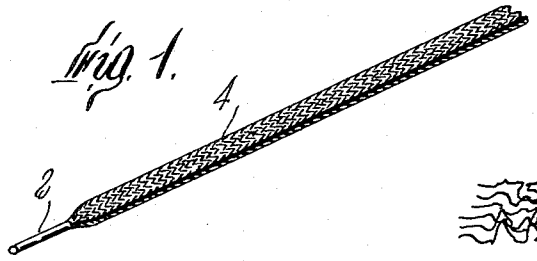
July 18, 1961 D. W. LIGHT 2,992,584

TIE CORD

Filed Oct. 10, 1958

Fig. 1.



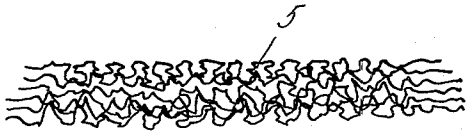


Fig. 2.

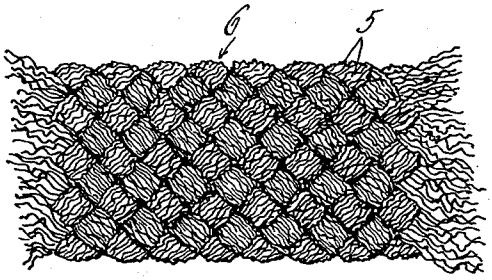


Fig. 3.

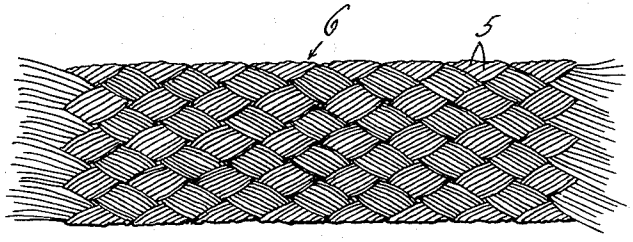


Fig. 4.

United States Patent Office 2,992,584 Patented July 18, 1961

2,992,584

TIE CORD

Donald W. Light, Groton, Mass., assignor to Pepperell Braiding Company Incorporated, East Pepperell, Mass., a corporation of Massachusetts

Filed Oct. 10, 1958, Ser. No. 766,569
3 Claims. (Cl. 87—2)

This invention relates to cord of the type that must be tied and untied frequently, and used for example, to adjust or bind articles of clothing or equipment, finding particular utility as shoe strings.

Tie cords currently are generally made by braiding textile yarns. Cotton yarns are most commonly used, but on occasion the braid yarns used have been made from filament or staple rayon or superpolyamidic fibers or mixture of these synthetic fibers with cotton, or elastic thread made of a rubber core tightly wound with fine textile yarns. Of these, my experience indicates that braided cotton cord has so far been thought to have achieved an optimum balance between good knotting characteristics and good wear characteristics, others, such as cords formed from superpolyamides, being so slippery and incompressible as to have poor knot behaviour. Therefore, these last-named materials have not made generally satisfactory tie cords.

Cotton cords, particularly when used as shoe strings, are still subject to much criticism due to breakage and coming untied at awkward moments.

My analysis of the essential desirable characteristics of cords, i.e., long wear and good knot behaviour, shows that the two sets of properties required are to a large extent mutually opposed.

By good knot behaviour, I mean a knot that is easily tied, will stay tied through ordinary use, but which can nevertheless be readily untied. To meet these requirements a cord must be soft and flexible and easily compressible, with high surface friction, still compatible with the requirement that it be capable of being readily untied whenever desired. On the other hand, long wear required high strength, endurance to flexing and resistance to chafing which in turn is improved by low surface friction. One cannot normally have low and high surface friction at the same time and in general these two sets of properties are opposed so that treatment or change to improve one, degrades the other, and a balance must be sought at as high a quality level as possible.

I have discovered that a tie cord combining these desirable and somewhat mutually antagonistic qualities to a degree heretofore thought unobtainable, may be achieved, quite surprisingly, by using as a braid material synthetic yarns which in their usual state are relatively hard, incompressible, and slippery, but which have been treated so that their surface characteristics yield improved qualities of flexibility and compressibility and higher surface friction together with a quality of stretch which is unexpectedly desirable and of a different character from that afforded by rubber threads of the prior art.

In accordance with the present invention, I make my improved tie cord by braiding permanently crimped superpolyamidic yarns in whih the filaments are also permanently crimped. This braiding results in helical arrangement of all the yarns with respet to the cord itself. While I prefer using permanently crimped superpolyamidic two-ply yarns ranging in weight from one hundred to two hundred ten denier per ply for use as shoe strings, I do not wish to limit myself to these weights or to this particular article because there are many other uses that can be advantageously served by the combination of long wear and good knot behaviour of my tie cord that may require a level of tension equilibrium different from shoe strings

and thereby a different range of yarn. Similarly, it is preferable for shoe strings to use thirty-two to eight-eight two-ply yarns in the braid. The braid construction must however be in proper balance to obtain maximum advantage from the presence of the crimp. For shoe string use, picks per inch in the extended or stretched condition under one pound tension multiplied by the square root of the total denier in a pick should be maintained within the range of approximately 350 to 550.

Further objects, features and advantages of the invention will become apparent from the following detailed description of a preferred embodiment thereof taken in conjunction with the accompanying drawings, wherein like numerals refer to like parts in the several views and in which:

FIG. 1 is a perspective view of one end portion of a tipped braided tie cord, made in accordance with my invention, to illustrate its appearance;

FIG. 2 is a plan view of some of the permanently crimped filaments in the unstretched state, to show specifically the source of the increased surface friction and compressibility described above;

FIG. 3 is a magnified plan view of a portion of the improved tie cord in an unstretched condition; and

FIG. 4 is a view of the same similar to FIG. 3 but showing the cord in a tensioned condition, illustrating the stretch effects.

Permanently crimped superpolyamides are utilized in this invention. There are various methods of crimping to give different configurations and character of crimp to superpolyamidic yarns and filaments, but the preferred one is that described by L. A. Billion in his United States Patent No. 2,564,245, issued August 14, 1951.

Braid tightness is defined by the number of pick crossings per inch of length along the braid. These are known in the trade as "picks per inch." For a given yarn material, tightness in a braid is a function of the product of the number of picks per inch and the square root of the total weight of yarn in a pick in the braid. In the preferred embodiment of my invention wherein the cord is used as a shoe string, with the weight of yarn measured in denier, I have found that such product should be maintained in the range of between about 350 to 550. Within these limits a cord is produced having an excellent balance of long wear and good knot behaviour, far exceeding the level of cotton or any other tie cords known to me. The crimp of the filaments and yarn increases the surface friction and compressibility at the knot to give superior holding properties for knots that are nevertheless easy to tie but still untie readily. The wear is not seriously impaired by crimping, and tests have shown such a cord will wear over five times as long as a high quality cotton cord that was twice as heavy.

As applied especially to shoe strings, the present invention has a further advantageous characteristic, one which was at first believed to be a serious disadvantage in that the crimped filaments and yarns would be expected to produce a stretchy braided tie cord. One would expect this cord to have the serious disadvantages of known elastic shoe strings, including difficulty in lacing to the proper tension so the shoe would feel firm and secure without binding and difficulty of tying and untying the knots. Tests and field trials have shown, however, that, within the construction limits of the invention, the stretch due to filament crimp is essentially all removed at the low tensions normally used in lacing a shoe resulting in a tension in the lacing which I have found to be close to the optimum for comfort and security. In fact, and here is where the advantage of this particular type and quality of stretch has appeared most strikingly, it was observed in field trials that the slight residual stretch or "give" remaining in the lacing in fact increased shoe comfort and the

sense of secure footing. It was also noted that the loops and ends above the knot, being under no tension, retracted to a degree where there was less likelihood of stepping and tripping on them while the free ends remained readily accessible to the grasp for pulling the knot undone. Also the stretch characteristic was not such as to make tying in the least difficult.

Referring now to FIG. 1, it will be seen that the braided cord **4** when provided with an ordinary tip **2** presents a fine appearance suitable for all lacing applications.

In FIG. 2 there are shown crimped superpolyamide filaments **5** which make up the yarn. In FIG. 3 there is shown a section of braid in a relaxed condition. A few filaments **5** are shown in each yarn **6** by way of illustrating the nature of the yarn.

FIG. 4 illustrates the partial straightening of the crimp of the filaments **5** comprising each yarn **6** and the change in character of this tie cord upon tensioning that enables it to combine the properties of long wear with those for good knot behaviour.

In general, the braiding of my improved tie cord is accomplished on conventional braiding machinery but with particular care to maintain uniform tensions. It has been found advantageous to wet process after braiding to ensure uniformity of cord compression.

It will thus be seen that the invention resides in part at least in my discovery that the surface friction and compressibility of tie cords made of braided superpolyamidic filament yarns can be increased to an unexpected extent by permanently crimping the yarns and filaments prior to braiding, obtaining a balance of long wear and good knot behaviour properties superior to any tie cords known to me. The invention further resides in my discovery that for use as shoe strings and the like such a tie cord functions as two different cords: in the laced area where the string is under some tension the properties contributing to long wear predominate, in the knot area, where there is no tension beyond the knot, the properties contributing to good knot behaviour predominate—thus resolving the opposition of these two sets of properties. Further, for use as shoe-strings, with such a tie cord construction within the limits described above, I have found that the slight residual stretch in the laced portion functions as an advantage instead of a disadvantage in the tension adjustment and the comfort of the shoe whereas in the portion above the knot where there is no tension the retraction of the loops and ends contributes to the safety and neat appearance of the shoe.

While I have herein illustrated and described a presently preferred form of the invention, it will nevertheless be understood that the same is susceptible of modifications and changes by those skilled in the art, and that the invention is, therefore, intended to be limited only by the proper scope to be afforded to the appended claims.

I claim:

1. A cord for securing articles to living beings, adapted to be tied and untied, said cord having a two phase stretch, the first of which is a ready stretch and compressibility pulled out at low tensions, and the second of which is a residual lesser stretch of a noticeably different magnitude and character in which phase the cord exists under normal tying tension, said cord being comprised of braided synthetic crimped yarn, and said cord having increased surface friction with its outer surface defined by exposed portions of said braided yarn, the second residual stretch providing a further yielding and tension adjustment of the cord when under normal tying tension in response to the increased stress attributable to the wearer, said cord being easily tied into a knot and holding the knot during active use while still being capable of being readily intentionally untied, said knot holding being augmented by said surface friction and by said compressibility, and the free, untensioned loops and ends of said cord being contracted by virtue of said first ready stretch.

2. A cord as claimed in claim 1 in which the synthetic crimped yarn is a superpolyamide.

3. A cord as claimed in claim 2 for use as a shoe string in which the picks per inch of its length in the extended or stretched condition under one pound tension multiplied by the square root of the total denier in a pick is maintained within the range of about 350 to 550.

References Cited in the file of this patent

UNITED STATES PATENTS

1,948,844	Dawes	Feb. 27, 1934
2,099,016	Houghton	Nov. 16, 1937
2,477,151	Stapleton	July 26, 1949
2,564,245	Billion	Aug. 14, 1951
2,715,309	Rosenstein et al.	Aug. 16, 1955
2,815,559	Robinson	Dec. 10, 1957
2,841,046	Runton	July 1, 1958
2,846,840	Billion	Aug. 12, 1958
2,887,005	Fromm	May 19, 1959

FOREIGN PATENTS

909,448	France	Dec. 20, 1945