(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 714 681 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
05.06.1996 Bulletin 1996/23

(51) Int. Cl.^{6}: A63B 49/02

(21) Application number: 95108367.4

(22) Date of filing: 01.06.1995

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB IT LI NL SE

(30) Priority: 01.12.1994 US 345646

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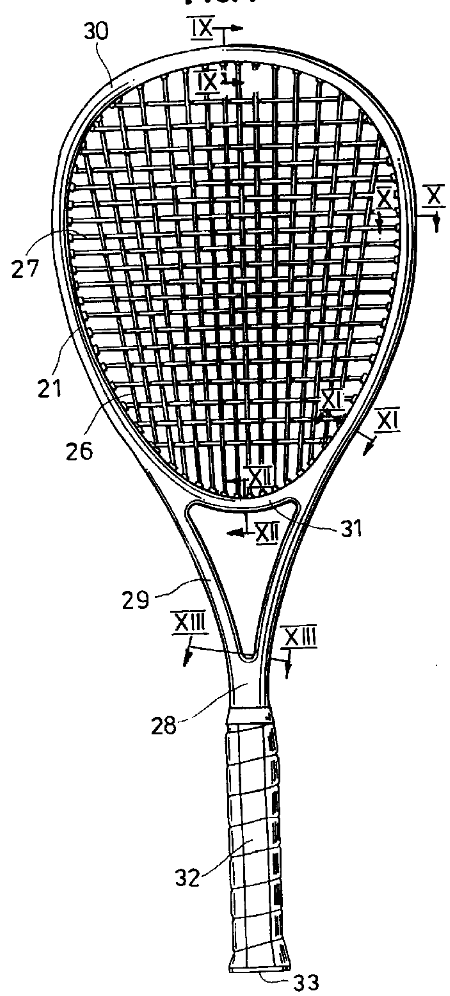
(54) Aerodynamic tennis racquet

(57) A tennis racquet is provided with a head portion which has a substantially circular cross section to provide an aerodynamic shape. The maximum outside dimension of the cross section is less than 15 mm. The cross section is annular in shape, and the thickness of the annular wall is preferably with the range of about 3 to 4 mm ± 0.5 mm. The racquet is preferably lightweight and preferably has a high center of gravity, a high center of percussion, and a high frequency of vibration.

FIG. I



EP 0 714 681 A1

Description

Background

This invention relates to tennis racquets, and, more particularly, to a tennis racquet which has an aerodynamic shape.

Most tennis racquets which are currently being sold have an aerodynamic shape when they are swung parallel to the ground and the plane of the strings is perpendicular to the ground. That shape is generally an elongated oval.

However, a tennis racquet is rarely swung parallel to the ground with the plane of the strings vertical. For example, when a player swings to apply topspin or backspin or when a player applies spin during a serve, the shape of the racquet is not aerodynamic in the direction in which it is moving.

U.S. Patent No. 5,076,583 describes a tennis racquet which has a circular cross section and which is said to have improved aerodynamics. The racquet illustrated in Figs. 1 and 2 includes throat portions 15A and 15B having a diameter of 15-27 mm, lower head sections 23A and 23B having a diameter of about 21.8 mm, middle head sections 25A and 25B having a diameter of about 18.0 mm, and a crown section 27 having a diameter of about 21 mm. Fig. 6 illustrates a racquet having a constant diameter in the head and throat of 15-25 mm "but can be smaller or larger". Fig. 7 illustrates a racquet having a constant taper from the crown to the throat from a diameter of 25-35 mm at the crown to a diameter of 15-25 mm at the lower head section. Column 4, lines 36-45 of Patent No. 5,076,583 states that the wall thickness of the frame may vary from 0.20 mm to 5.0 mm and the racquet frame may weigh from about 150 to 350 grams.

Despite the disclosure of the foregoing patent, tennis racquet designers have not made tennis racquets with a circular cross section below 18 mm and a weight below 314 grams (11 ounces). One specific embodiment of a racquet which is believed to have been made in accordance with the patent is identified as an Estusa Pryotech Midsize racquet. The racquet had the following characteristics:

Strung Weight (W)	314.5 gms	(11.09 ounces)
Balance (CG)	34.44 cm	(13.56 inches)
Length (L)	68.78 cm	(27.08 inches)
Stiffness (Si)	5.916 mm	
Frequency (f)	155 Hz	
Center of Percussion (CP)	47.77 cm	(18.68 inches)
Moment of inertia I end	2809.3 ounce-inches^2	
Moment of inertia Iy	89.27 ounce-inches^2	
Diameter at tip end of head	21.0 mm	(0.8267 inch)
Diameter at midpoint of head	18.2 mm	(0.7165 inch)
Diameter at yoke	22.9 mm	(0.9015 inch)
Diameter of shaft above grip	26.8 mm	(1.0551 inch)
Diamter of unclad grip	29.1 mm	(1.1456 inch)

The number for the balance or center of gravity is the distance of the balance point from the butt end or handle end of the racquet.

The stiffness is the amount of deflection of the tip or head end of the racquet when the racquet extends horizontally and the grip is clamped and a weight of 2.8kg is suspended from the tip of the racquet. Stiffness is measured as follows:

1. Measurements are made to a frame cut to production length, will all string holes drilled.
2. Place the frame in a fixture with the butt cap and against the back of the clamping fixture with the centerline of the frame in line with that of the fixture and the playing plane parallel to the base of the fixture firmly clamping in place.
3. Attach a 2.8 kg load to the frame at the 12 o'clock bow position. Allow the frame to flex and normalize itself for 20 to 60 seconds. Place a digital indicator as close to the load point as possible. Zero the indicator, carefully remove the 2.8 kg weight, and take a reading. Measurements are performed using millimeters.
4. Clamping fixture firmly clamps the first 6" of the handle end of the racquet, between two steel plates.

The frequency is the frequency of vibration of the first mode of bending under free-free constraint. That frequency is described more fully in EPO Patent No. 317,711.

The number for the center of percussion is the distance of the center of percussion from the butt end of the racquet when the center of percussion is measured with respect to an axis which extends perpendicularly to the longitudinal centerline of the racquet at the butt end and parallel to the plane of the strings.

I end is the moment of inertia about an axis which extends perpendicularly to the longitudinal centerline at the butt end and parallel to the plane of the strings.

Iy is the moment of inertia about the longitudinal centerline of the racquet.

Frolow U.S. Patent Re. 31,419 describes a racquet which is lighter than the standard weight of about 12 to 14 ounces (including the weight of the strings), and has a higher center of percussion, a higher center of gravity, a higher frequency of vibration, and a higher ratio of Ia/Is than conventional racquets. Specific values for the foregoing physical properties are set forth in Figure 40. Figure 22 illustrates a racquet made from graphite fibers and epoxy which has a non-oval head shape. The upper end of the head is relatively flat and extends somewhat perpendicularly to the longitudinal axis of the racquet.

For the past several years many racquets have been sold which are relatively lightweight and which have high centers of gravity, high centers of percussion, and high frequencies of vibration. For example, Wilson Sporting Goods Co. has sold tennis racquets under the names Hammer and Sledgehammer which have the properties shown in Table I. The racquets are made from graphite fibers and resin.

Table I

Model	Weight (Oz.)	Balance (In.)	Si (mm)	Frequency (Hertz)	Ia (oz. in.^{2})	Is (oz. in.^{2})	Center of Percussion From Butt (in.)	Length (in.)
Hammer 2.7si 95	9.72	15.35	2.7	198	89	2900	19.40	27.00
Hammer 2.7si 110	10.05	15.12	2.7	194	104	2925	19.40	27.00
Hammer 4.0si 95	9.72	15.35	4.0	178	89	2900	19.40	27.00
Hammer 4.0si 110	10.05	15.12	4.0	176	104	2925	19.40	27.00
Hammer 5.0si 95	9.72	15.35	5.0	162	89	2900	19.40	27.00
Hammer 5.0SI 110	10.05	15.12	5.0	160	104	2925	19.40	27.00
Hammer 5.2si 95	10.50	14.40	5.2	152	89	2900	19.20	27.00
Hammer 5.2si 110	10.50	14.40	5.2	150	101	2900	19.20	27.00
Hammer 6.2si 95	9.72	15.35	6.2	148	89	2900	19.40	27.00
Hammer 6.2si 110	10.05	15.12	6.2	144	104	2925	19.40	27.00
Sledgehammer 3.8si 95	9.20	15.94	3.8	207	89	2850	20.10	27.00
Sledgehammer 3.8si 110	9.20	15.94	3.8	192	105	2950	20.10	27.00

Model	Cp/L	Ia/Is	Cg/L	WCG (oz. in)	String Length	String Width
Hammer 2.7si 95	.720	.0306	.5685	149.2	12.642	9.538
Hammer 2.7si 110	.720	.0356	.560	151.96	12.600	10.235
Hammer 4.0si 95	.720	.0306	.5685	149.2	12.642	9.288
Hammer 4.0si 110	.720	.0356	.560	151.96	13.577	9.993
Hammer 5.0si 95	.720	.0306	.5685	149.2	12.642	9.288
Hammer 5.0SI 110	.720	.0356	.560	151.96	13.600	9.985
Hammer 5.2si 95	.711	.0306	.533	151.2	12.642	9.288
Hammer 5.2si 110	.711	.035	.533	151.2	13.368	10.034
Hammer 6.2si 95	.720	.0306	.5685	149.2	12.642	9.350
Hammer 6.2si 110	.720	.0356	.560	151.96	13.577	10.056
Sledgehammer 3.8si 95	.744	.031	.590	146.65	12.801	9.617
Sledgehammer 3.8si 110	.744	.036	.590	146.65	13.703	10.238

Despite the disclosure of the foregoing patents and the existence of the Estusa Pryotech, Hammer, and Sledgehammer racquets, I am not aware of any prior tennis racquet which has a substantially circular cross section of less than 15 mm and which is lightweight (less than 11 ounces) and which has a high balance point (at least 14 inches), a high center of percussion (at least 18.75 inches), and a relatively high frequency of vibration (at least 140 Hz). It is believed that racquet designers have thought that a racquet having a round cross section would not be strong enough if the cross section were less than 15 mm and the weight of the racquet were less than 11 ounces.

Summary of the Invention

I have designed a tennis racquet with a head which has a very narrow, substantially circular cross section. The cross section is less than 15mm, and the narrow, substantially circular cross section provides superior aerodynamic performance regardless of the orientation of the frame to the direction of movement. The racquet can be lightweight yet relatively stiff, with a high center of percussion, a high center of gravity, and a relatively high frequency of vibration.

Description of Drawing

The invention will be explained in conjunction with illustrative embodiments shown in the accompanying drawing, in which --

Figure 1 is a front elevational view of a racquet formed in accordance with the invention, the racquet having a head size of about 95 square inches;
Figure 2 is a side elevational view of the racquet of Figure 1;
Figure 3 is a front elevational view of a racquet having a head size of about 110 square inches;
Figure 4 is a side elevational view of the racquet of Figure 3;
Figure 5 is a front elevational view of another embodiment of a racquet having a head size of about 95 square inches;
Figure 6 is a side elevational view of another embodiment of a racquet having a head size of about 95 square inches;
Figure 7 is a is a front elevational view of a racquet having a head size of about 110 square inches;
Figure 8 is a side elevational view of a racquet having a head size of about 110 square inches;
Figure 9 is a sectional view taken along the lines IX-IX of Figures 1, 3, 5, and 7;
Figure 10 is a sectional view taken along the lines X-X of Figures 1, 3, 5, and 7;
Figure 11 is a sectional view taken along the lines XI-XI of Figures 1, 3, 5, and 7;
Figure 12 is a sectional view taken along the lines XII-XII of Figures 1, 3, 5, and 7;
Figure 13 is a sectional view taken along the lines XIII-XIII of Figures 1, 3, 5, and 7; and
Figure 14 is a front elevational view of the racquet of Figure 5 showing the locations of various cross sections along the length of the racquet.

Description of Specific Embodiments

The racquets 21, 22, 23, and 24 shown in Figures 1, 3, 5, and 7 are constructed in substantially the same way. The primary difference between the racquets is the size and shape of the head. The racquets 21, and 22 of Figures 1 and 3 have an ovoid-shaped head like Wilson's Sledgehammer racquets. The head size, i.e., the area of the strung surface, of the racquet 21 is about 95 square inches. The head size of the racquet 22 is about 110 square inches.

The racquets 23 and 24 of Figures 5 and 7 have an oval-shaped head. The head size of the racquet 23 is about 95 square inches, and the head size of the racquet 24 is about 110 square inches. Other sizes and shapes of racquets can be made in accordance with the invention.

Each of the racquets includes a frame 25 and longitudinal and transverse strings 26 and 27. The frame is formed from composite material consisting of fibers and resin. The fibers can be graphite, Kevlar, or other fibers which are conventionally used in tennis racquets. The resin is conventional resin which is used in composite tennis racquets.

Each frame includes an elongated shaft portion 28, a Y-shaped throat portion 29 formed by a pair of diverging arms, and a head portion 30. A yoke 31 extends between the sides of the throat and forms the bottom of the head. A grip or handle 32 is formed at the lower end of the shaft by spirally wrapped grip material, and the grip terminates in a butt end 33 at the bottom of the racquet.

As can be seen in Figures 9-13, each of the frames has a substantially circular cross section. Figure 9 shows the cross section at the tip of the head. In the specific embodiment illustrated the cross section at the tip is slightly oval, having a dimension A transverse to the plane of the strings slighter longer than the dimension B. In the embodmient illustrated, the dimension A is 13.20 mm (0.520 inch), and the dimension B is 10.76 mm (0.424 inch). The ratio of A/B is 1.23. The frame includes a conventional string groove 34.

Figure 10 shows the cross section at the widest part of the head. In the embodiment illustrated, that cross section is also slightly oval, having dimensions C and D of 13.64 mm (0.537 inch) and 11.27 mm (0.444 inch). The ratio C/D is 1.21.

Figure 11 illustrates the cross section just above the merger of the yoke 31 with the head 30. The illustrated embodiment is slightly oval, having dimensions E and F of 14.20 mm (0.559 inch) and 11.65 mm (0.458 inch).

In the preferred embodiments the thickness of the annular wall in the head portion 30 and preferably also in the throat portion 29 is within the range of about 3 to 4 mm ± 0.5 mm, i.e. from 2.5 to 4.5 mm. More preferably, the thickness is within the range of about 3 to 4 mm ± 0.25 mm, from 2.75 to 4.25 mm.

The thickness of the annular wall of the frame at each of the sections numbered 1 through 31 in Figure 14 is listed in Table II. The cross sections are spaced apart about one inch along the periphery of the frame, and the weight of each one inch long cross section is also listed.

Table II

Section Number	Weight in grams	Wall Thickness in millimeters
1	3.3	3.08
2	2.9	3.05
3	3.0	3.23
4	3.1	3.15
5	3.1	3.18
6	3.4	3.24
7	3.6	3.62
8	3.7	3.83
9	3.7	3.76
10	3.8	3.81
11	4.0	3.85
12	3.8	3.45
13	3.8	3.87
14	3.5	3.65
15	3.2	3.23
16	4.3	3.20
17	5.5	3.49
18	5.4	3.36
19	4.2	3.44
20	4.0	3.68
21	4.2	3.82
22	4.9	3.68
23	4.0	3.72
24	6.1	2.28
25	6.1	2.10
26	5.5	1.82
27	3.5	1.49
28	3.0	1.34
29	3.2	1.23
30	2.9	1.25
31	2.0	1.16

The foregoing weights and thicknesses were obtained from a painted frame which was drilled for string holes. The frame did not include a grip, buttcap, bumper or grommets.

The thickness of the annular wall in Table II varies between 3.05 and 3.87 mm between section 1 and section 23 in Figure 14. Below section 23 the two ends of the tube or hairpin which form the racquet are joined to form the handle. The wall thickness of each of the two end portions can therefore be smoewhat thinner.

The total weight is about 3 or 4 grams less than the original weight of the frame due to loss of shavings from the sectioning procedure. The particular racquet referred to in Table I had a maximum cross sectional diameter of about

14.9 mm at cross sections 16 or 17. For racquets having smaller maximum cross sectional diameters, the wall thicknesses would be greater than the thickness of Table II.

The racquet referred to in Table II also had a slight dual taper. The cross sectional diameter increased by about 1 mm from section 1 to section 16 or 17.

The wall thickness in the head was at a maximum in the area of sections 8-11 to provide perimeter weighting at the widest point of the head to increase the moment of inertia about the longitudinal centerline of the racquet.

Sections 16-18 were taken in the area where the yoke merges with the head, and the cross sectional shape was not substantially circular.

Sections 22 and 23 were taken in the transition area between the throat and the handle. Those sections were also slightly different in shape.

Sections 24-31 were taken through the handle portion. Those sections included the septum which is present in conventional molded racquets. Section 31 was less than 1 inch long.

Each of the wall thicknesses in Table II was on the average of three measurements taken at different locations around the cross section. In the specific embodiment listed in Table II, the wall thickness in the head was within the range 3.08 to 3.85 mm.

The cross section of the yoke 31 (Figure 12) is also slightly oval in the particular embodiment illustrated. The dimensions G and H are 12.00 mm (0.472 inch) and 10.50 mm (0.413 inch). The ratio G/H is 1.14.

The cross section of each of the diverging portions of the throat 29 is shown in Figure 13. In the embodiment illustrated, the cross section is slightly oval having dimensions I and J of 13.87 mm (0.546 inch) and 12.07 mm (0.475 inch). The ratio I and J is 1.15.

The size and shapes of the cross sections can vary. However, the maximum dimensions of any cross section is preferably less than 15 mm in order to provide optimum aerodynamics. Also, the cross section is preferably circular or substantially circular. The ratio of the maximum dimension to the minimum dimension of any cross section is preferably less than 1.30, and more preferably, less than 1.25.

Even though the cross section of the frame is narrow, the frame is provided with sufficient strength and stiffness because the wall thickness is substantially thick. Composite fiber and resin racquets are conventionally made by laying or wrapping the composite material over an inflatable bladder. The wrapped bladder is placed into a mold having the shape of the frame, the bladder is inflated, and the mold is heated to cure the resin. The cross section of a conventional frame therefore has a relatively thin wall of cured resin and fiber and a hollow interior which was formed by the inflated bladder.

Referring to Figures 9-11 and 13, each of the cross sections is generally annular and has a relatively thick, generally annular wall 35 surrounding a bore 36 having a relatively small diameter. In the preferred embodiments the thickness of the annular wall is within the range of about 3.05 to 3.87 mm.

Referring to Figure 12, the yoke 31 may be formed in the conventional manner from a tube 37 of composite fiber and resin which is filled with foamable resin 38. The resin 38 foams and expands in the mold to press the tube 37 against the mold. It is difficult to measure the wall thickness of the yoke because of the structural foam which fills the yoke cavity. The yoke is formed by wrapping carbon fiber prepreg around the foam material, and the assembly is roughly the side of the finished yoke. During molding the structural foam expands and presses the graphite against the mold to form the shape of the yoke. In one specific embodiment of the graphite 37 in the yoke was about 1.75 mm. However, it is difficult to obtain an accurate measurement of the thickness of the graphite in the yoke because of the foam.

The overall weight of the strung racquet is preferably less than 10.7 ounces, comparable to the prior Hammer and Sledgehammer racquets. However, the strung weight can also be in the more traditional range of 12-14 ounces.

The balance or center of gravity is preferably closer to the tip of the racquet than the butt end, making the racquet "head heavy." However, the balance can also be head light.

Even though the weight of the racquet is preferably less than 10.7 ounces, the thick wall of the frame provides good strength and stiffness. The stiffness index Si of the racquet is preferably at least 5.0 mm, i.e., the tip deflects 5.0 mm under a weight of 2.8 kg at the tip when the grip is clamped. The frequency of vibration of the first mode of bending under free-free constraint is preferably at least 150 Hz.

A tennis racquet in accordance with the invention preferably has the following physical characteristics:

Length	27.0 ± 0.125 inches
Strung weight	10.7 ounces or less
Balance	14 to 15 inches
Center of percussion	greater than 18.75 inches, more preferably greater than 19.0 inches
Stiffness Si	5.0 ± 0.3 mm
Frequency	135 to 180 Hz, more preferably greater than 150 Hz
I end	2900 ± 100 ounce-inch^2
Iy	86 ± 5 ounce-inch^2 for
	95 sq. in. racquets
	104 ± 5 ounce-inch^2 for
	100 sq. in. racquets

The values for balance and center of percussion are the distances from the butt end of the racquet. Center of percussion is measured with respect to an axis at the butt end which is perpendicular to the longitudinal centerline of the racquet and parallel to the plane of the strings. The balance is preferably beyond the midpoint of the racquet so that the ratio CG/L is greater than 0.51.

The narrow, substantially round cross section of the racquet frame allows a player to hit the ball with more spin. The reduced frontal area of the racquet even when the plane of the strings is at an acute angle to the direction of movement lowers the coefficient of drag and allows the frame to move faster. The substantially round cross section is aerodynamic at all angles of attack of the racquet relative to the ball.

The narrow profile of the frame allows the player to see the ball better as the racquet approaches the ball. That is particularly true during the serve. The player sees more of the strings and less of the frame than with conventional racquets.

Since the frame extends for only a short distance beyond the plane of the strings, the effective hitting surface of the racquet is larger than for other racquets. The ball can contact the strings very close to the frame without having the frame adversely affect the shot. Referring to Figures 9-12, the frame extends beyond the strings for only about one-half of the dimensions A, C, E, and G.

While in the foregoing specification, a detailed description of a specific embodiment of the invention was set forth for the purpose of illustration, it will be understood that many of the details herein given may be varied considerably by those skilled in the art without departing from the spirit and scope of the invention.

Claims

1. A tennis racquet comprising a frame formed from composite fiber and resin material, the frame having a head portion adapted to support a strung surface, a handle portion adapted to be held by a player, the handle portion having a butt end, a shaft portion connected to the handle portion, and a throat portion connecting the shaft portion and the head portion, the head portion being substantially circular in cross section, the racquet having a strung weight less than 10.7 ounces (303,35 g).

2. A tennis racquet comprising a frame formed from composite fiber and resin material, the frame having a head portion adapted to support a strung surface, a handle portion adapted to be held by a player, the handle portion having a butt end, a shaft portion connected to the handle portion, and a throat portion connecting the shaft portion and the head portion, the head portion being substantially circular in cross section, the distance of the center of gravity of the racquet from the butt end of the racquet being at least 14 inches.

3. A tennis racquet comprising a frame formed from composite fiber and resin material, the frame having a head portion adapted to support a strung surface, a handle portion adapted to be held by a player, the handle portion having a butt end, a shaft portion connected to the handle portion, and a throat portion connecting the shaft portion and the head portion, the head portion being substantially circular in cross section, the center of percussion of the racquet

measured with respect to an axis at the butt end of the handle portion being at least 18.75 inches from the butt end of the handle portion.

4. A tennis racquet comprising a frame formed from composite fiber and resin material, the frame having a head portion adapted to support a strung surface, a handle portion adapted to be held by a player, the handle portion having a butt end, a shaft portion connected to the handle portion, and a throat portion connecting the shaft portion and the head portion, the head portion being substantially circular in cross section, the head portion having an annular cross section provided by an annular wall, the thickness of the annular wall being within the range of about 2.5 to 4.5 mm.

5. The racquet of claim 1 in which the maximum cross sectional dimension of the head portion is less than 15 mm.

6. The racquet of claim 1 in which the throat portion is substantially circular in cross section.

7. The racquet of claim 1 in which the shaft portion is substantially circular in cross section.

8. The racquet of one of the claims 1 or 5 to 7 in which the throat portion includes a pair of diverging arms, and a yoke portion extending between arms and forming the bottom of a hoop-shaped head portion, the yoke portion being substantially circular in cross section.

9. The racquet of one of the claims 1 or 5 to 8 in which the ratio of the distance of the center of gravity of the racquet from the butt end of the handle portion to the length of the racquet is at least 0.52.

10. The racquet of one of the claims 1, 2, 5 to 9 in which the center of percussion of the racquet measured with respect to an axis at the butt end of the handle portion is at least 18.75 inches (47,625 cm) from the butt end of the handle portion.

11. The racquet of one of the claims 1, 2, 3, 5 to 10 in which the frequency of vibration of the racquet in the first mode of bending under free-free constraint is at least 150 Hz.

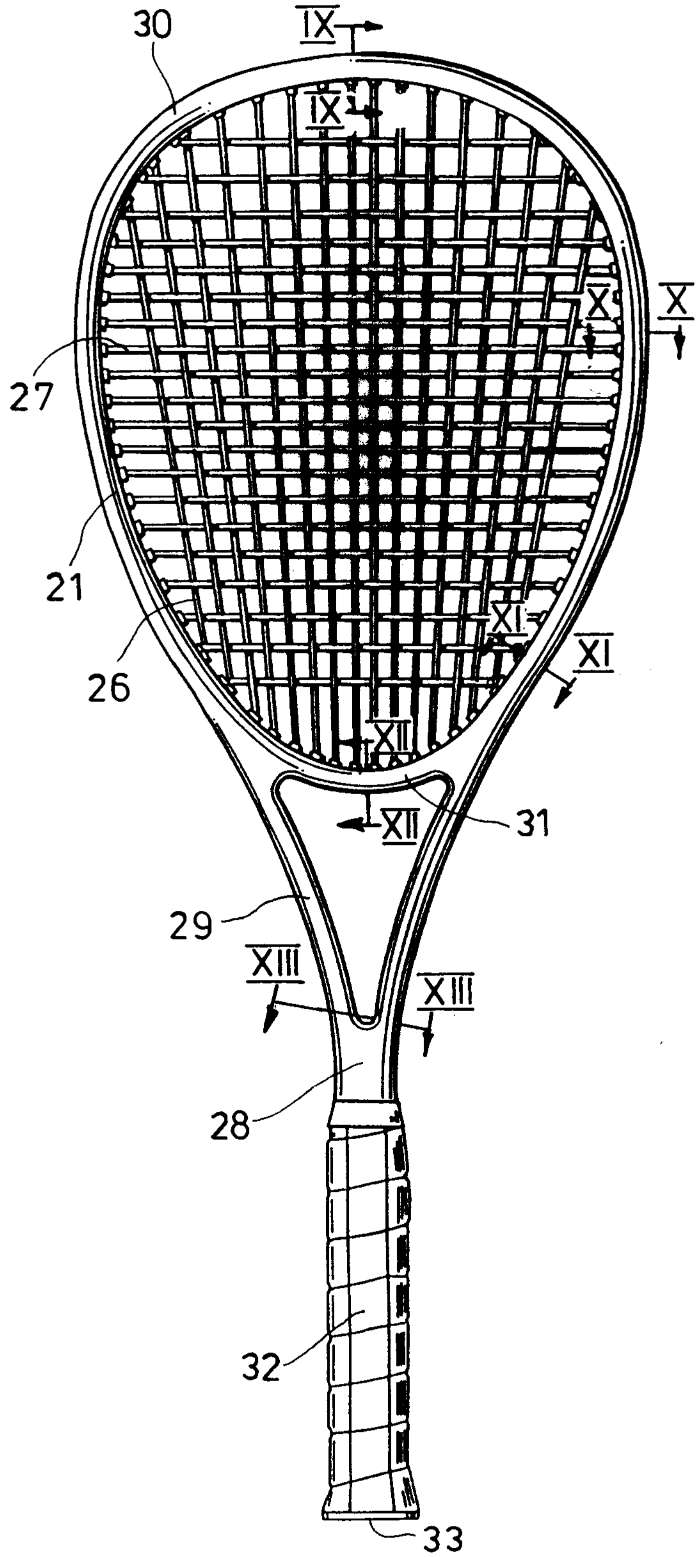
12. The racquet of one of the claims 1, 2, 3, 5 to 11 in which the head portion has an annular cross section provided by an annular wall, the thickness of the annular wall being within the range of about 2.5 to 4.5 mm.

13. The racquet of one of the claims 1 to 12 in which the maximum outer dimension of the annular wall is less than 15 mm.

14. The racquet of one of the claims 1 to 11 in which the head portion has an annular cross section provided by an annular wall, the thickness of the annular wall being within the range of about 2.75 to 4.25 mm, preferably within the range of about 3.05 to 3.87 mm.

15. The racquet of claim 1 in which the distance of the center of gravity of the racquet from the butt end of the racquet is at least 14 inches (35,56 cm).

FIG. 1


IX
IX
30
X
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21
XI
XI
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XII
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XIII
XIII
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32
33

FIG. 2

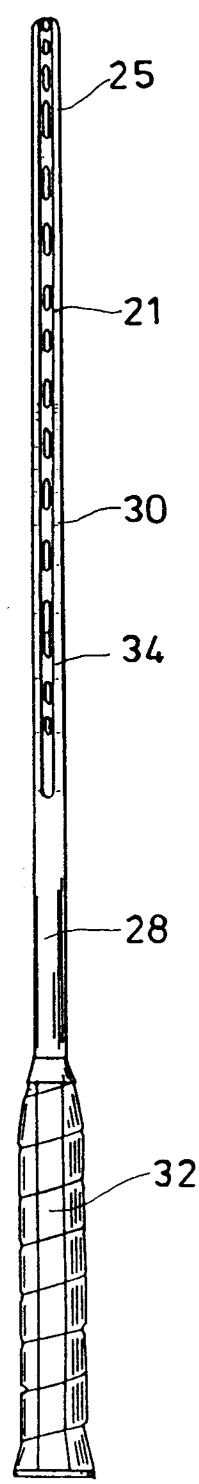
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FIG. 3

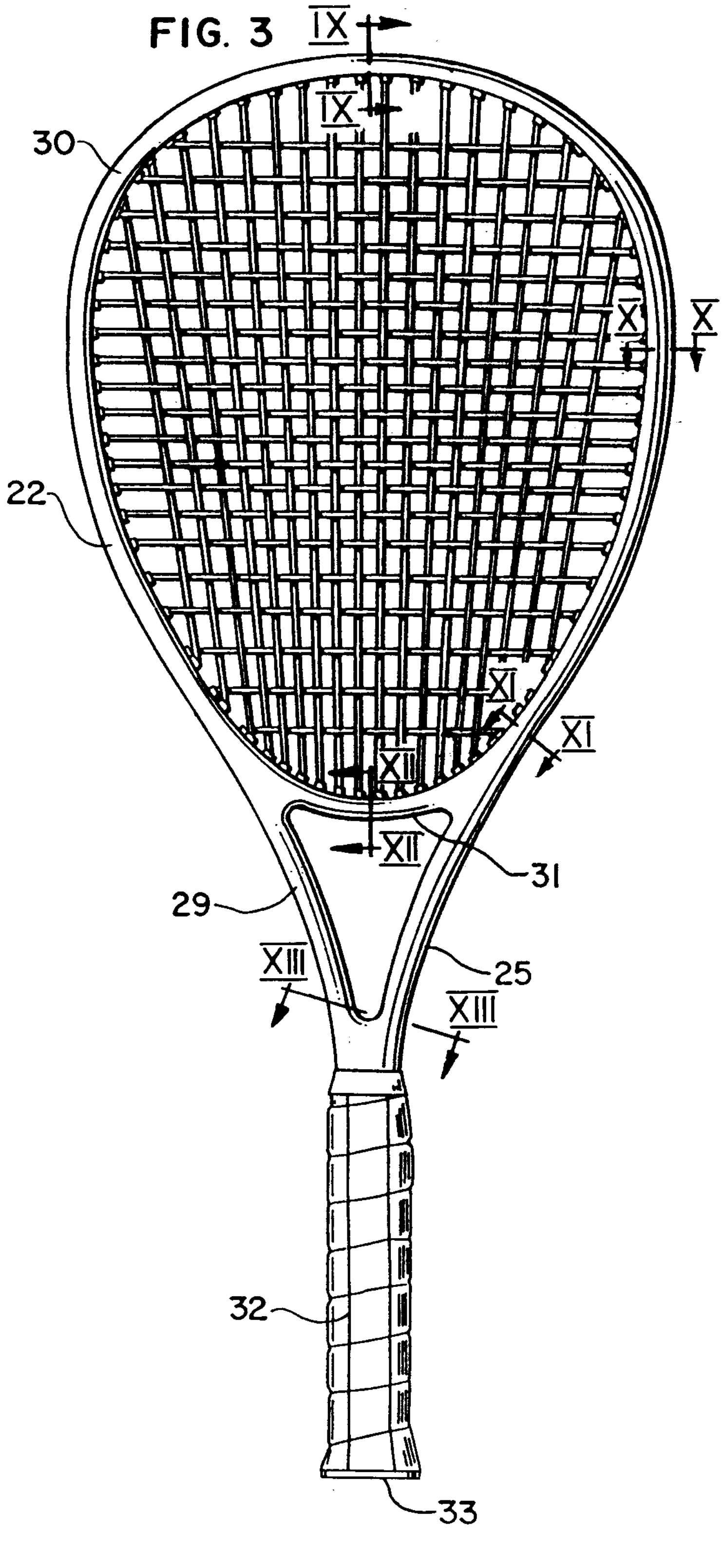


FIG. 4

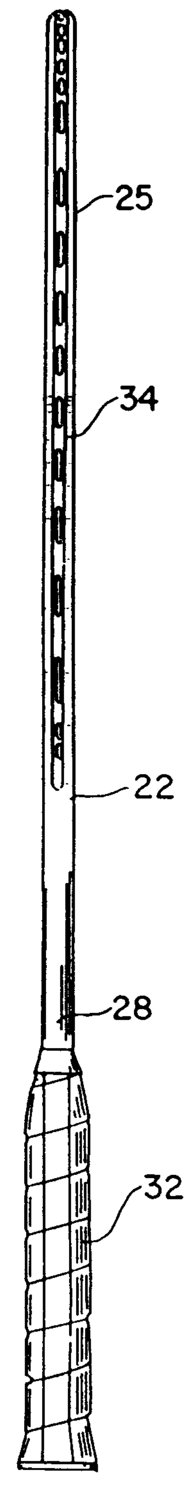


FIG. 5

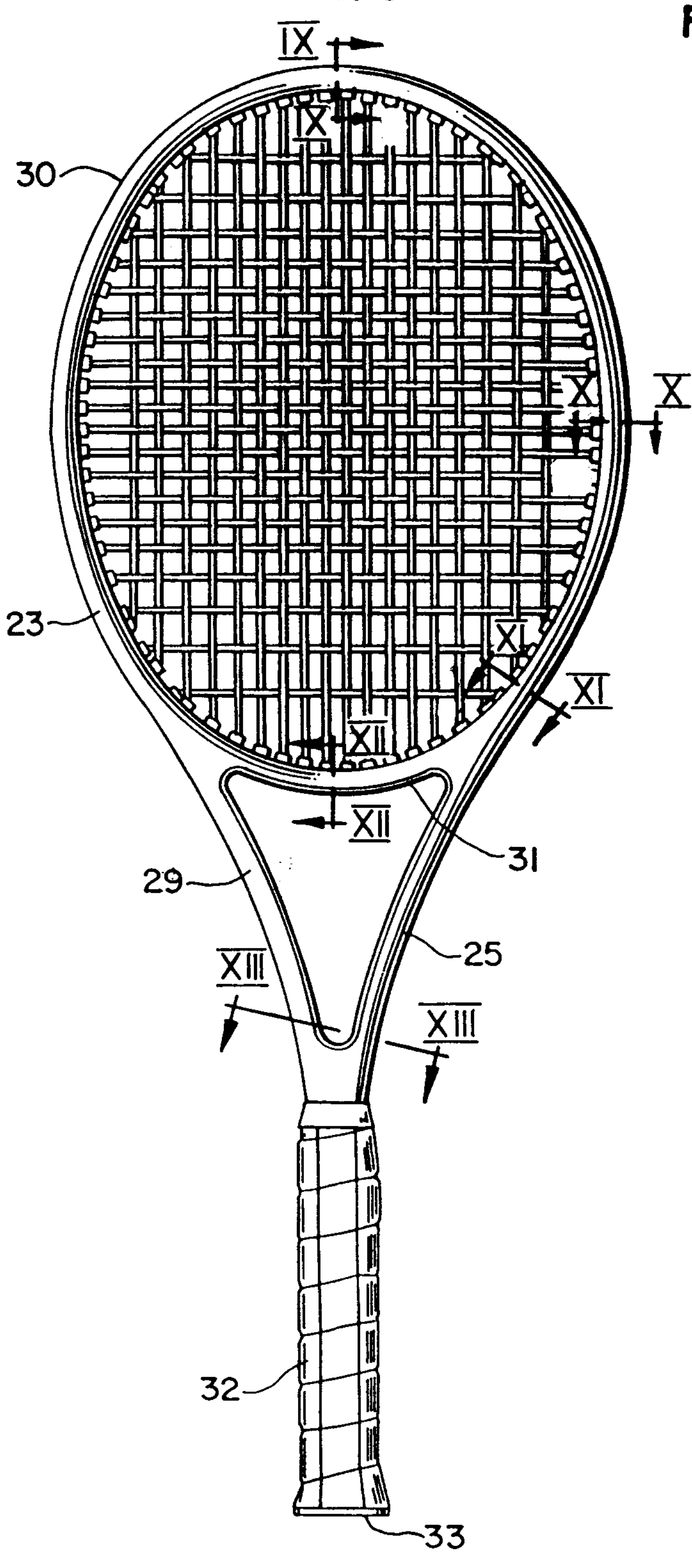


FIG. 6

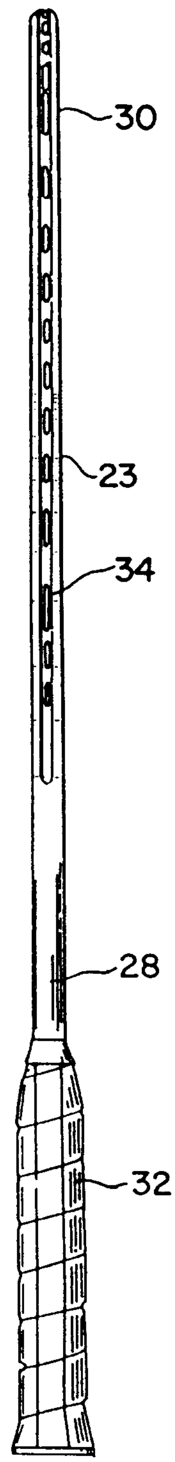


FIG. 7

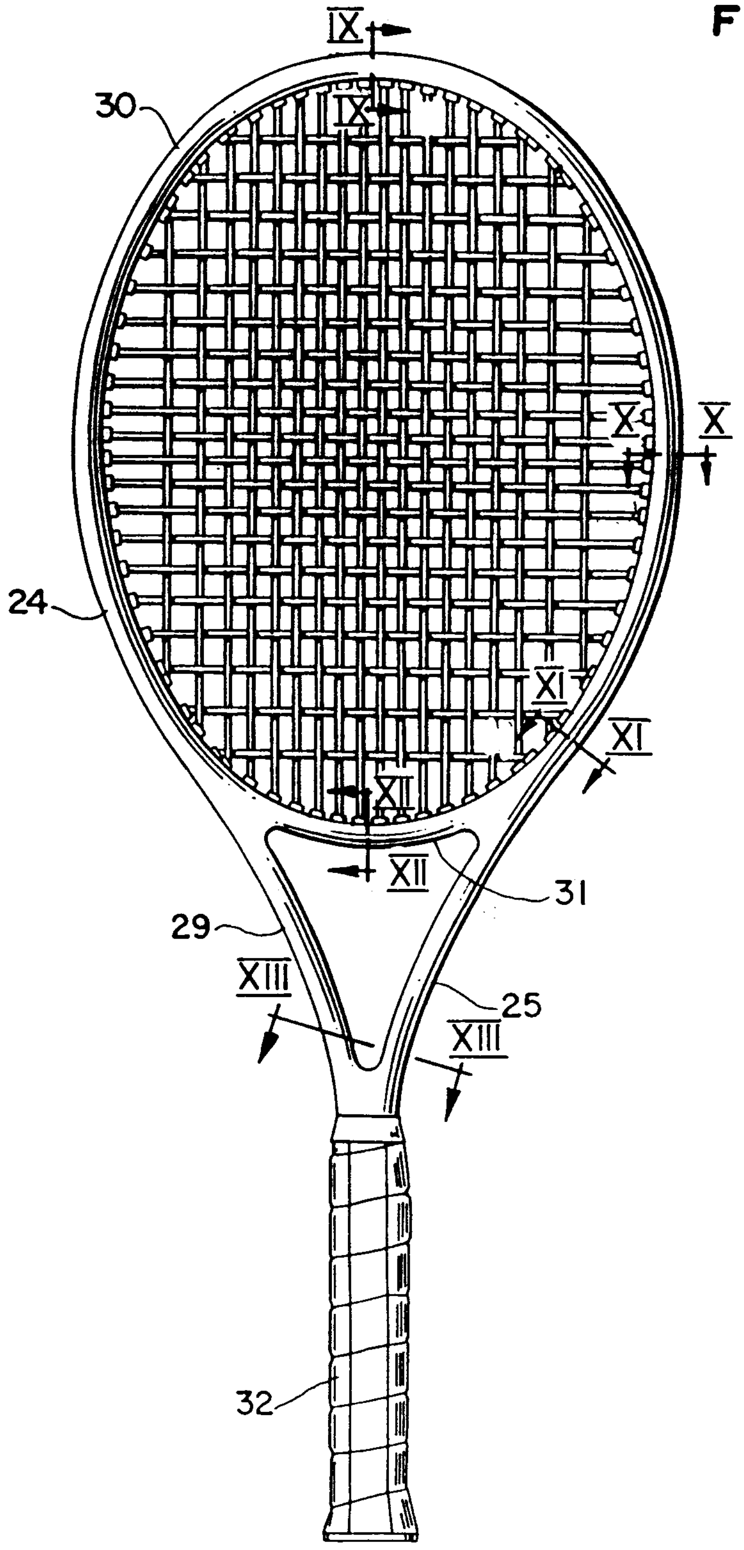


FIG. 8

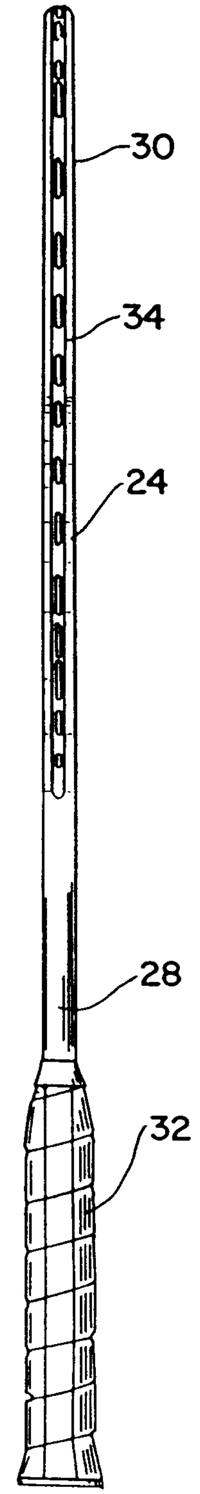


FIG. 9

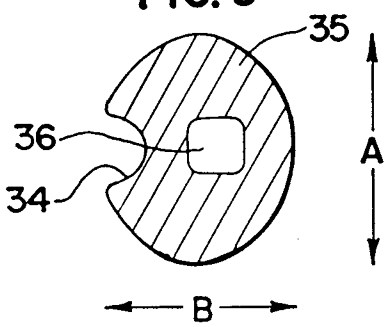


FIG. 10

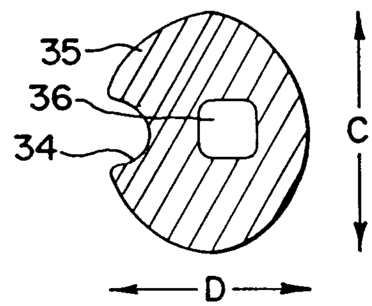


FIG. 11

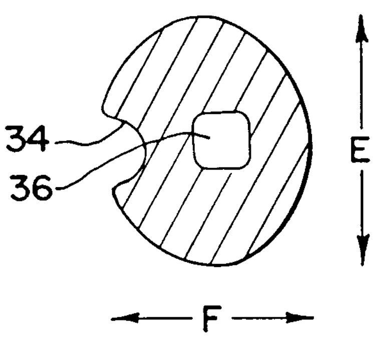


FIG. 12

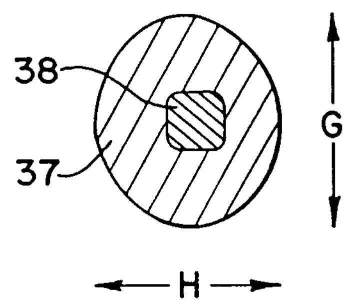


FIG. 13

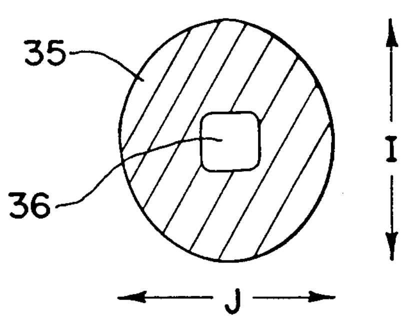
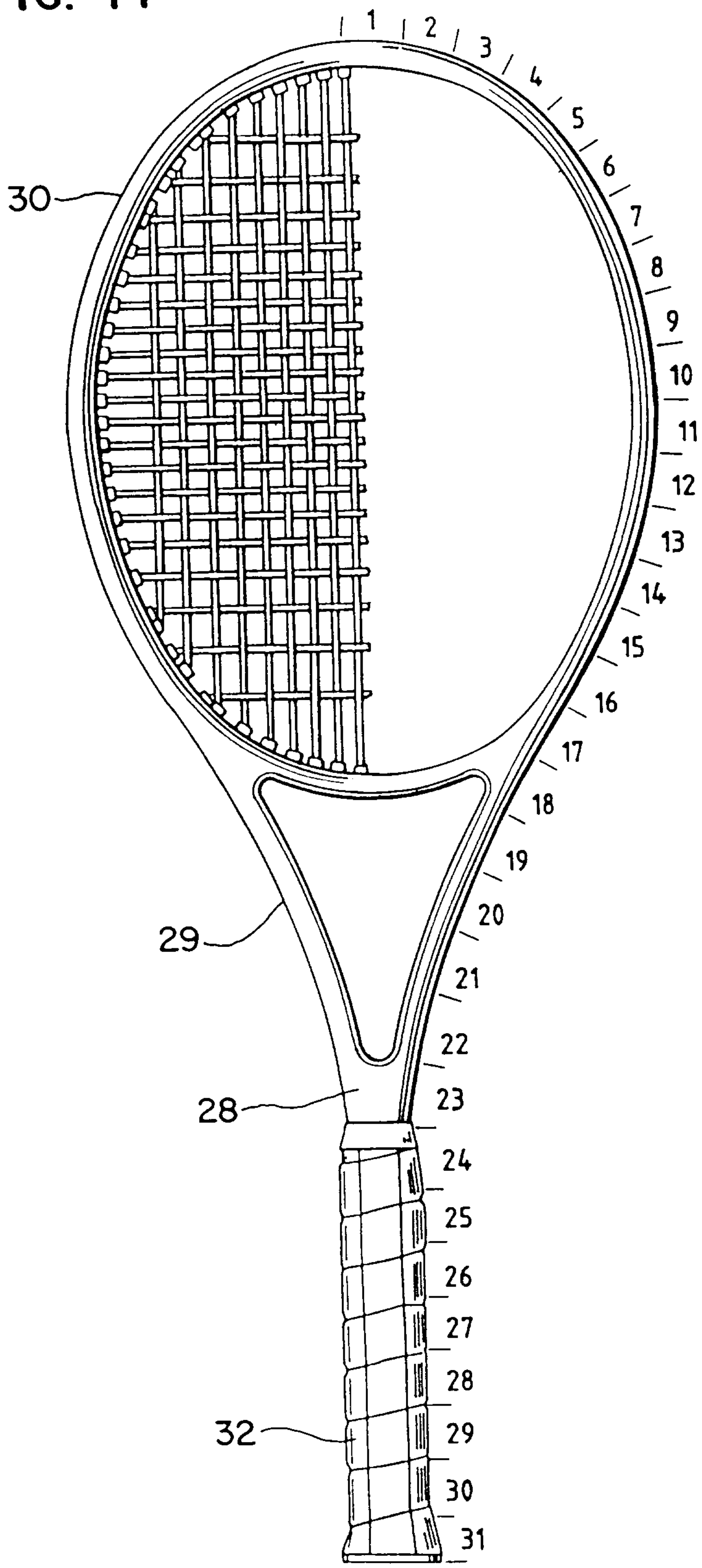


FIG. 14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EUROPEAN SEARCH REPORT

Application Number
EP 95 10 8367

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
D,X	US-A-5 076 583 (HSU) * the whole document * ---	1-15	A63B49/02
Y	US-E-33 372 (FROLOW) * column 3, line 32 - column 9, line 33; figures 1-15 * ---	1-3, 9-11,15	
D,Y	US-E-31 419 (FROLOW) * column 8, line 28 - column 20, line 50; figures 1,22-26,40 * ---	1-3, 9-11,15	
A	US-A-5 368 295 (SEVERA ET AL.) * the whole document * ---	1-3, 9-11,15	
A	US-A-5 075 056 (UMLAUFT ET AL.) * column 2, line 51 - column 4, line 50 * ---	4,14	
A	FR-A-2 358 170 (ROBERT BOSCH) -----		TECHNICAL FIELDS SEARCHED (Int.Cl.6) A63B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	13 March 1996	Williams, M

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