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Maki

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[45] **Feb. 11, 1975**

[54] **SYNTHETIC FIBROUS UNIT WHICH IS THREE-DIMENSIONALLY CRIMPED AND TWISTED**

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[73] Assignee: **Soko Co., Ltd.**, Tokyo, Japan

[22] Filed: **June 14, 1972**

[21] Appl. No.: **262,635**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 24,658, April 1, 1970, abandoned.

[52] **U.S. Cl.** ..... **57/140 J**, 161/173, 161/177, 161/179, 161/180, 225/93, 225/96.5, 264/Dig. 47, 264/DIG. 147, 28/Dig. 1 F

[51] **Int. Cl.** **D02g 3/00**, D02g 3/02

[58] **Field of Search** ..... 161/172, 173, 177, 179, 161/180, 169; 57/140 J

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Primary Examiner—George F. Lesmes
Assistant Examiner—Kendell, Lorraine T.

[57] **ABSTRACT**

A three-dimensionally crimped and twisted synthetic fibrous unit formed by a stem having a relatively large width. Branches randomly extend from the stem and have a width less than the stem width, and fine hairs randomly extend from the branches. Numerous peripherally and internally formed crevices are provided in the fibrous unit.

3 Claims, 24 Drawing Figures

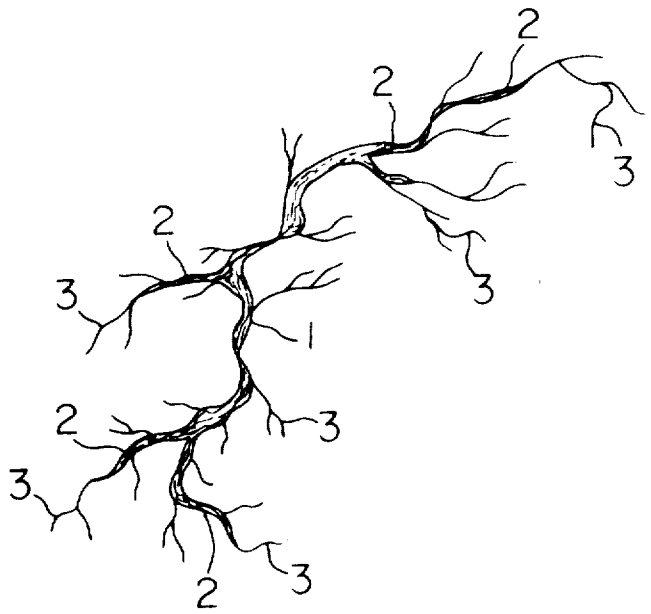


Fig. 1A

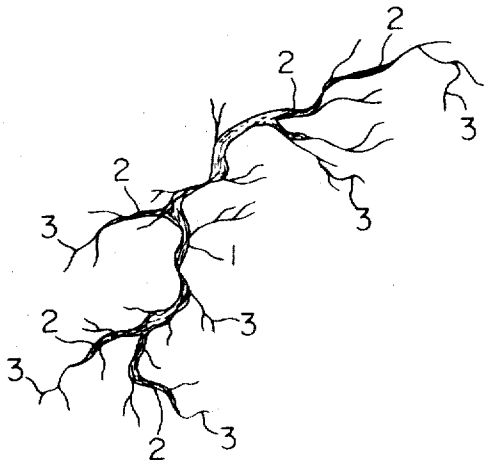




FIG. 1B



FIG.1C



FIG. 2

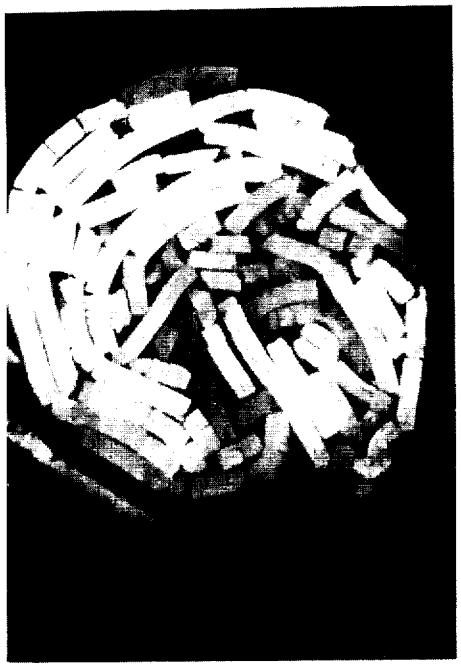


FIG. 3A



FIG. 3B



FIG. 4



FIG. 5

Fig. 6

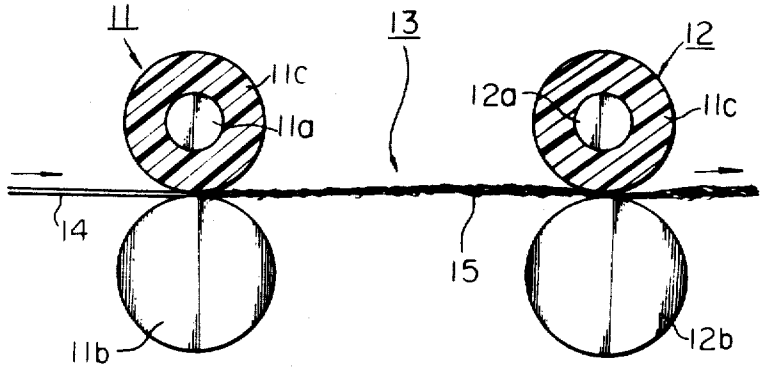


Fig. 7

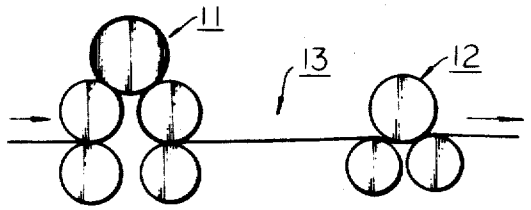


Fig. 8A

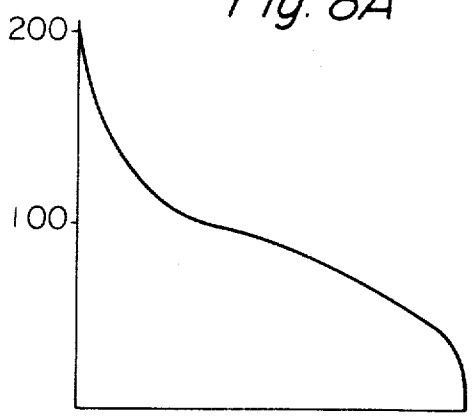


Fig. 8B

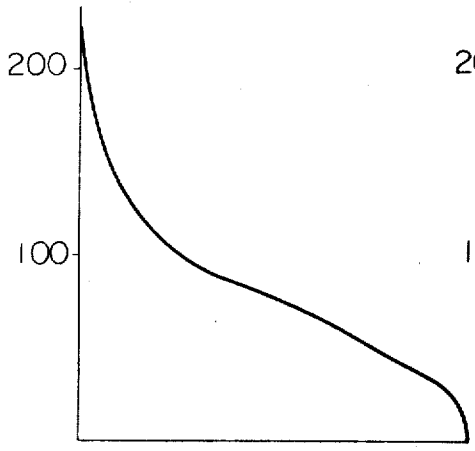


Fig. 8C

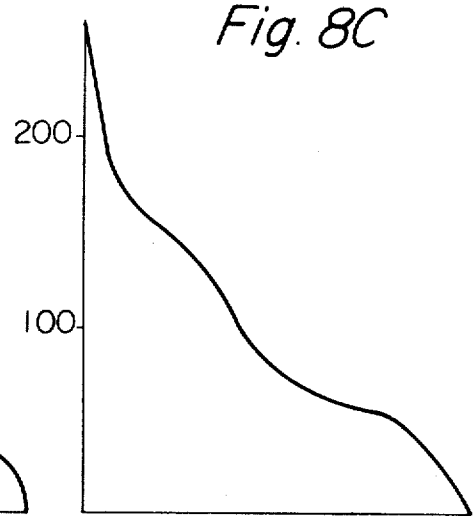


Fig. 9

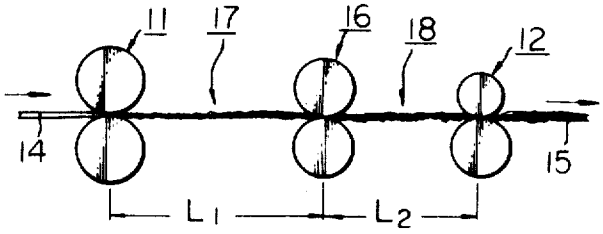


Fig. 10

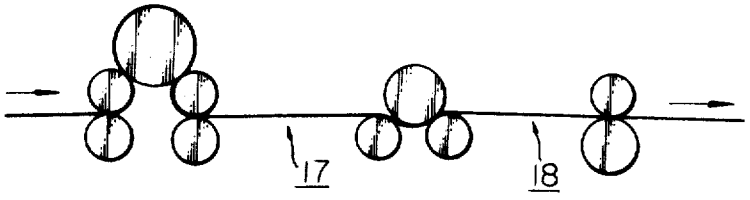


Fig. 11A

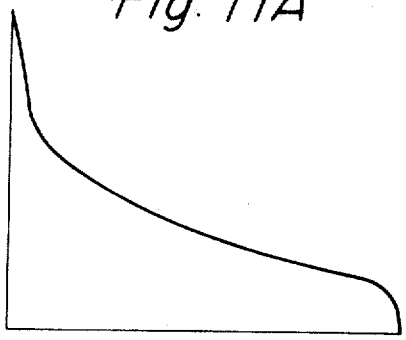


Fig. 11B

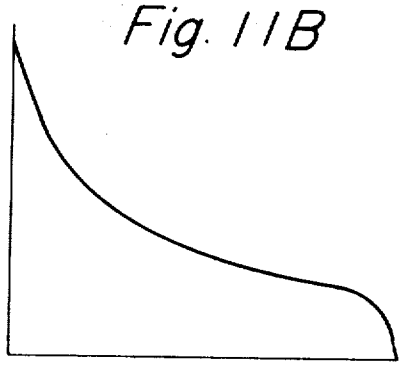


Fig. 11C

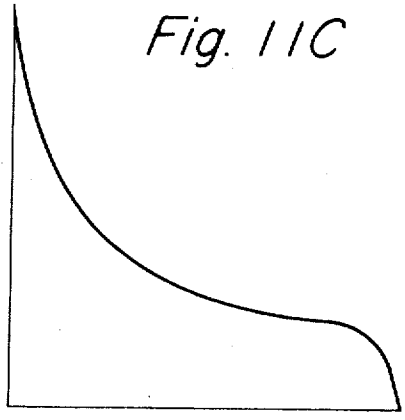


Fig. 12A

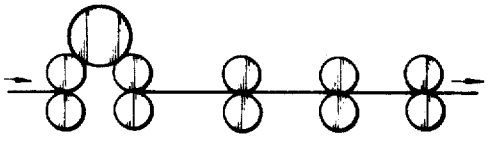
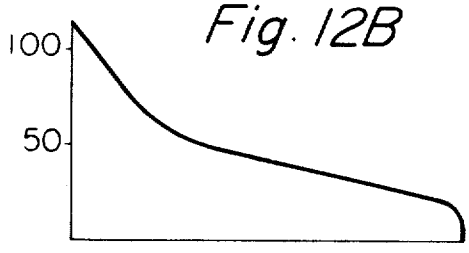


Fig. 12B



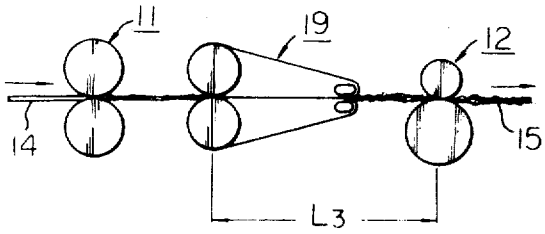
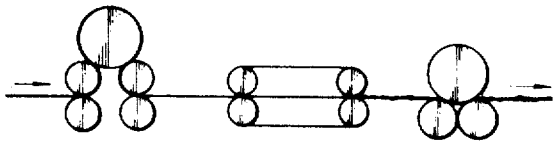


Fig. 13

Fig. 14



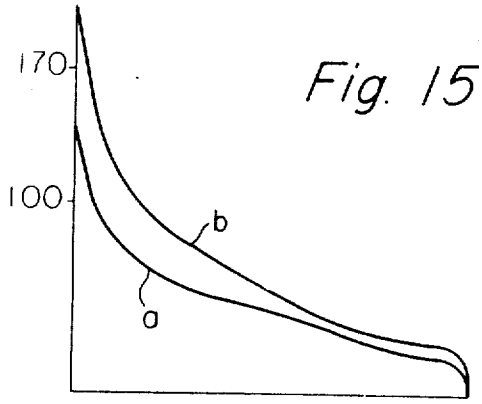
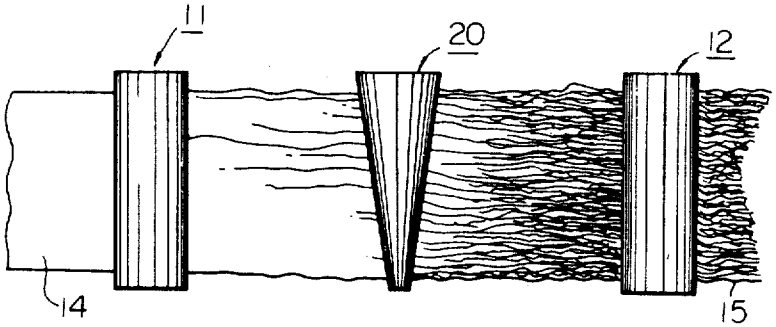


Fig. 15

Fig. 16



SYNTHETIC FIBROUS UNIT WHICH IS THREE-DIMENSIONALLY CRIMPED AND TWISTED

This is a continuation-in-part of an earlier filed co-pending application Ser. No. 24,658 filed Apr. 1, 1970 and now abandoned.

The present invention relates to a synthetic fibrous unit of novel configuration. This invention more particularly relates to a synthetic fibrous unit having diverse form of branched hairy configuration produced from one or more synthetic resinous films of a thermoplastic nature by utilizing a draft-fibrillation.

Most of the conventional synthetic fibers are produced by extruding material polymer solutions or molten material polymers in a filamentary form through a spinneret having fine spinning holes of given cross-sectional profiles. Both internally and externally, various types of cross-sectional features of the filament can be given as desired through modification in the extrusion mechanism and the spinning holes' cross-sectional profile. But, once the mechanical design is settled, no appreciable variation in the cross-sectional features along the filament length can be expected, except indispensable accidental variation in the fineness of relatively minor extent. In addition, unless any particular later-staged treatment is applied thereto, the produced filaments are in most cases provided with a remarkably smooth surface when compared with natural fibers. Such evenness in the cross-sectional feature and smooth surface leads to degraded inter-fibers frictional property and such a poor inter-fibers frictional property inevitably causes relatively poor coherency between the fibers composing a yarn.

Further, in the practical mill-production of the synthetic filaments by the extrusion technique, it is difficult to provide the resultant filaments with a fineness smaller than approximately 1.0 denier. This is firstly because of the flow characteristic inherent to the material polymer solution or molten material polymer at the time of extrusion and secondly because of the probable filament breakage after extrusion which oftentimes takes place due to excessively narrowed spinning holes. Because of this lower limit in the fineness of the produced filament, one cannot so much expect an excellent capillary attraction by the fibrous mass composing, for example, a fabric.

As an attempt to give the filament a three-dimensional diversity, there is the well-known crimping technique. However, even this technique cannot give a perfect solution to the problem of the superficial smoothness and the lengthwise evenness in the fineness inherent to the individual filament.

In order to mitigate the disadvantage encountered in the prior art, a method of splitting a given synthetic filmy band into a mass of fine fibrous units was recently developed. In this method, the given synthetic filmy band or strip is subjected to a rubbing action by suitable rubbing means or to a splitting action by suitable splitting means such as an inflicting roller or a peripherally screw grooved roller. In case the material filmy band has a relatively large width, it is usual to preliminary slit the band into a plurality of strips of smaller width. The obtained fibrous mass is composed of a plurality of randomly split fine-fibrous units connected to each other in a network configuration. It is true that this already developed splitting technique has, to some

extent, solved the problem of the superficial smoothness and the lengthwise evenness in the fineness of the filaments obtained. However, as is more apparently proved by the later description, the obtained fibrous unit does not fully meet the general requirement for the configurational diversity thereof. Further, in order to practice this manufacturing, it is necessary to furnish the manufacturing equipment with particular film slitting and/or splitting means such as above-mentioned. It is also assuredly known that the fibrous units manufactured by the conventional splitting method are not so fine as is suitable for yarns of finer thickness and fabrics of light and thin construction. For example, the lateral width of the fibrous units now on the market is at smallest 0.5 mm.

Therefore, it can be concluded that any of the conventionally developed synthetic filaments and split fibers cannot assure the provision of the fabric made thereof with sufficient softness, resiliency, warmth retainability, handling quality, bulkiness and hygroscopic property such as inherent in the fabrics made of natural fibers.

A principal object of the present invention is to provide a synthetic fibrous unit having a remarkably diverse form of configuration and considerably fine construction.

Another object of the present invention is to provide a synthetic fibrous unit having an enhanced inter-fibers frictional property.

A still other object of the present invention is to provide a synthetic fibrous unit capable of assuring an excellent capillary attraction to the fibrous mass composed thereof.

A further object of the present invention is to provide a synthetic fibrous unit capable of assuring a desirable softness, resiliency, warmth retainability, handling quality, bulkiness and hygroscopic property which is inherent to the natural fibers of a fabric made thereof.

In view of the above-mentioned objects, the synthetic fibrous unit of the present invention is composed of a stem of relatively large width, a plurality of branches randomly integral of the stem and a plurality of hairs extending at random from the stem and the branches. The entire configuration is three-dimensionally crimped and twisted. The fibrous unit is further provided with polygonally-profiled transverse cross section together with both internally and superficially formed numerous fine crevices.

In the manufacturing of the fibrous unit, one or more synthetic resinous films of a thermoplastic nature are firstly subjected to a uniaxial thermal pre-drawing. Thereafter, the uniaxially pre-drawn film or films are passed through a draft zone for a draft fibrillation. The draft zone is formed by two or more pairs of rotational rollers located apart in a prescribed distance and the superficial speed of the downstream rollers is made larger than that of the supstream rollers to such an extent so as to effectuate the purposed draft fibrillation of the given film. In a preferred embodiment, the system includes three pairs of rollers and a particular mechanical modification may be applied to the intermediate roller pair as later described in detail.

Further features and advantages of the present invention will be made more apparent from the following description, reference being made to the accompanying drawings; wherein

FIG. 1A is an enlarged diagrammatic representation of a fibrous unit of the present invention,

FIGS. 1B and 1C are microscopically enlarged photographical representations of the fibrous unit of the present invention,

FIG. 2 is a photographical representation of fibrous units of the present invention taken in a slackened massed disposition,

FIGS. 3A and 3B are photographical representations of the transverse cross sections of the fibrous units of the present invention,

FIG. 4 is an enlarged photographical representation of the transverse cross sections of the fibrous units of the present invention,

FIG. 5 is an enlarged photographical representation of the transverse cross sections of split fibers manufactured by the conventional film splitting method,

FIG. 6 is a partly sectional diagrammatic side view of a basic embodiment of the apparatus of the present invention,

FIG. 7 is a diagrammatic side view of another embodiment of the apparatus of the present invention whereon some example tests were performed,

FIGS. 8A to 8C are some examples of the staple diagram characteristic of the fibrous unit of the present invention,

FIG. 9 is a diagrammatic side view of a modified embodiment of the apparatus of the present invention, wherein a two-stage draft fibrillation is performed,

FIG. 10 is a diagrammatic side view of a practical embodiment of the apparatus shown in FIG. 9 whereon some example tests were performed,

FIGS. 11A to 11C are some examples of the staple diagram characteristic of the fibrous units of the present invention manufactured on an apparatus shown in FIG. 10,

FIG. 12A is a diagrammatic side view of a practical embodiment of the apparatus of the present invention having three stage successive draft zones,

FIG. 12B is a staple diagram of the fibrous units obtained on the apparatus shown in FIG. 12A,

FIG. 13 is a diagrammatic side view of another modified embodiment of the apparatus of the present invention,

FIG. 14 is a diagrammatic side view of a practical embodiment of the with-apron arrangement shown in FIG. 13, whereon an example test was performed,

FIG. 15 presents staple diagrams of the fibrous units manufactured on the apparatus shown in FIG. 14,

FIG. 16 is a diagrammatic plan view of a still another modification of the apparatus shown in FIG. 9.

Referring to FIGS. 1A to 1C, the fibrous unit of the present invention is diagrammatically and photographically shown in an enlarged illustration. As is diagrammatically shown in FIG. 1A, the fibrous unit of the present invention is provided with a stem 1 of relatively large width, a plurality of branches 2 randomly integral of the stem 1 and a plurality of fine hairs 3 extending at random from the stem 1 and the branches 2. The stem 1, the branches 2 and the hairs 3 are randomly and independently crimped and twisted in portions. The diverse form of the entire configuration of the fibrous unit of the present invention can be fairly confirmed by the photographs shown in FIGS. 1B and 1C. It was confirmed through the experimental observation by the inventor of the present invention that the fineness of the hair 3 in its finest portion was smaller than 0.2 denier.

This particular diverse form of external configuration cannot be found in any of the conventional synthetic and natural fibers and it provides a great many advantages when the fibrous units are formed into yarns or fabrics.

In the first place, the randomly crimped configuration of the branches 2 causes a sufficient extent of entanglement between the fibrous units when they are massed together. This mutually entangled condition will be understood from the graphical illustration shown in FIG. 2, wherein the fibrous units are massed together in a relatively slackened condition. Due to this considerably entangled condition, the coherency of the fibrous units composing the mass is remarkably enhanced and the enhanced coherency of the fibrous units in the mass assures the production of a fine yarn of increased tensile strength and a relatively thin silver or web of increased tearing strength.

Secondly, the randomly twisted configuration of the fibrous unit brings about a desirable increase in the bulkiness of the fibrous mass made thereof. This fairly satisfies the recent public preference for bulky apparel.

Thirdly, the presence of the numerous fine hairs leads to an enhanced capillary attraction of the fibrous mass made thereof, which capillary attraction promises a better hygroscopic property. Therefore, an improved wearing comfort results by using the fibrous units of the present invention as a material for fabrics.

Further, because the fibrous unit of the present invention is provided with the obvious diverse form of configuration such as variation in fineness, length, crimp and twist, a textile product made thereof can be accompanied with functional properties almost the same with those possessed by the products made of natural fibers while maintaining the advantages of the synthetic fibers such as, for example, an excellent resistance against chemical attack.

In addition to the above-mentioned external configurational features, the fibrous unit of the present invention should be evaluated from a view point of its internal configuration, more particularly from its transverse cross-sectional features.

Some examples of the transverse cross-sectional feature of the synthetic fibrous unit of the present invention are shown in FIGS. 3A and 3B, wherein it is observed that the transverse cross section of the fibrous unit is characterized by a variety of polygonal profiles. It is microscopically confirmed that the transverse cross-sectional profile varies from stem to stem, from branch to branch, from hair to hair, from stem to branch or hairs and from branch to hairs. This profile having a diverse form in the transverse cross section also, to a great extent, contributes to the enhancement in the inter-fibers frictional property to be possessed by the resultant fibrous unit.

As shown most clearly in FIG. 1A the widths or cross-sectional dimensions involved show a substantial variation in size when comparing the stem, the branches and the fine hairs. Stem 1 as particularly illustrated in FIG. 1A has a predetermined cross-sectional dimension of a relatively large size as compared to the branches and the fine hairs. Branches 2 extend from stem 1 and are seen to have a decreased cross-sectional dimension as compared to the width of stem 1. Fine hairs 3 extend from both the stem and the branches and are seen to

be greatly decreased in cross-sectional dimension as compared with the widths of both the stem and branches. The term "fine hair" is well understood in the art to represent a most minute cross-sectional dimension as both "fine" and "hair" have well understood meanings of very small, slender elements, and this contrast of widths is clearly shown in the FIG. 1A illustration.

Further, referring to FIG. 4, an enlarged photographical illustration of the transverse cross sections of the fibrous units of the present invention is given. As is clearly observed in the drawing, the transverse cross section is provided with numerous peripherally and internally formed crevices. The given illustration should be compared with the illustration given in FIG. 5, wherein an enlarged photographical illustration of the transverse cross sections of the split fibers manufactured by the conventional splitting process provided with suitable film inflicting means is shown. By this comparison, it will be understood that, although the conventional split fibers are provided with some peripherally and internally formed crevices also, their transverse cross-sectional profiles are remarkably smoother than those possessed by the fibrous units of the present invention.

The numerous fine crevices in the fibrous unit of the present invention assures an enhanced inter-fibers coherency and capillary attraction when the fibrous units are massed together to form a textile product.

The reason for the formation of the diverse form of transverse cross-sectional profile will be made apparent in the following description.

As a material for the fibrous unit of the present invention, one or more films of such synthetic resinous substances such as polypropylene, polyethylene, polyamide, polyacryl, polyester, polyvinylchloride, polyvinylidenechloride and polyvinylalcohol can be advantageously used.

The acquired fibrous units of the present invention are, in a massed disposition, advantageously used for such textile products as woven or knitted fabrics, nonwoven fabrics, synthetic papers, fishing nets, shock absorbers, heat insulators, noise absorbers and warmth retainers.

Referring to FIG. 6, a principal arrangement of a preferred embodiment of the apparatus of the present invention is shown diagrammatically. The apparatus includes a pair of back rollers 11 and a pair of front rollers 12 located apart from the pair of back rollers 11 at a prescribed distance. The respective pairs 11 and 12 are composed of axially rotational top rollers 11*a* and 12*a* and axially rotational bottom rollers 11*b* and 12*b* disposed in a pressure contact with the corresponding top rollers 11*a* and 12*a*. Preferably, the top rollers 11*a* and 12*a* are peripherally covered by elastic layers 11*c* and 12*c* for exerting a stable nip on the film and the fibrous units processed through the apparatus. The surface speed of the front rollers 12 is designed as larger than that of the back rollers 11 and is, to such an extent, sufficiently capable of causing a draft fibrillation of the given film. That is, a draft zone 13 is formed in between the pairs of rollers 11 and 12. On the apparatus designed as above, one or more uniaxially predrawn film 14 is processed through the nips by the roller pairs 11 and 12 and, within the draft zone 13, the film 14 is randomly fibrillated into a mass of numerous fine fibrous units 15.

The draft-fibrillating mechanism on the apparatus of the present invention will now be explained in detail in relation to the resultant diversity in the configurational features of the fibrous unit obtained.

In the material undrawn film, the film composing polymeric chains are connected randomly to each other by partial chemical links. By subjecting the film of this internal configuration to a uniaxial pre-drawing operation, which is usually performed at a drawing ratio up to 7 or 8, there takes place a compulsive interchains slippage and the chemical links connecting the chains are partially and randomly broken by this compulsive slippage. In this situation, the film 14 is introduced into the draft zone 13 and the film 14 is subjected to a uniaxial stretching force, which force causes a stress distribution in the film configuration. This distribution extends three-dimensionally throughout the films internal configuration. As is above-mentioned, breakage of the chemical links takes place at random location in the film configuration. That is, there must be a random distribution of weak-points throughout the film's internal configuration. As is well-known, when an article having weak-points is subjected to a force application, the stress caused by the applied force tends to concentrate upon the weak-points resulting in the breakage thereof. Once the breakage takes place at the weakest points, the balance of the stress distribution is disturbed and the stress tends to concentrate on the second weakest points. Breakage of the weakest points is observed externally as a locational tearing of the film, in other words, a locational fibrillation of the film. Due to the random distribution of the weak-points throughout the three-dimensional configuration of the film, the above-explained fibrillation takes place at random locations in the film configuration. With proceeding of the draft action, that is, as the film is transported downstreamly under the above-mentioned compulsive stretch, the breakage propagates one by one throughout the entire film configuration. Further, at the moment of film breakage at a particular location of the film, the stress distribution near that particular location is suddenly unbalanced and the momentary residual stress in film portions adjacent to that broken location tends to cause a random crimping and/or twisting in those film portions. Thus, the resultant fibrous unit of the present invention can be provided with both a diverse form of branched hairy configuration of randomly and partially crimped and/or twisted nature and diverse form of profiled transverse cross section having numerous fine crevices.

For confirmation of the advantages of the present invention, several mill-scale tests were performed by the inventor of the present invention and some examples are given as follows.

In all the examples, polypropylene was used as the material polymer. The material polypropylene was extruded into a film of 40 μ thickness and 650 mm width. After extrusion, the film was subsequently subjected to a uniaxial drawing at a drawing ratio of 10 and temperatures from 70° to 120°C in order to form a uniaxially drawn film of 10 μ thickness and 210 mm width.

EXAMPLE 1

A uniaxially drawn film of the above-described nature was processed through an arrangement shown in FIG. 7, wherein the back and front rollers were somewhat modified in their combination and arrangement

from that shown in FIG. **6** for the purpose of a stable and firm nip on the film. In the present example, the distance between the axial line of the back top roller and that of the front top roller was settled as 170 mm. In other words, the length of the draft zone was selected as 170 mm. The draft ratio was selected as 3.2.

The obtained result was as is shown in the following Table 1 and the obtained fibrous units were microscopically confirmed as being provided with considerably varied configurational diversity.

Table 1

Average length of the fibrous units in mm	105.0
Effective length of the fibrous units in mm	126.0
Content of short fibrous units in %	41.5

Measurement of the values listed in the table was achieved by the analysis of the obtained staple diagram in a manner generally employed in the cotton mill testing.

EXAMPLE 2

A uniaxially drawn film used in Example 1 was also processed through the arrangement shown in FIG. **7.** In this case, however, the draft ratio was selected as 2.5. The obtained fibrous units were provided with desirably diverse form of configurational features and the result of the staple diagram analysis were as shown in Table 2.

Table 2

Average length of the fibrous units in mm	84.0
Effective length of the fibrous units in mm	132.0
Content of short fibrous units in %	56.5

EXAMPLE 3

A uniaxially drawn film used in Example 1 was also processed through the arrangement shown in FIG. **7.** In this case, however, the draft zone length was selected as 270 mm and the draft ratio was selected as 3.2. The configurational features of the fibrous units obtained were considerably diverse in form and the result of the staple diagram analysis were as shown in Table 3.

Table 3

Average length of the fibrous units in mm	98.0
Effective length of the fibrous units in mm	168.0
Content of the short fibrous units in %	56.5

Referring to FIGS. **8A** to **8C**, some examples of the staple diagram sampled from the mass of the fibrous units of the present invention are shown. The one shown in FIG. **8A** corresponds to the fibrous units of Example 1, the one in FIG. **8B** to Example 2 and the one in FIG. **8C** to Example 3. From these illustrations, it is observed that the fibrous units of the present invention have a staple diagram very similar to those characteristics of natural fibers such as wool. This means that the fibrous unit of the present invention is perfectly distinguished and advanced from the conventional synthetic fibers in its fiber length characteristics, also.

EXAMPLE 4

Material polypropylene was formed into a film of 10 μ thickness by uniaxially drawing an extruded film at a draw ratio from 7 to 8. Next, the uniaxially drawn film was supplied to the arrangement shown in FIG. **6,** wherein the draft zone length was selected as 200 mm and the draft ratio was selected as 2.0. The obtained fibrous unit was provided with a configuration like that shown in FIG. **1A,** the maximum fiber length being about 200 mm the average fiber length being about 110 mm and the minimum fiber length being 30 mm. The fineness of the stem was about 15 denier and that of the finest hair was smaller than 0.1 denier. Further, the stem was provided with, in average, from 15 to 20 crimps per 1 inch length and the branches or hairs with, in average, from 25 to 30 crimps per 1 inch length.

Referring to FIG. **9,** a modification of the basic arrangement of the apparatus shown in FIG. **6** is diagrammatically shown, wherein two-stage draft fibrillation is carried out. In the arrangement, three pairs of rollers **11, 12** and **16** are disposed in a mutually spaced apart relationship. The first draft zone **17** is formed in between the back rollers **11** and the intermediate rollers **16** and the second draft zone **18** is formed in between the intermediate rollers **16** and the front rollers **12.** Assuming that the surface speed of the back rollers **11** is given by V_1, that of the intermediate rollers **16** by V_2, and that of the front rollers **12** by V_3, the following relationship is employed in the mechanical designing of the arrangement.

$$V_1 < V_2 < V_3 \tag{1}$$

As to the length of the respective draft zones, it was confirmed that the following relationship is established in the mechanical arrangement of the rollers, provided that the length of the first draft zone **17** is given by L_1 and that of the second draft zone by L_2.

$$L_1 > L_{22} \tag{2}$$

In the above mechanical arrangement, the supplied uniaxially pre-drawn film **14** is firstly fibrillated to some extent in the first draft zone **17** and next, being introduced into the second draft zone **18,** the partly fibrillated fibrous mass is now subjected to a complete fibrillation so as to be delivered through the nip by the front rollers **12** in the form of a mass of numerous fine fibrous units **15.** During the first draft zone fibrillation, numerous crevices are developed in the internal configuration of the film and thusly developed crevices assist, to a great extent, the second zone fibrillation.

Although, only the two-stage draft fibrillation is mentioned in the foregoing description, the above-presented mathematical relationships (1) and (2) can be well extended to cases wherein three or more staged fibrillation is performed in succession as follows.

$$V_i < V_i + 1 \tag{3}$$

$$L_j > L_j + 1 \tag{4}$$

wherein

V_i = A surface speed of the i th rollers (counted from the back rollers).

V_{i+1} = A surface speed of the $i+1$ th rollers (counted from the back rollers).

L_j = A length of the j th draft zone, which is formed in between the i th and the $i+1$ th rollers.

L_{j+1} = A length of the $j+1$ th draft zone, which is formed in between the $i+1$ th and the $i+2$ th rollers.

Further, through the repeated mill-tests by the inventor, it was emphatically confirmed that a desirable draft fibrillation effect can be obtained when the following mathematical relationships are mechanically satisfied in the arrangement of the apparatus.

$$1.2 \leqq (V_{i+1}/V_i) \leqq 5.0 \quad (5)$$

$$0.2 \leqq (L_{j+1}/L_j) \leqq 0.9 \quad (6)$$

The following examples are illustrative of the result obtained in the case of the two-stage draft fibrillation. The material uniaxially pre-drawn films used are similar to those used in the preceding examples and the film was processed through the arrangement shown in FIG. **10** in a manner shown in the drawing.

EXAMPLE 5

The first draft zone length was selected as 170 mm and the second draft zone length as 130 mm. The first draft ratio was selected as 2.5 and the second as 1.7. A mass of fibrous units having various configurational features was obtained and the staple diagram analysis resulted as shown in Table 4.

Table 4

Average length of the fibrous units in mm	60.5
Effective length of the fibrous units in mm	93.0
Content of the short fibrous units in %	52.0

EXAMPLE 6

The first draft zone length was selected as 270 mm and the second as 130 mm. The first draft ratio was selected as 2.0 and the second as 1.7. The result was as is shown in Table 5.

Table 5

Average length of the fibrous units in mm	68.0
Effective length of the fibrous units in mm	121.0
Content of the short fibrous units in %	64.5

EXAMPLE 7

The first draft zone length was selected as 270 mm and the second as 130 mm. The first draft ratio was selected as 3.2 and the second as 1.1. The result was as shown in Table 6.

Table 6

Average length of the fibrous units in mm	72.0
Effective length of the fibrous units in mm	134.0
Content of the short fibrous units in %	68.0

The staple diagrams sampled as to the fibrous units of Examples 5 to 7 are shown in FIGS. **11A**, **11B** and **11C** in the order of the Examples. It will be understood that the fibrous units of the present invention are accompanied with staple diagrams almost resembling those of natural fibers such as wool.

EXAMPLE 8

A uniaxially pre-drawn film used in the preceding examples was processed through the arrangement shown in FIG. **12A** and the mechanical setting was as follows:

The first draft zone length in mm	170
The second draft zone length in mm	130
The third draft zone length in mm	80
The first draft ratio	2.4
The second draft ratio	1.7
The third draft ratio	2.0

The obtained staple diagram is shown in FIGS. **12B** and the result of the analysis of the obtained staple diagram is as shown in Table 7.

Table 7

Average length of the fibrous units in mm	48.0
Effective length of the fibrous units in mm	83.0
Content of the short fibrous units in %	68.5

Referring to FIG. **13**, a modification of the apparatus shown in FIG. **9** is shown, in which modification a pair of apron rollers **19** replaces the intermediate rollers **16**. The surface speed of the apron rollers **19** is also so designed as to satisfy the above-presented relationship (3). By inserting this apron rollers **19**, whipping of the fibrous units at the moment of fibrillation can be effectively prevented and an abrasional contract of the apron surfaces with the partly fibrillated film, which advances downwardly at a speed approximately similar to the surface speed of the front rollers **12**, assures further propagated fibrillation of the film. It was further empirically determined that the maximum length of the resultant fibrous units are greatly dependent upon the distance L_3 between the axial line of the main roller of the apron **19** and the front nip. So, as a sideeffect of using this arrangement, the maximum length of the fibrous units can be changed as desired by only adjusting the location disposition of the apron rollers **19** while maintaining the location relationship between the back and front rollers **11** and **12**.

EXAMPLE 9

A uniaxially pre-drawn film used in the preceding examples was processed through the arrangement shown in FIG. **14**, wherein the distance between the back nip and the apron main roller's axial line was selected as 150 mm the total draft zone length was selected as 240 mm and the total draft ratio was selected as 1.9. For the purpose of comparison, the same type of film was also processed through the same arrangement under the same processing conditions with the only exception being that the apron rollers were removed.

The staple diagrams of the obtained fibrous units are shown in FIG. **15**, wherein the curve *a* is for the with-apron case and the curve *b* is for the without-apron case. The result of the staple diagram analysis is illustrated in Table 8. From this result, it is fairly confirmed that insertion of the apron roller mechanism has a re-

markable effect on the length of the fibrous units obtained.

TABLE 8

	with apron	without apron
Average length of the fibrous units in mm	52	67
Effective length of the fibrous units in mm	82	132
Content of the short fibrous units in %	61.5	72.0

Referring to FIG. **16**, another modification of the apparatus shown in FIG. **9** is illustrated, in which modification a pair of cone roller **20** replaces the intermediate rollers **16.** As is commonly known, when a cone roller axially rotates, its surface speed at the larger diametral portion is greater than that at the smaller diametral portion. So, in the present embodiment, the mechanical arrangement must be so designed that the smallest surface speed of the cone roller **20** is greater than the surface speed of the back roller **11** and that the largest surface speed of the cone roller **20** is smaller than the surface speed of the front roller **12.** Once a film **14** is supplied to this designed apparatus, the film portion corresponding to the larger diametral portion of the cone roller **20** starts to fibrillate first. This is because of the relatively large difference in the surface speed between the back roller and the large diametral portion of the cone roller **20.** Next, in the zone between the cone rollers **20** and the front rollers **12,** the film portion corresponding to the smaller siametral portion of the cone roller **20** starts to fibrillate. This is because of the relatively large difference in the surface speed between the small diametral portion of the cone roller **20** and the front rollers **12.** Because the largest surface speed of the cone roller **20** is designed as smaller than the surface speed of the front rollers **12,** the firstly fibrillated film portion is also subjected to an additional draft fibrillation while passing through the zone. Thus, a considerable variation in the fibrillating action can be obtained along the transversal direction of the film.

EXAMPLE 10

A polypropylene film was pre-drawn at a draw ratio from 7 to 8 and a uniaxially pre-drawn filament of 0.053 g/cm linear density and about 900 mm width was obtained. This film was processed through the arrangement shown in FIG. **16.** The distances between the three pairs of rollers were settled as 200 mm. The surface speed of the cone rollers **20** were so selected that the draft ratio between the back roller and the largest diametral end of the cone roller was 2, that the draft ratio between the back roller and the smallest diametral end of the cone roller was 1, that the draft ratio between the largest diametral end of the cone roller and the front roller was 1 and that the draft ratio between the smallest diametral end of the cone roller and the front roller was 2.

It was clearly observed that the fibrillation was firstly commenced in the film portion corresponding to the larger diametral portion of the cone rollers in the first draft zone and the fibrillation propagated to the remaining film portion in the second draft zone. The film was perfectly fibrillated into a mass of numerous fine fibrous units of diverse form of configurational features.

What I claim is:

1. A synthetic fibrous unit made of a polyolefin consisting of a single stem having a predetermined cross-sectional width, a plurality of branches randomly formed integral of said stem, and a plurality of numerous fine hairs extending at random from said stem and said branches, the entire configuration of said fibrous unit being three-dimensionally crimped and twisted at random, said branches having a decreased cross-sectional width as compared with said predetermined cross-sectional width, said fine hairs having a cross-sectional width greatly decreased as compared with the cross-sectional widths of said stem and said branches, and numerous crevices are formed peripherally and internally throughout said fibrous unit.

2. A synthetic fibrous unit according to claim **1,** made from a polyethylene.

3. A synthetic fibrous unit according to claim **1,** made from a polypropylene.

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