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(54) **Optimised thermoplastic racquet**

Optimierter thermoplastischer Schläger

Raquette thermoplastique optimisée

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(56) References cited:
**WO-A1-00/09219 DE-B- 1 043 897
DE-B- 1 089 675 GB-A- 1 201 649
GB-A- 2 150 444 US-A- 5 232 220**

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Description

FIELD OF THE INVENTION

[0001] The present invention relates generally to a sports racquet. In particular, the present invention relates to a racquet formed of a thermoplastic material including a thermoplastic resin and a plurality of fiber segments.

BACKGROUND OF THE INVENTION

[0002] Sport racquets, such as tennis racquets, are well known and typically include a frame having a head portion coupled to a handle portion. The head portion supports a string bed having a plurality of main string segments alternately interwoven with a plurality of cross string segments. Many racquets also include a throat portion positioned between and connecting the handle portion to the head portion. Sports racquets were initially primarily made of wood. Wood racquets were largely superseded by racquets formed of aluminium and other alloys. Aluminium racquets significantly improved the durability and reliability of racquets while increasing the power and strength of the racquets. Typically, aluminium racquets are formed of a drawn or extruded tube curved to substantially form a hoop with the two ends drawn together to form the throat tubes and the handle of the racquet. Today, many racquets are formed at least in part of a fiber composite material. Typically, bundles of high tensile strength fibers, such as carbon or graphite fibers, are coaxially aligned and intermixed with a resin typically formed of a thermoset material into sheets or layers of uncured fiber composite material. Multiple layers of uncured fiber composite material are typically carefully wrapped over a mandrel or an inflated tube to form the shape of a racquet. The wrapped layers are then placed into a mold and cured under heat and pressure to produce a fiber composite racquet frame. Racquets formed of fiber composite material have many advantageous characteristics, such as, for example, being lightweight, providing more design flexibility, and providing exceptional power, control and/or feel.

[0003] However, racquets formed of aluminium or fiber composite materials include some drawbacks. Aluminium is becoming increasingly expensive and more difficult to obtain and process for applications such as sports racquets. The supply and manufacturing expertise of aluminium is becoming increasingly short supply. Fiber composite materials have similar drawbacks with respect to increased cost and inconsistent supply. Further, the man-hours required to produce high quality fiber composite racquets are significant. Some prior art racquets have been produced of a thermoplastic material typically through an injection molding process. However such racquets have not been widely used due to poor reliability and durability issues, and undesirable feel and performance characteristics. Document GB-A-1201649 describes a racquet frame made of two interlocked sections.

[0004] Thus, there is a continuing need for a racquet that can be produced in a cost effective and reliable manner while providing exceptional performance, reliability and durability. What is needed is a racquet design that can provide greater design flexibility enabling racquets to be produced to meet different applications, and characteristics desired by players of various skill levels, engagement levels and budgets. It would be advantageous to provide a racquet that can be produced quickly and cost effectively without negatively effecting performance, feel, durability or playability. There is also a need for a racquet that can meet these needs without being a radical departure in look and design from traditional sport racquet designs.

SUMMARY OF THE INVENTION

[0005] The present invention provides a sports racquet extending along a longitudinal axis as claimed in claim 1 and configured for supporting a quantity of racquet string generally about a string plane. The racquet may include a frame formed of a thermoplastic material and including a head portion and a handle portion. The head portion may be formed of first and second hoop regions. At least one of the first and second hoop regions may include a first set of projections extending from one of the first and second hoop regions across the string plane and engaging the other of the first and second hoop regions. The first set of projections may space apart the first and second hoop regions by a first predetermined dimension to define a plurality of through-hoop region openings. The handle portion may be formed of first and second handle regions directly coupled together without defining either a plurality of handle openings.

[0006] According to an aspect of the invention, a sports racquet extends along a longitudinal axis and is configured for use with a quantity of racquet string about a string plane. The racquet may include a frame formed of a thermoplastic material. The frame may include first and second halves. The first and second halves may include first and second spaced apart hoop regions, first and second handle regions, first and second mating surfaces and first and second outer surfaces, respectively. At least one of the first and second halves may include a set of projections that extend from at least one of the first and second mating surfaces and across the string plane. At least one of the first and second halves may define a set of bores. The set of projections may be configured to matably engage the set of bores. At least two of the projections extending from at least one of the first and second hoop regions may be stepped projections having a proximal section and a distal section. The transverse cross-sectional area of the proximal section measured with respect to the string plane may be greater than the transverse cross-sectional area of the distal section measured with respect to the string plane. At least two of the set of bores of at least one of the first and second hoop portions may be configured to receive the corresponding distal section.

tions, but not the proximal sections, of the at least two stepped projections.

[0007] According to another aspect of the invention, a sports racquet extends along a longitudinal axis and is configured for use with a quantity of racquet string about a string plane. The racquet may include a frame formed of a thermoplastic material. The frame may include a first frame half coupled to a second frame half. The first and second halves may include first and second hoop regions, and first and second handle regions, respectively. The first and second handle regions may include first and second distal end sections, first and second proximal sections and first and second central sections, respectively. The first and second proximal end sections may include transversely extending end wall segments that form a butt end wall. The transverse cross-sectional area with respect to a plane perpendicular to the string plane of the coupled first and second proximal ends may be greater than the transverse cross-sectional area with respect to a plane perpendicular to the string plane of the coupled first and second distal end sections.

[0008] According to another aspect of the invention, a sports racquet extends along a longitudinal axis and is configured for use with a quantity of racquet string forming a string bed about a string plane. The racquet may include a frame formed of a thermoplastic material. The frame may include first and second halves. The first and second halves may include first and second spaced apart hoop regions, and first and second handle regions, respectively. At least one of the first and second hoop regions may include a set of projections extending from at least one of the first and second hoop regions in a direction orthogonal to the string plane. At least one of the first and second hoop regions may define a set of bores. The set of projections may be configured to matably engage the set of bores. The set of projections may extend through the string plane and may define curved bearing surfaces configured for engaging and supporting the racquet string. The set of projections may include at least first and second projections having at least first and second radii of curvature, respectively. The first radius of curvature may be at least 0.5 mm greater than the second radius of curvature. The curved bearing surfaces of the set of projections may have a radius of curvature within the range of greater than 2.0 to 12.0 mm.

[0009] According to another aspect of the invention, a sports racquet extends along a longitudinal axis and is configured for use with a quantity of racquet string forming a string bed about a string plane. The racquet may include a frame formed of a thermoplastic material including a thermoplastic resin and a plurality of fiber segments. The frame may include first and second halves. The first and second halves may include first and second spaced apart hoop regions, and first and second handle regions, respectively. At least one of the first and second hoop regions may include a set of projections extending from at least one of the first and second hoop regions in a direction orthogonal to the string plane. At least one of

the first and second hoop regions may define a set of bores. The set of projections may be configured to matably engage the set of bores. The set of projections may extend through the string plane and may define curved bearing surfaces configured for engaging and supporting the racquet string. At least two of the set of projections may define a cross-sectional area when measured with respect to the string plane that may be selected from the group consisting of semi-circular, elliptical, semi-elliptical, D-shaped, U-shaped, C-shaped, other non-circular curved shapes and combinations thereof.

[0010] An aspect of the present invention relates to a sports racquet extending along a longitudinal axis and configured for use with a quantity of racquet string forming a string bed about a string plane, the racquet comprising:

a frame formed of a thermoplastic material, the frame including first and second halves, the first and second halves including first and second spaced apart hoop regions, and first and second handle regions, respectively, at least one of the first and second hoop regions including a set of projections extending from at least one of the first and second hoop regions in a direction orthogonal to the string plane, at least one of the first and second hoop regions defining a set of bores, the set of projections being configured to matably engage the set of bores, the set of projections extending through the string plane and defining curved bearing surfaces configured for engaging and supporting the racquet string, the set of projections including at least first and second projections having at least first and second radii of curvature, respectively, the first radius of curvature being at least 0.5 mm greater than the second radius of curvature, the curved bearing surfaces of the set of projections having a radius of curvature within the range of greater than 2.0 to 12.0 mm.

[0011] The thermoplastic material may include a thermoplastic resin and a plurality of fiber segments.

[0012] The set of projections may include at least first, second and third projections having at least first, second and third radii of curvature, respectively. The first, second and third radii of curvature may be different from one another.

[0013] The first and second halves may include first and second throat regions, respectively.

[0014] The first and second frame halves may be substantially identical to each other.

[0015] The first and second halves may be coupled together by an adhesive, thermal bonding, chemical bonding, thermal welding, sonic welding, and combinations thereof.

[0016] The first and second frame halves may include first and second outer surfaces and first and second mating surfaces, respectively. The set of bores and the set of projections may be aligned with respect to the longi-

tudinal axis such that when the first and second frame halves are positioned with the mating surface of the first frame half facing the mating surface of the second frame half, the first and second frame halves fit together to form the frame.

[0017] When the first and second frame halves are engaged the set of projections may be evenly spaced apart from each other about the periphery of the engaged first and second hoop regions.

[0018] When the first and second frame halves are engaged the set of projections may be unevenly spaced apart from each other about the periphery of the engaged first and second hoop regions.

[0019] When the first and second frame halves are engaged, the set of projections may be spaced apart from each other about the periphery of the engaged first and second hoop regions, and wherein the spaced apart projections may define openings for receiving the racquet string.

[0020] A majority of the set of projections may have a circular cross-sectional area when measured with respect to the string plane.

[0021] The majority of the set of projections may have a generally D-shaped cross-sectional area when measured with respect to the string plane.

[0022] Each of the first and second handle regions may include a plurality of structural support members.

[0023] The first and second handle regions may include first and second proximal ends respectively. The transverse cross-sectional area of the handle portion at the first and second proximal ends may be greater than the transverse cross-sectional area at other locations along the handle portion. The first and second proximal ends may form a butt end wall of the racquet. The first and second proximal ends and the butt end wall may be shaped in the form of a butt cap.

[0024] The first and second hoop regions may include a distal end area. The wall thickness of the first and second hoop regions at the distal end area may be greater than other locations of the first and second hoop regions such that the distal end area forms a raised bumper guard.

[0025] The first and second hoop regions may have a wall thickness within the range of 0.8 to 3.0 mm.

[0026] The first and second hoop regions may be spaced apart by a distance measured with respect to a plane perpendicular to the string plane within the range of 2.0 to 12.0 mm.

[0027] The racquet string may be molded with at least one of the first or second frame halves to form the string bed.

[0028] An aspect of the present invention relates to a sports racquet extending along a longitudinal axis and configured for use with a quantity of racquet string forming a string bed about a string plane, the racquet comprising:

a frame formed of a thermoplastic material including

a thermoplastic resin and a plurality of fiber segments, the frame including first and second halves, the first and second halves including first and second spaced apart hoop regions, and first and second handle regions, respectively, at least one of the first and second hoop regions including a set of projections extending from at least one of the first and second hoop regions in a direction orthogonal to the string plane, at least one of the first and second hoop regions defining a set of bores, the set of projections being configured to matably engage the set of bores, the set of projections extending through the string plane and defining curved bearing surfaces configured for engaging and supporting the racquet string, at least two of the set of projections defining a cross-sectional area when measured with respect to the string plane that is selected from the group consisting of semi-circular, elliptical, semi-elliptical, D-shaped, U-shaped, C-shaped, other non-circular curved shapes and combinations thereof.

[0029] The curved bearing surfaces of the set of projections may have a radius of curvature within the range of greater than 2.0 to 12.0 mm.

[0030] An aspect of the present invention relates to a sports racquet extending along a longitudinal axis and configured for supporting a quantity of racquet string generally about a string plane, the racquet comprising:

a frame formed of a thermoplastic material, the frame including a head portion and a handle portion, the head portion being formed of first and second hoop regions, at least one of the first and second hoop regions including a first set of projections extending from one of the first and second hoop regions across the string plane and engaging the other of the first and second hoop regions, the first set of projections spacing apart the first and second hoop regions by a first predetermined dimension to define a plurality of through-hoop region openings, the handle portion being formed of first and second handle regions directly coupled together without defining one of a plurality of handle openings.

[0031] The thermoplastic material may include a thermoplastic resin and a plurality of fiber segments.

[0032] The first predetermined dimension measured in a direction orthogonal to the string plane may be within the range of 2 to 12 mm.

[0033] The frame may further include a throat region or portion. The throat portion may be formed of first and second throat regions directly coupled together without defining one of a plurality of throat openings.

[0034] The first and second hoop regions may define first and second hoops, respectively.

[0035] The frame may be formed of first and second frame halves. The first and second frame halves may include the first and second hoop regions and the first

and second handle regions, respectively. The first and second frame halves may be substantially identical to each other.

[0036] The first and second halves may be coupled together by an adhesive, thermal bonding, chemical bonding, thermal welding, sonic welding, and/or combinations thereof.

[0037] The first and second head regions may further define a plurality of bores. Each of the plurality of bores may be configured to receive a corresponding one of the set of projections.

[0038] Each of the first and second frame halves may have a mating surface and an outer surface. The plurality of bores and the set of projections may be aligned with respect to the longitudinal axis such that when the first and second frame halves are positioned with an inner surface of the first frame half facing an inner surface of the second frame half, the first and second frame halves may engage each other to form the frame.

[0039] Each of the first and second handle regions may include a plurality of structural support members.

[0040] The first and second handle regions may include first and second proximal ends respectively. The transverse cross-sectional area of the handle portion at the first and second proximal ends may be greater than the transverse cross-sectional area at other locations along the handle portion. The transverse cross-sectional areas may be taken with respect to a plane perpendicular to the string plane.

[0041] The first and second proximal ends may form a butt end wall of the racquet. The first and second proximal ends and the butt end wall may be shaped in the form of a butt cap.

[0042] The first and second hoop regions may include a distal end area. The wall thickness of the first and second hoop regions at the distal end area may be greater than other locations of the first and second hoop regions such that the distal end area forms a raised bumper guard.

[0043] The thermoplastic resin may be formed of a material selected from the group consisting of nylon, polystyrene, polycarbonate, polyphenylene sulfide, polyether ether ketone, polytetrafluoroethylene, acrylonitrile-butadiene-styrene, acetal, phenylene oxide, vinyl, polyvinyl chloride, polyamide, polyurethane, polyethylene terephthalate, polypropylene, other polyethylenes, and combinations thereof.

[0044] The fibers may be formed of a material selected from the group consisting of carbon, glass, graphite, boron, basalt, carbon, aramid, Kevlar®, Spectra®, polypara-phenylene-2, 6-benzobisoxazole (PBO), hemp, flax, and combinations thereof.

[0045] The handle portion formed of the first and second handle regions may be configured in the shape of a pallet.

[0046] The thermoplastic material used to form the frame may have a durometer value within the range of 20 on the Shore A hardness scale to 40 on the Shore D

hardness scale.

[0047] The handle portion may be shaped to replicate the contour of a racquet pallet and a butt cap.

[0048] The thermoplastic material may form a first thermoplastic layer of the first and second handle regions. A second thermoplastic layer formed of a second thermoplastic material may be molded over the first thermoplastic layer. The thermoplastic material of the first thermoplastic layer may have a durometer value measured on the Shore A or Shore D hardness scale that is greater than the durometer value of the second thermoplastic material measured on the Shore A or Shore D hardness scale.

[0049] An aspect of the present invention relates to a sports racquet extending along a longitudinal axis and configured for use with a quantity of racquet string about a string plane, the racquet comprising:

a frame formed of a thermoplastic material, the frame including first and second halves, the first and second halves including first and second spaced apart hoop regions, first and second handle regions, first and second mating surfaces and first and second outer surfaces, respectively, at least one of the first and second halves including a set of projections extending from at least one of the first and second mating surfaces and across the string plane, at least one of the first and second halves defining a set of bores, the set of projections being configured to matably engage the set of bores, at least two of the projections extending from at least one of the first and second hoop regions being stepped projections having a proximal section and a distal section, the transverse cross-sectional area of the proximal section measured with respect to the string plane being greater than the transverse cross-sectional area of the distal section measured with respect to the string plane, at least two of the set of bores of at least one of the first and second hoop portions being configured to receive the corresponding distal sections, but not the proximal sections, of the at least two stepped projections.

[0050] The thermoplastic material may include a thermoplastic resin and a plurality of fiber segments.

[0051] The proximal section of each of the at least two stepped projections may have a projected height measured with respect to a plane orthogonal to the string bed. The projected height of the proximal section of the at least two stepped projections may substantially define the spacing between the first and second hoop portions.

[0052] The first and second halves may include first and second throat regions, respectively.

[0053] The first and second frame halves may be substantially identical to each other.

[0054] The first and second frame halves may be formed in an injection molding operation.

[0055] The first and second halves may be coupled

together by an adhesive, thermal bonding, chemical bonding, thermal welding, sonic welding, and combinations thereof.

[0056] The set of bores and the set of projections may be aligned with respect to the longitudinal axis such that when the first and second frame halves are positioned with the mating surface of the first frame half facing the mating surface of the second frame half, the first and second frame halves fit together to form the frame.

[0057] Each of the first and second handle regions may include a plurality of structural support members.

[0058] The first and second handle regions may include first and second proximal ends respectively. The transverse cross-sectional area of the handle portion at the first and second proximal ends may be greater than the transverse cross-sectional area at other locations along the handle portion. The first and second proximal ends may form a butt end wall of the racquet. The first and second proximal ends and the butt end wall may be shaped in the form of a butt cap.

[0059] The first and second hoop regions may include a distal end area. The wall thickness of the first and second hoop regions at the distal end area may be greater than other locations of the first and second hoop regions such that the distal end area may form a raised bumper guard.

[0060] At least one quarter of the set of projections may have a non-circular cross-sectional area when measured about a plane extending parallel to the string plane.

[0061] At least one quarter of the plurality of projections may be solid non-hollow projections.

[0062] The projected height of the proximal section of the stepped projection may be within the range of 2 to 12 mm.

[0063] The thermoplastic resin may be formed of a material selected from the group consisting of nylon, polystyrene, polycarbonate, polyphenylene sulfide, polyether ether ketone, polytetrafluoroethylene, acrylonitrile-butadiene-styrene, acetal, phenylene oxide, vinyl, polyvinyl chloride, polyamide, polyurethane, polyethylene terephthalate, polypropylene, other polyethylenes, and combinations thereof.

[0064] The fibers may be formed of a material selected from the group consisting of carbon, glass, graphite, boron, basalt, carbon, aramid, Kevlar®, Spectra®, polypara-phenylene-2, 6-benzobisoxazole (PBO), hemp, flax, and combinations thereof.

[0065] The handle portion formed by the first and second handle regions may be configured in the shape of a pallet.

[0066] The thermoplastic material forming the frame may have a durometer value within the range of 20 on the Shore A hardness scale to 40 on the Shore D hardness scale.

[0067] The handle portion may be shaped to replicate the contour of a racquet pallet and a butt cap.

[0068] The thermoplastic material may form a first thermoplastic layer of the first and second handle regions. A

second thermoplastic layer formed of a second thermoplastic material may be molded over the first thermoplastic layer. The thermoplastic material of the first thermoplastic layer may have a durometer value measured on the Shore A or Shore D hardness scale that is greater than the durometer value of the second thermoplastic material measured on the Shore A or Shore D hardness scale.

[0069] An aspect of the present invention relates to a sports racquet extending along a longitudinal axis and configured for use with a quantity of racquet string about a string plane, the racquet comprising:

a frame formed of a thermoplastic material, the frame including a first frame half coupled to a second frame half, the first and second halves including first and second hoop regions, and first and second handle regions, respectively, the first and second handle regions including first and second distal end sections, first and second proximal end sections and first and second central sections, respectively, the first and second proximal end sections include transversely extending end wall segments that form a butt end wall, the transverse cross-sectional area with respect to a plane perpendicular to the string plane of the coupled first and second proximal ends being greater than the transverse cross-sectional area with respect to a plane perpendicular to the string plane of the coupled first and second distal end sections.

[0070] The thermoplastic material may include a thermoplastic resin and a plurality of fiber segments.

[0071] The transverse cross-sectional area of the coupled first and second proximal ends may be greater than the transverse cross-sectional area with respect to a plane perpendicular to the string plane of the coupled first and second central section sections.

[0072] The first and second proximal ends and the butt end wall may be shaped in the form of a butt cap.

[0073] The first and second halves may include first and second throat regions, respectively.

[0074] The first and second frame halves may be substantially identical to each other.

[0075] The first and second frame halves may be formed in an injection molding operation.

[0076] The first and second halves may be coupled together by an adhesive, thermal bonding, chemical bonding, thermal welding, sonic welding, and/or combinations thereof.

[0077] Each of the first and second handle regions may include a plurality of structural support members.

[0078] The first and second handle regions may be configured in the shape of a pallet.

[0079] The first and second distal end sections of the first and second handle regions, respectively may be configured in the shape of a top cap.

[0080] The first and second hoop regions may include a distal end area. The wall thickness of the first and sec-

ond hoop regions at the distal end area may be greater than other locations of the first and second hoop regions such that the distal end area forms a raised bumper guard.

[0081] The thermoplastic material may form a first thermoplastic layer of the first and second handle regions. A second thermoplastic layer formed of a second thermoplastic material may be molded over the first thermoplastic layer. The thermoplastic material of the first thermoplastic layer may have a durometer value measured on the Shore A or Shore D hardness scale that is greater than the durometer value of the second thermoplastic material measured on the Shore A or Shore D hardness scale.

[0082] A third thermoplastic material that includes a foaming agent may be formed over the first thermoplastic layer. The second thermoplastic layer may be molded over the third thermoplastic layer.

[0083] Graphical and/or alpha-numeric indicia may be formed into the butt end wall.

[0084] The thermoplastic resin may be formed of a material selected from the group consisting of nylon, polystyrene, polycarbonate, polyphenylene sulfide, polyether ether ketone, polytetrafluoroethylene, acrylonitrile-butadiene-styrene, acetal, phenylene oxide, vinyl, polyvinyl chloride, polyamide, polyurethane, polyethylene terephthalate, polypropylene, other polyethylenes, and combinations thereof.

[0085] The fibers may be formed of a material selected from the group consisting of carbon, glass, graphite, boron, basalt, carrot, aramid, Kevlar®, Spectra®, polypara-phenylene-2, 6-benzobisoxazole (PBO), hemp, flax, and combinations thereof.

[0086] The thermoplastic material of the frame may have a durometer value within the range of 20 on the Shore A hardness scale to 40 on the Shore D hardness scale.

[0087] Other aspects of the present invention relate to methods of manufacturing or forming a sports racquet, such as a sports racquet as defined in relation to any other aspect.

[0088] It should be understood that features defined in relation to one aspect may be provided in combination with any other aspect.

BRIEF DESCRIPTION OF THE DRAWINGS

[0089] These and other aspect of the present invention will now be described, by way of example only, with reference to the accompanying drawings as noted below, wherein like reference numerals refer to like parts.

FIGURE 1 is a front side perspective view of a racquet in accordance with a preferred embodiment of the present invention.

FIGURE 2 is a schematic depiction of an injection molding apparatus.

FIGURE 3 is a front end perspective view of a first

half of a frame of the racquet of FIG. 1.

FIGURE 4 is a rear view of the first half of the frame of FIG. 3.

FIGURE 5 is a side perspective view of the first half of the frame of FIG. 3.

FIGURE 6 is a side perspective view of a first hoop region of the first half of the frame of FIG. 3.

FIGURE 7 is a side sectional view of first and second hoop regions of the frame of the racquet of FIG. 1.

FIGURE 8 is a side sectional view of first and second hoop regions of the frame of the racquet in accordance with an alternative preferred embodiment of the present invention.

FIGURE 9 is a side perspective view of a first throat region of the first half of the frame of FIG. 3.

FIGURE 10 is a side perspective view of a first handle region of the first half of the frame of FIG. 3.

FIGURE 11 is a rear view of a portion of the hoop region of the first half of the frame of FIG. 3 showing racquet string engaging the hoop region.

FIGURE 12 is a side perspective view of first and second halves of the frame of the racquet of FIG. 1 shown spaced apart from each other.

FIGURE 13 is a side view of the first and second halves of the frame of the racquet of FIG. 1 shown spaced apart and facing each other.

FIGURE 14 is a side view of first and second halves of the frame of the racquet of FIG. 1.

FIGURES 15a and 15b are longitudinal cross-sectional views of the handle region of the frame of the racquet in accordance with two alternative preferred embodiments of the present invention.

FIGURES 16 and 17 are rear views of a first half of a frame of a racquet in accordance with two other alternative preferred embodiments of the present invention.

FIGURE 18 is a front view of a hoop region of a racquet in accordance with another alternative preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0090] Referring to FIG. 1, a sports racquet is indicated generally at 10. The racquet 10 of FIG. 1 is configured as a tennis racquet. The racquet 10 includes a frame 12 and a string bed 14. The frame 12 extends along a longitudinal axis 16 and including a head portion 18, a handle portion 20, and a throat portion 22 coupling the head and handle portions 18 and 20.

[0091] The head portion 18 includes a distal region 28, first and second side regions 30 and 32, and a proximal region 34, which collectively define a hoop 36 having a string bed area 38 for receiving and supporting the string bed 14. In one preferred embodiment, the proximal region 34 includes a yoke 40. The string bed area 38 is also referred to as the head size of the racquet 10. In a preferred embodiment, the head size or string bed area

38 of the racquet 10 is within the range of 203-343 cm² 80 to 135 square inches). In a more preferred embodiment, the head size of the racquet 10 is within the range 249-292 cm² (98 to 115 square inches). In alternative preferred embodiments, other head sizes can also be used and are contemplated under the present invention. The hoop 36 can be any closed curved shape including, for example, a generally oval shape, a generally tear-drop shape, a generally pear shape, a generally circular shape and combinations thereof. The head portion 18 is configured for supporting the string bed 14 formed by a plurality of main string segments 50 alternately interwoven or interlaced with a plurality of cross string segments 52. The string bed 14 defines a string plane 54 as it extends about the string bed area 38. The main and cross string segments 50 and 52 can be formed of a high tensile strength, flexible material. In preferred embodiments, the racquet string can be formed of a polyester material, a nylon, a natural gut material and/or a synthetic gut material. The polyester materials used to make the racquet string can include polyether ether ketone (PEEK), polytetrafluoroethylene (PTFE), other polyester materials, and combinations thereof. The racquet string can be formed in a monofilament construction or in a multiple-filament construction. The racquet string can be formed of various different diameters (or gauges). Preferably, the diameter of the racquet string is within the range 1.10 to 1.55 mm.

[0092] The throat portion 22 can be formed of first and second throat tubes 42 and 44 generally extending from the head portion 18 and converging toward the handle portion 20. The handle portion 20 includes a grip 46 for grasping by a player.

[0093] The frame 12 is preferably a two piece structure formed of first and second frame halves 12a and 12b (see FIG. 12). Each of the first and second frame halves 12a and 12b is preferably formed of a thermoplastic material. In a preferred embodiment, the thermoplastic material includes a thermoplastic resin and a plurality of fiber segments. The thermoplastic material offers many advantageous characteristics that are beneficial for the design and use of a sports racquet including providing exceptional feel, high strength, toughness, durability, reliability, consistency, cost-effectiveness, ease of construction, and exceptional performance. The thermoplastic resin is preferably a nylon. In alternative preferred embodiments, the thermoplastic resin can be polystyrene, polycarbonate, polyphenylene sulfide, polyether ether ketone (PEEK), polytetrafluoroethylene (PTFE), acrylonitrile-butadiene-styrene (ABS), acetal, phenylene oxide, vinyl, polyvinyl chloride (PVC), polyamide, polyurethane, polyethylene terephthalate (PET), polypropylene, other polyethylenes, and combinations thereof. The plurality of fibers are typically co-axially aligned and arranged in bundles. The fibers are formed of a high tensile strength material such as carbon. Alternatively, the fibers can be formed of other materials such as, for example, glass, graphite, boron, basalt, carrot, aramid, Kevlar®,

Spectra®, poly-para-phenylene-2, 6-benzobisoxazole (PBO), hemp, flax, and combinations thereof. The fibers are preferably cut to a length within the range of 1 mm to 75 mm. In a particularly preferred embodiment, the fibers are cut to a length within the range of 1 to 10 mm. The fibers are preferably randomly orientated and dispersed within the thermoplastic resin prior to injection or during the injection molding process. In alternative preferred embodiments, the fibers can be generally aligned in one, two or more primary directions prior to or during the injection molding process. The fibers preferably account for a percentage of the weight of the thermoplastic material within the range of 10 to 60 percent. In a preferred embodiment, the fibers account for 25 to 35 percent of the weight of the thermoplastic material. The fibers preferably account for a percentage of the volume of the thermoplastic material within the range of 10 to 40 percent. In a preferred embodiment, the fibers account for 25 to 35 percent of the volume of the thermoplastic material. In an alternative preferred embodiment, the thermoplastic material can be formed without a plurality of fibers.

[0094] The frame 12 is preferably formed of a thermoplastic material having a durometer value within the range of 20 on the Shore A hardness scale to 40 on the Shore D hardness scale.

[0095] Referring to FIG. 2, the thermoplastic material is preferably formed into the desired structure (e.g. the frame halves 12a and 12b) through an injection molding process or operation using an injection molding apparatus 100. The injection molding apparatus 100 can include a water cooled injection mold 102 having a mold cavity 104 that defines the shape of the frame half 12a. The mold 102 can be a split mold having two major sections 102a and 102b. The thermoplastic material can be injected into the mold cavity 104 from an injection molding extruder 106. The thermoplastic material can be supplied through an inlet tube 108 to the interior of the extruder 106, which is heated to reduce the viscosity of the thermoplastic material and make it flowable. A piston or screw 110 can be used to force the flowable thermoplastic material out of the extruder 106 into a manifold system 112, which can be heated. The manifold system 112 can include one, two, three or more flow paths, such as flowpaths 114 and 116, for routing the flowable thermoplastic material to first and second injection ports 118 and 120, respectively. The locations of the injection ports 118 and 120 are spaced apart to enable the thermoplastic material to readily flow and fill the mold cavity 104 in an efficient and timely manner. The injection of the flowable thermoplastic material can be performed in two stages through the use of one or more valves 122. In one stage, the flow of the thermoplastic material can be directed through a specific injection flowpath, such as flowpath 114 through the first injection port 118. The direction and flowpath of flowable thermoplastic material can be used to facilitate the general orientation of the fibers within the thermoplastic material. One or more pressure sensors 124 or

other forms of sensor, such as temperature sensors, can be utilized with the mold to determine when the flowable thermoplastic material has reached selected locations within the mold cavity. When the flow of the thermoplastic material reaches a predetermined value, such as a predetermined pressure at one of the pressure sensors 124, the valve 122 can reposition and reroute or redirect the flow of the thermoplastic material down the second flow-path 116 through the second injection port 120. In alternative preferred embodiments, other forms of injection mold apparatuses can be used. The type of mold, the number of flow paths, the number of injections ports or gates, the number of valves, the configuration of the valves, the type of extruder or other injection mechanism, the configuration, pressure, temperature and order of the flow and introduction of the thermoplastic material can be varied. The injection molding apparatus described above is one example and is not intended to be limiting. One of skill in the art understands that a wide variety of injection molding apparatuses can be used to achieve the desired result from injection molding process or operation.

[0096] Referring to FIG. 12, the frame 12 is formed of the first and second frame halves 12a and 12b that include first and second hoop regions 18a and 18b, first and second handle regions 20a and 20b and first and second throat regions 22a and 22b, respectively. Each of the first and second frame halves 12a and 12b are formed within the mold cavity 104 of the injection molding apparatus 100 (or an equivalent injection mold apparatus). In a preferred embodiment, the first and second halves 12a and 12b are identical halves. Accordingly, a reference to a component of the first frame half 12a is equally applicable to the same component of the second frame half 12b (e.g. the first hoop region 18a is preferably the same as the second hoop region 18b).

[0097] Referring to FIGS. 3 through 5, the first frame half 12a is shown in further detail. The first frame half 12a includes a main curved wall 24 that includes an outer surface 56 configured to represent the exterior of the frame 12 of the racquet, and an opposing inner surface 58 (also referred to as a mating surface). The wall thickness of the main curved wall 24 of the first half frame 12a is defined by the distance between the outer and inner surfaces 56 and 58. In one preferred embodiment, the wall thickness of the main curved wall 24 is within the range of 0.5 to 3.0 mm. In other alternative embodiments, thicknesses of the main curved wall 24 outside of this range can also be used. Referring to FIGS. 3 through 8, the main curved wall 24 is preferably configured to define first and second peripheral edges 25 and 26. The first and second peripheral edges 25 and 26 preferably extend along the same plane throughout one or more of the first hoop region 18a, the first handle region 20a and the first throat region 22a.

[0098] A distal region 28a of the first frame half 12a can include a raised region 60 that resembles a conventional racquet raised bumper guard. In one preferred em-

bodiment, the raised region 60 is formed by increasing the wall thickness of the main curved wall 24 of the first frame half 12a at the distal region 28a to produce the raised region 60. In one particularly preferred embodiment, the wall thickness at the distal region 28a can be within the range of 2.0 to 3.0 mm, and the wall thickness at the remaining locations of the first half 12a can be within the range of 1.0 to 2.5 mm. In other preferred embodiments, other wall thicknesses can be used. In another alternative preferred embodiment, the contours of the mold cavity 104 can provide for the distal region 28a to extend outward at the raised region 60 without significantly increasing the wall thickness of the main curved wall 24. The present invention eliminates the need to attach a separate bumper guard to the distal region of the head portion 18 of the racquet 10 making production of the racquet 10 more efficient.

[0099] Referring to FIGS. 3 through 5 and 10, the first handle region 20a is preferably formed to include a pallet 62. The first handle region 20a defines one half of the pallet 62, and the second handle region 12b defines the other half. The pallet 62 preferably has an octagonal transverse cross-sectional shape when combined with the second handle region 20b and viewed with respect to a transverse plane extending perpendicular to the string plane 54. The octagonal shaped pallet 62 simplifies the manufacturing of the racquet 10 by providing surfaces for direct application of the grip 46 without needing to add a separate component (a conventional racquet pallet) to the handle of the racquet. The grip 46 can be readily applied to and/or wrapped about the outer surface 56 of the frame 12 at the handle region 20a.

[0100] The first handle region 20a includes a first proximal end section 64a, a distal end section 66a and a first central section 68a between the first proximal and distal end sections 64a and 66a. The first handle region 20a increases in size as it extends from the first central section 68a to the first proximal end section 64a. The increased size of the first proximal end section 64a when measured with respect to a transverse plane extending perpendicular to the string plane 54 can be found by comparing the transverse cross-sectional area defined by the first proximal end section 64a (when combined with a second proximal end section 64b (FIG. 9)) to the transverse cross-section area defined by the first distal end section 66a (when combined with the second distal end section), or to the transverse cross-section area defined by the first central section 68a (when combined with the second central section). The transverse cross-sectional area of the first proximal section 64a (when combined with the second proximal end section) is greater than the transverse cross-sectional area of the first distal section 66a (when combined with the second distal end section), and the transverse cross-sectional area of the first proximal section 64a (when combined with the second proximal end section) is greater than the transverse cross-sectional area of the first central section 68a (when combined with the second central section). In one preferred

embodiment, the transverse cross-sectional area of the first proximal section 64 can be at least 20 percent greater than the transverse cross-sectional area of the first distal end section 66a, or of the first central section 68a. In another preferred embodiment, the difference in transverse cross-sectional areas can be at least 30 percent. The first proximal end section 64a includes a transversely extending first butt end wall 70a that in combination with a second butt end wall 70b (FIG. 9) of the second frame half 12b substantially closes or covers the proximal end of the racquet frame 12. The increased area or size of the first and second proximal end sections 64a and 64b along with the first and second butt end walls 70a and 70b define a butt end region 72 of the racquet 10 that takes the shape of a conventional racquet butt cap. The present invention eliminates the need to attach a separate butt cap to the end of the racquet making production of the racquet more efficient. The butt end region 72 provides all of the desirable attributes of a conventional butt cap such as providing an enlarged region for gripping or indexing of a player's grip, and providing a cover to inhibit debris and/or moisture from entering the racquet frame, but without requiring a separate butt cap to be attached to the end of the racquet. The first and second butt end walls 70a and 70b can include graphical and/or alpha-numeric indicia 74, such as, for example, a trademark. Alternatively, the indicia 74 can include size information, model information, grip replacement information, supplier information, regulatory information and other forms of indicia. In preferred embodiments, the graphical and/or alpha-numeric indicia 74 can be applied in the form of a decal, a sticker, inks, paint or other secondary marking processes. In an alternative preferred embodiment, the graphical and/or alphanumeric indicia can be formed or shaped as part of the shape of the first and second butt end walls 70a and 70b. In other words, the indicia 74 can be molded into the shape of the first and/or second butt end walls 70a and 70b. In alternative preferred embodiments, the frame half 12a can be formed without one or more or all of the raised region 60, the pallet configuration, the butt end walls and the enlarged proximal end section.

[0101] In one preferred embodiment referring to FIG. 3, the distal end section 66a of the first handle region 20a is formed in a shape to define a top cap 67a. The top cap 67a forms a smooth transition between the distal end of the handle region 20a and the first throat region 22a. The top cap 67a and the top cap 67b collectively form the top cap 67 of the racquet frame 12.

[0102] Referring to FIGS. 4 and 10, the first handle region 20a preferably includes a plurality of structural support members 80. The structural support members 80 are formed with the first frame half 12a during the injection molding process. The structural support members 80 provide additional structural integrity to the first handle region 20a. The structural support members 80 preferably can take the form of a plurality, network or matrix of interconnected ribs 82. The thickness, size,

shape, orientation, number and spacing of the structural support members 80 can be varied to provide the desired amount of strength, rigidity, stiffness, responsiveness or feel. For example, in one preferred embodiment, the structural support members 80 can be configured to increase the torsional stability or stiffness of the handle region or of the racquet as a whole. In other alternative preferred embodiments, the structural support members can be configured to adjust the longitudinal stiffness, flexibility, durability, reliability, feel, performance, responsiveness or combinations thereof. In other preferred embodiments, the structural support members can use other structural configurations, such as, for example, increased wall thickness of the main curved wall 24 at the first handle region 20a, and/or adding one or more structural foams within the frame halves.

[0103] Referring to FIGS. 4 through 6, 9 and 10, the first frame half 12a includes a plurality of projections 84 that extend from the inner surface 58 so as to cross the string plane 54. The plurality of projections 84 also preferably extend beyond the plane defined by the first and second edges 25 and 26. The plane defined by the first and second edges 25 and 26 can be used to define the height of the projection 84 or a height of a portion of the projections. In one particularly preferred embodiment, the string plane 54 is the same plane defined by the first and second edges 25 and 26 for the handle portion 20a and for a majority of the throat portion 22a. Further, in the particularly preferred embodiment, the plane defined by the first and second edges 25 and 26 at the hoop region 18a can be parallel to but be spaced apart from the string plane 54. In other alternative preferred embodiment, the plane defined by the first and second edges 25 and 26 at the hoop region 18a can also lie in the same plane as the string plane 54. In other preferred embodiments, the first and second edges of the curved main wall 24 may not lie on a plane, but may be curved, sloped or irregular. A plurality of curved walls 86 extend from the inner surface 58 (or mating surface) to define a plurality of bores 88. In one preferred embodiment, the plurality of projections 84 and the plurality of bores 88 are configured to be corresponding pairs of projections and bores about an axis, such as the longitudinal axis 16. The corresponding pairs of projections and bores correspond for engagement or coupling to another frame half, such as the second frame half 12b. Referring to FIGS. 4 and 6, the four projections 84c, 84d, 84e and 84f are positioned at first, second, third and fourth distances (d1, d2, d3 and d4) away from the longitudinal axis 16, and the four bores 88c, 88d, 88e and 88f are positioned at the same first, second, third and fourth distances (d1, d2, d3 and d4) from the longitudinal axis 16 but in opposite directions. Additionally, the projection 84c is shaped to substantially correspond to the shape of the bore 88c. Likewise, the shapes of projections 84d, 84e and 84f are shaped to substantially correspond to the shapes of the bores 88d, 88e and 88f, respectively. Accordingly, the projections 84 are preferably sized, positioned and

shaped to substantially correspond to the size position and shape of the bores 88 with respect to the longitudinal axis 16.

[0104] Referring to FIGS. 6 and 7, at least two of the projections 84 extending from the first hoop region 18a can be non-continuous projections. In one preferred embodiment, the non-continuous projection can take the form of a stepped projection having a proximal section 90 and a distal section 92. The proximal section 90 and the distal section 92 each have a transverse cross-sectional area measured with respect to the string plane 54. The transverse cross-sectional area of the proximal section 90 is preferably greater than the transverse cross-sectional area of the distal section 92. The transition between the proximal section 90 and the distal section 92 can be stepped to form a projection shoulder 94 on the stepped projection 84. The bores 88 are configured to correspond to the non-continuous projections 84 are preferably sized to receive only a portion of or all of the distal section 92 and not the proximal section 90 of the stepped projection 84. Referring to FIG. 8, in another preferred embodiment, the non-continuous projection 84 can take a different shape. The transition from the proximal section to the distal section can be gradual, frusto-conical, and non-stepped so as not to define a projection shoulder on the projection. The shape of the frusto-conical projection corresponds to the size of the end of the bore 88. The distal section of the projection 84 is received by the bore 88 but as the diameter of the frusto-conical projection 84 matches the size of the end of the bore 88, the engagement between the projection 84 and the bore 88 stops. In other alternative preferred embodiments, other shapes for the projections and the bores are contemplated to provide the desired amount of engagement.

[0105] Referring to FIGS. 4, 6, 9 and 10, the shape and spacing of the projections 84 and the corresponding bores 88 can vary throughout the first frame half 12a, and within one or more of the first hoop region 18a, the first throat region 22a and the first handle region 20a. Referring to FIGS. 4 and 9, the projections 84 and bores 88 of on first and second throat tubes 42a and 44a of the throat region 22a of the first frame half 12a are primarily configured for facilitating alignment and coupling to a corresponding frame half (such as the second frame half 12b). The projections 84 and bores 88 are preferably corresponding about or with respect to the longitudinal axis 16. The projections 84 of the first throat tube 42a are positioned along one side of the longitudinal axis 16 and the bores of the second throat tube 44a are positioned along the other side of the axis 16. Further, the distance from the axis 16 for each corresponding pair of projections 84 and bores 88, and the spacing of one corresponding pair to the next, is also substantially the same. In alternative preferred embodiments, the projections 84 and bores 88 in the throat region 22a can be staggered or randomly arranged so that some projections, and some bores, are on the first throat tube 42a and others are on the second throat tube 44b provided that the cor-

responding nature of the projections and bores remains. Additionally, in other alternative embodiments, the distance that each corresponding pair of projections and bores is from the longitudinal axis 16, and the spacing between adjacent corresponding pairs of projections and bores, can be varied from one corresponding pair to another corresponding pair. The first and second throat tubes 42a and 44a also include a support rib 98 for increasing the structural integrity of the first and second throat tubes 42a and 44a. The support rib 98 is formed with the first frame half 12a. In other alternative preferred embodiments, the thickness, height, shape, number, orientation and spacing of the support rib can be varied to meet a particular application, player need or other design requirement. In one preferred embodiment, the first and second edges 25 and 26 of the main curved wall 24 over a majority of the first and second throat tubes 42a and 44a extend to lie in a common plane, and the common plane is the same plane as the string plane 54. In other alternative preferred embodiments, the first and second edges 25 and 26 of the first and second throat tubes 42a and 44a can lie in a common plane that is parallel to but spaced apart from the string plane 54.

[0106] Referring to FIGS. 4 and 10, the projections 84 and bores 88 of the handle portion 20a are primarily configured for facilitating alignment and coupling to a corresponding frame half (such as the second frame half 12b). The projections 84 and bores 88 are preferably corresponding about or with respect to the longitudinal axis 16. The projections 84 of the handle region 20a are positioned along one side of the longitudinal axis 16 and the bores along the other side of the axis 16. Further, the distance from the axis 16 for each corresponding pair of projections 84 and bores 88 is also substantially the same. In alternative preferred embodiments, the projections 84 and bores 88 in the handle region 20a can be staggered or randomly arranged so that some projections are on one side of the axis 16 and others are on the other side provided that the corresponding nature of the projections and bores remains. Additionally, in other alternative embodiments, the distance that each corresponding pair of projections and bores is from the longitudinal axis 16 can be varied from one corresponding pair to another corresponding pair. In one preferred embodiment, the first edges 25 of the main curved wall 24 over the first handle region 20a extend to lie in a common plane, and the common plane is the same plane as the string plane 54. In other alternative preferred embodiments, the first and second edges 25 and 26 of the first handle region 20a can lie in a common plane that is parallel to but spaced apart from the string plane 54.

[0107] Referring to FIGS. 4, 6 and 11, the size and shape of the projections 84 and bores 88 of the first hoop region 18a vary about the periphery of the hoop 36. In a preferred embodiment, most of the projections 84 of the hoop region 18a are stepped projections. The shape of projection 84 and of the proximal section 90 of the projection 84 can include a curved bearing surface 130. The

curved bearing surface 130 is preferably configured to extend about the outer periphery of the respective projection 84 so that the curved bearing surface 130 provides surface for supporting and engaging a portion of the racquet string bed 14. In particular, as shown in FIG. 11, the curved bearing surface 130 can support and direct the racquet string as it extends from one cross string segment 52 to another cross string segment 52. The projections 84 and bores 88 of the first hoop region 18a can be sized and shaped into a plurality of different subsets of projections and corresponding bores. The projection 84c and the bore 88c can represent a first subset, and the projections 84d, 84e and 84f and bores 88d, 88e and 88f can define second, third and fourth subsets of projections and bores. Additional subsets of projections and bores are also present on the first hoop region 18a as shown in FIGS. 4 and 6. The number of projections and bores in a single subset can be one projection and one bore, or any number of projection and bores. The curved bearing surface 130 of the proximal section 90 preferably extends over at least 120 degrees of curvature. In a more preferred embodiment, the curved bearing surface 130 extends over at least 180 degrees of curvature. The curved bearing surface 130 preferably generally defines a circular arc having a radius of curvature, r , over a predetermined number of degrees of curvature. The radius r of the circular arc (or the radius of curvature) can vary from one subset of projections to another subset of projections. The radius r of curvature preferably is within a range of 2 mm to 12 mm. The subsets of projections preferably include at least two different radii r of curvature. The set of projections can include at least first and second projections (or at least two subsets of projections) having at least first and second radii of curvature, respectively. In one preferred embodiment, the first radius of curvature is at least 0.5 mm greater than the second radius of curvature. In another preferred embodiment, the set of projections can include at least first, second and third projections having at least first, second and third radii of curvature, respectively. The first, second and third radii of curvature are different from one another. In one particularly preferred embodiment, each of the first, second and third radii of curvature vary in size by at least 0.5 mm. In another preferred embodiment, the curved bearing surfaces 130 of a first subset of projections 84 have a radius of curvature r that falls within a first range of 2 mm to less than or equal to 6 mm, and the curved bearing surfaces 130 of a second subset of projections 84 have a radius of curvature r that falls within the range of greater than 6 mm to 12 mm. In other preferred embodiments, the number of different radii of curvatures r or ranges of radii of curvature can be three or more. The bores 88 corresponding to the projections 84 are sized and shaped accordingly to engage each other.

[0108] The projections 84 are preferably circular, semi-circular or form only portion of a circular arc. In one preferred embodiment, at least two of the projections 84 can have a generally D-shaped transverse cross-sectional

area with respect to the string plane 54. In another preferred embodiments, a majority of the projections 84 have a generally D-shaped transverse cross sectional area. In other preferred embodiments, the projections can have transverse cross sectional shapes with respect to the string plane 54 can take one or more of the following shapes or a combination thereof, circular, semi-circular, elliptical, semi-elliptical, U-shaped, C-shaped, other curved shapes, rectangular, triangular, square, other polygonal shapes, and irregular shapes. When the projection has a shape that is not circular, the string is directed about the periphery of the curved surface and not about a radius of a circle. The size of the radius of curvature of the curved bearing surface 130 of the projection 84, or the distance covered by the curved bearing surfaces that do not include at least part of a circular shape, can be used to define the spacing between adjacent main string segments 52 or adjacent cross string segments 50 of the string bed 14. The spacing between the projections 84 and the bores 88 can also be varied about the periphery of the hoop region 18a to provide the desired pattern and spacing of the string bed 14. The size of the radii of curvature or the curved surface of the curved bearing surfaces 130 of the projections configured to support string segments extending through or near the centre of the hoop 36 may be smaller or the projections may be positioned closer together than the projection 84 at positions away from the centre of the hoop 36. In other preferred embodiments, other radii of curvature and spacing apart of the curved bearing surfaces of the projections about the periphery of the first hoop region can be used to accommodate any desired string bed pattern. The projections 84 that are not also configured for supporting a main or cross string segment 50 or 52 can have any shape, including non-curved shapes. Accordingly, in one preferred embodiment, the projections 84 of the hoop region 12a can have a curved bearing surface, and the projections 84 of the handle regions 20a and/or the throat region 22a can take any shape.

[0109] Referring to FIGS. 7 and 12 through 14, the first and second frame halves 12a and 12b are preferably identical. The frame halves 12a and 12b can be produced separately from the same injection molding apparatus 100. Referring to FIGS. 12 and 13, when the first frame half 12a is positioned with the inner surface 58 of the main curved wall 24 facing the inner curved surface 58 of the second frame half 12b, the corresponding projections 84 and bores 88 align with each other enabling the first frame half 12a to matably engage to second half frame 12b, as shown in FIG. 14. Essentially, the rotation of the second frame half 12b 180 degrees about the longitudinal axis 16 places the projections 84 and bores 88 of the first frame half 12a in alignment with the projections 84 and bores 88 of the second frame half enabling the two frame halves to readily engage each other. The first frame half 12a can be coupled to the second frame half 12b through the engagement of the corresponding projections and bores and through a cyanoacrylate adhe-

sive. In alternative embodiments, the first and second frame halves 12a and 12b can be coupled together through other adhesives, thermal bonding, chemical bonding, and combinations thereof.

[0110] Referring to FIGS. 7 and 12 through 14, the stepped or non-continuous projections 84 of the first and second hoop regions 18a and 18b are configured to engage each other. The shoulder 94 of the stepped projections 84 engage the ends of the curved walls 86 defining the bores 88 to allow for only the distal end section 92 to be received within the bore 88. In one preferred embodiment, as shown in FIGS. 7 and 14, the first hoop region 18a is spaced apart from the second hoop region 18b, while the first and second handle regions 20a and 20b and substantially all of the first and second throat regions 22a and 22b are not spaced apart from each other. Accordingly, there is no channel, groove or holes formed at the coupling location of the first and second handle regions 20a and 20b, and no channel, groove or holes formed at the coupling location about most of the first and second throat regions 22a and 22b. A slight depression or channel may be formed by the coupling of the first and second handle regions 20a and 20b and/or the first and second throat regions 22a and 22b, but the depression or channel would not exceed 0.5 mm in depth under one preferred embodiment. The term "spaced apart" in this context refers to the separation of the first edges 25 and the second edges 26 of the main curved wall 24 of the first and second frame halves 12a and 12b, and can be defined by a projected height *h* of the proximal section 90 of the stepped projections 84. The spacing apart of only the first and second hoop regions 18a and 18b provides the spacing and defines openings where they are desired and eliminates openings where they are not needed or desired (e.g. on the handle portion 20 or the throat portion 22 of the racquet frame 12). The projected height *h* can be measured as the distance between the first edge 25 of the first hoop region 18a to the first edge 25 of the second hoop region 18b. Alternatively, the projected height *h* can be measured from a plane defined by the first and second edges 25 and 26 of either the first or the second hoop region 18a and 18b, wherein the plane is measured with respect to the string plane 54. The plane is preferably parallel to and spaced apart from the string plane 54. The plane defines one reference point and the other is a plane defined by the shoulder 94 of the stepped projection 84. In another preferred embodiment, the projected height, *h*, can be measured as the height of the proximal section 90 of the stepped projection 84 measured in a direction that is perpendicular to the string plane 54. In one preferred embodiment, the projected height *h* is within the range of 1.5 mm to 12 mm. In a particularly preferred embodiment the projected height *h* is within the range of 2 to 6 mm.

[0111] Referring to FIGS. 7 and 14, the spacing apart of the hoop regions 18a and 18b and the proximal sections 90 of the stepped projections 84 define a plurality of openings 96 (or through hoop region openings). The

spacing apart the first and second frame halves 12a and 12b, and/or one or more of the hoop regions 18a and 18b, the handle regions 20a and 20b and the throat regions 22a and 22b can form a channel between the first and second halves or regions. The plurality of openings 96 can be used to accommodate racquet string to form the string bed 14. The curved bearing surfaces 130 of the proximal sections 90 of the stepped projections 84 provide support for the racquet string. The main and cross string segments 50 and 52 of the string bed can be supported by the curved bearing surfaces 130 to allow for formation of the string bed 14. The present invention eliminates the need to drill, punch or otherwise make string holes through the first and second hoop regions 18a and 18b. The present invention also makes the use of grommet strips unnecessary. Accordingly, the present design offers another benefit of eliminating the need for grommet strips and eliminating the need to drill or form string holes into a head portion of a racquet. The drilling or forming of string holes within a racquet frame can introduce stress risers at or near the string holes and can lead to premature failure or reduced durability of the racquet frame. In an alternative preferred embodiment, one or both of the handle regions 20a and 20b and the throat regions 22a and 22b can be spaced apart from each other in a manner similar to the spacing apart of the hoop regions 18a and 18b. In other preferred embodiment, the bores can be defined by openings in a continuous section of material such as a structural foam or a portion of the wall thickness of the frame half. In other preferred embodiments, the projections and bores can be replaced by a hook and loop configuration, a tongue and groove configuration, or other fastening mechanism.

[0112] Referring to FIG. 15a, in an alternative preferred embodiment, the handle regions 20a and 20b can be formed of first and second thermoplastic materials. The first thermoplastic material is used to form the frame including the base layer of the handle region 20a. A second thermoplastic layer 140 can be molded over the base layer of the handle region 20a to form an overmolded handle. The first thermoplastic material has a durometer value measured on the Shore A or Shore D hardness scale that is greater than the durometer value of the second thermoplastic material of the second thermoplastic layer 140 measured on the Shore A or Shore D hardness scale. In other words, the second thermoplastic layer 140 formed of the second thermoplastic material is softer to the touch than the first thermoplastic material of the frame 12. In this configuration, the softer overmolded second thermoplastic layer 140 can be used in place of a conventional grip. Alternatively, a grip (such as the grip 46 of FIG. 1) can be formed over the second thermoplastic layer 140 to provide a softer and more dampened feel to the completed racquet.

[0113] Referring to FIG. 15b, in another alternative preferred embodiment, the handle regions 20a and 20b can be formed first, second and third thermoplastic materials. The first thermoplastic material is used to form the frame

including the base layer of the handle region 20a. A third thermoplastic material that includes a foaming agent is formed over the base layer to form a cushion layer 142. The second thermoplastic layer 140 is can then be molded over the cushion layer 142 and the base layer of the handle region 20a to form a cushioned overmolded handle. The first thermoplastic material has a durometer value measured on the Shore A or Shore D hardness scale that is greater than the durometer value of the second thermoplastic material measured on the Shore A or Shore D hardness scale. Additionally, the first and second thermoplastic materials can have durometer values that are greater (or harder) than the durometer value of the third material.

[0114] Referring to FIGS. 16 and 17, alternative preferred embodiments of the first frame half 12a are shown. The first frame half 12a of FIG. 16 and of FIG. 17 include projections 84 and bores 88 having different shapes and different spacing. The present invention contemplates the use of different quantities of projections and bores, different shapes and sizes of projections and bores and different spacing of the projections and bores. The size, shape and spacing of the bores and the projections can be varied to provide different stringing patterns to the head portion of the racquet, or to provide a slightly different feel. The different configurations can also result in a slight variation in weight, rigidity, torsional stability, or other characteristic.

[0115] Referring to FIG. 18, the head portion 18 of a racquet is shown. The head portion is formed of first and second hoop regions 18a and 18b as a thermoplastic racquet produced in an injection molding operation. In one preferred embodiment, the string bed 14 of the racquet of FIG. 16 is a pattern of crossed strings that are bonded where they cross, and not alternately interlaced like a conventional string bed. The non-interlaced string bed is produced as a one piece structure in an injection molding apparatus. The injection molded string bed can be produced with one of the first or second hoop regions 18a and 18b, or produced as a one piece separate structure that is connected to one or both of the first and second hoop regions 18a and 18b. The racquet string is formed of a high tensile strength, flexible material. In preferred embodiments, the racquet string can be formed of a polyester material, a nylon, a natural gut material and/or a synthetic gut material. In an alternative preferred embodiment, the main string segments or the cross-string segments can be formed as injection molded thermoplastic material and the other of the main string segment or the cross string segments can be interlaced with the molded string segments.

[0116] The present invention provides a cost effective manner of producing a sports racquet having exceptional performance, reliability and durability. The present invention provides greater design flexibility enabling racquets to be produced to meet different applications, and characteristics desired by players of various skill levels, needs and budgets. Sports racquets built in accordance with

the present invention can be produced quickly and cost effectively without negatively effecting performance, feel, durability or playability. The sports racquets built in accordance with the present invention do not require a number of extra components in order to be fully assembled. A separate butt cap, a separate pallet, a separate bumper guard, and one or more grommet strips can all be eliminated under embodiments of the present invention. Additionally, the need to perform extra machining operations to drill string holes into the racquet frame can also be eliminated. The present invention provides these advantages without radically departing from the look and design from traditional sport racquet designs.

[0117] While the preferred embodiments of the invention have been illustrated and described, it will be appreciated that various changes can be made therein. For example, each of the first and second frame halves can be formed as two or more separate injection molded pieces from an injection molding operation that are coupled together to form the completed racquet. One of skill in the art will understand that the invention may also be practiced without many of the details described above. Accordingly, it will be intended to include all such alternatives, modifications and variations set forth within the scope of the appended claims. Further, some well-known structures or functions may not be shown or described in detail because such structures or functions would be known to one skilled in the art. Unless a term is specifically and overtly defined in this specification, the terminology used in the present specification is intended to be interpreted in its broadest reasonable manner, even though may be used conjunction with the description of certain specific embodiments of the present invention.

Claims

1. A sports racquet (10) extending along a longitudinal axis (16) and configured for use with a quantity of racquet string forming a string bed (14) about a string plane (54), the racquet (10) comprising:

a frame (12) formed of a thermoplastic material, the frame (12) including first and second halves (12a, 12b), the first and second halves including first and second spaced apart hoop regions (18a, 18b), and first and second handle regions (20a, 20b), respectively, at least one of the first and second hoop regions (18a, 18b) including a set of projections (84) extending from at least one of the first and second hoop regions (18a, 18b) in a direction orthogonal to the string plane (54), at least one of the first and second hoop regions (18a, 18b) defining a set of bores (88), the set of projections (84) being configured to matably engage the set of bores (88), the set of projections (84) extending through the string plane (54) and defining curved bearing surfaces

- (130) configured for engaging and supporting the racquet string (50, 52), the set of projections (84) including at least first and second projections having curved bearing surfaces (130) with at least first and second radii of curvature, respectively, the first radius of curvature being greater than the second radius of curvature, wherein when the first and second frame halves (12a, 12b) are engaged the set of projections (84) are unevenly spaced apart from each other about the periphery of the engaged first and second hoop regions (18a, 18b).
2. The sports racquet (10) of claim 1, wherein the thermoplastic material includes a thermoplastic resin and a plurality of fiber segments.
 3. The sports racquet (10) of claim 1 or 2, wherein the set of projections (84) include at least first, second and third projections having at least first, second and third radii of curvature, respectively, and wherein the first, second and third radii of curvature are different from one another.
 4. The sports racquet (10) of claim 1, 2 or 3, wherein the first and second frame halves (12a, 12b) include first and second throat regions (22a, 22b), respectively.
 5. The sports racquet (10) of any preceding claim, wherein the first and second frame halves (12a, 12b) are substantially identical to each other.
 6. The sports racquet (10) of any preceding claim, wherein the first and second frame halves (12a, 12b) are coupled together by an adhesive, thermal bonding, chemical bonding, thermal welding, sonic welding, and combinations thereof.
 7. The sports racquet (10) of any preceding claim, wherein, when the first and second frame halves (12a, 12b) are engaged, the set of projections (84) are spaced apart from each other about the periphery of the engaged first and second hoop regions (18a, 18b), and wherein the spaced apart projections define openings (96) for receiving the racquet string.
 8. The sports racquet (10) of any preceding claim, wherein each of the first and second handle regions (20a, 20b) includes a plurality of structural support members (80).
 9. The sports racquet (10) of any preceding claim, wherein the first and second handle regions (20a, 20b) include first and second proximal ends (64a, 64b) respectively, wherein the transverse cross-sectional area of the handle portion (20) at the first and second proximal ends (64a, 64b) is greater than the transverse cross-sectional area at other locations along the handle portion (20), and wherein the first and second proximal ends (64a, 64b) form a butt end wall (70a, 70b) of the racquet, and wherein the first and second proximal ends (64a, 64b) and the butt end wall (70a, 70b) are shaped in the form of a butt cap.
 10. The sports racquet (10) of any preceding claim, wherein the first and second hoop regions (18a, 18b) include a distal end area (28), and wherein the wall thickness of the first and second hoop regions (18a, 18b) at the distal end area (28) is greater than other locations of the first and second hoop regions (18a, 18b) such that the distal end area (28) forms a raised bumper guard.
 11. The sports racquet (10) of any preceding claim, wherein the first and second hoop regions (18a, 18b) have a wall thickness within the range of 0.8 to 3.0 mm.
 12. The sports racquet (10) of any preceding claim, wherein the first and second hoop regions (18a, 18b) are spaced apart by a distance measured with respect to a plane perpendicular to the string plane (54) within the range of 2.0 to 12.0 mm.
 13. The sports racquet (10) of any preceding claim, wherein at least two of the set of projections (84) define a cross-sectional area when measured with respect to the string plane (54) that is selected from the group consisting of semi-circular, elliptical, semi-elliptical, D-shaped, U-shaped, C-shaped, other non-circular curved shapes and combinations thereof.
 14. The sports racquet (10) of any preceding claim, wherein the first radius of curvature is at least 0.5 mm greater than the second radius of curvature, the curved bearing surfaces of the set of projections having a radius of curvature within the range of greater than 2.0 to 12.0 mm.

Patentansprüche

1. Sportschläger (10), der sich entlang einer Längsachse (16) erstreckt und zur Verwendung mit einer Anzahl von Schläger-Saiten ausgebildet ist, die ein Saitenbett (14) um eine Saitenebene (54) formen, wobei der Schläger (10) Folgendes umfasst:

ein Gestell (12), das aus thermoplastischem Material besteht, wobei das Gestell (12) eine erste und zweite Hälfte (12a, 12b) umfasst, wobei die erste und zweite Hälfte jeweils einen ersten und zweiten Reifenbereich (18a, 18b), die

- voneinander beabstandet sind, und einen ersten und zweiten Griffbereich (20a, 20b) umfassen, wobei zumindest der erste oder der zweite Reifenbereich (18a, 18b) einen Satz von Vorsprüngen (84) aufweist, die sich zumindest von dem ersten oder zweiten Reifenbereich (18a, 18b) in einer zur Saitenebene (54) orthogonalen Richtung erstrecken, wobei zumindest der erste oder der zweite Reifenbereich (18a, 18b) einen Satz von Bohrungen (88) definiert, wobei der Satz von Vorsprüngen (84) ausgebildet ist, um in dem Satz von Bohrungen (88) passend einzugreifen, wobei der Satz von Vorsprüngen (84) sich durch die Saitenebene (54) erstreckt und gekrümmte Auflageflächen (130) definiert, die zum Ergreifen und Tragen der Schläger-Saite (50, 52) ausgebildet sind, wobei der Satz von Vorsprüngen (84) jeweils zumindest erste und zweite Vorsprünge umfasst, die gekrümmte Auflageflächen (130) aufweisen, mit jeweils mindestens ersten und zweiten Krümmungsradien, wobei der erste Krümmungsradius größer ist als der zweite Krümmungsradius, wobei, wenn die erste und zweite Gestellhälfte (12a, 12b) verbunden sind, der Satz von Vorsprüngen (84) unregelmäßig voneinander beabstandet um den Umfang des ersten und zweiten Reifenbereiches (18a, 18b) angeordnet ist.
2. Sportschläger (10) nach Anspruch 1, wobei das thermoplastische Material einen thermoplastischen Harz und eine Mehrzahl von Faserabschnitten umfasst.
 3. Sportschläger (10) nach Anspruch 1 oder 2, wobei der Satz von Vorsprüngen (84) zumindest einen ersten, zweiten und dritten Vorsprung umfasst, die jeweils einen ersten, zweiten und dritten Krümmungsradius aufweisen, und wobei der erste, zweite und dritte Krümmungsradius voneinander unterschiedlich sind.
 4. Sportschläger (10) nach Anspruch 1, 2 oder 3, wobei die erste und zweite Gestellhälfte (12a, 12b) jeweils einen ersten und zweiten Halsbereich (22a, 22b) umfassen.
 5. Sportschläger (10) nach einem der vorhergehenden Ansprüche, wobei die erste und zweite Gestellhälfte (12a, 12b) im Wesentlichen zueinander identisch sind.
 6. Sportschläger (10) nach einem der vorhergehenden Ansprüche, wobei die erste und zweite Gestellhälfte (12a, 12b) durch Kleben, thermische Verbindung, chemische Verbindung, thermisches Schweißen, Ultraschall-Schweißen und Kombinationen davon verbunden sind.
 7. Sportschläger (10) nach einem der vorhergehenden Ansprüche, wobei, wenn die erste und zweite Gestellhälfte (12a, 12b) verbunden sind, der Satz Vorsprünge (84) voneinander beabstandet um den Umfang des ersten und zweiten verbundenen Reifenbereiches (18a, 18b) angeordnet ist, und wobei die beabstandeten Vorsprünge zum Aufnehmen der Schläger-Saite Öffnungen (96) definieren.
 8. Sportschläger (10) nach einem der vorhergehenden Ansprüche, wobei jeder des ersten und zweiten Griffbereiches (20a, 20b) eine Mehrzahl von strukturellen Trägergliedern (80) umfasst.
 9. Sportschläger (10) nach einem der vorhergehenden Ansprüche, wobei der erste und zweite Griffbereich (20a, 20b) jeweils ein erstes und zweites proximales Ende (64a, 64b) umfassen, wobei die quergerichtete Querschnittfläche des Griffteils (20) am ersten und zweiten proximalen Ende (64a, 64b) größer ist als die quergerichtete Querschnittfläche an anderen Stellen entlang des Griffbereiches (20), und wobei das erste und zweite proximale Ende (64a, 64b) eine Griffendwand (70a, 70b) des Schlägers formen, und wobei das erste und zweite proximale Ende (64a, 64b) und die Griffendwand (70a, 70b) die Gestalt einer Abschlusskappe aufweisen.
 10. Sportschläger (10) nach einem der vorhergehenden Ansprüche, wobei der erste und zweite Reifenbereich (18a, 18b) einen distalen Endbereich (28) umfassen, und wobei die Wandstärke des ersten und zweiten Reifenbereiches (18a, 18b) im distalen Endbereich (28) größer ist als an anderen Stellen des ersten und zweiten Reifenbereiches (18a, 18b), so dass der distale Endbereich (28) einen erhabenen Pufferschutz gestaltet.
 11. Sportschläger (10) nach einem der vorhergehenden Ansprüche, wobei der erste und zweite Reifenbereich (18a, 18b) eine Wandstärke zwischen 0,8 und 3,0 mm aufweisen.
 12. Sportschläger (10) nach einem der vorhergehenden Ansprüche, wobei der erste und zweite Reifenbereich (18a, 18b) voneinander beabstandet sind, wobei der Abstand, gemessen mit Bezug auf einer zur Saitenebene (54) senkrechten Ebene, zwischen 2,0 und 12,0 mm beträgt.
 13. Sportschläger (10) nach einem der vorhergehenden Ansprüche, wobei zumindest zwei des Satzes von Vorsprüngen (84) eine Querschnittsfläche definieren, mit Bezug auf die Saitenebene (54) gemessen, die aus der Gruppe von halbkreisförmigen, elliptischen, halb-elliptischen, D-förmigen, U-förmigen, C-förmigen, anderen nicht kreisförmig gekrümmten Formen und Kombinationen davon ausgewählt wird.

14. Sportschläger (10) nach einem der vorhergehenden Ansprüche, wobei der erste Krümmungsradius zu-
mindest 0,5 mm größer ist als der zweite Krü-
mmungsradius, wobei die gekrümmten Auflageflä-
chen des Vorsprungssatzes einen Krümmungsradi-
us zwischen größer als 2,0 und 12,0 mm aufweisen.

Revendications

1. Raquette de sport (10) s'étendant le long d'un axe longitudinal (16) et configurée pour une utilisation avec une quantité de cordage de raquette formant un tamis de raquette (14) autour d'un plan de cor-
dage (54), la raquette (10) comprenant :

un cadre (12) formé en un matériau thermoplas-
tique, le cadre (12) comprenant des première et
deuxième moitiés (12a, 12b), les première et
deuxième moitiés comprenant des première et
deuxième régions d'arceau (18a, 18b) espa-
cées l'une de l'autre, et des première et deuxiè-
me régions de poignée (20a, 20b), respective-
ment, au moins une parmi les première et
deuxième régions d'arceau (18a, 18b) compren-
nant une série de saillies (84) s'étendant à partir
d'au moins une parmi les première et deuxième
régions d'arceau (18a, 18b) dans une direction
orthogonale par rapport au plan de cordage (54),
au moins une parmi les première et deuxième
régions d'arceau (18a, 18b) définissant une sé-
rie d'alésages (88), la série de saillies (84) étant
configurées pour venir en prise de manière ap-
pariée avec la série d'alésages (88), la série de
saillies (84) s'étendant à travers le plan de cor-
dage (54) et définissant des surfaces d'appui
courbes (130) configurées pour venir en prise
et supporter le cordage de raquette (50, 52), la
série de saillies (84) comprenant au moins des
première et deuxième saillies présentant des
surfaces d'appui courbes (130) avec au moins
des premier et deuxième rayons de courbure,
respectivement, le premier rayon de courbure
étant supérieur au deuxième rayon de courbure,
dans laquelle, lorsque les première et deuxième
moitiés de cadre (12a, 12b) sont en prise, la sé-
rie de saillies (84) sont espacées de manière
irrégulière les unes par rapport aux autres
autour de la périphérie des première et deuxiè-
me régions d'arceau (18a, 18b) mises en prise.

2. Raquette de sport (10) selon la revendication 1, dans laquelle le matériau thermoplastique comprend une résine thermoplastique et une pluralité de segments de fibre.
3. Raquette de sport (10) selon la revendication 1 ou 2, dans laquelle la série de saillies (84) comprennent

au moins des première, deuxième et troisième saillies présentant au moins des premier, deuxième et troisième rayons de courbure, respectivement, et dans laquelle les premier, deuxième et troisième rayons de courbure sont différents les uns et des autres.

4. Raquette de sport (10) selon la revendication 1, 2 ou 3, dans laquelle les première et deuxième moitiés de cadre (12a, 12b) comprennent des première et deuxième régions de coeur (22a, 22b), respective-
ment.

5. Raquette de sport (10) selon l'une quelconque des revendications précédentes, dans laquelle les pre-
mière et deuxième moitiés de cadre (12a, 12b) sont essentiellement identiques l'une à l'autre.

6. Raquette de sport (10) selon l'une quelconque des revendications précédentes, dans laquelle les pre-
mière et deuxième moitiés de cadre (12a, 12b) sont couplées ensemble grâce à une substance adhési-
ve, une liaison thermique, une liaison chimique, une soudure thermique, une soudure sonique, et des combinaisons de celles-ci.

7. Raquette de sport (10) selon l'une quelconque des revendications précédentes, dans laquelle, lorsque les première et deuxième moitiés de cadre (12a, 12b) sont en prise, la série de saillies (84) sont es-
pacées les unes des autres autour de la périphérie des première et deuxième régions d'arceau (18a, 18b) mises en prise, et dans laquelle les saillies es-
pacées les unes des autres définissent des ouver-
tures (96) permettant d'accueillir le cordage de ra-
quette.

8. Raquette de sport (10) selon l'une quelconque des revendications précédentes, dans laquelle chacune parmi les première et deuxième régions de poignée (20a, 20b) comprend une pluralité d'éléments de support structurels (80).

9. Raquette de sport (10) selon l'une quelconque des revendications précédentes, dans laquelle les pre-
mière et deuxième régions de poignée (20a, 20b) comprennent des première et deuxième extrémités proximales (64a, 64b), respectivement, dans laquel-
le la surface en coupe transversale de la partie poi-
gnée (20) au niveau des première et deuxième ex-
trémités proximales (64a, 64b) est supérieure à la surface en coupe transversale au niveau d'autres emplacements le long de la partie poignée (20), et dans laquelle les première et deuxième extrémités proximales (64a, 64b) forment une paroi de talon (70a, 70b) de la raquette, et dans laquelle les pre-
mière et deuxième extrémités proximales (64a, 64b) et la paroi de talon (70a, 70b) sont réalisées sous la

forme d'une embase.

10. Raquette de sport (10) selon l'une quelconque des revendications précédentes, dans laquelle les première et deuxième régions d'arceau (18a, 18b) comprennent une zone d'extrémité distale (28), et dans laquelle l'épaisseur de paroi des première et deuxième régions d'arceau (18a, 18b) au niveau de la zone d'extrémité distale (28) est plus grande qu'au niveau d'autres emplacements des première et deuxième régions d'arceau (18a, 18b) de telle manière que la zone d'extrémité distale (28) forme une bande de protection surélevée.

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11. Raquette de sport (10) selon l'une quelconque des revendications précédentes, dans laquelle les première et deuxième régions d'arceau (18a, 18b) présentent une épaisseur de paroi comprise dans la plage de 0,8 à 3,0 mm.

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12. Raquette de sport (10) selon l'une quelconque des revendications précédentes, dans laquelle les première et deuxième régions d'arceau (18a, 18b) sont espacées l'une de l'autre d'une distance, mesurée par rapport à un plan perpendiculaire au plan de cordage (54), comprise dans la plage de 2,0 à 12,0 mm.

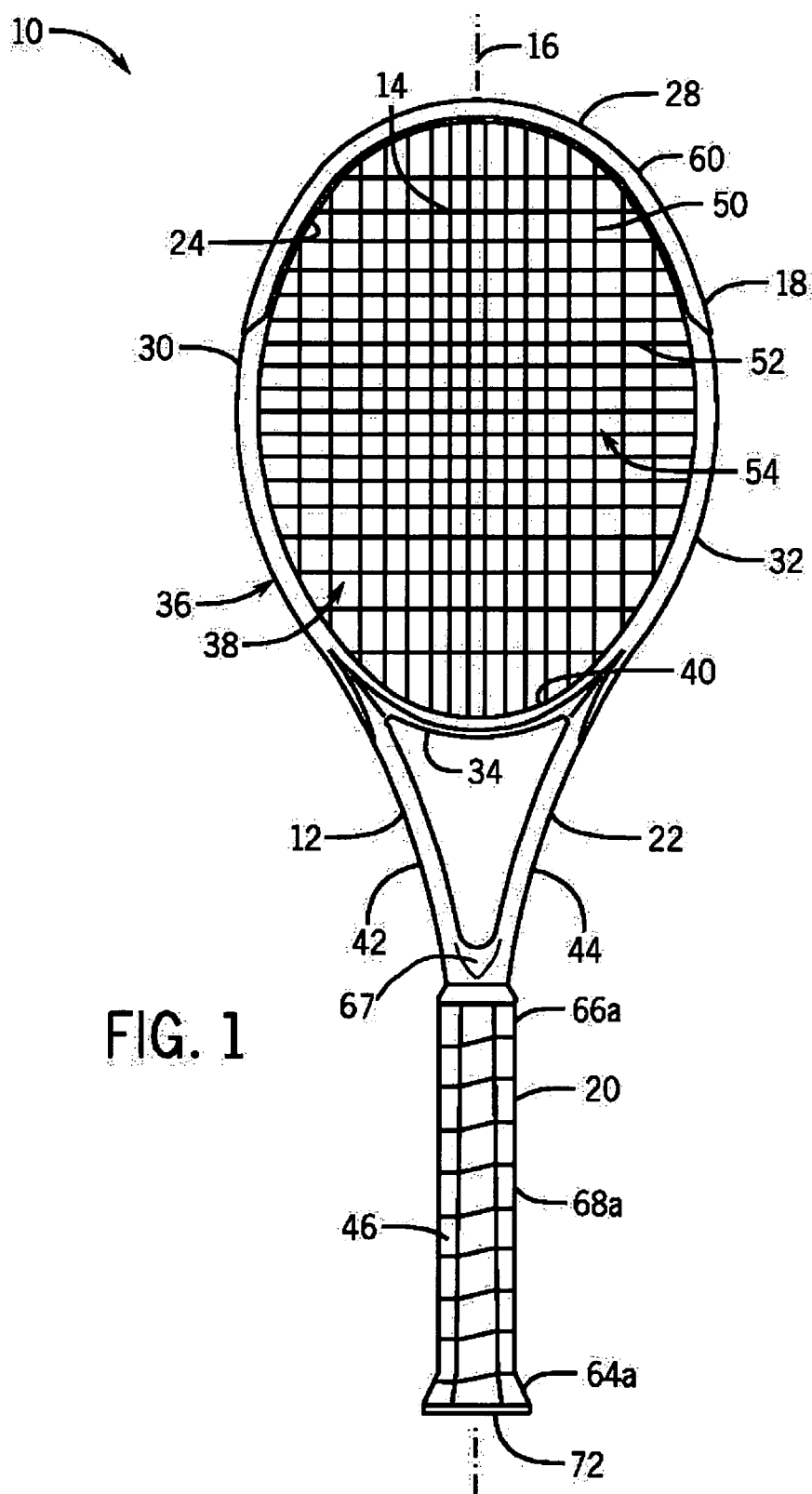
25
13. Raquette de sport (10) selon l'une quelconque des revendications précédentes, dans laquelle au moins deux parmi la série de saillies (84) définissent une surface en coupe transversale, mesurée par rapport au plan de cordage (54), qui est sélectionnée parmi le groupe constitué des formes semi-circulaires, elliptiques, semi-elliptiques, en forme de D, en forme de U, en forme de C, d'autres formes courbes non circulaires et des combinaisons de celles-ci.

30
35
14. Raquette de sport (10) selon l'une quelconque des revendications précédentes, dans laquelle le premier rayon de courbure est supérieur d'au moins 0,5 mm au deuxième rayon de courbure, les surfaces d'appui courbes de la série de saillies présentant un rayon de courbure compris dans la plage de plus de 2,0 à 12,0 mm.

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45

50

55



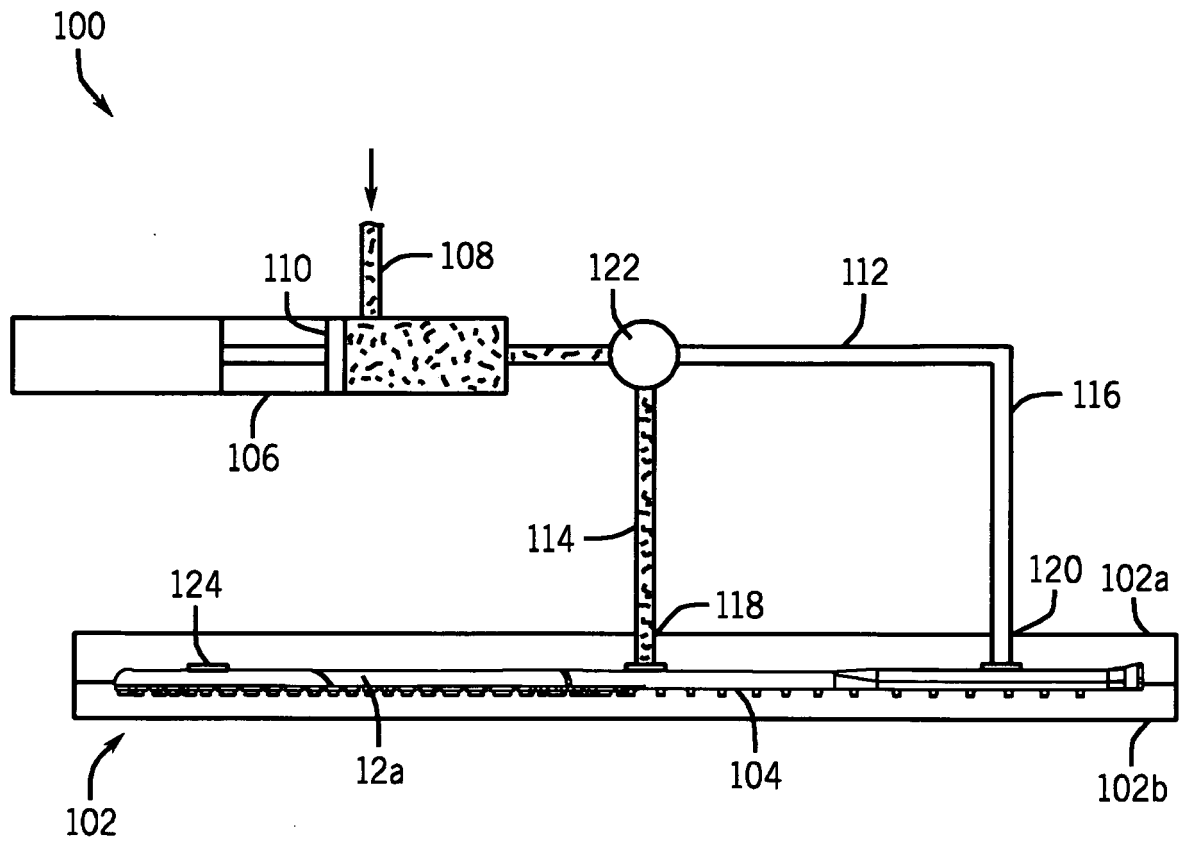


FIG. 2

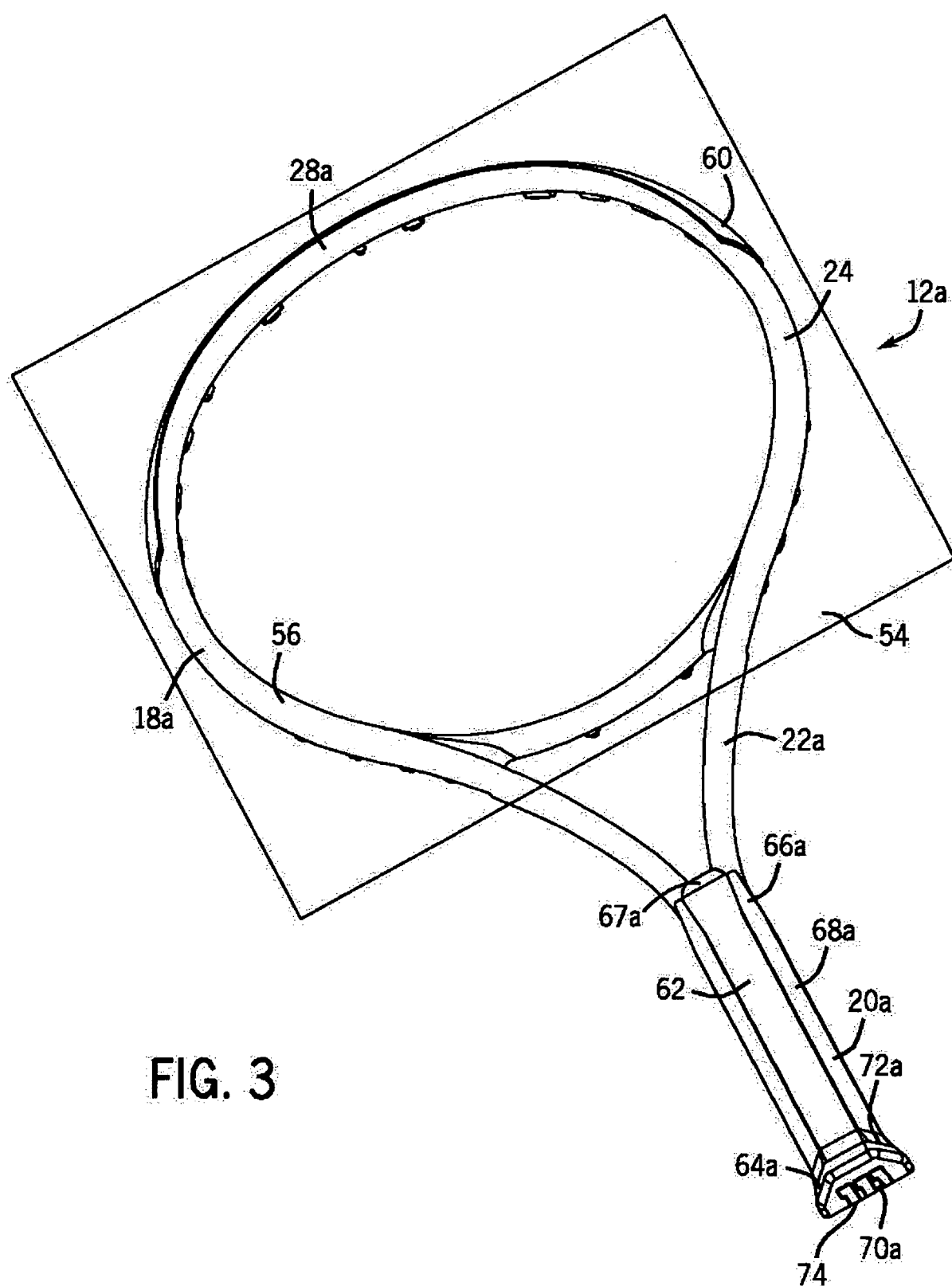
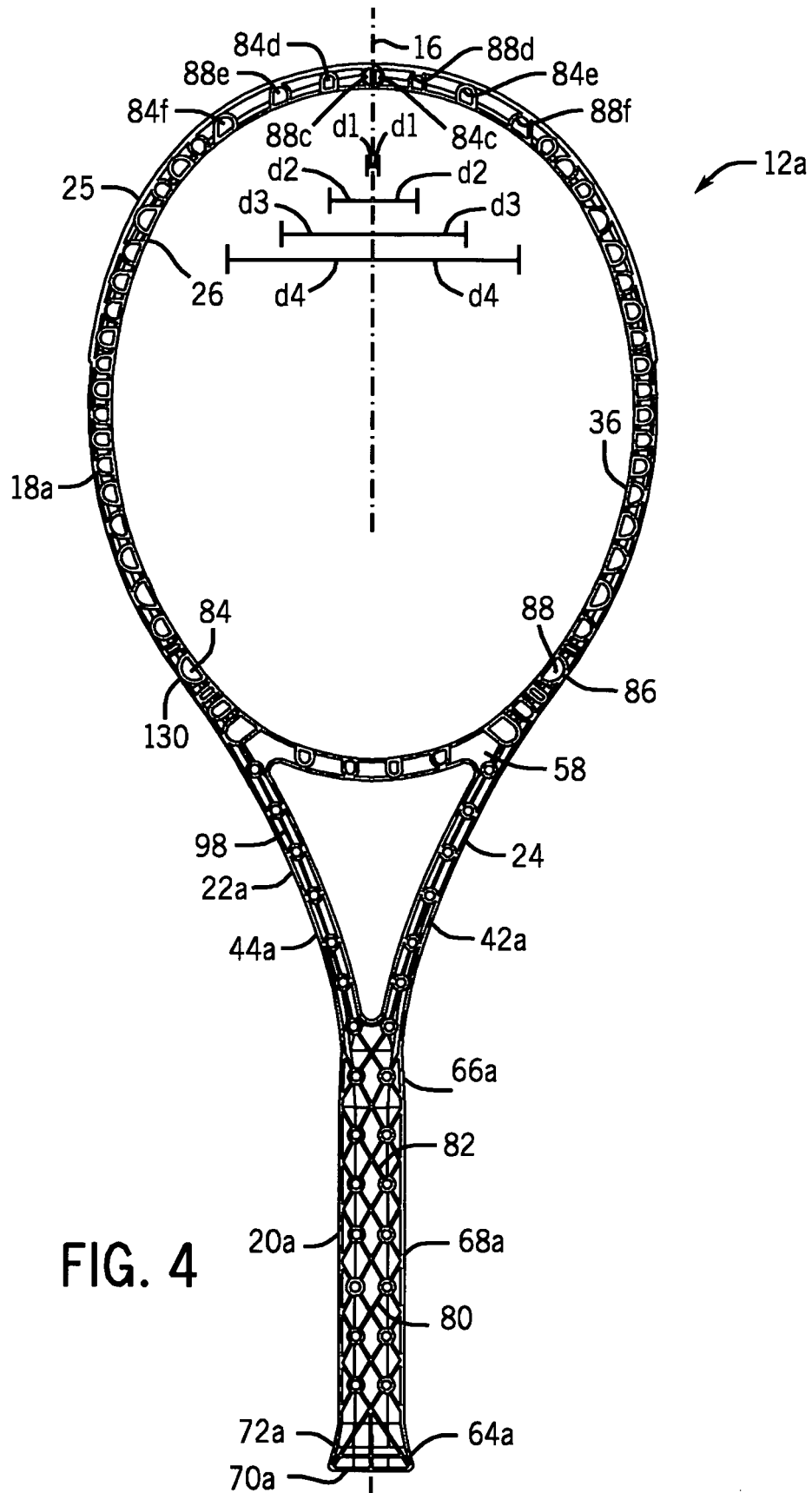
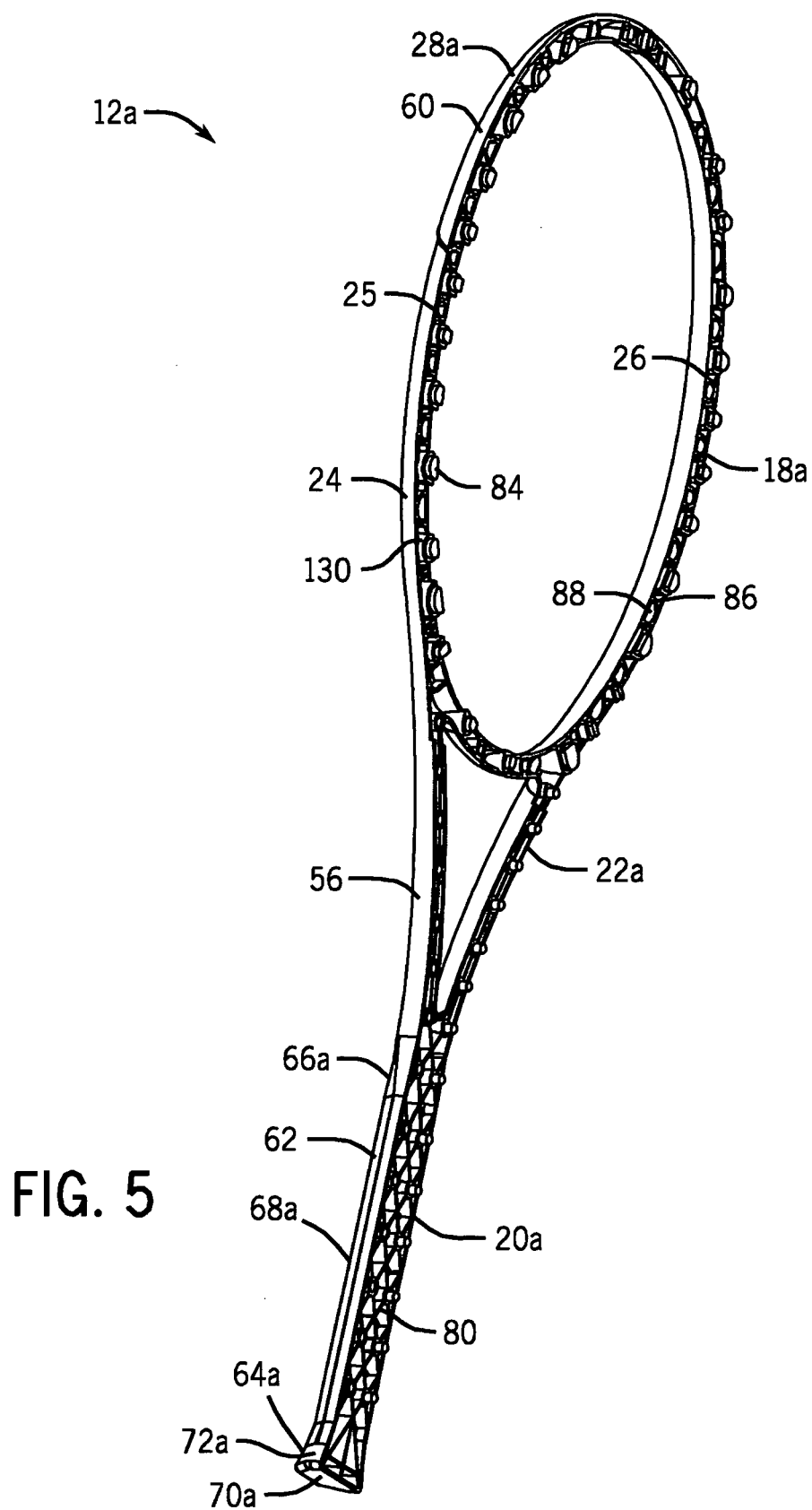


FIG. 3





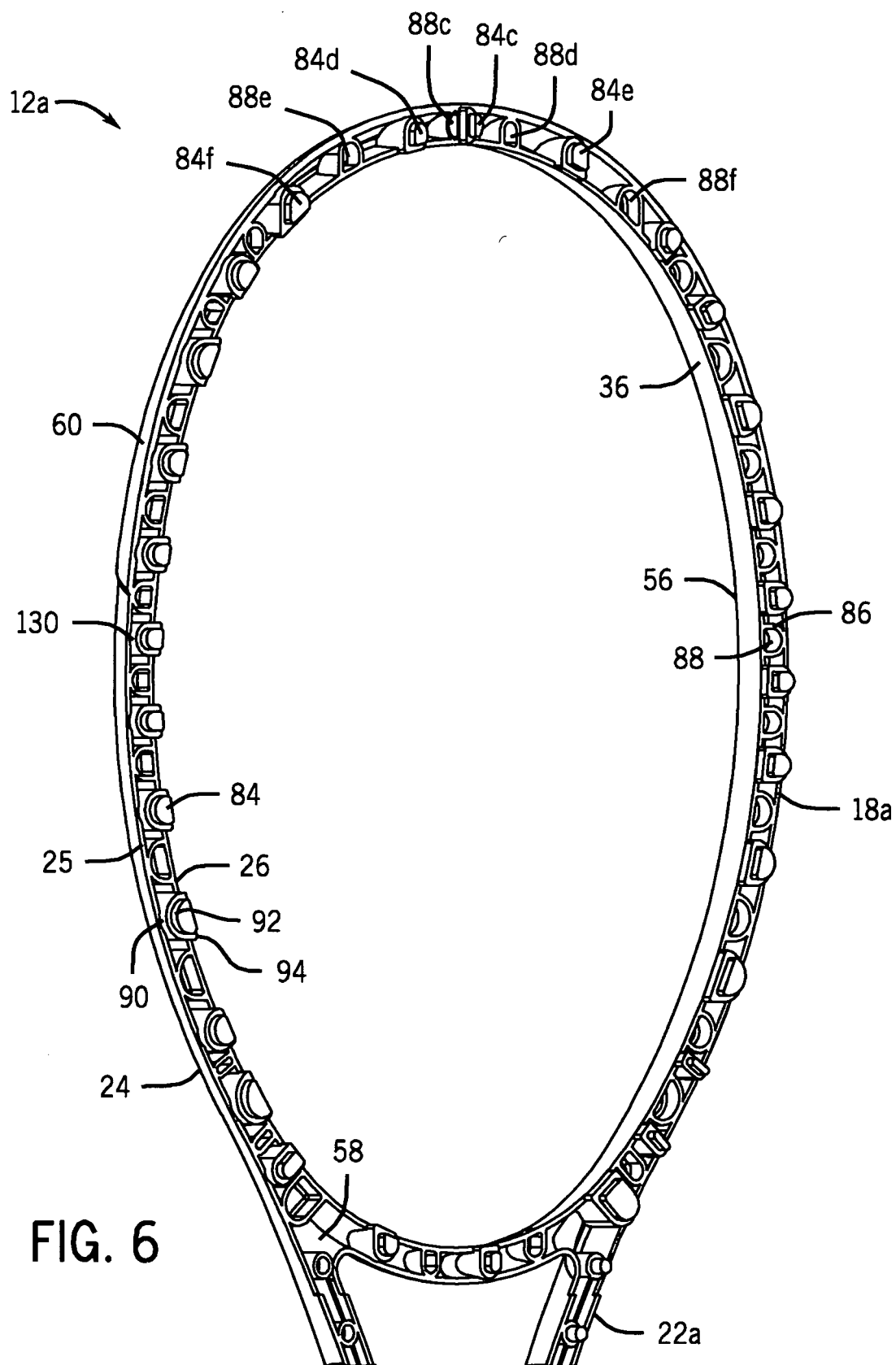


FIG. 6

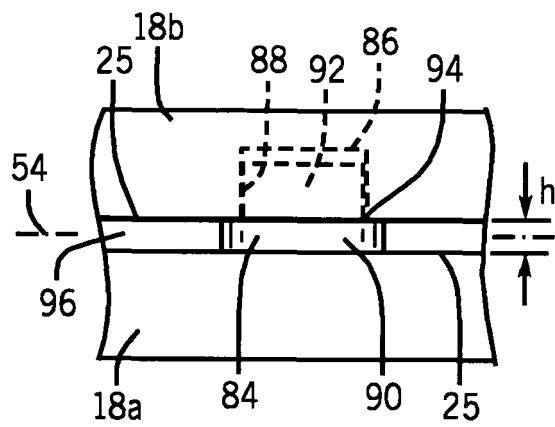


FIG. 7

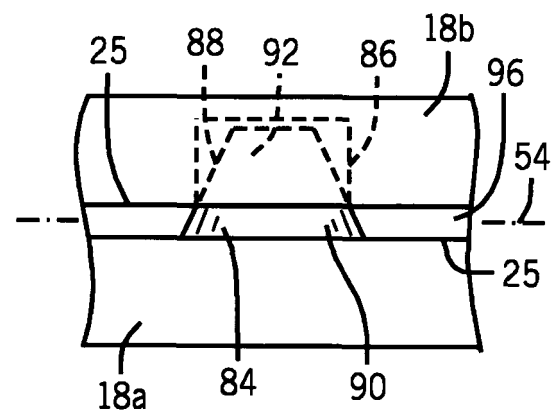


FIG. 8

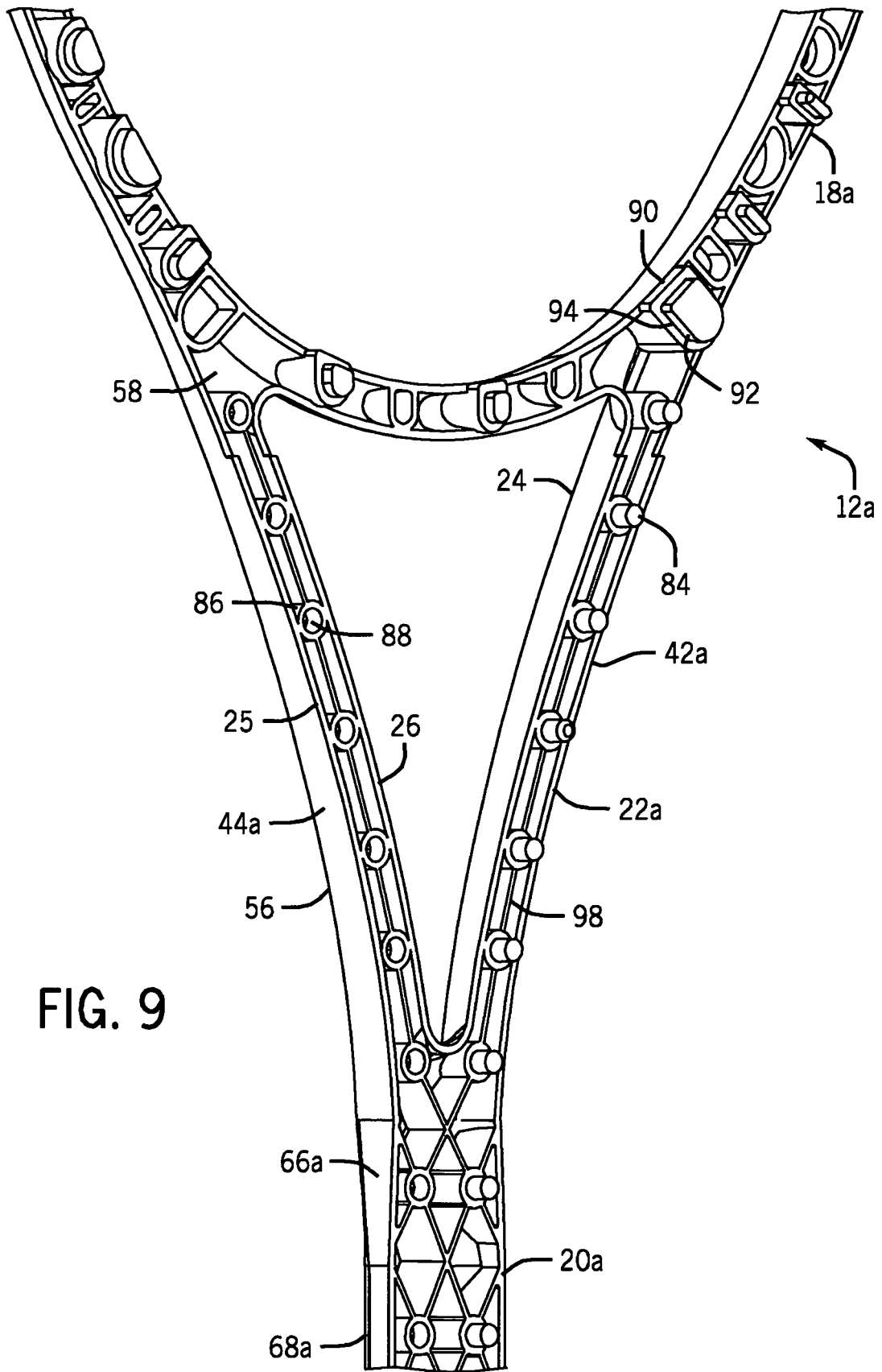
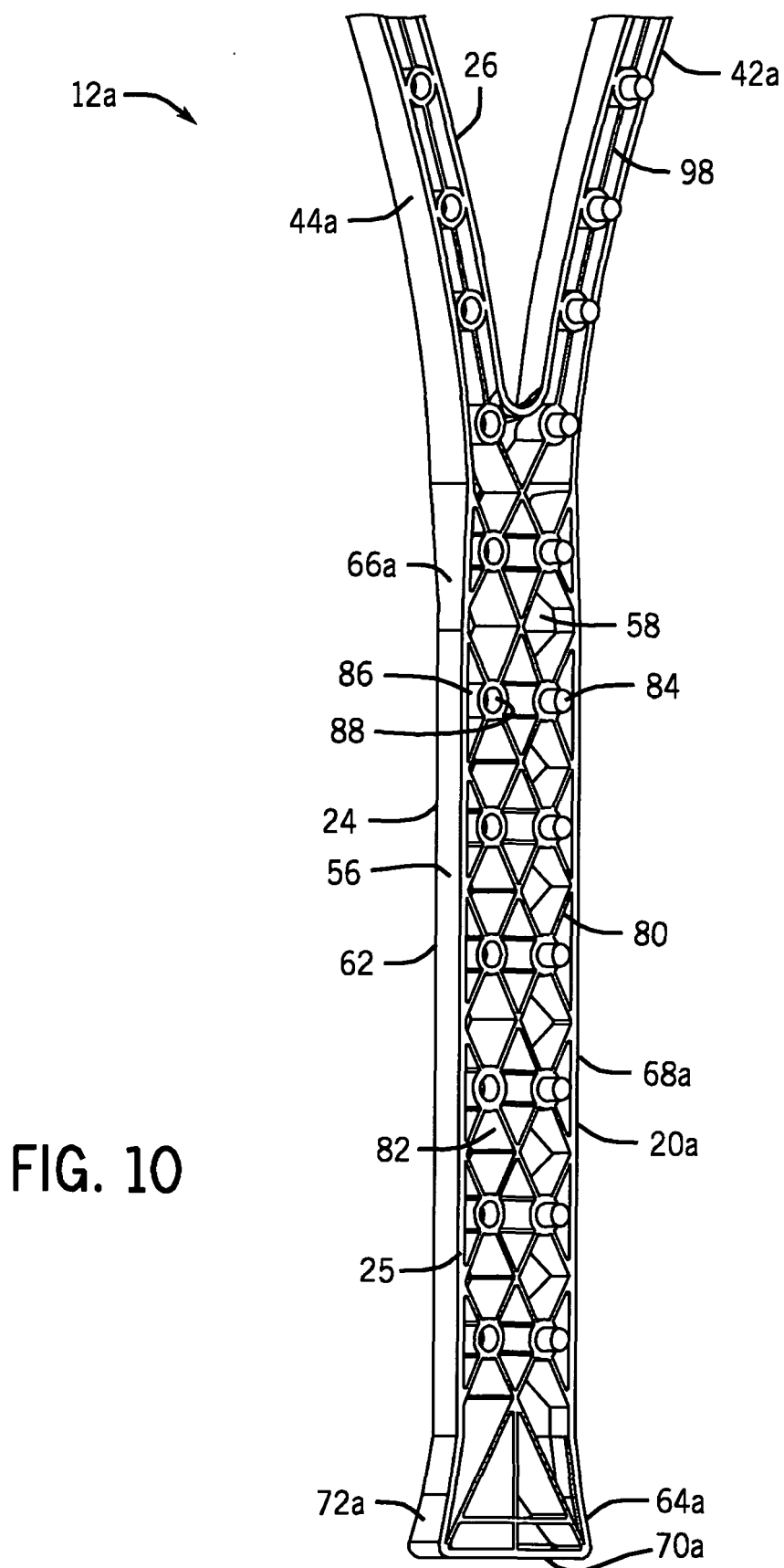


FIG. 9



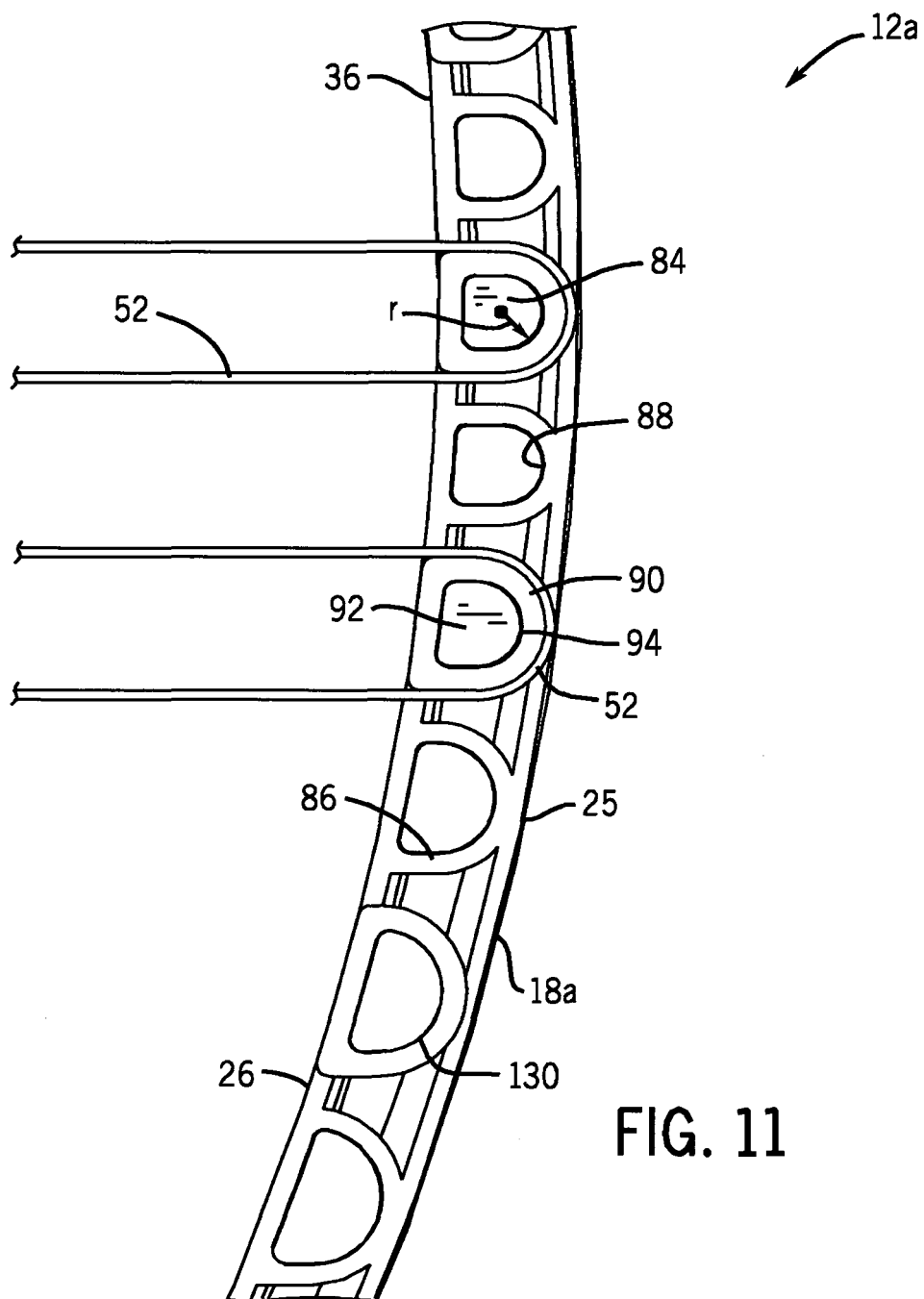


FIG. 11

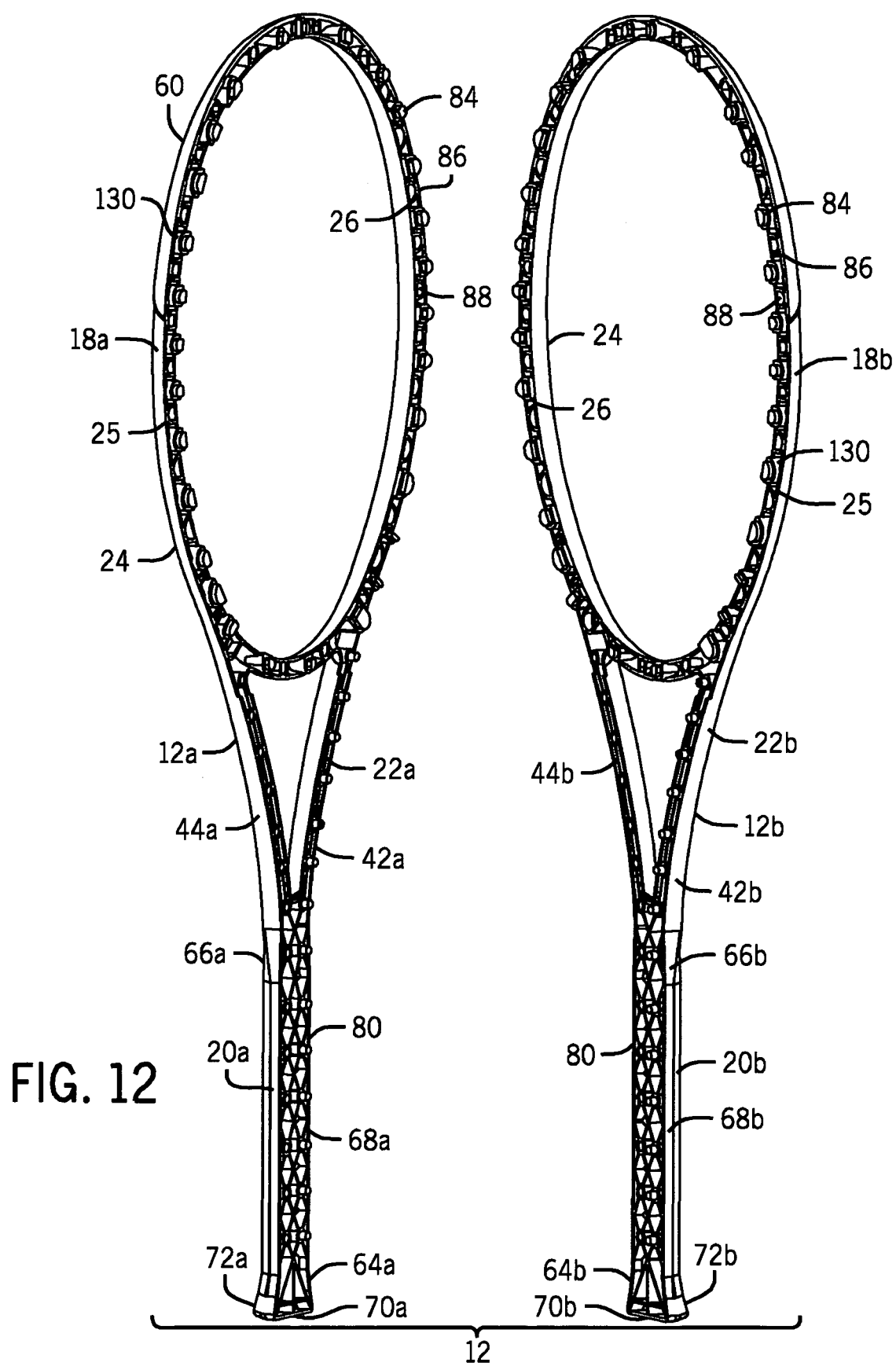


FIG. 13

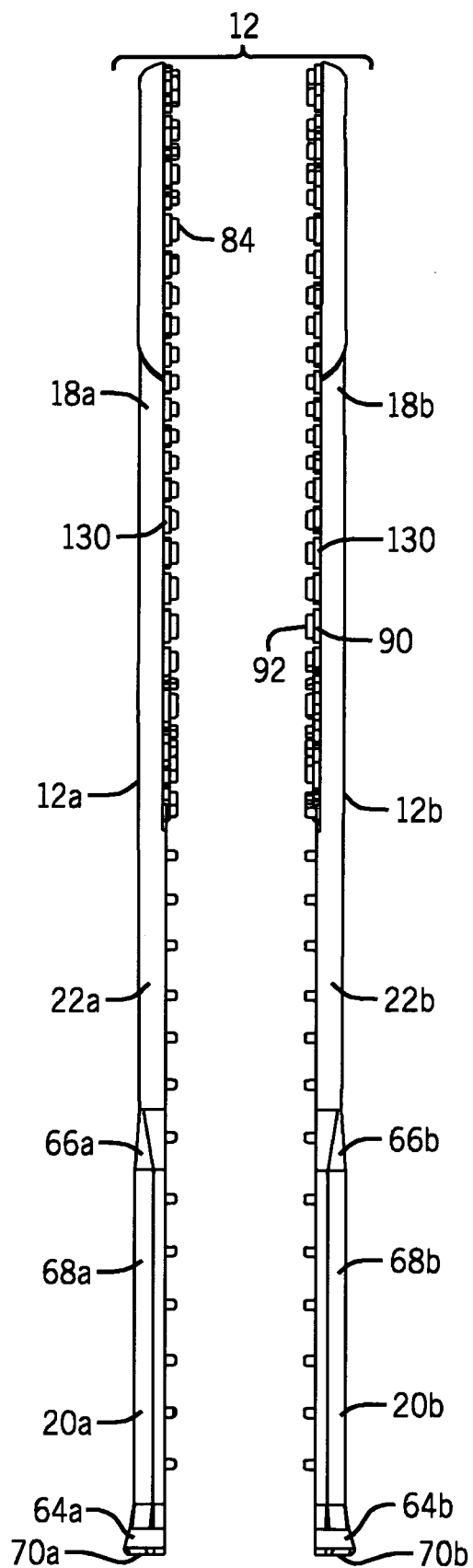
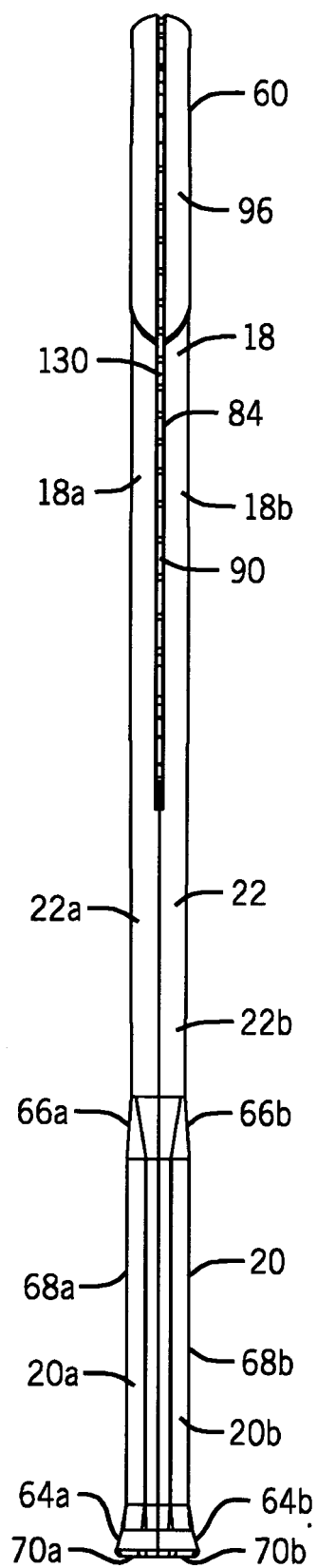


FIG. 14



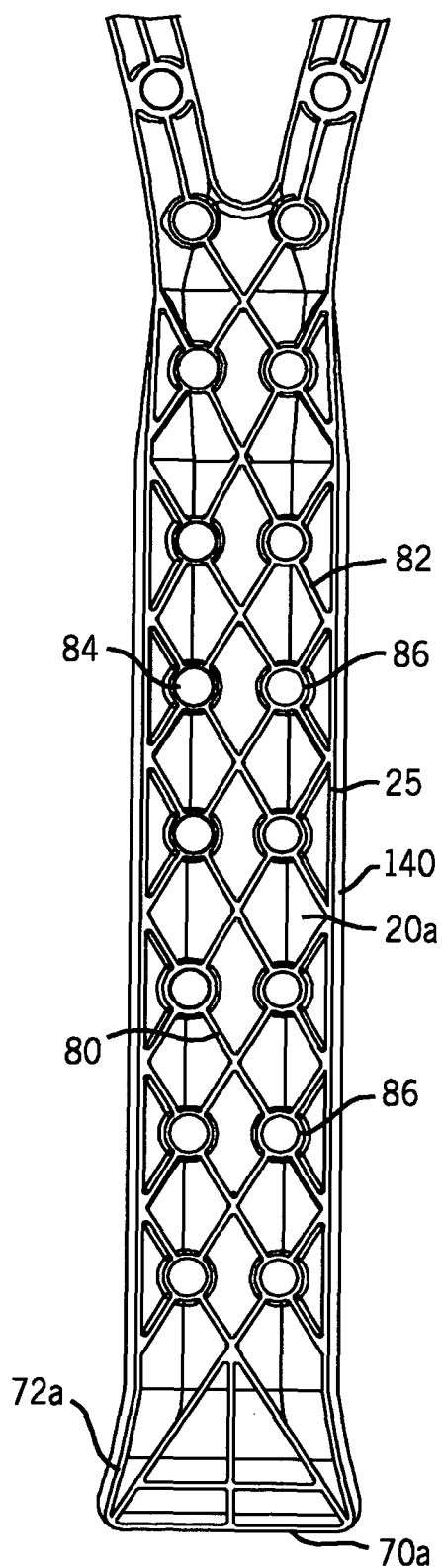


FIG. 15a

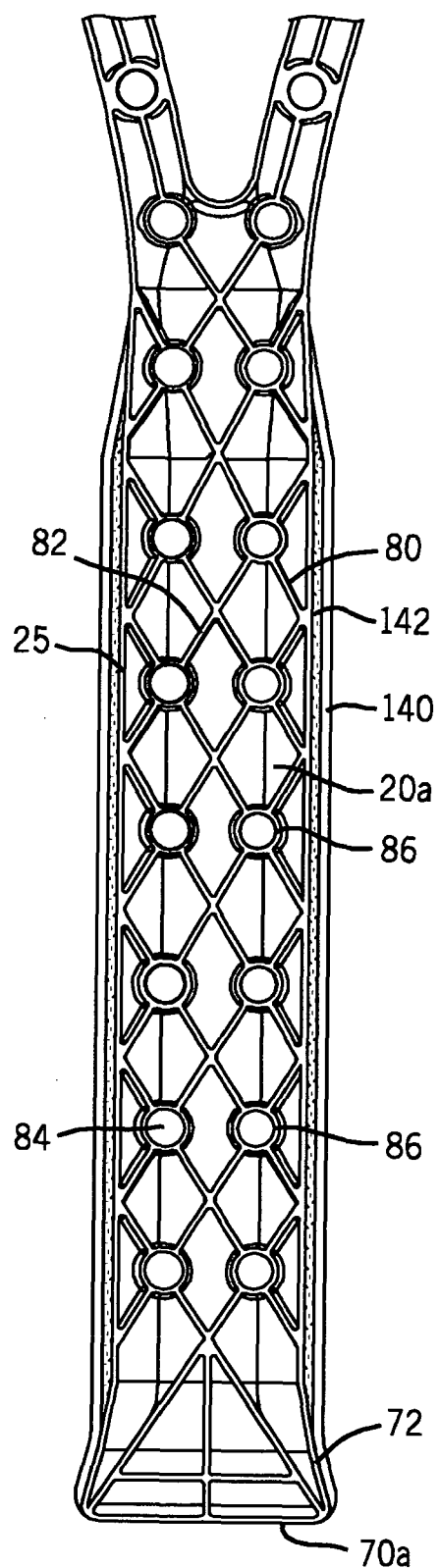


FIG. 15b

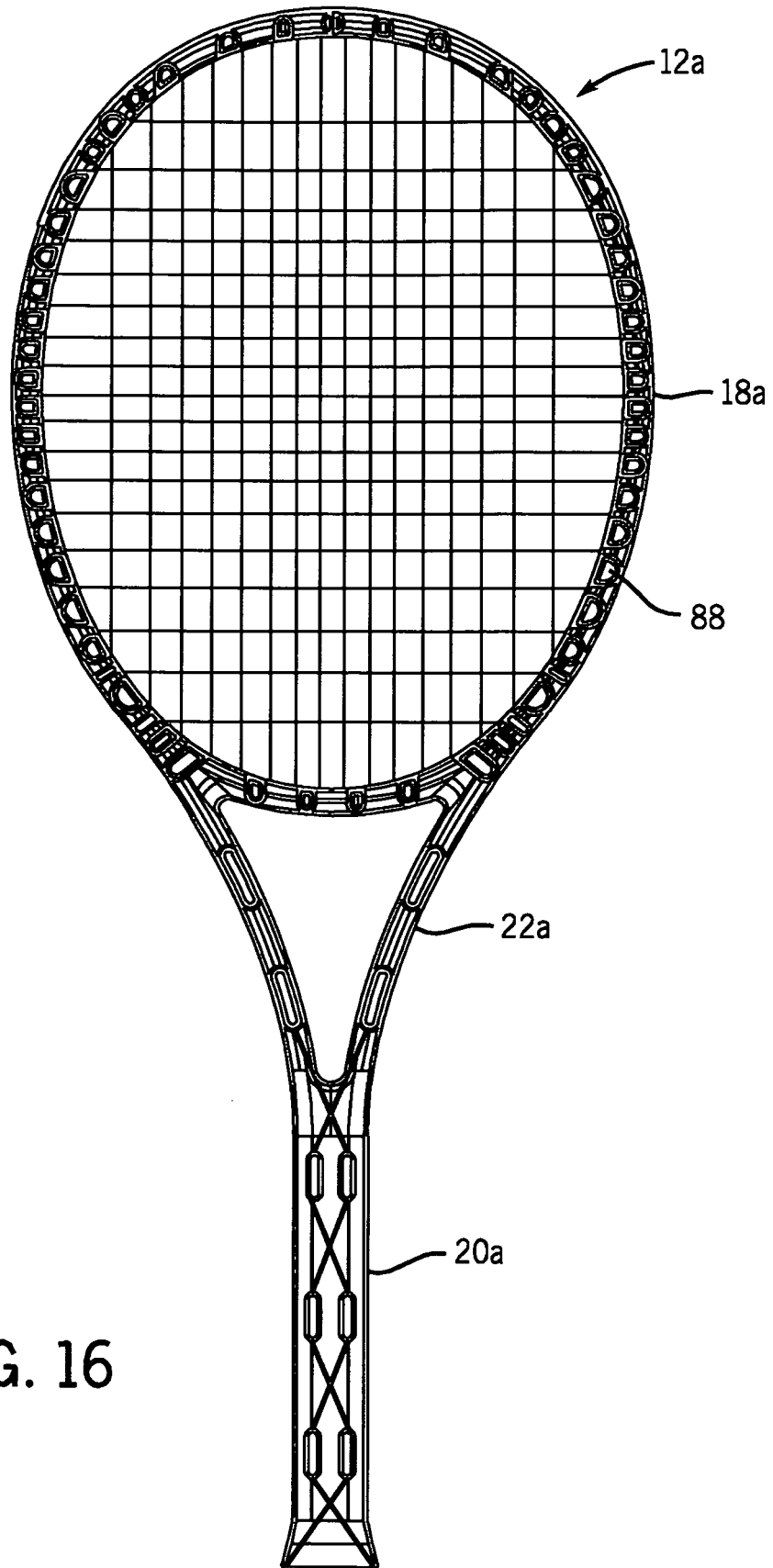


FIG. 16

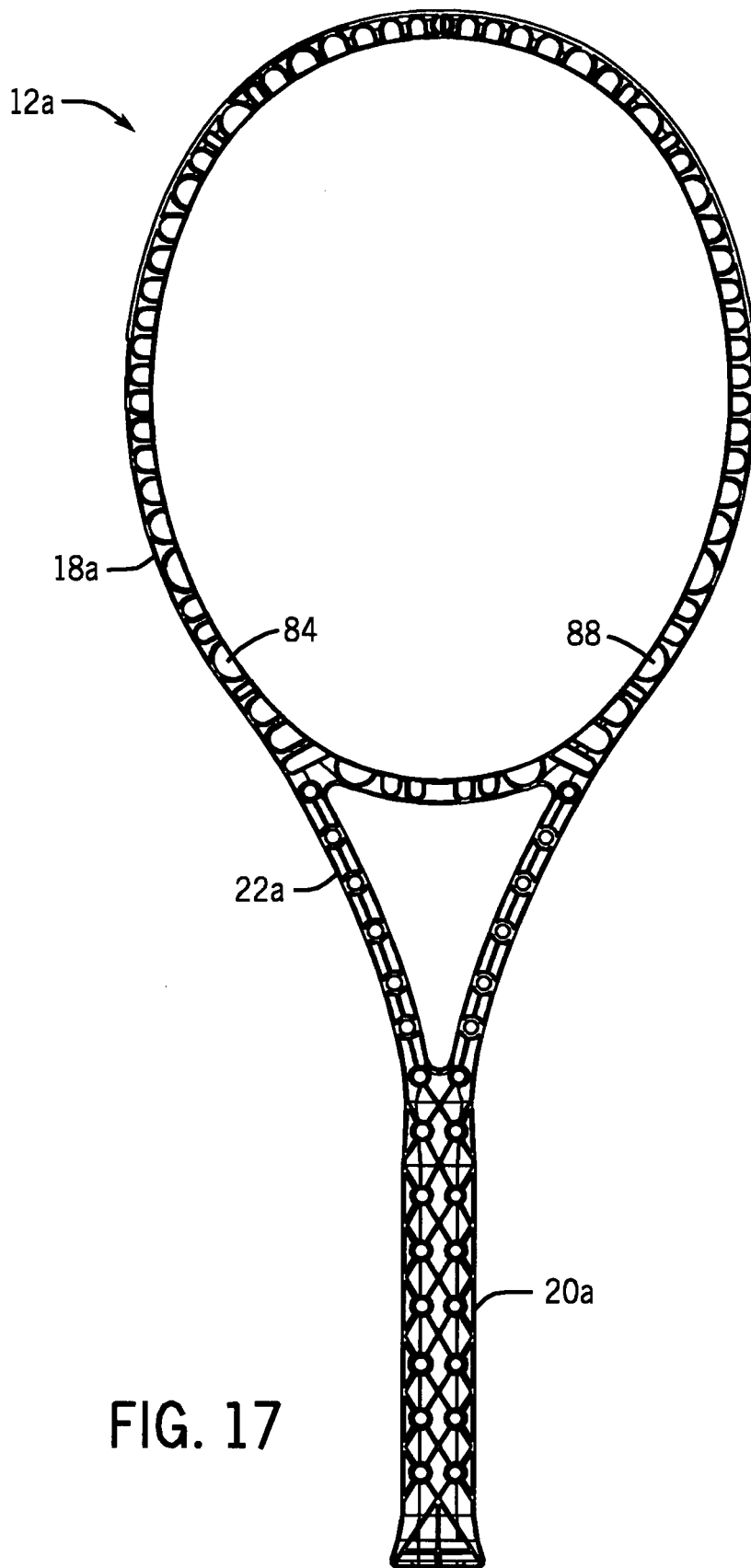


FIG. 17

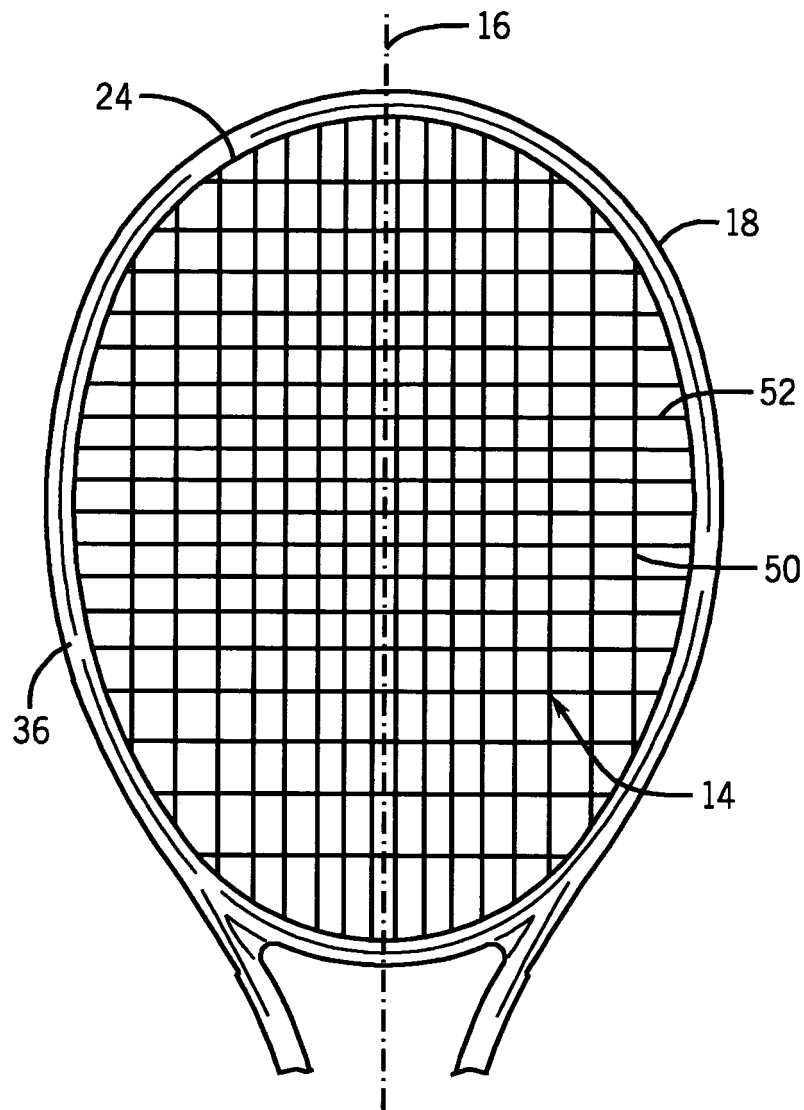


FIG. 18

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- GB 1201649 A [0003]