig. 6) is performed by heating a textured yarn with a heater or the like, and the processing temperature is the crystallization temperature of the polymer used $\pm 30^{\circ}\text{C}$ as an index. In the case of the treatment in this temperature range, since the treatment temperature is far from the melting point of the polymer, a fused and cured part between the sheath yarns or the core yarns is not generated. Thus, there is no foreign body sensation, and the good touch feeling of the bulky yarn of the present invention is not impaired. A general contact type or non-contact type heater can be employed as a heater used in the heat treatment step, but a non-contact type heater is suitably employed from the viewpoint of bulkiness before heat treatment and suppression of deterioration of the sheath yarn. The non-contact type heater herein is an air heating type heater such as a slit type heater or a tube type heater, a steam heater for heating with high temperature steam, and a halogen heater, a carbon heater, and a microwave heater in which radiant heating is used.

[0092] From the viewpoint of heating efficiency, a heater utilizing radiant heating is preferable. The index of the heating time is, for example, the time when the fiber structure of the fibers that constitute the textured yarn is fixed after the crystallization, or the shape of the textured yarn is fixed and crimp exhibition of the sheath yarn is completed, and is suitably adjusted according to the intended characteristics at the treatment temperature and the treatment time. The speed of the textured yarn that has undergone the heat treatment step is restricted by a delivery roller (reference sign 17 in Fig. 6) and wound with a winder or the like equipped with a tension control function (reference sign 18 in Fig. 6). Regarding the winding shape, there is no particular limitation and it is possible to employ so-called cheese winding or bobbin winding. In consideration of processing into the final product, it is also possible to preliminarily consolidate a plurality of pieces to make a tow, or to form the textured yarn into a sheet as it is.

[0093] It is preferable that a silicone oil agent be uniformly attached to the bulky yarn of the present invention before and after the heat treatment step. It is advisable to form a silicone film on the sheath yarn and the core yarn by moderately crosslinking the silicone to be attached by heat treatment or the like. Examples of the silicone oil agent referred to herein include dimethylpolysiloxane, hydrodienemethylpolysiloxane, aminopolysiloxane, and epoxypolysiloxane, and these may be used alone or in combination. From the viewpoint of uniformly forming a film on the bulky yarn, a dispersant, a viscosity modifier, a crosslinking accelerator, an antioxidant, a fire retardant, and an antistatic agent can be incorporated within a range not impairing the purpose of silicone attachment. Although the silicone oil agent may be straight or used as an aqueous emulsion, it is suitable to use the silicone oil agent as an aqueous emulsion from the viewpoint of uniform attachment of the oil agent. It is suitable that the silicone oil agent be treated so that 0.1 to 5.0 wt% of the silicone oil agent can be attached to the bulky yarn in mass ratio by using an oil agent guide, an oiling roller, or a spray. After that, it is preferable to dry the silicone oil agent at an arbitrary temperature and an arbitrary time to cause a crosslinking reaction. The silicone oil agent can be attached in a plurality of separate portions, and it is also suitable to laminate a strong silicone film by separately attaching the same kind of silicone or different kinds of silicone in separate portions. By forming the silicone film on the bulky yarn by the above-mentioned treatment, the slipperiness and the touch feeling of the bulky yarn are improved, and the effect of the present invention can be further enhanced.

EXAMPLES

[0094] Hereinafter, the bulky yarn of the present invention will be specifically described with reference to examples.

[0095] For the examples and comparative examples, the following evaluations were made.

A. Fineness

[0096] Fineness was calculated by measuring the weight of 100 m of a fiber and multiplying the weight by 100. This calculation was repeated 10 times, and the value obtained by rounding off the simple average of the 10 calculation results to the first decimal place was taken as the fineness of the fiber. The single yarn fineness was calculated by dividing the above-mentioned fineness by the number of filaments that constitute the fiber. Also in this case, the value obtained by rounding off the value to the first decimal place was taken as the single yarn fineness.

B. Mechanical properties (strength, elastic modulus, and 10% modulus) of fiber

[0097] Using a tensile tester Tensilon model UCT-100 manufactured by Orientec Co., Ltd., a stress-strain curve of a fiber was obtained under conditions of a sample length of 20 cm and a tensile speed of 100%/min. The load at breakage

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was read and the load was divided by the initial fineness to calculate the strength. The elastic modulus was determined from the slope of the initial rising portion of the stress-strain curve by linear approximation. The 10% modulus was calculated by reading a load of 10% strain and dividing the value by the initial fineness. All the values were obtained by performing the same operation on 5 samples for each level, obtaining a simple average value of the obtained results, and rounding off the simple average value to the nearest whole number for the strength and the elastic modulus, and to the first decimal place for the 10% modulus.

C. Extension recovery rate of fiber at 10% extension

[0098] Using a tensile tester Tensilon model UCT-100 manufactured by Orientec Co., Ltd., a fiber was extended by 10% under conditions of a sample length of 20 cm and a tensile speed of 100%/min, then left to stand for 1 minute, and recovered to the original sample length at the same speed. This operation was repeated 10 times, the stress-strain curve at this time was recorded, and the length (S0) at 10% extension and the length (S1) at which the stress reached 0 were obtained to obtain the extension recovery rate by the following formula. The same operation was performed on 5 samples for each level, and a simple average value of the obtained results was obtained, and rounded off to the nearest whole number to obtain the extension recovery rate.

$$\text{Extension recovery rate (\%)} = (S0 - S1) / S0 \times 100$$

[S0: length at 10% extension, S1: length at which the stress reached 0]

D. Fiber extension ratio at load application and fiber length restoration rate

[0099] On a 1 m/circumference skein, 5 m of a fiber was taken, and the taken fiber was hung with one end of the skein hooked. Then, an initial load of 0.03 cN/dtex was hung from the skein to measure the original length (L0). Subsequently, the initial load was removed, a load of 1.5 cN/dtex was hung, and the sample was left to stand for 1 minute. Then, the sample length (L1) at load application extension was measured, and the fiber extension ratio at load application was calculated using the formula below. The extension ratio at load application was obtained by performing the same operation on 5 samples for each level, obtaining a simple average value of the obtained results, and rounding off the simple average value to the first decimal place.

$$\text{Extension ratio at load application} = L1 / L0$$

[L0: original length before load application extension (cm), L1: length at load application extension (cm)]

[0100] Following the measurement of the extension ratio at load application, the applied extension load was removed, then, a load of 0.03 cN/dtex same as the initial load was hung from the skein, and the sample length (L2) after the load application was measured to obtain the fiber length restoration rate by the following formula. Also in this case, the fiber length restoration rate was obtained by performing the same operation on 5 samples for each level, obtaining a simple average value of the obtained results, and rounding off the simple average value to the nearest whole number.

$$\text{Fiber length restoration rate (\%)} \text{ after load}$$

$$\text{application extension} = (L1 - L2) / (L1 - L0) \times 100$$

[L0: original length before load application extension (cm), L1: length at load application extension (cm), L2: length after load application extension (cm)]

E. Density

[0101] The density of the fiber was measured according to JIS L 1013: 2010 using a density gradient tube. After the sample reached the equilibrium position in the liquid and stopped, the sedimentation depth of the sample was read from the scale of the density gradient tube to 1 mm, and the value was compared with the correction curve to obtain the density. The density was obtained by performing this operation twice for each level, obtaining a simple average value of the obtained results, and rounding off the simple average value to the second decimal place.

F. Evaluation of loop (size, number, and breakage)

[0102] A load of 0.01 cN/dtex was applied so that slack does not occur in the textured yarn, and a fixed length of the textured yarn was placed on a pair of yarn path guides as shown in Fig. 2. The side of the placed textured yarn was photographed at a magnification enabling observation of the entire loop with Microscope VHX-2000 manufactured by Keyence Corporation. The distances (reference sign 5 in Fig. 2) from the surface of the yarn to the tip of the loop were measured using image processing software (WINROOF) at 10 randomly selected positions in the obtained image. This procedure was performed for a total of 10 images, and a total of 100 points were measured in units of millimeters up to the first decimal place. An average value of these numerical values was calculated, and a value obtained by rounding off the value to the first decimal place was taken as the loop size (protrusion) in the present invention.

[0103] For the same 10 images, the tips of the loops and the breaking points of the sheath yarn per unit distance were counted, and the number of loops and breaking points per millimeter were calculated. The same operation was performed for the 10 images, and the value obtained by rounding off the average value to the nearest whole number was taken as the number of loops. Regarding the breaking points of the loops, the counted breaking points of the loops were averaged and rounded off to the first decimal place to obtain the breaking points of the loops. A sample having less than 0.2 breaking points/mm was regarded as a sample in which the loops of the present invention are continuously present and evaluated as a sample having no breaking points (evaluation: A), and a sample having not less than 0.2 breaking points/mm was evaluated as a sample having breakages (evaluation: C).

G. Crimp form evaluation (three-dimensional crimp and curvature radius)

[0104] At each of 10 points randomly selected from the textured yarn, 10 or more single yarns were sampled, and each single yarn was observed with Microscope VHX-2000 manufactured by Keyence Corporation at a magnification enabling confirmation of the crimp form. In the image, if the observed single yarn had a spirally swirling form, the yarn was judged to have a three-dimensional crimped structure (evaluation: A), and if the single yarn had a straight form, the yarn was judged not to have a crimped structure (evaluation: C). From the same image, the radius of the perfect circle inscribed most frequently at two or more points in the curve (reference sign 6 in Fig. 3) of crimped fibers was determined using image processing software (WINROOF). A total of 100 single yarns randomly extracted as described above were measured up to the second decimal place in units of millimeters, and the value obtained by rounding off the simple average to the first decimal place was defined as the curvature radius of the three-dimensional crimped structure of the present invention.

H. Coefficient of static friction between fibers

[0105] The coefficient of static friction between fibers was measured by a radar type coefficient of friction tester according to JIS L 1015 (2010). The coefficient of static friction between fibers was herein determined by arranging the textured yarns in parallel in a cylinder.

I. Unwinding properties (effect of suppressing fastener phenomenon)

[0106] A drum on which not less than 500 m of the textured yarn was wound was laid on a creel, released in the direction of the cross section of the drum for 5 minutes at a speed of 30 m/min, and the disarraying and tangling of the yarn due to the fastener phenomenon were visually confirmed and evaluated in the following four levels.

- S: Disarraying of the yarn is not seen and the yarn can be unwound well.
- A: Though disarraying of the yarn is seen slightly, the yarn can be unwound without problem.
- B: Though disarraying of the yarn and slight tangling is seen, the yarn can be unwound.
- C: Disarraying and tangling of the yarn occur and the yarn cannot be unwound.

J. Touch feeling

[0107] A drum on which not less than 500 m of the textured yarn was wound was laid on a creel, and the yarn was unwound using a measuring machine in the direction of the cross section of the drum to form a winding form, thereby obtaining a 10 m yarn skein. The yarn skein was fixed at one position and a sample for texture evaluation was prepared. The touch feeling when the sample was gripped was evaluated in the following four levels.

- S: The yarn has excellent bulkiness and flexibility, and an excellent texture without any foreign body sensation.
- A: The yarn has bulkiness, flexibility, and a good texture.

B: The yarn has bulkiness and a good texture to the extent that a foreign body sensation is not felt.

C: The yarn has no bulkiness, and has a poor texture that gives a foreign body sensation.

K. Bulkiness evaluation

[0108] The textured yarn (20 g) was filled in a cylindrical container having an inner diameter of 28.8 cm and a height of 50.0 cm, the height H (cm) of the space occupied by the textured yarn when a load of 0.15 g/cm² was applied vertically to the filled textured yarn from above was measured, the bulkiness (inch³/20 g) was calculated from the following formula, and the integer value obtained by rounding off the value to the nearest whole number was taken as the bulkiness of the textured yarn.

$$\text{Bulkiness (inch}^3\text{/20 g)} = (14.4^2\pi/2.54^3) \times H$$

[0109] The height of each textured yarn was measured by reading the height from the scale with the zero point on the bottom of the cylindrical container in mm units.

Example 1

[0110] High viscosity polyethylene terephthalate (PET 1: IV = 0.8 dl/g) as A polymer and low viscosity polyethylene terephthalate (PET 2: IV = 0.5 dl/g) as B polymer were prepared, melted at 295°C, then weighed, flowed into a spinning pack equipped with a composite spinneret, and discharged so as to give a side-by-side conjugate cross section composed of A polymer and B polymer as exemplified in Fig. 4 (4-1) (conjugate ratio: A polymer/B polymer = 50/50). Cooling air at 20°C was blown against the discharged yarn at a flow rate of 20 m/min to cool and solidify the yarn, and after application of a spinning oil agent, an undrawn yarn was wound up at a spinning speed of 1500 m/min. A conjugate fiber (single yarn fineness: 7.0 dtex) obtained by drawing the wound undrawn yarn 3.0 times at a drawing speed of 800 m/min between rollers heated at 90°C and 140°C was used as a core yarn.

[0111] Next, polyethylene terephthalate (PET3: IV = 0.6 dl/g) was melted at 290°C, weighed, flowed into a spinning pack, and discharged from a hollow cross-sectional discharge hole in which three slits (width of 0.1 mm, reference sign 23 in Fig. 8) as shown in Fig. 8 were concentrically disposed to give a yarn with a hollow rate of 30%. Cooling air at 20°C was blown from one side against the discharged yarn at a flow rate of 30 m/min to cool and solidify the yarn, and after application of a spinning oil agent, an undrawn yarn was wound up at a spinning speed of 1500 m/min. Subsequently, a hollow fiber (single yarn fineness: 6.5 dtex) obtained by drawing the wound undrawn yarn 3.0 times at a drawing speed of 800 m/min between rollers heated at 90°C and 140°C was used as a sheath yarn.

[0112] In the process illustrated in Fig. 6, the core yarn and the sheath yarn were supplied to the suction nozzle at supply roller speeds of 50 m/min and 1000 m/min. In the suction nozzle, compressed air was injected at 20° against the traveling yarn at an airflow rate of 400 m/s, and the core yarn and the sheath yarn were jetted out together with the accompanying airflow from the nozzle without entangling. The yarn injected from the nozzle was made to travel for 1.0×10^{-4} seconds with the airflow, the yarn path was changed using a ceramic guide, and the textured yarn having the loop formed by the sheath yarn was taken up by a roller of 50 m/min. The textured yarn was continuously guided to a tube heater via rollers and heat-treated with heated air at 150°C for 10 seconds to set the form of the bulky yarn and to cause crimps to appear in the core yarn and the sheath yarn. The bulky yarn was wound on a drum at 52 m/min by a tension control type winder installed behind the tube heater.

[0113] In Example 1, a bulky yarn having 22/mm loops formed by a sheath yarn protruding by 38.0 mm on average from the surface was obtained. The protruding loops were excellent in size and period uniformity. The sheath yarn of the textured yarn had a three-dimensional crimped structure with a curvature radius of 5.7 mm on the millimeter order, and the sheath yarn had continuously formed loops without any broken portions. (number of broken portions: 0.0)

[0114] Subsequently, a silicone oil agent containing polysiloxane at a concentration of 8 wt% was uniformly sprayed to the textured yarn with a spray so that the final amount of polysiloxane attached was 1 wt% with respect to the bulky yarn, and the resulting product was heat-treated at a temperature of 165°C for 20 minutes to obtain the bulky yarn of the present invention.

[0115] In the bulky yarn, the sheath yarn that had continuously formed loops had a three-dimensional crimped structure, the coefficient of static friction between fibers was 0.1, the textured yarn had no problem in the unwinding properties, and the yarn was successfully smoothly unwound from the drum around which the yarn was wound without tangling or the like (unwinding properties: S). The elastic modulus that represents rigidity was 73 cN/dtex, and the extension recovery rate was 83%. Thus, the yarn had comfortable stretchability (texture: S). The results are shown in Table 1.

Example 2

[0116] Example 2 was carried out in accordance with Example 1 except that a PET 1/PET 2 side-by-side conjugate fiber with a single yarn fineness adjusted to 3.0 dtex by adjusting the discharge amount was used as a core yarn using the combination of polymers used for the core yarn of Example 1.

[0117] In Example 2, the number of loops was slightly increased by decreasing the single yarn fineness of the core yarn. The yarn was easily deformed at the time of extension deformation and had a more flexible texture than Example 1 did. The results are shown in Table 1.

Examples 3 and 4

[0118] Example 3 was carried out all in accordance with Example 1 except that A polymer was changed to polybutylene terephthalate (PBT: IV = 1.2 dl/g) and a PBT/PET 2 side-by-side conjugate fiber collected by yarn making using a composite spinneret used in Example 1 at a spinning temperature of 290°C was used as the core yarn. A bulky yarn having the PBT/PET 2 side-by-side conjugate fiber having a single yarn fineness adjusted to 3.0 dtex by adjusting the discharge amount as a core yarn was sampled in the same polymer combination as in Example 3 (Example 4).

[0119] In Examples 3 and 4, the core yarn exhibited relatively fine crimps at the original yarn stage, and the number of loops was decreased in the bulky textured yarn. As compared with that of Example 1, the yarns had a low elastic modulus, were extremely flexible, and extended and deformed at low stress. The extension recovery rate was largely improved, and even when the yarn was deformed to a relatively high degree, the yarn was not flattened. Thus, the yarn is a material suitable for use in a site that is largely moved. The results are shown in Table 1.

[Table 1]

			Example 1	Example 2	Example 3	Example 4
Core yarn	A polymer	-	PET 1	PET 1	PBT	PBT
	B polymer	-	PET 2	PET 2	PET 2	PET 2
	A/B ratio	-	50/50	50/50	50/50	50/50
	Cross-sectional shape		Side-by-side Fig. 4 (4-1)	Side-by-side Fig. 4 (4-1)	Side-by-side Fig. 4 (4-1)	Side-by-side Fig. 4 (4-1)
	Single yarn fineness	dtex/F	7.0	3.0	7.0	3.0
Sheath yarn	Polymer type	-	PET 3	PET 3	PET 3	PET 3
	Cross-sectional shape	-	Single hollow	Single hollow	Single hollow	Single hollow
	Single yarn fineness	dtex/F	6.5	6.5	6.5	6.5
	Density	g/cm ³	0.97	0.97	0.97	0.97

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(continued)

				Example 1	Example 2	Example 3	Example 4
Fluid processing	Feed rate	Core yarn feed rate	m/min	50	50	50	50
		Sheath yarn feed rate	m/min	1000	1000	1000	1000
		Feed rate ratio	-	20	20	20	20
	Fineness ratio	Sheath/core	-	0.9	2.2	0.9	2.2
	Nozzle	Airflow rate	m/s	400	400	400	400
		Airflow rate/ yarn speed	-	480	480	480	480
		Injection angle	°	20	20	20	20
		Intermingling/ opening within nozzle	-	Absent	Absent	Absent	Absent
		Turning point (distance/ airflow rate)	s	0.0001	0.0001	0.0001	0.0001

(continued)

				Example 1	Example 2	Example 3	Example 4
Bulky yarn	Loop	Size (protrusion)	mm	38.0	32.0	25.9	22.4
		Number	Number/mm	22	28	7	8
		Breakage (breaking point)	-	Absent (0.0)	Absent (0.0)	Absent (0.0)	Absent (0.0)
		Three-dimensional crimp	-	Present	Present	Present	Present
		Curvature radius	mm	5.7	5.7	5.7	5.7
	Characteristic	Strength	cN/dtex	3.5	3.0	4.0	3.5
		Elastic modulus	cN/dtex	73	71	56	51
		10% modulus	cN/dtex	1.5	1.5	1.4	1.4
		Extension recovery rate	%	83	79	94	89
		Fiber extension ratio	-	1.2	1.1	1.3	1.2
		Fiber length restoration rate	%	88	84	100	95
		Coefficient of static friction between fibers	-	0.1	0.1	0.1	0.1
		Fastener phenomenon	-	S	S	S	S
		Touch feeling	-	S	S	S	S
		Bulkiness	inch ³ /20 g	506	426	496	431

Comparative Example 1

[0120] The polyethylene terephthalate (PET3: IV = 0.6 dl/g) used in the sheath yarn in Example 1 was melted at 290°C, weighed, flowed into a spinning pack, and discharged from a hollow cross-sectional discharge hole in which three slits (width of 0.1 mm, reference sign 23 in Fig. 8) as exemplified in Fig. 8 were concentrically disposed to give a yarn with a hollow rate of 30%. Cooling air at 20°C increased (100 m/min) compared to that in Example 1 was blown from one side against the yarn to cool and solidify the yarn, and after application of a spinning oil agent, an undrawn yarn was wound up at a spinning speed of 1500 m/min. Subsequently, procedures were carried out all in accordance with those in Example 1 except that a hollow fiber (single yarn fineness: 6.5 dtex) obtained by drawing the wound undrawn yarn 3.0 times at a drawing speed of 800 m/min between rollers heated at 90°C and 140°C was used as the core yarn and the sheath yarn.

[0121] In Comparative Example 1, the yarn had almost the same form properties as those of Example 1, but the size of loops was small and the number of loops was reduced. Although the yarn was relatively satisfactory in unwinding properties and texture, it had a high elastic modulus and a decreased extension recovery rate. The results are shown in Table 2.

Comparative Example 2

[0122] All of the procedures were carried out in accordance with Comparative Example 1 except that a nozzle having an injection angle of compressed air changed to 90° was used and no turning point by a ceramic guide was provided. However, in Comparative Example 2, at the compressed airflow rate similar to that of Comparative Example 1, the entanglement between the core yarn and the sheath yarn was excessive and clogging of the nozzle occurred. Therefore, the airflow rate was decreased to 200 m/s, which is half of that of Comparative Example 1, to collect the textured yarn and evaluate properties thereof.

[0123] In the textured yarn of Comparative Example 2, since the loop size formed by the sheath yarn was smaller than those of Example 1 and Comparative Example 1 before the heat treatment, and the loops were formed in a very short period. Therefore, though loops were formed in the yarn when the sheath yarn was heat-treated to be crimped, the bulkiness was poor. Investigation of the details of the loop formed by the sheath yarn proved that the loop size was not uniform and there were a relatively large number of breaking points that were not confirmed before the heat treatment (breakage present: 0.5). The results are shown in Table 2.

Comparative Example 3

[0124] The textured yarn of Comparative Example 2 was abraded with a pair of rubber discs to perform an untwisting treatment. Although bulkiness seemed to be apparently improved, the breakage of the loop was further increased as compared with Comparative Example 2, entanglement of the sheath yarns was promoted, and a foreign body sensation was felt when compressed. Also, in comparison with Comparative Example 2, tangling of the yarn frequently occurred, and unwinding properties were deteriorated at the time of unwinding. The results are shown in Table 2.

[Table 2]

			Comparative Example 1	Comparative Example 2	Comparative Example 3
Core yarn	A polymer	-	PET 3	PET 3	PET 3
	B polymer	-	-	-	-
	A/B ratio	-	100/0	100/0	100/0
	Cross-sectional shape		Single hollow	Single hollow	Single hollow
	Single yarn fineness	dtex/F	6.5	6.5	6.5
Sheath yarn	Polymer type	-	PET 3	PET 3	PET 3
	Cross-sectional shape	-	Single hollow	Single hollow	Single hollow
	Single yarn fineness	dtex/F	6.5	6.5	6.5
	Density	g/cm ³	0.97	0.97	0.97

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(continued)

				Comparative Example 1	Comparative Example 2	Comparative Example 3
Fluid processing	Feed rate	Core yarn feed rate	m/min	50	50	50
		Sheath yarn feed rate	m/min	1000	1000	1000
		Feed rate ratio	-	20	20	20
	Fineness ratio	Sheath/core	-	1.0	1.0	1.0
	Nozzle	Airflow rate	m/s	400	200	200
		Airflowrate/yarn speed	-	480	240	240
		Injection angle	°	20	90	90
		Intermingling/ opening within nozzle	-	Absent	Present	Present
		Turning point (distance/ airflow rate)	s	0.0001	0	0
Bulky yarn	Loop	Size (protrusion)	mm	23.0	1.0	2.0
		Number	Number/mm	13	73	54
		Breakage (breaking point)	-	Absent (0.0)	Present (0.5)	Present (0.7)
		Three- dimensional crimp	-	Present	Present	Present
		Curvature radius	mm	5.0	4.2	4.0
	Characteristic	Strength	cN/dtex	4.2	2.3	1.9
		Elastic modulus	cN/dtex	104	101	103
		10% modulus	cN/dtex	2.9	2.9	2.9
		Extension recovery rate	%	34	32	34
		Fiber extension ratio	-	Breakage	Breakage	Breakage
		Fiber length restoration rate	%			
		Coefficient of static friction between fibers	-	0.3	0.5	0.6
		Fastener phenomenon	-	S	C	C
		Touch feeling	-	A	C	C
		Bulkiness	inch ³ /20 g	450	14	27

Example 5

[0125] Example 5 was carried out all in accordance with Example 2 except that A polymer was changed to polytri-methylene terephthalate (3GT: IV = 1.2 dl/g) and a 3GT/PET 2 side-by-side conjugate fiber collected by yarn making using a composite spinneret used in Example 1 at a spinning temperature of 280°C was used as the core yarn (single yarn fineness: 3.0 dtex).

[0126] In Example 5, the number of loops was reduced as compared with Example 1, and the extension recovery rate was reduced due to extension of the crimp of the core yarn at the time of processing. However, the stretchability was sufficiently secured, and the yarn had a more flexible texture due to a decrease in elastic modulus. The results are shown in Table 3.

Examples 6 and 7

[0127] Examples 6 and 7 were carried out all in accordance with Example 1 except that the feed rate was changed to 50 m/min for the core yarn and 500 m/min for the sheath yarn (Example 6), and 20 m/min for the core yarn and 1000 m/min for the sheath yarn (Example 7).

[0128] In Example 6 in which the feed rate ratio was decreased, the loop size was slightly smaller than that in Example 1, but the stretchability which is a characteristic of the present invention was comparable and the texture was good.

[0129] In Example 7 in which the feed rate ratio was increased, although the size of the loop was 60.1 mm, which was larger than that in Example 1, the loop had little slack. Regarding the texture, the yarn had flexibility and excellent bulkiness, and had a structure in which cutting and slack of the sheath yarn were also suppressed, and the yarn was also good in unwinding properties. The results are shown in Table 3.

Example 8

[0130] All the procedures were carried out in accordance with Example 7 except that the airflow rate was changed to 500 m/s.

[0131] In Example 8, although the tension between the nozzle and the take-up roller was decreased by increasing the airflow rate and the traveling of the textured yarn was slightly disturbed, the textured yarn was collected without any problem. In the textured yarn, slack of the loop was rarely seen, but the yarn had no problem in the unwinding properties, and a bulky yarn having the stretchability, which is a characteristic of the present invention, was successfully collected. The results are shown in Table 3.

[Table 3]

			Example 5	Example 6	Example 7	Example 8
Core yarn	A polymer	-	3GT	PET 1	PET 1	PET 1
	B polymer	-	PET 2	PET 2	PET 2	PET 2
	A/B ratio	-	50/50	50/50	50/50	50/50
	Cross-sectional shape		Side-by-side Fig. 4 (4-1)	Side-by-side Fig. 4 (4-1)	Side-by-side Fig. 4 (4-1)	Side-by-side Fig. 4 (4-1)
	Single yarn fineness	dtex/F	3.0	7.0	7.0	7.0
Sheath yarn	Polymer type	-	PET 3	PET 3	PET 3	PET 3
	Cross-sectional shape	-	Single hollow	Single hollow	Single hollow	Single hollow
	Single yarn fineness	dtex/F	6.5	6.5	6.5	6.5
	Density	g/cm ³	0.97	0.97	0.97	0.97

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(continued)

				Example 5	Example 6	Example 7	Example 8
Fluid processing	Feed rate	Core yarn feed rate	m/min	50	50	20	20
		Sheath yarn feed rate	m/min	1000	500	1000	1000
		Feed rate ratio	-	20	10	50	50
	Fineness ratio	Sheath/core	-	2.2	0.9	0.9	0.9
	Nozzle	Airflow rate	m/s	400	400	400	500
		Airflow rate/ yarn speed	-	480	480	1200	1500
		Injection angle	°	20	20	20	20
		Intermingling/ opening within nozzle	-	Absent	Absent	Absent	Absent
		Turning point (distance/ airflow rate)	s	0.0001	0.0001	0.0001	0.00011

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(continued)

				Example 5	Example 6	Example 7	Example 8
Bulky yarn	Loop	Size (protrusion)	mm	34.9	26.9	60.1	36.0
		Number	Number/mm	8	21	30	30
		Breakage (breaking point)	-	Absent (0.0)	Absent (0.0)	Absent (0.1)	Absent (0.0)
		Three- dimensional crimp	-	Present	Present	Present	Present
		Curvature radius	mm	7.5	4.5	6.3	6.0
	Characteristic	Strength	cN/dtex	3.5	3.9	4.0	3.7
		Elastic modulus	cN/dtex	50	78	70	71
		10% modulus	cN/dtex	1.3	1.5	1.5	1.5
		Extension recovery rate	%	52	84	75	73
		Fiber extension ratio	-	0.7	1.2	1.0	1.0
		Fiber length restoration rate	%	55	89	80	78
		Coefficient of static friction between fibers	-	0.1	0.1	0.2	0.3
		Fastener phenomenon	-	S	S	A	B
		Touch feeling	-	S	A	S	A
		Bulkiness	inch ³ /20 g	381	335	667	400

Examples 9 and 10

[0132] All the procedures were carried out in accordance with Example 2 except that the ratio of A polymer to B polymer was changed to 60/40 (Example 9) and 30/70 (Example 10) with respect to the conjugate fiber used for the core yarn.

[0133] In Example 9, there was no significant difference in the crimp form of the core yarn, and the form and the like of the loop of the textured yarn was not greatly affected. Therefore, the yarn had almost the same characteristics as those in Example 2.

[0134] In Example 10, the number of loops was reduced due to the small crimp form of the core yarn, and the extension recovery rate was increased as compared with that in Example 2. The results are shown in Table 4.

Examples 11 and 12

[0135] All the procedures were carried out in accordance with Example 2 except that an eccentric sheath-core conjugate fiber of PET 1/PET 2 (Example 11) and PBT/PET 2 (Example 12) obtained using the composite spinneret that provides an eccentric sheath-core conjugate cross section illustrated in Fig. 4 (4-2) was used as the core yarn, and the distance

of the turning point was set to 0.0006.

[0136] In Example 11, the number of loops was slightly smaller than that in Example 2. On the other hand, in Example 12, the number of loops was increased as compared with that in Example 4, and the binding between the sheath yarn and the core yarn was increased. Therefore, the stretchability was improved. The results are shown in Table 4.

Comparative Example 4

[0137] All the procedure was carried out according to Comparative Example 2 except that the hollow cross-section PET fiber used in Comparative Example 2 was used as a core yarn and the 3GT/PET 2 side-by-side conjugate fiber used in Example 5 was used as a sheath yarn.

[0138] In the sample of Comparative Example 4, the sheath yarn exhibited a three-dimensional crimped shape after the heat treatment, but the fiber forming the loop was very fine and had a curvature radius of several tens of micrometers, and the sheath yarn breakages were observed in some places (breakage present: 0.4). Due to the exhibition of this crimped form, the loop of the sheath yarn greatly shrunk as compared with that before the heat treatment, and few loops exceeding 0.6 mm from the surface of the yarn were present. For this reason, although the touch feeling of the textured yarn was a unique rubber-like feeling, the yarn did not have the bulkiness and flexibility which are the objects of the present invention. Because of the microfine crimp on the micrometer order, breakage of the sheath yarn and unevenness of the protrusion of the loop, the coefficient of static friction between fibers was relatively high (0.4), and the unwinding properties of the drum were not good. The results are shown in Table 4.

[Table 4]

			Example 9	Example 10	Example 11	Example 12	Comparative Example 4
	A polymer	-	PET 1	PET 1	PET 1	PBT	PET 3
Core yarn	B polymer	-	PET 2	PET 2	PET 2	PET 2	-
	A/B ratio	-	60/40	30/70	50/50	50/50	-
	Cross-sectional shape		Side-by-side Fig. 4 (4-1)	Side-by-side Fig. 4 (4-1)	Eccentric core-in-sheath Fig. 4 (4-2)	Eccentric core-in-sheath Fig. 4 (4-2)	Single hollow
	Single yarn fineness	dtex/F	3.0	3.0	3.0	3.0	6.5
Sheath yarn	Polymer type	-	PET 3	PET 3	PET 3	PET 3	3GT/PET 2
	Cross-sectional shape	-	Single hollow	Single hollow	Single hollow	Single hollow	Side-by-side Fig. 4 (4-1)
	Single yarn fineness	dtex/F	6.5	6.5	6.5	6.5	6.5
	Density	g/cm ³	0.97	0.97	0.97	0.97	1.36
Fluid processing	Core yarn feed rate	m/min	50	50	50	50	50
	Sheath yarn feed rate	m/min	1000	1000	1000	1000	1000
	Feed rate ratio	-	20	20	20	20	20
	Fineness ratio	-	2.2	2.2	2.2	2.2	1.0
	Nozzle	m/s	400	400	400	400	200
	Airflow rate/yarn speed	-	480	480	480	480	240
	Injection angle	°	20	20	45	45	90
	Intermingling/opening within nozzle	-	Absent	Absent	Absent	Absent	Present
	Turning point (distance/airflow rate)	s	0.0001	0.0001	0.0006	0.0006	0

(continued)

Bulky yarn	Loop			Example 9	Example 10	Example 11	Example 12	Comparative Example 4
		Size (protrusion)	mm	32.0	26.2	31.9	21.7	0.6
		Number	Number/mm	19	15	18	13	93
		Breakage (breaking point)	-	Absent (0.0)	Absent (0.0)	Absent (0.0)	Absent (0.0)	Present (0.4)
		Three-dimensional crimp	-	Present	Present	Present	Present	Absent
		Curvature radius	mm	6.3	6.1	5.0	5.0	0.3
		Strength	cN/dtex	3.0	3.0	4.8	4.8	1.4
		Elastic modulus	cN/dtex	70	70	69	51	104
		10% modulus	cN/dtex	1.5	1.5	1.5	1.5	2.4
		Extension recovery rate	%	88	94	88	100	48
		Fiber extension ratio	-	1.2	1.3	1.2	1.4	Breakage
		Fiber length restoration rate	%	94	100	94	100	-
		Coefficient of static friction between fibers	-	0.1	0.1	0.1	0.1	0.4
		Fastener phenomenon	-	S	S	S	S	B
		Touch feeling	-	S	S	A	A	C
		Bulkiness	inch ³ /20 g	426	349	424	325	6

Example 13

[0139] To increase the stretchability and flexibility of the textured yarn, the 3GT used in A polymer of Example 5 was melted at 275°C, weighed, flowed into a spinning pack, and discharged from a hollow cross-sectional discharge hole in which three slits (width of 0.1 mm, reference sign 23 in Fig. 8) as exemplified in Fig. 8 were concentrically disposed to give a yarn with a hollow rate of 10%. Cooling air at 20°C was blown against the discharged yarn at a flow rate of 20 m/min to cool and solidify the yarn, and after application of a spinning oil agent, an undrawn yarn was wound up at a spinning speed of 1500 m/min. The procedures were carried out all in accordance with those in Example 1 except that a fiber (single yarn fineness: 7.0 dtex) obtained by drawing the wound undrawn yarn 2.8 times at a drawing speed of 800 m/min between rollers heated at 70°C and 130°C was used as the core yarn.

[0140] In Example 13, a bulky yarn having 22/mm loops formed by a sheath yarn protruding by 38.0 mm on average from the surface was obtained. The protruding loops were excellent in size and period uniformity. The sheath yarn of the textured yarn had a three-dimensional crimped structure with a curvature radius of 5.7 mm on the millimeter order, and the sheath yarn had continuously formed loops without any broken portions. (number of broken portions: 0.0)

[0141] In the bulky yarn, the sheath yarn that had continuously formed loops had a three-dimensional crimped structure, the coefficient of static friction between fibers was 0.1, the bulky yarn had no problem in the unwinding properties, and the yarn was successfully smoothly unwound from the drum around which the yarn was wound without tangling or the like (unwinding properties: S). In particular, the 10% modulus that represents the resistance at the time of expansion and contraction was as low as 1.2 cN/dtex, and the fiber restoration rate after the load application was 100%. Thus, the yarn was excellent in anti-flattening properties, and had stretchability with a flexible texture that allows the yarn to stretch well at low stress (texture: S). The results are shown in Table 5.

Example 14

[0142] To further increase the stretchability and the anti-flattening properties compared to Example 13, all the procedures were carried out in accordance with Example 13 except that the polymer was changed to a PBT elastomer ("Hytrel" manufactured by Du Pont-Toray Co., Ltd.) and a core yarn produced at a spinning temperature of 260°C was collected.

[0143] In Example 14, the polymer type of the core yarn was changed to a PBT elastomer excellent in flexibility, and the bulky yarn had a 10% modulus significantly lowered as compared with that in Example 13. The yarn had both excellent stretchability and excellent flexibility. Also, the fiber length restoration rate was greatly improved, and there was almost no flattening even when the yarn was deformed by application of high stress. Thus, it was found that the yarn is a material suitably usable in a site to which deformation compression is applied repeatedly and a site that is extended and deformed largely when used for clothing. The results are shown in Table 5.

Example 15

[0144] Polypropylene (PP: MFR = 9 g/10 min) as an island component and PET3 (0.65 dl/g) used in Example 1 as a sea component were separately melted at 265°C and at 300°C, respectively, weighed, and flowed into a spinning pack. A hollow islands-in-sea conjugate yarn as exemplified in Fig. 5 having a hollow portion at the center of the fiber cross section and having a sea-island structure in a donut shape around the hollow portion was melt-spun at a spin block temperature of 280°C. A composite spinneret consisting of a weighing plate and a distribution plate described in Japanese Patent Laid-open Publication No. 2011-174215 was used for the spinneret incorporated in the spinning pack. The distribution plate used was a distribution plate in which a circular space not provided with a distribution hole was provided in the center of the plate, the distribution holes of the sea component polymer were arranged in a ring shape around the periphery of the circular space, and further one distribution hole of the island component polymer was surrounded by six distribution hole of the sea component polymer on the outer circumference. To the conjugate polymer stream discharged at a conjugate ratio of islands/sea = 30/70, cooling air at 20°C was blown from a side at a flow rate of 100 m/min to cool and solidify the stream. Then, an oil agent was applied to the resulting product, and the undrawn yarn was wound at a spinning rate of 1200 m/min. Then, the yarn was drawn 2.9 times at a drawing rate of 600 m/min between rollers heated at 90°C and 130°C to obtain a drawn yarn having a fineness of 78 dtex, a number of filaments of 12, 32 islands per filament, a hollow rate of 30%, and a density of 0.87 g/cm³. Since cooling air was applied to the hollow islands-in-sea conjugate yarn at high speed, the yarn was cooled asymmetrically between the left and right of the fiber, and gently crimped after the heat treatment.

[0145] In the process shown in Fig. 6, the obtained hollow islands-in-sea conjugate yarn was supplied one by one to the two supply rollers, and sucked with a suction nozzle with one of the supply rollers rotated at a speed of 50 m/min and the other at a speed of 1000 m/min. In the suction nozzle, compressed air was injected at 20° against the traveling yarn at an airflow rate of 400 m/s, and the core yarn and the sheath yarn were jetted out together with the accompanying airflow from the nozzle without entangling. The yarn injected from the nozzle was made to travel for 1.0×10^{-4} seconds

with the airflow, the yarn path was changed using a ceramic guide, and the textured yarn having the loop formed by the sheath yarn was taken up with a take-up roller at 50 m/min.

[0146] Subsequently, the textured yarn was guided to a tube heater via rollers and heat-treated with heated air at 150°C for 10 seconds to set the form of the bulky yarn and to cause a three-dimensional crimp to appear in the sheath yarn. The bulky yarn was wound on a drum at 52 m/min by a tension control type winder installed behind the tube heater. Furthermore, a silicone oil agent containing polysiloxane at a concentration of 8 wt% was uniformly sprayed to the collected bulky yarn with a spray so that the final amount of polysiloxane attached was 1 wt% with respect to the bulky yarn, and the resulting product was heat-treated at a temperature of 165°C for 20 minutes to obtain a textured yarn.

[0147] The bulky yarn collected in Example 15 had a structure in which a loop formed by a sheath yarn protruded from the surface of the yarn by 21.0 mm on average, and the number of loops was 22/mm. The protruding loops were excellent in size and period uniformity.

[0148] The core yarn and the sheath yarn had a three-dimensional crimped structure with a curvature radius of 4.5 mm on the millimeter order, and the sheath yarn had continuously formed loops without any broken portions.

(number of broken portions: 0.0)

[0149] In the bulky yarn, the sheath yarn that had continuously formed loops had a three-dimensional crimped structure, the coefficient of static friction between fibers was 0.1, the unwinding from the drum around which the yarn was wound was smooth, and thus, the yarn was excellent in unwinding properties (unwinding properties: S). The yarn had bulkiness derived from the specific structure of the present invention and had a texture excellent also in flexibility (texture: S). In Example 15, the stretchability was lower than that in Example 1, but the bulkiness evaluation showed excellent performance of 645 inch³/20 g. The results are shown in Table 5.

Examples 16 and 17

[0150] Procedures were carried out in accordance with Example 15 except that the island/sea conjugate ratio and the drawn yarn density of the hollow islands-in-sea conjugate yarn used in the sheath yarn were changed to an island/sea ratio of 20/80 and a density of 0.90 g/cm³ (Example 16), and an island/sea ratio of 10/90 and a density of 0.93 g/cm³ (Example 17).

[0151] The bulky yarn collected in Example 16 had continuously formed loops of the sheath yarn without broken portions. The sheath yarn had a three-dimensional crimped structure, was excellent in unwinding properties from the drum around which the yarn was wound (unwinding properties: S), and had a texture excellent in flexibility (texture: S). In bulkiness evaluation, the yarn showed excellent bulkiness of 606 inch³/20 g.

[0152] The bulky yarn collected in Example 17 had continuously formed loops of the sheath yarn without broken portions. The sheath yarn had a three-dimensional crimped structure, was excellent in unwinding properties from the drum around which the yarn was wound (unwinding properties: S), and had a texture excellent in flexibility (texture: S). In bulkiness evaluation, the yarn showed excellent bulkiness of 581 inch³/20 g. The results are shown in Table 5.

[Table 5]

			Example 13	Example 14	Example 15	Example 16	Example 17
Core yarn	A polymer	-	3GT	"Hytrel"	PP	PP	PP
	B polymer	-	-	-	PET 3	PET 3	PET 3
	A/B ratio	-	-	-	30/70	20/80	10/90
	Cross-sectional shape		Single hollow	Single hollow	Sea-island hollow Fig. 5	Sea-island hollow Fig. 5	Sea-island hollow Fig. 5
	Single yarn fineness	dtex/F	7.0	7.0	6.5	6.5	6.5
Sheath yarn	A polymer	-	PET 3	PET 3	PP	PP	PP
	B polymer	-	-	-	PET 3	PET 3	PET 3
	Cross-sectional shape	-	Single hollow	Single hollow	Sea-island hollow Fig. 5	Sea-island hollow Fig. 5	Sea-island hollow Fig. 5
	Single yarn fineness	dtex/F	6.5	6.5	6.5	6.5	6.5
	Density	g/cm ³	0.97	0.97	0.87	0.90	0.93
Fluid processing	Core yarn feed rate	m/min	50	50	50	50	50
	Sheath yarn feed rate	m/min	1000	1000	1000	1000	1000
	Feed rate ratio	-	20	20	20	20	20
	Fineness ratio	-	0.9	0.9	0.9	0.9	0.9
	Nozzle	m/s	400	400	400	400	400
	Airflow rate/yarn speed	-	480	480	480	480	480
	Injection angle	°	20	20	20	20	20
	Intermingling/opening within nozzle	-	Absent	Absent	Absent	Absent	Absent
	Turning point (distance/airflow rate)	s	0.0001	0.0001	0.0001	0.0001	0.0001

(continued)

Bulky yarn	Loop			Example 13	Example 14	Example 15	Example 16	Example 17
		Size (protrusion)	mm					
		Number	Number/mm	22	18	22	27	18
		Breakage (breaking point)	-	Absent (0.0)	Absent (0.0)	Absent (0.0)	Absent (0.0)	Present (0.4)
		Three-dimensional crimp	-	Present	Present	Present	Present	Absent
		Curvature radius	mm	5.7	5.2	4.5	4.1	3.9
		Strength	cN/dtex	2.6	3.4	3.6	3.4	3.5
		Elastic modulus	cN/dtex	26	32	74	61	52
		10% modulus	cN/dtex	1.2	0.2	2.4	1.9	1.5
		Extension recovery rate	%	88	93	80	81	83
		Fiber extension ratio	-	2.6	2.8	1.1	1.1	1.2
		Fiber length restoration rate	%	100	100	85	86	80
		Coefficient of static friction between fibers	-	0.1	0.1	0.1	0.1	0.1
		Fastener phenomenon	-	S	S	S	S	S
		Touch feeling	-	S	S	A	A	A
		Bulkiness	inch ³ /20 g	374	327	645	606	581

Examples 18 and 19

[0153] Procedures were carried out all in accordance with Example 12 except that the eccentric sheath-core conjugate fiber of PBT/PET 2 used in Example 12 was used as a core yarn and the feed rate was changed to 50 m/min for the core yarn and 500 m/min for the sheath yarn (Example 18), and 20 m/min for the core yarn and 1000 m/min for the sheath yarn (Example 19).

[0154] In Example 18 in which the feed rate ratio was decreased, the loop size was slightly smaller than that in Example 12, but the yarn had good stretchability which is a characteristic of the present invention and exhibited an excellent texture.

[0155] In Example 19 in which the feed rate ratio was increased, although the size of the loop was 38.0 mm, which was larger than that in Example 12, the loop had little slack. Regarding the texture, the yarn had flexibility and excellent bulkiness, and had a structure in which cutting and slack of the sheath yarn were also suppressed, and the yarn was also good in unwinding properties. The results are shown in Table 6.

Examples 20 and 21

[0156] All the procedures were carried out in accordance with Example 15 except that the eccentric sheath-core conjugate fiber of PBT/PET 2 used in Example 12 was used as a core yarn and the PP/PET3 hollow islands-in-sea conjugate yarn used in Example 15 was used as a sheath yarn (Example 20). As a case where the feed rate ratio is changed, a textured yarn obtained at a feed rate of the core yarn of 20 m/min and a feed rate of the sheath yarn of 1000 m/min was also collected (Example 21).

[0157] In Example 20, loops having resilience derived from the PET component was formed even at low density, and as in Example 15, the yarn exhibited excellent bulkiness and good stretchability derived from the eccentric sheath-core conjugate yarn arranged as the core yarn. Thus, the yarn had properties that were not conventionally achieved.

[0158] In Example 21, by further increasing the sheath/core ratio, the loop of the sheath yarn was further enlarged, and the bulkiness was further improved as compared with Example 20. In Example 21, although the loop was enlarged, the loop was excellent in uniformity in the fiber axis direction of the textured yarn, and looseness of the loop was not observed. In the yarn, the sea-island hollow fiber having a large crimp was wound around the core yarn having stretchability due to crimping to make the loop self-stand. Owing to the effect of the PET component in addition to such loops, the yarn had comfortable resilience. The results are shown in Table 6.

Example 22

[0159] The procedures were carried out in accordance with Example 20 except that a high elastic yarn made of the PBT elastomer ("Hytrel") used in Example 14 was used as the core yarn.

[0160] The textured yarn of Example 22 exhibited excellent stretchability by the use of an elastic yarn that extends and deforms under low stress as a core yarn, the fiber length was not changed even when the yarn was deformed to a relatively high degree, and thus the yarn had excellent resilience. As in Example 20, a sea-island hollow fiber was adopted as the sheath yarn, and the bulkiness was also excellent.

[Table 6]

	Example 18		Example 19		Example 20		Example 21		Example 22	
	A polymer	-	PBT	PBT	PBT	PBT	PBT	"Hytel"		
Core yarn	B polymer	-	PET 2	PET 2	PET 2	PET 2	PET 2	-		
	A/B ratio	-	50/50	50/50	50/50	50/50	50/50	-		
	Cross-sectional shape		Eccentric core-in-sheath Fig. 4 (4-2)	Eccentric core-in-sheath Fig. 4 (4-2)	Eccentric core-in-sheath Fig. 4 (4-2)	Eccentric core-in-sheath Fig. 4 (4-2)	Eccentric core-in-sheath Fig. 4 (4-2)	Single hollow		
	Single yarn fineness	dtex/F	3.0	3.0	3.0	3.0	3.0	7.0		
Sheath yarn	A polymer	-	PET 3	PET 3	PP	PP	PP	PP		
	B polymer	-	-	-	PET 3	PET 3	PET 3	PET 3		
	Cross-sectional shape	-	Single hollow	Single hollow	Sea-island hollow Fig. 5	Sea-island hollow Fig. 5	Sea-island hollow Fig. 5	Sea-island hollow Fig. 5		
	Single yarn fineness	dtex/F	6.5	6.5	6.5	6.5	6.5	6.5		
	Density	g/cm ³	0.97	0.97	0.87	0.87	0.87	0.87		

(continued)

Fluid processing	Feed rate	Core yarn feed rate	m/min	Example 18	Example 19	Example 20	Example 21	Example 22
		Sheath yarn feed rate	m/min	50	20	50	20	50
		Feed rate ratio	-	500	1000	1000	1000	1000
	Fineness ratio	Sheath/core	-	10	50	20	50	20
		Airflow rate	m/s	2.2	2.2	0.9	2.2	0.9
	Nozzle	Airflow rate		400	400	400	400	400
		Airflow rate/yarn speed	-	480	1200	480	1200	480
		Injection angle	°	20	20	20	20	20
		Intermingling/opening within nozzle	-	Absent	Absent	Absent	Absent	Absent
	Turning point (distance/airflow rate)		s	0.0001	0.0001	0.0001	0.0001	0.0001

(continued)

Bulky yarn	Loop	Size (protrusion)	Example 18	Example 19	Example 20	Example 21	Example 22
			mm				
		Number	23	18	22	18	18
		Breakage (breaking point)	Absent (0.0)	Absent (0.0)	Absent (0.0)	Absent (0.0)	Present (0.4)
		Three-dimensional crimp	Present	Present	Present	Present	Absent
		Curvature radius	5.1	5.2	4.5	4.5	4.5
		Strength	4.8	3.8	4.8	3.8	3.4
		Elastic modulus	51	46	51	46	32
		10% modulus	1.4	1.4	2.4	1.9	1.5
		Extension recovery rate	91	90	80	81	83
		Fiber extension ratio	1.3	1.3	1.1	1.3	2.8
		Fiber length restoration rate	97	100	85	86	100
		Coefficient of static friction between fibers	0.1	0.1	0.1	0.1	0.1
		Fastener phenomenon	A	S	S	S	S
		Touch feeling	S	S	A	A	A
		Bulkiness	352	633	671	702	680
			inch ³ /20 g				

DESCRIPTION OF REFERENCE SIGNS

[0161]

- 5 1: Sheath yarn
- 2: Core yarn
- 3: Yarn surface
- 4: Yarn path guide
- 5: Distance from yarn surface
- 10 6: Curve of three-dimensional crimp
- 7: A polymer
- 8: B polymer
- 9: Hollow portion
- 10: Island component
- 15 11: Sea component
- 12: Suction nozzle
- 13: Turning point
- 14: Textured yarn
- 15: Take-up roller
- 20 16: Heater
- 17: Delivery roller
- 18: Winder
- 19: Supply roller
- 20: Core yarn
- 25 21: Sheath yarn
- 22: Injection angle of compressed air
- 23: Slit-shaped discharge hole

30 **Claims**

1. A bulky yarn comprising:

- 35 a sheath yarn that has continuously formed loops without any breakages; and
 a core yarn that substantially fixes the sheath yarn by being interlaced with the sheath yarn,
 wherein a number of loops protruding from a yarn surface layer by not less than 3.0 mm is in a range of 1 to
 30 loops/mm, an elastic modulus is not greater than 80 cN/dtex, and an extension recovery rate at a time of
 10% extension recovery is not less than 50%.

- 40 2. The bulky yarn according to claim 1, wherein a single yarn fineness of a constituent fiber is not less than 3.0 dtex,
 and a single yarn fineness ratio of the sheath yarn to the core yarn (sheath/core) is in a range of 0.5 to 2.5.

3. The bulky yarn according to claim 1 or 2, wherein the core yarn is a side-by-side or eccentric core-in-sheath conjugate
 fiber, and a fiber that constitutes the sheath yarn is a three-dimensional crimped structure yarn having a curvature
 45 radius of 2.0 mm to 30.0 mm.

4. The bulky yarn according to claim 1 or 2, comprising:

- 50 a sheath yarn that has formed loops; and
 a core yarn that substantially fixes the sheath yarn by being interlaced with the sheath yarn,
 wherein the sheath yarn has continuously formed loops substantially without any breakages and is a conjugate
 fiber having a density of less than 1.00 g/cm³.

- 55 5. The bulky yarn according to claim 4, wherein the sheath yarn has a three-dimensional crimped structure.

6. The bulky yarn according to claim 4 or 5, wherein the sheath yarn is an islands-in-sea conjugate fiber having a
 hollow cross section with a hollow rate of not less than 20%.

7. The bulky yarn according to claim 6, wherein an island component in the islands-in-sea conjugate fiber contains a polyolefin and a sea component in the islands-in-sea conjugate fiber contains a polyester.

8. The bulky yarn according to claim 1 or 2, comprising:

a sheath yarn that has formed loops and a three-dimensional crimped structure; and
a core yarn that substantially fixes the sheath yarn by being interlaced with the sheath yarn,
wherein a 10% modulus is less than 1.5 cN/dtex, a fiber extension ratio at load application is not less than 1.1,
and a fiber length restoration rate after load application extension is 80 to 100%.

9. The bulky yarn according to claim 8, wherein the fiber extension ratio at load application is not less than 1.5, and the fiber length restoration rate after load application extension is 90 to 100%.

10. The bulky yarn according to any one of claims 1 to 9, wherein a coefficient of static friction between fibers is not greater than 0.3.

11. The bulky yarn according to any one of claims 1 to 10, wherein both the core yarn and the sheath yarn are composed of hollow cross-section fibers with a hollow rate of not less than 20%.

12. A fiber product comprising the bulky yarn according to any one of claims 1 to 11 in at least a part of the fiber product.

Figure 1

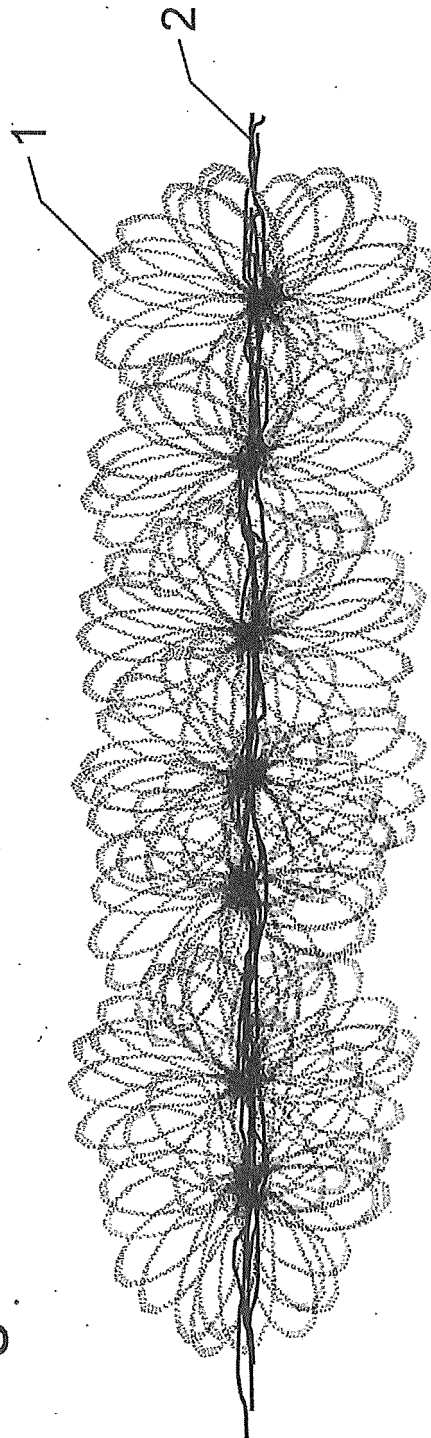


Figure 2

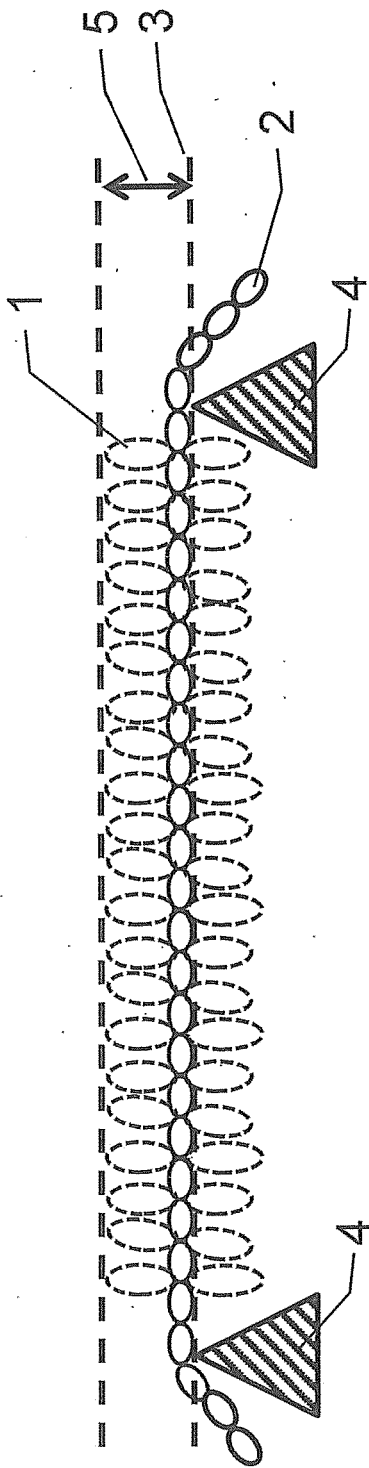


Figure 3

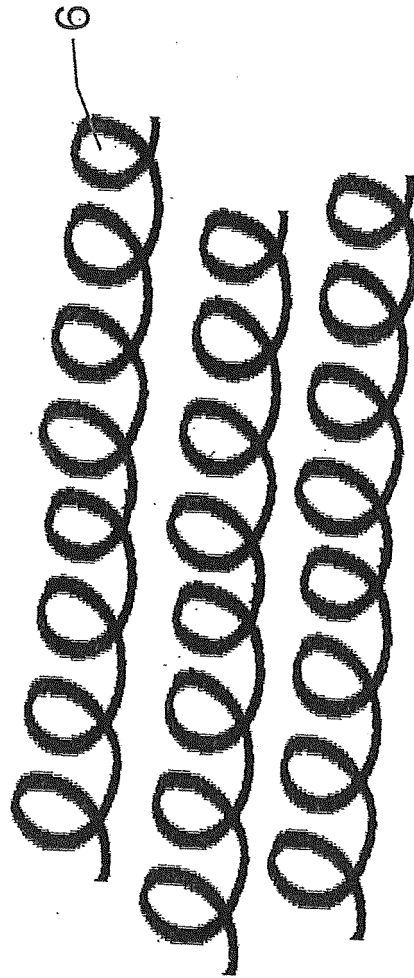
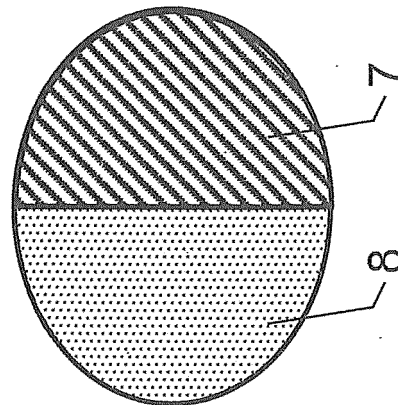


Figure 4

4-1



4-2

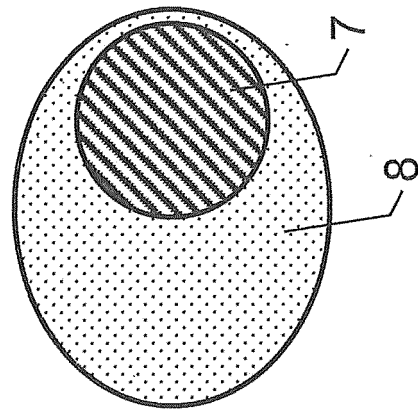


Figure 5

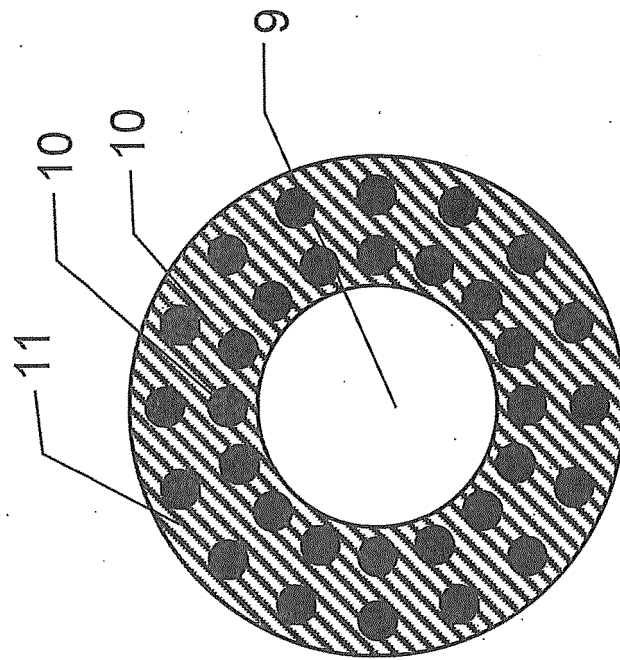


Figure 6

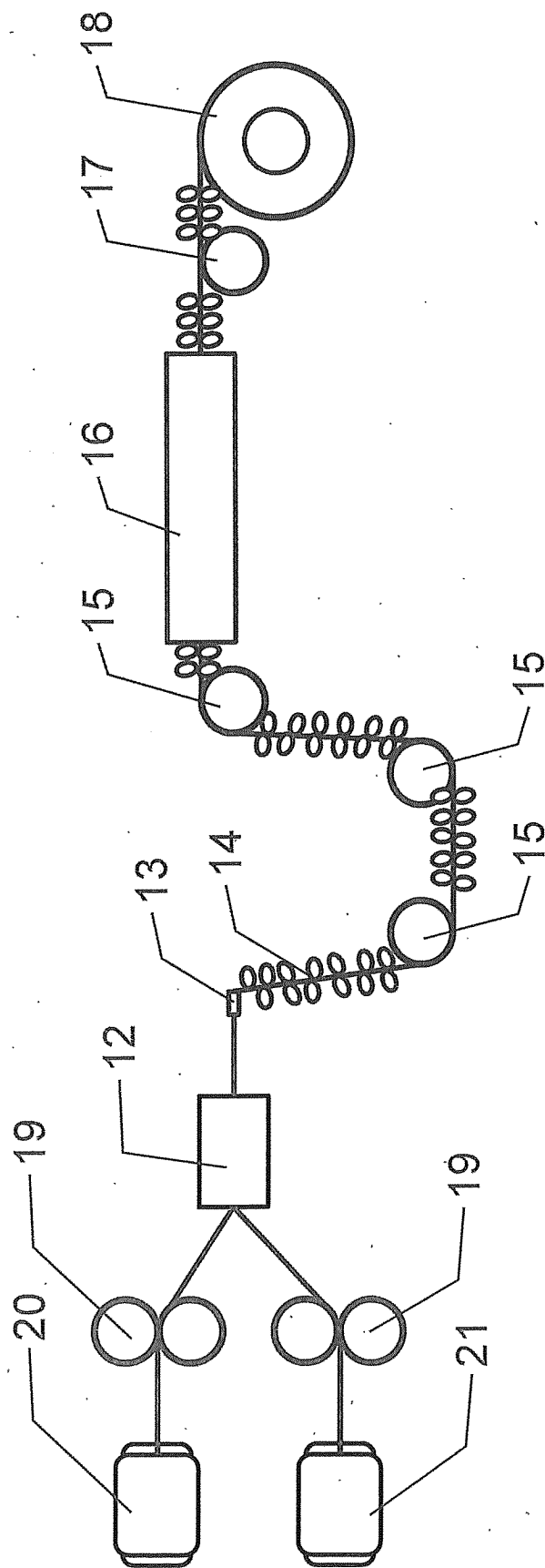


Figure 7

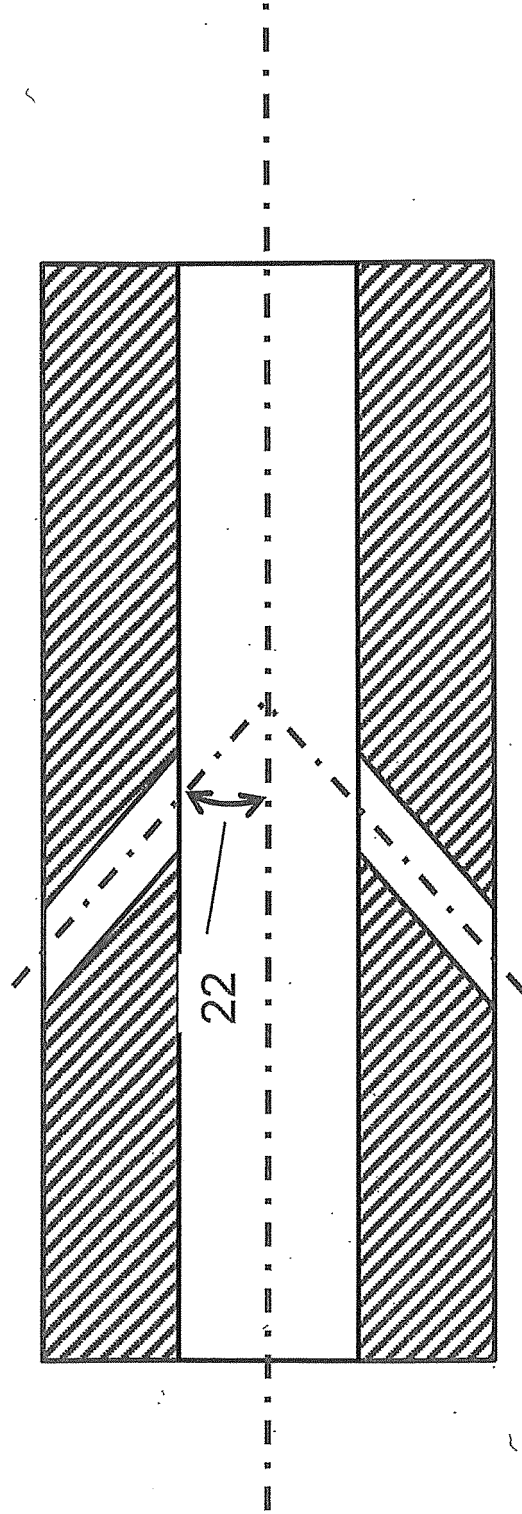
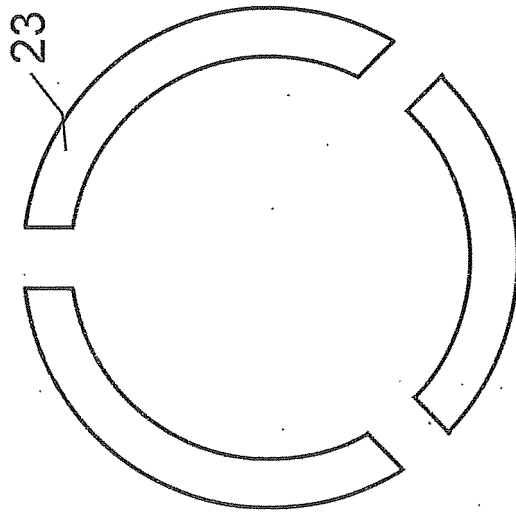


Figure 8



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/015820

A. CLASSIFICATION OF SUBJECT MATTER

D02G3/34(2006.01) i

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)

D02G1/00-3/48, D02J1/00-13/00, A41G11/00-11/02, B68G1/00

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 1996-2017

Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

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	WO 2012/026424 A1 (Kurabo Industries Ltd.), 01 March 2012 (01.03.2012), paragraph [0029]; fig. 7 & EP 2610211 A1 paragraph [0029]; fig. 7 & JP 2012-67429 A & JP 2012-67430 A & JP 2015-132041 A & US 2013/0136892 A1 & CN 103097280 A & KR 10-2014-0018176 A	1-12
A	JP 64-52843 A (Unitika Ltd.), 28 February 1989 (28.02.1989), claims; drawings (Family: none)	1-12

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

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"&" document member of the same patent family

Date of the actual completion of the international search

12 July 2017 (12.07.17)

Date of mailing of the international search report

25 July 2017 (25.07.17)

Name and mailing address of the ISA/

Japan Patent Office

3-4-3, Kasumigaseki, Chiyoda-ku,

Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/015820

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P, A	WO 2017/014241 A1 (Toray Industries, Inc.), 26 January 2017 (26.01.2017), paragraph [0055]; claims; drawings (Family: none)	1-12

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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- JP 51039134 A [0011]
- JP 2011246850 A [0011]
- JP 2012067430 A [0011]
- JP 2011174215 A [0144]