

PATENT SPECIFICATION (11)

1599782

(21) Application No. 5522/78 (22) Filed 10 Feb. 1978 (19)
 (31) Convention Application Nos. 905/77 (32) Filed 10 Feb. 1977
 3098/77 2 May 1977
 3100/77 2 May 1977 in



(33) Austria (AT)
 (44) Complete Specification published 7 Oct. 1981
 (51) INT. CL.³ D07B 5/00 1/02
 (52) Index at acceptance
 D1T 1B 1H 1M

(54) METHOD FOR THE PRODUCTION OF PLASTIC STRINGING FOR BALL-GAMED RACQUETS

(71) We, FISCHER GESELLSCHAFT m.b.H., of Griesgass 10—11, A-4910 Ried im Innkreis, Austria, an Austrian Company, do hereby declare the invention, for which we

prayer that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a process for producing plastics stringing for ball-game racquets, in particular tennis racquets, and to stringing so produced.

The technique of making stringing from animal gut has long been known, even though initially it was exclusively used to produce stringing for musical instruments. When the first ball-games using racquets evolved (from which tennis in its present-day form is derived) natural gut strings were available, which fact played a direct part in the constitution of the ball and racquet, and an indirect part in the nature and form of the playing area and in the rules of the game. This is the reason why, despite certain fundamental disadvantages, natural gut stringing has held its leading position over other forms of stringing.

The raw material for the production of natural gut stringing is sheep-gut (more recently ox-gut has been used), which is first cut into laminae, of which, after various chemical processes, a few pieces are twisted together. Drying in a controlled atmosphere is then carried out. Thereafter the crude strings are polished round and smooth, and finally are impregnated with a special oil or lacquer.

A major disadvantage of natural gut string for racquets is its hygroscopic nature, which, with a high ambient humidity or even a wet playing field, leads to a slackening of the stringing tension, and to increased stringing wear. With the high costs enforced by costly production, this particular sensitivity requires careful conservation of natural gut

stringing.

This disadvantage, and others favours the development of stringing of synthetic materials (predominantly types of polyamides), which with the current state of the art leave little to be desired with regard to resistance to wear and also constancy of tension under all climatic conditions, and moreover may be produced substantially more economically than natural gut strings.

The disadvantage found with the usual synthetic stringing materials lies in their elastic behaviour which differs from that of natural gut stringing, and in practice makes itself apparent in perceptibly poorer playing qualities. This means, among other things, that racquets strung with synthetic strings convey a "hard" feed with heavyblows—a circumstance likely to lead to irritation of the player's arm, particularly in the region of the elbow and the armpit tendons.

Synthetic stringing takes many forms, it can be said that plain single strands offer less playing comfort than, for instance, strings that are produced by twisting a plurality of single strands or split fibres. However even the best synthetic stringing materials are far from equalling those from natural gut.

According to one aspect of the invention there is provided a process for producing plastics stringing from a single plastics sheeting element which comprises twisting about its longitudinal axis, a plastics sheeting element the molecules of which are highly oriented monoaxially and at least partly in a direction which differs appreciably from the longitudinal direction of the sheeting element.

A second aspect of the invention provides a process for producing plastic stringing comprising: laying a plurality of plastics sheeting elements one over the other, the molecules of at least one of the elements being highly oriented at least partly in a direction which differs appreciably from the

1599782

(11)

longitudinal direction of the element; and twisting the plurality of elements together to form the stringing.

5 A third aspect of the invention provides plastics stringing for forming a striking surface of a strung racquet which comprises a plastics sheeting element the molecules of which are highly oriented monoaxially and at least partly in a direction which differs appreciably from the longitudinal direction of the sheeting element, which element has been twisted about its longitudinal axis to form the stringing.

10 A fourth aspect of the invention provides plastics stringing for forming a striking surface of a strung racquet which comprises a plurality of plastics sheeting elements, the molecules of at least one of which are highly oriented monoaxially and the molecules of another one of which are oriented in a direction which differs appreciably from the longitudinal direction of the element, the elements being twisted together about their longitudinal axes to form the stringing.

25 From the number of elements (this is regulated according to the breadth and thickness of the elements and also according to the number of twists per unit length) necessary for forming the stringing (diameter about 1.2—1.4, or 1.6 mm), it is possible for some of them to be turned around the longitudinal axis of the element (that is, upper sides and undersides of these strips are exchanged), so that in this part of the elements the direction of the orientation longitudinally of the plastic molecules (that is the direction of drawing) is turned about the longitudinal direction as axis of symmetry relative to that of the others of the elements; in the case where the elements were taken at 45° to the original drawing direction, the molecular orientations of the two elements includes an angle of 90°.

40 It is possible for the elements to be twisted together to be stretched bi-axially. Here the elements may have the form of tapes that are cut to any desired angle, or of blown tubing when the string being produced can also be twisted from only one element.

50 Bi-axially drawn tapes or blown tubing are plastics tapes or plastics blown tubing that is to say plastic tubing which whilst still warm has had its wall thickness reduced by blowing, stretched parallel to and also perpendicular to the direction of extrusion to a multiple of their original dimensions. The use of bi-axially drawn elements for stringing materials yields an elasticity pattern which closely approaches that of natural gut stringing. The resulting playing qualities are similar to those of natural gut stringing and are superior to those of all synthetic strings from monoaxially drawn elements.

65 Blown foil tubing subjected to twisting preferably has a diameter of about 20 mm

and a wall thickness of about 0.01 mm. The transverse drawing being effected normal to the direction of extrusion should be comparable in its extent to the longitudinal drawing. Longitudinal to transverse drawing ratio about 0.3 to 3.0; which because of the diverse basically suitable materials (e.g. polyamide or polyvinylidene fluoride) should not constitute a restriction.

70 When a plurality of narrow elements are twisted together, it is also possible for some of them to be cut only from mono-axially drawn materials. Through a variation of the angle between the cutting direction for the production of the narrow tapes from the material and the two drawing direction, it is possible with a chosen ratio of longitudinal to transverse drawing for the production to be effected of many strings varying in their properties within a certain range.

80 The stringing, once formed, may be coated with a substance, for instance an adhesive or lacquer. In this way the playing surface is protected against abrasion, moisture and ultra-violet radiation in a way similar to natural gut stringing. It was then found that the timing of the coating is significant for the quality of the stringing and its characteristics. Surprisingly it is possible to establish better fixing of the twisting, and an increase in wear resistance if an adhesive is applied prior to or during twisting.

90 The use of an adhesive also leads to coupling of the (possibly) different directions of highest mechanical strength of the elements, by which a stringing with superior playing and strength characteristics is obtained. Stringing results with an elastic behaviour very similar to that of natural gut stringing, so that the playing characteristics of all plastics stringings produced in the usual manner—with which the narrow foil strips or filaments used for manufacture are only drawn in the direction of their longitudinal extension—are surpassed.

100 The stringing produced in such a way should be protected against abrasion, moisture and ultra-violet radiation by coating in a similar manner to that which is customary with stringings from natural gut.

110 This can either be effected through a rather generous application of adhesive prior to or during twisting, such that after twisting the surplus adhesive forms a uniform coating on the stringing—(providing always that the adhesive can fulfil the protective functions of a coating) or by the stringing, once formed, being coated with a protective lacquer.

115 An embodiment of the invention will now be described with reference to the attached drawing, in which:—

120 Figure 1 diagrammatically shows a piece of a length of plastics material from which it is possible to obtain, by cutting, any desired length of elements of limited breadth sub- 130

(13)

stantially diagonally to the longitudinal direction of the length of the material.

Figure 2 shows part of Figure 1 to an enlarged scale, and

Figure 3 diagrammatically illustrates the arrangement of three pairs of narrow elements, which are identified by different forms of broken line, before twisting, together.

A length of plastics material sheet 1 from which narrow tapes 2 are cut according to the pattern shown. The direction of drawing of the material sheet 1 is indicated by arrow B. The length of plastics material sheet is extended to a multiple of its length in this direction before cutting.

It is possible to provide for a second direction of stretching normal to or obliquely to the direction B, and also for the stretching direction B to be obliquely of the longitudinal direction of the sheet.

To effect the process of the invention, the procedure is that in one direction of the sheet, (in the present example along the stretch direction B) a set of narrow bands 2 is cut out in a zig-zag pattern. As can be seen from Figure 2, in the straight parts of the cut the narrow tapes include the angles $180-\alpha^\circ$, $180+\alpha^\circ$ or $360-\alpha^\circ$ (preferably $\alpha=45^\circ$) to the longitudinal direction of the sheet. The change of direction—through an angle of $180-2\alpha^\circ$ —must not be abrupt as this would form a notch and thus a weak point, but should be curved, the radius of which is dependent upon the breadth of the narrow tapes.

In the zones of the curvature the tapes pass through points at which the angle they make to the longitudinal direction of the sheet is zero and for a distance to either side of that point the tapes do not make the desired angle to the direction of stretch. However it is possible to make the ratio of the lengths of straight parts of the tapes to their curved parts large, particularly when narrow tapes are being formed, so that this factor may be ignored (especially as the most unfavourable condition ($\beta=0$) is only ever applicable in the apex of the curve).

As a general rule two or three elements of the same or differing drawing properties are twisted together. When two zig-zag elements are used it is similar to Figure 3, (in which as an example three pairs of elements 2 have been chosen), in that expediently the elements are staggered relative to one another longitudinally by half the length of the identical phase of this zig-zag pattern, so that a left or right curve of one element lies (in the "gap") between two left or right curves of the other.

The elements so produced and arranged are, as described earlier, twisted into a stringing material with the addition of an adhesive, which if necessary may be provided with a protective lacquer.

Obviously different design variations may be undertaken within the framework of the invention. Thus it is possible to choose a cutting pattern through which elements are produced that run partly in the stretch direction and partly at an angle thereto. It is also possible for the cutting of zig-zag elements to be effected in a similar manner from bi-axially stretched sheets.

It is possible within the scope of the invention for any desired number of elements to be twisted together, the molecules of individual ones of which are oriented in the same or different directions. Thus it is possible for all the elements to be oriented bi-axially. It is also possible for some elements to be stretched in a different direction.

It is also possible to use elements some of which, or only one of which may be mono-axially stretched, while at least one other is bi-axially drawn, when the directions of stretch may be as desired. Thus one stretch direction can be in the longitudinal direction of the elements and the other perpendicular or oblique relative to this direction. It is also possible for the directions of stretch to be at any desired angle to the longitudinal direction of the elements.

The extend of the stretching may in all cases be chosen as desired and is dependent upon the nature of the materials used. Basically various materials are suitable for manufacture, such as polyamides, polyesters, polypropylenes, the uppermost limit after which a longitudinal splitting of the material sheets occurs (and where oblique cutting of the elements is no longer possible), is dependent upon the material and to some extent also upon the stretch behaviour of the sheet (with bi-axially stretched sheets or in the case of multi-layer bonded sheets with differing orientation of the individual sheets the longitudinal splitting loses significance). Needless low stretch conditions (that is, remote from the risk of longitudinal splitting) reduces the strength which could be obtained, that is, the modulus of elasticity that can be attained is less and the danger of the string creeping is higher. In the case of polypropylene for instance longitudinal splitting occurs at about 10:1 to 12:1, usable stretch ratios are therefore about 8:1 to 9:1.

For strings from polyamide material sheets it is possible to use polyurethane adhesives or lacquers, or lacquers on a polyamidoamine/epoxy basis as convenient, and for strings from polyester material sheets, pretreated with TN activator (Bayer) for instance, a polyurethane adhesive or lacquer can be used.

For the production of very good strings, bi-axially stretched polyester material sheets (Hostaphan RGHH of the Kalle firm) is for example suitable: majority of the elements cut at 30° to the predominating longitudinal

14

stretch direction (in this direction the E-modulus of the sheet is about 700,000 N/cm²), the remainder at 60° thereto. Twisting in such a rotational direction that the direction of maximum strength in the majority of the elements lie in the longitudinal direction of the resultant string.

The adhesive or coating material may be a flexible polyurethane resin.

It is also possible to use Hostaphan RNHH of the Kalle firm. With this material all the elements are cut out of a sheet of the material in a direction bisecting the angle (=45°) between the two—equal in value—stretch directions (E-modulus in each of the two directions about 450,000 N/cm²).

WHAT WE CLAIM IS:—

1. A process for producing plastics stringing from a single plastics sheeting element which comprises twisting about its longitudinal axis, a plastics sheeting element the molecules of which are highly oriented monoaxially and at least partly in a direction which differs appreciably from the longitudinal direction of the sheeting element.

2. A process according to Claim 1, wherein the element is highly oriented at least partly at an angle of 45° to the longitudinal axis of the element.

3. A process according to Claim 1 or Claim 2, wherein said element comprises a tape.

4. A process according to Claim 1 or Claim 2, wherein said element comprises blown tubing.

5. A process according to Claim 1 or Claim 2, wherein said element comprises a bi-axially oriented tape.

6. A process according to Claim 1 or Claim 2, wherein the element is a tape cut in zig-zag fashion from plastics sheeting and the longitudinal direction of the tape coincides with the direction of orientation of the plastics sheeting.

7. A process for producing plastic stringing comprising: laying a plurality plastics of sheeting elements one over the other, the molecules of at least one of the elements being highly oriented at least partly in a direction which differs appreciably from the longitudinal direction of the element; and twisting the plurality of elements together to form the stringing.

8. A process according to Claim 7, wherein oriented sheeting elements comprise tapes that are twisted together.

9. A process according to Claim 7, in which said at least one element comprises blown tubing twisted with said plurality of sheeting elements.

10. A process according to Claim 7, in which said sheeting elements are tapes cut in zig-zag fashion from plastic sheeting and the longitudinal direction of each tape coincides

with the direction of orientation of the plastic sheeting.

11. A process according to Claim 7, wherein all said oriented sheeting elements comprise blown tubing.

12. A process according to Claim 10, characterised in that the tapes cut in zig-zag fashion have first portions extending in a first direction, and second portions extending in a second direction and intermediate portions including bends interconnecting said first and second portions, the tapes being arranged such that the bends are longitudinally offset and the tapes required to make one string are longitudinally offset in such a manner that the bends of the tapes are distributed as uniformly as possible.

13. A process according to any one of Claims 7 to 12, in which said elements are coated with adhesive prior to or during twisting such that the elements are upon twisting, adhesively coupled together.

14. A process according to Claim 13, in which sufficient adhesive is applied to said elements to form a covering for said stringing.

15. A process according to any one of Claims 1 to 14, in which the stringing is formed by combining the or each element with other elements of the same or differing materials.

16. A process according to any one of Claims 1 to 15, in which the formed stringing is coated with lacquer.

17. A process according to Claim 1 or Claim 7 and substantially as herein described.

18. Plastics stringing for forming a striking surface of a strung racquet which comprises a plastics sheeting element the molecules of which are highly oriented monoaxially and at least partly in a direction which differs appreciably from the longitudinal direction of the sheeting element, which element has been twisted about its longitudinal axis to form the stringing.

19. Plastics stringing for forming a striking surface of a strung racquet which comprises a plurality of plastics sheeting elements, the molecules of at least one of which are highly oriented monoaxially and the molecules of another one of which are oriented in a direction which differs appreciably from the longitudinal direction of the element, the elements being twisted together about their longitudinal axes to form the stringing.

20. Plastics stringing formed by the process of any one of Claims 1 to 17, and substantially as herein described.

stretch direction (in this direction the E-modulus of the sheet is about 700,000 N/cm²), the remainder at 60° thereto. Twisting in such a rotational direction that the direction of maximum strength in the majority of the elements lie in the longitudinal direction of the resultant string.

The adhesive or coating material may be a flexible polyurethane resin.

It is also possible to use Hostaphan RNHH of the Kalle firm. With this material all the elements are cut out of a sheet of the material in a direction bisecting the angle (=45°) between the two—equal in value—stretch directions (E-modulus in each of the two directions about 450,000 N/cm²).

WHAT WE CLAIM IS:—

1. A process for producing plastics stringing from a single plastics sheeting element which comprises twisting about its longitudinal axis, a plastics sheeting element the molecules of which are highly oriented monoaxially and at least partly in a direction which differs appreciably from the longitudinal direction of the sheeting element.

2. A process according to Claim 1, wherein the element is highly oriented at least partly at an angle of 45° to the longitudinal axis of the element.

3. A process according to Claim 1 or Claim 2, wherein said element comprises a tape.

4. A process according to Claim 1 or Claim 2, wherein said element comprises blown tubing.

5. A process according to Claim 1 or Claim 2, wherein said element comprises a bi-axially oriented tape.

6. A process according to Claim 1 or Claim 2, wherein the element is a tape cut in zig-zag fashion from plastics sheeting and the longitudinal direction of the tape coincides with the direction of orientation of the plastics sheeting.

7. A process for producing plastic stringing comprising: laying a plurality plastics of sheeting elements one over the other, the molecules of at least one of the elements being highly oriented at least partly in a direction which differs appreciably from the longitudinal direction of the element; and twisting the plurality of elements together to form the stringing.

8. A process according to Claim 7, wherein oriented sheeting elements comprise tapes that are twisted together.

9. A process according to Claim 7, in which said at least one element comprises blown tubing twisted with said plurality of sheeting elements.

10. A process according to Claim 7, in which said sheeting elements are tapes cut in zig-zag fashion from plastic sheeting and the longitudinal direction of each tape coincides

with the direction of orientation of the plastic sheeting.

11. A process according to Claim 7, wherein all said oriented sheeting elements comprise blown tubing.

12. A process according to Claim 10, characterised in that the tapes cut in zig-zag fashion have first portions extending in a first direction, and second portions extending in a second direction and intermediate portions including bends interconnecting said first and second portions, the tapes being arranged such that the bends are longitudinally offset and the tapes required to make one string are longitudinally offset in such a manner that the bends of the tapes are distributed as uniformly as possible.

13. A process according to any one of Claims 7 to 12, in which said elements are coated with adhesive prior to or during twisting such that the elements are upon twisting, adhesively coupled together.

14. A process according to Claim 13, in which sufficient adhesive is applied to said elements to form a covering for said stringing.

15. A process according to any one of Claims 1 to 14, in which the stringing is formed by combining the or each element with other elements of the same or differing materials.

16. A process according to any one of Claims 1 to 15, in which the formed stringing is coated with lacquer.

17. A process according to Claim 1 or Claim 7 and substantially as herein described.

18. Plastics stringing for forming a striking surface of a strung racquet which comprises a plastics sheeting element the molecules of which are highly oriented monoaxially and at least partly in a direction which differs appreciably from the longitudinal direction of the sheeting element, which element has been twisted about its longitudinal axis to form the stringing.

19. Plastics stringing for forming a striking surface of a strung racquet which comprises a plurality of plastics sheeting elements, the molecules of at least one of which are highly oriented monoaxially and the molecules of another one of which are oriented in a direction which differs appreciably from the longitudinal direction of the element, the elements being twisted together about their longitudinal axes to form the stringing.

20. Plastics stringing formed by the process of any one of Claims 1 to 17, and substantially as herein described.



(B)

FITZPATRICKS,
Chartered Patent Agents,
Warwick House,
Warwick Court,
London WC1R 5DJ,
and
14—18 Cadogan Street,
Glasgow G2 6QW.

Printed for Her Majesty's Stationery Office by Burgess & Son
(Abingdon) Ltd.—1981. Published at The Patent Office,
25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.