Sept. 30, 1969 J. J. CHAMBERLAIN, JR., ET AL 3,469,387

BULKY TEXTILE YARN AND METHOD OF FORMING SAME

Filed June 26, 1967

Fig-1

Fig-2

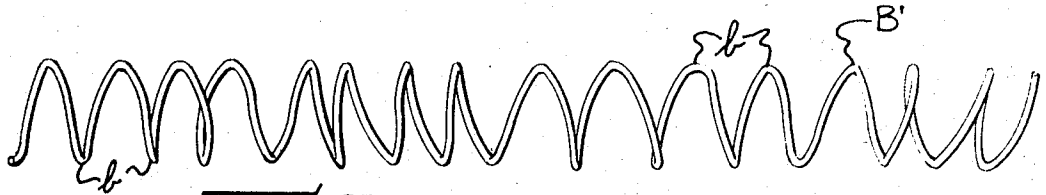

Fig-3

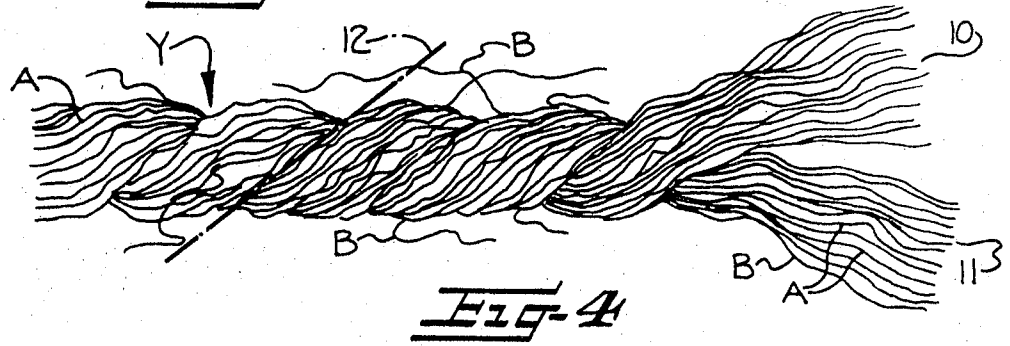

Fig-4

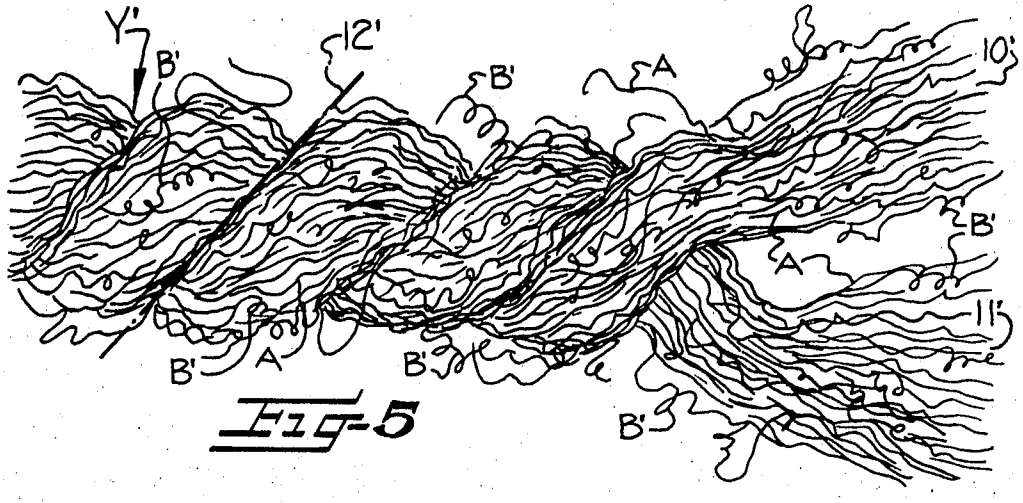

Fig-5

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3,469,387

BULKY TEXTILE YARN AND METHOD OF FORMING SAME

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U.S. Cl. 57—140 6 Claims

ABSTRACT OF THE DISCLOSURE

The bulky yarn is produced by blending a relatively high percentage of mechanically crimped thermoplastic staple fibers with a relatively small percentage of substantially straight, self-crimpable, bi-component staple fibers having an inherent ability to coil and shrink when heated in unrestrained condition. The blended fibers are then spun with a sufficient strength to the spun yarn. The yarn is subsequently heated to activate the bi-component fibers and thereby cause the yarn to "bloom" or increase in bulk.

This invention relates generally to a bulky spun yarn and a method of forming the same. More particularly, the present bulky yarn includes two different types of staple length synthetic fibers, one group of such fibers having a mechanically induced type crimp that is developed before the yarn is spun and the other group of fibers being of the bi-component type, and having an inherent ability to coil, that is developed after the yarn is spun.

It is well known that good insulating and covering qualities can be obtained in a textile article by utilizing a high bulk yarn and there are groups of patents which suggest different methods of imparting bulk to spun yarns. Most of these patents are directed to forming the yarn by blending synthetic fibers having differential shrinkage characteristics. Examples of this type of bulky yarn are found in U.S. Patents Nos. 2,810,281 and 2,985,940.

U.S. Patent No. 3,161,011 discloses a bulky spun yarn which is formed by blending a first group of highly crimped, dimensionally stable fibers with a second group of essentially straight bi-component fibers which have the ability to develop a high crimp. These blended fibers are then spun and the high crimp is developed in the fibers of the second group to cause the yarn to bulk. According to this patent, it is necessary that the fibers of the second group comprise at least 15% of the blend (preferably 30% to 40%) and that the yarn be spun with a very low order of twist (a twist multiplier not greater than about 2). This relatively high percentage of bi-component fibers substantially increases the cost of the yarn and the low order of twist is not sufficient that the yarn can be used in many different types of textile products.

With the foregoing in mind, it is an object of the present invention to provide a bulky yarn and method of forming the same whereby a relatively low percentage of bi-component fibers is blended with a relatively high percentage of mechanically crimped fibers so that the cost of producing the yarn is reduced, and a relatively high order of twist is used to provide substantial strength to the yarn.

It is another object of this invention to provide a bulky yarn and method of processing the same whereby the strength of the yarn is enhanced by the presence of the developed bi-component fibers which intertwine and interlace with the mechanically crimped fibers.

It is a more specific object of this invention to provide a bulky yarn and method of forming the same which

has sufficient bulking characteristics that substantial bulk is obtained even when two or more ends are plied together, thereby permitting use of the present bulky yarn in a wide range of textile articles, such as carpets and the like.

The bulky yarn of this invention is formed by the proper proportional blending of mechanically crimped staple length fibers and bi-component staple length fibers. The group of mechanically crimped staple length fibers has an irregular crimp which is developed and heat-set therein prior to the blending operation. The group of bi-component staple length fibers is substantially straight when blended with the mechanically crimped fibers and formed into a yarn. The bi-component fibers have an inherent ability to coil and form substantially uniform loops and whorls when heated in an unrestrained condition. The bi-component fibers are uniformly blended with the mechanically crimped fibers in the twisted yarn and are therefore in a somewhat restrained condition. However, when the yarn is heated, there is sufficient development of the coils in the bi-component fibers to cause a substantial separation of the mechanically crimped fibers and to thereby impart greatly enhanced bulk to the yarn. The heat treatment to develop the coil in the bi-component fibers may be applied to the yarn before it is used in a textile article, or the heat treatment may be applied to the textile article after the yarn has been incorporated therein.

Some of the objects of the invention having been stated, other objects will appear as the description proceeds when taken in connection with the accompanying drawings, in which—

FIGURE 1 is a greatly enlarged elevational view of a single mechanically crimped fiber, illustrating the type of irregular crimp which is heat-set therein;

FIGURE 2 is a greatly enlarged elevational view of a single bi-component fiber, illustrating its substantially straight configuration;

FIGURE 3 is a greatly enlarged elevational view of the bi-component fiber shown in FIGURE 2 but illustrating the uniformly coiled configuration the fiber assumes when heated in unrestrained condition;

FIGURE 4 is an enlarged fragmentary elevation of a plied yarn formed of the blended fibers of FIGURES 1 and 2 and illustrating its appearance prior to the development of the bi-component fibers therein; and

FIGURE 5 is a view similar to FIGURE 4, but illustrating the increased bulk of the yarn, after the bi-component fibers are developed.

Generally, the bulky yarn of the present invention includes a relatively low percentage of bi-component staple fibers and a relatively high percentage of mechanically crimped staple fibers which were crimped and heat-set prior to the blending and spinning of the yarn. The bi-component staple fibers comprise not more than about 10% by weight of the yarn and in the preferred yarn, the bi-component fibers comprise only about 5%. Surprisingly, this low percentage of bi-component gives substantially the same bulk as yarns which contain as much as 30% of the bi-component fibers. The bulky yarn has particular utility when formed in a relatively large size (for use as the pile yarn in carpets) and with a relatively high twist (a preferred twist multiplier greater than 2).

The yarn of the present invention may be utilized as a single yarn, although it is preferred that two ends be piled together when the yarn is to be used as the pile yarn in carpets and the like. Normally, the degree of bulk is reduced as the twist in the yarn is increased and it would be assumed that the degree of bulk would be further reduced by plying two yarns together. To the contrary, relatively high twist plied yarns formed in accordance with the present invention are bulked by about

30% or more. The presence of the bi-component fibers also greatly enhances the strength of the yarn and this is in contrast to the results which would normally be expected. For example, one would expect the bi-component fibers to cause the strength of the yarn to be reduced, since the development of the coils in these fibers causes some separation of the mechanically crimped fibers in the yarn. While it is not completely understood why the strength of the yarn is increased, it appears that the coiling of the bi-component fibers causes a further interlacing of the fibers and presents a resistance to pulling apart of the mechanically crimped fibers as a longitudinal force is applied to the yarn.

As has been stated, the yarn of the present invention is of particular significance when utilized in the formation of a cut pile carpet wherein the yarns are tied into the base fabric but are in free, unrestrained condition otherwise. Further, the yarn of the present invention has shown outstanding advantages in a "shaggy" carpet which has a relatively long cut pile yarn that has a tendency to lay down in use.

The crimp in the single fiber shown in FIGURE 1 is typical of the type of mechanical crimp which is formed by the well-known "stuffer box" method. In this method, the thermoplastic fibers (in staple or continuous form) are fed into a confined area where they are crimped and heated to at least partially set the crimp therein. The crimp may be further set by steam under pressure. The mechanically crimped fiber is indicated by the reference character A in FIGURE 1 and the irregular crimps are indicated at *c*. In addition to the up and down distortion shown in FIGURE 1, the fiber is also distorted in a plane toward and away from the observer. While the crimps *c* may be removed by a longitudinal pull on the fiber, they will return to substantially the same condition after the longitudinal pull is removed. The mechanically crimped fibers may be of any desired staple length, preferably from about ½ inch to 12 inches, and within the range of about 6 to 20 denier.

A single bi-component fiber is indicated at B in FIGURE 2, illustrating its uncoiled, substantially straight appearance when it is blended with the mechanically crimped fibers A. As illustrated, the bi-component fiber B is substantially straight, having a slightly wavy configuration. This bi-component fiber is of the type produced and sold by Du Pont under the name of "Cantrece," a trademark registered by Du Pont. Generally, this bi-component fiber is formed by uniting components of nylon having different shrinkage characteristics to form a single fiber. When heat is applied to the bi-component fiber B (FIGURE 2), the developed fiber B' (FIGURE 3) assumes a substantially regular and uniformly convoluted configuration of reversing coils or loops, as indicated at *b*.

In order to form the regular and substantially uniform coils *b*, the fiber B' must be in unrestranied condition when subjected to the heat, since any substantial amount of restraint will prevent the formation of the coils therein. A detailed description of the manufacture of this bi-component fiber is set forth in British Patent No. 950,429 (published Feb. 26, 1964). The denier and staple length of the bi-component fibers may be varied as desired, preferably being about the same as the mechanically crimped fibers with which they are to be blended.

As shown in FIGURE 4, individual twisted yarns **10**, **11** are initially formed of a blend of the mechanically crimped fibers A and the bi-component fibers B, and these yarns are then preferably plied together, as illustrated in the left-hand portion of FIGURE 4. It is preferred that the twist in the individual yarns **10**, **11** be imparted in one direction and the yarns plied together in the opposite direction. After the yarn Y is formed of the fibers A and B, it is subjected to heat, while in an unrestrained condition, to develop the crimp or curl in the bi-component fibers and produce an increase in bulk, as illustrated by the yarn Y' in FIGURE 5. It will be noted that the bi-component fibers B' (FIGURE 5) have assumed a coiled condition as the loops and coils are developed therein to cause separation of the mechanical fibers A' and increase the bulk of the yarn Y'. As the bulk of the yarn is increased, the surface of the yarn becomes more irregular, to reduce the light reflection properties of the yarn so that richer, deeper colors are obtained when the bulked yarn is dyed. As the yarn bulks, it also shrinks and the angle of twist is reduced, as illustrated by the dash-dot twist angle lines **12** and **12'** in FIGURES 4 and 5.

While various sizes and types of bulky yarns may be formed in accordance with the present invention, the invention will be more clearly understood by reference to the following specific examples, which are merely illustrative and are not intended to limit the invention.

Example I

Mechanically crimped staple fibers, of the type shown in FIGURE 1, are blended with untreated bi-component staple fibers in the ratio of 95 parts, by weight, of the mechanically crimped fibers to 5 parts of the bi-component fibers, which are then in the substantially straight, uncoiled condition shown in FIGURE 2. The bi-component fibers are 15 denier and are cut to a staple length of 5½ inches. The mechanically crimped fibers are formed by passing nylon filaments through a stuffer box crimper where the crimp is set by heat and then the filaments are cut to the desired staple length, of about 5¼ inches. These mechanically crimped fibers are further set by steam under pressure, in an autoclave.

The combined fibers are thoroughly blended as they are passed through a gill box and successive pin drafters. The blended fibers are then spun to impart 4½ turns per inch in a Z direction and produce a yarn having a worsted count of 3.25 and a twist multiplier of approximately 3. This single yarn has substantial strength and is useful for many purposes in this condition; however, it is preferred that two ends of this yarn be plied for use as the pile yarn in carpets. The two single ends are combined with a ply twist of 3.81 turns per inch and the ply twist is applied in the S direction.

The plied yarn has substantially the appearance of the yarn illustrated in FIGURE 4 (before being bulked) and the fibers A are blended with the bi-component fibers B which are then in substantially straight condition. This plied yarn is then steamed under pressure at a twist-setting temperature while in relaxed condition, such as in skins, so that the bi-component fibers B are activated. The bi-component fibers try to assume the coiled condition shown in FIGURE 3, but because of the restriction confining action of the mechanically crimped fibers A, all the potential coil in the fibers B is not completely developed. The degree of development of the coil of the fibers B' varies, depending upon the position of the fibers in the yarn and the amount of restraint imposed thereon by the fibers A' in the yarn Y'. The partial and full development of the coils in the fibers B' causes a separation or spreading apart of the fibers A' to increase the bulk of the yarn.

A comparison of this bulked yarn was made with a control yarn of similar construction, except that it was formed entirely of mechanically crimped fibers. The yarn of the present invention has approximately 30% more bulk than the control yarn and the tensile or breaking strength of the present yarn has been increased by approximately 25%.

A sample of tufted cut pile shaggy carpet was formed using the bulked yarn of the present invention in one side and the control yarn in the other side. The carpet sample was dyed and finished in the usual manner and the side formed of the present bulky yarn has a much richer appearance, the twist angle of the yarn is reduced, and the pile provides much more cover for the backing.

Example II

Single yarn ends are spun from the same blend of fibers as set forth in Example I to provide 4½ turns Z twist in each single end and form a yarn having a worsted count of 3.40. The Z twisted yarns are then plied with 5¼ turns per inch ply twist in an S direction. This yarn is then steamed in an autoclave while in a relaxed condition, and because of the higher number of turns of ply twist, the yarn curls and kinks upon itself. Even with the high number of turns of ply twist, this yarn develops increased bulk as the coils and loops of the bi-component fibers develop during the steaming of the yarn.

While the bulk has been developed in the above Examples I and II by steaming the yarn in relaxed condition, it is to be understood that the bulk of the yarn of the present invention may be developed after the yarns are incorporated in a textile product, such as the pile yarns of a carpet. In this case, the bulk may be developed during the dyeing of the carpet. Also, in cases in which the yarn is dyed prior to fabrication into a textile fabric, the dyeing operation may be used to develop or further enhance the bulk in the yarn.

We claim:

1. A method of forming a bulky spun yarn comprising the steps of

(a) blending at least 90% by weight of mechanically crimped and heat-set thermoplastic staple fibers with up to 10% by weight of substantially straight bi-component self-crimpable thermoplastic staple fibers, the bi-component fibers having an inherent ability to coil and shrink when heated in unrestrained condition;

(b) spinning the blended fibers to form a yarn while imparting sufficient twist to provide a twist multiplier greater than 2; and

(c) heating the yarn while in substantially relaxed condition to at least partially develop the coils in the bi-component fibers and impart increased bulk to the yarn while setting the same.

2. A method according to claim 1 including the further step of plying two of the yarns formed in step (b) prior to the heating of the yarn, the two yarns being plied in a direction opposite the direction of twist in the yarns.

3. A bulky spun yarn having sufficient twist and strength to be useful in carpets and the like, said yarn comprising mechanically crimped thermoplastic staple fibers and coiled bi-component thermoplastic staple fibers twisted together, said mechanically crimped fibers comprising at least 90% by weight and said coiled bi-component fibers comprising up to 10% by weight, said bi-component fibers being uniformly distributed among and between said mechanically crimped fibers, and said bi-component fibers causing a separation and spreading apart of the mechanically crimped fibers to provide a much greater bulk than the same weight yarn containing only mechanically crimped fibers.

4. A yarn according to claim 3 wherein the mechanically crimped fibers are present in an amount equal to about 95% by weight of the yarn, and the bi-component fibers are present in amount equal to about 5% by weight of the yarn.

5. A yarn according to claim 4 wherein the yarn is twisted with 4½ turns per inch and has a worsted count of about 3.46.

6. A plied yarn comprising two yarn ends of the type set forth in claim 5, and wherein the two yarn ends are plied together with about 3.81 turns per inch.

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JOHN PETRAKES, Primary Examiner

U.S. Cl. X.R.

28—72; 57—157