May 28, 1946. A. F. SMITH 2,401,291

RACKET STRING

Filed June 11, 1943

Fig. 1.

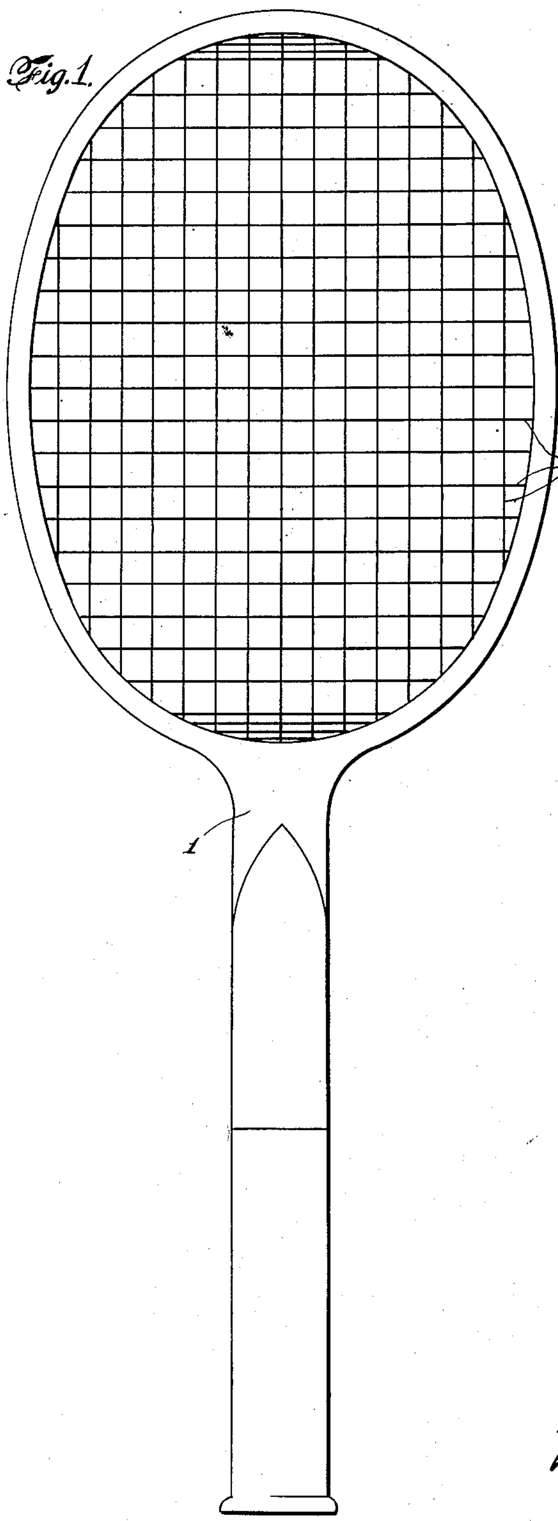


Fig. 2.

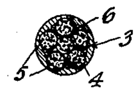


Fig. 3.

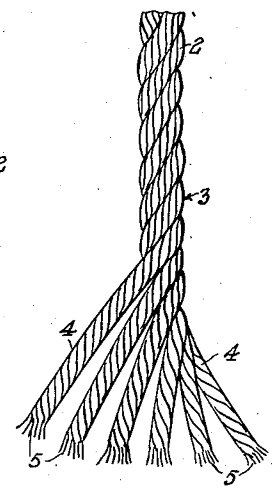
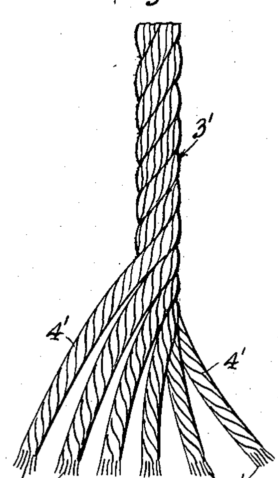


Fig. 4.



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2,401,291

RACKET STRING

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2 Claims. (Cl. 57—140)

This invention relates to coated nylon cords. More particularly, it relates to the coating of cords of multifilament nylon yarns to produce resilient, tough, high-impact strength, abrasion-resisting structures for use as athletic racket strings.

Although the cords of the invention are suitable for all uses where toughness, resilience, high-impact strength, abrasion-resistance, etc., are demanded, the invention will be discussed in terms of athletic racket strings, and particularly tennis racket strings, for convenience.

Tennis rackets strung with single strand nylon monofils, while vastly superior in most respects to rackets strung with gut, have had certain inferior playing qualities and other disadvantages attendant upon the use of such single strand nylon monofils. The disadvantages are apparently due to the physical structure and formation of the monofils. It has been found that longitudinal splitting of the monofils occurs after a certain length of time. The splitting is regarded as being due to the lowered transverse strength because of the high longitudinal orientation of the monofils. The splitting results from nicks which are caused by the contact of the taut string with the dirt and grit carried by the ball. In stringing a racket, the longitudinal strings are drawn across the transverse strings with a force approximating 80–100 pounds to achieve the necessary final high string tension. The nylon monofil strings formerly used have been known to become weakened and to eventually break in play because of chipping or wearing at points where the strings cross each other. This failure may be caused by brittleness, surface flaws, the absence of symmetry throughout the length and structure of the filament, or grooving of the transverse filaments in stringing.

It is an object of this invention to produce nylon tennis racket strings superior to former nylon tennis strings and devoid of the above-stated objections.

It is a further object to produce nylon tennis strings which possess all of the desirable properties of the nylon of former tennis strings and, in addition, that elusive quality known as good playing characteristics.

Other objects will appear hereinafter.

The objects are accomplished by forming a cord of twisted nylon multifilament yarns and coating it to product a tough, seamless skin on the twisted cord structure.

Nylon tennis racket strings have heretofore been made exclusively of single strand monofilamentary yarn since nylon multifilament yarns were considered obviously and wholly unsuited to such usages because of their ease of stretchability, their lack of requisite stiffness or body, as well as the extreme sensitivity of the exposed filaments to abrasive action.

An important discovery of this invention rests in the fact that multifilament nylon yarns, when corded to produce a balanced cord and coated, make entirely acceptable and even superior tennis strings. These new tennis strings inherently possess the resiliency and recovery from stretch of twisted yarns, the iron-like strength of nylon yarns and the abrasion-resistance afforded by the coating which are important prerequisites for satisfactory tennis strings.

The present invention is illustrated in the accompanying drawing forming a part of this specification and wherein:

Figure 1 is a top plan view of a tennis racket strung with strings embodying the principles of the instant invention;

Figure 2 is a cross-section of a string shown in Figure 1;

Figure 3 is an enlarged and exaggerated view of one embodiment of a string, the coating being omitted, and partly raveled to show the construction thereof; and

Figure 4 is an enlarged and exaggerated view of another embodiment of a string, the coating being omitted, and partly raveled to show the construction thereof.

Referring now to the drawing, the reference numeral **1** designates a tennis racket frame strung with strings **2**. Each string **2** consists of a cord **3** obtained by twisting together a plurality of strands **4**, and each strand **4** is obtained by twisting together a plurality of nylon filaments **5**. The cord **3** is provided with a coating **6**.

In order that the invention may be more clearly understood, the following are examples of the method of construction of these nylon tennis strings:

Example I

210-denier, 68-filament, 1-turn S polyhexamethylene adipamide yarn **5** was treated in the relaxed condition with boiling water as is known in the art to increase the impact strength. Six ends of the yarn **5** were twisted together 6.2 turns S to yield the strand **4**. Six ends of the strand **4** were then twisted together 2.7 turns Z to form the cord **3**. The cord **3**, which weighed 0.85 gram per yard, was coated with a nylon solution to build up a coating **6** weighing approximately 0.37 gram per yard by applying separate coats and drying between the successive applications of the coating. The coating solution consisted of an interpolyamide prepared from hexamethylenediammonium adipate, hexamethylenediammonium sebacate and caprolactam in a ratio of 40:30:30 and dissolved in isobutyl alcohol to approximately 6.6% solids content. The coating solution was applied at the speed of 8 feet per minute and loose felt wipers on the cord removed the excess coating. The coating was dried at about 90° C. in a 12-foot oven and one dry pass was used after the application of the last coat.

The cord so formed and which was composed of about 30% coating was then strung in a tennis racket frame and, after being experimentally used and tested for over a period of a year under conditions of actual use, the racket exhibited exceptionally good service and was considered superior to former nylon monofil strung rackets.

Example II

30-denier filaments 5' of polyhexamethylene adipamide were treated with aqueous phenol as is understood in the art to improve the impact strength. Thirty-six ends were twisted 5 turns S and six ends of the resulting strand 4' were twisted 4 turns Z to form the cord 3'. The corded structure was coated with N-methoxymethyl polyamide, made from polyhexamethylene adipamide, in an ethyl alcohol solution (10% solids content). By successive coatings, a covering of about 28% of the final structure was produced. The coated structure was then baked at 120° C. for 3 minutes. When strung in a tennis racket in the usual way, it was found to have excellent playing characteristics and very long life.

The multifilament nylon yarns which can be used in this invention are not limited to those disclosed in the foregoing examples but include also all filaments comprising fiber-forming synthetic linear polymers, especially those of the classes described in U. S. Patents Nos. 2,071,250, 2,071,251, 2,071,253, 2,130,523, and 2,130,948, as well as those filaments comprising the interpolymers of U. S. Patents Nos. 2,252,554 and 2,252,555. In other words, the invention is intended to include for the preparation of the filaments all water-insoluble and fiber-forming nylon superpolymers and interpolymers.

The method of twisting and stranding the filaments given in the examples is merely illustrative of conventional procedures used in making cords for tennis rackets, and the invention is not meant to be limited thereto since it is obvious that there can be used other combinations of twists, number of ends for building up a cord, amount or direction of twist of either the strand or cord or both, to produce a final cord structure having the proper balance to produce resilience, impact strength and abrasion-resistance.

As shown by the examples, the coating composition will preferably comprise any of the synthetic linear polyamides capable of forming coating compositions, such as, for example, the polyamides and interpolyamides of the type mentioned in U. S. Patents Nos. 2,071,253 and 2,130,948.

The invention is not limited, however, to the use of synthetic linear polyamides as coating compositions. Other coating compositions which produce well-adhering, tough, abrasion-resisting, flexible and fatigue-resisting covering can be used. Examples of other materials which may be used are polyesters, polyacetals, polyesteramides, polyurethanes, polythioureas and polymeric ethylêne. Properly plasticized polymeric methacrylates, polymeric acrylates, polyvinyl butyral, vinyl chloride vinyl acetate interpolymers, alkyd resins, heat-hardenable phenol-formaldehyde resins, and cellulose derivatives or suitable mixtures of the above resins are also applicable.

While the examples have shown the coating to be approximately 30% of the cord structure, the coating may constitute 20–40% of the final cord structure without departing from the spirit and scope of the invention.

The coating may be applied by any of the conventional coating methods, i. e., spraying, dipping, extrusion, dispersion, etc. While a preference has been shown for the application of the coating by solvent methods, the invention is not so limited. Any technique which results in a uniform, continuous, adherent coating is satisfactory.

The tennis racket strings of this invention have exceptionally good playing characteristics. Because of their structure, the strings possess greater resilience and flexibility, higher tensile and impact strengths, more highly abrasive-resisting coatings and longer playing life than have been achieved heretofore. These strings also possess a pronounced fatigue-resistance, holding approximately the same string tension after a year of use. The strings of the invention are capable of withstanding the great force necessary for stringing and the smooth, tough coating will give sufficient protection against abrasion when the string is pulled through sharp bends to prevent the loss of any of the desirable playing characteristics or durability in the stringing operation.

The improved strings of this invention are especially valuable in athletic rackets, such as tennis, badminton, squash rackets and the like.

Since it is obvious that various changes and modifications may be made in the above description without departing from the nature or spirit thereof, this invention is not restricted thereto except as set forth in the appended claims.

I claim:

1. An athletic racket string comprising a corded structure having a smooth coating of an interpolyamide prepared from hexamethylenediammonium adipate, hexamethylenediammonium sebacate and caprolactam in a ratio of 40:30:30, said coating giving sufficient protection against abrasion when the string is pulled through sharp bends to prevent the loss of the desirable playing characteristics or durability in the stringing operation, said corded structure comprising a plurality of strands twisted together, each strand comprising a plurality of polyhexamethylene adipamide filaments twisted together, said coating constituting about 30% by weight of said string.

2. An athletic racket string comprising a corded structure having a smooth coating of a synthetic linear polyamide prepared from hexamethylenediammonium adipate, hexamethylenediammonium sebacate and caprolactam in the ratio of 40:30:30, said coating giving sufficient protection against abrasion when the string is pulled through sharp bends to prevent the loss of the undesirable playing characteristics or durability in the stringing operation, said corded structure comprising a plurality of strands twisted together, each strand comprising a plurality of polyhexamethylene adipamide filaments twisted together, said coating constituting 20% to 40% by weight of said string.

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