

[54] CONSTRUCTION OF TENNIS STRINGS

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[58] Field of Search 57/139, 140, 144,
57/149, 153, 156, 157, 160, 162, 163, 164

[56] References Cited

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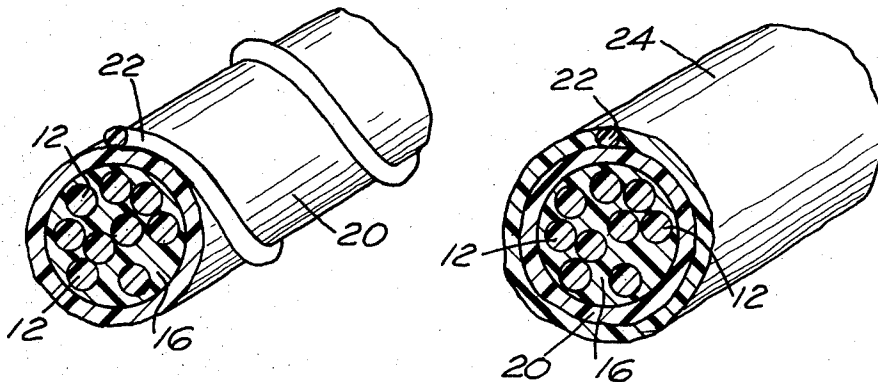
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[57] ABSTRACT

A string for use in connection with athletic rackets, such as tennis, badminton, squash and the like comprising a thermoplastic core made from a plurality of twisted thermoplastic strands, said core having a coating of plastic material covering and integrated therewith, a thermoplastic filament wrap extending spirally around said coated core, the pitch of said wrap being such that substantial spacing exists between adjacent convolutions, and a further coating of plastic material covering and integrated with said coated and wrapped core.

13 Claims, 11 Drawing Figures



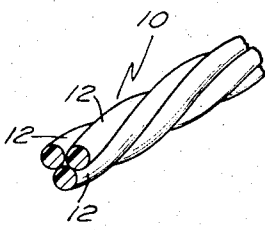


FIG. 1

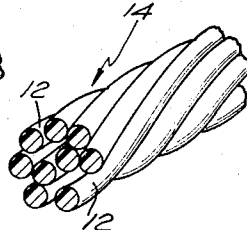


FIG. 2

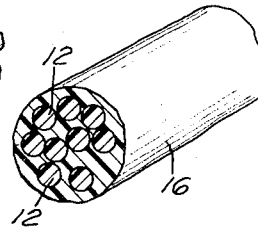


FIG. 3

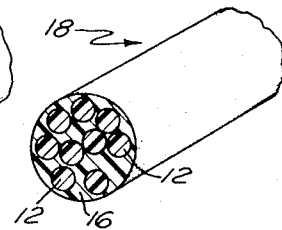


FIG. 4

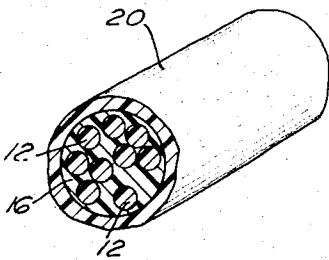


FIG. 5

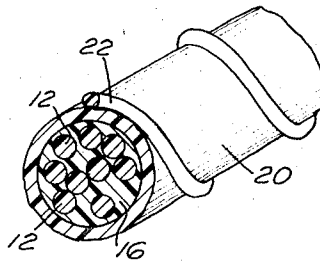


FIG. 6

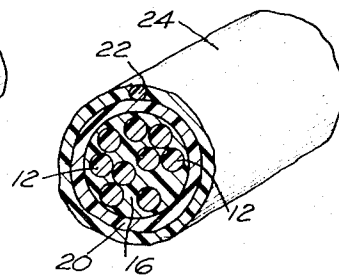


FIG. 7

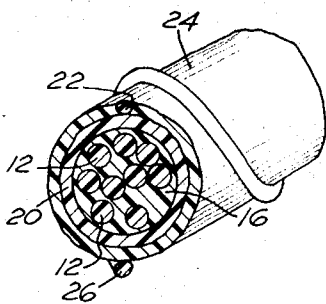


FIG. 8

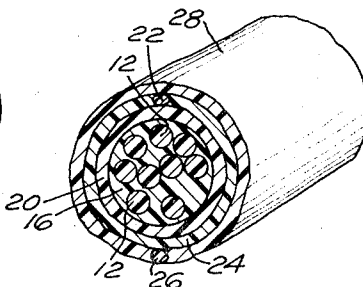


FIG. 9

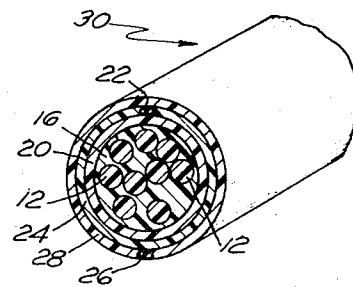


FIG. 10

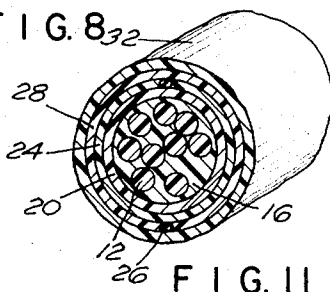


FIG. 11

CONSTRUCTION OF TENNIS STRINGS

BACKGROUND AND SUMMARY OF THE INVENTION

It has been found that a highly durable and effective string for tennis rackets and the like may be formed by providing a core of twisted thermoplastic strands, coating said core with a plastic formulation, providing a wrap around said coated core with a thermoplastic filament, and then providing another similar coating over the wrap. Strings of this general construction have been heretofore known in the art, reference being made, for example, to applicant's prior U.S. Pat. Nos. 2,649,833 dated Aug. 24, 1953; No. 2,712,263 dated July 5, 1955; No. 2,735,258 dated Feb. 21, 1956; and No. 2,861,417 dated Nov. 25, 1958. In all of these prior string constructions, the wrap around the core of the string was either of a closely braided sheath, or a spiral wrap with the adjacent convolutions of the wrap in abutting engagement with each other. Although strings of this type have generally proven satisfactory for the intended purpose, it has been found that the braided sheath or the closely wound spiral wrap acts as a shield during the final coating operation of the string that impedes and resists complete integration of the outer coating with the inner core. Furthermore, the braided sheath or closely wound spiral wrap imparts more rigidity to the string than is actually necessary, which excessive rigidity makes stringing of a racket a rather difficult chore.

On the other hand, where the braided sheath or the spiral wrap is eliminated altogether, the string is so limp and lacking in rigidity as to likewise make stringing of a racket an unnecessarily difficult chore. Also, of course, the complete elimination of the braided sheath or the spiral wrap tends to materially weaken the string.

It is therefore an object of the present invention to provide a string of the character described having a core of twisted thermoplastic filamentous strands, which core is then coated in a plastic formulation, the coated core then having a thermoplastic strand wrapped spirally therearound, but with adjacent convolutions of the spiral substantially spaced from each other. The wrapped core is then once again coated; and for best results, a second similar wrap is applied before final coating of the completed string.

It has been found that a string construction in accordance with the present invention is possessed of sufficient rigidity and strength as a result of the aforesaid spiral wrap, so as to facilitate stringing of a racket, while at the same time not making the string overly rigid. In other words, the spaced spiral wrap which constitutes an important feature of the present invention has been found to impart the desired degree of rigidity to the string so as to facilitate and not impede subsequent stringing of a racket. In addition, due to the spacing between adjacent convolutions of the spiral wrap, more complete and uniform integration of the coated string is achieved, since the spacing between adjacent convolutions permits relatively free flow of the outer coating to the inner core of the string.

Other objects, features and advantages of the invention shall become apparent as the description thereof proceeds when considered in connection with the accompanying illustrative drawings.

DESCRIPTION OF THE DRAWINGS

In the drawings which illustrate the best mode presently contemplated in carrying out the present invention:

FIG. 1 is a fragmentary perspective view showing one of the groups of twisted strands that form a part of the core of my improved string;

FIG. 2 shows a plurality of the groups of FIG. 1 twisted together to form the string core;

FIG. 3 shows the core of FIG. 2 with a plastic coating therearound;

FIG. 4 shows the coated core of FIG. 3 after it has been stretched;

FIG. 5 shows the stretched core of FIG. 4 with an additional plastic coating formed therearound;

FIG. 6 shows the coated core of FIG. 5 with a filamentous strand spirally wrapped therearound;

FIG. 7 shows the wrapped core of FIG. 6 with a further plastic coating therearound;

FIG. 8 shows the string of FIG. 7 with a second spiral wrap therearound;

FIG. 9 shows the string of FIG. 8 once again coated;

FIG. 10 shows the string of FIG. 9 after it has been heat stretched; and

FIG. 11 shows the string of FIG. 10 with the final coating applied thereto.

DESCRIPTION OF THE INVENTION

Referring now to the drawings, and more specifically to FIG. 1, there is shown at 10 a group comprising a plurality of thermoplastic filamentous strands 12 gently twisted together; and specifically, the preferred twist being somewhere between 3 and 7 turns per inch. Any number of the strands 12 may be twisted together to form the group 10, although, in practice, three strands has been found to give good results. The strands 12 may be of any suitable thermoplastic material, although nylon filaments of 840 denier have proven highly satisfactory.

Referring now to FIG. 2, a plurality of groups 10 have been twisted together to form the core 14; and in this case, a total of three such groups have been twisted, thus resulting in a total of nine individual strands in the core; although, a greater or lesser number of strands may be used in the formation of the core with satisfactory results. Preferably the groups 10 are twisted together at 1.5 to 3.5 turns per inch. The next step is to coat the core 14 with a plastic coating 16, as shown in FIG. 3, it being noted that the coating 16 penetrates into and integrates with the core 14. For purposes of illustration, in FIG. 3, and succeeding figures, the core strands are shown as being separate and distinct from the various coatings; but it will be understood that in actual practice, said strands will substantially integrate with the surrounding coating.

Although it has been found that many synthetic resins and solutions may be used for the coating 16, and the subsequent coating steps to be later described, it has been found that a nylon base solution of the following formulation provides extremely satisfactory results: A nylon solution, preferably comprising by weight approximately 14.4 percent nylon; 61.1 percent Methanol; 4.9 percent tetrahydrofurfuryl alcohol; and 19.6 percent water. The above proportions are not critical but have been found to be desirable for providing a nylon solution of suitable consistency.

It will be understood that in applying the plastic coating 16 to the core 14, the core is passed through a tank containing the aforesaid formulation, the tank temperature preferably being in the range of 120°F and then the coated string is passed through a drying tower which is maintained at a temperature of approximately 220°F. It has been found that rather than applying a single heavier layer, several thin layers are preferable; and to this end core 14 is passed through the coating tank and drying tower a total of 10 times; although, obviously, the precise number of trips may be somewhat varied.

In order to better integrate the string 16 after the coating has been applied, the coated string is heat stretched, whereby the string is somewhat reduced in diameter and is more completely integrated, as the core and coating are softened under the heat and pressure to more effectively lock together. More specifically, the heat stretched string, shown at 18 in FIG. 4, is preferably stretched under approximately 30 pounds tension at a temperature of approximately 450°F. The percentage stretch of the string under these conditions is approximately 15 percent. It will be understood that the heat stretching of the string reduces the elongation of the string so as to more closely match the elongation of the filamentous strands 12.

The next step is to once again coat the string, using the same procedure and formulation as heretofore described, and at this stage of the operation the further coating 20 (FIG. 5) is formed preferably by passing the string through the coating tank and the drying tower twice.

Referring now to FIG. 6, it will be seen that a thermoplastic filamentous strand 22, preferably 30-denier nylon, is spirally wrapped around the coated string of FIG. 5, the pitch of said wrap being substantially the same as the pitch at which the groups 10 are twisted together, i.e., approximately 1.3 to 3.5 turns per inch, but in the opposite hand. This opposite wrapping of the strand 22 tends to equalize the elongation of the core, so that both the core and wrap will have approximately the same limit of elongation, thus maximizing the strength of the integrated string. It is important to note that the pitch of the strand 22 is such that adjacent convolutions are substantially spaced from each other, thus stiffening and strengthening the string to the desired degree, without imparting undue rigidity to the string. Also, the substantial spacing between adjacent convolutions of the strand 22 permit better integration of the string when subsequent coats are applied, and in FIG. 7 it will be seen that a further coating 24 of the aforesaid plastic formulation has been applied, and preferably the coating 24 is achieved by passing the string through the coating tank and drying tower six additional times.

For best results, although not absolutely essential to a successful end product, the string of FIG. 7 is provided with a second spiral wrap 26, in the same hand and pitch as that of the aforesaid wrap 24, although preferably staggered with respect thereto. The second wrap also preferably comprises a 30-denier nylon filamentous strand. After the wrap 26 has been applied, the string is passed through the coating tank and drying tower six additional times to form the further coating 28, after which the coated string is once again stretched at a temperature of approximately 450°F., but this time preferably at a tension of approximately 45 pounds, to

impart a further elongation of approximately 15 percent to the string. The heat-stretched string 30, shown in FIG. 10, is then given a final coating, as shown at 32 in FIG. 11. More specifically, after the heat stretching operation, the string goes through the coating tank and drying tower four times and then is allowed to sit for approximately 24 hours at room temperature to allow the solvents in the plastic formulation to evaporated. After this time interval, the string is once again passed through the coating tank and drying tower four times, whereupon cavities in the string caused by evaporation of the solvents are filled in to provide a substantially smooth and uninterrupted string surface.

In some cases, it has been found desirable, although not absolutely essential, to coat the groups 10 by passing them through the aforesaid formulation prior to twisting the groups together to form the core 14.

While there is shown and described herein certain specific structure embodying the invention, it will be manifest to those skilled in the art that various modifications and rearrangements of the parts may be made without departing from the spirit and scope of the underlying inventive concept and that the same is not limited to the particular forms herein shown and described except insofar as indicated by the scope of the appended claims.

What is claimed is:

1. An integrated string having a core comprising a plurality of groups of thermoplastic strands, each group comprising a plurality of strands twisted together in a first direction, said groups being twisted together to form said core, a coating of plastic material covering and integrated with said core, a thermoplastic filament wrap extending spirally around said coated core, the pitch of said wrap being such that substantial spacing exists between adjacent convolutions, and a further coating of plastic material covering and integrated with said coated and wrapped core.

2. In the string of claim 1, a second thermoplastic filament wrap extending around said further coating, said second wrap being of substantially the same pitch as said first wrap, and an outer coating of plastic material covering and integrated with said second wrap and said string.

3. In the string of claim 2, the pitch of said thermoplastic filament wraps being substantially the same as the pitch at which said groups are twisted together, but in the opposite hand.

4. In the string of claim 1, each of said groups having a coating of plastic material thereover, said coated groups then being twisted together to form said core.

5. In the string of claim 3, said strands being twisted together at approximately three to seven turns per inch to form said groups, said groups being twisted together at approximately 1.5 to 3.5 turns per inch to form said core.

6. The method of manufacturing an integrated string comprising the following steps:

- A. twisting a plurality of the thermoplastic strands together to form a group,
- B. twisting a plurality of said groups together to form a core,
- C. dipping said core into a thermoplastic formulation.
- D. passing said coated core through a drying chamber,
- E. stretching the integrated string under heat;

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- F. repeating steps C and D supra,
- G. spirally wrapping a thermoplastic strand around said coated string with the adjacent convolutions of said strand substantially spaced from each other,
- H. repeating steps C, D and E; and
- I. repeating steps C and D at a substantial time interval after the completion of step H.

7. The method of claim 6 further characterized in that between steps G and H steps C, D and G are again performed.

8. In the method of claim 7, all of said strands and said formation being nylon.

9. In the method of claim 7, said thermoplastic strands being wrapped in the opposite hand from the twist of said groups, but at substantially the same pitch. 15

10. In the method of claim 9, said strands being twisted together at approximately three to seven turns per inch to form said groups, said groups being twisted together at approximately 1.5 to 3.5 turns per inch to form said core.

11. In the method of claim 6, said groups each being coated with a plastic material prior to performing step B.

12. In the method of claim 6, the time interval between steps H and I being approximately 24 hours.

13. In the method of claim 6, the string being elongated approximately 15 percent during the performance of Step E.

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