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(54) RACKET

(57) A tennis racket includes throats 16. Each throat 16 includes a fiber reinforced layer 34 and a vibration damper 36. The vibration damper 36 is surrounded by the fiber reinforced layer 34. The fiber reinforced layer 34 includes a plurality of reinforcement fibers and a matrix. The reinforcement fibers are typically carbon fibers. The material of the matrix is a resin composition whose base material is an epoxy resin. The vibration damper 36 is formed of a polymer composition. The polymer composition contains a base polymer. The base polymer is preferably a styrene-isoprene-styrene block copolymer or an acrylic elastomer.

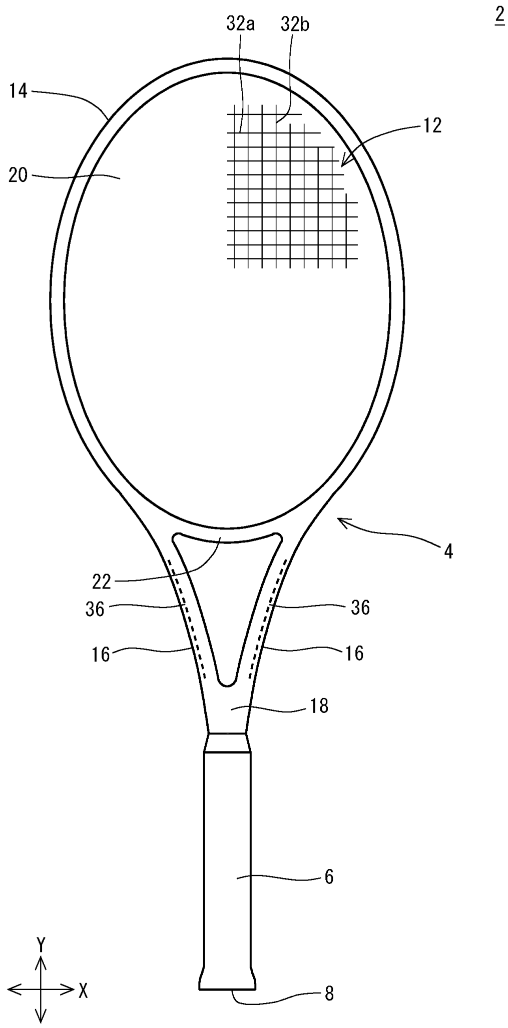

FIG. 1

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Description

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to and the benefit of Japanese Patent Application No. 2020-101333, filed on June 11, 2020, the entire disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to rackets for use in, for example, tennis.

Description of the Related Art

[0003] When a player hits a ball with a tennis racket, the racket vibrates. The vibration propagates to the player, thereby causing discomfort to the player.

[0004] Japanese Laid-Open Patent Application Publication No. 2002-045444 discloses a racket frame including a fiber reinforced layer and a vibration absorber. The vibration absorber is inserted in the fiber reinforced layer. The vibration absorber can suppress the vibration that propagates to the player.

[0005] The vibration absorber disclosed in Japanese Laid-Open Patent Application Publication No. 2002-045444 has insufficient adhesion to the fiber reinforced layer. Such a vibration absorber impairs the stiffness of the frame. A racket that is inferior in stiffness is also inferior in rebound performance.

[0006] An object of the present invention is to provide a racket that is not only capable of suppressing the vibration that propagates to the player, but also has excellent stiffness.

SUMMARY OF THE INVENTION

[0007] A racket according to the present invention includes a frame. The frame includes a fiber reinforced layer and a vibration damper joined to the fiber reinforced layer. The fiber reinforced layer includes a reinforcement fiber and a matrix whose base material is an epoxy resin. A material of the vibration damper is a polymer composition whose base material is a styrene-isoprene-styrene block copolymer or an acrylic elastomer.

[0008] In the racket according to the present invention, the vibration damper damps vibration that occurs at the frame. Therefore, vibration that propagates to a player using the racket can be suppressed. This allows the player to have an excellent feel at impact. The vibration damper is excellent in adhesion to the epoxy resin of the fiber reinforced layer. Therefore, the vibration damper does not significantly impair the stiffness of the racket. The racket not only provides an excellent feel at impact, but also has excellent stiffness.

[0009] The frame may include a head, two throats, and a shaft. Preferably, each throat includes the vibration damper.

[0010] Preferably, a thickness of the vibration damper is greater than or equal to 0.10 mm but less than or equal to 1.00 mm.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

FIG. 1 is a front view of a racket according to one embodiment of the present invention.
FIG. 2 is an enlarged exploded view of a part of the racket of FIG. 1.
FIG. 3 is an enlarged front view of a part of the racket of FIG. 1.
FIG. 4 is an enlarged sectional view taken along line IV-IV in FIG. 3.
FIG. 5 is a sectional view taken along line V-V in FIG. 4.
FIG. 6 is an enlarged sectional view of a part of the racket of FIG. 5.
FIG. 7 is a perspective view showing a part of a manufacturing process of the racket of FIG. 1.
FIG. 8 is a sectional view of a part of a racket according to another embodiment of the present invention.
FIG. 9 is a sectional view of a part of a racket according to yet another embodiment of the present invention.
FIG. 10 is a sectional view of a part of a racket according to yet another embodiment of the present invention.
FIG. 11 is a sectional view of a part of a racket according to yet another embodiment of the present invention.
FIG. 12 is a front view of a racket according to yet another embodiment of the present invention.
FIG. 13 is an enlarged sectional view taken along line XIII-XIII in FIG. 12.

FIG. 14 is a front view of a racket according to yet another embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] Hereinafter, the present invention is described in detail based on preferred embodiments with appropriate reference to the accompanying drawings.

[0013] FIGS. 1 and 2 show a tennis racket 2. The tennis racket 2 includes a frame 4, a grip 6, an end cap 8, a grommet 10, and a string 12. The tennis racket 2 can be used in regulation-ball tennis. In FIG. 1, an arrow X represents the width direction of the tennis racket 2, and an arrow Y represents the axial direction of the tennis racket 2.

[0014] The frame 4 includes a head 14, two throats 16, and a shaft 18. The head 14 forms the contour of a face 20 (the face 20 will be described below in detail). The front shape of the head 14 is substantially an ellipse. The major axis direction of the ellipse coincides with the axial direction Y of the tennis racket 2. The minor axis direction of the ellipse coincides with the width direction X of the tennis racket 2. One end of each throat 16 is continuous with the head 14. Each throat 16, at the vicinity of the other end thereof, merges with the other throat 16. The throats 16 extend from the head 14 to the shaft 18. The shaft 18 extends from the location where the two throats 16 merge together. The shaft 18 is formed so as to be continuous with, and integrated with, the throats 16. A portion of the head 14, the portion being positioned between the two throats 16, is a yoke 22. The frame 4 is hollow.

[0015] The main material of the frame 4 is a fiber reinforced resin. In the present embodiment, the matrix resin of the fiber reinforced resin is a thermosetting resin. The thermosetting resin is typically an epoxy resin. The fibers of the fiber reinforced resin are typically carbon fibers. The fibers are long filament fibers.

[0016] As shown in FIG. 2, the head 14 includes a grommet groove 24. The grommet groove 24 is recessed from the outer peripheral surface of the head 14. The grommet groove 24 is formed over substantially the entire periphery of the head 14, except the yoke 22.

[0017] The head 14 further includes a plurality of holes 26. Each hole 26 extends through the head 14. The plurality of holes 26 are arranged over substantially the entire periphery of the head 14.

[0018] The grip 6 is formed by a tape wound around the shaft 18. The grip 6 suppresses a slip between a hand of a player and the tennis racket 2 when the tennis racket 2 is swung. The end cap 8 is attached to the end of the grip 6.

[0019] As shown in FIG. 2, the grommet 10 includes a base 28 and a plurality of pipes 30. The base 28 is belt-shaped. Each pipe 30 is formed so as to be integrated with the base 28. The pipe 30 rises from the base 28. Atypical material of the grommet 10 is a synthetic resin that is softer than the frame 4. The tennis racket 2 may include a plurality of grommets 10. Each grommet 10 may be spaced apart from its adjacent grommet(s) 10. The number of pipes 30 of each grommet 10 may be one.

[0020] The grommet 10 is attached to the head 14. In a state where the grommet 10 is attached to the head 14, the base 28 is accommodated in the grommet groove 24. The base 28 may partly protrude from the grommet groove 24. Further, in the state where the grommet 10 is attached to the head 14, the pipes 30 extend through the respective holes 26.

[0021] As shown in FIG. 1, the string 12 is stretched on the head 14. The string 12 is stretched along the width direction X and the axial direction Y. The string 12 forms a large number of threads. Of the string 12, portions extending along the width direction X are referred to as transverse threads 32a. Of the string 12, portions extending along the axial direction Y are referred to as longitudinal threads 32b. The face 20 is formed by a plurality of transverse threads 32a and a plurality of longitudinal threads 32b. The face 20 generally extends along an X-Y plane. The face 20 may be formed by two or more strings 12.

[0022] FIG. 3 is an enlarged front view of a part of the tennis racket 2 of FIG. 1. FIG. 3 shows the frame 4 in the vicinity of the throats 16. FIG. 3 shows a pair of left and right throats 16. FIG. 4 is an enlarged sectional view taken along line IV-IV in FIG. 3. FIG. 5 is a sectional view taken along line V-V in FIG. 4. FIG. 4 shows the right-side throat 16. The left-side throat 16 has a shape that is left-right reversed from the shape shown in FIG. 4. FIG. 5 shows the right-side throat 16. The left-side throat 16 has a shape that is left-right reversed from the shape shown in FIG. 5.

[0023] FIGS. 4 and 5 show a fiber reinforced layer 34 and a vibration damper 36. The fiber reinforced layer 34 includes a plurality of reinforcement fibers and a matrix. The reinforcement fibers are typically carbon fibers. The material of the matrix is a resin composition whose base material is an epoxy resin.

[0024] In the present embodiment, the vibration damper 36 is laminar. The vibration damper 36 is surrounded by the fiber reinforced layer 34. The vibration damper 36 is disposed in the outer side of the throat 16 in the width direction (the right side in FIG. 4), i.e., disposed unevenly in the throat 16. Alternatively, the vibration damper 36 may be unevenly disposed in the inner side of the throat 16 in the width direction (the left side in FIG. 4).

[0025] The vibration damper 36 is formed of a polymer composition. The polymer composition contains a base polymer. The polymer composition may contain additive agents as necessary.

[0026] The base polymer of the vibration damper 36 is typically a styrene-isoprene-styrene block copolymer. The styrene-isoprene-styrene block copolymer contains a polystyrene block as a hard segment and a polyisoprene block as a soft segment. One example of a sheet molded from the styrene-isoprene-styrene block copolymer is "KRAIBON" (trade name) available from Gummiwerk KRAIBURG GmbH & Co. KG.

[0027] The vibration damper 36 whose base material is the styrene-isoprene-styrene block copolymer has excellent damping performance. When a player hits a ball with the tennis racket 2, the frame 4 vibrates. The vibration damper 36 gradually decreases the amplitude of the vibration. In the case of the tennis racket 2, the amplitude of the vibration that propagates to the player is small. Therefore, the player feels less discomfort when hitting the ball with the tennis racket 2. The tennis racket 2 provides an excellent feel at impact.

[0028] As previously described, in the present embodiment, the vibration damper 36 is present in each throat 16. When the player hits a ball with the face 20, vibration is generated at the head 14, and the vibration is damped by the throat 16. Then, the damped vibration propagates to the player.

[0029] Since the styrene-isoprene-styrene block copolymer has excellent vibration damping performance, even though the vibration damper 36 is thin, the vibration damper 36 can contribute to the feel at impact. The thin vibration damper 36 does not significantly impair the stiffness of the frame 4.

[0030] The styrene-isoprene-styrene block copolymer is excellent in adhesion to epoxy resins. Therefore, the vibration damper 36 can be firmly joined to the fiber reinforced layer 34. The firm joining can contribute to the stiffness of the frame 4. The tennis racket 2 having excellent stiffness has excellent rebound performance. The player can hit a fast shot by using the tennis racket 2. The firm joining can also contribute to the durability of the tennis racket 2.

[0031] Another base polymer suitable for use in the vibration damper 36 is an acrylic elastomer. The acrylic elastomer contains an acrylic resin block as a hard segment and a soft segment. One example of a sheet molded from the acrylic elastomer is "PIEZON" (trade name) available from TITECS JAPAN Inc.

[0032] The vibration damper 36 whose base material is the acrylic elastomer has excellent damping performance. When a player hits a ball with the tennis racket 2, the frame 4 vibrates. The vibration damper 36 gradually decreases the amplitude of the vibration. In the case of the tennis racket 2, the amplitude of the vibration that propagates to the player is small. Therefore, the player feels less discomfort when hitting the ball with the tennis racket 2. The tennis racket 2 provides an excellent feel at impact.

[0033] Since the acrylic elastomer has excellent vibration damping performance, even though the vibration damper 36 is thin, the vibration damper 36 can contribute to the feel at impact. The thin vibration damper 36 does not significantly impair the stiffness of the frame 4.

[0034] The acrylic elastomer is excellent in adhesion to epoxy resins. Therefore, the vibration damper 36 can be firmly joined to the fiber reinforced layer 34. The firm joining can contribute to the stiffness of the frame 4. The tennis racket 2 having excellent stiffness has excellent rebound performance. The player can hit a fast shot by using the tennis racket 2. The firm joining can also contribute to the durability of the tennis racket 2.

[0035] FIG. 6 is a further enlarged sectional view of the tennis racket 2 of FIG. 5. FIG. 6 shows the throat 16. In FIG. 6, an arrow Ti indicates the thickness of the vibration damper 36. Preferably, the thickness Ti is greater than or equal to 0.10 mm but less than or equal to 1.00 mm. An excellent feel at impact can be achieved by the vibration damper 36 having the thickness Ti of greater than or equal to 0.10 mm. In light of this, the thickness Ti is more preferably greater than or equal to 0.20 mm, and particularly preferably greater than or equal to 0.30 mm. The vibration damper 36 having the thickness Ti of less than or equal to 1.00 mm does not significantly impair the stiffness of the frame 4. In light of this, the thickness Ti is more preferably less than or equal to 0.80 mm, and particularly preferably less than or equal to 0.60 mm.

[0036] In FIG. 3, an arrow Le indicates the length of the vibration damper 36. In light of vibration damping performance, the length Le is preferably greater than or equal to 30 mm, more preferably greater than or equal to 50 mm, and particularly preferably greater than or equal to 60 mm.

[0037] The total of the lengths Le of all the vibration dampers 36 in the tennis racket 2 is preferably greater than or equal to 50 mm, more preferably greater than or equal to 80 mm, and particularly preferably greater than or equal to 100 mm.

[0038] Preferably, the Shore A hardness of the vibration damper 36 is higher than or equal to 40 but lower than or equal to 95. The vibration damper 36 having the Shore A hardness of higher than or equal to 40 does not significantly impair the stiffness of the frame 4. In light of this, the Shore A hardness of the vibration damper 36 is more preferably higher than or equal to 45, and particularly preferably higher than or equal to 50. An excellent feel at impact can be achieved by the vibration damper 36 having the Shore A hardness of lower than or equal to 95. In light of this, the Shore A hardness of the vibration damper 36 is more preferably lower than or equal to 90, and particularly preferably lower than or equal to 87. The Shore A hardness of the vibration damper 36 is measured by using a test piece that contains the same material as that of the vibration damper 36. The measurement is performed in compliance with the "JIS K 6253-3" standards.

[0039] Preferably, the elongation rate at break (hereinafter, simply referred to as "elongation rate") of the vibration damper 36 is higher than or equal to 200%. An excellent feel at impact can be achieved by the vibration damper 36 having the elongation rate of higher than or equal to 200%. In light of this, the elongation rate is more preferably higher than or equal to 240%, and particularly preferably higher than or equal to 260%. The elongation rate is measured by a tensile test. The tensile test is performed in compliance with the "JIS K 6251" standards.

[0040] Hereinafter, one example of a method of manufacturing the tennis racket 2 according to the present invention is described with reference to FIG. 7. In this manufacturing method, a mandrel, a tube, a plurality of prepregs 38, and two films are prepared. Each prepreg 38 is made from a plurality of reinforcement fibers arranged in parallel and a matrix resin. In this manufacturing method, first, the mandrel is inserted into the tube. The prepregs 38 are sequentially wound around the tube. As a result of the winding, the prepregs 38 have a tubular shape. FIG. 7 shows a tubular prepreg 38a and a sheet-shaped prepreg 38b. Two films 40 are placed on the sheet-shaped prepreg 38b. In FIG. 7, the illustration of the mandrel and the tube is omitted.

[0041] By rotating the mandrel, the prepreg 38b is wound around the prepreg 38a. As a result of the winding, the prepreg 38b has a tubular shape. Each film 40 is sandwiched between the prepreg 38a and the prepreg 38b. Another prepreg 38 or prepregs 38 is/are wound around the prepreg 38b as necessary.

[0042] After the mandrel is removed from the tube, the tube and the prepregs 38 are set in a mold. In the mold, gas is injected into the tube, thereby inflating the tube. The prepregs 38 are pressed against the cavity surface of the mold by the inflation. The prepregs 38 are heated to cure the matrix resin. A molded article is obtained by the curing. The molded article has a reverse shape of that of the cavity surface.

[0043] The holes 26 are drilled in the molded article. The molded article is further subjected to treatments such as surface polishing and painting, and thereby the frame 4 is obtained. Components such as the grip 6 and the grommet 10 are attached to the frame 4. Further, the string 12 is stretched on the frame 4, and thus the manufacturing of the tennis racket 2 is completed. The vibration damper 36 of the left-side throat 16 is formed by one film 40. The vibration damper 36 of the right-side throat 16 is formed by the other film 40.

[0044] FIG. 8 is a sectional view of a part of a tennis racket according to another embodiment of the present invention. FIG. 8 shows a cross section of a right-side throat 42. The cross-sectional shape of the left-side throat 42 and the cross-sectional shape of the right-side throat 42 are symmetrical with each other. The configuration of each part of the tennis racket, except the throats, is the same as that of the tennis racket 2 shown in FIG. 1.

[0045] The tennis racket includes a fiber reinforced layer 44, a first vibration damper 46, and a second vibration damper 48. The fiber reinforced layer 44 includes a plurality of reinforcement fibers and a matrix. The reinforcement fibers are typically carbon fibers. The material of the matrix is a resin composition whose base material is an epoxy resin. The first vibration damper 46 is surrounded by the fiber reinforced layer 44. The second vibration damper 48 is surrounded by the fiber reinforced layer 44. The fiber reinforced layer 44 is present between the first vibration damper 46 and the second vibration damper 48. The second vibration damper 48 is spaced apart from the first vibration damper 46.

[0046] The material, thickness, and physical properties of the first vibration damper 46 are the same as those of the vibration damper 36 shown in FIG. 4. The first vibration damper 46 is firmly joined to the fiber reinforced layer 44. The material, thickness, and physical properties of the second vibration damper 48 are the same as those of the vibration damper 36 shown in FIG. 4. The second vibration damper 48 is firmly joined to the fiber reinforced layer 44.

[0047] When a player hits a ball with the tennis racket, the frame vibrates. The first vibration damper 46 and the second vibration damper 48 gradually decrease the amplitude of the vibration. In the case of this tennis racket, the amplitude of the vibration that propagates to the player is small. Therefore, the player feels less discomfort when hitting the ball with the tennis racket. The tennis racket provides an excellent feel at impact.

[0048] FIG. 9 is a sectional view of a part of a tennis racket according to yet another embodiment of the present invention. FIG. 9 shows a cross section of a right-side throat 50. The cross-sectional shape of the left-side throat 50 and the cross-sectional shape of the right-side throat 50 are symmetrical with each other. The configuration of each part of the tennis racket, except the throats, is the same as that of the tennis racket 2 shown in FIG. 1.

[0049] The tennis racket includes a fiber reinforced layer 52, a first vibration damper 54, and a second vibration damper 56. The fiber reinforced layer 52 includes a plurality of reinforcement fibers and a matrix. The reinforcement fibers are typically carbon fibers. The material of the matrix is a resin composition whose base material is an epoxy resin. The first vibration damper 54 is surrounded by the fiber reinforced layer 52. The position of the first vibration damper 54 is shifted from the center of the throat 50 toward the outer side in the width direction (the right side in FIG. 9). The second vibration damper 56 is surrounded by the fiber reinforced layer 52. The position of the second vibration damper 56 is shifted from the center of the throat 50 toward the inner side in the width direction (the left side in FIG. 9).

[0050] The material, thickness, and physical properties of the first vibration damper 54 are the same as those of the vibration damper 36 shown in FIG. 4. The first vibration damper 54 is firmly joined to the fiber reinforced layer 52. The material, thickness, and physical properties of the second vibration damper 56 are the same as those of the vibration damper 36 shown in FIG. 4. The second vibration damper 56 is firmly joined to the fiber reinforced layer 52.

[0051] When a player hits a ball with the tennis racket, the frame vibrates. The first vibration damper 54 and the second vibration damper 56 gradually decrease the amplitude of the vibration. In the case of this tennis racket, the amplitude of the vibration that propagates to the player is small. Therefore, the player feels less discomfort when hitting the ball with the tennis racket. The tennis racket provides an excellent feel at impact.

[0052] FIG. 10 is a sectional view of a part of a tennis racket according to yet another embodiment of the present invention. FIG. 10 shows a cross section of a right-side throat 58. The cross-sectional shape of the left-side throat 58 and the cross-sectional shape of the right-side throat 58 are symmetrical with each other. The configuration of each part of the tennis racket, except the throats, is the same as that of the tennis racket 2 shown in FIG. 1.

[0053] The tennis racket includes a fiber reinforced layer 60 and a vibration damper 62. The fiber reinforced layer 60 includes a plurality of reinforcement fibers and a matrix. The reinforcement fibers are typically carbon fibers. The material of the matrix is a resin composition whose base material is an epoxy resin. In the cross section of FIG. 10, the vibration damper 62 forms a loop. The vibration damper 62 is surrounded by the fiber reinforced layer 60. The material, thickness, and physical properties of the vibration damper 62 are the same as those of the vibration damper 36 shown in FIG. 4. The vibration damper 62 is firmly joined to the fiber reinforced layer 60.

[0054] When a player hits a ball with the tennis racket, the frame vibrates. The vibration damper 62 gradually decreases the amplitude of the vibration. In the case of this tennis racket, the amplitude of the vibration that propagates to the player is small. Therefore, the player feels less discomfort when hitting the ball with the tennis racket. The tennis racket provides an excellent feel at impact.

[0055] FIG. 11 is a sectional view of a part of a tennis racket according to yet another embodiment of the present invention. FIG. 11 shows a cross section of a right-side throat 64. The cross-sectional shape of the left-side throat 64 and the cross-sectional shape of the right-side throat 64 are symmetrical with each other. The configuration of each part of the tennis racket, except the throats, is the same as that of the tennis racket 2 shown in FIG. 1.

[0056] The tennis racket includes a fiber reinforced layer 66 and a vibration damper 68. The fiber reinforced layer 66 includes a plurality of reinforcement fibers and a matrix. The reinforcement fibers are typically carbon fibers. The material of the matrix is a resin composition whose base material is an epoxy resin. The vibration damper 68 is laminated on the inner surface of the fiber reinforced layer 66. The material, thickness, and physical properties of the vibration damper 68 are the same as those of the vibration damper 36 shown in FIG. 4. The vibration damper 68 is firmly joined to the fiber reinforced layer 66.

[0057] When a player hits a ball with the tennis racket, the frame vibrates. The vibration damper 68 gradually decreases the amplitude of the vibration. In the case of this tennis racket, the amplitude of the vibration that propagates to the player is small. Therefore, the player feels less discomfort when hitting the ball with the tennis racket. The tennis racket provides an excellent feel at impact.

[0058] FIG. 12 is a front view of a tennis racket 70 according to yet another embodiment of the present invention. A head 72 of the tennis racket 70 includes a vibration damper 74. The vibration damper 74 is arranged over substantially the entire head 72, except a yoke 76. Throats 78 of the tennis racket 70 include no vibration damper. Alternatively, in the tennis racket 70, not only does the head 72 include the vibration damper 74, but the throats 78 may each include a vibration damper.

[0059] FIG. 13 is an enlarged sectional view taken along line XIII-XIII in FIG. 12. The head 72 includes a fiber reinforced layer 80 and the vibration damper 74. The fiber reinforced layer 80 includes a plurality of reinforcement fibers and a matrix. The reinforcement fibers are typically carbon fibers. The material of the matrix is a resin composition whose base material is an epoxy resin. The vibration damper 74 is surrounded by the fiber reinforced layer 80. The material, thickness, and physical properties of the vibration damper 74 are the same as those of the vibration damper 36 shown in FIG. 4. The vibration damper 74 is firmly joined to the fiber reinforced layer 80.

[0060] When a player hits a ball with the tennis racket 70, the frame vibrates. The vibration damper 74 gradually decreases the amplitude of the vibration. In the case of the tennis racket 70, the amplitude of the vibration that propagates to the player is small. Therefore, the player feels less discomfort when hitting the ball with the tennis racket 70. The tennis racket 70 provides an excellent feel at impact.

[0061] FIG. 14 is a front view of a tennis racket 82 according to yet another embodiment of the present invention. A head 84 of the tennis racket 82 includes a first vibration damper 86 and a second vibration damper 88. The position of the first vibration damper 86 is shifted to the right from the center of the head 84. The position of the second vibration damper 88 is shifted to the left from the center of the head 84. The first vibration damper 86 and the second vibration damper 88 are symmetrical with each other.

[0062] The material, thickness, and physical properties of the first vibration damper 86 are the same as those of the vibration damper 36 shown in FIG. 4. The first vibration damper 86 is firmly joined to the fiber reinforced layer. The material, thickness, and physical properties of the second vibration damper 88 are the same as those of the vibration damper 36 shown in FIG. 4. The second vibration damper 88 is firmly joined to the fiber reinforced layer.

[0063] When a player hits a ball with the tennis racket 82, the frame vibrates. The first vibration damper 86 and the second vibration damper 88 gradually decrease the amplitude of the vibration. In the case of the tennis racket 82, the amplitude of the vibration that propagates to the player is small. Therefore, the player feels less discomfort when hitting the ball with the tennis racket 82. The tennis racket 82 provides an excellent feel at impact.

EXAMPLES

Example 1

[0064] The tennis racket shown in FIGS. 1 to 6 was obtained. The racket includes a fiber reinforced layer and a vibration damper. The fiber reinforced layer includes reinforcement fibers and a matrix whose base material is an epoxy resin. As the vibration damper, a commercially available sheet (the aforementioned "KRAIBON" (trade name)) was used. The material of the vibration damper is a polymer composition whose base material is a styrene-isoprene-styrene block copolymer. The thickness of the vibration damper is 0.5 mm.

Example 2

[0065] A tennis racket of Example 2 was obtained in the same manner as in Example 1, except that a different commercially available sheet (trade name "PIEZON") was used as the vibration damper. The material of the vibration damper is a polymer composition whose base material is an acrylic elastomer.

Comparative Example 1

[0066] A tennis racket of Comparative Example 1 was obtained in the same manner as in Example 1, except that a different commercially available sheet was used as the vibration damper. The material of the vibration damper is a polymer composition whose base material is chlorinated polyethylene.

Comparative Example 2

[0067] A tennis racket of Comparative Example 2 was obtained in the same manner as in Example 1, except that the tennis racket of Comparative Example 2 includes no vibration damper.

Examples 3 to 8

[0068] Tennis rackets of Examples 3 to 8 were obtained in the same manner as in Example 1, except that the position of the vibration damper was varied as shown in Table 2 below.

Evaluation

[0069] Players did a rally by using each tennis racket. The players evaluated the rebound performance (flight), vibration absorption performance, feel at impact, and control performance of each racket. The evaluation results are shown in Tables 1 and 2 below.

[0070] In Tables 1 and 2, the greater the numerical value, the higher the evaluation.

Table 1: Evaluation results.

	Example 1	Example 2	Comparative Example 1	Comparative Example 2
Material	SIS	AC	PE	-
Position	FIG. 3 FIG. 4	FIG. 3 FIG. 4	FIG. 3 FIG. 4	- -
Rebound performance	8	6	4	8
Vibration absorption performance	8	8	8	3
Feel at impact	9	8	6	4
Control performance	8	8	7	5
Overall evaluation	9	7	6	5
SIS: Styrene-isoprene-styrene block copolymer AC: Acrylic elastomer PE: Chlorinated polyethylene				

Table 2: Evaluation Results.

	Example 3	Example 4	Example 5	Example 6	Example 7	Example 8
Material	SIS	SIS	SIS	SIS	SIS	SIS
Position	FIG. 8	FIG. 9	FIG. 10	FIG. 11	FIG. 12 FIG. 13	FIG. 14
Rebound performance	7	7	7	8	6	7
Vibration absorption performance	9	9	9	7	9	8
Feel at impact	9	9	9	8	9	9
Control performance	8	8	8	8	8	8
Overall evaluation	8	8	8	7	7	8
SIS: Styrene-isoprene-styrene block copolymer AC: Acrylic elastomer PE: Chlorinated polyethylene						

[0071] It is clear from Tables 1 and 2 that the tennis racket in each Example is well-balanced in various performances. These evaluation results clearly indicate the superiority of the present invention.

[0072] The racket according to the present invention can be used in various sports, such as soft tennis, squash, and badminton. The foregoing description is in all aspects illustrative, and various modifications can be made without departing from the essential features of the invention.

Claims

1. A racket (2; 70) comprising a frame (4), wherein
the frame (4) includes a fiber reinforced layer (34) and a vibration damper (36) joined to the fiber reinforced layer (34), the fiber reinforced layer (34) includes a reinforcement fiber and a matrix whose base material is an epoxy resin, and a material of the vibration damper (36) is a polymer composition whose base material is a styrene-isoprene-styrene block copolymer or an acrylic elastomer.

2. The racket (2; 70) according to claim 1, wherein
the frame (4) includes a head (14), two throats (16), and a shaft (18), and
each throat (16) includes the vibration damper (36) and/or wherein
the frame includes a head (72), two throats (78), and a shaft, and the head (72) includes the vibration damper (74).

3. The racket (2, 70) according to claim 2, wherein
the frame (4) includes a head (14) and each of the two throats (16) has a first end that is continuous with the head (14) and a second end that merges with the other throat (16).

4. The racket (2; 70) according to claim 1, 2, or 3, wherein
a thickness (Ti) of the vibration damper (36; 74) is greater than or equal to 0.10 mm but less than or equal to 1.00 mm.

5. The racket (2; 70) according to any one of claims 1 to 4, wherein
the fiber reinforced layer (34) comprises carbon fibers and/or long filament fibers.

6. The racket (2; 70) according to any one of claims 1 to 5, wherein
the frame (4) includes a head (14) and the head (14) includes a grommet groove (24), preferably wherein the grommet groove (24) is recessed from an outer peripheral surface of the head (14) and/or the grommet groove (24) is formed over substantially the entire periphery of the head (14), except a yoke (22).

7. The racket (2; 70) according to any one of claims 1 to 6, wherein the vibration damper (36; 74) is laminar and/or wherein the vibration damper (36; 74) is surrounded by the fiber reinforced layer (34).

8. The racket (2; 70) according to any one of claims 1 to 7, wherein the at least one throat (16) and/or the head (14) is hollow.

9. The racket (2) according to any one of claims 1 to 8, wherein the vibration damper (36) is disposed unevenly in the respective throat (16), preferably wherein the vibration damper (36) is disposed only in an outer side of the respective throat (16) in the width direction or wherein the vibration damper (36) is disposed only in an inner side of the respective throat (16) in the width direction.

10. The racket (2) according to any one of claims 1 to 9, wherein
a length (Le) of at least one of the vibration dampers (36) is greater than or equal to 30 mm, preferably greater than or equal to 50 mm.

11. The racket (2) according to any one of claims 1 to 10, wherein a total of the lengths (Le) of all the vibration dampers (36) in the tennis racket (2) is greater than or equal to 50 mm, preferably greater than or equal to 80 mm.

12. The racket (2; 70) according to any one of claims 1 to 11, wherein a Shore A hardness of the vibration damper (36; 74) is higher than or equal to 40 but lower than or equal to 95.

13. The racket (2; 70) according to any one of claims 1 to 12, wherein an elongation rate at break of the vibration damper (36; 74) is higher than or equal to 200%.

14. The racket (2) according to any one of claims 1 to 13, wherein the racket (2), preferably each of the throats (16), comprises a first vibration damper (46; 54) and a second vibration damper (48; 56).

15. The racket (70) according to any one of claims 1 to 14, wherein
the frame (4) includes a head (72) with a vibration damper (74)., preferably wherein the vibration damper (74) is arranged over substantially the entire head (72), except a yoke (76).

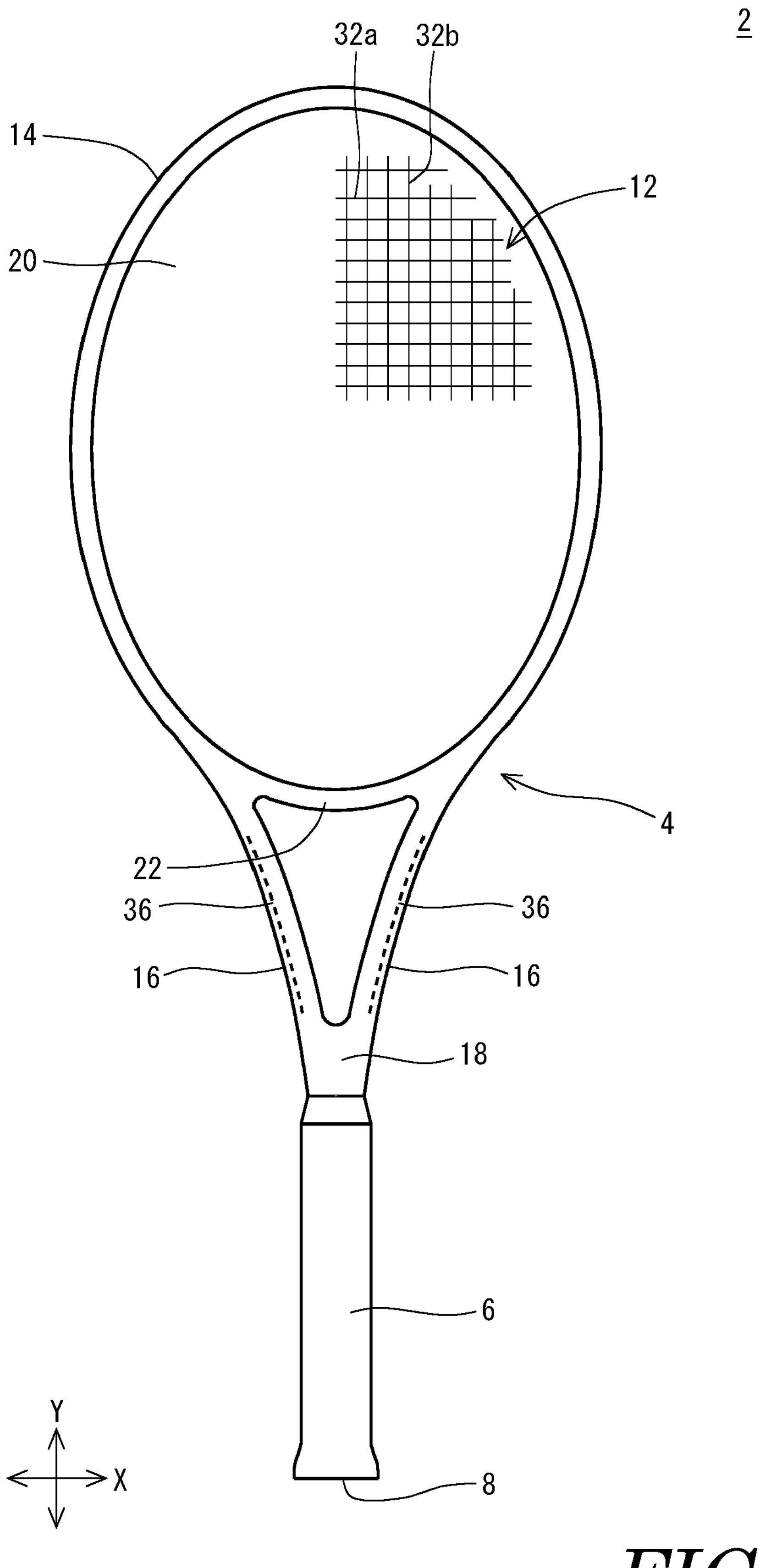


FIG. 1

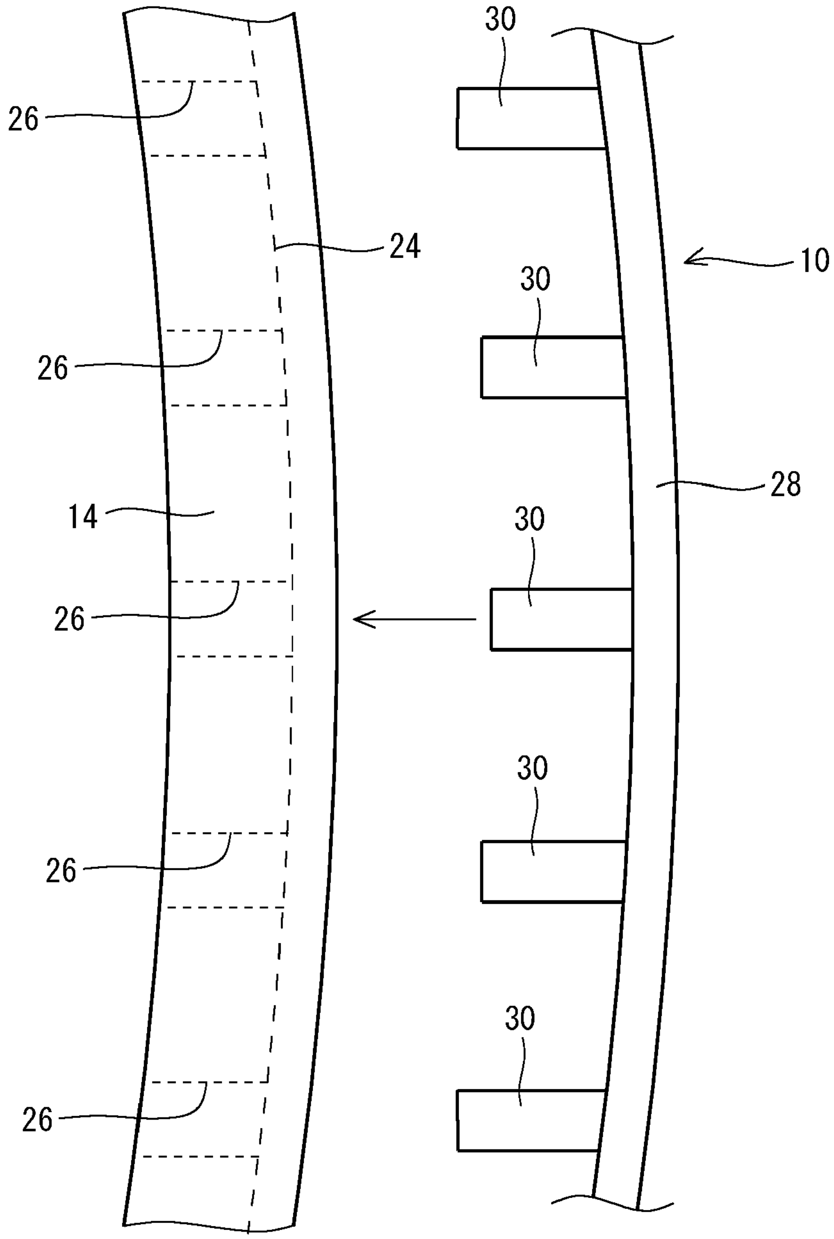


FIG. 2

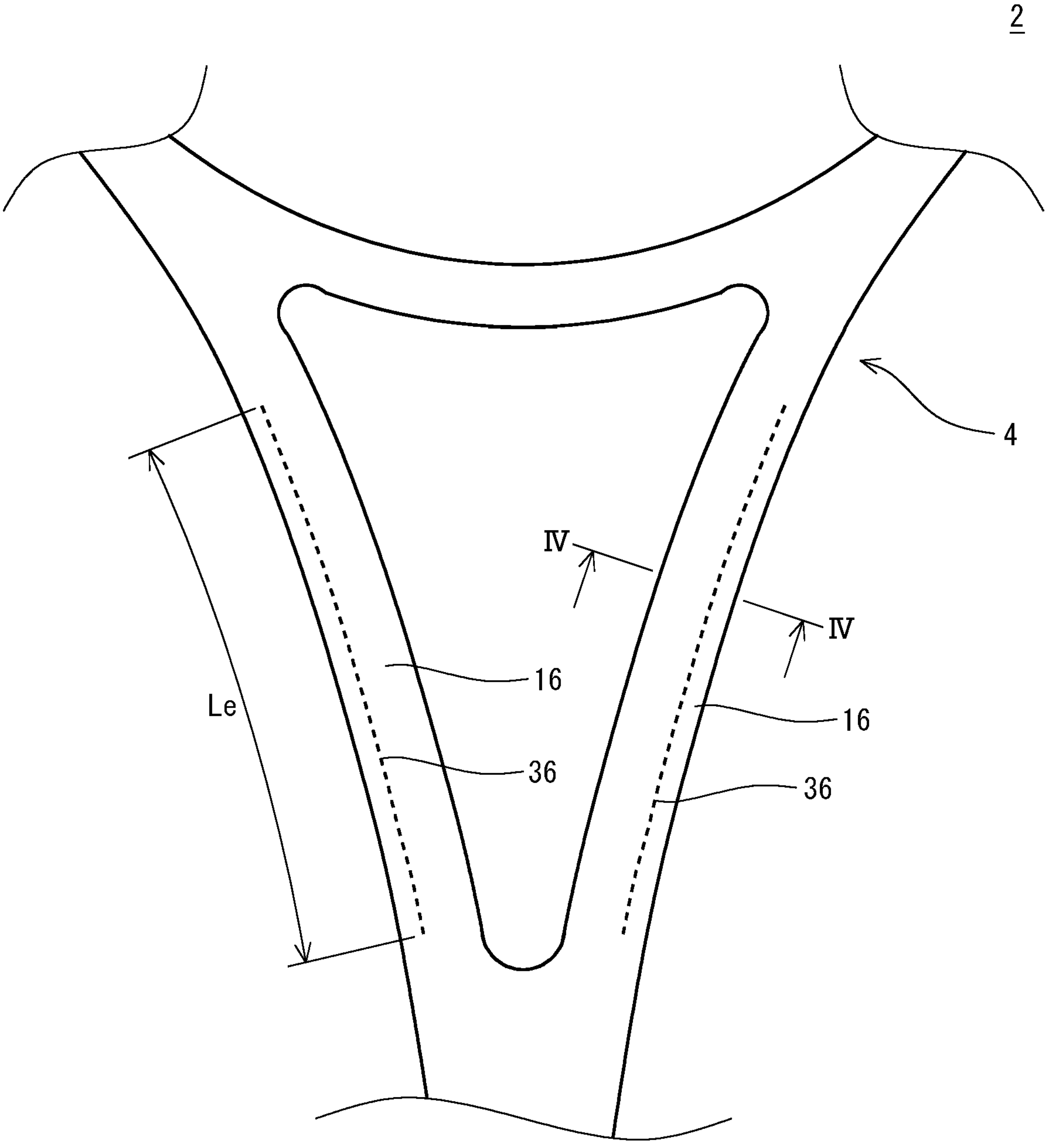


FIG. 3

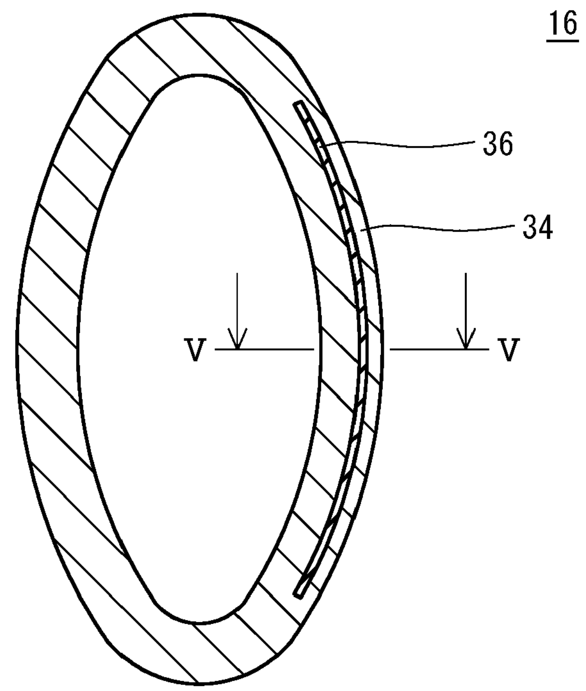


FIG. 4

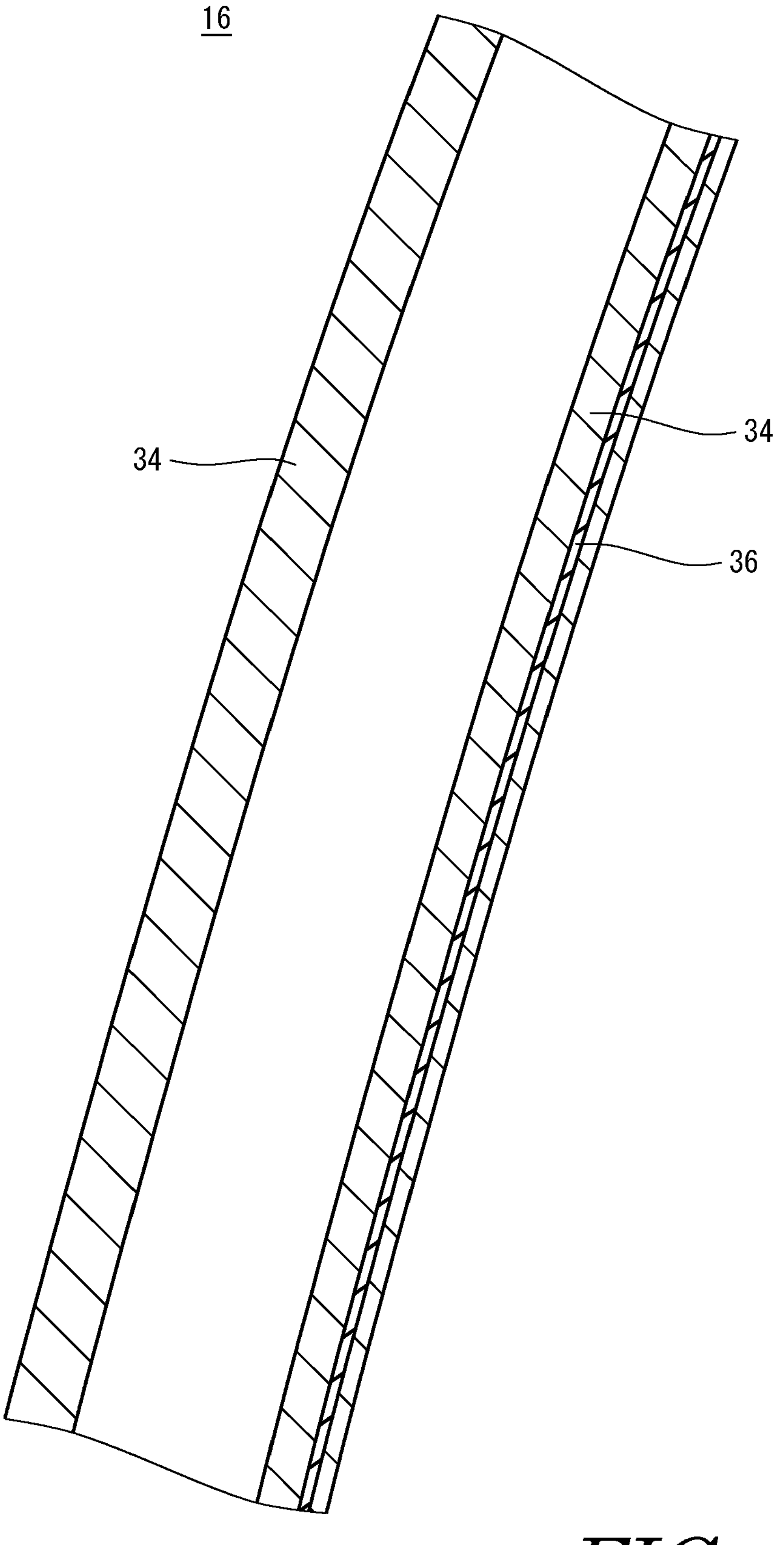
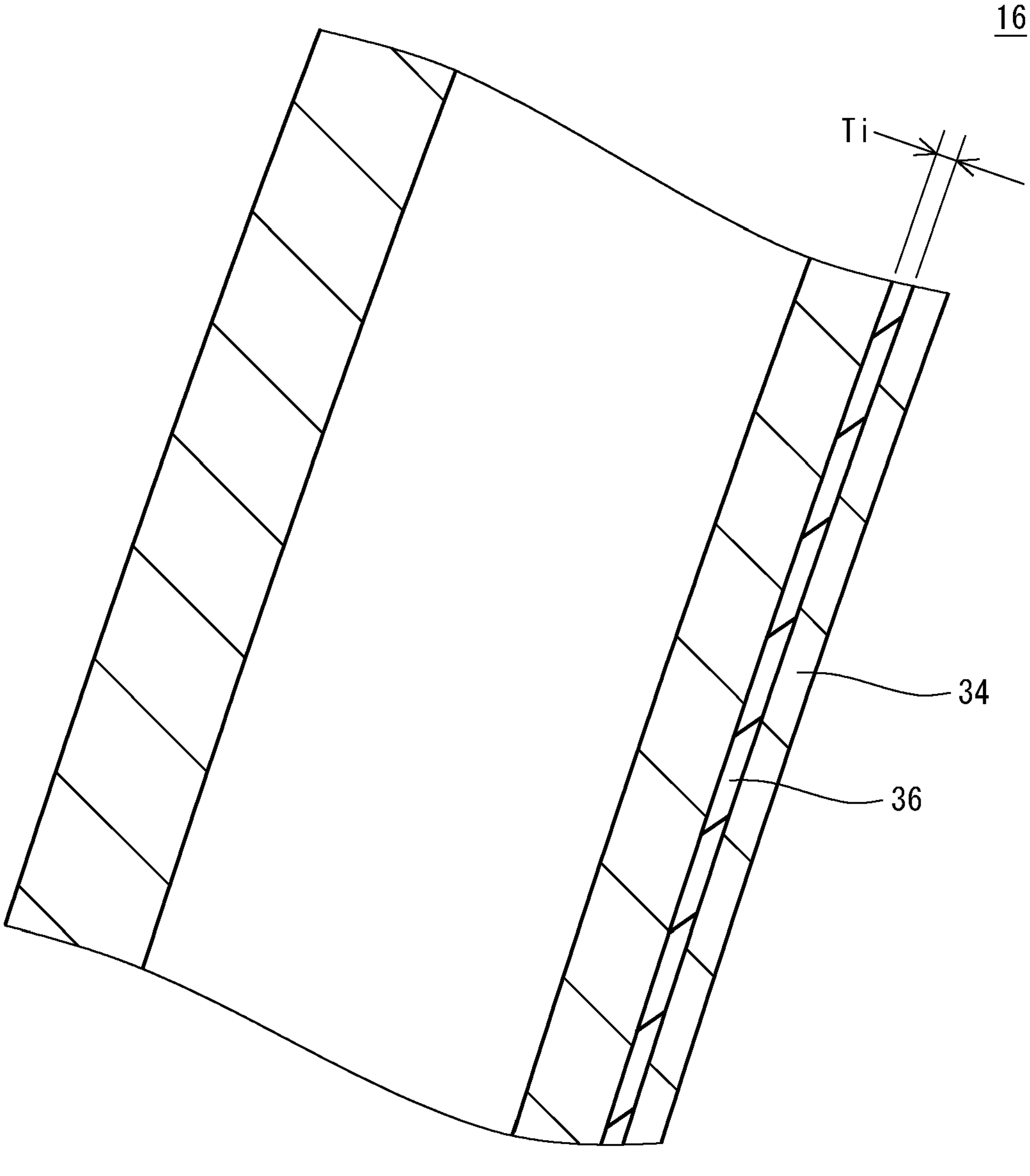


FIG. 5



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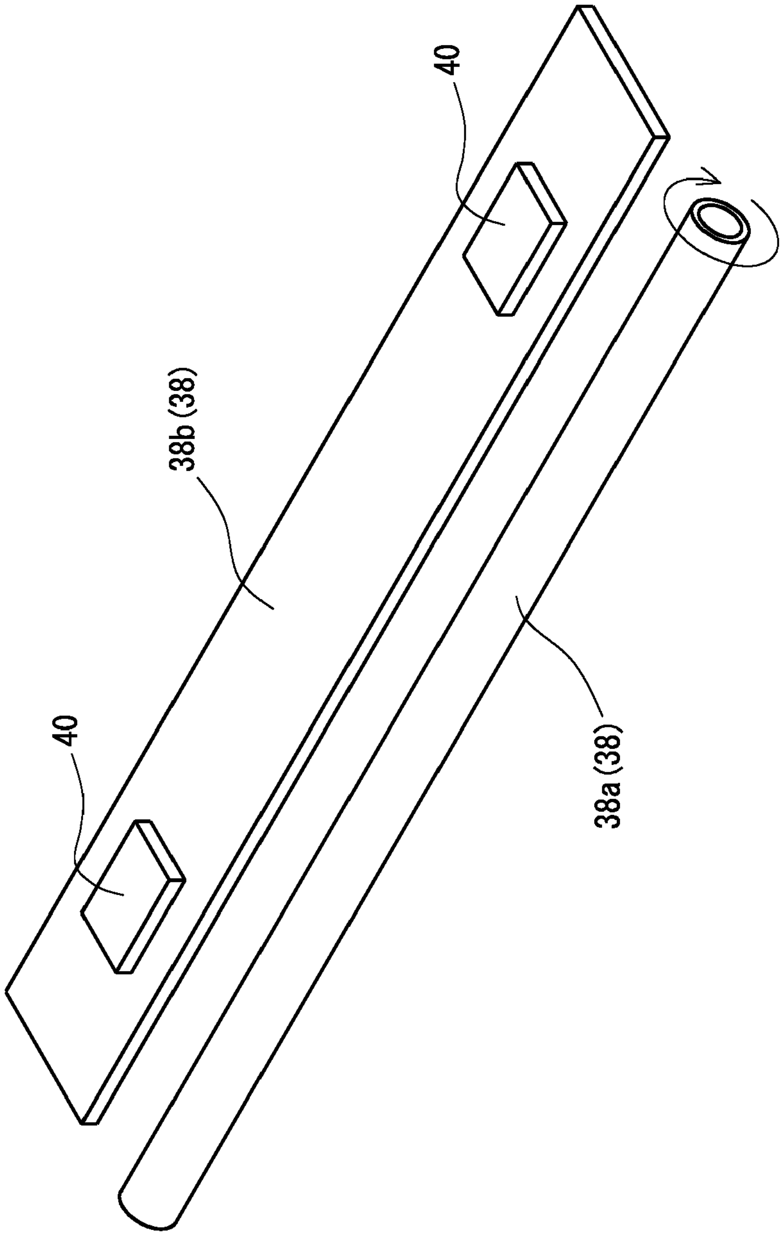

FIG. 7

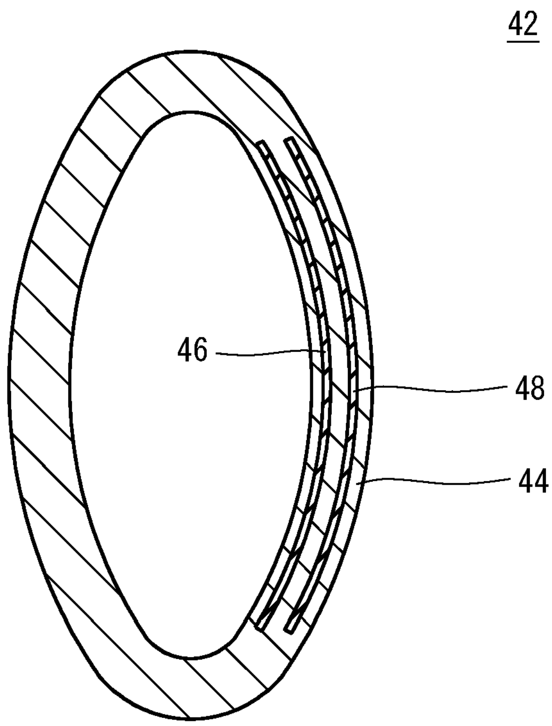

FIG. 8

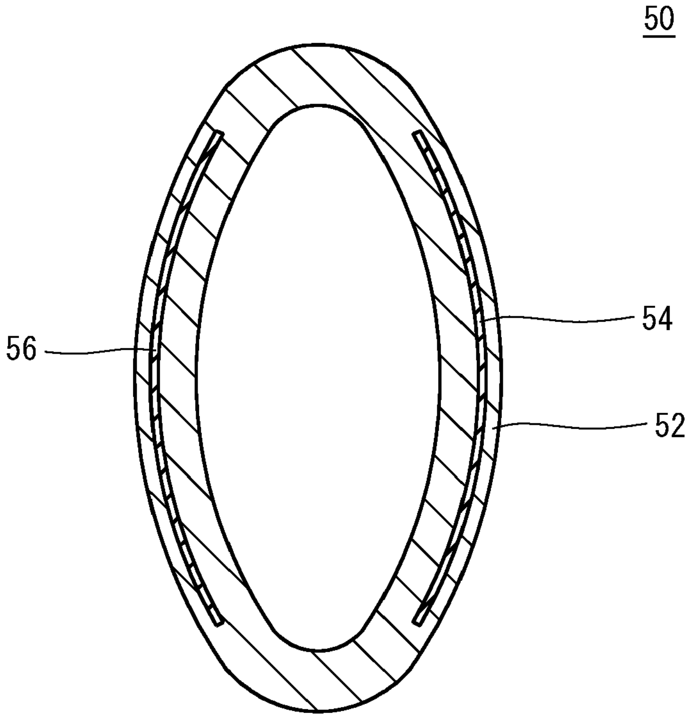

FIG. 9

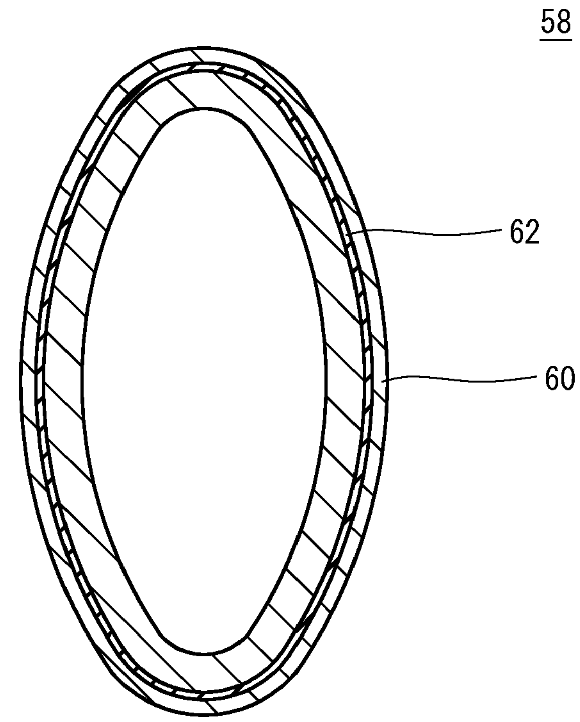

FIG. 10

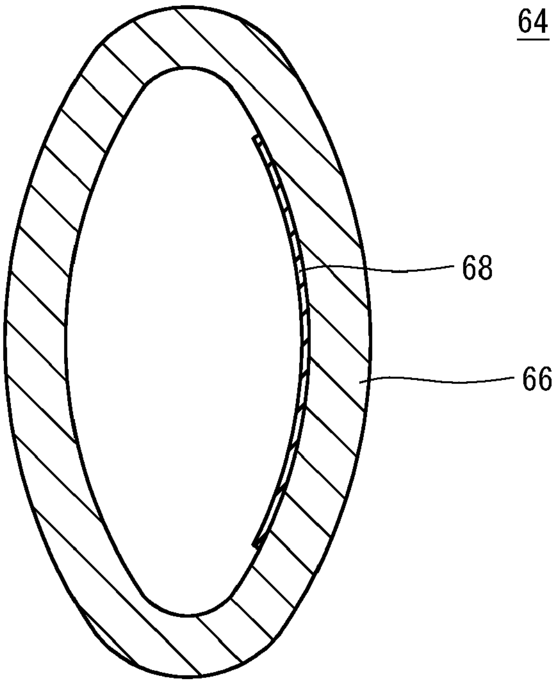

FIG. 11

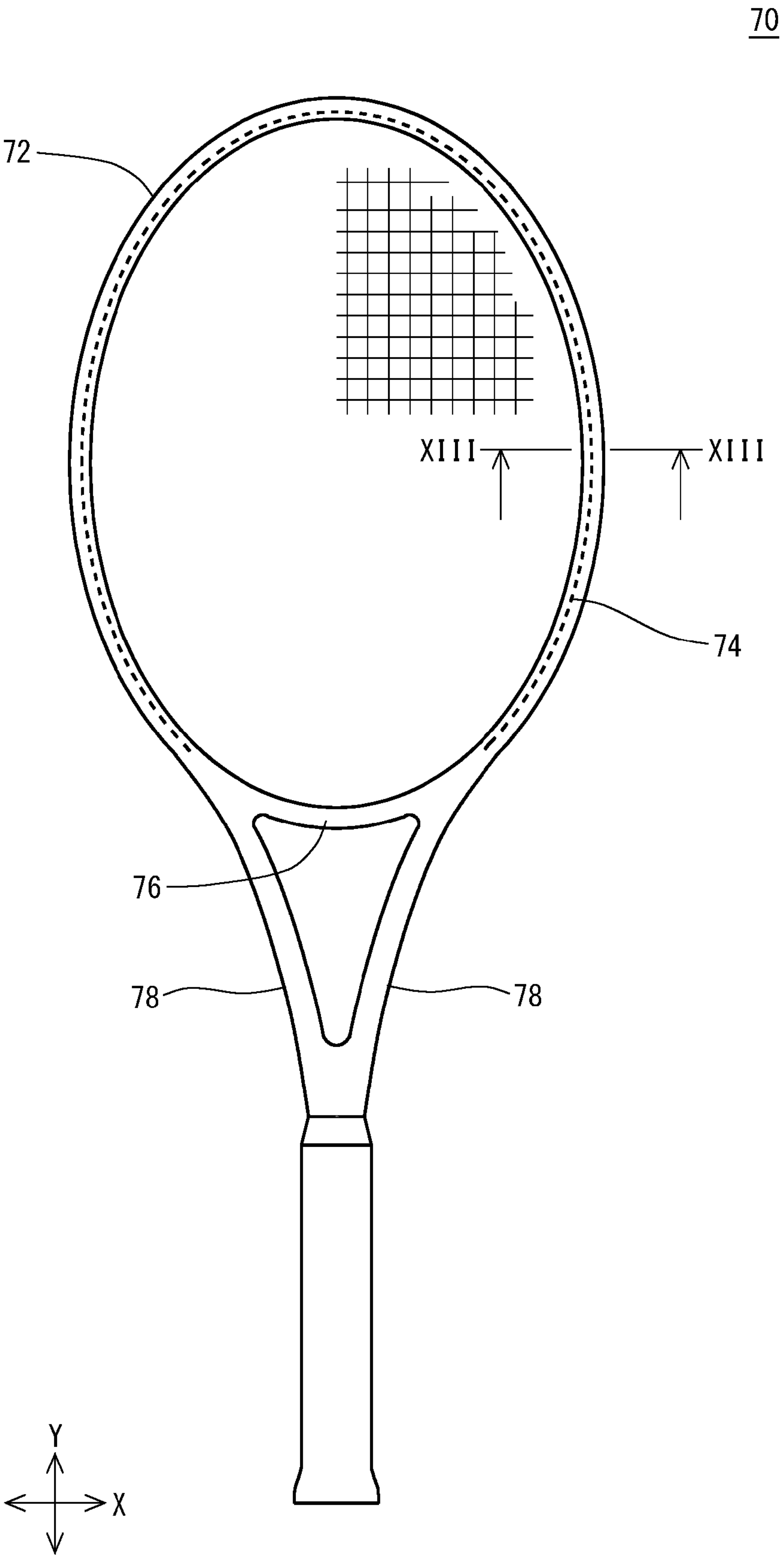

FIG. 12

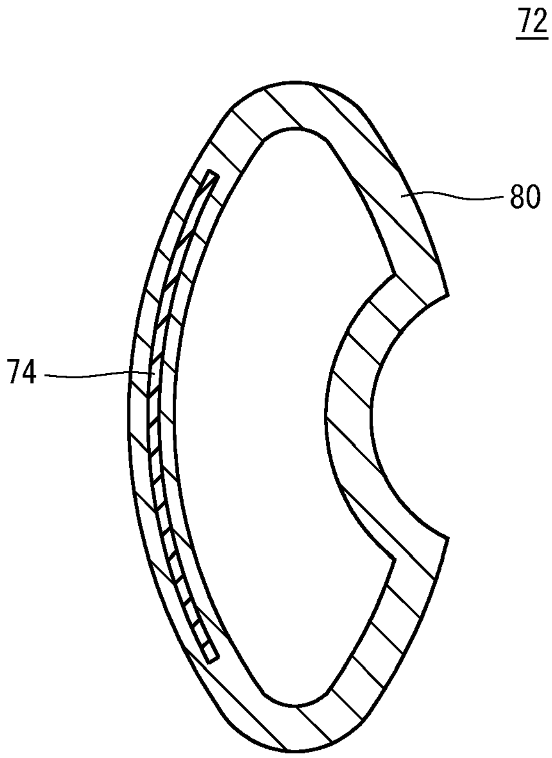

FIG. 13

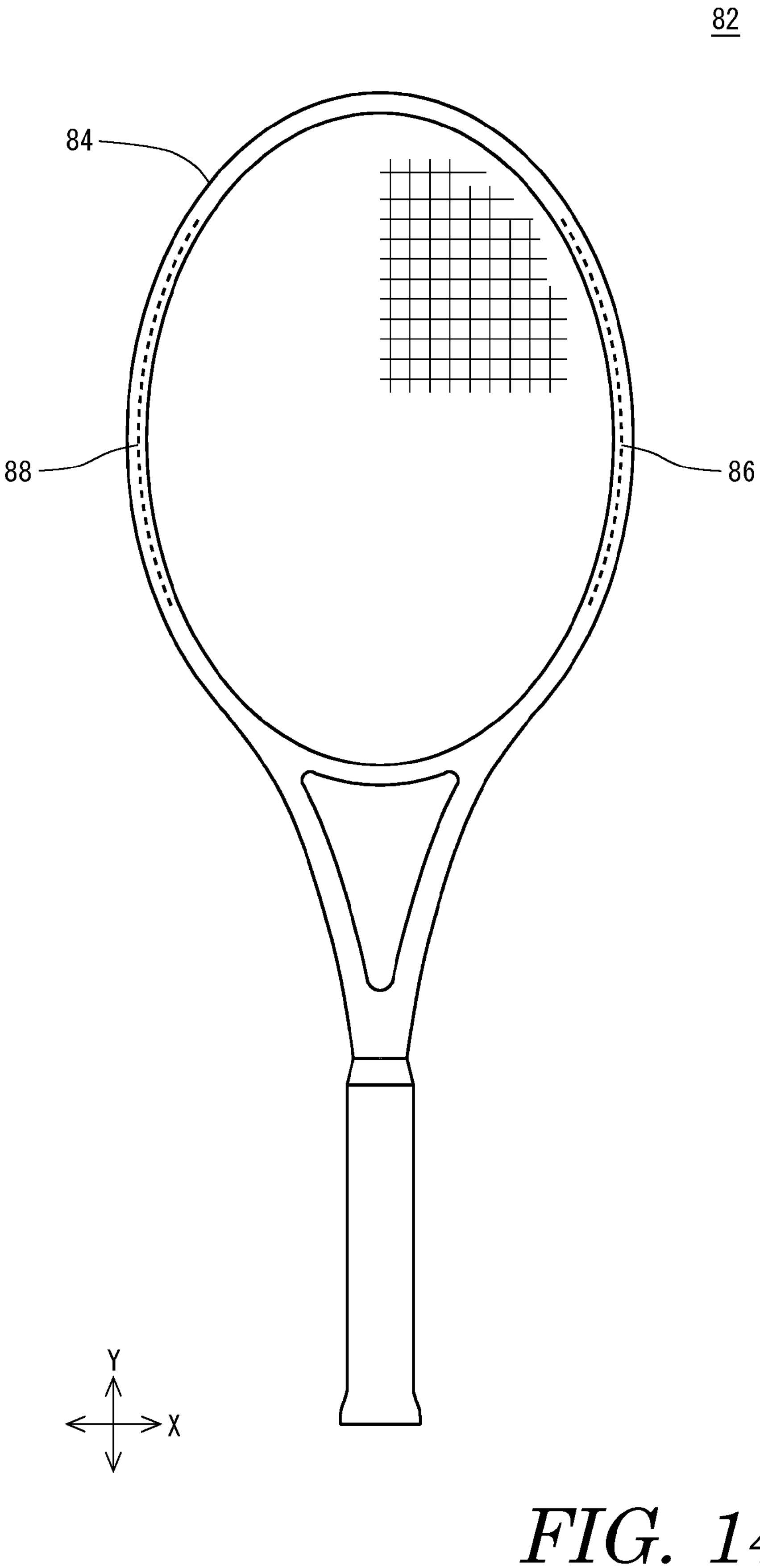

FIG. 14

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EUROPEAN SEARCH REPORT

Application Number
EP 21 16 9453

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 4 363006 B2 (SUMITOMO RUBBER IND) 11 November 2009 (2009-11-11) * paragraph [0024] - paragraph [0084]; figures 1-14 * -----	1-15	INV. A63B49/10 A63B49/02 A63B49/03 A63B60/54
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A63B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	6 October 2021	Jekabsons, Armands

CATEGORY OF CITED DOCUMENTS

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

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