TENNIS RACKET HAVING A PRIMARILY RECTANGULAR SHAPE

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ABSTRACT

Tennis rackets having a primarily rectangular shape comprise a frame and string arrangement that creates a tennis racket with the advantages of a rectangular racket without the structure and weight of a purely rectangular racket. An embodiment has an outer frame with generally straight portions at a top and bottom of the outer frame. Lateral strings connected to these generally straight portions have generally the same length. A separate distal lateral member of the frame provides a connection component for longitudinal strings having generally the same length. The tennis racket having a primarily rectangular shape with separate distal lateral member creates a sweet spot that is much larger than conventional oval-shaped rackets, but is lighter and structurally stronger than rectangular rackets lacking these features.
TENNIS RACKET HAVING A PRIMARILY RECTANGULAR SHAPE
CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the benefit of U.S. Provisional Application No. 60/607,632, filed Sep. 7, 2004, herein incorporated by reference.

BACKGROUND

[0002] Numerous factors determine the performance of a tennis racket, including the shape, string structure and tension, and weighting. U.S. Pat. No. 6,344,006, and U.S. application Ser. No. 09/971,830, both herein incorporated by reference, describe how a rectangular racket performs much better than a conventional racket having a generally oval shape, primarily because of the uniform string structure and larger moments of inertia.

[0003] FIGS. 1 and 2 illustrate the better performance of a rectangular racket as compared to a conventional racket. FIG. 1 shows velocity ratio (VR, the fraction of incident ball and racket speed returned to the ball) contours for a forehand swing of a conventional racket, where the lines denote regions of constant VRs. The region 10 near the bottom of the racket face is known as the “sweet spot” and is the area of best performance for a ball strike (largest hit ball speed). The regions farther away from the region 10 are of increasingly lower performance. The corresponding contours for the rectangular racket are shown in FIG. 2. The regions of best performance are seen to be much larger for the rectangular racket.

[0004] In both the conventional and rectangular rackets, the decrease in performance away from the sweet spot can be partially compensated for by changing the tensions in the strings in the outer portions of the racket face. Because of the large increase in the tensions of the strings involved during an impact with a ball, the choice of the optimal string tensions is not simple and must be determined by a sophisticated computer analysis of the impact between the racket and the ball.

[0005] When these optimal tension values are implemented, the resultant performance increase is much greater for the rectangular racket than for the conventional racket. This performance increase is illustrated in FIGS. 3 and 4 for the case in which three different tensions are used for each racket. For the conventional racket shown in FIG. 3, the increase in sweet spot size is seen to be not large, whereas for the rectangular racket shown in FIG. 4, the increase in sweet spot size is seen to be considerable.

[0006] If weights are added to the frame of the racket, then, for a given swing speed, the performance of the racket will increase. This weight related performance increase is because the increased moment of inertias of the racket will result in decreased reactive motion and, therefore, increased hit ball speed. The increased racket weight will, of course, result in a lower swing speed, which will decrease performance. But if the positions and values of the added weights are optimally chosen, then the combined effect can be a net performance increase.

[0007] When a weight is added to the frame of a racket, the larger the distance from the central vertical axis, and the larger the distance from the horizontal axis at the bottom of the face, the greater will be the performance increase. For a conventional racket, because of the curvature of the frame, it is not possible for an added weight to be maximally far from each of these axes, and so a compromise must be made. The performance increase is consequently limited, as illustrated in FIG. 5 which shows the effect of adding a one ounce weight to the upper left and right sides of the frame (at y=15°). These weights somewhat increase the sweet spot size in the vertical direction, but not in the horizontal direction. For a rectangular racket, weights added to the upper left and right corners will be maximally far from each axis. The performance increase will, therefore, be significant, as illustrated in FIG. 6 which shows the effect of adding a one ounce weight to each upper corner.

[0008] There are obviously enormous advantages, as illustrated above, of the rectangular frame, but there is also a disadvantage. A rectangular or nearly rectangular tennis racket frame made of contemporary composite material would have to be rather heavy in order to withstand the forces generated by the string tensions.

SUMMARY

[0009] The present invention provides the advantages of a racket having a generally rectangular shape while minimizing the disadvantages noted above. Various racket frame designs are described herein. These designs incorporate the performance advantages of a rectangular racket, but which result in frames that are both strong and light.

[0010] Accordingly, and embodiment of the tennis racket comprises a handle; an outer frame comprising: a proximal generally curved section proximate to and attached to the handle, a portion of the proximal generally curved section defining a portion of a throat section via which the outer frame is attached to the handle; a distal generally curved section opposite the proximal generally curved section; first and second straight sections lying between the proximal and distal generally curved sections; the tennis racket further comprising: a lateral frame section distinct from the outer frame and attached to one of the generally curved sections; a plurality of lateral strings having a generally common length directly attached to both the first and second straight sections of the outer frame; and a plurality of longitudinal strings having a generally common length directly attached to the lateral frame section.

[0011] The lateral frame section may be a distal lateral frame section and be attached to the distal generally curved section. This racket may further comprise a proximal lateral frame section distinct from the outer frame and attached to the proximal generally curved section of the outer frame; wherein the plurality of longitudinal strings are further directly attached to the proximal lateral frame section. The proximal lateral frame section and the distal lateral frame section may be formed as straight sections. In an embodiment, the distal lateral frame section may be formed as a curved section. The curve of the distal lateral frame section may generally parallel to the proximal generally curved section of the outer frame. The plurality of longitudinal strings may be directly attached to the proximal generally curved section of the outer frame. According to an embodiment, a majority of the lateral strings are generally a same length, and a majority of the longitudinal strings are gener-
ally a same length. In an embodiment, the strings may utilize variable string tensions. In an embodiment, the frame may include perimeter weighting.

[0012] An additional embodiment of the invention is directed to a tennis racket comprising: a handle; an outer frame comprising: a proximal generally curved section proximate to and attached to the handle; a portion of the proximal generally curved section defining a portion of a throat section via which the outer frame is attached to the handle; a distal generally curved section opposite the proximal generally curved section; the tennis racket further comprising: a distal lateral frame section distinct from the outer frame and attached to the distal generally curved section; a plurality of lateral strings directly attached to the outer frame; and a plurality of longitudinal strings directly attached to the distal lateral frame section.

[0013] Finally, an additional embodiment of the invention is directed to a tennis racket comprising: a handle; a frame comprising longitudinal string attachment points and lateral string attachment points; a plurality of longitudinal strings attached to the longitudinal string attachment points, wherein a majority of the plurality of longitudinal strings are of generally the same length, and a minority of the plurality of longitudinal strings are of a length shorter than the length of the majority of the plurality of longitudinal strings; and a plurality of lateral strings attached to the lateral string attachment points, wherein a majority of the plurality of lateral strings are of generally the same length, and a minority of the plurality of lateral strings are of a length shorter than the length of the majority of the plurality of lateral strings.

DESCRIPTION OF THE DRAWINGS

[0014] The invention is best understood with reference to the Figures illustrating embodiments of the invention, as described below.

[0015] FIG. 1 is a graphical diagram illustrating velocity ratio contours for an oval racket;

[0016] FIG. 2 is a graphical diagram illustrating velocity ratio contours for a rectangular racket;

[0017] FIG. 3 is a graphical diagram illustrating velocity ratio contours for an oval racket with optimal tension values;

[0018] FIG. 4 is a graphical diagram illustrating velocity ratio contours for a rectangular racket with optimal tension values;

[0019] FIG. 5 is a graphical diagram illustrating velocity ratio contours for an oval racket with a weighted frame;

[0020] FIG. 6 is a graphical diagram illustrating velocity ratio contours for a rectangular racket with a weighted frame;

[0021] FIG. 7 is a pictorial diagram of a first embodiment according to the invention comprising straight components;

[0022] FIG. 8 is a pictorial diagram of a second embodiment according to the invention comprising curved components;

[0023] FIG. 9 is a pictorial diagram of a rectangular racket with a superimposed sweet spot illustration;

[0024] FIG. 10 is a pictorial diagram of the first embodiment as illustrated in FIG. 7 with a superimposed sweet spot illustration;

[0025] FIG. 11 is a pictorial diagram of the first embodiment as illustrated in FIG. 8 with a superimposed sweet spot illustration; and

[0026] FIG. 12 is a pictorial diagram of a conventional oval racket with a superimposed sweet spot illustration.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] Various embodiments of the invention are described below.

[0028] In the first embodiment, shown in FIG. 7, there is an outer frame 20 which has a distal frame curve 22 and proximal frame curve 24, as in conventional rackets, but which incorporates straight parallel components 25a, 25b at the top and bottom portions of the frame 20, which connect to these curved sections 22, 24. As used herein, the term “proximal” relates to being proximate the racket handle 21, and the term “distal” relates to being distal from the racket handle 21.

[0029] In addition, the frame incorporates parallel vertical sections, including a distal straight frame component 26.1 and a proximal straight frame component 28.1 located near the right and left ends of the frame respectively. These vertical sections 26.1, 28.1 strengthen the frame, to compensate for the inherent weakness of the straight components, and also provide interior anchors for most of the longitudinal strings 30 (left-right strings in the Figures). The upper- and lower-most of these strings 30a, 30b have slightly shorter lengths, but these strings 30a, 30b are in areas of the racket face of low performance and so the effect of their shortening is minimal. Most of the lateral strings 32 (up-down strings in the Figures) on the proximal side of the face are also of equal length. The lateral strings 32b on the distal side of the face are of increasingly shorter length, but again, these strings 32b are in areas of low performance. The sweet spot of this racket will be almost as large as that of a rectangular racket, but this embodiment of the racket frame will be much stronger for a given weight.

[0030] In the second embodiment, shown in FIG. 8, there is also an outer frame 20 which is curved at the distal 22 and proximal 24 ends, as in conventional rackets, and which incorporates straight parallel components 25a, 25b at the top and bottom, which connect to these curved sections 22, 24. There is now added an internal curved section 26.2 at the distal end, which is parallel to a curved section 28.2 at the left end of the frame. This vertical section 26.2 strengthens the distal half of the frame, again to compensate for the inherent weakness of the straight components, and it also provides an interior anchor for most of the longitudinal strings 30.

[0031] The throat section 27 at the proximal end similarly strengthens the proximal half of the frame. Notice that the added curved section 26.2 on the distal end serves to structurally balance the effect of the throat 27 on the proximal end. The longitudinal strings 30 running between the parallel distal 26.2 and proximal 28.2 curved sections will all be of equal length, as will the lateral strings 32 running between the parallel upper and lower straight segments 25a, 25b.

[0032] The longitudinal strings 30a, 30b running between the left curved section 28.2 and the right curved 26.2
sections above and below the parallel segment are of shorter lengths, as are the lateral strings 32b to the right of the straight segments 25a, 25b, but these strings 32b are again in areas of the racket face of low performance, and so the effect is again minimal. The lateral strings 32a to the left of the straight segments 25a, 25b are also of shorter length. The central parts of these strings lie in an area of high-performance, and so the negative effect of these shorter strings is minimal and can be compensated for by decreasing the tensions in these strings. The sweet spot of this racket will again be almost as large as that of a rectangular racket, and again this racket frame will be much stronger for a given weight.

[0033] These new racket embodiments of FIGS. 7 and 8 are compared with a conventional racket and a rectangular racket in FIGS. 9-12. The frames are drawn to scale, with selected strings and sweet spots indicated. The length of the handle 21 and throat 27 is the same for each racket (about 131/4). The length of the longest horizontal string (14") and the longest vertical string (11") is also the same for each racket. The overall length of the rectangular racket shown in FIG. 9 and the conventional racket shown in FIG. 12 are about 27", whereas the new rackets shown in FIGS. 10 and 11 are about 2" longer because of the added structures at the right/distal ends.

[0034] As discussed above, the sweet spot 10 of the rectangular racket shown in FIG. 9 is much larger than that of the conventional racket shown in FIG. 12. The sweet spots 10 of the new rackets shown in FIGS. 10 and 11 are seen to be nearly as large as that of the rectangular racket, and still much larger than that of the conventional racket. These new rackets also have larger moments of inertia and better improvements from using variable string tensions and perimeter weighting. Compared with the rectangular racket, although the sweet spots are slightly smaller, the new racket designs have the advantages of lighter weight (for the same degree of stability) and better playability.

[0035] For the purposes of promoting an understanding of the principles of the invention, reference has been made to the preferred embodiments illustrated in the drawings, and specific language has been used to describe these embodiments. However, no limitation of the scope of the invention is intended by this specific language, and the invention should be construed to encompass all embodiments that would normally occur to one of ordinary skill in the art.

[0036] The particular implementations shown and described herein are illustrative examples of the invention and are not intended to otherwise limit the scope of the invention in any way. For the sake of brevity, conventional aspects may not be described in detail. Furthermore, the connecting lines, or connectors shown in the various figures presented are intended to represent exemplary functional relationships and/or physical or logical couplings between the various elements. It should be noted that many alternative or additional functional relationships, physical connections or logical connections may be present in a practical device. Moreover, no item or component is essential to the practice of the invention unless the element is specifically described as "essential" or "critical". Numerous modifications and adaptations will be readily apparent to those skilled in this art without departing from the spirit and scope of the present invention.

What is claimed is:
1. A tennis racket comprising:
   a handle;
   an outer frame comprising:
      a proximal generally curved section proximate to and attached to the handle, a portion of the proximal generally curved section defining a portion of a throat section via which the outer frame is attached to the handle;
      a distal generally curved section opposite the proximal generally curved section;
      first and second straight sections lying between the proximal and distal generally curved sections;
   the tennis racket further comprising:
      a lateral frame section distinct from the outer frame and attached to one of the generally curved sections;
      a plurality of lateral strings having a generally common length directly attached to both the first and second straight sections of the outer frame; and
      a plurality of longitudinal strings having a generally common length directly attached to the lateral frame section.
2. The tennis racket according to claim 1, wherein the lateral frame section is a distal lateral frame section and is attached to the distal generally curved section.
3. The tennis racket according to claim 2, further comprising:
   a proximal lateral frame section distinct from the outer frame and attached to the proximal generally curved section of the outer frame;
   wherein the plurality of longitudinal strings are further directly attached to the proximal lateral frame section.
4. The tennis racket according to claim 3, wherein the proximal lateral frame section and the distal lateral frame section are formed as straight sections.
5. The tennis racket according to claim 2, wherein the distal lateral frame section is formed as a curved section.
6. The tennis racket according to claim 5, wherein the curve of the distal lateral frame section is generally parallel to the proximal generally curved section of the outer frame.
7. The tennis racket according to claim 6, wherein the plurality of longitudinal strings are directly attached to the proximal generally curved section of the outer frame.
8. The tennis racket according to claim 5, further comprising:
   the throat section is configured to strengthen the proximal half of the frame and to structurally balance the distal lateral frame section.
9. The tennis racket according to claim 1, wherein a majority of the lateral strings are generally a same length, and a majority of the longitudinal strings are generally a same length.
10. The tennis racket according to claim 1, wherein a length of the handle and throat section is approximately 131/4".
11. The tennis racket according to claim 1, wherein a length of a longest longitudinal string is approximately 14".
12. The tennis racket according to claim 1, wherein a length of a longest lateral string is approximately 11".
13. The tennis racket according to claim 1, wherein an overall length of the racket is approximately 29”.
14. The tennis racket according to claim 1, wherein the strings utilize variable string tensions.
15. The tennis racket according to claim 1, further comprising perimeter weighting.
16. A tennis racket comprising:
   a handle;
   an outer frame comprising:
       a proximal generally curved section proximate to and attached to the handle, a portion of the proximal generally curved section defining a portion of a throat section via which the outer frame is attached to the handle;
       a distal generally curved section opposite the proximal generally curved section;
   the tennis racket further comprising:
   a distal lateral frame section distinct from the outer frame and attached to the distal generally curved section;
   a plurality of lateral strings directly attached to the outer frame; and
   a plurality of longitudinal strings directly attached to the distal lateral frame section.
17. A tennis racket comprising:
   a handle;
   a frame comprising longitudinal string attachment points and lateral string attachment points;
   a plurality of longitudinal strings attached to the longitudinal string attachment points, wherein a majority of the plurality of longitudinal strings are of generally a same length, and a minority of the plurality of longitudinal strings are of a length shorter than the length of the majority of the plurality of longitudinal strings; and
   a plurality of lateral strings attached to the lateral string attachment points, wherein a majority of the plurality of lateral strings are of generally a same length, and a minority of the plurality of lateral strings are of a length shorter than the length of the majority of the plurality of lateral strings.

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