

- [54] **SYNTHETIC TEXTILE YARN**
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- [63] Continuation of Ser. No. 746,522, July 22, 1968, abandoned.
- [52] U.S. Cl.57/155, 28/1 F, 161/172
- [51] Int. Cl.D02g 3/02, D02g 3/06
- [58] Field of Search57/140 J, 140 R,
57/155; 28/1 F; 161/DIG. 6, 172; 264/DIG.
81, 147, 140, 141

[56] **References Cited**

UNITED STATES PATENTS

- 3,495,752 2/1970 Kim et al.28/1 F X

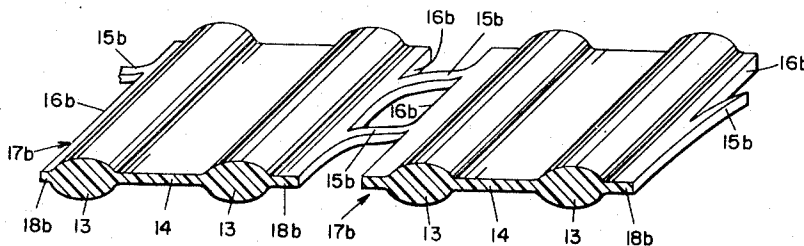
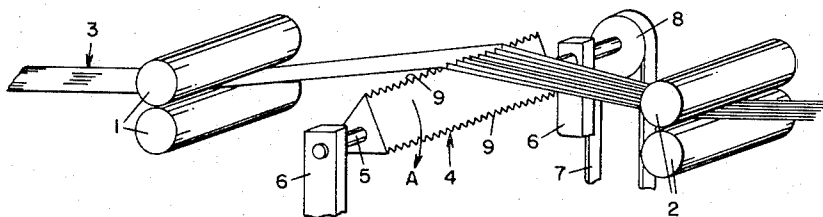
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Primary Examiner—Donald E. Watkins
Attorney—John W. Whitson

[57] **ABSTRACT**

This invention relates to forming synthetic textile yarn by the fibrillation of a thermoplastic ribbon, and particularly to a yarn having increased bulk, resilience and luster formed by the fibrillation of a striated ribbon, and comprises engaging the ribbon by edge means having teeth on a gauge equal to a whole number multiple in excess of two of the gauge of the striations of the film, and the teeth on the successive edge means are aligned angularly whereby the teeth will engage the film continuously between the same two striations to split the ribbon into continuous filaments each of which consists of two or more striations.

2 Claims, 6 Drawing Figures



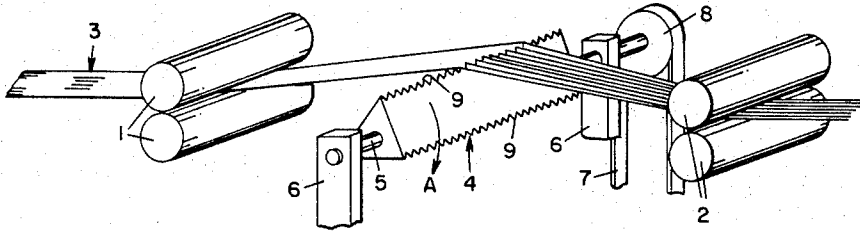


FIG. 1

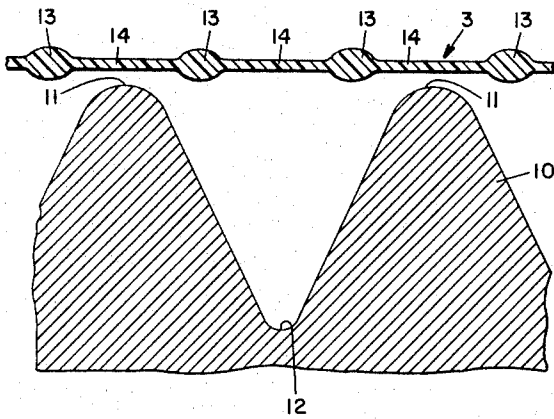


FIG. 2

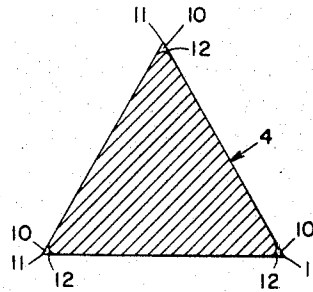


FIG. 3

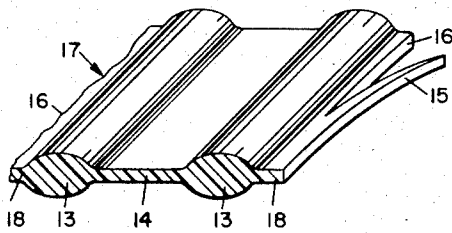


FIG. 4

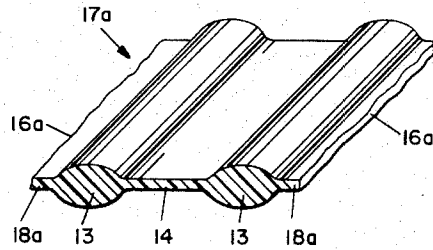


FIG. 5

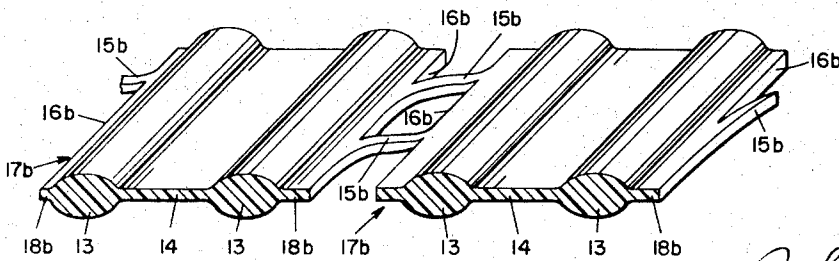


FIG. 6

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SYNTHETIC TEXTILE YARN

This application is a continuation of our copending application Ser. No. 746,522 filed July 22, 1968, now abandoned.

The present invention relates to a synthetic yarn formed from a plastic material and to a method and apparatus for forming the same by the fibrillation of striated film, that is, film having a plurality of striations or ribs extending in spaced parallel relation lengthwise of the film and interconnected by laterally extending webs or reduced thickness.

One of the most important advantages of synthetic yarn produced by the fibrillation of an uniaxially oriented film is that it is generally less expensive than yarn produced by the usual spinnerette process. However, because of process limitations, the range of products that can be produced in this manner is limited and the yarns from fibrillated film have therefore found use in a limited number of applications and these have generally been in the coarser products such as twice or rope and the products made therefrom such as in fabric for making cotton bales, sandbags or carpet backing.

It is known that various physical properties of synthetic yarns can be improved by carrying the cross-section of the individual filaments. By way of example, filaments produced by the usual spinnerette processes are substantially round in cross-section. In contrast to such conventional filaments, a yarn composed of filaments having a non-circular cross-section, such as a Y-shaped configuration, has improved bulk, resilience and lustre. The improved bulk is produced because the odd-shaped or irregular filaments cannot be packed as densely as round filaments. The improved resilience is due to the greater stiffness and resistance to bending of the non-circular filaments. The lustre is improved by the increased surface area of the filaments.

One of the limitations with respect to yarns from filaments formed by the fibrillation of flat thermoplastic film is that it is limited to a substantially rectangular cross-section. Like the circular cross-section, the rectangular cross-section is regular and such filaments can be packed relatively densely and have reduced bulk, lustre and resilience in comparison with filaments having an irregular cross-section. Filaments having an irregular cross-section have been made from fibrillated film by use of a striated film such as that described in U.S. Pat. application Ser. No. 674,332, now U.S. Pat. No. 3,470,685 to Hall and Kim, granted Oct. 7, 1969. The method and apparatus disclosed in U.S. Pat. application Ser. No. 696,376, now U.S. Pat. No. 3,494,522 to Kim and Samluk, granted Feb. 10, 1970, may be used in preparation of such filaments. These filaments individually correspond to a striation or rib of the original film with a portion of the webs of the original film extending laterally from the opposite edges of the filament. Thus, although these filaments have an irregular cross-section, they do not have the improved bulk, lustre and resilience that is achieved with filaments which are even more irregularly shaped in their cross-section.

The objects of this invention are to provide a synthetic yarn adapted to be produced by the fibrillation of a ribbon of plastic film, and which yarn includes filaments having a cross-section that is particularly designed to impart increased bulk, resilience and lustre

to the yarn. It is also an object of this invention to provide such a yarn of filaments that are continuous in length and uniform in cross-section along the length thereof as well as between different filaments whereby the yarn will have uniform properties and appearance. Other objects of the invention are to provide a commercially economical method and apparatus for making such a yarn.

In accordance with this invention, there is provided a filament having a cross-section that consists essentially of a pair of striations or ribs that are thickened and somewhat circular, in cross-section, which ribs are held in spaced parallel relation by intervening web portions. The method and apparatus for producing this product involves the fibrillation of a striated film along lines disposed intermediate alternate ribs or striations of the film. The disclosed apparatus for effecting such fibrillation comprises a beater device similar to that of application Ser. No. 696,376, now U.S. 3,494,522, in which the teeth on each film-engaging edge are spaced apart along this edge a distance substantially equal to the width of a pair of striations on the film, with the teeth of each successive edge aligned in circular paths with the corresponding teeth in each of the other edges whereby the corresponding teeth on the successive edges engage the film between the same two striations.

With the above and other objects in view, the preferred embodiment of the invention is hereinafter described with reference to the accompanying drawings, in which:

FIG. 1 is a fragmentary view of an apparatus in accordance with this invention, which apparatus is designed to practice the process and to make a yarn in accordance with this invention.

FIG. 2 is a detail view showing a striated ribbon in cross-section and the teeth of the fibrillation device of FIG. 1.

FIG. 3 is a sectional view transversely of the fibrillation element of the apparatus of FIG. 1.

FIG. 4 is a fragmentary view in perspective of a section of a filament in accordance with the invention.

FIG. 5 is a view similar to FIG. 4 illustrating a different filament in accordance with this invention.

FIG. 6 is a view similar to FIGS. 4 and 5 illustrating a further type of filament in accordance with this invention.

With reference to the drawings, there is illustrated in FIG. 1 an apparatus embodying the present invention and comprising a pair of feed rolls 1 and a pair of draw rolls 2 which together define a feed mechanism for advancing a ribbon 3 of striated plastic material. The space between the feed rolls 1 and draw rolls 2 defines what is herein termed a fibrillation zone wherein the ribbon 3 is split longitudinally into filaments. The draw rolls 2 are driven at a speed slightly greater than the speed of the feed rolls 1 so that the length of the ribbon 3 in the fibrillation zone is maintained under a slight tension.

The means for effecting fibrillation of the ribbon 3 comprises a rotatable bar 4 having a shaft 5 journaled at its ends in brackets 6. Rotation in the direction of the arrow A is imparted to the bar 4 by means of a belt 7 running about a pulley 8 fast on the shaft 5. The illustrated bar 4 has a cross-section in the shape of an equilateral triangle whereby there are provided three edges

9 spaced equidistant relative to the axis of the bar. Each of the edges 9 is serrated to provide teeth 10 having points 11 and valleys 12 between the teeth.

The bar 4 is arranged with the axis thereof in a plane substantially normal to the length of the ribbon 3 in the fibrillation zone and is disposed substantially parallel to the ribbon and in position to deflect the same over the edges 9. As a specific example, the bar 4 may be disposed with the axis thereof substantially on a straight line extending between the nips of the feed rolls 1 and draw rolls 2 whereby the maximum deflection of the ribbon from that line will be equal to the radius of the edge 9.

Each of the edges 9 is substantially identical and the teeth 10 of each edge 9 are rotatably aligned with the corresponding teeth of each of the other edges. Stated differently, the corresponding teeth 10 of each edge 9 are disposed within the points 11 thereof in a common plane that is normal to the axis of the bar 4 whereby they travel in the same rotary path.

The ribbon 3 comprises a thin strip of striated film, that is, a film consisting of a series of substantially uniformly spaced striations or ribs 13 extending in parallel relation longitudinally thereof and interconnected laterally by webs 14 of reduced thickness relative to the ribs 13. By way of example, the film may be of polypropylene and may be formed in the same manner as the film disclosed in the above noted application Ser. No. 674,332, now U.S. 3,470,685. Briefly, that method comprises extrusion of the film through dies having a die opening consisting of a series of rib openings that are substantially circular with a diameter of about twelve mils and spaced apart center-to-center a distance of about 30 mils with the adjacent rib openings interconnected along their center plane by web openings that are substantially 2 mils wide. The extruded film may be melt drawn at a ratio of four-to-one and then oriented at a draw ratio of six-to-one to provide a film with striations or ribs 13 having an average thickness of about 1.0 to 1.5 mils and a gauge of about 10 mils, and interconnected by webs 14 having an average thickness of 0.2 to 0.5 mil.

The gauge of the teeth 10 on the edges 9 is made substantially equal to the gauge of a plurality of the ribs 13 of the film, which, with a ribbon 3 having dimensions such as in the above illustration and with a tooth gauge equal to twice the rib gauge, would mean a spacing of the teeth 10 at a distance of 20 mils.

In operation, the bar 4 is rotated as the ribbon 3 is advanced thereover. With the ribbon 3 under tension because of the speed differential between the feed rolls 1 and draw rolls 2, and with the bar 4 positioned whereby the edges 9 thereof deflect the ribbon, the teeth 10 are forced through the ribbon. In accordance with the teachings of the above noted application Ser. No. 696,376, now U.S. 3,494,522, the points 11 of the teeth 10 are relatively blunt in comparison with the dimension of the ribs 13 of the ribbon 3 and tend to split the ribbon by impact and by imposing a lateral tension thereon as a tooth 10 contacts and is advanced into the ribbon. At the same time, since the webs 14 are substantially weaker in the lateral direction than the ribs 13, the ribbon 3 tends to split generally along the midpoint of the webs 14.

In accordance with the teachings of the above noted application Serial No. 696,376, now U.S. 3,494,522, different products can be produced by varying the speed of the bar 4 relative to that of the ribbon 3 and by varying the orientation level of the ribbon 3. As the orientation level of the ribbon 3 is increased, the amount of lateral extensibility that the ribbon will withstand without splitting is correspondingly reduced so that a ribbon 3 that is highly oriented can be readily split by the teeth 10. A less highly oriented ribbon has greater lateral extensibility and requires a greater penetrating force before it will split.

With a highly oriented ribbon, as each tooth engages the ribbon 3, it forms a point of penetration that is spaced from the preceding point of penetration by the amount that the ribbon has advanced in the time between the engagement of the ribbon by the successive edges 9. Inasmuch as the webs 14 tend to split endwise of the ribbon along the lines of molecular orientation, which themselves have slight lateral wandering even in highly oriented materials, some molecules of the material wander between the successive penetration points. By running the bar 4 at a speed which, relative to the speed of the ribbon 3, produces a relatively long stroke of the tooth on the ribbon 3, these laterally unsplit portions between the successive points of penetration are run out at one end to produce a small fibril at the edge of the other of the filaments. As shown in FIG. 4, there is illustrated such a fibril 15 extending laterally from the edge 16 of a filament 17 which includes two ribs 13, an unsplit interconnecting web 14 between the same, and web sections 18 extending laterally outwardly from each of the ribs 13 and terminating in the edges 16 along which the filament 17 was split and from the adjacent portions of the ribbon 3.

By running the bar 4 at a speed which, relative to the speed of the ribbon 3, produces a shorter stroke, the teeth 10 will penetrate the ribbon 3 at spaced points to produce a net-like structure such as illustrated in FIG. 6 in which each filament 17b consists of two ribs 13 interconnected by an unsplit web 14 and having web sections 18b extending laterally outwardly from the ribs 13 to edges 16b, with fibrils 15b extending from the edges 16b and connecting the adjacent filaments together in a net-like structure.

With a ribbon 3 having a relatively low level of orientation, the lateral extensibility of the film may be so high that the increased lateral tension in the ribbon as a tooth is advanced into it, causes the ribs to shift relative to the tooth rather than for the web to split immediately at the point of contact. With greater lateral extensibility, the weakest point of the ribbon is at the end of the previous split so that as the tooth imposes increasing tension on the ribbon, it shifts under the influence of any unbalanced forces and the tooth tends to enter the end of the prior split and to extend that split rather than form a new split. Such a product is shown in FIG. 5 in which there is illustrated a filament 17a that consists of two ribs 13, an interconnecting unsplit web 14, and web sections 18a extending outwardly from the ribs 13 to free edges 16a along which the filament was separated from the adjacent filaments in the ribbon 3.

As noted above, the teeth 10 on each of the edges 9 are, in accordance with this invention, aligned angu-

larly or in a plane normal to the axis of the bar 4 with the corresponding teeth on the other edges of the bar 4, and are also spaced apart uniformly along the edge at a distance substantially equal to the gauge of the ribbon over two or more of the ribs, that is, the spacing from a point on one rib 13 to the corresponding point on another rib that is spaced from it by at least one intervening rib. When the bar 4 is rotated relative to the ribbon 3, the corresponding teeth 10 on each edge 9 generally engage the ribbon 3 in succession between the same two ribs 13 since the teeth tend to position the ribs 13 and there is not sufficient time between the successive teeth for the ribs 13 to shift laterally. Thus, the split is extended lengthwise to produce continuous filaments having two or more ribs 13 with the edges of the filaments having either a torn edge at 16a or with fibrils such as 15 or 15b.

While the bar 4 is herein illustrated as triangular in cross-section, it will be evident that other configurations can be used, for example, rectangular. At the same time, completely circular rings could also be used although such an arrangement would only propagate a split in the ribbon 3 in the nature of a smooth tear and would not produce fibrils such as at 15 and 15b.

The ribs 13 in the ribbon 3 in the illustrated embodiment are uniformly spaced laterally but it will be evident that a nonuniform but repetitive arrangement could be used. For example, the alternating ribs 13 may be arranged in closely spaced pairs that are spaced at a greater distance from the adjacent pairs. The important feature in accordance with this invention is that the teeth 10 are spaced along the edge 9 at a distance relative to the spacing of the ribs 13 of the ribbon 3 so that adjacent teeth will span two or more ribs. The corresponding teeth 10 of the different edges 9 are aligned about the axis of the bar 4 so that each succeeding tooth will follow its corresponding tooth on the other edges into the web between the same pair of adjacent ribs. Uniform spacing of the teeth 10 on the edges 9

and the repetitive spacing of the ribs 13 of the ribbon 3 at a comparable gauge avoids the necessity of aligning the ribs 13 with the teeth 10 in order to achieve uniform fibrillation. The alignment of the corresponding teeth 10 about the periphery of the bar 4 avoids lateral wandering of the ribbon 3 during fibrillation.

In the illustrated embodiments, the filaments 17, 17a and 17b are each formed with two ribs 13. It will, however, be apparent that within the scope of the invention the number of ribs could be increased for example to three.

With filaments having a plurality of ribs 13, the increased cross-section adds stiffness and resilience to the filaments, while the increased surface area makes the yarn more lustrous or brilliant. The irregular cross-section also provides increased bulk. A further important advantage of the present invention is the production of filaments by the fibrillation of a film, which filaments are not only continuous but are also uniform in cross-section along the length thereof to provide improved uniformity in its physical properties such as strength, stiffness, resilience, and brilliance.

What we claim and desire to protect by Letters Patent is:

1. A synthetic yarn comprising a plurality of continuous longitudinally-oriented filaments having an irregular cross-section that is substantially uniform along the length thereof and including two to three striations extending in spaced parallel relation lengthwise of each filament with each pair of adjacent striations interconnected by a web of reduced thickness relative to the thickness of said striations and with the opposed outer edges of each filament having a web portion extending laterally from the outer edges of the outermost striations and terminating in a split edge.

2. A synthetic yarn in accordance with claim 1 having a plurality of fibrils integral at one end with said filaments at the split edges thereof and extending therefrom to a free end.

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