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(54) **RACQUET HAVING AN IMPROVED HANDLE ASSEMBLY**

(57) A racquet including a tubular frame formed of a fiber composite material, a pallet and a butt cap. The frame includes first and second end regions and a mid-region. The handle portion includes a distal region, proximal region and a central region positioned between the distal and proximal regions of the handle portion. The central and proximal regions of the handle portion have outer surfaces that define first and second transverse cross-sectional areas, respectively. The second transverse cross-sectional area is larger than the first transverse cross-sectional area. The pallet is coupled to and longitudinally extends over the central region but not over the proximal region of the handle portion. The butt cap is secured to the proximal region and includes a peripheral wall and less than half of the length of the peripheral wall extends over the pallet.

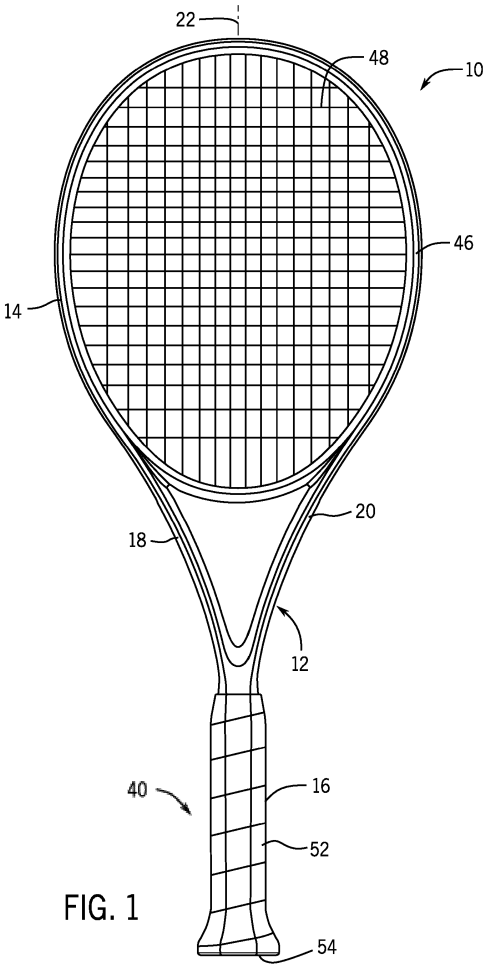

FIG. 1

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Description

FIELD

[0001] The present disclosure relates generally to a sports racquet. In particular, the present disclosure relates to a sports racquet. In particular, the present disclosure relates to a handle assembly for a sports racquet wherein the handle assembly includes a handle portion with an enlarged proximal region.

BACKGROUND

[0002] Sport racquets, such as tennis, racquetball, squash and badminton racquets, are well known and typically include a head portion coupled to a handle assembly. The head portion supports a string bed having a plurality of main string segments alternately interwoven with a plurality of cross string segments. The handle assembly typically includes a handle, a pallet, a butt cap and a grip.

[0003] The pallet is typically formed of a rigid material that extends to the proximal end of the handle portion, and the butt cap is attached to the pallet at the proximal end of the racquet. In some instances, butt caps can become dislodged, loosened or otherwise disconnected from the pallet of racquets over time. Thus, there is a continuing need for a racquet with an improved handle assembly that can improve the durability and reliability of a handle assembly of a racquet and further inhibit the dislodging or disconnection of a butt cap from a handle portion of a racquet.

SUMMARY

[0004] An aspect of the present disclosure relates to a sports racquet including a tubular frame formed of a fiber composite material, a pallet and a butt cap. The frame includes first and second end regions and a mid-region. The first and second end regions extend alongside each other at a handle portion, and the mid-region forms part of a head portion. The handle portion includes a distal region, proximal region and a central region positioned between the distal and proximal regions of the handle portion. The central and proximal regions of the handle portion have outer surfaces that define first and second transverse cross-sectional areas, respectively. The second transverse cross-sectional area is larger than the first transverse cross-sectional area. The pallet is coupled to and longitudinally extends over the central region of the handle portion but not over the proximal region of the handle portion. The butt cap is fixedly secured to the proximal region of the handle portion. The butt cap includes a proximal end wall and a peripheral wall. The proximal wall has a length extending from the proximal end wall and about the proximal region of the handle portion such that less than half of length of the proximal end wall extends over the pallet.

[0005] The second transverse cross-sectional area may have a polygonal shape. Any other suitable shape, such as round, oval etc. may be provided.

[0006] The sports racquet may further comprise a grip disposed over the pallet.

[0007] The mid-region of the frame may also form a pair of throat tubes between the head portion and the handle portion.

[0008] The butt cap may be directly connected to the proximal region of the handle portion through an adhesive. The butt cap may be directly connected to the proximal region of the handle portion by one or more fasteners. The butt cap may be connected to the proximal region of the handle portion by a fastening mechanism selected from the group consisting of an adhesive, staples, nails, rivets, pins, screws, an interference fit and combinations thereof.

[0009] The proximal region may include a side wall forming the second transverse cross-sectional area.

[0010] The handle portion may include a proximal end. The side wall may have a first length that defines a consistent shaped (e.g., polygonal shaped) transverse cross-sectional area from the proximal end of the handle portion extending in a direction toward the head portion.

[0011] The first length of the side wall measured from the proximal end toward the head portion may be at least 10 mm. The first length of the side wall measured from the proximal end toward the head portion may be within the range of 10 to 50 mm.

[0012] The side wall may also define a second length having a transverse cross-sectional area that varies from the first length to the central region of the handle portion.

[0013] The second length of the side wall may be at least 10 mm. The second length may define a depth of at least 5 mm.

[0014] The proximal end wall of the butt cap may not extend over the pallet.

[0015] According to an aspect of the present disclosure, a handle assembly for a sports racquet includes a handle base portion formed of a fiber composite material, a pallet and a butt cap. The handle base portion includes a distal region, proximal region and a central region positioned between the distal and proximal regions of the handle base portion. The central and proximal regions of the handle base portion have outer surfaces that define first and second transverse cross-sectional areas, respectively. The second transverse cross-sectional area is larger than the first transverse cross-sectional area. The proximal region includes a proximal end and a side wall forming the polygonal-shaped

transverse cross-sectional area. The side wall has first and second side portions. The first side portion extends from the proximal end and has a length of at least 10 mm. The first side portion defines a consistent polygonal-shaped transverse cross-sectional area along its length. The second side wall portion defines a transverse cross-sectional area that varies from the first side wall portion to the central region of the handle base portion. The second side wall portion having a length of at least 10 mm. The pallet is coupled to and longitudinally extends over the central region of the handle base portion but not over the proximal region of the handle portion. The butt cap is secured to the proximal region of the handle base portion. The butt cap includes a proximal end wall and a peripheral wall. The proximal wall has a length extending from the proximal end wall and about the proximal region of the handle portion such that less than half of length of the proximal end wall extends over the pallet.

[0016] The first side wall portion may have a length measured longitudinally from the proximal end that is within the range of 10 to 50 mm. The first side wall portion may have a length measured longitudinally from the proximal end that is within the range of 10 to 30 mm.

[0017] The second side wall portion may define a depth measured with respect to the outer surface of the first side wall portion of at least 5 mm.

[0018] The proximal end wall of the butt cap may not extend over the pallet.

[0019] An aspect of the present disclosure relates to a handle assembly for a sports racquet. The handle assembly includes a handle portion formed of a fiber composite material. The handle portion includes a distal region, proximal region and a central region positioned between the distal and proximal regions of the handle portion. The central and proximal regions of the handle portion have outer surfaces that define first and second transverse cross-sectional areas, respectively. The second transverse cross-sectional area is larger than the first transverse cross-sectional area. A pallet is coupled to and longitudinally extends over the central region of the handle portion but not over the proximal region of the handle portion. A butt cap is fixedly secured to the proximal region of the handle portion. The butt cap includes a proximal end wall and a peripheral wall. The proximal wall has a length extending from the proximal end wall and about the proximal region of the handle portion such that less than half of length of the proximal end wall extends over the pallet.

[0020] An aspect of the present disclosure relates to a handle assembly for a sports racquet, comprising:

a handle portion formed of a fiber composite material, the handle portion including a distal region, proximal region and a central region positioned between the distal and proximal regions of the handle portion, wherein the central and proximal regions of the handle portion have outer surfaces that define first and second transverse cross-sectional areas, respectively, the second transverse cross-sectional area being larger than the first transverse cross-sectional area;

a pallet coupled to and longitudinally extending over the central region of the handle portion but not over the proximal region of the handle portion;

a butt cap fixedly secured to the proximal region of the handle portion, the butt cap including a proximal end wall and a peripheral wall, the proximal wall having a length extending from the proximal end wall and about the proximal region of the handle portion such that less than half of length of the proximal end wall extends over the pallet.

[0021] It should be understood that the features defined in relation to one aspect may be provided in combination with any other aspect.

[0022] These and other aspects of the present disclosure will become more fully understood from the following detailed description, taken in conjunction with the accompanying drawings described herein below, and wherein like reference numerals refer to like parts.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023]

FIGURE 1 is a front perspective view of a racquet in accordance with one implementation of the present invention.

FIGURE 2 is a side view of a portion of a lay-up or arrangement of layers of fiber composite material positioned about a bladder and a mandrel prior to molding.

FIGURE 3 is top side perspective view of the lay-up of layers of fiber composite material with the mandrel removed and the lay-up of layers curved to approximate the shape of a racquet, and a yoke fiber composite lay-up.

FIGURE 4 is a top side perspective view of the lay-up of layers of fiber composite material of FIG. 7 prior to being placed into a racquet-forming mold.

FIGURE 5 is a top side exploded view of the lay-up of layers of fiber material being placed into a racquet-forming mold.

FIGURE 6 is a side, end perspective view of a handle portion of the racquet of FIG. 1.

FIGURE 7A is a transverse cross-sectional view taken about line 7A - 7A of FIG. 6.

FIGURE 7B is a transverse cross-sectional view taken about line 7B - 7B of FIG. 6.

FIGURE 7C is a transverse cross-sectional view taken about line 7B - 7B of FIG. 6 in accordance with an alternative implementation of the present invention.

FIGURE 8 is a top view of the handle portion of the racquet of FIG. 1.

FIGURE 9 is a side view of the handle portion of the racquet of FIG. 1.

FIGURE 10 is a longitudinal cross-sectional view of the handle assembly of the racquet of FIG. 1.

FIGURE 11 is a top perspective view of the central and proximal regions of the handle portion, and a longitudinal cross-sectional view of the butt cap of the racquet in accordance with another implementation of the present invention.

FIGURES 12 and 13 are top perspective views of the central and proximal regions of the handle portions, and a longitudinal cross-sectional view of the butt caps of racquets in accordance with other implementations of the present invention.

FIGURE 14 is a top perspective view of the central and proximal regions of the handle portion, and a longitudinal cross-sectional view of the butt cap of the racquet in accordance with another implementation of the present invention.

FIGURE 15 is a top, side perspective view of a racquet torsional stability test assembly and a racquet undergoing a racquet torsional stability test with a first weight applied to the racquet torsional stability assembly.

FIGURE 16 is a first end, side perspective view of the racquet torsional stability test assembly of FIG. 15.

FIGURE 17 is a top, side perspective view of the racquet torsional stability test assembly and the racquet undergoing a racquet torsional stability test of FIG. 15 with the first weight removed from the racquet torsional stability assembly.

DETAILED DESCRIPTION OF EXAMPLES

[0024] Referring to FIG. 1, a sports racquet is indicated generally at 10. The racquet 10 of FIG. 1 is configured as a tennis racquet, however, the disclosure also extends to other types of sports racquets, such as, for example, a racquetball racquet, a squash racquet, and/or a badminton racquet. The racquet 10 includes a frame 12 defining a head portion 14 and a handle assembly 16 having a handle portion 40. In one implementation, the frame 12 can also include a pair of throat tubes 18 forming a throat region 20 between the head portion 14 and the handle portion 40.

[0025] The frame 12 is preferably formed of a strong lightweight material, such as a fiber composite material. As used herein, the term "fiber composite material" or "composite material" refers to a plurality of fibers within and permeated or distributed throughout a matrix material, such as a resin. The fibers can be co-axially aligned in sheets, layers or plies, or braided or weaved in sheets or layers, and/or chopped and randomly dispersed in one or more layers. A single ply typically includes hundreds or thousands of fiber bundles that are initially arranged to extend coaxially and parallel with each other through the resin that is initially uncured. Each of the fiber bundles includes a plurality of fibers. The fibers are formed of a high tensile strength material such as carbon. The fibers can be formed of other materials such as, for example, glass, graphite, boron, basalt, carrot, Kevlar®, Spectra®, poly-para-phenylene-2, 6-benzobisoxazole (PBO), hemp, flax, other natural fibers and combinations thereof. In one implementation the matrix material may comprise a thermosetting resin such as an epoxy or a polyester resin. In another implementation the matrix material may comprise a thermoplastic resin. The composite material is typically wrapped about a mandrel and/or a comparable structure, and cured under heat and/or pressure. While curing, the matrix material is configured to flow and fully disperse and extend throughout the matrix of fibers. In multiple layer or ply constructions, the fibers can be aligned in different directions with respect to a longitudinal axis 22, and/or in braids or weaves from layer to layer.

[0026] Referring to FIGS. 2-5, the production of the frame 12 of the racquet 10 made of fiber composite material is illustrated. FIG. 2 illustrates an example arrangement of layers of fiber composite material forming a tube 26 of uncured

fiber composite material being wrapped or formed about a mandrel 28. The arrangements of layers of fiber composite material of the tube 26 can include a wide range of numbers of layers, lengths of layers, widths of layers, shapes of layers, a range of fiber angle values of layers, other sequences of layers, and combinations thereof are contemplated under the present disclosure. The number of plies used to form a frame 12 can be within the range of 2 to 150. In an example, the number of plies used to form the frame 12, or the head portion 14, throat region 20 and handle portion 40 thereof, can be at least 10 plies. In other implementations, other numbers of plies can be used.

[0027] The mandrel 28 is a body that is generally shaped to form the internal surface of the molded component and serves as a core upon which the layers of uncured fiber composite material can be wrapped or applied over. In one implementation, the mandrel 28 is an elongate body having a generally rectangular cross-sectional area with rounded corners. In other implementations, the mandrel can have other cross-sectional shapes. A bladder 30 is placed over, and fits around the outer surface of, the mandrel 28. Each layer is wrapped or formed about a bladder 30 and mandrel 28 and follows the form or shape of the bladder 30 and mandrel 28.

[0028] In one implementation, at least 50 percent of the layers forming the tube 26 of the lay-up or plurality of ply arrangements can be formed with carbon fibers. The lay-up can include a matrix material (e.g., resin) and can have a fiber area weight of at least 120 g/m^2.

[0029] Referring to FIG. 2, when the layers of uni-directional plies of fiber composite material are wrapped or laid up around the bladder 30 and the mandrel 28, the plies are no longer arranged in a flat sheet, and therefore, the fiber bundles and fibers of the plies no longer follow or define generally parallel lines. Rather, the fiber bundles and fibers are adjacent to one another, and are curved or otherwise formed so that they follow substantially the same adjacent paths. The fibers remain adjacent to one another, are aligned with each other and follow substantially similar paths that are essentially parallel (or even co-axial).

[0030] In one implementation, the mandrel 28 may include a pull tab for facilitating the pulling or removal of the mandrel 28 from the tube 26 wrapped about the bladder 30 and the mandrel 28. Referring to FIGS. 3 and 4, once the mandrel 28 is removed from the bladder 30 and the lay-up or tube 26, the uncured tube 26 can be gently positioned into the shape of a racquet frame. The uncured tube 26 includes first and second end regions 56 and 58 and a mid-region 60. The first and second end regions 56 and 58 are placed alongside each other to form the handle portion 40 and the mid-region 60 is used to form the head portion 14 along with a yoke lay-up 34. The uncured yoke lay-up 34 can also be formed of a fiber composite material. As shown in FIG. 4, the tube 26 can be shaped to resemble a racquet frame, and the yoke lay-up 34 can be attached to the tube 26.

[0031] Referring to FIG. 5, the uncured tube 26 and the uncured yoke lay-up 34 are positioned within a mold cavity of a racquet-forming mold 36. The mold cavity of the racquet-forming mold 36 includes a unique shape that defines a unique shape to the handle portion 16 of the frame 12. A supply line can be attached to the bladder 30 for supplying air or other gas to the bladder, and the pieces of the racquet-forming mold 36 can be positioned around the tube 26 and the yoke lay-up 34. The bladder 30 can be pressurized by air or other gas to a predetermined pressure, and the racquet-forming mold 36 can then be heated in an oven or furnace to a predetermined temperature. Once subjected to heat and pressure, the viscosity of the matrix material (e.g., resin) in the lay-up of layers in the tube 26 and the yoke lay-up 34 drops and the matrix material (e.g., resin) flows throughout the tube 26 and the yoke lay-up 34 in the mold cavity creating a more uniform structure and the fibers are positioned into the shape of the mold cavity. After a first predetermined amount of time, the racquet-forming mold 36 is removed from the heat and the tube 26 and yoke lay-up 34 are allowed to cool and cure. After a second pre-determined amount of time, the racquet-forming mold 36 is opened and the racquet frame 12 is removed from the mold 36. The frame 12 of the racquet 10 can have a weight within the range of 260 gm to 355 gm. In other implementations, the frame of the racquet can have a weight outside of the 180 gm to 370 gm range.

[0032] Referring to FIG. 1, the head portion 14 is a tubular structure defining a generally oval shaped opening 46. The head portion 14 maintains in tension a latticework of strings forming a string bed 48. The string bed 48 defines a string bed plane 49 (see FIG. 15). The throat region 20 includes the pair of throat tubes 18 outwardly extending from the head portion 14 and converging at the handle portion 40. The throat region 20 couples the head portion 14 to the handle portion 40. In one implementation, the pair of throat tubes 18 is integrally formed with the head portion 14 and the handle portion 40. In an alternative preferred example, the throat region 20 can include an elastomeric isolator (not shown) positioned between the head portion 14 and the handle portion 40. The handle portion 40 outwardly extends from the throat region 20 along a longitudinal axis 22.

[0033] Referring to FIGS. 6 through 14, the handle assembly 16 is shown in greater detail. The handle assembly 16 includes the handle portion 40, a pallet 50, a grip 52, and a butt cap 54 (see FIG. 10). The handle assembly 16 is configured for grasping by one or both hands of a player during use. Referring to FIG. 10, in one implementation, the handle portion 40 is formed by the first and second end regions 56 and 58 of the tube 26 after it is cured. During molding and curing, the first and second end regions 56 and 58 expand to take the shape of the surface of the mold cavity and cure together as one integral member. The first and second end regions 56 and 58 extend alongside each other and form one integral structure. Accordingly, in such implementations, the frame 12 can be formed of one continuous tube of material (e.g., fiber composite material) that is curved at the mid-region 60 to form the head portion 14. Then, each

side of the continuous tube of material can form the throat tubes 18 that converge toward each other in the throat region 20, and the first and second end regions 56 and 58 of the continuous tube can be arranged side by side to form the handle portion 40. In such implementations, the frame 12 is formed as a one-piece integral structure. In other implementations, the handle portion 40 can be a tubular structure that does not include an extension of the throat tubes 18. In such implementations, the handle portion 40 can be a tubular structure separate from either the throat portion 20 or the head portion 14 of the frame 12 and attached to the throat portion 20 through use of conventional fasteners, molding techniques, bonding techniques, adhesives or combinations thereof.

[0034] Referring to FIGS. 6 through 8, the handle portion 40 includes a distal region 62, a proximal region 64 and a central region 66 positioned between the distal and proximal regions 62 and 64 of the handle portion 40. The central region 66 and proximal region 64 of the handle portion 40 have outer surfaces 68 and 70 that define first and second transverse cross-sectional areas, respectively. FIG. 7A illustrates the first transverse cross-sectional area of the central region 66 having an octagonal shape. FIG. 7B illustrates the second transverse cross-sectional area of the proximal region 64 also having an octagonal shape. FIG. 7C illustrates the second transverse cross-sectional area of the proximal region 64 also having an octagonal shape. In the racquet of FIG. 7C, the tubular frame 12 can be filled with a fill material 86 to improve the sound and feel of the racquet. In one implementation, the fill material 86 can be a urethane foam having a total weight within the range of 8 to 14 grams. In other implementations, other materials can be used as the fill material, such as other foams, and the weight of the fill material can also be varied.

[0035] Importantly, the proximal region 64 of the handle portion 40 is enlarged such that the second transverse cross-sectional area defined by the outer surface 70 of the proximal region 64 is larger than the first transverse cross-sectional area defined by the outer surface 68 of the central region 66. Each of the distal region 62, the proximal region 64 and the central region 66 have outer surfaces that define polygonal-shaped transverse cross-sectional shapes. In other implementations, other transverse cross-sectional shapes can be used such as oval, circular and irregular. The proximal region 64 of the handle portion 40 includes a proximal end 72 and a side wall 74 including first and second lengths, l_1 and l_2. The first length l_1 of the side wall 74 can define a consistent polygonal-shaped transverse cross-sectional area from the proximal end 72 of the proximal region 64 extending in a direction toward the head portion 14. In one implementation, the first length l_1 can be at least 10 mm. In other implementations, the first length l_1 can be within the range 10 to 50 mm. In other implementations, the first length l_1 can be within the range 10 to 30 mm. FIGS. 11 through 13 illustrate three examples of the first length l_1 being of different lengths thereby increasing or decreasing the length and size of the proximal region 64 of the handle portion 40. The second length l_2 of the side wall 74 has a transverse cross-sectional area that varies from the first length l_1 to the central region 66 of the handle portion 40. The second length l_2 can be at least 10 mm. The central region 66, and the second length l2 of the proximal region 64, and the distal region 62 can define a recess 80. The recess 80 can have a depth d defined by an outer surface 76 of the central region 66 and the outer surface of the proximal region 64 of at least 2 mm. In other implementations, the depth d of the recess 80 can be within the range of 1 to 10 mm. The recess 80 can uniformly and inwardly extend into the sides of the polygonal shaped central region 66, such that the second transverse cross-sectional area of the proximal region 64 is greater than the first transverse cross-sectional area of the central region 66.

[0036] Referring to FIG. 14, in another implementation, the proximal region 64 may be formed with a continuously variable transverse cross-sectional shape from the proximal end 72 to the central region 64 of the handle portion 40. In such an implementation, the handle portion would not necessarily have two distinct lengths l_1 and l_2 defined by regions of consistent and variable transverse cross-sectional areas, but rather one entire length l_3 that defines a continuously variable transverse cross-sectional shape. In the implementation of FIG. 14, the transverse cross-sectional shapes are polygonal (such as octagonal) and the decrease in size from the proximal end 72 to the central region 64. In other implementations, the transverse cross-sectional area can take other shapes and can vary in size in other manners such as different amounts of tapering over a particular sub-length, generally convex, generally concave, or variable. In each instance, the proximal region 64 is enlarged to enable the direct connection or attachment of the butt cap 54 to the proximal region 64.

[0037] Referring to FIG. 10, the pallet 50 is coupled to and longitudinally extends over the central region 66 of the handle portion 40 but not over the proximal region 64 of the handle portion 40. For purposes of this disclosure, the term "coupled" means directly or indirectly connected. In one implementation, the pallet 50 is positioned over the central region 66 of the handle portion 40. In other implementations, the pallet 50 can also be positioned over a portion of the proximal and distal regions 62 and 64 of the handle portion 40. In each case, the pallet 50 is formed or sized to match the contour of the central regions 66 and any portion of the proximal and/or distal regions 62 and 64 it may extend over. In one implementation, the pallet 50 can be over-molded over the handle portion 40. In other implementations, the pallet 50 can be applied over the handle portion through other means such as for example adhesives, one or more fasteners, interference fit and combinations thereof. The pallet 50 preferably has a polygonal transverse cross-section shape, such as an octagonal shape formed by eight outer longitudinally extending surfaces interconnected along eight longitudinally extending gripping edges. In alternative preferred embodiments, the pallet 50 can have alternative transverse cross-sectional shapes such as, for example, other polygonal shapes, oval, circular and irregular. The pallet 50 is made of a

strong, lightweight, durable material, such as a rigid polyurethane foam. Alternatively, the pallet 50 can be formed of other materials, such as, for example, other structural urethane foams, other structural foams, a plastic material, or wood. In other implementations, the pallet 50 can be formed of an elastomeric material that can be stretched over the handle portion 40. In an example, the pallet 50 has a length between 101.6 and 241.3 mm (4.0 and 9.5 inches); and, in a particular example, the pallet 50 has a length of approximately 152.4 to 203.2 mm (6.0 to 8.0 inches).

[0038] The butt cap 54 is fixedly secured to the proximal region 64 of the handle portion 40 and covers the proximal end 72 and at least a portion of the outer surface 70 of the proximal region 64. The butt cap 54 is formed of a lightweight durable material, such as a plastic. Alternatively, the butt cap can be formed of other materials, such as nylon, wood, thermoset or thermosetting materials, thermoplastic materials, and combinations thereof. The butt cap 54 includes a proximal end wall 84 and a peripheral wall 82 extending from the proximal end wall 84 and about the proximal region 64 of the handle portion 40 without extending over the pallet 50. In one implementation, the peripheral wall 82 extends over the first length l_1 of the proximal region 64. In one implementation, the butt cap 54 is directly connected to the proximal region 64 of the handle portion 40. In other implementations, the butt cap 54 can be fixedly secured to the proximal region 64 through one or more fastening mechanisms, such as an adhesive, a pin, a screw, a nail, a rivet, a staple, an interference fit, and combinations thereof. In one implementation, the butt cap 54 is secured to the proximal region 64 through one or more staples. The peripheral wall 82 has a length extending from the proximal end wall 84 and about the proximal region 64 of the handle portion 40 with less than half of the length of the proximal end wall extending over the pallet 50. In one implementation, the butt cap 54 is secured to the proximal region 64 of the handle portion 40 in manner that the peripheral wall 82 extends over the proximal region 64 and less than half of the length of the peripheral wall 82 can also extend over a portion of the pallet 50. The length of the peripheral wall 82 is measured with reference to the longitudinal axis 22 of the racquet 10, and extends from the proximal end wall 84 to a distal edge of the peripheral wall 82 of the butt cap 54. In other implementations, less than a quarter of the length of the peripheral wall 82 can extend over the pallet 50. In another implementation, the peripheral wall 82 extends only over the proximal region 64 of the handle portion 40 and does not extend over the pallet 50.

[0039] The enlarged proximal region 64 of the handle portion 40 enables the butt cap 54 to be connected to the proximal region 64 without the peripheral wall 82 extending over the pallet 50. The proximal region 64 formed of the fiber composite material is stronger and more durable than the pallet 50. According, in accordance with above-described implementations, the direct connect of the butt cap 54 to the proximal region 64 significantly increases the durability of the butt cap 54 and the racquet 10. Butt caps on conventional racquets are typically connected to the less durable pallet, which typically extends entirely to the proximal end of the racquet. The pallet is weaker, and more susceptible to cracking or breaking that the proximal region 64 of the handle portion 40. When racquets are dropped, the butt cap can impact the ground or other surface. Additionally, players often grip the butt cap when serving or performing other tennis strokes. Accordingly, the butt cap receives a lot of load during use. Over time, the repeated use can cause the connection of the butt cap to the pallet to weaken and even fail causing the butt cap to loosen, dislodge and/or separate from the racquet. The present implementations with the connection of the butt cap 54 directly to the enlarged peripheral region 64 of the handle portion 40 significantly strengthens the connection of the butt cap 54 to the handle portion 40 thereby significantly increasing the reliability and durability of the racquet 10 as a whole.

[0040] The grip 52 is applied over the outer surface of the pallet 50, a portion of the proximal region 64, and a portion of the peripheral wall 82 of the butt cap 54. In one implementation, the grip 52 may include an adhesive tape. Alternatively, the grip 52 can be attached to the pallet 50 and the proximal region 64 by other means, such as, for example, a conventional fluid adhesive, thermal bonding or mechanical bonding. The grip 52 may be an elongate strip of soft, durable material. The grip 52 can be made of a leather, a synthetic leather, a rubber, other thermoset or thermosetting materials, thermoplastic materials and combinations thereof. The grip 52 is typically spirally or helically wrapped about the outer surface of the pallet 50. In an alternative example, the grip 28 can be a tubular member that is slidably connected to the outer surface of the pallet 50 and the proximal region 64.

[0041] Referring to FIGS. 15 through 17, Wilson Sporting Goods Co. conducted a racquet torsional stability test using a racquet torsional stability test assembly 140. The racquet torsional stability test includes a frame 142 with first and second test fixtures 144 and 146 for mounting the racquet 10 to at first and second locations 148 and 150 of the racquet 10, respectively. The term "racquet torsional stability test" means a test meeting the following description. The string bed is removed from the head portion 14 of the frame 12, and the grip 52 and the butt cap 54 are removed from the handle assembly 16 of the racquet 10. The racquet 10 is positioned in the first and second test fixtures 144 and 146 with the longitudinal axis 22 and string bed plane 49 of the racquet 10 parallel to the ground. The first test fixture 144 fixedly secures the handle assembly 16, without the grip and the butt cap, and is pivotally mounted to the frame 142 to allow for pivotal or rotational movement of the first fixture 144 (and the handle assembly 16 clamped to the first fixture 144) about the longitudinal axis 22 of the racquet 10. The first test fixture 144 further includes an arm 152 that radially projects or extends from the first test fixture 144 and the longitudinally axis 16. The arm 152 includes one or more indexes 154 for receiving a first weight 156 at a predetermined distance from the longitudinal axis 16. In one implementation, the first weight is a 6.9 kg weight and the predetermined distance is 40 cm from the longitudinal axis 22. The second

test fixture 146 fixedly secures the head portion 18 of the racquet 10 in a fixed position with the string bed plane 49 of the racquet 10 positioned parallel to the ground. A digital inclinometer 160, such as a Wixey™ Digital Angle Gauge, Model No. WR300, Type 2, by Barry Wixey Development of Sanibel, Florida, is removably mounted to the second test fixture 144 at the longitudinal axis 22. The first weight 156 is applied to the arm 152 at the predetermined distance of 40 cm from the axis 22. The first weight 156 applied to the arm 152 places a torsional load onto the handle assembly 16 of the racquet 10 and causes rotation of the first test fixture 144 (and the handle assembly 16) with respect to the frame 142 and about the longitudinal axis 22. Referring to FIG. 17, the digital inclinometer 160 is zeroed, and the first weight 156 is removed. The angular deflection or movement of the arm 152 and the handle assembly 16 with respect to the longitudinal axis 22 is measured. Although the racquet shown in FIGS. 15-17 is unstrung, the racquet torsional stability test can also be performed on a strung racquet. For purposes of the claimed invention, the racquet tested under the racquet torsional stability test is unstrung.

[0042] The racquet torsional stability test was performed on six racquets. A first set of three racquets were three existing Wilson® Blade® v7.0 racquets that did not include the enlarged proximal region 64 of the handle portion 40. Rather, in the first set of three Wilson® Blade® v7.0 racquets, the transverse cross-sectional areas of the handle portions 40 were constant from the central regions 66 to the proximal ends 72 of the handle portions 40. Additionally, the pallets 50 also extended to the proximal ends 72 of the handle portion 40, and the butt caps 54 were attached to the pallets 50 in a conventional manner. The second set of three racquets were prototype racquets, which were the same as the first set of three Wilson® Blade® v7.0 racquets except that the handle portions 40 were formed in accordance with the implementation of the present disclosure with the proximal regions 64 of the handle portions 40 being enlarged, such as shown in FIGS. 9 and 10. Table 1 below lists the results of the racquet torsional stability test of the first and second sets of three racquets. All of the racquets were tested unstrung.

Table 1 Racquet Torsional Stability Measurements

Racquet	Torsional Deflection Measurement (degrees)	Improvement in Torsional Stability (%) Compared to Existing Wilson® Blade® v7.0 Racquet
Wilson® Blade® v7.0 Racquet 1	5.8	20.7
Prototype 1	4.6	
Wilson® Blade® v7.0 Racquet 2	5.25	13.3
Prototype 2	4.55	
Wilson® Blade® v7.0 Racquet 3	6.0	21.7
Prototype 3	4.7	
Average Decrease or Improvement in Torsional Stability		18.56

[0043] The racquet torsional stability test results of the first set of three existing racquets compared to the second set of three prototype racquets having an enlarged proximal region 64 of the handle portion 40 demonstrate a significant improvement in the torsional stability of the racquet, or reduction in the amount of angular deflection of the racquet under the test. The three prototype racquets having the enlarged proximal region 64 of the handle portion 40 exhibited torsional angular deflection values that were at least 13.3 percent lower or better than the corresponding existing racquets. The prototype racquets exhibited angular deflection values of no greater than 4.7 degrees under the racquet torsional stability test. Accordingly, racquets formed in accordance with the present invention provide a more durable butt cap connection to the handle assembly, and also provide significantly improved torsional stability.

[0044] While example implementations of the present disclosure have been described and illustrated, numerous departures therefrom can be contemplated by persons skilled in the art. Therefore, the present disclosure is not limited to the foregoing description but only by the scope of the appended claims.

Claims

1. A sports racquet (10) comprising:

a tubular frame (12) formed of a fiber composite material including first and second end regions (56, 58) and a

mid-region (60), the first and second end regions (56, 58) extending alongside each other at a handle portion (40), and the mid-region (60) forming part of a head portion (14), the handle portion (40) including a distal region (62), proximal region (64) and a central region (66) positioned between the distal and proximal regions (62, 64) of the handle portion (40), the central and proximal regions (66, 64) of the handle portion (40) having outer surfaces (68, 70) that define first and second transverse cross-sectional areas, respectively, the second transverse cross-sectional area being larger than the first transverse cross-sectional area;
a pallet (50) coupled to and longitudinally extending over the central region (66) of the handle portion (40) but not over the proximal region (64) of the handle portion (40); and
a butt cap (54) fixedly secured to the proximal region (64) of the handle portion (40), the butt cap (54) including a proximal end wall (84) and a peripheral wall (82), the peripheral wall (82) having a length extending from the proximal end wall (84) and about the proximal region (64) of the handle portion (40) with less than half of the length of the peripheral wall (82) extending over the pallet (50).

2. The sports racquet (10) of claim 1, wherein the second transverse cross-sectional area has a polygonal shape.

3. The sports racquet (10) of claim 1 or 2, further comprising a grip (52) disposed over the pallet (50).

4. The sports racquet (10) of any preceding claim, wherein the mid-region (60) of the frame (12) also forms a pair of throat tubes (18) between the head portion (14) and the handle portion (40).

5. The sports racquet (10) of any preceding claim, wherein the butt cap (54) is directly connected to the proximal region (64) of the handle portion (40) through at least one of an adhesive and one or more fasteners.

6. The sports racquet (10) of any preceding claim, wherein the butt cap (64) is connected to the proximal region (64) of the handle portion (40) by a fastening mechanism selected from the group consisting of an adhesive, staples, nails, rivets, pins, screws, an interference fit and combinations thereof.

7. The sports racquet (10) of any preceding claim, wherein the proximal region (64) includes a side wall (74) forming the second transverse cross-sectional area.

8. The sports racquet (10) of claim 7, wherein the handle portion (40) includes a proximal end (72), and wherein the side wall has a first length (l_1) that defines a consistent polygonal shaped transverse cross-sectional area from the proximal end (72) of the handle portion (40) extending in a direction toward the head portion (14).

9. The sports racquet (10) of claim 8, wherein the first length (l_1) of the side wall (74) measured from the proximal end (72) toward the head portion (14) is at least 10 mm, optionally
wherein the first length (l_1) of the side wall (74) measured from the proximal end (72) toward the head portion (14) is within the range of 10 to 50 mm.

10. The sports racquet (10) of claim 8 or 9, wherein the side wall (74) also defines a second length (l_2) having a transverse cross-sectional area that varies from the first length (l_1) to the central region (66) of the handle portion (40), optionally wherein the second length (l_2) of the side wall (74) is at least 10 mm, optionally wherein the second length (l_2) defines a depth (d) of at least 5 mm.

11. The sports racquet (10) of any preceding claim, wherein the proximal end wall (84) of the butt cap (54) does not extend over the pallet (50).

12. A handle assembly (16) for a sports racquet (10) comprising:

a handle base portion formed of a fiber composite material, the handle base portion including a distal region (62), proximal region (64) and a central region (66) positioned between the distal and proximal regions (62, 64) of the handle base portion, the central and proximal regions (66, 64) of the handle base portion having outer surfaces (68, 70) that define first and second transverse cross-sectional areas, respectively, the second transverse cross-sectional area being larger than the first transverse cross-sectional area, the proximal region (64) including a proximal end (72) and a side wall (74) forming the polygonal-shaped transverse cross-sectional area, the side wall (74) having first and second side portions, the first side portion extending from the proximal end (72) and having a length of at least 10 mm, the first side portion defining a consistent polygonal-shaped transverse cross-sectional area along its length, the second side wall portion defining a transverse cross-

sectional area that varies from the first side wall portion to the central region (66) of the handle base portion, the second side wall portion having a length of at least 10 mm;

a pallet (50) coupled to and longitudinally extending over the central region (66) of the handle base portion but not over the proximal region (64) of the handle base portion; and

a butt cap (54) secured to the proximal region (64) of the handle base portion, the butt cap (54) including a proximal end wall (84) and a peripheral wall (82) extending from the proximal end wall (84) and about the proximal region (64) of the handle base portion, the peripheral wall (82) having a length extending from the proximal end wall (84) and about the proximal region (64) of the handle base portion with less than half of the length of the peripheral wall (82) extending over the pallet (50).

13. The handle assembly (16) of claim 12, wherein the first side wall portion has a length measured longitudinally from the proximal end (72) that is within the range of 10 to 50 mm, optionally wherein the first side wall portion has a length measured longitudinally from the proximal end (72) that is within the range of 10 to 30 mm.

14. The handle assembly (16) of claim 12 or 13, wherein the second side wall portion defines a depth (d) measured with respect to the outer surface of the first side wall portion of at least 5 mm.

15. The handle assembly (16) of any one of claims 12 to 14, wherein the proximal end wall (84) of the butt cap (54) does not extend over the pallet (50).

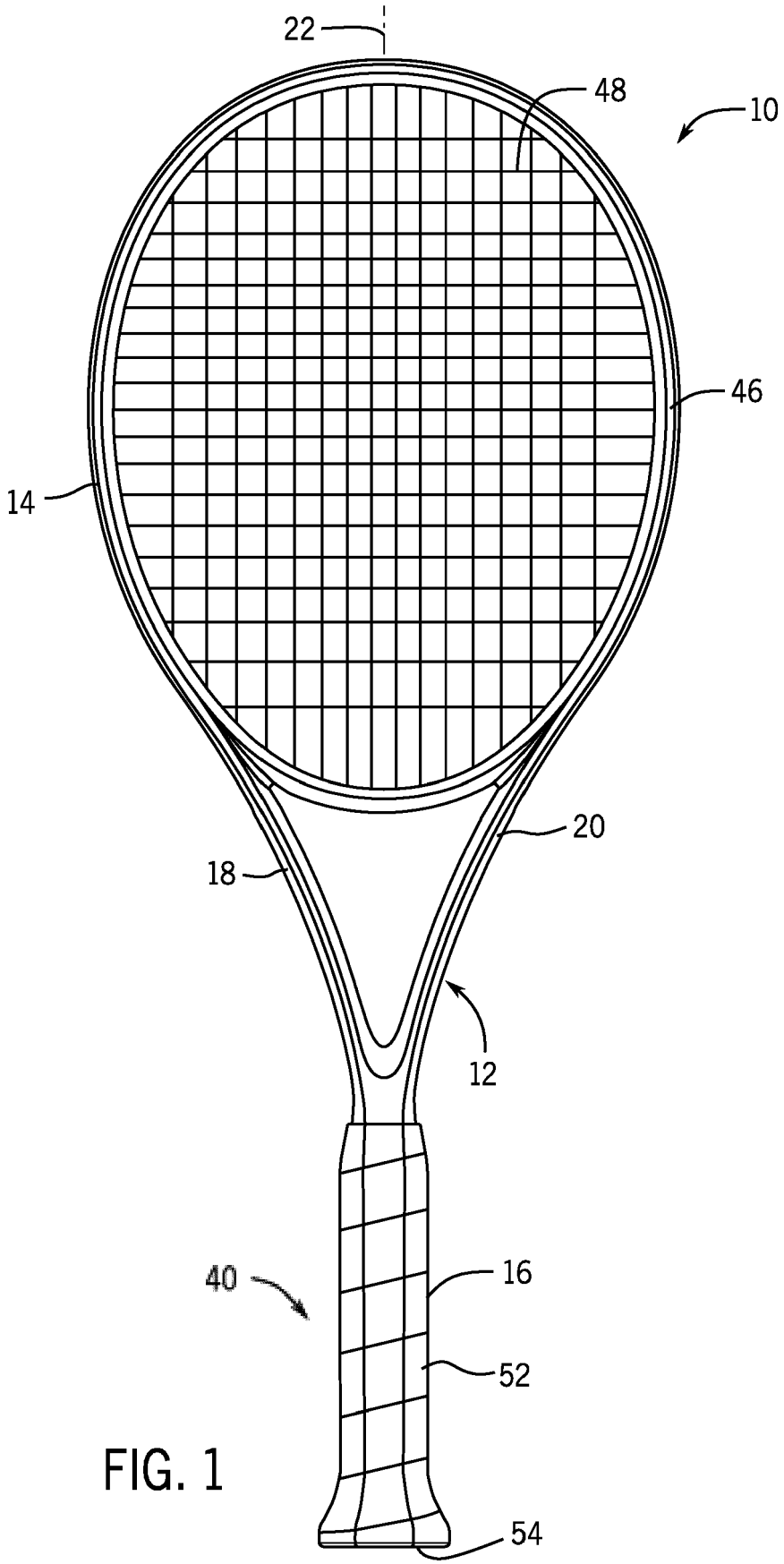


FIG. 1

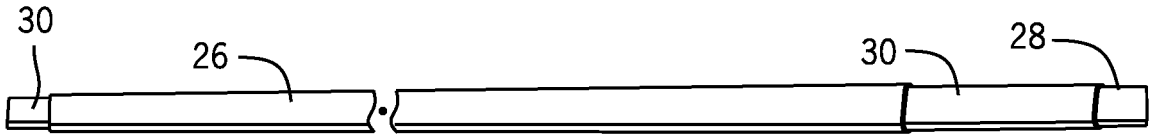


FIG. 2

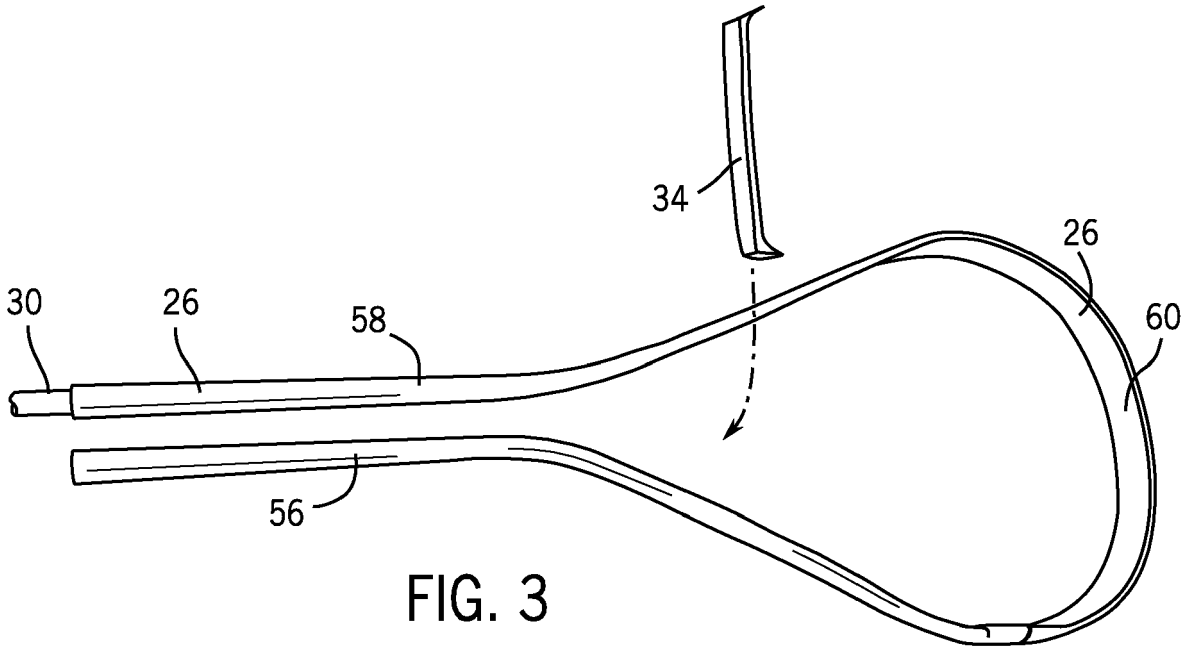


FIG. 3

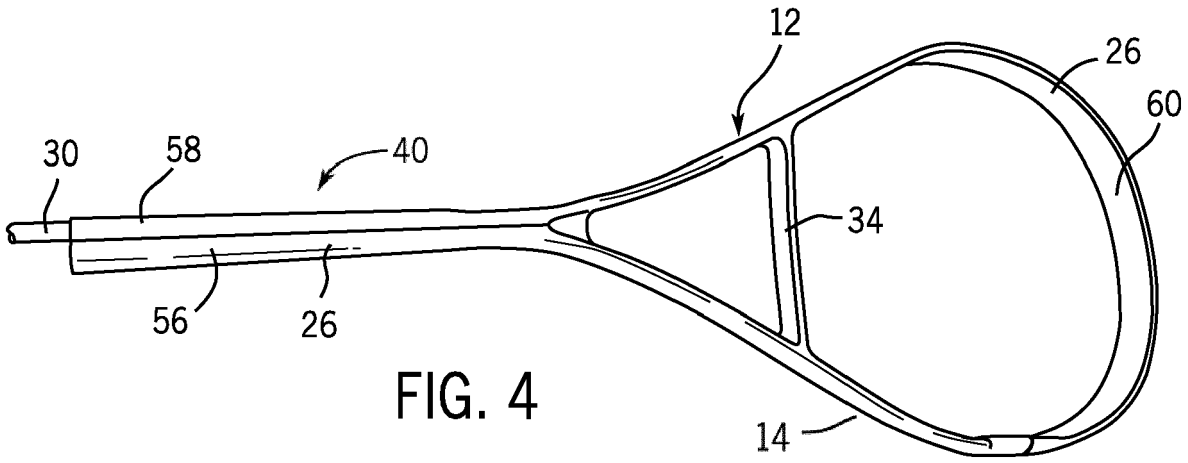
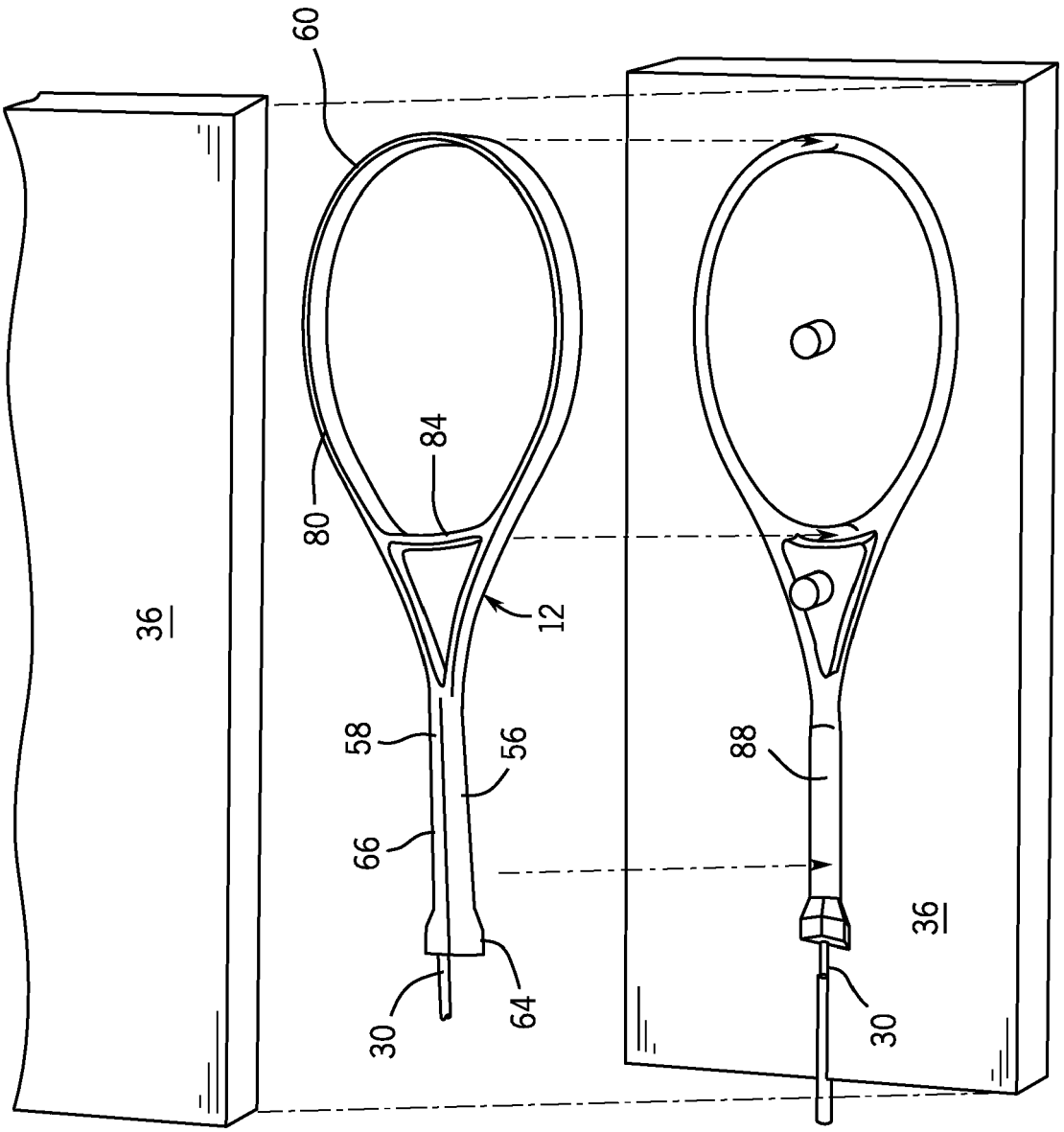


FIG. 4

FIG. 5



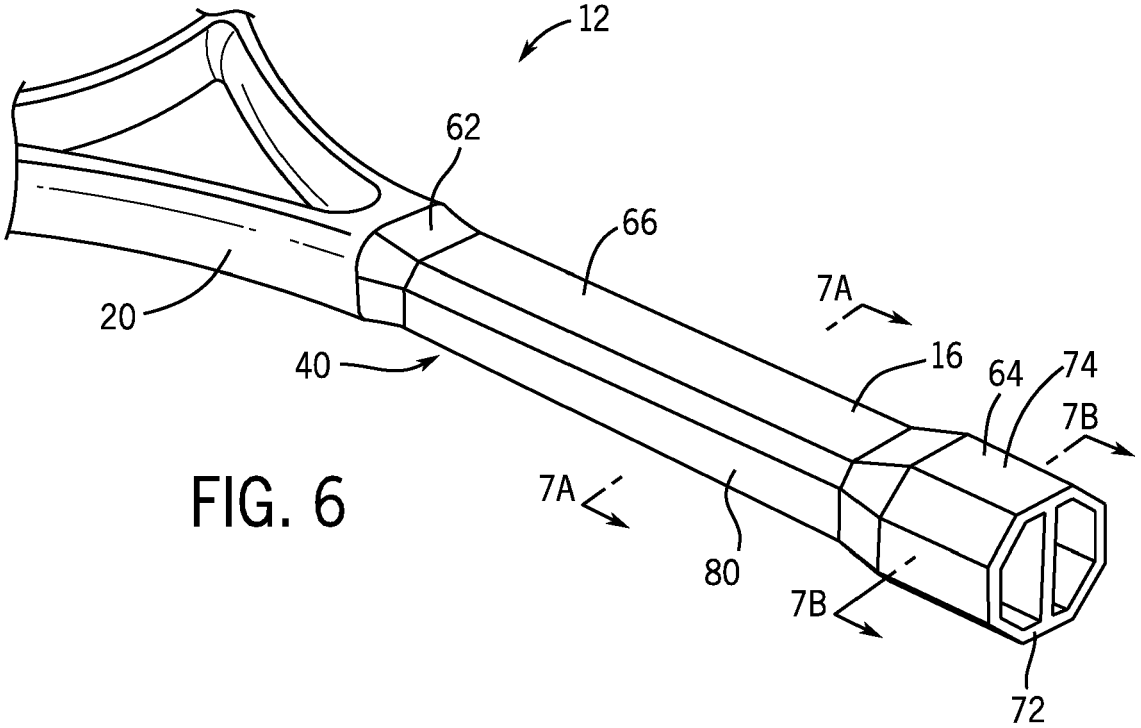


FIG. 6

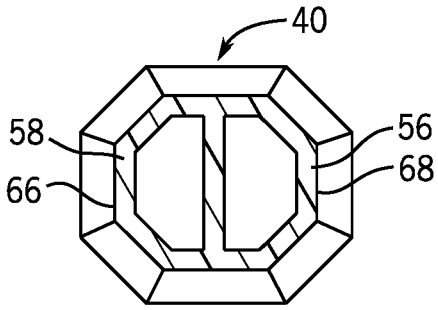


FIG. 7A

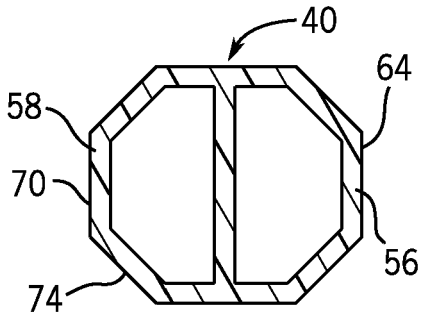


FIG. 7B

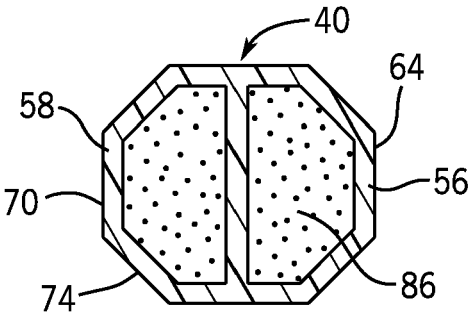


FIG. 7C

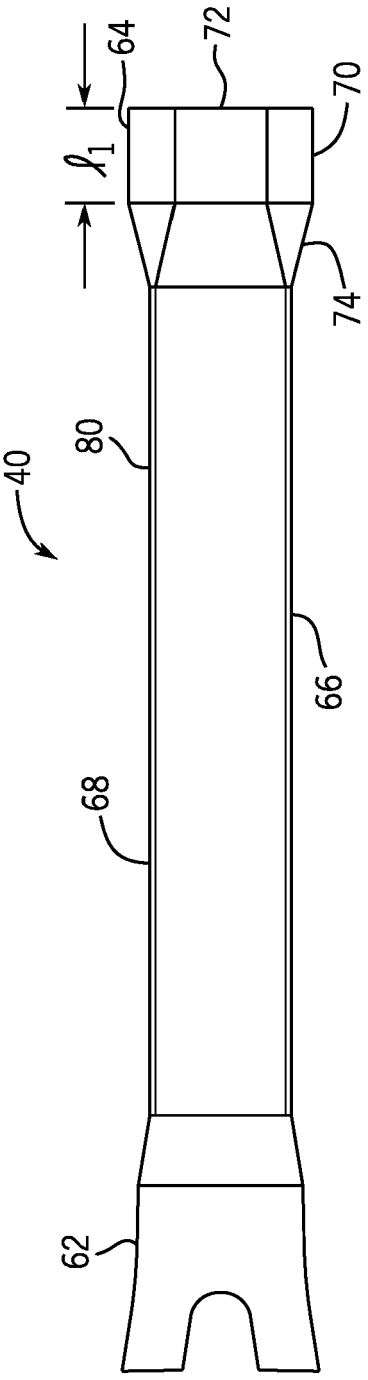


FIG. 8

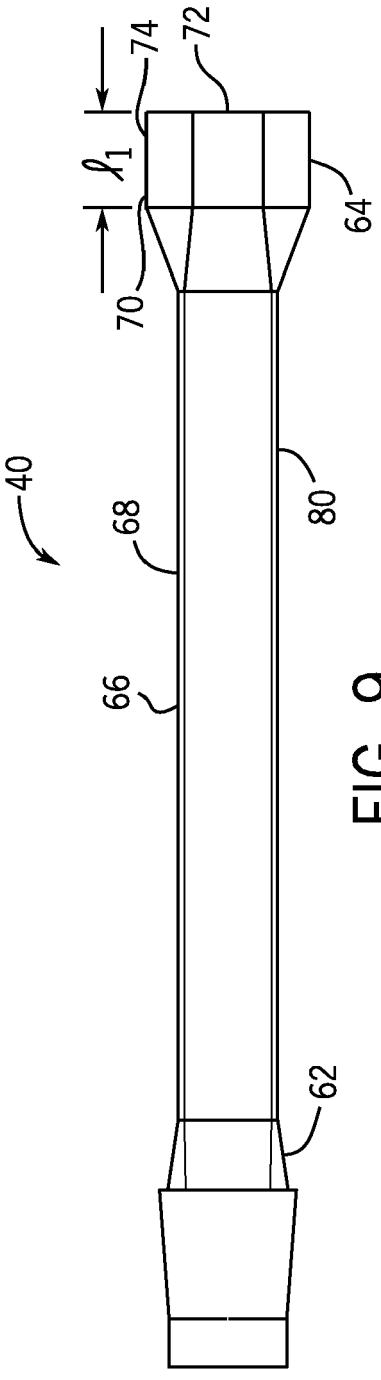


FIG. 9

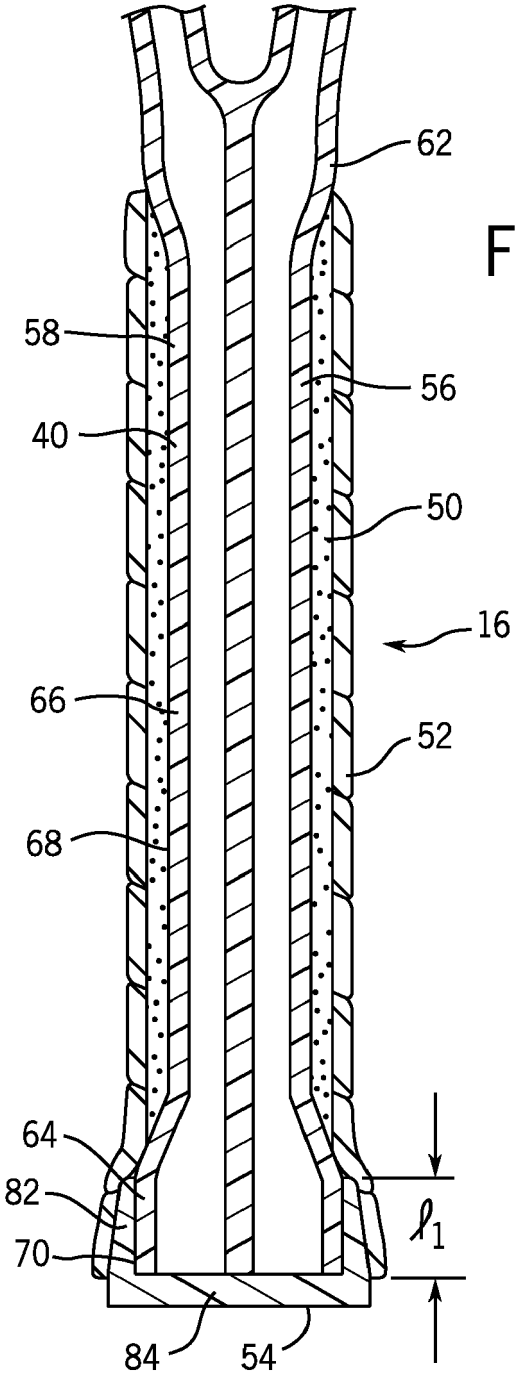


FIG. 10

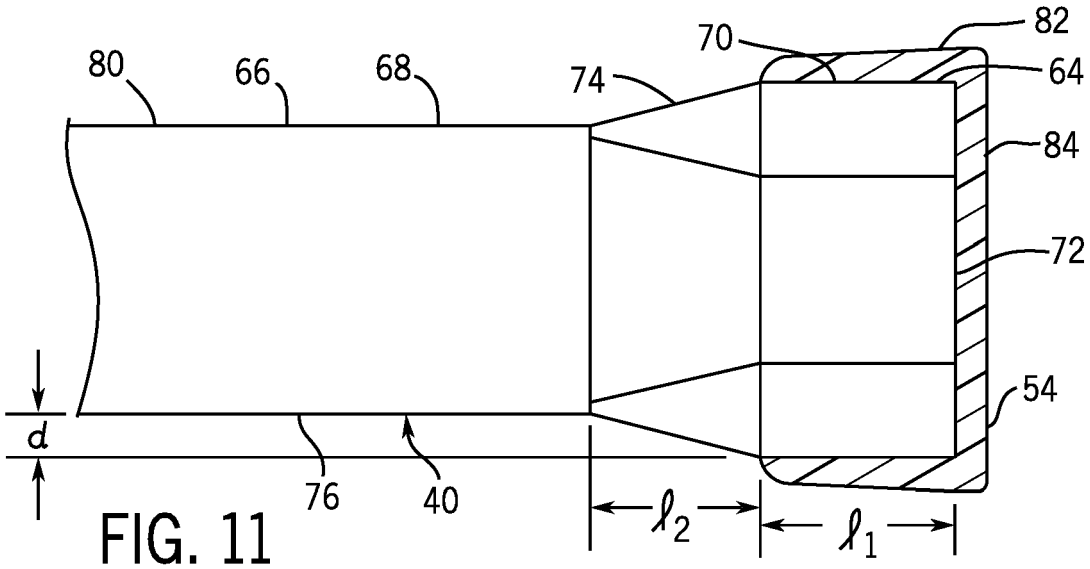


FIG. 11

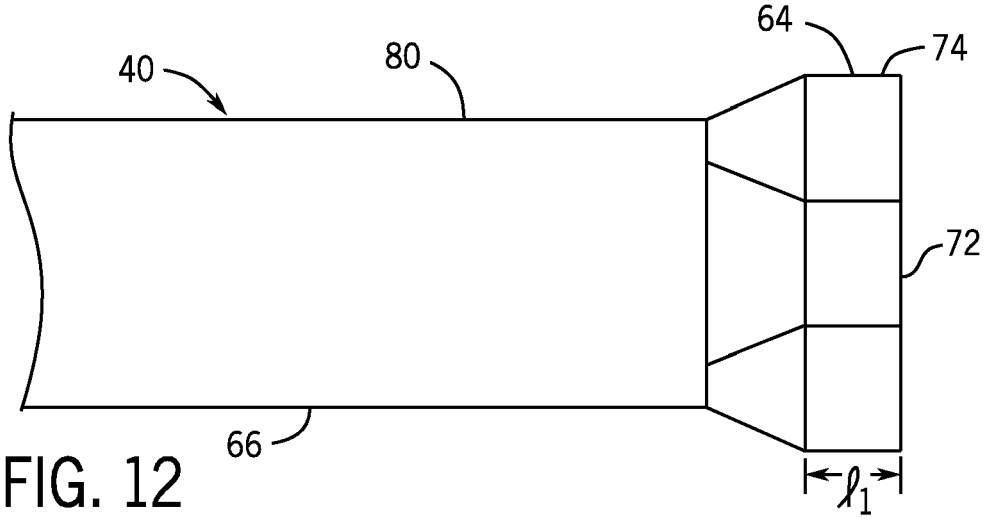


FIG. 12

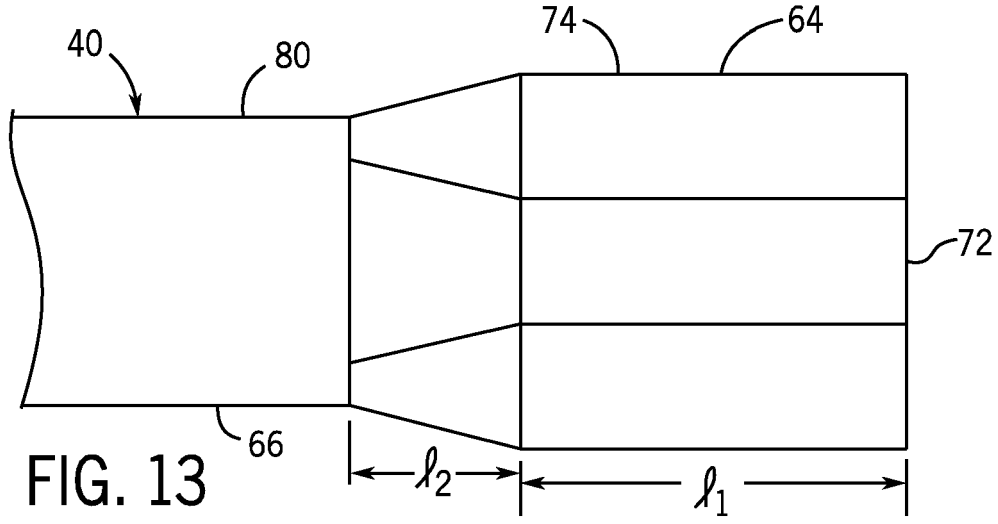


FIG. 13

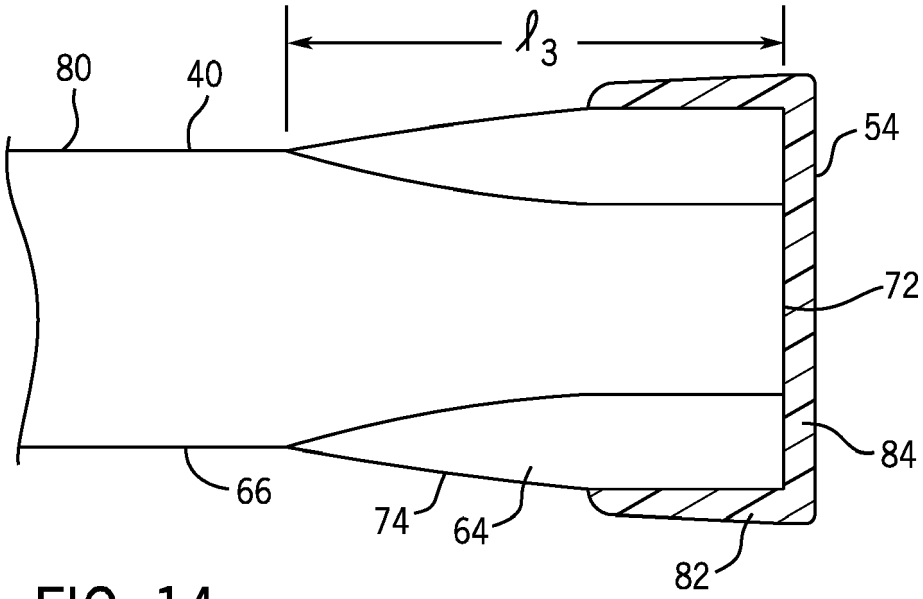


FIG. 14

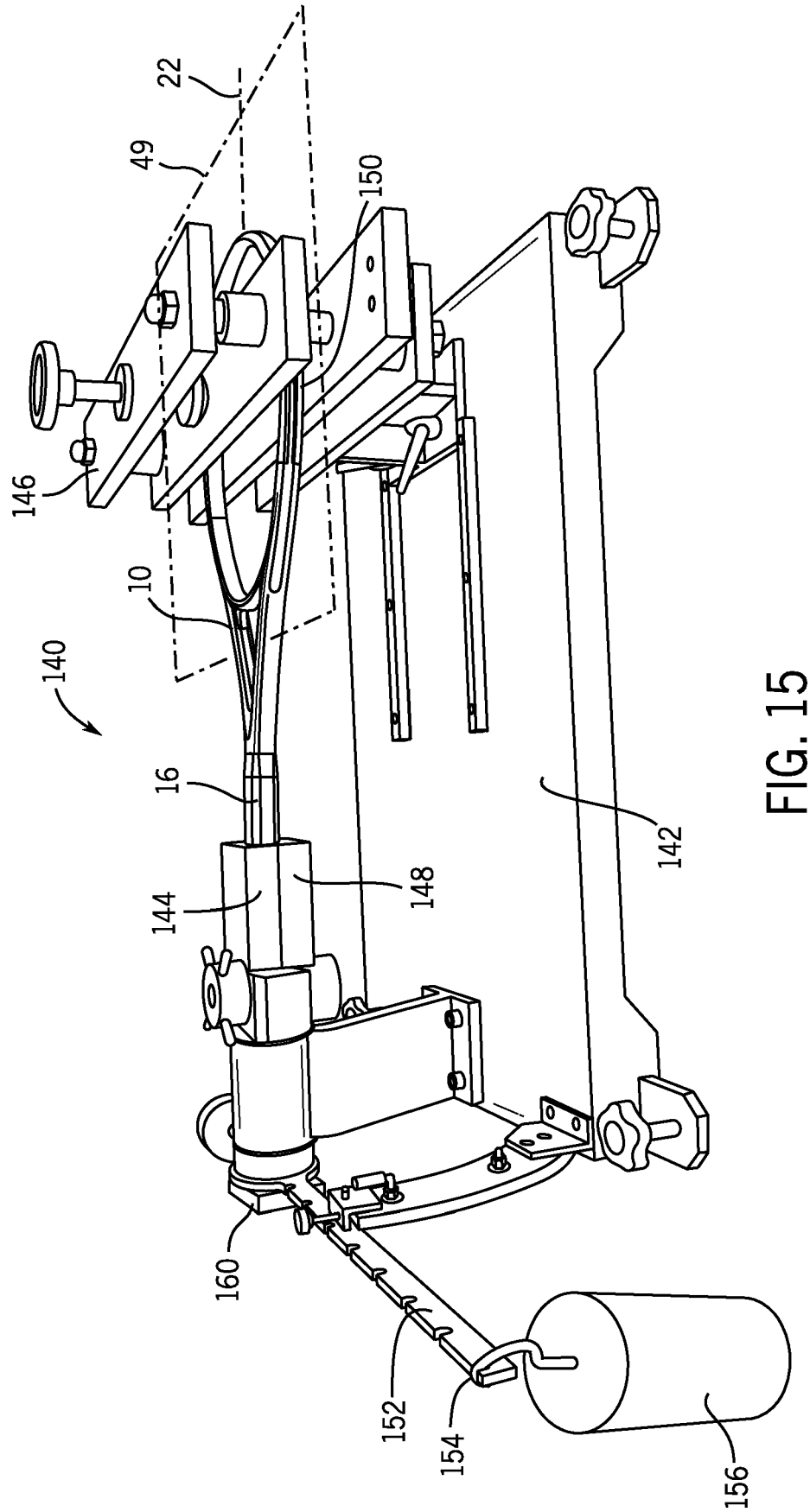


FIG. 15

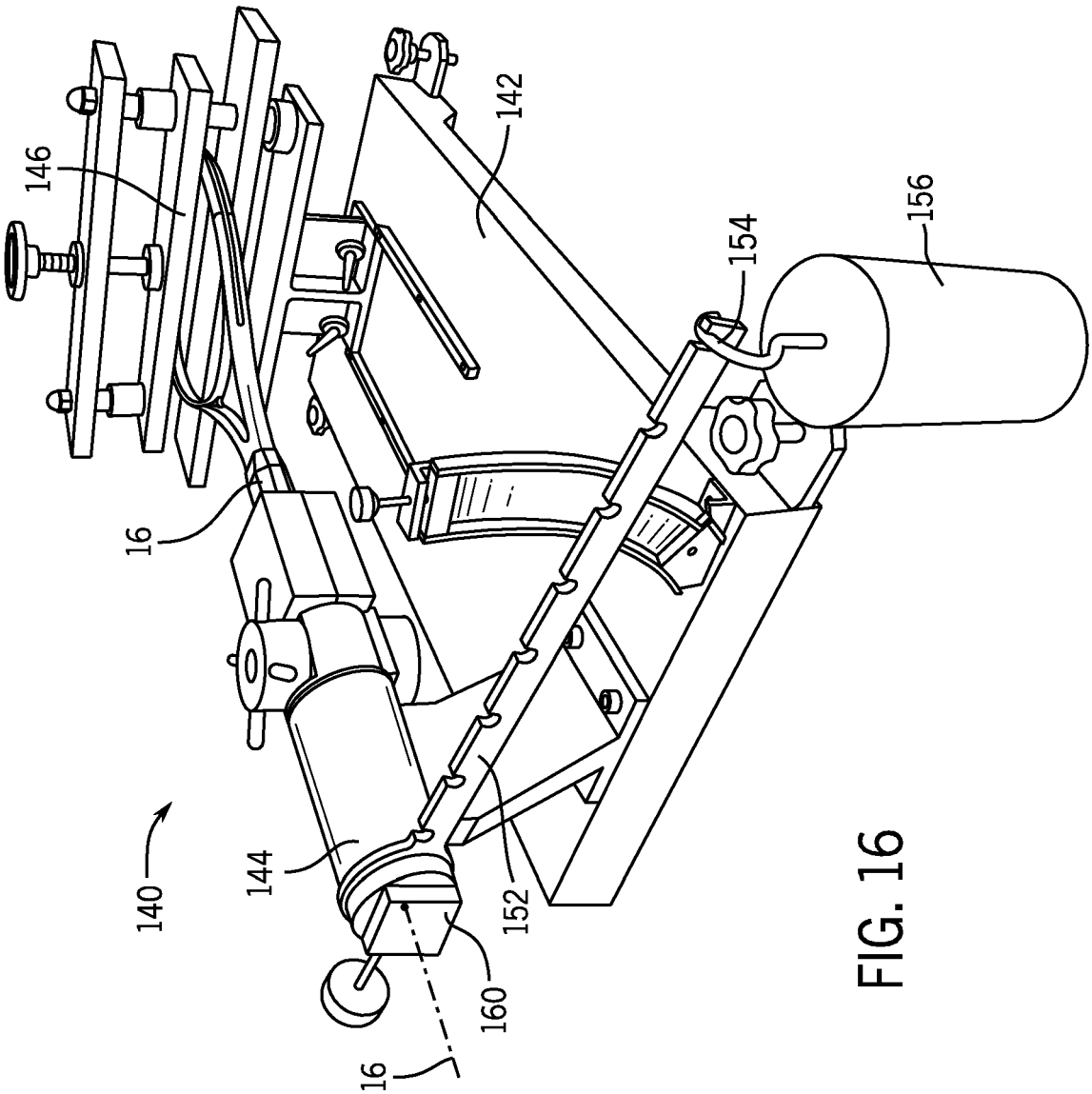


FIG. 16

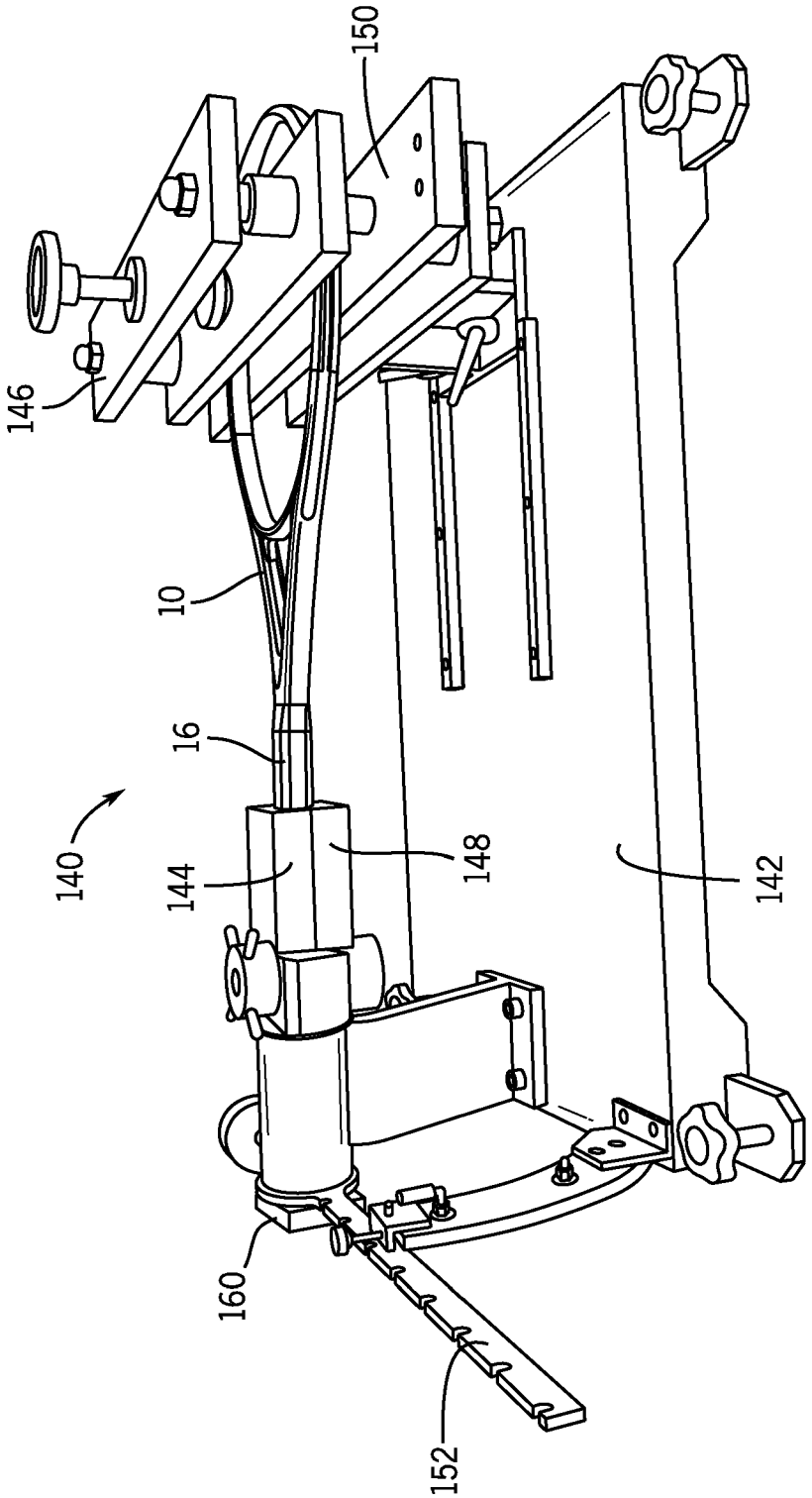


FIG. 17

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EUROPEAN SEARCH REPORT

Application Number
EP 22 17 0657

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	JP H06 63068 U (YAMAHA CORPORATION) 6 September 1994 (1994-09-06) * paragraphs [0018]-[0019]; figures 1-2, 4 *	1,12	
A	EP 2 522 406 A1 (WILSON SPORTING GOODS [US]) 14 November 2012 (2012-11-14) * paragraphs [0025], [0031], [0033]; figures 1-4, 6A-7C *	1,12	
A	US 4 961 572 A (BADILLO PAUL [US] ET AL) 9 October 1990 (1990-10-09) * figures 4-6, 9-13, 16-24 *	7,8,13, 14	TECHNICAL FIELDS SEARCHED (IPC) A63B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	23 November 2022	Vesin, Stéphane

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 17 0657

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82