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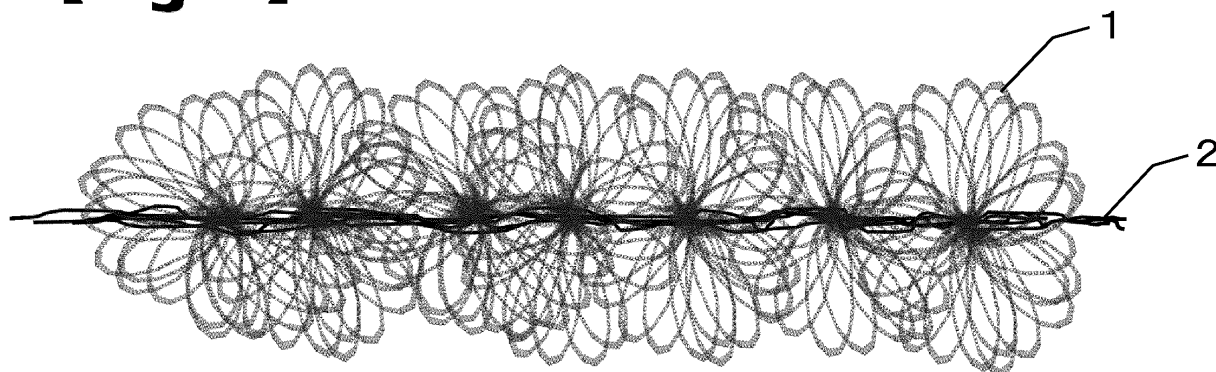
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(54) **BULKY YARN**

(57) An object of the present invention is to provide a bulky yarn made of synthetic fibers, which is suppressed in tanglement between filaments while having a loop shape in the surface layer thereof, and has a soft texture and is light and excellent in heat retention properties while being good in handleability in high-order

processing. The present invention provides a bulky yarn made of synthetic fibers, including: a sheath yarn (1) having a three-dimensional crimped structure; and a core yarn (2) twisted with the sheath yarn (1) to fix the sheath yarn (1), wherein the sheath yarn (1) is not substantially broken and continuously forms loops.

【Fig. 1】



Description

TECHNICAL FIELD

- 5 **[0001]** The present invention relates to a bulky yarn made of synthetic fibers, which includes a sheath yarn and a core yarn and has a plurality of loops.

BACKGROUND ART

- 10 **[0002]** Synthetic fibers made from thermoplastic polymers such as polyesters and polyamides have features that they have good basic characteristics such as mechanical properties and dimensional stability, and are excellent in the balance of such characteristics. Fiber materials based on these characteristics, which are obtained by spinning and are made to have various structural forms by high-order processing, are widely used not only in clothing applications but also in interior, vehicle interior, and industrial applications. It is no exaggeration to say that technological innovation has been
15 made on the development of new techniques related to synthetic fibers based on a motivation to simulate natural materials. Various technological proposals have been made to make synthetic fibers develop functions derived from natural complex structural forms. For example, some kind of synthetic fibers are made to develop a special texture such as squeaky touch and flexibility through simulation of a cross section of silk. Another kind of synthetic fibers are made to develop a special color through simulation of the Morpho butterfly or the like. Moreover, water repellency is imparted
20 to a fabric through simulation of the lotus leaf. Moreover, there is an effort to obtain a fiber structure having a soft texture and functions such as lightweight and heat retention properties of natural down.

- [0003]** As the natural down, 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 very light, and develop excellent heat retention properties owing to their special structural
25 form formed of keratin fibers. For this reason, functions of products including natural feathers as batting have been recognized by even general users, and the natural down is widely used in bedclothes and clothing items such as jackets. Capture of waterfowls, however, is limited from the viewpoint of nature conservation, and the total production of natural down is restricted. Furthermore, due to the recent abnormal weather and occurrence of the plague, there is a problem that the supply of natural down largely fluctuates, and is also a problem of price increase. In addition, despite the number
30 of steps for the use of natural down, 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 down in Europe and other countries. For this reason, attention is being paid to a batting material made of synthetic fibers that is capable of stable supply.

- [0004]** Many batting materials made of synthetic fibers have been proposed from long ago, but there are no batting
35 materials comparable to natural down in terms of basic characteristics such as the bulkiness, compression recovery, and soft texture.

- [0005]** Conventionally used yarn processing techniques intended for adding high value to fibers have been generally known to be capable of producing a bulky textured yarn by subjecting the fibers to real twisting and then untwisting the fibers, or by mixing one or more kinds of fibers with a fluid processing nozzle or the like, for example. Since such bulky
40 textured yarns are basically made of long fibers, they can be processed into various forms, and can also be applied to a batting material based on the bulkiness and soft texture of the textured yarns.

- [0006]** Patent Document 1 discloses the following textured yarn. First, 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 real twisting to form loops by the swayed fibers. After that, the fibers are untwisted by further being scratched with two
45 discs or the like to provide a bulky textured yarn. The fibers are subjected to heat treatment at the same time with or after the untwisting step, or sheath yarns are fused to each other with a binder in order to strengthen the fixing of the sheath yarns. Indeed, the method disclosed in Patent Document 1 has a possibility of providing a bulky yarn having loops of sheath yarns by adjusting the degree of yarn swaying or the like in accordance with a conventional technique.

- [0007]** Patent Document 2 discloses a technique of injecting compressed air to threads traveling inside an interlacing
50 nozzle from a direction perpendicular to the threads to open and tangle the threads, so that the excessively supplied sheath yarns are fixed by the difference in the yarn length. Similarly to Patent Document 1, in Patent Document 2, it is possible to obtain a bulky textured yarn including sheath yarns having loop shapes.

- [0008]** Such bulky yarns having loops suffer from tanglement between fibers, which is generally recognized as "entanglement". The entanglement is thought to cause poor unwinding in the high-order processing, and to have an influence
55 on the deterioration of the texture of textile products and durability of textile products. For this reason, attempts have been made to remedy the entanglement starting from a fluid processed yarn.

- [0009]** Patent Document 3 discloses that a bulky fluid jet textured yarn having a loop portion made of polytrimethylene terephthalate (3GT) is less likely to suffer from entanglement owing to the elasticity of the 3GT fibers.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

5 **[0010]**

Patent Document 1: Japanese Patent Laid-open Publication No. 2011-246850

Patent Document 2: Japanese Patent Laid-open Publication No. 2012-67430

Patent Document 3: Japanese Patent Laid-open Publication No. 11-100740

10 SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

15 **[0011]** In Patent Document 1 of the prior art described above, the textured yarn can possibly be used as a batting material if the binder is mixed in advance and the sheath yarns are fused to each other after the processing to fix the loops. However, if loop yarns from which the sheath yarns are partially protruded are subjected to real twisting and the fibers are untwisted by scratching with the rubber or the like of a mechanical kneading machine, the loops may be partially broken or deteriorated. If the textured yarn is used as the batting, eventually, several to several tens of the yarns are bundled and filled. As a result, the sheath yarns are broken in many portions to become fluff, and tangled with the sheath yarns of the nearby textured yarn, so that there are cases where the poor unwinding in the molding processing is caused or the process passability in the molding processing is deteriorated. Furthermore, since the sheath yarns are remarkably tangled with each other between the textured yarns, when the textured yarns are filled, the textured yarns give a feeling of a foreign body and impair the texture. Another problem is that fusion and fixing of the tangled portion gives a more remarkable feeling of a foreign body.

20 **[0012]** According to the technique of Patent Document 2, in the case of intermingling the traveling threads in the nozzle, and opening and interlacing the fibers, the traveling threads sway in a very short period to cause tanglement 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 interlaced with the core yarn, the size of the loops varies in the fiber axis direction, and the yarn is insufficient in the bulkiness. Further, the loop yarns formed in the nozzle stay inside the nozzle, and then discharged to the outside of the nozzle by the injected 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 the process passability in the high-order processing and that the portion where the sheath yarns are tangled with each other leads to a feeling of a foreign body.

35 **[0013]** In the technique of Patent Document 3, the use of 3GT which elastically elongates and deforms can possibly suppress the entanglement while keeping the moderate resilience of the sheath yarns, because the loops are compactly converged although the sheath yarns have a difference in the yarn length. The loop is, however, as small as about 0.6 mm at most. Moreover, if the number of loops is increased for achieving the bulkiness, the density of the sheath yarns increases, so that the sheath yarns tend to be tangled with each other, and the entanglement cannot be suppressed in some cases.

40 **[0014]** It is desired to provide a material for batting which solves the conventional problems and is suppressed in tanglement between textured yarns despite its high bulkiness and compression recoverability comparable to those of natural down. The present invention provides a bulky yarn which is good in handleability in high-order processing, and has a soft texture and is light and excellent in heat retention properties.

SOLUTIONS TO THE PROBLEMS

50 **[0015]** The above-mentioned objects are achieved by the following means.

1. A bulky yarn made of synthetic fibers, including:

a sheath yarn having a three-dimensional crimped structure; and
a core yarn twisted with the sheath yarn to fix the sheath yarn,
55 wherein the sheath yarn is not substantially broken and continuously forms loops.

2. Preferable aspects of the bulky yarn include the following.

The bulky yarn, wherein the core yarn and the sheath yarn have a single yarn fineness ratio (sheath/core) in a range

of 0.5 to 2.0,

the core yarn and the sheath yarn have 1/mm to 30/mm twist points in a fiber axis direction of the bulky yarn, and the crimped structure of the sheath yarn has a radius of curvature of 2 mm to 30 mm.

3. The bulky yarn according to either of the above items, wherein the fibers that constitute the bulky yarn have a single yarn fineness of 3.0 dtex or more, and

the bulky yarn has a coefficient of static friction between fibers of 0.3 or less.

4. The bulky yarn according to any one of the above items, wherein the core yarn has a three-dimensional crimp.

5. The bulky yarn according to any one of the above items, wherein both or one of the core yarn and the sheath yarn is hollow section fibers having a hollow rate of 20% or more.

6. The bulky yarn according to any one of the above items, wherein the core yarn and the sheath yarn are mono-component fibers of same type.

In addition, the following product can be mentioned as a product including the bulky yarn.

7. A textile product, including the bulky yarn according to any one of the above items in at least part thereof.

EFFECTS OF THE INVENTION

[0016] The bulky yarn of the present invention is suppressed in tanglement between the bulky yarns while having a loop shape, is good in handleability in high-order processing, has a soft texture, and is light and excellent in heat retention properties.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Fig. 1 is a schematic side view of a bulky yarn according to an example of the present invention.

Fig. 2 is a simulated view for illustrating a method for measuring a center line of a textured yarn.

Fig. 3 is a simulated view for illustrating a three-dimensional crimped structure.

Fig. 4 is a schematic process diagram schematically showing an example of a method for producing a bulky yarn of the present invention.

Fig. 5 is a schematic side view for illustrating a suction nozzle used in the method for producing a bulky yarn of the present invention.

Fig. 6 is a schematic cross-sectional view for illustrating a discharge hole of a spinneret for a hollow cross section used in the method for producing a bulky yarn of the present invention.

EMBODIMENTS OF THE INVENTION

[0018] Hereinafter, embodiments of the invention will be described. Since the bulky yarn of the present invention can be obtained by processing a multifilament, the bulky yarn and a material in the course of production of the bulky yarn may be referred to as a "textured yarn".

[0019] The bulky yarn of the present invention is made of synthetic fibers and has a bulky structure. This structure is composed of a sheath yarn forming loops and a core yarn that is twisted with the sheath yarn to substantially fix the sheath yarn. A feature of the structure is that the sheath yarn has a three-dimensional crimped structure. In addition, in the present invention, the sheath yarn is not substantially broken. That is, the sheath yarn is a bulky yarn and is almost continuous. Moreover, the sheath yarn continuously forms a plurality of loops.

[0020] Herein, the synthetic fibers are fibers made of a high molecular weight polymer. The synthetic fibers used may be fibers produced by melt spinning, solution spinning or the like. Among high molecular weight polymers, a melt-moldable thermoplastic polymer is suitable for use in the present invention because such thermoplastic polymer can be used for producing the fibers used in the present invention by a melt spinning method of high productivity.

[0021] Herein, examples of the thermoplastic polymer include melt-moldable polymers such as polyethylene terephthalate and copolymers thereof, polyethylene naphthalate, polybutylene terephthalate, polytrimethylene terephthalate, polypropylene, polyolefins, polycarbonate, polyacrylate, polyamides, polylactic acid, and thermoplastic polyurethane. Among these thermoplastic polymers, polycondensation polymers typified by polyesters and polyamides are suitable because these polymers are crystalline polymers and have a high melting point, so that they are free from deterioration or fatigue even if they are heated at a relatively high temperature in the subsequent process, molding processing, and actual use. From the viewpoint of heat resistance, the melting point of the polymer is preferably 165°C or higher.

[0022] The synthetic fibers used in the present invention may contain various additives such as inorganic substances including titanium oxide, silica, and barium oxide, coloring agents such as carbon black, dyes, and pigments, flame retardants, fluorescent whitening agents, antioxidants, and ultraviolet absorbers.

[0023] As illustrated in Fig. 1, the bulky yarn of the present invention is composed of a sheath yarn 1 forming loops and a core yarn 2 twisted with the sheath yarn to substantially fix the sheath yarn.

[0024] See Fig. 2. The core yarn is a filament, and is preferably present in the range of 0.6 mm from a center line 3 of a textured yarn. The center line of a textured yarn means a straight line connecting a pair of thread guides 4 on which a textured yarn of a fixed length is threaded. A filament present within the range of a distance 5 from the center line of the textured yarn of 0.6 mm or less is the core yarn referred to herein, and serves as a supporting yarn for the loops of the sheath yarn. The sheath yarn is also a filament, and is preferably protruded in a loop shape at a distance of 1.0 mm or more from the center line of the textured yarn. The sheath yarn is responsible for the bulkiness of the yarn of the present invention. In the present invention, the core yarn fixes the sheath yarn forming loops. The twist points play a role of supporting loops of the sheath yarn which are a feature of the present invention, and are suitably present at a moderate period. From this viewpoint, it is preferable that the core yarn and the sheath yarn in the bulky yarn have 1/mm to 30/mm twist points per 1 mm of the bulky yarn. When the number of twist points is within this range, even after the sheath yarn is three-dimensionally crimped, the loops are present at a moderate interval. Further from this viewpoint, it is more preferable that the number of twist points be 5/mm to 15/mm.

[0025] In order to define the core yarn and the sheath yarn and continuously evaluate the number of twist points and the number of loops per unit length in the longitudinal direction of the bulky yarn, a photoelectric fluff detection device can be utilized. For example, with use of a photoelectric fluff measuring machine (TORAY FRAY COUNTER), distances of 0.6 mm and 1.0 mm from the center line of the textured yarn are evaluated under the conditions of a yarn speed of 10 m/min and a traveling yarn tension of 0.1 cN/dtex.

[0026] The sheath yarn having loops of the present invention has a protruding shape in the cross section of the bulky yarn as viewed from the longitudinal direction of the bulky yarn, and has larger loops than those of common interlaced yarns and taslan textured yarns.

[0027] Herein, the size of each loop means the distance 5 from the center line 3 of the textured yarn to the apex of the loop as shown in Fig. 2. The size of the loop is measured by observing a bulky yarn of a fixed length threaded on the pair of thread guides 4 from the side surface, and measuring the size in the observed image. A photograph of one randomly selected bulky yarn is taken so that 10 or more loops formed in the bulky yarn can be observed, and the distance 5 from the center line of the textured yarn to the apex of each loop is measured for 10 loops in the image. Total of 10 sites per one bulky yarn are photographed, and the size of a total of 100 loops per one bulky yarn is measured up to the second decimal place in millimeters. The average of these numerical values is calculated, and a value obtained by rounding off the average to the first decimal place is taken as the size of the loops in the bulky yarn.

[0028] According to the study of the inventors, as for the size of the loops, it is preferable that the distance of protrusion of the loops from the center line of the textured yarn be in the range of 1.0 mm or more and 100.0 mm or less. When the distance is within this range, in combination with the crimped structure of the sheath yarn, the loops enhance the intended effects of the present invention, that is, the bulkiness and suppression of tanglement. In consideration of processability into a bulky yarn described later, the distance is more preferably 3.0 mm or more and 70.0 mm or less. Moreover, in consideration of repeated deformation with compression recovery under harsh environments as in sports clothing, it is particularly preferable to set the distance to 5.0 mm or more and 60.0 mm or less.

[0029] Herein, the shape of the loops of the sheath yarn is preferably a teardrop-shaped loop (teardrop shape) rather than an arched loop formed by general interlacing. In the case of the arched loop, the twist point between the core yarn and the sheath yarn is not fixed, and the loop moves freely to some extent. Therefore, when compressive deformation is applied to such a yarn, the twist point will move. For this reason, the yarn hardly returns to the original shape after compressive deformation, so that the yarn having an arched loop may be disadvantageous from the viewpoint of durability of the bulkiness. On the other hand, in the case of the teardrop-shaped loop, since the loop is substantially fixed at the twist point with the core yarn, the loop of the sheath yarn easily returns to the original shape even after compressive deformation. Thus, this shape is suitable for exhibiting the bulkiness originally having resilience. The teardrop-shaped loop, however, has been thought to be disadvantageous from the viewpoint of suppressing the tanglement between the sheath yarns since the sheath yarns are fixed. In the present invention, the three-dimensionally crimped sheath yarns suppress the tanglement between the sheath yarns. Further, the present inventors also found that the three-dimensional crimp and the loop shape can develop high bulkiness.

[0030] It was found that the above-mentioned effects tend to deteriorate when the loops of the sheath yarns are broken in the middle or partially deteriorated. For this reason, in the present invention, the sheath yarns are not substantially broken in order to satisfy the contradicting characteristics of both the bulkiness and suppression of tanglement unprecendently. It is particularly preferable that the sheath yarn be not substantially broken in the middle of the loop.

[0031] In the determination of loop breakage in the present invention, at 10 sites randomly selected from a single textured yarn consisting of a sheath yarn and a core yarn, the textured yarn is photographed at a magnification at which 10 or more sections from a twist point between the core yarn and the sheath yarn to the next twist point (that is, each section is one loop) can be recognized in the longitudinal direction of the textured yarn, and observed for the determination. That is, for each of the 10 photographed images, the number of breaking points of the sheath yarn per 1 mm of the bulky

yarn was counted for 10 loops. The average of the number of breaking points of the loops was calculated, and the average was rounded off to the first decimal place to give the number of breaking points of the loops (number/mm). Herein, when the number of breaking points on average of the total of 100 loops is 0.2/mm or less, it means that the sheath yarn according to the present invention is not substantially broken, that is, the sheath yarn is almost continuous in the length direction of the bulky yarn. When the number of breaking points is within this range, there is substantially no sheath yarn that has a free end, and it is possible to form loops that are not tangled with other sheath yarns.

[0032] In the case of subjecting a yarn to real twisting and then an untwisting step, or intermingling and opening the yarn in the nozzle by strong air injection as in the conventional method, the traveling thread may be slammed into the inside of the nozzle made of metal at high frequency to be broken or deteriorated. Further, when loops are to be formed, it is necessary to scratch the yarn between rubber discs to untwist the yarn, so that the sheath yarn may be broken or the mechanical properties may be largely deteriorated. Accordingly, it is thought that the broken sheath yarn is wound around other sheath yarns or the sheath yarns are tangled with each other to promote the entanglement, resulting in constraining the structural form and high-order processing of the yarn. In the present invention, these points are greatly remedied, and as described above, the effects produced by the three-dimensionally crimped sheath yarn can be sufficiently exhibited.

[0033] The sheath yarn responsible for the bulkiness has a three-dimensional crimped structure, and is not substantially broken and continuously forms loops. The three-dimensional crimped structure in the present invention means a structure in which a filament single yarn has a spiral structure as illustrated in Fig. 3.

[0034] For the evaluation of the three-dimensional crimp, at each of 10 sites randomly selected from a bulky yarn, 10 or more sheath yarns are selected, and the sheath yarns are observed with a digital microscope or the like at a magnification at which the crimp form of the sheath yarns can be recognized. In these images, if the observed sheath yarns have a spirally swirling form, the sheath yarns are determined to have a three-dimensional crimped structure, and if not, the sheath yarns are determined not to have a three-dimensional crimped structure.

[0035] Fibers having such a three-dimensional crimped structure similar to a spring have resilience against elongation deformation and compressive deformation. The bulky yarn of the present invention exhibits comfortable resilience since the sheath yarn has such structure. In the case where the bulky yarn of the present invention is doubled and filled in the form of a yarn bundle between fabrics, the peculiar resilience produced by the bulky yarn of the present invention develops a good touch of the filled material, and the sheath yarn supporting the filled material recovers the shape like a spring even after repeated compression recovery. Thus, the bulky yarn is suitable also from the viewpoint of suppression of fatigue. The size of the three-dimensional crimp of a latent crimped yarn which is obtained by common production methods, such as conventional side-by-side composite fibers and hollow fibers, is generally on the order of microns (10^{-6} m). In the present invention, in order to enhance the effects of the present invention, it is preferable that the size of the crimp be on the order of millimeters (10^{-3} m) which is larger than the above. In the present invention, owing to such size of the three-dimensional crimp, it is possible to freely control the bulkiness at the cross section of the bulky yarn viewed from the longitudinal direction of the bulky yarn as well as the resilience of the bulky yarn. With use of the resilience, it is naturally possible to suppress the tanglement between the sheath yarns, which is one of the objects of the present invention. In particular, when the crimp size is set to a value on the order of millimeters, tanglement between the sheath yarns is suppressed while both the bulkiness and compressibility of mainly the sheath yarn are satisfied.

[0036] In the sheath yarn of the present invention, the spirally swirling spiral structure preferably has a radius of curvature in the range of 1.0 to 30.0 mm. Herein, for the determination of the radius of curvature of the spiral structure, an image two-dimensionally observed with a digital microscope or the like is used in the same manner as in the above-mentioned determination of the presence or absence of the three-dimensional crimp. As shown in Fig. 3, the radius of a curvature 6 formed by a fiber having a spiral structure is defined as the radius of curvature. At each of 10 sites randomly selected from a bulky yarn, 10 or more sheath yarns are collected, and the sheath yarns are observed with a digital microscope or the like at a magnification at which the crimp form of the sheath yarns can be recognized. In this way, the radius of curvature of a total of 100 sheath yarns is measured up to the second decimal place in millimeters. The simple average of these measured values is calculated, and a value obtained by rounding off the average to the first decimal place is taken as the radius of curvature of the three-dimensional crimped structure.

[0037] The radius of curvature is more preferably 2.0 to 20.0 mm. When the radius of curvature is within this range, the sheath yarns come into point contact with each other while having moderate resilience against the compression of the bulky yarn in the cross section viewed from the longitudinal direction of the bulky yarn, so that the bulkiness having moderate resilience is exhibited. The radius of curvature is particularly preferably 3.0 to 15.0 mm. When the radius of curvature is within this range, there is no problem in the long-term durability of the bulky yarn, and the effects of the present invention are positively exerted when the bulky yarn is used in clothing applications in which compression recovery is repeatedly exerted, particularly sports clothing used under harsh environments. This is because the single yarn itself has a three-dimensional stereoscopic form rather than two-dimensional bending that can be imparted by mechanical pushing, and has a spiral structure or a similar structure. Since these crimps have a form of fine crimps on the order of microns, the fine spiral structures mesh with each other, so that the entanglement is easily promoted.

[0038] Meanwhile, the present inventors pushed forward the study focusing on the form of the monofilaments, in order to achieve suppression of tanglement between the bulky yarns which is one of the objects of the present invention. As a result, they found that a phenomenon completely opposite to the conventional recognition occurs when the sheath yarn is formed of a single yarn having a three-dimensional crimp on the order of millimeters. This is thought to be because the bulky yarns have a suitable excluded volume even when being made into a yarn bundle since the sheath yarns have a three-dimensional crimp on the order of millimeters, and the meshing between the sheath yarns is largely suppressed. That is, the sheath yarn in the bulky yarn of the present invention has a movable space depending on the size of the loops. According to the definition of the present invention, each loop has, around the twist point thereof, a relatively large hemispherical movable space having a radius of 1.0 mm or more. In this case, the sheath yarns having a three-dimensional crimp which is overwhelmingly large in size relative to the fiber diameter come into point contact with each other and resile each other, so that each sheath yarn can exist alone without being tangled with other sheath yarns. Further, in the sheath yarn having a three-dimensional crimp, in addition to having the movable space described above, the sheath yarn itself can elongate like a spring in the fiber axis direction. Thus, when the sheath yarns cross each other, the sheath yarns can be easily unwound by the application of vibration.

[0039] Furthermore, the three-dimensional crimp of the sheath yarn works effectively also from the viewpoint of bulkiness which is the basic characteristics of the present invention. The point contact between the sheath yarns as described above produces an effect that the sheath yarns resile one another even within one bulky yarn, and not only the initial bulkiness but also the state where the loops of the sheath yarns are radially opened can be maintained even after the lapse of time. The spring-like behavior of the sheath yarn of the present invention is difficult to achieve with a conventional merely straight sheath yarn.

[0040] The feature of form that the sheath yarn of the present invention forms loops and has a three-dimensional crimped structure also has an effect on the reduction of the coefficient of friction. As described above, this is the effect produced by the point contact of the sheath yarn with other sheath yarns, and is one of the effects produced by the bulky yarn having the unique structure of the present invention. According to the study of the present inventors, it is preferable that the coefficient of static friction between fibers be 0.3 or less in order to suppress tanglement between the bulky yarns while maintaining the bulkiness. The "coefficient of static friction between fibers" as used herein is measured with a radar type coefficient of friction tester according to the method described in "coefficient of friction" in JIS L 1015 (2010) "Chemical fiber staple testing method". Since the JIS is intended for staples, the standard specifies that a preliminary work such as opening of fibers should be carried out for the measurement. In the measurement according to the present invention, however, treatment such as opening of fibers is not carried out, and the coefficient of friction can be evaluated by arranging bulky yarns in parallel into a cylindrical sliver.

[0041] In the case where the bulky yarn of the present invention is made into a textile product, the coefficient of static friction between fibers is preferably low since the texture is improved if the fibers moderately slide and move at the time of compression. The coefficient of static friction between fibers is more preferably 0.2 or less, particularly preferably 0.1 or less.

[0042] In addition, from the viewpoint of seeking for a more excellent touch with the bulky yarn of the present invention, the sheath yarn and the core yarn preferably have a single yarn fineness ratio (sheath/core) in the range of 0.5 to 2.0. When the single yarn fineness ratio is within this range, the fineness of the sheath yarn is close to that of the core yarn, and the bulky yarn can be used without any feeling of a foreign body when compressed. Further, a range of the single yarn fineness ratio (sheath/core) in which the bulky processing can be efficiently carried out may be 0.7 to 1.5. Further, in the bulky yarn of the present invention, it is possible to combine various fibers. From the viewpoint of the efficient fluid processing and no feeling of a foreign body at the time of compression as described above, the core yarn and the sheath yarn suitably have the same single yarn fineness and the same mechanical properties. Specifically, in the present invention, it is preferable to prepare two or more 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.

[0043] From the viewpoint of reduction of the coefficient of friction and suppression of tanglement in the bulky yarn as described above, it is preferable that the core yarn also have a three-dimensional crimped structure on the order of millimeters in addition to the sheath yarn. The radius of curvature of the spiral structure of the core yarn is preferably in the range of 1.0 to 30.0 mm. When the radius of curvature is within this range, at the twist point of the core yarn substantially fixing the sheath yarn, there is an inter-filament void derived from the three-dimensional crimp of the core yarn. In this case, when no tension is applied to the bulky yarn, the fulcrum of the loop can move in a limited space also in the longitudinal direction. Thus, the movable space of the sheath yarn is expanded, and the effects of the present invention, that is, the suppression of tanglement and a soft texture, are more remarkably exhibited. On the other hand, when tension is applied to the bulky yarn, the core yarn elongates and the binding force at the twist point between the core yarn and the sheath yarn is increased, so that practically positive effects such as prevention of loosening of the loops and falling off of the sheath yarn can be exhibited. The three-dimensional crimp of the core yarn can also be confirmed by observing a randomly collected core yarn in accordance with the evaluation method for the three-dimensional crimp of the sheath yarn as described above. The radius of curvature of the spiral structure of the core yarn is more

preferably 3.0 to 15.0 mm. When the radius of curvature is within this range, the bulky yarn is good in the long-term durability, and the effects of the present invention are positively exerted when the bulky yarn is used in clothing applications or sports clothing in which elongation deformation is repeatedly applied to the bulky yarn.

[0044] It is preferable that the core yarn and/or the sheath yarn used in the present invention be hollow section fibers. It is more preferable that the fibers having a three-dimensional crimped structure be hollow section fibers. This is because the hollow section fibers are advantageous in that the size of the three-dimensional crimp can be adjusted relatively freely from large to small.

[0045] Also from the viewpoint of protrusion of the loops, the hollow section fibers are preferable. The reason will be described below. In the bulky yarn of the present invention, the loops of the sheath yarn originate from the twist points with the core yarn, and are capable of protruding due to the rigidity of the sheath yarn. In view of prevention of fatigue, it is preferable that the sheath yarn itself have a small mass. Therefore, from the viewpoint of the lightweight properties of the sheath yarn, hollow section fibers having a hollow rate of 20% or more are preferable. Herein, the "hollow rate" is the volume fraction of a part of the fibers in which no material is present.

[0046] For example, the hollow rate can be measured by the following method. The sheath yarn or the core yarn is cut so that the cross section can be observed, and then the cross section of the fibers is photographed with an electron microscope (SEM) at a magnification at which cross sections of 10 or more fibers can be observed. From the photographed image, 10 fibers are randomly selected and extracted, and the equivalent circle diameters of the fibers and the hollow portions are measured with image processing software. The area rate of the hollow portions is calculated from the measured values. The above-mentioned operation is carried out on the 10 photographed images, and the average of the 10 images is taken as the hollow rate of the hollow section fibers of the present invention.

[0047] In the case of round hollow fibers, there are the following methods for conveniently evaluating the hollow rate.

[0048] The side surface of a hollow section fiber is observed with an enlarging means such as a microscope, and the fiber diameter in terms of the round cross section is obtained from the image. From the fiber diameter and the density of the fiber material, the rate of the measured fineness to the fineness of a non-hollow fiber can be calculated as the hollow rate.

[0049] From the viewpoint of lightweight and heat retention properties which are objects of the present invention, the bulky yarn of the present invention suitably contains more air. Thus, the hollow rate is more preferably 30% or more. When the hollow rate is within this range, it is possible to feel better lightweight properties when a bundle of the bulky yarns is held. In addition, since a bulky yarn having such a hollow rate contains more air having a low thermal conductivity inside, it is possible to further enhance the heat retention properties. From such a viewpoint, the higher the value of the hollow rate is, the more suitable it is. The hollow rate, however, is preferably 50% or less in order that the hollow portions may be stably produced without being collapsed in the yarn-making step and the fluid processing step described later.

[0050] The bulky yarn of the present invention has excellent bulkiness, and it is preferable that the yarn that constitutes the bulky yarn have moderate resilience. In consideration of the problems to be solved by the present invention, it is preferable that the synthetic fibers that constitute the bulky yarn have a single yarn fineness of 3.0 dtex or more. Further, it is preferable that the filaments that constitute the bulky yarn have moderate rigidity, since deformation such as repeated compression recovery is applied to the bulky yarn when the bulky yarn is used as batting. Thus, it is more preferable that the single yarn fineness be 6.0 dtex or more. Herein, the fineness means a value calculated from the obtained fiber diameter, number of filaments, and density, or a value of the mass per 10000 m calculated from the simple average of a plurality of measurements of the weight of the fibers per unit length.

[0051] The bulky yarn of the present invention preferably has a breaking strength of 0.5 to 10.0 cN/dtex and an elongation of 5% to 700%. Herein, the strength is a value obtained by drawing a load-elongation curve of a yarn under the conditions shown in JIS L 1013 (1999), and dividing the load value at break by the initial fineness. The elongation is a value obtained by dividing the elongated length at break by the initial sample length. The breaking strength of the bulky yarn of the present invention is preferably 0.5 cN/dtex or more in order for the bulky yarn to have process passability in the high-order processing step and to be capable of withstanding practical use, and the practicable upper limit of the breaking strength is 10.0 cN/dtex. In addition, it is preferable that the elongation be 5% or more in consideration of process passability in the post-processing step, and the practicable upper limit of the elongation is 700%. The breaking strength and elongation can be adjusted by controlling the conditions in the production process depending on the intended use. In the case where the bulky yarn of the present invention is used in general clothing applications such as inner and outer clothing, or bedclothes such as futons and pillows, the breaking strength is preferably 0.5 to 4.0 cN/dtex. Further, in sports clothing applications in which the usage conditions are relatively harsh, the breaking strength is preferably 1.0 to 6.0 cN/dtex.

[0052] The bulky yarn of the present invention can be made into various fiber structures such as fiber winding packages, tows, cut fibers, batting, fiber balls, cords, pile, and woven, knitted, and nonwoven fabrics, and further made into various textile products. Herein, the "textile products" can be used in applications such as general clothing, sports clothing, clothing materials, interior products such as carpets, sofas, and curtains, vehicle interior products such as car seats, daily necessities such as cosmetics, cosmetic masks, wiping cloths, and health supplies, and environmental and in-

dustrial materials such as filters and products for removing hazardous substances. In particular, the bulky yarn of the present invention is suitably used as the batting because of its bulkiness and effects such as suppression of tanglement. In this case, since the batting is filled into the outer fabric, the bulky yarn is preferably made into a yarn bundle of several to several tens of yarns, or a sheet-like material such as a nonwoven fabric. In particular, as for the bulky yarn made

into a sheet, it is easy to fill the sheet into an outer fabric, and to adjust the filling amount depending on the intended use. For this reason, the bulky yarn is made into a thin, light material having heat retention properties, and there is no concern that the material comes out of an outer fabric. Since unnecessary sewing can be omitted, there is no restriction on the form of the textile product, and the textile product may have a complicated design.

[0053] Hereinafter, an example of the method for producing a bulky yarn of the present invention will be described.

[0054] As the core yarn and the sheath yarn used in the present invention, synthetic fibers obtained by fiberizing a thermoplastic polymer by a melt spinning method may be used.

[0055] The spinning temperature for obtaining the synthetic fibers used in the present invention is a temperature at which the used polymer exhibits fluidity. The temperature at which the polymer exhibits fluidity varies depending on the molecular weight. An indication of the temperature is the melting point of the polymer, and the temperature may be set at a temperature equal to or higher than the melting point to (melting point + 60°C) or lower. A temperature of (melting point + 60°C) or lower is preferable because the polymer is not thermally decomposed in a spinning head or a spinning pack, and the reduction in the molecular weight is suppressed. In addition, the discharge amount of the polymer is generally 0.1 g/min/hole to 20.0 g/min/hole per discharge hole since a discharge amount within this range allows stable discharge of the polymer. In this case, it is preferable to consider the pressure loss in the discharge hole at which the stable discharge can be ensured. A preferable indication of the pressure loss is within the range of 0.1 MPa to 40 MPa, and the pressure loss can be adjusted according to the melt viscosity of the used polymer, the specification of the discharge hole, and the discharge amount.

[0056] The molten polymer discharged in this manner is cooled and solidified, an oil agent is imparted to the molten polymer, and the molten polymer is taken up with a roller to be formed into fibers. Herein, the take-up speed should be determined according to the discharge amount and the intended fiber diameter. In order to stably produce the fibers, it is preferable to set the take-up speed in the range of 100 to 7000 m/min. From the viewpoint of enhancing the orientation of the synthetic fibers and improving the mechanical properties thereof, the synthetic fibers may be wound up and then stretched, or the synthetic fibers may be stretched without being wound up once. As for the stretching conditions, for example, in a stretching machine having one or more pairs of rollers, in the case of a melt-spinnable polymer, generally, the polymer is stretched by the circumferential speed ratio between a first roller set at a temperature equal to or higher than the glass transition temperature and a second roller set at about a crystallization temperature (second roller/first roller), and then the polymer is wound up on a winding machine. In the case of a polymer that exhibits no glass transition, a dynamic viscoelasticity measurement ($\tan \delta$) of the composite fibers may be carried out, and a temperature equal to or higher than the peak of the temperature/ $\tan \delta$ curve (when there are a plurality of peaks, the one having the highest temperature) as a preliminary heating temperature may be employed as the first roller temperature. Herein, from the viewpoint of increasing the stretch ratio and improving the mechanical properties, it is also a suitable means to carry out the stretching step in multiple stages.

[0057] The cross-sectional shape of the synthetic fibers of the present invention is not particularly limited, and fibers having a general round cross section, a triangular cross section, a Y-shaped cross section, an octofoil cross section, a flat cross section, or an amorphous shape such as a polymorphic cross section or a hollow cross section can be obtained by changing the shape of the discharge hole of the spinneret. Further, there is no need to form the synthetic fibers from a single polymer, and the fibers may be composite fibers formed from two or more kinds of polymers. However, from the viewpoint of developing the three-dimensional crimp of the sheath yarn, which is an important requirement of the present invention, it is appropriate to use side-by-side composite fibers having a hollow cross section and including two kinds of polymers bonded together. In these fibers, a three-dimensional crimp can be developed due to the presence of foreign substances in the cross section of the monofilaments by subjecting the fibers to yarn-making and yarn processing, and the subsequent heat treatment. Therefore, although the fibers are so-called straight fibers at the time of fluid processing described later, the fibers develop the three-dimensional crimp through the loop forming step of the sheath yarn and the subsequent heat treatment.

[0058] If the fibers are straight at the time of bulky processing, the threads are easy to stably travel without blocking a nozzle or the like. Also in forming the loops of the present invention, the core yarn and the sheath yarn are efficiently swirled, so that the loops have very similar shapes in the fiber axis direction of the textured yarn. Heat-treating the textured yarn having the loops at around the crystallization temperature of the polymer makes the sheath yarn develop a three-dimensional crimp to give a bulky yarn. The three-dimensional crimp of the sheath yarn develops satisfactory bulkiness both in the circumferential direction and in the cross-sectional direction of the textured yarn. It is preferable to control the three-dimensional crimp to a moderate level depending on the desired characteristics.

[0059] From the viewpoint of controlling the degree of crimp development after the heat treatment, it is more preferable that the fibers used be hollow section fibers made from a monocomponent polymer. Hollow section fibers have an air

layer having low thermal conductivity at the center of the fibers. Therefore, a difference in the structure is produced in the cross-sectional direction of the fibers, for example, by discharging the fibers from a spinneret capable of forming a hollow cross section, and then forcibly cooling one side of the fibers with excessive cooling air or the like, or excessively heat-treating one side of the fibers with a heating roller or the like at the time of stretching. In the case of hollow section fibers made from a monocomponent polymer, not only the fibers are capable of yarn-making with a single spinning machine, but also a three-dimensional crimp in a large size to a small size can be relatively easily obtained by the above-mentioned operation. Therefore, such fibers are suitable for use in the present invention. Also from the viewpoint of crimp control by the above-mentioned operation, as described above, the hollow rate is preferably 20% or more, more preferably 30% or more.

[0060] Next, an example of a method for producing a bulky yarn from fibers obtained by spinning will be described.

[0061] The method for producing a bulky yarn described herein as an example is roughly composed of two steps. The first step is bulky processing in which a core yarn and a sheath yarn are twisted with each other with a fluid to form loops of the sheath yarn. The second step is a heat treatment step in which the thread having been subjected to the bulky processing is subjected to heat treatment to make the sheath yarn develop a three-dimensional crimp.

[0062] An example of the method for producing a bulky yarn of the present invention will be described with reference to the schematic process diagram in Fig. 4. In the first step, a predetermined amount of synthetic fibers 8 as a raw material are unwound with supply rollers 7 having a nip roller or the like, and sucked as a core yarn and a sheath yarn with a suction nozzle 9 capable of injecting compressed air.

[0063] In the suction nozzle 9, the flow rate of the compressed air injected from the nozzle should be such a flow rate that the thread inserted from the supply rollers into the nozzle has the minimum required tension and stably travels between the supply rollers and the nozzle and within the nozzle without swaying. Although the optimum flow rate varies depending on the hole diameter of the used suction nozzle, an indicator of the range in which the tension can be imparted to the yarn and the loops described later can be smoothly formed is an air speed in the nozzle of 100 m/s or more. An indicator of the upper limit of the air speed is 700 m/s or less. When the air speed is within this range, the thread can stably travel inside the nozzle without being swayed by the excessively injected compressed air.

[0064] In addition, from the viewpoint of preventing intermingling and opening of the textured yarn inside the suction nozzle, a propellant air jet stream injected at an injection angle (reference sign 16 in Fig. 5) of the compressed air less than 60° with respect to the traveling thread is preferable. This is because the loops of the sheath yarn can be uniformly formed with high productivity. Processing with a vertical air jet stream of a fluid injected at an injection angle of 90° with respect to the traveling thread is of course capable of producing the bulky yarn of the present invention. However, processing with a propellant air jet stream is preferable from the viewpoint of suppressing the opening of the traveling thread due to the injection of the air jet stream from the vertical direction, and suppressing the tanglement between single yarns in a narrow space in the nozzle. The processing with the propellant air jet stream can also suppress the formation of arch-shaped small loops in a short period, which are easily formed in the case of the vertical air jet stream.

[0065] In order to form the loops of the sheath yarn required for the bulky yarn of the present invention, it is suitable not to carry out intermingling or opening in the suction nozzle. From the viewpoint of making a multifilament composed of single-digit number to double-digit numbers of yarns travel in the nozzle without being opened, it is more preferable that the injection angle of the compressed air be 45° or less with respect to the traveling thread. Furthermore, in order to form loops outside the nozzle as described later, it is suitable that the injected air stream immediately after the nozzle have high stability and high propelling power. From this viewpoint, the injection angle is particularly preferably 20° or less with respect to the traveling thread.

[0066] There are cases where the threads led to the suction nozzle are fed at once or in two installments. In order to produce the bulky yarn of the present invention, it is suitable to process the yarn by feeding the threads in two installments. The wording "feeding in two installments" as used herein refers to a technique of supplying the core yarn and the sheath yarn to the nozzle at different feed speeds (amounts) with separate supply rollers or the like. The turning force caused by an air stream described later is utilized, so that one of the yarns that is excessively supplied serves as a sheath yarn and forms loops.

[0067] When the feeding in two installments is carried out, it is also possible to form loops in the nozzle with use of an interlacing nozzle or a taslan nozzle that imparts the effects of intermingling, opening, and interlacing to the traveling thread inside the nozzle. However, the textured yarn obtained with such a nozzle tends to have loops formed in a short period, and also tends to have loops small in size.

[0068] Therefore, in order to produce a bulky yarn satisfying the objects of the present invention, it is necessary to precisely control a large number of parameters. In addition, when multi-spindle spinning is carried out, there is a possibility that the bulkiness of the bulky yarn will be different by the spindle. Thus, it is suitable to employ a technique based on air stream control outside the nozzle as described later also from the viewpoint of stability of the quality. As for this point, the present inventors considered not to positively carry out intermingling and opening in the nozzle.

[0069] Next, a step of swirling, outside the nozzle, the thread to which the compressed air has been applied to form loops of the sheath yarn is carried out. This operation is based on a concept that loops can be formed by swirling the

supplied two yarns at a position distant from the nozzle. It was found that there is a specific phenomenon in which the sheath yarn swirls while being opened outside the nozzle when the ratio of the air speed to the yarn speed (air speed/yarn speed) is 100 to 3000.

[0070] Herein, the air speed means the speed of the air stream injected together with the traveling thread from the suction nozzle outlet. This speed can be controlled by the discharge diameter of the nozzle and the flow rate of the compressed air. Further, the yarn speed can be controlled by the circulating speed of the rollers which take up the yarn after the fluid processing nozzle. Since the turning force of the traveling thread increases and decreases depending on the speed ratio between the air stream and the yarn, in the case of strengthening the twist point of the intended bulky yarn, this speed ratio should be approximated to 3000. Alternatively, in the case of loosening the twist point, this speed ratio should be approximated to 100. Varying this speed ratio, for example, by intermittently varying the flow rate of the compressed air, or by varying the speed of the take-up rollers, can vary the degree of the twist point. Meanwhile, in the case where the bulky yarn of the present invention is used in applications in which deformation of compression recovery is repeatedly applied as in the batting, it is preferable to set the air speed/yarn speed to 200 to 2000. In particular, in the case of producing a bulky yarn used in clothing such as jackets to which deformation is frequently applied, it is particularly preferable to set the air speed/yarn speed to 400 to 1500 from the viewpoint of imparting moderate binding and flexibility.

[0071] The turning force is developed when the accompanying air stream gets away from the traveling thread. Then, a turning point 10 for changing the thread path is arranged. Specifically, the thread path may be changed with a bar guide or the like. Then, the thread is taken up at a predetermined speed, so that the sheath yarn is swirled around the core yarn to form loops. From the viewpoint of ensuring the space for the swirling and of loosening the sheath yarn by the vibration utilizing the diffusion of the air stream injected from the nozzle, it is suitable that the turning point of the traveling thread be located away from the nozzle discharge hole. However, the distance between the nozzle and the turning point which is suitable for producing the bulky yarn of the present invention varies depending on the speed of the ejected air stream. The turning point 10 is preferably present within a range in which the ejected air stream travels for 1.0×10^{-5} to 1.0×10^{-3} seconds. In order to form twist points between the core yarn and the sheath yarn at an appropriate period in balance with the diffusion of the air stream, the distance between the nozzle and the turning point is more preferably present within a range in which the ejected air stream travels for 2.0×10^{-5} to 5.0×10^{-4} seconds.

[0072] Adjusting the position of the turning point enables control of the period of the twist points of the bulky yarn of the present invention. The twist points play a role of supporting the self-supporting loops of the sheath yarn which are a feature of the present invention, and are suitably present at a moderate period. From this viewpoint, it is preferable to adjust the turning point so that the core yarn and the sheath yarn in the bulky yarn have 1/mm to 30/mm twist points. When the number of twist points is within this range, it is preferable because even after the sheath yarn is three-dimensionally crimped, the loops are present at a moderate interval. Further from this viewpoint, it is more preferable to adjust the turning point so that the number of twist points be 5/mm to 15/mm.

[0073] A textured yarn 11 (Fig. 4) having loops of the sheath yarn is preferably subjected to heat treatment after being wound up once or following the bulky processing for the purpose of fixing the form and developing the three-dimensional crimp. Fig. 4 illustrates a processing step of carrying out heat treatment subsequently to the loop forming step.

[0074] The heat treatment is carried out, for example, with a heater 13 (Fig. 4). An indicator of the temperature is the crystallization temperature of the used polymer $\pm 30^\circ\text{C}$. When the heat treatment is carried out at a temperature within this range, there is no fused and cured portion between the sheath yarns and between the core yarns, and no feeling of a foreign body, and the good touch is not impaired, since the treatment temperature is far from the melting point of the polymer. The heater used in the heat treatment step may be a general contact heater or non-contact heater. From the viewpoint of bulkiness before the heat treatment and suppression of deterioration of the sheath yarn, use of a non-contact heater is preferable. The non-contact heater herein may be an air heating heater such as a slit heater or a tube heater, a steam heater for heating with high temperature steam, or a halogen heater, a carbon heater, or a microwave heater based on radiation heating.

[0075] Herein, from the viewpoint of heating efficiency, a heater based on radiation heating is preferable. As for the heating time, for example, the time for fixing the fiber structure of the fibers that constitute the textured yarn, fixing the form of the textured yarn, and completing the crimp development of the sheath yarn through the crystallization should be taken into consideration. Thus, the treatment temperature and time should be adjusted according to the desired characteristics. After completion of the heat treatment step, the speed of the textured yarn may be restricted with a roller 14 (Fig. 4), and the textured yarn may be wound on a winder 15 having a tension control function. The wound shape is not particularly limited, and it is possible to employ the so-called cheese winding or bobbin winding. In consideration of processing into the final product, it is also possible to preliminarily double a plurality of textured yarns to make a tow, or form a sheet of the textured yarns as it is.

[0076] It is preferable to make a silicone oil agent uniformly adhere to the bulky yarn of the present invention before and after the heat treatment step. Preferably, a silicone film is formed on the sheath yarn and the core yarn by moderately crosslinking the silicone through heat treatment or the like. Herein, examples of the silicone oil agent include dimethylpolysiloxane, hydrogen methylpolysiloxane, aminopolysiloxane, and epoxypolysiloxane, and these can be used alone

or as a mixture. In order to form a uniform film on the surface of the bulky yarn, the oil agent may contain a dispersant, a viscosity modifier, a crosslinking accelerator, an antioxidant, a flame retardant, and an antistatic agent as long as the object of the adhesion of silicone is not impaired. The silicone oil agent can be used without solvent or in the form of a solution or an aqueous emulsion. From the viewpoint of uniform adhesion of the oil agent, an aqueous emulsion is preferably used. It is suitable that the silicone oil agent be treated so that 0.1 to 5.0% by mass of the silicone oil agent can be made to adhere to the bulky yarn with use of an oil agent guide, an oiling roller, or a spray. After that, it is preferable to dry the oil agent at an arbitrary temperature for an arbitrary time to cause a crosslinking reaction. The silicone oil agent can be made to adhere in plural installments, and it is also suitable to laminate a strong silicone film by making one kind of silicone or different kinds of silicone adhere in plural installments. Forming a silicone film on the bulky yarn by the above-mentioned treatment improves the slidability and touch of the bulky yarn, and further enhances the effects of the present invention.

EXAMPLES

[0077] Hereinafter, the bulky yarn of the present invention and the effects thereof will be specifically described with reference to examples.

[0078] In the examples and comparative examples, the following evaluations were made.

A. Fineness

[0079] The mass of 100 m of fibers was measured and multiplied by 100 to calculate the fineness. This operation was repeated 10 times, and the simple average of the 10 values was obtained. The simple average was rounded off to the first decimal place, and the obtained value was taken as the fineness (dtex) of the fibers. The single yarn fineness was calculated by dividing the fineness by the number of filaments that constitute the fibers. Also for the single yarn fineness, the value was rounded off to the first decimal place, and the obtained value was taken as the single yarn fineness.

B. Mechanical properties of fibers

[0080] Using a tensile tester "TENSILON" (registered trademark) UCT-100 manufactured by ORIENTEC CORPORATION, fibers having a sample length of 20 cm were pulled under the condition of a tension speed of 100%/min, and a stress-strain curve was obtained. The load at break was read, and the load was divided by the initial fineness to calculate the breaking strength (cN/dtex). Further, the strain at break was read, and the strain was divided by the sample length. This value was multiplied by 100 to calculate the elongation at break (%). Both for the breaking strength and elongation at break, this operation was repeated 5 times at each level, the simple average of the resultant values was obtained, and the obtained value was rounded off to the first decimal place.

C. Evaluation of loops (size, twist point, and breaking point)

[0081] A load of 0.01 cN/dtex was applied to a sample yarn so that the sample yarn would not be slackened, and the yarn of a fixed length was threaded on the pair of thread guides 4 as illustrated in Fig. 2. The side surface of the threaded bulky yarn was photographed with Microscope VHX-2000 manufactured by KEYENCE CORPORATION at a magnification at which 10 or more loops could be observed. For the 10 loops randomly selected from the image, a distance 5 from a center line 3 of the textured yarn to the apex of the loop at the tip of the loop (Fig. 2) was measured with image processing software (WINROOF). Total of 10 sites per one textured yarn were photographed, and the size of a total of 100 loops per one textured yarn was measured up to the second decimal place in millimeters. The average of these numerical values was calculated, and a value obtained by rounding off the average to the first decimal place was taken as the size of the loops in the bulky yarn.

[0082] In the 10 images same as described above, a point at which a sheath yarn having a loop apex at a position of 1.0 mm or more from the center line 3 of the textured yarn crosses a straight line at a position of 0.6 mm from the center line 3 of the textured yarn was defined as a twist point, and the number of twist points per 1 mm of the textured yarn was counted. The number of twist points (number/mm) of a total of 10 images was counted, and the average thereof was rounded off to the closest whole number.

[0083] In the 10 images same as described above, the number of breaking points in 10 loops per 1 mm of the textured yarn was counted. The number of breaking points (number/mm) of a total of 100 loops per one bulky yarn was counted, and the average thereof was rounded off to the first decimal place. Herein, a sample having less than 0.2/mm breaking points was evaluated as a sample in which the sheath yarn is not substantially broken (described as "absent" in the description of the examples and comparative examples and in Tables 1, 2, and 3), and a sample having 0.2/mm or more breaking points was evaluated as a sample in which the sheath yarn is broken (described as "present" in the description

of the examples and comparative examples and in the tables).

D. Evaluation of crimp form (presence or absence of three-dimensional crimp, and radius of curvature)

[0084] A textured yarn was observed at randomly selected 10 sites with Microscope VHX-2000 manufactured by KEYENCE CORPORATION at a magnification at which the crimp form of a single yarn can be recognized. In each of the 10 images, 10 core yarns and 10 sheath yarns were observed. A yarn having a spirally swirling form (spiral structure) was determined as having a three-dimensional crimped structure (described as "present" in the description of the examples and comparative examples and in Tables 1, 2, and 3), and a yarn not having a spiral structure was determined as not having a crimped structure (described as "absent" in the description of the examples and comparative examples and in the tables). In addition, in the same images as described above, the radius of the curvature 6 (Fig. 3) of a crimped single yarn was measured with image processing software (WINROOF). The radii of the 100 core yarns and 100 sheath yarns randomly selected as described above were measured up to the second decimal place in millimeters, and the simple average of the measured values was obtained. The simple average was rounded off to the first decimal place, and the obtained value was taken as the radius of curvature of the three-dimensional crimped structure.

E. Coefficient of static friction between fibers

[0085] The coefficient of static friction between fibers was measured with a radar type coefficient of friction tester according to JIS L 1015 (2010). It should be noted that no pretreatment such as opening was carried out, and the coefficient of static friction between fibers was evaluated by arranging samples in parallel into a cylinder.

F. Unwinding properties (effect of suppressing entanglement)

[0086] A drum on which 500 m or more of a textured yarn is wound was placed on a creel, and the textured yarn was unwound in the cross-sectional direction of the drum at a speed of 30 m/min for 5 minutes. The disarrayed yarn and yarn tangle due to the entanglement were visually confirmed and evaluated on the following four scales.

- A: No disarrayed yarn is observed and the yarn can be satisfactorily unwound.
- B: Slight disarrayed yarn is observed, but the yarn can be unwound without problem.
- C: Disarrayed yarn and slight yarn tangle are observed, but the yarn can be unwound.
- D: Disarrayed yarn and yarn tangle are observed, and the yarn cannot be unwound.

G. Touch

[0087] A drum on which 500 m or more of a textured yarn is wound was placed on a creel, and the textured yarn was unwound and wound into a skein having a length of 10 m in the cross-sectional direction of the drum with a measuring machine. One position of the skein was fixed to prepare a sample for texture evaluation. The touch of the sample when gripped was evaluated on the following four scales.

- A: The sample is excellent in bulkiness and flexibility, and has an excellent texture without feeling of a foreign body.
- B: The sample has a good texture with bulkiness and flexibility.
- C: The sample has bulkiness, and has a good texture without feeling of a foreign body.
- D: The sample has no bulkiness, and has a poor texture with feeling of a foreign body.

H. Intrinsic viscosity (IV) of polymer

[0088] In 10 mL of o-chlorophenol having a purity of 98% or more at a temperature of 25°C, 0.8 g of the polymer to be evaluated was dissolved, and the intrinsic viscosity (IV) of the polymer was determined with an Ostwald viscometer at a temperature of 25°C.

Example 1

[0089] Polyethylene terephthalate (PET: IV = 0.65 dl/g) was melted at 290°C, weighed, charged into a spinning pack, and discharged from a discharge hole for a hollow cross section having 3 slits 17 (width: 0.1 mm) in concentric sectors as shown in Fig. 6. Cooling air at 20°C was blown to one side of the discharged thread at a flow of 100 m/min to cool and solidify the thread. A nonionic spinning oil agent was applied to the thread, and an unstretched yarn was wound up at a spinning speed of 1500 m/min. Then, the wound unstretched yarn was stretched 3.0 times between rollers heated

at 90°C and 140°C at a stretching speed of 800 m/min to give a stretched yarn having a fineness of 78 dtex, a number of filaments of 12, and a hollow rate of 30%.

[0090] As shown in Fig. 4, each of two supply rollers was supplied with one hollow section yarn, and the hollow section yarns were sucked to the suction nozzle with one of the supply rollers running at a speed of 50 m/min and the other running at a speed of 1000 m/min. In the suction nozzle, compressed air at an angle of 20° with respect to the traveling thread was injected at an air speed of 400 m/s, and the thread was ejected from the nozzle together with the accompanying air stream so that the core yarn and the sheath yarn would not twist with each other. The thread injected from the nozzle was made to travel together with the air stream for 1.0×10^{-4} seconds, and the thread path was changed with use of a ceramic guide to give a textured yarn having loops of the sheath yarn. The textured yarn was then taken up with take-up rollers at 50 m/min.

[0091] Then, the textured yarn was led to a tube heater through the rollers and heat-treated with heated air at 150°C for 10 seconds to set the form of the bulky yarn and develop a three-dimensional crimp of the sheath yarn. The bulky yarn was wound on a drum at 52 m/min with a tension control type winding machine installed behind the tube heater.

[0092] The bulky yarn collected in Example 1 had a structure in which loops of the sheath yarn protruded by 23.0 mm on average from the center line of the textured yarn, and had the loops at a frequency of 13/mm. The protruded loops were excellent in the uniformity of size and period.

[0093] The sheath yarn formed loops and was fixed by being twisted with the core yarn. The core yarn and the sheath yarn had a three-dimensional crimped structure on the order of millimeters and having a radius of curvature of 5.0 mm. No broken site was observed in the sheath yarn, and the sheath yarn continuously formed loops. (Number of broken sites: 0.0)

[0094] In the bulky yarn, the sheath yarn forming continuous loops had a three-dimensional crimped structure, the coefficient of static friction between fibers was 0.3, the bulky yarn had no problem in the unwinding properties, and the bulky yarn was smoothly unwound from the drum on which it is wound without causing any yarn tangle or the like (unwinding properties: B). In addition, the bulky yarn had a good texture with bulkiness derived from the specific structure of the present invention (texture: B). The results are shown in Table 1.

Example 2

[0095] A silicone oil agent containing polysiloxane at a concentration of 8% by mass was uniformly sprayed to the bulky yarn collected in Example 1 so that the final polysiloxane deposition amount would be 1% by mass with respect to the bulky yarn. The bulky yarn was heat-treated at a temperature of 165°C for 20 minutes to collect a bulky yarn of Example 2.

[0096] In Example 2, due to the formation of the silicone film, the bulky yarn had a smoother touch than that of Example 1 did, and the bulky yarn had a pleasant glossy feeling as well as the bulkiness of the bulky yarn. The bulky yarn had a coefficient of static friction between fibers of 0.1, which was found to be further lower than that in Example 1. As a result of investigating the influence of the silicone treatment on the form of the bulky yarn, the form characteristics of the bulky yarn was roughly in agreement with the form characteristics in Example 1, and other functions were maintained. The bulky yarn was also excellent in the unwinding properties and texture.

[0097] In addition to the unwinding properties, the bulky yarn was easily separable. That is, when 10 bulky yarns each having a length of 50 cm were cut and formed into a bundle, and both the ends of the bundle were held and kneaded or rubbed, the sheath yarns were not tangled with each other, and one bulky yarn was easily taken out of the yarn bundle. The results are shown in Table 1.

[Table 1]

[0098]

[Table 1]

			Example 1	Example 2
Core yarn	Type of polymer	-	PET	PET
	Single yarn fineness	dtex/F	6.5	6.5
	Hollow rate	%	30	30

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(continued)

				Example 1	Example 2	
Sheath yarn		Type of polymer	-	PET	PET	
		Single yarn fineness	dtex/F	6.5	6.5	
		Hollow rate	%	30	30	
Fluid processing	Feed speed	Core yarn feed speed	m/min	50	50	
		Sheath yarn feed speed	m/min	1000	1000	
	Fineness ratio	Sheath/core fineness ratio	-	1.0	1.0	
		Nozzle	Air speed	m/s	400	400
	Air speed/yarn speed		-	480	480	
	Injection angle		O	20	20	
	Intermingling and opening in nozzle		-	absent	absent	
	Turning point (distance/air speed)		s	0.0001	0.0001	
	Silicone		Deposition amount	% by mass	0	1
	Bulky structure yarn	Loop	Loop size	mm	23.0	18.0
Twist point			number/mm	13	10	
Loop breakage (number of breaking points (number/mm))			-	absent (0.0)	absent (0.0)	
Core yarn		Three-dimensional crimp	-	present	present	
		Radius of curvature	mm	5.0	4.7	
Sheath yarn		Three-dimensional crimp	-	present	present	
		Radius of curvature	mm	5.0	4.5	
Charac-teristics		Strength	cN/dtex	4.2	3.5	
		Elongation	%	31	38	
		Coefficient of static friction between fibers	-	0.3	0.1	
		Unwinding properties (effect of suppressing entanglement)	-	B	A	
		Touch	-	B	A	
Remarks						

Comparative Examples 1 and 2

[0099] In order to verify the effect of the bulky processing of the present invention, the same operation as in Example 1 was carried out except that a nozzle whose injection angle of compressed air was changed to 90° was used, and no turning point of the ceramic guide was provided. In Comparative Example 1, however, since the core yarn and the sheath yarn were excessively tangled with each other at the same flow rate of compressed air as in Example 1, and stable yarn processing was difficult due to clogging of the nozzle, the air speed was reduced to 200 m/s, which was half of that in Example 1. As a result, the yarn became capable of traveling. Thus, the obtained textured yarn was collected, and the characteristics were evaluated (Comparative Example 1).

[0100] In the textured yarn of Comparative Example 1, the size of the loops of the sheath yarn was smaller than that in Example 1 before the heat treatment, and the loops were formed in a very short period. Therefore, the textured yarn was heat-treated to be crimped, but the textured yarn was poor in bulkiness although the sheath yarn had loops. When the loops of the sheath yarn were observed in detail, the loop size was uneven, and a relatively large number of breaking points which had not been recognized in the textured yarn picked out before the heat treatment were observed (broken

sites: "present", number of breaking points: 0.5).

[0101] With use of the textured yarn obtained in Comparative Example 1, untwisting treatment was carried out by scratching the textured yarn with a pair of rubber discs (Comparative Example 2). Although the bulkiness seemingly improved, the breakage of the loops was further increased as compared with Comparative Example 1, the tanglement between the sheath yarns was promoted, and the textured yarn gave a feeling of a foreign body when being compressed. In addition, as compared with Comparative Example 1, the yarn tangles increased, and the textured yarn was poor in unwinding properties at the time of unwinding. The results are shown in Table 2.

Comparative Example 3

[0102] With use of the textured yarn of Comparative Example 1, silicone treatment was carried out in the same manner as in the treatment carried out in Example 2 to give a textured yarn of Comparative Example 3.

[0103] As compared with Comparative Example 1, although the textured yarn showed a tendency toward improvement in unwinding properties due to the slidability of silicone, the form of the obtained textured yarn was not largely changed, and the textured yarn had small loops in a short period. As a result, the textured yarn was poor in swelling feeling and also poor in the texture as compared with that in Example 2. The results are shown in Table 2.

Comparative Example 4

[0104] In order to verify the effect of the bulky processing of the present invention, the same operation as in Comparative Example 3 was carried out except that a nozzle whose injection angle of compressed air was changed to 60° was used, and the ceramic guide was arranged so that the yarn can be discharged immediately after the discharge hole of the nozzle.

[0105] In Comparative Example 4, before the heat treatment, small-sized loops and relatively large-sized loops were mixed. Although the core yarn and the sheath yarn contracted due to the heat treatment and a three-dimensional crimped structure was developed, the textured yarn was greatly reduced in the overall bulkiness as compared with Example 1. In addition, the unevenness of the loops before the heat treatment was promoted, and a site where the loops were partially slackened was observed. In addition, since the injection angle of the compressed air was large, the yarn was intermingled and opened in the nozzle, and the yarn was deteriorated due to scratching of the single yarn against the inner wall of the nozzle at high frequency. For this reason, after the heat treatment, the breaking points of the loops were partially observed although the textured yarn showed a small tendency toward improvement as compared with Comparative Example 3. The results are shown in Table 2.

[Table 2]

[0106]

[Table 2]

Core yarn	Type of polymer	-	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4
	Single yarn fineness	dtex/F	6.5	6.5	PET	PET
Sheath yarn	Hollow rate	%	30	30	30	30
	Type of polymer	-	PET1	PET1	PET1	PET1
	Single yarn fineness	dtex/F	6.5	6.5	6.5	6.5
	Hollow rate	%	30	30	30	30
Fluid processing	Core yarn feed speed	m/min	50	50	50	50
	Sheath yarn feed speed	m/min	1000	1000	1000	1000
	Sheath/core fineness ratio	-	1.0	1.0	1.0	1.0
	Air speed	m/s	200	200	400	400
	Air speed/yarn speed	-	240	240	480	480
	Injection angle	°	90	90	90	60
	Intermingling and opening in nozzle	-	present	present	present	present
	Turning point (distance/air speed)	s	0	0	0	0.0000025
	Deposition amount	% by mass	0	0	1	1
	Silicone					

(continued)

Bulky structure yarn	Loop	Loop size	mm	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4
		Twist point	number/m m				
		Loop breakage (Number of breaking points (number/mm))	-				
	Core yarn	Three-dimensional crimp	-	present	present	present	present
		Radius of curvature	mm	4.7	4.8	4.6	4.1
		Three-dimensional crimp	-	present	present	present	present
	Sheath yarn	Radius of curvature	mm	4.2	4	4.5	4.8
		Strength	cN/dtex	2.3	1.9	1.9	2.5
	Charac-teristics	Elongation	%	21	18	32	29
		Coefficient of static friction between fibers	-	0.5	0.6	0.4	0.4
		Unwinding properties (effect of suppressing entanglement)	-	D	D	D	D
		Touch	-	D	D	C	C
		Remarks		Strong rough touch Breakage occurred	Feeling of foreign body due to entanglement of sheath yarn	Feeling of foreign body Breakage occurred	Feeling of foreign body Breakage occurred

Examples 3 and 4

[0107] The same operation as in Example 2 was carried out except that the feed speed was changed to 50 m/min for the core yarn and 500 m/min for the sheath yarn in Example 3, and 20 m/min for the core yarn and 1000 m/min for the sheath yarn in Example 4.

[0108] In Example 3, the size of the loops was 12 mm and somewhat smaller than that in Example 2, but the yarn was excellent in the unwinding properties, and had a good texture.

[0109] In Example 4, although the loop size was 59 mm and larger than that in Example 2, the loops had almost no slack. As for the texture, the yarn had flexibility and excellent bulkiness. Moreover, since the yarn had a structure in which the cutting and slack of the sheath yarn were also suppressed, the yarn was good in the unwinding properties. The results are shown in Table 3.

Example 5

[0110] A stretched yarn having a different single yarn fineness and a different hollow rate (fineness: 78 dtex, number of filaments: 6 (single yarn fineness: 13 dtex), hollow rate: 20%) was collected by yarn-making so as to have a hollow rate of 20% with use of a different spinneret having 6 holes. The same operation as in Example 1 was carried out except that the stretched yarn was used as a sheath yarn.

[0111] In Example 5, due to the thicker sheath yarn, the rigidity of the loops was improved, and a bulky yarn excellent in resilience was obtained. Although the yarn was reduced in flexibility as compared with Example 1, the yarn had sufficient bulkiness. In actual use, the touch of the product can be adjusted by adjusting the number of yarns to be doubled, and the yarn was at a level without problem. The results are shown in Table 3.

Example 6

[0112] A stretched yarn having a different single yarn fineness and a different hollow rate (fineness: 78 dtex, number of filaments: 24 (single yarn fineness: 3.3 dtex), hollow rate: 40%) was collected with use of a different spinneret having 24 discharge holes for a hollow cross section having 4 slits each 0.1 mm in width in concentric circles for yarn-making. The same operation as in Example 1 was carried out except that the stretched yarn was used as a sheath yarn.

[0113] In Example 6, the loops of the sheath yarn were self-supporting due to the twisting with the core yarn, and the sheath yarn was thinner than that in Example 1. As a result, the bulky yarn was excellent in flexibility. As the number of filaments of the sheath yarn increased and the radius of curvature of the crimp decreased (1.5 mm), some disarrayed yarn was seen at the time of unwinding from the drum. However, the disarrayed yarn was eliminated by adjusting the winding tension on the drum, and the yarn was at a level without problem in practical use. The results are shown in Table 3.

[Table 3]

[0114]

[Table 3]

			Example 3	Example 4	Example 5	Example 6
Core yarn	Type of polymer	-	PET	PET	PET	PET
	Single yarn fineness	dtex/F	6.5	6.5	6.5	6.5
	Hollow rate	%	30	30	30	30
Sheath yarn	Type of polymer	-	PET	PET	PET	PET
	Single yarn fineness	dtex/F	6.5	6.5	13.0	3.3
	Hollow rate	%	30	30	30	40

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(continued)

				Example 3	Example 4	Example 5	Example 6	
Fluid processing	Feed speed	Core yarn feed speed	m/min	50	20	50	50	
		Sheath yarn feed speed	m/min	500	1000	1000	1000	
	Fineness ratio	Sheath/core fineness ratio	-	1.0	1.0	2.0	0.5	
	Air	Air speed	m/s	400	400	400	400	
		Air speed/yarn speed	-	480	1200	480	480	
		Injection angle	°	20	20	20	20	
		Intermingling and opening in nozzle	-	absent	absent	absent	absent	
		Turning point (distance/air speed)	s	0.0001	0.0001	0.0001	0.0001	
	Silicone	Deposition amount	% by mass	1	1	0	0	
Bulky structure yarn	Loop	Loop size	mm	11.7	58.5	23.4	23.4	
		Twist point	number/m m	13	10	2	18	
		Loopbreakage number of breaking points (number/mm)	-	absent (0.0)	absent (0.1)	absent (0.0)	absent (0.2)	
	Core yarn	Three-dimensional crimp	-	present	present	present	present	
		Radius of curvature	mm	4.7	4.7	5.0	4.9	
	Sheath yarn	Three-dimensional crimp	-	present	present	present	present	
		Radius of curvature	mm	4.5	4.5	1.5	13	
	Charac- -teristics	Strength	cN/dtex	3.9	4.0	3.7	4.3	
		Elongation	%	38	39	35	32	
		Coefficient of static friction between fibers	-	0.1	0.2	0.2	0.3	
		Unwinding properties (effect of suppressing entanglement)	-	A	B	A	C	
		Touch	-	B	A	C	A	
	Remarks							

Example 7

[0115] A stretched yarn was collected under the same conditions as in Example 1 with use of a different spinneret having 12 round holes so that general round section fibers would be obtained, and the yarn was spun while being excessively cooled from one side with cooling air at 20°C in the same manner as in Example 1. The crimp form of the collected stretched yarn after the heat treatment was loose as compared with that in Example 1, and the radius of curvature of the crimp was 28 mm. The same operation as in Example 2 was carried out except that the stretched yarn was used as a sheath yarn.

[0116] In Example 7, since the crimp form of the sheath yarn was loose, the loops of the sheath yarn had a tufted

shape, and the yarn had an excellent texture having moderate resilience. The results are shown in Table 4.

Example 8

[0117] The same operation as in Example 7 was carried out except that the round section fibers used in Example 7 were used not only in the sheath yarn but also in the core yarn.

[0118] Also in Example 8, since a loose crimp form of the sheath yarn was developed, loops of the sheath yarn formed a tufted structure. In addition, since the crimp form of the core yarn was loose, the binding at the twist point between the core yarn and the sheath yarn was weak, and even when a load was applied to the bulky yarn in the fiber axis direction, the sheath yarn was capable of moving laterally. At the time of unwinding, the yarn was sometimes tangled due to the lateral movement although at a lower frequency than in Example 7, but the yarn was at a level without problem in practical use. The results are shown in Table 4.

Comparative Example 5

[0119] In order to verify the effect of the three-dimensional crimp form of the core yarn and the sheath yarn, yarn processing was carried out with a core yarn and a sheath yarn that were made under different conditions from those in Example 2.

[0120] First, the core yarn was made with a spinneret for general round section fibers used in Example 7, the sheath yarn was made with a spinneret having a discharge hole for a hollow cross section having 3 slits each 0.1 mm in width in concentric circles used in Example 1, and the speed of the cooling air was changed to 20 m/min. A stretched yarn was collected in the same manner as in Example 1 except for the above-mentioned conditions. Both the stretched yarn for the core yarn and the stretched yarn for the sheath yarn had a fineness of 78 dtex and a number of filaments of 12, and did not develop the three-dimensional crimp form in the present invention even after the heat treatment. A textured yarn was collected in the same manner as in Example 1 except that these stretched yarns were used.

[0121] In Comparative Example 5, although it was possible to form loops by providing a turning point outside the nozzle, the crimp of the sheath yarn did not develop even after the heat treatment, and the sheath yarn maintained the straight form. In addition, because the sheath yarn did not develop the crimp, the loop size was uneven as compared with that in Comparative Example 1, and the loops were partially slackened.

[0122] In Comparative Example 5, since the sheath yarns had loops even though they did not develop the three-dimensional crimp, the sheath yarns tended to be tangled with each other more easily than in Example 1, and a lot of yarn tangles were observed at the time of unwinding. In addition, since the textured yarn unwound from the drum underwent compressive deformation, the loops were fatigued and fixed in the state of being laterally slid. Thus, the textured yarn was reduced in the bulkiness. The results are shown in Table 4.

Comparative Example 6

[0123] Low viscosity PET (IV = 0.51 dl/g) and polytrimethylene terephthalate (3GT) (IV = 1.20 dl/g) were prepared, and melted at 280°C. Then, the materials were weighed so that they would be compounded at a ratio of low viscosity PET/3GT = 50/50, poured into a spinning pack having a bonding type composite spinneret, and a composite polymer flow was discharged. Then, cooling air at 20°C was blown to the thread at a rate of 20 m/min, the thread was cooled and solidified, and an oil agent was imparted to the thread. Then, an unstretched yarn was wound at a spinning speed of 1500 m/min. Then, the wound unstretched yarn was stretched 3.0 times between rollers heated at 90°C and 130°C at a stretching speed of 800 m/min to give a stretched yarn of side-by-side composite fibers having a fineness of 78 dtex and a number of filaments of 12. A textured yarn was collected according to Comparative Example 1 except that the stretched yarn was used as a sheath yarn and the round section fibers used in Comparative Example 5 were used as a core yarn.

[0124] In the sample of Comparative Example 6, although the sheath yarn developed a three-dimensional crimp form after the heat treatment, the sheath yarn had a very small radius of curvature of several tens of micrometers, and the sheath yarn was broken at some sites (broken sites: "present", 0.4/mm). In addition, the loops of the sheath yarn were greatly reduced in size as compared with the loops before the heat treatment due to the development of the crimp form, and the number of loops having a distance exceeding 0.6 mm from the center line of the textured yarn was small. For this reason, the textured yarn had a unique rubber-like touch, but did not have the bulkiness and flexibility which are the objects of the present invention. In addition, due to the fine crimp on the order of micrometers, breakage of the sheath yarn, and uneven protrusion of the loops, 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]

[0125]

[Table 4]

		Example 7	Example 8	Comparative Example 5	Comparative Example 6
Core yarn	Type of polymer	PET	PET	PET	PET
	Single yarn fineness	6.5	6.5	6.5	6.5
	Hollow rate	30	0	30	0
Sheath yarn	Type of polymer	PET	PET	PET1	PET/3GT
	Single yarn fineness	6.5	6.5	6.5	6.5
	Hollow rate	0	0	30	0
Fluid processing	Core yarn feed speed	20	50	50	50
	Sheath yarn feed speed	1000	1000	1000	1000
	Sheath/core fineness ratio	1.0	1.0	1.0	1.0
	Air speed	500	300	400	200
	Air speed/yarn speed	1500	360	480	240
	Injection angle	20	45	90	90
	Intermingling and opening in nozzle	absent	absent	present	present
	Turning point (distance/air speed)	0.00011	0.00005	0.0001	0
	Silicone	1	1	1	0
	Deposition amount	% by mass			

(continued)

			Example 7	Example 8	Comparative Example 5	Comparative Example 6	
Bulky structure yam	Loop	Loop size	mm	58.5	23.4	19.0	0.6
		Twist point	number/mm	20	9	69	93
		Loop breakage (Number of breaking points (number/mm))	Presence or absence	absent (0.0)	absent (0.0)	present (0.4)	present (0.4)
	Core yam	Three-dimensional crimp	Presence or absence	present	present	absent	absent
		Radius of curvature	mm	5.0	4.8	absent	absent
Bulky structure yam	Sheath yarn	Three-dimensional crimp	Presence or absence	present	present	absent	present
		Radius of curvature	mm	28	5.0	absent	0.3
	Charac-teristics	Strength	cN/dtex	3.7	4.8	2.4	1.4
		Elongation	%	36	25	18	33
		Coefficient of static friction between fibers	-	0.3	0.1	0.6	0.4
Remarks	Unwinding properties (effect of suppressing entanglement)		-	C	A	D	C
	Touch		-	B	B	C	D
					Feeling of foreign body Breakage occurred		Poor in bulkiness

DESCRIPTION OF REFERENCE SIGNS

[0126]

- 5 1: Sheath yarn
 2: Core yarn
 3: Center line of textured yarn
 4: Thread guide
 5: Distance from center line of textured yarn to apex of loop
 10 6: Three-dimensional crimp
 7: Supply roller
 8: Synthetic fiber
 9: Suction nozzle
 10: Turning point
 15 11: Textured yarn
 12: Take-up roller
 13: Heater
 14: Delivery roller
 15: Winder
 20 16: Injection angle of compressed air

 17: Slit-shaped discharge hole

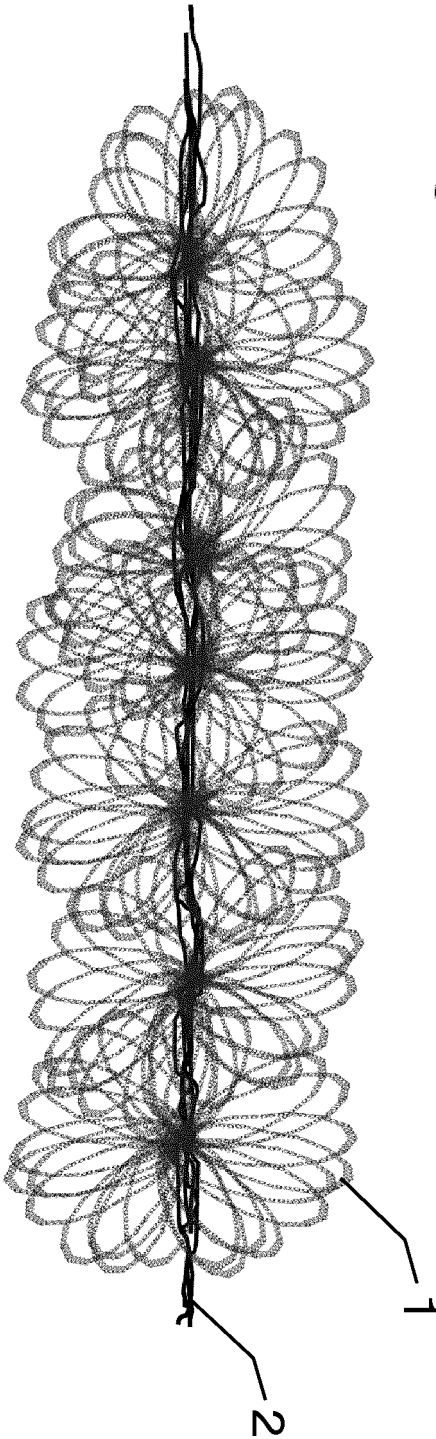
25 Claims

1. A bulky yarn made of synthetic fibers, comprising:

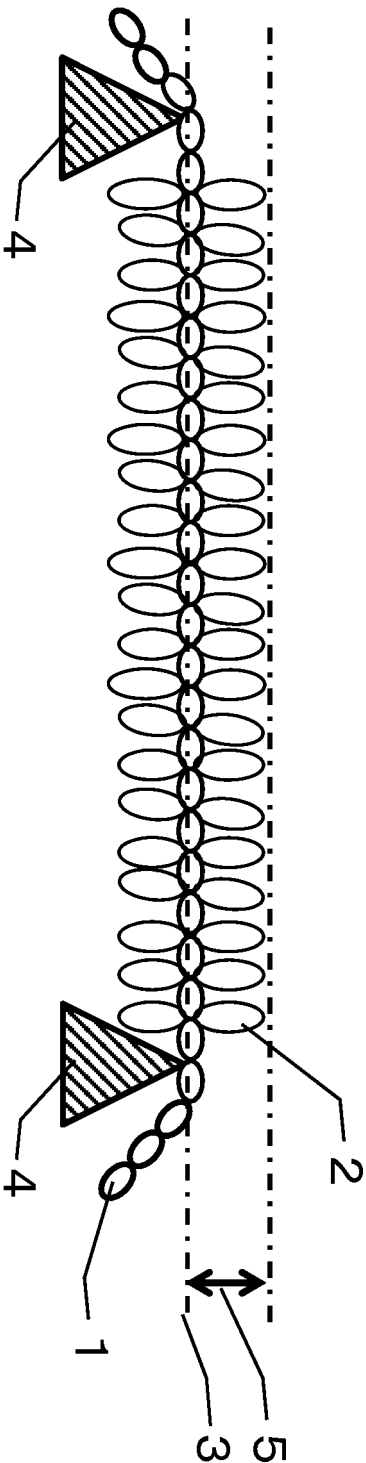
 a sheath yarn having a three-dimensional crimped structure; and
 30 a core yarn twisted with the sheath yarn to fix the sheath yarn,
 wherein the sheath yarn is not substantially broken and continuously forms loops.
2. The bulky yarn according to claim 1, wherein the core yarn and the sheath yarn have a single yarn fineness ratio (sheath/core) in a range of 0.5 to 2.0,
 35 the core yarn and the sheath yarn have 1/mm to 30/mm twist points in a fiber axis direction of the bulky yarn, and
 the crimped structure of the sheath yarn has a radius of curvature of 2 mm to 30 mm.
3. The bulky yarn according to claim 1 or 2, wherein the fibers that constitute the bulky yarn have a single yarn fineness of 3.0 dtex or more, and
 40 the bulky yarn has a coefficient of static friction between fibers of 0.3 or less.
4. The bulky yarn according to any one of claims 1 to 3, wherein the core yarn has a three-dimensional crimp.
5. The bulky yarn according to any one of claims 1 to 4, wherein both or one of the core yarn and the sheath yarn is
 45 hollow section fibers having a hollow rate of 20% or more.
6. The bulky yarn according to any one of claims 1 to 5, wherein the core yarn and the sheath yarn are monocomponent fibers of same type.
- 50 7. A textile product, comprising the bulky yarn according to claims 1 to 6 in at least part thereof.

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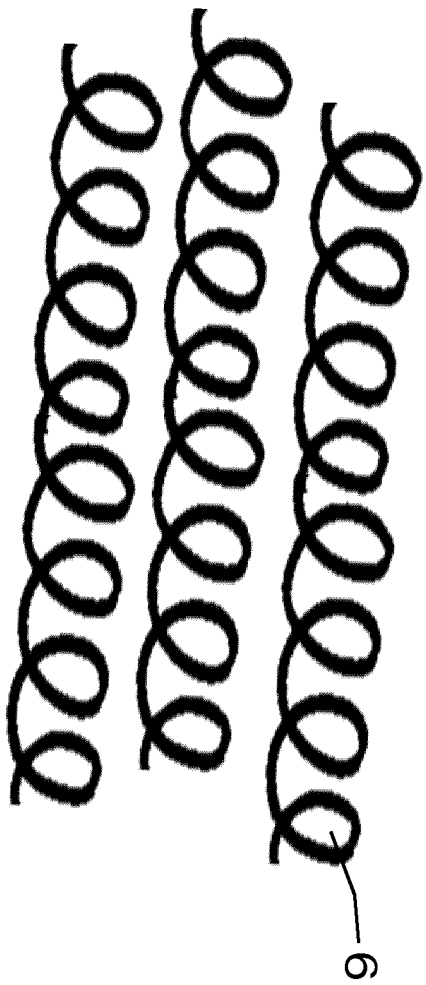
[Fig. 1]



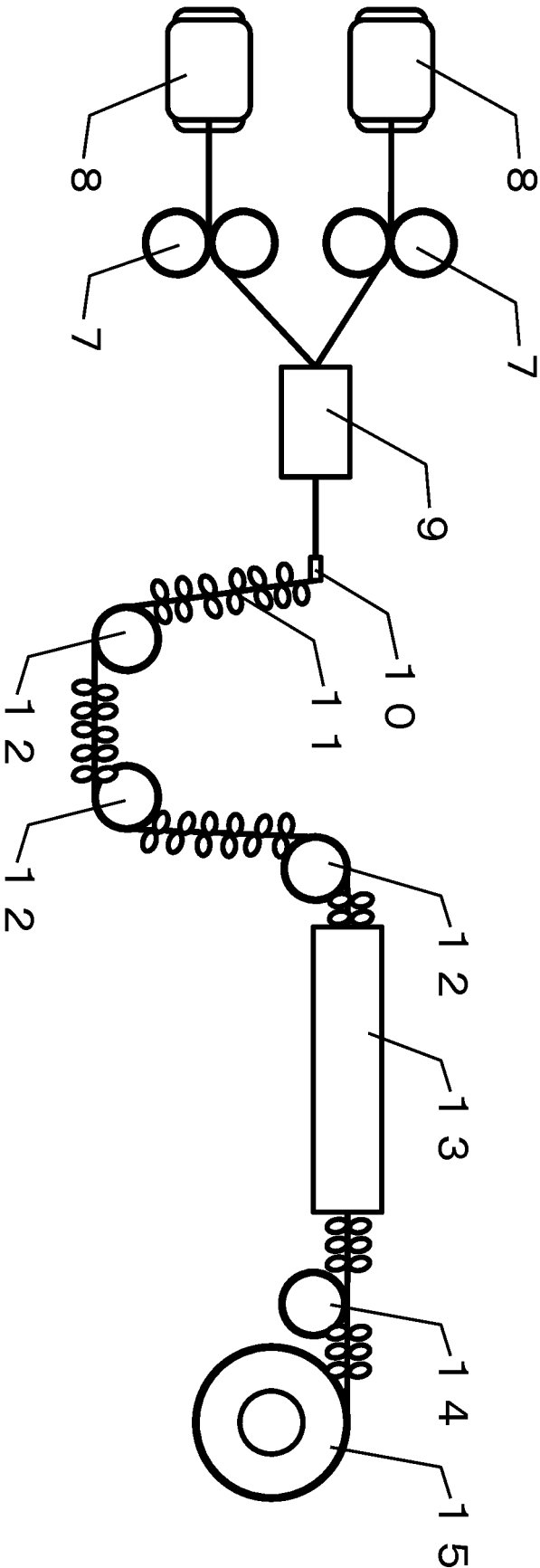
[Fig. 2]



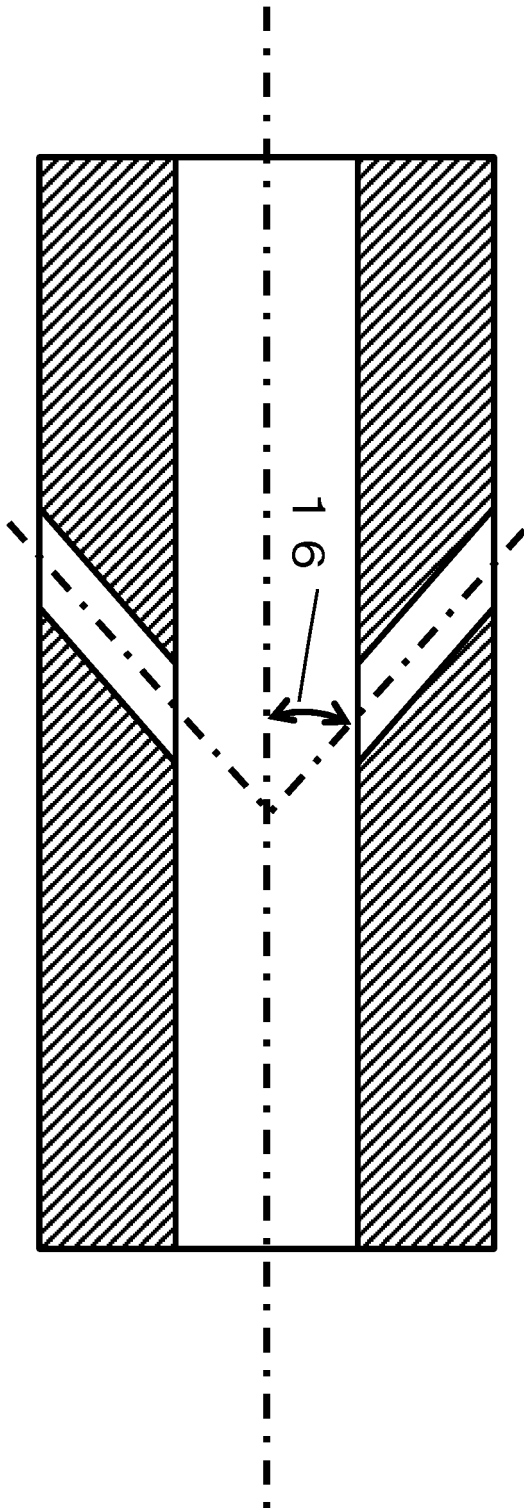
[Fig. 3]



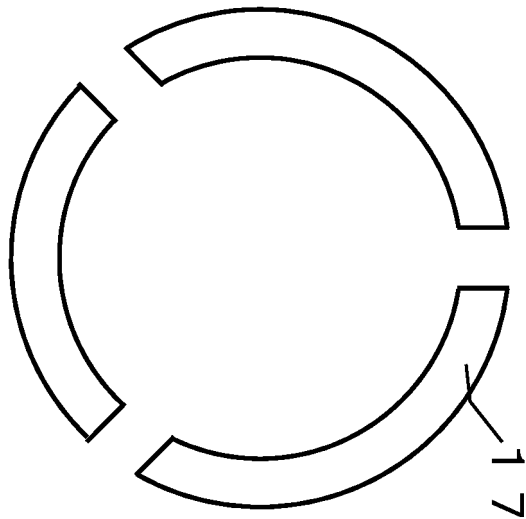
[Fig. 4]



[Fig. 5]



[Fig. 6]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/071299

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 1996-2016

Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2000-144541 A (Toray Industries, Inc.), 26 May 2000 (26.05.2000), claims; example 1 (Family: none)	1-7
A	WO 2012/026424 A1 (Kurabo Industries Ltd.), 01 March 2012 (01.03.2012), claims; drawings & EP 2610211 A1 claims; figures & JP 2012-67429 A & JP 2012-67430 A & JP 2015-132041 A & US 2013/0136892 A1 & CN 103097280 A & KR 10-2014-0018176 A	1-7

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

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Date of the actual completion of the international search
04 October 2016 (04.10.16)Date of mailing of the international search report
18 October 2016 (18.10.16)Name and mailing address of the ISA/
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