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(71) Applicant: **KARSTEN MANUFACTURING CORPORATION** [US/US]; 2201 West Desert Cove, Phoenix, Arizona 85029 (US).

(72) Inventors: **NIZIOLEK, Tayler, N.**; 2201 West Desert Cove, Phoenix, Arizona 85029 (US). **BRUBAKER, Cole, D.**; 2201 West Desert Cove, Phoenix, Arizona 85029 (US).

(74) Agent: **JENNY, Paul, A.**; 2201 West Desert Cove, Phoenix, Arizona 85029 (US).

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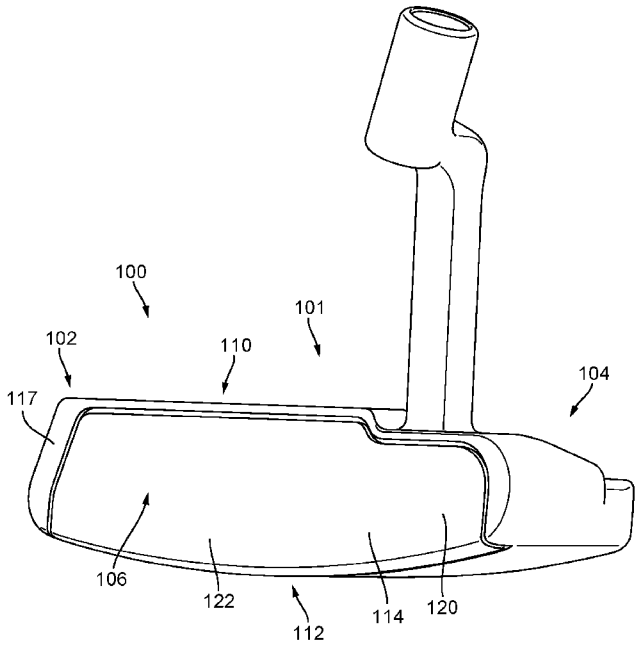

FIG. 1

(57) Abstract: Described herein are embodiments of a putter-type club head with a variable durometer face insert. The face insert achieves a variable durometer profile with three or more discrete regions, or zones, wherein a central zone has the lowest hardness, and each consecutive distal zone has a greater hardness than the adjacent medial zone. The face insert strategically reduces the smash factor in the center of the face to normalize the smash factor across the face to provide more predictable ball roll out distances on miss hits.

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VARIABLE DUROMETER GOLF CLUB FACE

CROSS REFERENCE PRIORITIES

[0001] This application claims the benefit of U.S. Provisional Application No. 63/506,014, filed June 2, 2023, the contents of which are fully incorporated herein by reference.

TECHNICAL FIELD

[0002] This disclosure relates generally to golf club heads and more particularly to putter-type golf club heads with face inserts.

BACKGROUND

[0003] Golfers generally seek to execute a consistent swing, so that the same area of the club contacts the ball on each swing. This is particularly so when putting, where precision is paramount. Striking the golf ball at various locations on the putter-type club head can alter the amount of energy transferred from the putter head to the golf ball during initial contact. Specifically, variation in strike face location can cause difference in ball speed across the striking surface, causing putts to travel unpredictable distances. Conventional putter-type golf clubs fail to adequately compensate for off-center ball strikes.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] To facilitate further description of the embodiments, the following drawings are provided in which:

[0005] FIG. 1 is a front perspective view of a putter having a face insert according to aspects of the present invention.

[0006] FIG. 2 is an exploded assembly view of the putter of FIG. 1.

[0007] FIG. 3 is a top plan view, in cross-section, of the face insert of the putter of FIG. 1.

[0008] FIG. 4 is another top plan view, in cross-section, of the face insert of the putter of FIG. 1

[0009] FIG. 5 is a front elevation view of the putter of FIG. 1 with a face plate of the face insert removed.

[0010] FIG. 6 is a front elevation view of another embodiment of a golf club having a face insert according to aspects of the present invention, with a face plate of the face insert removed.

[0011] FIG. 7 is a front elevation view of another embodiment of a golf club having a face insert according to aspects of the present invention, with a face plate of the face insert removed.

[0012] FIG. 8 is a front elevation view of another embodiment of a golf club having a face insert according to aspects of the present invention, with a face plate of the face insert removed.

[0013] FIG. 9 is a front elevation view of another embodiment of a golf club having a face insert according to aspects of the present invention, with a face plate of the face insert removed.

[0014] FIG. 10 is a front elevation view of another embodiment of a golf club having a face insert according to aspects of the present invention, with a face plate of the face insert removed.

[0015] FIG. 11 is a front elevation view of another embodiment of a golf club having a face insert according to aspects of the present invention, with a face plate of the face insert removed.

[0016] FIG. 12 is a front elevation view of another embodiment of a golf club having a face insert according to aspects of the present invention, with a face plate of the face insert removed.

[0017] FIG. 13 is a front elevation view of another embodiment of a golf club having a face insert according to aspects of the present invention, with a face plate of the face insert removed.

[0018] FIG. 14 is a graphical representation illustrating a smash factor vs impact location for a putter having a face insert according to the present invention.

[0019] FIG. 15 is a graphical representation illustrating a smash factor vs impact location for a putter having a face insert according to the present invention.

DETAILED DESCRIPTION

[0020] Described herein is a putter striking face that provides consistent ball speeds across the face when hitting a golf ball during a putting stroke. The putter striking face has relatively lower energy transfer in the center and progressively higher energy transfer at points further away from the center so that the ball speed is equalized across the face, resulting in more predictable distance control and improved miss hits. The putter striking face achieves consistent ball speeds by utilizing a variable durometer face insert.

DEFINITIONS

[0021] For simplicity and clarity of illustration, the drawing figures illustrate the general manner of construction, and descriptions and details of well-known features and techniques may be omitted to avoid unnecessarily obscuring the invention. Additionally, elements in the drawing figures are not necessarily drawn to scale. For example, the dimensions of some of the elements in the figures may be exaggerated relative to other elements to help improve understanding of embodiments of the present invention. The same reference numerals in different figures denote the same elements.

[0022] The terms “first,” “second,” “third,” “fourth,” and the like in the description and in the claims, if any, are used for distinguishing between similar elements and not necessarily for describing a particular sequential or chronological order. It is to be understood that the terms so used are interchangeable under appropriate circumstances such that the embodiments described herein are, for example, capable of operation in sequences other than those illustrated or otherwise described herein. Furthermore, the terms “include,” and “have,” and any variations thereof, are intended to cover a non-exclusive inclusion, such that a process, method, system, article, device, or apparatus that comprises a list of elements is not necessarily limited to those elements but may include other elements not expressly listed or inherent to such process, method, system, article, device, or apparatus.

[0023] The terms “left,” “right,” “front,” “back,” “top,” “bottom,” “over,” “under,” and the like in the description and in the claims, if any, are used for descriptive purposes and not necessarily for describing permanent relative positions. It is to be understood that the terms so used are interchangeable under appropriate circumstances such that the embodiments of the invention

described herein are, for example, capable of operation in other orientations than those illustrated or otherwise described herein.

[0024] The terms "couple," "coupled," "couples," "coupling," and the like should be broadly understood and refer to connecting two or more elements or signals, electrically, mechanically and/or otherwise.

[0025] The term "strike face," as used herein, refers to a club head front surface that is configured to strike a golf ball. The term strike face can be used interchangeably with the term "face.".

[0026] The term "geometric centerpoint," or "geometric center" of the strike face, as used herein, can refer to a geometric centerpoint of the strike face perimeter, and at a midpoint of the face height of the strike face. In the same or other examples, the geometric centerpoint also can be centered with respect to an engineered impact zone, which can be defined by a region of grooves on the strike face. As another approach, the geometric centerpoint of the strike face can be located in accordance with the definition of a golf governing body such as the United States Golf Association (USGA).

[0027] The term "ground plane," as used herein, can refer to a reference plane associated with the surface on which a golf ball is placed. The ground plane can be a horizontal plane tangent to the sole at an address position.

[0028] The term "loft plane," as used herein, can refer to a reference plane that is tangent to the geometric centerpoint of the strike face.

[0029] The term "loft angle," as used herein, can refer to an angle measured between the loft plane and an XY plane that is perpendicular to the ground plane and extends in a heel-toe direction.

[0030] The term "putter," can, in some embodiments, refer to a putter-type club head having a loft angle less than 10 degrees. In many embodiments, the loft angle of the putter can be between 0 and 5 degrees, between 0 and 6 degrees, between 0 and 7 degrees, or between 0 and 8 degrees. For example, the loft angle of the club head can be less than 10 degrees, less than 9 degrees, less than 8 degrees, less than 7 degrees, less than 6 degrees, or less than 5 degrees. For further example, the loft angle of the club head can be 0 degrees, 1 degree, 2 degrees, 3 degrees, 4 degrees, 5 degrees, 6

degrees, 7 degrees, 8 degrees, 9 degrees, or 10 degrees. The putter-type golf club head can be a blade type putter, a mid-mallet type putter, or a mallet type putter.

[0031] The putters described herein include a variable durometer face insert having regions of varying hardness. The regions are strategically located across the striking surface to promote consistent ball speeds. Increasing the hardness of the striking surface results in increased roll out distance when compared to a lower hardness. Therefore, the striking surface, according to aspects of the present invention has a region of lower hardness near the center to reduce the energy transfer, or "deaden" center impacts, and regions of progressively increased hardness towards distal/perimeter regions of the striking surface to equalize the energy loss to off center hits. The variable durometer/hardness profile promotes consistent ball speeds across the face so that the ball roll-out distance is more predictable on miss hits.

[0032] The face insert has a plurality of regions, or zones, that form the striking surface, or a striking sub-surface to provide the putter with a variable durometer profile. Each region of the plurality of regions comprise a different hardness value than adjacent regions. Specifically, the hardness of the regions that are located at or closer to the center have a lower hardness than the regions that are located further away from the geometric center. The hardness profile can vary in a heel-toe direction, top-bottom direction, or both. There can be anywhere from 3 to 20 regions that form the striking surface or a striking sub-surface, thereby to vary the hardness of the insert promotes consistent ball speeds across the face. Described herein are various exemplary embodiments of face inserts forming a variable durometer profile.

I. General Putter Description

[0033] An exemplary putter-type club head 100 having a variable durometer face insert, according to aspects of the present invention, is shown in FIGS. 1 and 2. The putter-type club head 100 comprises a body 101, a toe end 102, a heel end 104 opposite the toe end 102, a front end 106, a rear end 108 opposite the front end 106, a top 110, a bottom 112 opposite the top 110, and a front surface 114. A front rim 117 extends around at least a portion of a perimeter of the front end 106, and an inner side wall 119 extends from the front rim 117 to a forward-facing recessed front wall 118. The front rim 117, inner side wall 119, and recessed front wall 118 together define a front recess 116

extending from the front surface 114 toward the rear end 108. As best shown in FIG. 3, the club head 100 further comprises a face insert 120 disposed in the front recess 116 and having a geometric center 5 (hereafter 'GC').

[0034] The club head 100 of FIGS. 1 and 2 resembles a blade style putter. In other embodiments, the club head 100 can be a mid-mallet or mallet style putter. The variable durometer face insert described herein can be used in any desired style of putter to allow for consistent roll out speeds.

[0035] The putter-type club heads have a loft angle of less than 10 degrees with a planar, or flat, striking surface. Putter-type club heads have a substantially rectangular front surface where the height of the front surface, measured in a top to bottom direction, is typically less than 1.25 inches and the width of the front surface, measured in a heel-toe direction, is over 3.25 inches. The top and bottom periphery edges of the striking surface can be substantially horizontal (i.e., parallel to the ground plane).

[0036] The putter-type club head can have a mass ranging from 275 to 375 grams. In some embodiments, the putter-type club head can have a mass ranging from 275 to 300 grams, 300 to 325 grams, 325 to 350 grams, or 350 grams to 375 grams.

II. Insert Embodiments

[0037] An exemplary face insert 120 having a variable durometer hardness profile according to aspects of the present invention is illustrated at FIGS. 3-5. In this embodiment, the face insert 120 has a three-layer construction comprising a face plate 122, a middle layer 124, and an adhesive layer 126. The face plate 122 is the outboard layer while the adhesive layer 126 is the inboard layer. The face plate 122 forms a portion of the front surface 114 of the club head 100, and is configured to impact the golf ball during a putting stroke. The adhesive layer 126 is the inner-most layer and is configured to couple the face insert 120 to the recessed front wall 118 of the body 101. The middle layer 124 is disposed between the adhesive layer 126 and face plate 122. In other embodiments, the face insert 120 can have a single layer construction where the middle layer 124 is co-molded to the club head 100 or a two layer construction where the face insert 120 does not have a face plate 122 and the middle layer 124 forms an exterior surface and a portion of the front surface 114.

[0038] The face plate 122 can have a thickness ranging from 0.005 inch to 0.075 inch. In some embodiments, the face plate thickness ranges from 0.005 to 0.010 inch, 0.010 to 0.020 inch, 0.020 to 0.030 inch, 0.030 to 0.040 inch, 0.040 to 0.050 inch, 0.050 to 0.060 inch, or from 0.060 to 0.075 inch. In some embodiments, the face plate 122 can have a thickness less than 0.075 inch, less than 0.070 inch, less than 0.065 inch, less than 0.060 inch, less than 0.055 inch, less than 0.050 inch, or less than 0.045 inch. The face plate 122 thickness can be adjusted to provide a desired sound and feel of the putter.

[0039] The middle layer 124 comprises a plurality of regions, or zones, of varying hardness to create a variable durometer profile. In the illustrated embodiment of FIGS. 3-5, the middle layer 124 comprises a central zone 130, a first toe zone 140, a first heel zone 145, a second toe zone 150, a second heel zone 155, a third toe zone 160, and a third heel zone 165. The first toe zone 140 is located between the central zone 130 and the toe end 102. The first heel zone 145 is located between the central zone 130 and the heel end 104. The second toe zone 150 is located between the first toe zone 140 and the toe end 102. The second heel zone 155 is located between the first heel zone 145 and the heel end 104. The third toe zone 160 is located between second toe zone 150 and the toe end 102. The third heel zone 165 is located between the second heel zone 155 and the heel end 104.

[0040] The central zone 130 comprises a central zone toe surface 132, a central zone heel surface 134, and a central zone midline 136 located halfway (equidistant) between the central zone heel surface 134 and central zone toe surface 132. In some embodiments, the central zone midline 136 intersects the geometric center 5 or is coplanar with the GC midplane 10. In other embodiments, the central zone midline 136 can be offset either towards the toe end or towards the heel end of the GC midplane 10. The central zone 130 is formed of a central zone material having a central zone hardness ranging from 10 to 35 on a Shore D hardness scale. The central zone 130 affects the energy transfer of the ball on center hits. As such, the central zone 130 has the lowest durometer of each of the zones in the plurality of zones to strategically deaden center impacts so that the smash factor is equalized across the striking face. The central zone 130 forms the portion of the middle layer that comprises the geometric center 5.

[0041] The first toe zone 140 comprises a first toe zone distal surface 141, a first toe zone medial surface 142, and a first toe zone midline 143 located halfway (equidistant) between the first toe zone

medial surface 142 and the first toe zone distal surface 141. The first toe zone distal surface 141 is located toeward of the first toe zone midline 143. The first toe zone medial surface 142 is located heelward of the first toe zone midline 143. The first toe zone medial surface 142 is configured to abut, or border, the central zone toe surface 132. The first toe zone 140 is formed of a first toe zone material having a first toe zone hardness ranging from 15 to 40 on a Shore D hardness scale. The first toe zone 140 has a greater hardness than the central zone 130, but a lower hardness than the second toe zone 150 and third toe zone 160. The first toe zone 140 affects the energy transfer of the ball on off center hits that are toeward of the central zone 130 but heelward of the second toe zone 150.

[0042] The first heel zone 145 comprises a first heel zone distal surface 146, a first heel zone medial surface 147, and a first heel zone midline 148 located halfway (equidistant) between the first heel zone medial surface 147 and the first heel zone distal surface 146. The first heel zone distal surface 146 is located heelward of the first heel zone midline 148. The first heel zone medial surface 147 is located toeward of the first heel zone midline 148. The first heel zone medial surface 147 abuts the central zone heel surface 134. The first heel zone 145 is formed of a first heel zone material having a first heel zone hardness ranging from 15 to 40 on a Shore D hardness scale. The first heel zone 145 has a greater hardness than the central zone 130, but a lower hardness than the second heel zone 155 and third heel zone 165.

[0043] The second toe zone 150 comprises a second toe zone distal surface 151, a second toe zone medial surface 152, and a second toe zone midline 153 located halfway (equidistant) between the second toe zone medial surface 152 and the second toe zone distal surface 151. The second toe zone distal surface 151 is located toeward of the second toe zone midline 153. The second toe zone medial surface 152 is located heelward of the second toe zone midline 153. The second toe zone medial surface 152 abuts the first toe zone distal surface 141. The second toe zone 150 is formed of a second toe zone material having a second toe zone hardness ranging from 20 to 45 on a Shore D hardness scale. The second toe zone hardness has a greater hardness than the first toe zone hardness so that the ball roll-out distance and smash factor are equalized across the zones. The second toe zone 150 affects the energy transfer for off center hits in an area between the central zone 130 and the toe end 102.

[0044] The second heel zone 155 comprises a second heel zone distal surface 156, a second heel zone medial surface 157, and a second heel zone midline 158 located halfway (equidistant) between the second heel zone medial surface 157 and the second heel zone distal surface 156. The second heel zone distal surface 156 is located heelward of the second heel zone midline 158. The second heel zone medial surface 157 is located toeward of the second heel zone midline 158. The second heel zone medial surface 157 abuts the first heel zone distal surface 146. The second heel zone 155 is formed of a second heel zone material having a second heel zone hardness ranging from 20 to 45 on a Shore D hardness scale. The second heel zone hardness is greater than the first heel zone hardness and greater than the central zone hardness so that the ball roll-out distance and smash factor are equalized across the face. The second heel zone 155 affects the energy transfer for off center hits in an area between the first heel zone 145 and the heel end 104.

[0045] The third toe zone 160 comprises a third toe zone distal surface 161, a third toe zone medial surface 162, and a third toe zone midline 163 located halfway (equidistant) between the third toe zone distal surface 161 and the third toe zone medial surface 162. The third toe zone distal surface 161 is located toeward of the third toe zone midline 163. The third toe zone medial surface 162 is located heelward of the third toe zone midline 163. The third toe zone medial surface 162 abuts the second toe zone distal surface 151. The third toe zone 160 is formed of a third toe zone material having a third toe zone hardness ranging from 25 to 55 on a Shore D hardness scale. The third toe zone hardness is greater than the second toe zone hardness, greater than the first toe zone hardness, and greater than the central zone hardness so that the ball roll-out distance and smash factor are equalized across the face. The third toe zone 160 affects the energy transfer for off center hits in an area between the second toe zone 150 and the toe end 102.

[0046] The third heel zone 165 comprises a third heel zone distal surface 166, a third heel zone medial surface 167, and a third heel zone midline 168 located halfway (equidistant) between the third heel zone distal surface 166 and the third heel zone medial surface 167. The third heel zone distal surface 166 is located heelward of the third heel zone midline 168. The third heel zone medial surface 167 is located toeward of the third heel zone midline 168. The third heel zone medial surface 167 abuts the second heel zone distal surface 156. The third heel zone 165 is formed of a third heel zone material having a third heel zone hardness ranging from 25 to 55 on a Shore D hardness scale. The

third heel zone hardness is greater than the second heel zone hardness, the first heel zone hardness, and the central zone hardness so that the ball roll-out distance and smash factor are equalized across the face. The third heel zone 165 affects the energy transfer for off center hits in an area between the second heel zone 155 and the heel end 104.

[0047] The locations of the zones relative to the GC midplane 10 can be selected to provide the putter with a desired variable durometer hardness profile. In some embodiments, the central zone midline 136 can be coincident with the GC midplane 10. In other embodiments, the central zone midline 136 can be offset towards the heel or towards the toe at a distance ranging from 0.01 inch to 0.25 inch. For example, in some embodiments, the central zone midline 136 can be offset from the GC midplane 10 at a distance ranging from 0.01 inch to 0.075 inch, 0.075 to 0.10 inch, 0.10 to 0.15 inch, 0.15 to 0.20 inch, or from 0.20 to 0.25 inch. The offset distance of the central zone midline 136 can be adjusted to locate the central zone material at any desired location. The offset distance of the central zone midline 136 can be adjusted through changing the position of the central zone toe surface 132 and central zone heel surface 134 relative to the GC midplane 10.

[0048] Similarly, the central zone hardness can be selected to provide a desired smash factor in the central zone to strategically deaden center impacts. As mentioned above, the central zone hardness can range from 10 to 35 on the Shore D hardness scale. For example, in some embodiments the central zone hardness can range from 10 to 15, 15 to 20, 20 to 25, 25 to 30, or 30 to 35 on the Shore D hardness scale. In some embodiments, the central zone hardness can be less than 35, less than 30, less than 25, less than 20, or less than 15 on the Shore D hardness scale. The central zone hardness has a lower hardness than the first toe zone hardness and the first heel zone hardness.

[0049] In some embodiments, the first toe zone midline 143 can be located towards the toe at a distance from the GC midplane 10 ranging from 0.10 to 0.50 inch. For example, in some embodiments the first toe zone midline 143 can be located at a distance from the GC midplane 10 ranging from 0.10 to 0.20 inch, 0.20 to 0.30 inch, 0.30 to 0.40 inch, or 0.40 to 0.50 inch. In some embodiments, the first toe zone midline 143 can be located at distance from the GC midplane 10 that is less than 0.50 inch, less than 0.45 inch, less than 0.40 inch, less than 0.35 inch, less than 0.30 inch, less than 0.25 inch, less than 0.20 inch, or less than 0.15 inch. The location and distance of first toe zone

midline 143 away from the GC midplane 10 can be adjusted to achieve a desired durometer profile and thus, desired smash factor of the first toe zone 140.

[0050] Similarly, the first toe zone hardness can be selected to provide a desired smash factor in the first toe zone 140. As mentioned above, the first toe zone hardness can range from 15 to 40 on a Shore D hardness scale. For example, in some embodiments the first toe zone hardness can range from 15 to 20, 20 to 25, 25 to 30, 30 to 35, or 35 to 40 on the Shore D hardness scale. In some embodiments, the first toe zone hardness is 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, or 40 on the Shore D hardness scale. The first toe zone hardness is greater than the central zone hardness. The first toe zone hardness can be adjusted according to the size and location of the first toe zone 140.

[0051] In some embodiments, the first heel zone midline 148 can be located towards the heel at a distance from the GC midplane 10 ranging from 0.10 to 0.50 inch. For example, in some embodiments the first heel zone midline 148 can be located at a distance from the GC midplane 10 ranging from 0.10 to 0.20 inch, 0.20 to 0.30 inch, 0.30 to 0.40 inch, or 0.40 to 0.50 inch. In some embodiments, the first heel zone midline 148 can be located at distance from the GC midplane 10 that is less than 0.50 inch, less than 0.45 inch, less than 0.40 inch, less than 0.35 inch, less than 0.30 inch, less than 0.25 inch, less than 0.20 inch, or less than 0.15 inch. The location and offset distance of first heel zone midline 148 away from the GC midplane 10 can be adjusted by altering the placement of the first heel zone distal surface 146 and the first heel zone medial surface 147. The location and offset distance can be adjusted to achieve a desired smash factor of the first heel zone 145 to equalize the smash factor across the striking surface.

[0052] Similarly, the first heel zone hardness can be selected to provide a desired smash factor in the first heel zone 145. As mentioned above, the first heel zone hardness can range from 15 to 40 on a Shore D hardness scale. For example, in some embodiments the first heel zone hardness can range from 15 to 20, 20 to 25, 25 to 30, 30 to 35, or 35 to 40 on the Shore D hardness scale. In some embodiments, the first heel zone hardness is 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, or 40 on the Shore D hardness scale. The first heel zone hardness is greater than the central zone hardness. In some embodiments, the first heel zone hardness is equal to the first toe zone hardness. In other embodiments, the first heel zone hardness is less than the first

toe zone hardness. In other embodiments, the first heel zone hardness is greater than the first toe zone hardness. For example, in one embodiment, the first heel zone hardness can be 31 and the first toe zone hardness can be 37 on the Shore D hardness scale. The first heel zone hardness can be adjusted according to the size and location of the first heel zone 145.

[0053] The second toe zone midline 153 can be located towards the toe at a distance from the GC midplane 10 ranging from 0.15 to 0.75 inch. For example, in some embodiments the second toe zone midline 153 can be located at a distance from the GC midplane 10 ranging from 0.15 to 0.20 inch, 0.20 to 0.30 inch, 0.30 to 0.40 inch, 0.40 to 0.50 inch, 0.50 to 0.60 inch, or 0.60 to 0.75 inch. In some embodiments, the second toe zone midline 153 can be located at distance from the GC midplane 10 that is less than 0.50 inch, less than 0.45 inch, less than 0.40 inch, less than 0.35 inch, less than 0.30 inch, less than 0.25 inch, less than 0.20 inch, or less than 0.15 inch. The location and offset distance of the second toe zone midline 153 away from the GC midplane 10 can be adjusted by altering the placement of the second toe zone distal surface 151 and the second toe zone medial surface 152. The location and offset distance can be adjusted to achieve a desired smash factor of the second toe zone 150 to equalize the smash factor across the striking surface.

[0054] Similarly, the second toe zone hardness can be adjusted to provide a desired smash factor in the second toe zone 150. As mentioned above, the second toe zone hardness can range from 20 to 45 on a Shore D hardness scale. For example, in some embodiments the second toe zone hardness can range from 20 to 25, 25 to 30, 30 to 35, 35 to 40, or 40 to 45 on the Shore D hardness scale. In some embodiments, the second toe zone hardness is 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, or 45 on the Shore D hardness scale. The second toe zone hardness is greater than the central zone hardness and greater than the first toe zone hardness. The second toe zone hardness can be adjusted according to the size and location of the second toe zone 150.

[0055] The second heel zone midline 158 can be located towards the heel at a distance from the GC midplane 10 ranging from 0.15 to 0.75 inch. For example, in some embodiments the second heel zone midline 158 can be located at a distance from the GC midplane 10 ranging from 0.15 to 0.20 inch, 0.20 to 0.30 inch, 0.30 to 0.40 inch, 0.40 to 0.50 inch, 0.50 to 0.60 inch, or 0.60 to 0.75 inch. In some embodiments, the second heel zone midline 158 can be located at distance from the GC

midplane 10 that is less than 0.50 inch, less than 0.45 inch, less than 0.40 inch, less than 0.35 inch, less than 0.30 inch, less than 0.25 inch, less than 0.20 inch, or less than 0.15 inch. The location and offset distance of the second heel zone midline 158 away from the GC midplane 10 can be adjusted by altering the placement of the second heel zone distal surface 156 and the second heel zone medial surface 157. The location and offset distance can be adjusted to achieve a desired smash factor of the second heel zone 155 to equalize the smash factor across the striking surface.

[0056] Similarly, the second heel zone hardness can be selected to provide a desired smash factor in the second heel zone 155. As mentioned above, the second heel zone hardness can range from 20 to 45 on a Shore D hardness scale. For example, in some embodiments the second heel zone hardness can range from 20 to 25, 25 to 30, 30 to 35, 35 to 40, or 40 to 45 on the Shore D hardness scale. In some embodiments, the second heel zone hardness is 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, or 45 on the Shore D hardness scale. The second heel zone hardness is greater than the central zone hardness and greater than the first heel zone hardness. In some embodiments, the second heel zone hardness is equal to the second toe zone hardness. In other embodiments, the second heel zone hardness is less than the second toe zone hardness. In other embodiments, the second heel zone hardness is greater than the second toe zone hardness. For example, in one embodiment, the second heel zone hardness can be 38 and the second toe zone hardness can be 41 on the Shore D hardness scale. The second heel zone hardness can be adjusted as desired according to the size and location of the second heel zone 155.

[0057] The third toe zone midline 163 is located towards the toe at a distance from the GC midplane 10 ranging from 0.20 to 1.5 inch. For example, in some embodiments the third toe zone midline 163 can be located at a distance from the GC midplane 10 ranging from 0.20 to 0.30 inch, 0.30 to 0.40 inch, 0.40 to 0.50 inch, 0.50 to 0.60 inch, 0.60 to 0.70 inch, 0.70 to 0.80 inch, 0.80 to 0.90 inch, 0.90 to 1.00 inch, 1.0 to 1.1 inch, 1.1 to 1.2 inch, 1.2 to 1.3 inch, 1.3 to 1.4 inch, or 1.4 to 1.5 inch. In some embodiments, the third toe zone midline 163 can be located at distance from the GC midplane 10 that is less than 1.5 inches, less than 1.4 inches, less than 1.3 inches, less than 1.2 inches, less than 1.1 inches, less than 1.0 inch, less than 0.9 inch, or less than 0.8 inch. The location and offset distance of the third toe zone midline 163 away from the GC midplane 10 can be adjusted by altering the placement of the third toe zone distal surface 161 and the third toe zone medial surface

162. The location and offset distance can be adjusted to achieve a desired smash factor of the third toe zone 160 to equalize the smash factor across the striking surface.

[0058] Similarly, the third toe zone hardness can be selected to provide a desired smash factor in the third toe zone 160. As mentioned above, the third toe zone hardness can range from 25 to 50 on a Shore D hardness scale. For example, in some embodiments the third toe zone hardness can range from 20 to 25, 25 to 30, 30 to 35, 35 to 40, or 40 to 45 on the Shore D hardness scale. In some embodiments, the third toe zone hardness is 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, or 45 on the Shore D hardness scale. The third toe zone hardness is greater than the central zone hardness, greater than the first toe zone hardness, and greater than the second toe zone hardness. The third toe zone hardness can be adjusted according to the size and location of the third toe zone 160.

[0059] The third heel zone midline 168 can be located towards the heel at a distance from the GC midplane 10 ranging from 0.20 to 1.5 inch. For example, in some embodiments the third heel zone midline 168 can be located at a distance from the GC midplane 10 ranging from 0.20 to 0.30 inch, 0.30 to 0.40 inch, 0.40 to 0.50 inch, 0.50 to 0.60 inch, 0.60 to 0.70 inch, 0.70 to 0.80 inch, 0.80 to 0.90 inch, 0.90 to 1.00 inch, 1.0 to 1.1 inch, 1.1 to 1.2 inch, 1.2 to 1.3 inch, 1.3 to 1.4 inch, or 1.4 to 1.5 inch. In some embodiments, the third heel zone midline 168 can be located at distance from the GC midplane 10 that is less than 1.5 inches, less than 1.4 inches, less than 1.3 inches, less than 1.2 inches, less than 1.1 inches, less than 1.0 inch, less than 0.9 inch, or less than 0.8 inch. The location and offset distance of the third heel zone midline 168 away from the GC midplane 10 can be adjusted by altering the placement of the third heel zone distal surface 166 and the third heel zone medial surface 167. The location and offset distance can be adjusted to achieve a desired smash factor of the third heel zone 165 to equalize the smash factor across the striking surface.

[0060] The midlines 143, 148, 153, 158, 163, 168 can be symmetrically spaced about the GC midplane 10 or non-symmetrical. In some embodiments, the first toe zone midline 143 and the first heel zone midline 148 are equidistant from the GC midplane 10, the second toe zone midline 153 and the second heel zone midline 158 are equidistant from the GC midplane 10, and/or the third toe zone midline 163 and third heel zone midline 168 are equidistant from the GC midplane 10. In other embodiments, the first toe zone midline 143 and the first heel zone midline 148 have different spacing

distances from the GC midplane 10, the second toe zone midline 153 and the second heel zone midline 158 have different spacing distances from the GC midplane 10, and/or the third toe zone midline 163 and the third heel zone midline 168 have different spacing distances from the GC midplane 10.

[0061] The middle layer 124 can have a thickness ranging from 0.025 inch to 0.75 inch. For example, the middle layer 124 thickness can range from 0.025 to 0.10 inch, 0.10 to 0.20 inch, 0.20 to 0.30 inch, 0.30 to 0.40 inch, 0.40 to 0.50 inch, 0.50 to 0.60 inch, or 0.60 to 0.75 inch. In some embodiments, the middle layer 124 thickness can be less than 0.75 inch, less than 0.70 inch, less than 0.65 inch, less than 0.60 inch, less than 0.55 inch, or less than 0.50 inch. In other embodiments, the middle layer 124 thickness can be greater than 0.025 inch, greater than 0.050 inch, greater than 0.075 inch, greater than 0.10 inch, greater than 0.15 inch, greater than 0.20 inch, or greater than 0.25 inch.

[0062] The size, shaping, number, and location of each of the zones can vary according to aspects of the present invention to provide a desired durometer profile to adjust the smash factor and ball speed at desired locations across the face. For example, lowering the durometer of a specific zone will lower the smash factor and raising the durometer of a specific zone will raise the smash factor. Similarly, placing the zone closer to the GC midplane 10 will raise the smash factor and placing the zone further away from the GC midplane 10 will lower the smash factor. The number of zones can be increased or decreased depending on the desired smash factor profile at specific locations on the face. The zones can be arranged to adjust the smash factor profile in a heel-toe direction and/or a top to bottom direction. FIGS. 6-13 illustrate various exemplary embodiments of putter face inserts comprising a variable durometer profile.

[0063] Another exemplary putter-type club head 200 having a variable durometer hardness profile shifted towards the toe is illustrated at FIG. 6. The club head 200 comprises a toe end 202, a heel end 204, and a face insert 220 forming a portion of a front surface 214. The face insert 220 of this embodiment is similar to the face insert 120 described above in that the face insert 220 comprises a variable durometer profile having a central zone 230, a first toe zone 240, a first heel zone 245, a second toe zone 250, a second heel zone 255, a third toe zone 260, and a third heel zone 265. The face insert 220 is different than the face insert 120 in that the central zone 230 has a central zone midline 236 that is offset towards the toe end from the GC midplane 10. In other words, the central zone midline 236 does not coincide with the GC midplane 10. Similarly, a first toe zone midline 243,

a first heel zone midline 248, a second toe zone midline 253, a second heel zone midline 258, a third toe zone midline 263, and a third heel zone midline 268 are offset towards the toe end from the GC midplane 10 to create a non-symmetrical durometer profile about the GC midplane 10. The first toe zone midline 243, the second toe zone midline 253, and the third toe zone midline 263 are located at a greater distance from the GC midplane 10 than the first heel zone midline 248, second heel zone midline 258, and third heel zone midline 268, respectively.

[0064] Another exemplary putter-type club head 300 having a variable durometer hardness profile with zones of varying widths is illustrated at FIG. 7. The club head 300 comprises a toe end 302, a heel end 304, and a face insert 320 forming a portion of a front surface 314. The face insert 320 is similar to the face inserts 120, 220 described above in that the face insert 320 comprises a plurality of zones that form a variable durometer profile. The face insert 320 is different than the face inserts 120, 220 described above in that the face 320 comprises differently shaped zones, lacks a central zone, and includes two additional zones in both the heel end 304 and the toe end 302. In this embodiment, the GC midplane 10 is located at the junction of the first toe zone 340 and the first heel zone 345 such that there is no central zone. In this embodiment, the more distal zones comprise a smaller width than the adjacent medial zone, except for the fifth toe zone 380 and the fifth heel zone 385. As such, both the fourth toe zone 370 and the fourth heel zone 375 have a smaller width than the third toe zone 360 and the third heel zone 365, respectively. Further, the third toe zone 360 and the third heel zone 365 have a smaller width than the second toe zone 350 and the second heel zone 355, respectively. The second toe zone 350 and the second heel zone 355 have a smaller width than the first toe zone 340 and the first heel zone 345, respectively.

[0065] Another exemplary putter-type club head 400 having a variable durometer hardness profile with large central zones and small perimeter zones is illustrated at FIG. 8. The club head 400 comprises a toe end 402, a heel end 404, and a face insert 420 forming a portion of a front surface 414. The face insert 420 is similar to face inserts 120, 220, 320 described above in that the face insert 420 comprises a plurality of zones that form a variable durometer profile. The face insert 420 is different than the face inserts 120, 220, 320 in that the face insert 420 has differently sized zones. Specifically, the face insert 420 comprises four or five distal zones each having the same and smallest width. The face insert 420 comprises a third toe zone 460, a fourth toe zone 470, a fifth toe zone 480

and a sixth toe zone 490 that all comprise the same width. The width of these zones 460, 470, 480, 490 is smaller than the width of the second toe zone 450 and the first toe zone 440. Similarly, the third heel zone 465, fourth heel zone 475, fifth heel zone 485, and sixth heel zone 495 all comprise the same width. The width of these zones 465, 475, 485, 495 are smaller than the width of the second heel zone 455 and the first heel zone 445.

[0066] Another exemplary putter-type club head 500 having a variable durometer hardness profile having a chevron pattern is illustrated at FIG. 9. The club head 500 comprises a toe end 502, a heel end 504, and a face insert 520 forming a portion of a front surface 514. The face insert 520 is similar to the face inserts 120, 220, 320, 420 described above in that the face insert 520 comprises a plurality of zones that form a variable durometer profile. The face insert 520 is different than the face inserts 120, 220, 320, 420 in that the face insert 520 has different shaped zones. Specifically, the face insert 520 has a plurality of V-shaped, or angled, zones rather than vertical columns. The face insert 520 comprises a central zone 530, a first toe zone 540, a first heel zone 545, a second toe zone 550, a second heel zone 555, a third toe zone 560, and a third heel zone 565. The central zone comprises a diamond shape such that the width of the central zone reduces toward to the top and towards the bottom of the face. The first toe zone 540, the second toe zone 550, and the third toe zone 560 have a V-shaped appearance such that the top and bottom ends of each zone are angled towards the GC midplane 10. Similarly, the first heel zone 545, the second heel zone 555, and the third heel zone 565 have a V-shaped appearance such that the top and bottom ends of each zone are angled towards the GC midplane 10. The V-shaped appearance of the zones creates a variable durometer profile in a top to bottom direction as well as a heel-toe direction.

[0067] Another exemplary putter-type club head 600 having a variable durometer hardness profile having arcuate zones is illustrated at FIG. 10. The club head 600 comprises a toe end 602, a heel end 604, and a face insert 620 forming a portion of a front surface 614. The face insert 620 is similar to the face inserts 120, 220, 320, 420, 520 described above in that the face insert 620 comprises a plurality of zones that form a variable durometer profile. The face insert 620 is different than the face inserts 120, 220, 320, 420, 520 in that the face insert 620 has different shaped zones. Instead of zones with V-shaped appearances found in face insert 520, the face insert 620 has zones that are curved or arcuate in shape.

[0068] Another exemplary putter-type club head 700 having a variable durometer hardness profile having a lesser angled zones is illustrated at FIG. 11. The club head 700 comprises a toe end 702, a heel end 704, and a face insert 720 forming a portion of a front surface 714. The face insert 720 is similar to the face inserts 120, 220, 320, 420, 520, 620 described above in that the face insert 720 comprises a plurality of zones that form a variable durometer profile. The face insert 720 is different than the face inserts 120, 220, 320, 420, 520, 620 in that the face insert 720 has different shaped zones. Instead of vertical column zones found in face inserts 120, 220, 320, 420, the face insert 720 has zones that are angled. Specifically, the top of the zones are more toeward than the bottom of the zones.

[0069] Another exemplary putter-type club head 800 having a variable durometer hardness profile having greater angled zones is illustrated at FIG. 12 The club head 800 comprises a toe end 802, a heel end 804, and a face insert 820 forming a portion of a front surface 814. The face insert 820 is similar to the face insert 720 described above in that the face insert 820 comprises a plurality of angled zones that form a variable durometer profile. The face insert 820 is different than the face insert 720 in that the zones of face insert 820 have a greater slant angle.

[0070] Another exemplary putter-type club head 900 having a variable durometer hardness profile having horizontal zones is illustrated at FIG. 13. The club head 900 comprises a toe end 902, a heel end 904, and a face insert 920 forming a portion of a front surface 914. The face insert 720 is similar to the face inserts 120, 220, 320, 420, 520, 620 described above in that the face insert 720 comprises a plurality of zones that form a variable durometer profile. The face insert 720 is different than the face inserts 120, 220, 320, 420, 520, 620 in that the face insert 720 has different shaped zones. Instead of vertical column zones founds in face inserts 120, 220, 320, 420, the face insert 720 has zones that are angled. Specifically, the top of the zones are more toeward than the bottom of the zones.

[0071] In some embodiments, transition zones having a gradually changing durometer are provided between zones of constant durometers, so that the overall durometer hardness profile of the face insert changes progressively rather than abruptly. For example, the transition zones can comprise two or more micro-zones that have relatively small changes in durometer between micro-zones to provide a progressive change in hardness between two durometer portions. In one embodiment, a

transition zone that located between a zone with a hardness of 30 on a Shore D scale and another zone with a hardness of 35 on a shore D scale can comprise four micro-zones where the hardness of the four micro-zones are 31, 32, 33, and 34 on the Shore D hardness scale to provide a more gradual change between zones having 30 and 35 Shore D hardnesses.

III. Materials

[0072] The face plate 122 can be made of any of the following materials: aluminum, stainless steel, copper, thermoplastic co-polyester elastomer (TPC), thermoplastic elastomer (TPE), thermoplastic urethane (TPU), steel, nickel, TPU/aluminum, TPE/aluminum, plastic/metal screen insert, polyethylene, polypropylene, polytetrafluoroethylene, polyisobutylene, polyvinyl chloride, PEBAX®, or any other desired material. The outer layer material can be selected as to provide any desired sound and/or feel characteristics. The face plate may further comprise grooves to improve grip or spin if desired. The face plate is configured to cover the variable durometer middle layer to provide a single material and uniform striking surface.

[0073] The middle layer can be made from a PEBAX® material. PEBAX® is a polyether block amide that is a thermoplastic elastomer made of a flexible polyether and rigid polyamide. The rigid polyamide can comprise Nylon. The PEBAX® can comprise different compounds that correspond to different Shore D hardness values, polyether percentages, and/or polyamide percentages. The chemical compound of the PEBAX® can vary between each zone in the middle layer to alter the hardness and thereby adjust the smash factor profile.

[0074] In many embodiments, the PEBAX® of the different zones can comprise a PEBAX® 4033 (Arkema, Paris France) or a PEBAX® 6333 (Arkema, Paris France). The PEBAX® 4033 (Arkema, Paris France) comprises a tetra methylene oxide (53% wt) and a Nylon 12. The PEBAX® 6333 (Arkema, Paris France) comprises a Nylon 11.

[0075] The PEBAX® can comprise a percentage of polyether by volume. In some embodiments, the PEBAX® can comprise 0% to 10%, 10% to 20%, 15% to 30%, 20% to 30%, 30% to 40%, 30% to 50%, 30% to 60%, 40% to 50%, 40% to 60%, 50% to 60%, or 60% to 70% polyether by volume. For example, the PEBAX® can comprise 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, or 70% of polyether by volume. In some embodiments, the PEBAX® can

comprise 0% to 10%, 10% to 20%, 15% to 30%, 20% to 30%, 30% to 40%, 40% to 50%, 40% to 60%, 50% to 60%, or 60% to 70% of polyamide by volume. For example, the PEBAX® can comprise 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, or 70% of polyamide by volume. As the percentage of polyether percentage increases, the hardness of the PEBAX® decreases. As the percentage of polyamide percentage increases, the hardness of the PEBAX® increases. For example, the PEBAX® 4033 (Arkema, Paris France) can comprise 40% to 60% polyether by volume and 15% to 30% polyamide by volume. For example, the PEBAX® 6333 (Arkema, Paris France) can comprise 15% to 30% polyether by volume and 40% to 60% polyamide by volume.

[0076] In many embodiments, the PEBAX® can comprise a hardness ranging from Shore 15D to Shore 75D. In some embodiments, the hardness of the PEBAX® can range from Shore 15D to Shore 25D, Shore 25D to Shore 35D, Shore 35D to Shore 45D, Shore 36D to Shore 44D, Shore 38D to Shore 42D, Shore 45D to Shore 55D, Shore 55D to Shore 65D, Shore 56D to Shore 64D, Shore 60D to Shore 65D, or Shore 65D to Shore 75D. For example, the hardness of the PEBAX® can be Shore D 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, or 70.

[0077] In many embodiments, the PEBAX® 4033 (Arkema, Paris France) can comprise a lower hardness than the PEBAX® 6333 (Arkema, Paris France). In many embodiments, the PEBAX® 4033 (Arkema, Paris France) can comprise a hardness range of Shore 15D to Shore 55D. In some embodiments, the PEBAX® 4033 (Arkema, Paris France) can comprise a hardness range of Shore 38D to Shore 42D, or Shore 39D to Shore 41D. For example, the PEBAX® 4033 (Arkema, Paris France) can be comprise a Shore D hardness of 40. In many embodiments, the PEBAX® 6333 (Arkema, Paris France) can comprise a hardness range of Shore 50D to Shore 75D. In some embodiments, the PEBAX® 6333 (Arkema, Paris France) can comprise a hardness range of Shore 55D to Shore 70D, or Shore 60D to Shore 65D. For example, the PEBAX® 6333 (Arkema, Paris France) can comprise a Shore D hardness of 63.

[0078] In many embodiments, the PEBAX® 4033 (Arkema, Paris France) can comprise a lower hardness than the PEBAX® 6333 (Arkema, Paris France). In many embodiments, the PEBAX® 4033 (Arkema, Paris France) can comprise a hardness range of Shore 35D to Shore 55D. In some embodiments, the PEBAX® 4033 (Arkema, Paris France) can comprise a hardness range of Shore

38D to Shore 42D, or Shore 39D to Shore 41D. For example, the PEBAX® 4033 (Arkema, Paris France) can be comprise a Shore D hardness of 40. In many embodiments, the PEBAX® 6333 (Arkema, Paris France) can comprise a hardness range of Shore 50D to Shore 75D. In some embodiments, the PEBAX® 6333 (Arkema, Paris France) can comprise a hardness range of Shore 55D to Shore 70D, or Shore 60D to Shore 65D. For example, the PEBAX® 6333 (Arkema, Paris France) can comprise a Shore D hardness of 63.

[0079] In other embodiments, the variable durometer middle layer can be made from any combination of the following: thermoplastic co-polyester elastomer (TPC), thermoplastic elastomer (TPE), thermoplastic urethane (TPU), steel, nickel, TPU/aluminum, TPE/aluminum, plastic/metal screen insert, polyethylene, polypropylene, polytetrafluoroethylene, polyisobutylene, polyvinyl chloride polycarbonate (PC), polyester (PBT), polyphenylene sulfide (PPS), polyamide (PA) (e.g. polyamide 6 (PA6), polyamide 6-6 (PA66), polyamide-12 (PA12), polyamide-612 (PA612), polyamide 11 (PA11)), thermoplastic polyurethane (TPU), polyphthalamide (PPA), acrylonitrile butadiene styrene (ABS), polybutylene terephthalate (PBT), polyvinylidene fluoride (PVDF), polyethylene (PE), polyphenylene ether/oxide (PPE), polyoxymethylene (POM), polypropylene (PP), styrene acrylonitrile (SAN), polymethylpentene (PMP), polyethylene terephthalate (PET), acrylonitrile styrene acrylate (ASA), polyetherimide (PEI), polyvinylidene fluoride (PVDF), polymethylmethacrylate (PMMA), polyether ether ketone (PEEK), polyether ketone (PEK), polyetherimide (PEI), polyethersulfone (PES), polyphenylene oxide (PPO), polystyrene (PS), polysulfone (PSU), polyvinyl chloride (PVC), liquid crystal polymer (LCP), thermoplastic elastomer (TPE), ultra-high molecular weight polyethylene (UHMWPE), or alloys of the above described thermoplastic materials, such as an alloy of acrylonitrile butadiene styrene (ABS) and polycarbonate (PC) or an alloy of acrylonitrile butadiene styrene (ABS) and polyamide (PA).

IV. Construction

[0080] In some embodiments, each zone can be formed separately and then joined together to form the middle layer. For example, one zone can be cut into a desired shape from a larger stock of a material that has the desired durometer. A second zone can be cut from a different stock having a different durometer. The two zones can then be coupled together to form at least a portion of the middle layer. For example, the central zone can be coupled together at the central zone toe surface

and the first toe zone medial surface through an adhesive or epoxy. More zones can be formed separately and attached as desired. In other embodiments, the zones can be integrally formed through a co-molding process or multi-material injection molding process where two or more materials are molded into one integral part. Similarly, the face plate can also be formed separately and then attached, or co-molded to the middle layer.

[0081] The middle layer is secured to the club head body through an adhesive layer. The adhesive layer can be a VHB tape, epoxy, or other similar adhesive material to adequately secure the middle layer to the body. In other embodiments, the middle layer can be attached to the club head body through co-molding, mechanical fasteners, press fitting, or other fastening means.

[0082] The face inserts, described herein, achieve consistent smash factor across the face by forming the center region, or zone, with the lowest durometer material, and increasing the durometer of each distal zone in the heel and toe direction. Increasing the durometer of the distal zones offsets the energy loss to rotation, thereby providing the same smash factor as a ball hit in the central zone. The durometer of the distal regions can be adjusted according to the distance away from the geometric center such that the durometer is increased. As such, each zone of the face insert achieves a less than 1.25% change in smash factor across the face to provide more predictable ball roll-out distances.

[0083] Clause 1: A putter-type club head comprising: a body having a toe end, a heel end opposite the toe end, a front end, a rear end opposite the front end, a top, and a bottom opposite the top; a front surface of the front end and a front recess extending from the front surface toward the rear end; a face insert disposed in the front recess and having a geometric center; wherein: the face insert comprises a face plate, a middle layer, and an adhesive layer; the middle layer comprises: a central zone formed of a central zone material having a central zone hardness ranging from 28 to 32 on a Shore D hardness scale; a first toe zone located between the central zone and the toe end, the first toe zone is formed of a first toe zone material having a first toe zone hardness ranging from 33 to 37 on the Shore D hardness scale; a first heel zone located between the central zone and the heel end, the first heel zone is formed of a first heel zone material having a first heel zone hardness ranging from 30 to 35 on the Shore D hardness scale.

[0084] Clause 2: The putter-type club head of clause 1, wherein: a second toe zone located between the first toe zone and the toe end; a second heel zone located between the first heel zone and the heel end; the first toe zone borders the central zone; and the first heel zone borders the central zone.

[0085] Clause 3: The putter-type club head of clause 2, wherein: the second toe zone is formed of a second toe zone material having a second toe zone hardness ranging from 35 to 42 on the Shore D hardness scale; and the second heel zone is formed of a second heel zone material having a second heel zone hardness ranging from 35 to 42 on the Shore D hardness scale.

[0086] Clause 4: The putter-type club head of clause 3, wherein: the middle layer is formed from a PEBAX® material; and the face plate is formed from an aluminum material.

[0087] Clause 5: The putter-type club head of clause 3, wherein: the face plate has a thickness that is less than 0.050 inch; and the middle layer has a thickness that is between 0.10 and 0.25 inch.

[0088] Clause 6: A putter-type club head comprising: a body having a toe end, a heel end opposite the toe end, a front end, a rear end opposite the front end, a top, and a bottom portion opposite the top; a front surface and a front recess located on the front surface; a face insert having a geometric center; and wherein: the face insert comprises a face plate, a middle layer, and an adhesive layer; the face plate is formed from a metallic material and completely covers the middle layer and adhesive layer such that no portion of the middle layer or the adhesive layer are visible when in the front recess; the face plate forms a portion of the front surface to form an uninterrupted front surface configured to impact a golf ball; the middle layer comprises a central zone, a first toe zone, a first heel zone, a second toe zone, and a second heel zone; the central zone comprises a central zone toe surface and a central zone heel surface; the first toe zone comprises a first toe zone distal surface and a first toe zone medial surface; the first heel zone comprises a first heel zone distal surface and a first heel zone medial surface; the second toe zone comprises a second toe zone distal surface and a second toe zone medial surface; the second heel zone comprises a second heel zone distal surface and a second heel zone medial surface; the central zone toe surface abuts the first toe zone medial surface, the central zone heel surface abuts the first heel zone medial surface; the first heel zone distal surface abuts the second heel zone medial surface, the first toe zone distal surface abuts the second toe zone medial surface; the central zone comprises a central durometer ranging from 28 to 32 on a Shore D hardness

scale; the first toe zone comprises a first toe zone durometer ranging from 33 to 37 on the Shore D hardness scale; the first heel zone comprises a first heel zone durometer ranging from 30 to 35 on the Shore D hardness scale; the second toe zone comprises a second toe zone durometer ranging from 35 to 42 on the Shore D hardness scale; and the second heel zone comprises a second heel zone durometer ranging from 35 to 42 on the Shore D hardness scale.

[0089] Clause 7: The putter-type club head of clause 6, wherein: the middle layer comprises a third heel zone and a third toe zone; the third heel zone comprises a third heel zone distal surface and a third heel zone medial surface; the third toe zone comprises a third toe zone distal surface and a third toe zone medial surface; the third heel zone medial surface abuts the second heel zone distal surface; the third toe zone medial surface abuts the second toe zone distal surface; the third heel zone comprises a third heel zone durometer ranging from 38 to 47 on the Shore D hardness scale; and the third toe zone comprises a third toe zone durometer ranging from 38-47 on the Shore D hardness scale.

[0090] Clause 8: The putter-type club head of clause 7, wherein: the body comprises an imaginary insert midplane that is perpendicular to a ground plane and extends through the geometric center; the central zone comprises a central zone midline that is perpendicular to the front surface and is equidistant from the first toe zone medial surface and the first heel zone medial surface and extends perpendicular to the front surface; the first heel zone comprises a first heel zone midline that is perpendicular to the front surface and is equidistant from the first heel zone distal surface and the first heel zone medial surface; the second toe zone comprises a second toe midline that is perpendicular to the front surface and is equidistant from the second toe zone distal surface and the second toe zone medial surface; the second heel zone comprises a second heel zone midline that is perpendicular to the front surface and is equidistant from the second heel zone distal surface and the second heel zone medial surface; the third toe zone comprises a third toe zone midline that is perpendicular to the front surface and is equidistant from the third toe zone distal surface and the third toe zone medial surface; the third heel zone comprises a third heel zone midline that is perpendicular to the front surface and is equidistant from the third heel zone distal surface and the third heel zone medial surface; the third toe zone comprises a third toe zone midline that is perpendicular to the front surface and is equidistant from the third toe zone distal surface and the third toe zone medial surface; the central zone midline

is coplanar with the imaginary insert midplane; the first heel zone midline is 0.20 to 0.30 inch away from the imaginary insert midplane; the second toe midline is 0.20 to 0.30 inch away from the imaginary insert midplane; the second heel zone midline is 0.45 to 0.55 inch away from the imaginary insert midplane; the third toe zone midline is 0.45 to 0.55 inch away from the imaginary insert midplane; the third heel zone midline is 0.65 to 0.75 inch away from the imaginary insert midplane; and the third toe zone midline is 0.65 to 0.75 inch away from the imaginary insert midplane.

[0091] Clause 9: The putter-type club head of clause 7, wherein: the face plate has a thickness that is between 0.005 and 0.050 inch; and the middle layer has a thickness that is between 0.025 and 0.25 inch.

[0092] Clause 10: The putter-type club head of clause 9, wherein: the front surface defines a loft angle that is between 0 and 8 degrees; the body comprises a mass between 345 and 380 grams; and the front surface comprises a max height that is less than 1.25 inches.

[0093] Clause 11: The putter-type club head of clause 8, wherein the face plate comprises a plurality of horizontal grooves extending in a heel-toe direction.

[0094] Clause 12: A putter-type club head comprising: a body having toe end, a heel end opposite the toe end, a front end, a rear end opposite the front end, a top, and a bottom portion opposite the top; a front surface and a front recess located on the front surface; a face insert having a geometric center; and a midplane that is perpendicular to a ground plane and extends through the geometric center; wherein: the face insert comprises face plate, a middle layer, and an adhesive layer; the face plate is located outboard, the adhesive layer is located inboard, and the middle layer is disposed between the face plate and adhesive layer; the face insert further comprises a first heel point, a first toe point, a first heel zone point, and a second toe point; the first heel point is located 0.25 inch horizontally and heelward of the midplane; the first toe point is located 0.25 inch horizontally and toeward of the midplane; the first heel zone point is located 0.50 inch horizontally and heelward of the midplane; the second toe point is located 0.50 inch horizontally and toeward of the midplane; the middle layer comprises a center durometer at the geometric center that is less than 30 shore; the middle layer comprises a first heel durometer at the first heel point that is between 30 and 35 shore; the middle layer comprises a first toe durometer at the first toe point that is between 35 and 40 shore; the middle layer comprises a first heel zone durometer at the first heel zone point that is between 35

and 40; and the middle layer comprises a second toe durometer at the second toe point that is between 40 and 45 shore.

EXAMPLES

Example 1 – Pendulum Test Exemplary Club Head vs. Control Club Head

[0095] A pendulum test was conducted to compare an exemplary putter type club head according to aspects of the present invention to a control club head. The test was designed to illustrate the smash factor change between a putter having a variable durometer face insert, according to aspects of the present invention, to a single durometer putter face. The exemplary putter comprised a variable durometer face insert similar to the face insert of FIGS. 1-5 in that the exemplary putter had five discrete zones with variable hardness. The exemplary putter comprised a central zone, a first toe zone and a first heel zone located on the toe side and heel side of the central zone respectively. The exemplary putter further comprises a second toe zone and a second heel zone located toeward of the first toe zone and heelward of the second heel zone, respectively. The central zone comprised the lowest hardness of shore 60A. The first toe zone and first heel zone comprised a hardness of shore 55D. The second toe zone and the second heel zone comprised the greatest hardness of shore 63D. The control club head comprised a solid metal construction with strike face having a single, non-variable, durometer profile.

[0096] The exemplary putter and the control putter were hit at two distances. At each distance, the putters hit 5 balls at 5 different locations across the strike face. The smash factors were recorded for each hit and were averaged at each of the 5 locations to give a smash factor profile across, for each of the two distances. FIG. 14 illustrates the smash factor profile of the exemplary club head and the control club head for shots hit to the first distance of 10 feet. FIG. 15 illustrates the smash factor profile of the exemplary club head and the control club head for shots hit to the second distance of 20 feet. The smash factor profiles include 5 points: center strike, 0.5 inch toeward (from center), 0.5 inch heelward (from center), 1.25 inch toeward (from center), 1.25 inch heelward (from center). Each putter was hit 5 times at each point. The results of the 5 shots were averaged to give one number for each of the 5 points. The five points of the strike corresponded to the five discrete zones of the exemplary embodiment, described above.

[0097] As illustrated in FIGS. 14 and 15, the exemplary putter had a lower smash factor than the control putter on a center strikes for both the 10 foot and 20 foot putts. Further, the exemplary putter

had an increase smash factor on the 1.25 toeward and 1.25 heelward strikes. The exemplary putter exhibited a more even smash factor distribution across the face than the control club head which lead to a more predictable ball roll out distance on miss hits.

Example 2 – Comparison of Simulated Exemplary Club Head vs. Actual Control Club Head

[0098] A comparative test was conducted to compare an exemplary club head according to aspects of the present invention to a control club head. The test mathematically modeled smash factor for the exemplary club head at 5 different locations across the face and compared the smash factor to the smash factor of the control club head, which was measured in a pendulum test. The results of the test are illustrated as a percent reduction of smash factor relative to the center smash factor. The exemplary putter comprised a variable durometer face insert similar to the face insert in FIGS 1-5 in that the exemplary putter had five discrete zones with different hardnesses. The exemplary putter comprised a central zone, a first toe zone and a first heel zone located on the toe side and heel side of the central zone respectively. The exemplary putter further comprises a second toe zone and a second heel zone located toeward of the first toe zone and heelward of the second heel zone, respectively. The central zone comprised a hardness of 30 on a Shore D hardness scale. The first toe zone comprised a hardness of 37 on a Shore D hardness scale. The first heel zone comprised a hardness of shore 31 on the Shore D hardness scale. The second toe zone comprised a hardness of 41 on the Shore D hardness scale. The second heel zone comprised a hardness of 38 on the Shore D hardness scale. The control club head comprised a solid metal construction with strike face having a single, non-variable, durometer profile.

[0099] The smash factor for each club head was mathematically predicted at 5 locations: center (at the GC), 0.25 inch toeward of center, 0.25 inch heelward of center, 0.5 inch toeward of center, and 0.5 inch heelward of center. Each smash factor location corresponded to each of the hardness zones described above.

[0100] As shown in Table 1 below, the exemplary club head exhibited a more consistent smash factor across the face when compared to the control club head. As such, the exemplary club head that comprised a variable durometer insert, according to aspects of the present invention, was able to provide more consistent ball speeds and predictable roll out distances when compared to a club head without a variable durometer insert.

Table 1

Location	Exemplary Club Head Smash Factor (% Reduction from Center)	Control Club Head Smash Factor (% Reduction from Center)
0.5 inch heel	0.07%	2.30%
0.25 inch heel	0.26%	0.14%
Center	0%	0%
0.25 inch toe	0.05%	2.23%
0.5 inch toe	0.01%	2.78%

CLAIMS

1. A putter-type club head comprising:

a body having a toe end, a heel end opposite the toe end, a front end, a rear end opposite the front end, a top, and a bottom opposite the top;

a front surface of the front end and a front recess extending from the front surface toward the rear end;

a face insert disposed in the front recess and having a geometric center;

wherein:

the face insert comprises a face plate, a middle layer, and an adhesive layer;

the middle layer comprises:

a central zone formed of a central zone material having a central zone hardness ranging from 28 to 32 on a Shore D hardness scale;

a first toe zone located between the central zone and the toe end, the first toe zone is formed of a first toe zone material having a first toe zone hardness ranging from 33 to 37 on the Shore D hardness scale;

a first heel zone located between the central zone and the heel end, the first heel zone is formed of a first heel zone material having a first heel zone hardness ranging from 30 to 35 on the Shore D hardness scale.

2. The putter-type club head of claim 1, wherein:

a second toe zone located between the first toe zone and the toe end;

a second heel zone located between the first heel zone and the heel end;

the first toe zone borders the central zone; and

the first heel zone borders the central zone.

3. The putter-type club head of claim 2, wherein:

the second toe zone is formed of a second toe zone material having a second toe zone hardness ranging from 35 to 42 on the Shore D hardness scale; and

the second heel zone is formed of a second heel zone material having a second heel zone hardness ranging from 35 to 42 on the Shore D hardness scale.

4. The putter-type club head of claim 3, wherein:

the middle layer is formed from a PEBAX® material; and

the face plate is formed from an aluminum material.

5. The putter-type club head of claim 3, wherein:

The face plate has a thickness that is less than 0.050 inch; and

The middle layer has a thickness that is between 0.10 and 0.25 inch.

6. A putter-type club head comprising:

a body having a toe end, a heel end opposite the toe end, a front end, a rear end opposite the front end, a top, and a bottom portion opposite the top;

a front surface and a front recess located on the front surface;

a face insert having a geometric center; and

wherein:

the face insert comprises a face plate, a middle layer, and an adhesive layer;

the face plate is formed from a metallic material and completely covers the middle layer and adhesive layer such that no portion of the middle layer or the adhesive layer are visible when in the front recess;

the face plate forms a portion of the front surface to form an uninterrupted front surface configured to impact a golf ball;

the middle layer comprises a central zone, a first toe zone, a first heel zone, a second toe zone, and a second heel zone;

the central zone comprises a central zone toe surface and a central zone heel surface;

the first toe zone comprises a first toe zone distal surface and a first toe zone medial surface;

the first heel zone comprises a first heel zone distal surface and a first heel zone medial surface;

the second toe zone comprises a second toe zone distal surface and a second toe zone medial surface;

the second heel zone comprises a second heel zone distal surface and a second heel zone medial surface;

the central zone toe surface abuts the first toe zone medial surface, the central zone heel surface abuts the first heel zone medial surface;

the first heel zone distal surface abuts the second heel zone medial surface, the first toe zone distal surface abuts the second toe zone medial surface;

the central zone comprises a central durometer ranging from 28 to 32 on a Shore D hardness scale;

the first toe zone comprises a first toe zone durometer ranging from 33 to 37 on the Shore D hardness scale;

the first heel zone comprises a first heel zone durometer ranging from 30 to 35 on the Shore D hardness scale;

the second toe zone comprises a second toe zone durometer ranging from 35 to 42 on the Shore D hardness scale; and

the second heel zone comprises a second heel zone durometer ranging from 35 to 42 on the Shore D hardness scale.

7. The putter-type club head of claim 6, wherein:

the middle layer comprises a third heel zone and a third toe zone;

the third heel zone comprises a third heel zone distal surface and a third heel zone medial surface;

the third toe zone comprises a third toe zone distal surface and a third toe zone medial surface;

the third heel zone medial surface abuts the second heel zone distal surface;

the third toe zone medial surface abuts the second toe zone distal surface;

the third heel zone comprises a third heel zone durometer ranging from 38 to 47 on the Shore D hardness scale; and

the third toe zone comprises a third toe zone durometer ranging from 38-47 on the Shore D hardness scale.

8. The putter-type club head of claim 7, wherein:

the body comprises an imaginary insert midplane that is perpendicular to a ground plane and extends through the geometric center;

the central zone comprises a central zone midline that is perpendicular to the front surface and is equidistant from the first toe zone medial surface and the first heel zone medial surface and extends perpendicular to the front surface;

the first heel zone comprises a first heel zone midline that is perpendicular to the front surface and is equidistant from the first heel zone distal surface and the first heel zone medial surface;

the second toe zone comprises a second toe midline that is perpendicular to the front surface and is equidistant from the second toe zone distal surface and the second toe zone medial surface;

the second heel zone comprises a second heel zone midline that is perpendicular to the front surface and is equidistant from the second heel zone distal surface and the second heel zone medial surface;

the third toe zone comprises a third toe zone midline that is perpendicular to the front surface and is equidistant from the third toe zone distal surface and the third toe zone medial surface;

the third heel zone comprises a third heel zone midline that is perpendicular to the front surface and is equidistant from the third heel zone distal surface and the third heel zone medial surface;

the third toe zone comprises a third toe zone midline that is perpendicular to the front surface and is equidistant from the third toe zone distal surface and the third toe zone medial surface;

the central zone midline is coplanar with the imaginary insert midplane;

the first heel zone midline is 0.20 to 0.30 inch away from the imaginary insert midplane;

the second toe midline is 0.20 to 0.30 inch away from the imaginary insert midplane;

the second heel zone midline is 0.45 to 0.55 inch away from the imaginary insert midplane;

the third toe zone midline is 0.45 to 0.55 inch away from the imaginary insert midplane;

the third heel zone midline is 0.65 to 0.75 inch away from the imaginary insert midplane; and

the third toe zone midline is 0.65 to 0.75 inch away from the imaginary insert midplane.

9. The putter-type club head of claim 7, wherein:

the face plate has a thickness that is between 0.005 and 0.050 inch; and

the middle layer has a thickness that is between 0.025 and 0.25 inch.

10. The putter-type club head of claim 9, wherein:

the front surface defines a loft angle that is between 0 and 8 degrees;

the body comprises a mass between 345 and 380 grams; and

the front surface comprises a max height that is less than 1.25 inches.

11. The putter-type club head of claim 8, wherein:

the face plate comprises a plurality of horizontal grooves extending in a heel-toe direction.

12. A putter-type club head comprising:

a body having toe end, a heel end opposite the toe end, a front end, a rear end opposite the front end, a top, and a bottom portion opposite the top;

a front surface and a front recess located on the front surface;

a face insert having a geometric center; and

a midplane that is perpendicular to a ground plane and extends through the geometric center;

wherein:

the face insert comprises face plate, a middle layer, and an adhesive layer;

the face plate is located outboard, the adhesive layer is located inboard, and the middle layer is disposed between the face plate and adhesive layer;

the face insert further comprises a first heel point, a first toe point, a first heel zone point, and a second toe point;

the first heel point is located 0.25 inch horizontally and heelward of the midplane;

the first toe point is located 0.25 inch horizontally and toeward of the midplane;

the first heel zone point is located 0.50 inch horizontally and heelward of the midplane;

the second toe point is located 0.50 inch horizontally and toeward of the midplane;

the middle layer comprises a center durometer at the geometric center that is less than 30 shore;

the middle layer comprises a first heel durometer at the first heel point that is between 30 and 35 shore;

the middle layer comprises a first toe durometer at the first toe point that is between 35 and 40 shore;

the middle layer comprises a first heel zone durometer at the first heel zone point that is between 35 and 40; and

the middle layer comprises a second toe durometer at the second toe point that is between 40 and 45 shore.

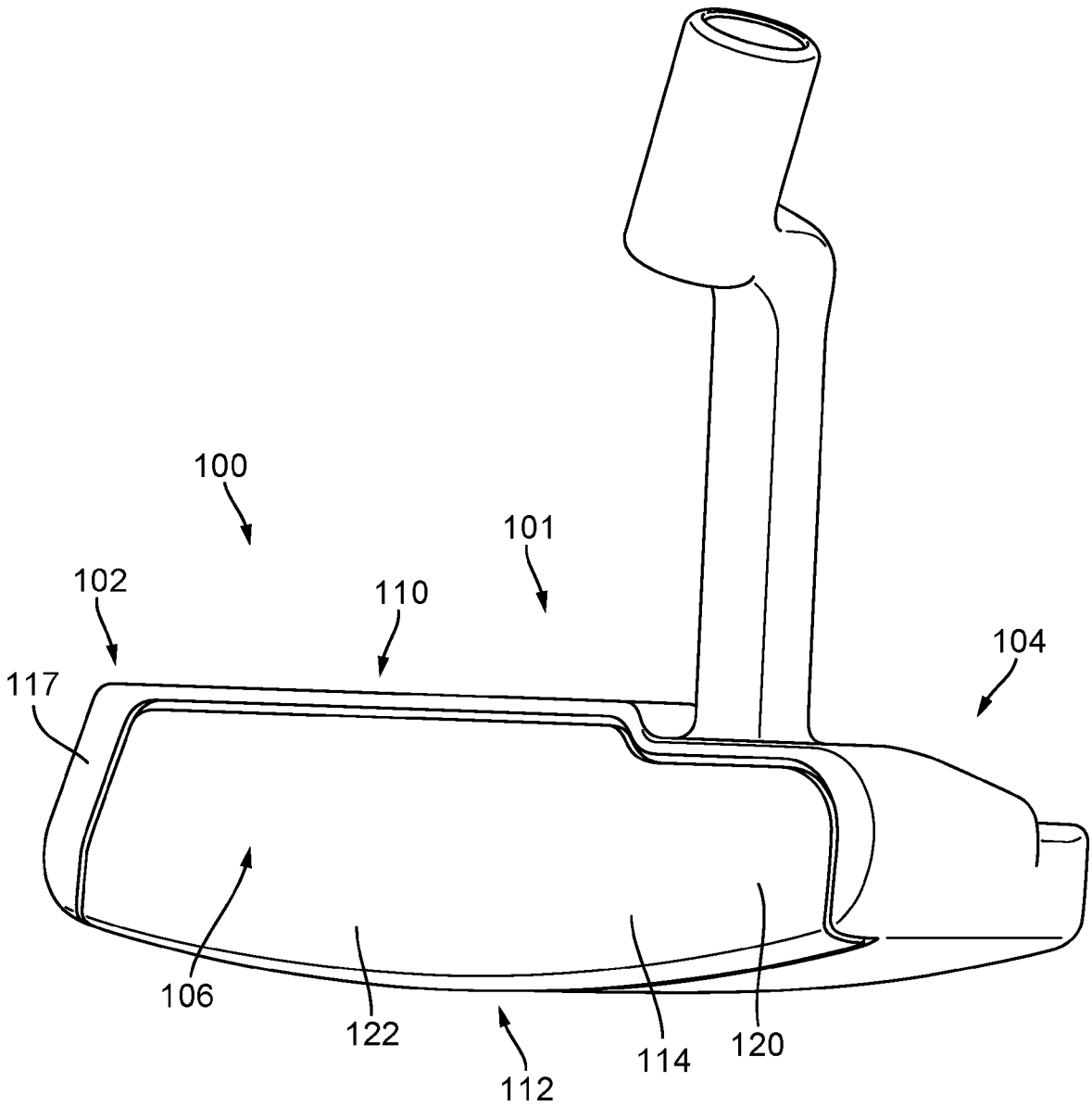


FIG. 1

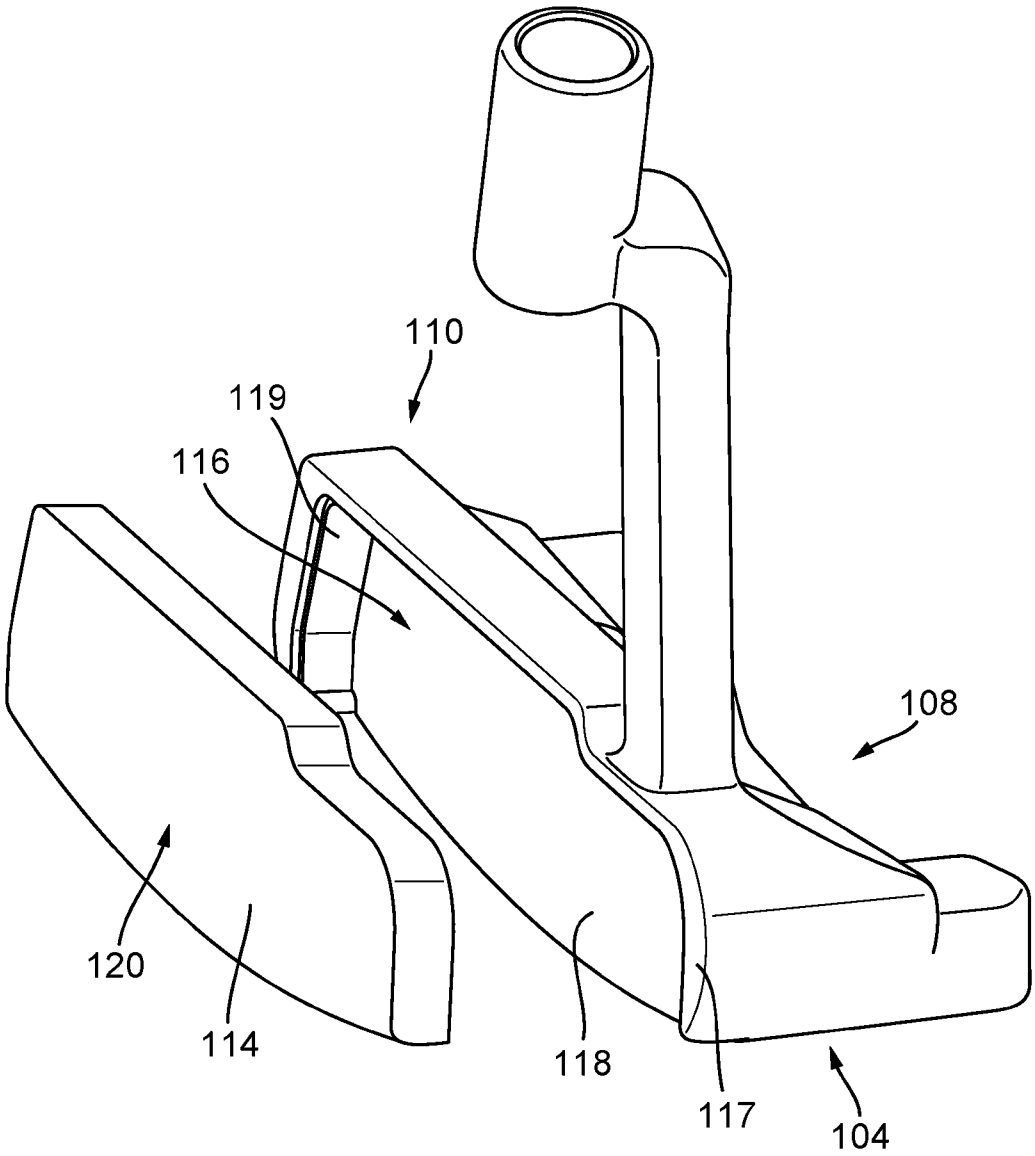
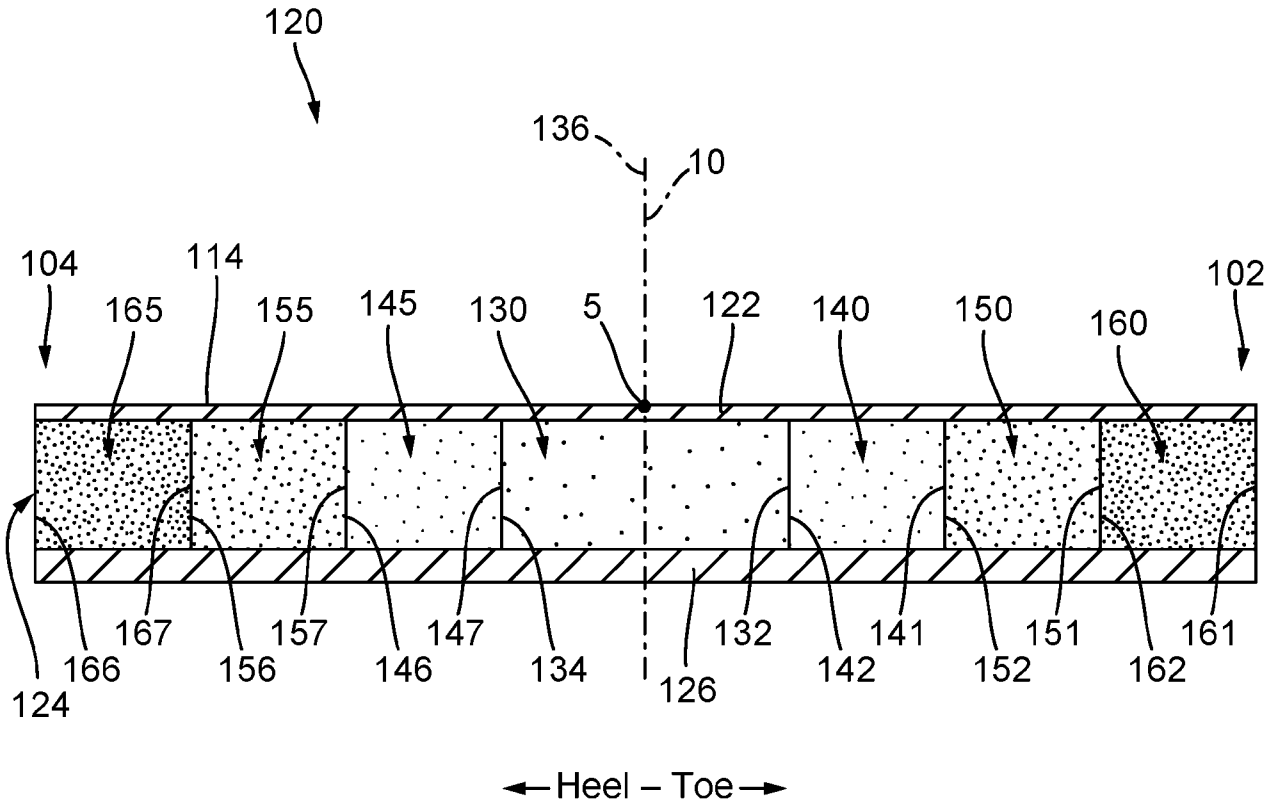


FIG. 2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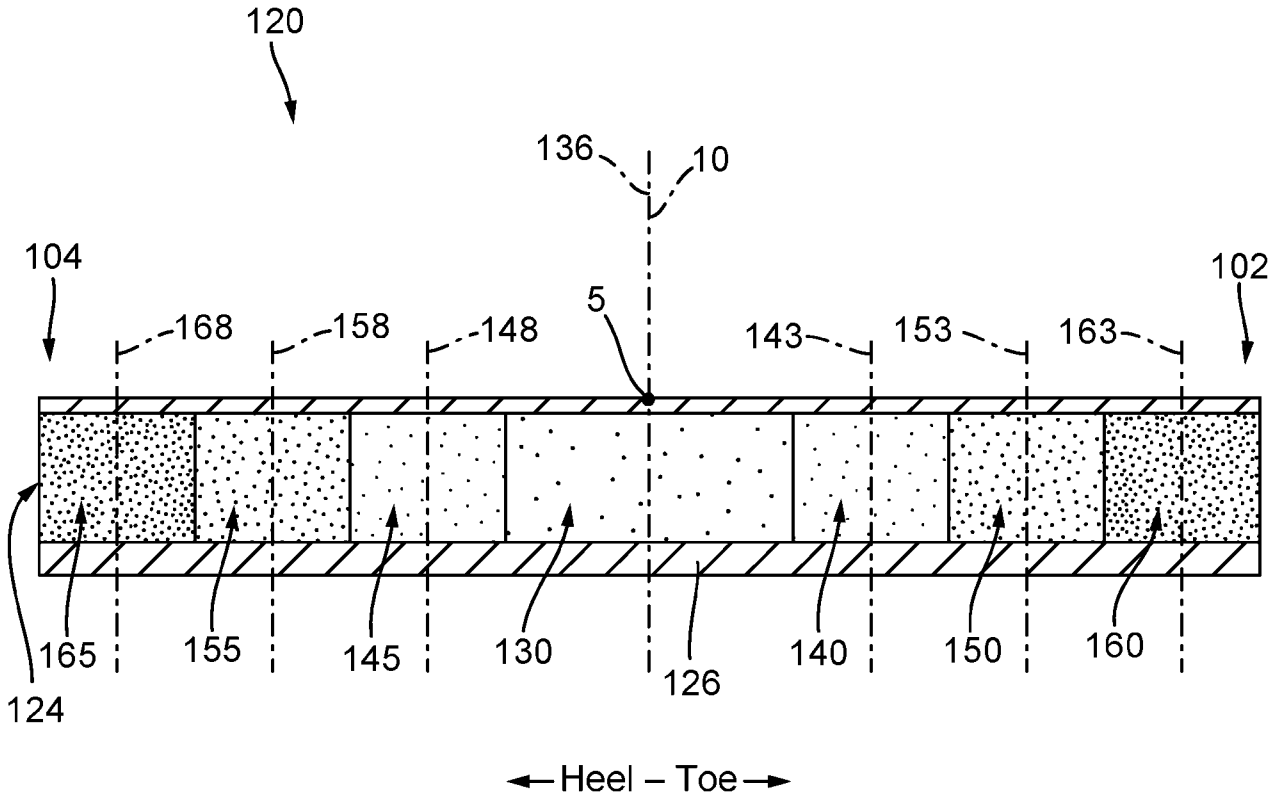
Heel – Toe

FIG. 3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Heel – Toe

FIG. 4

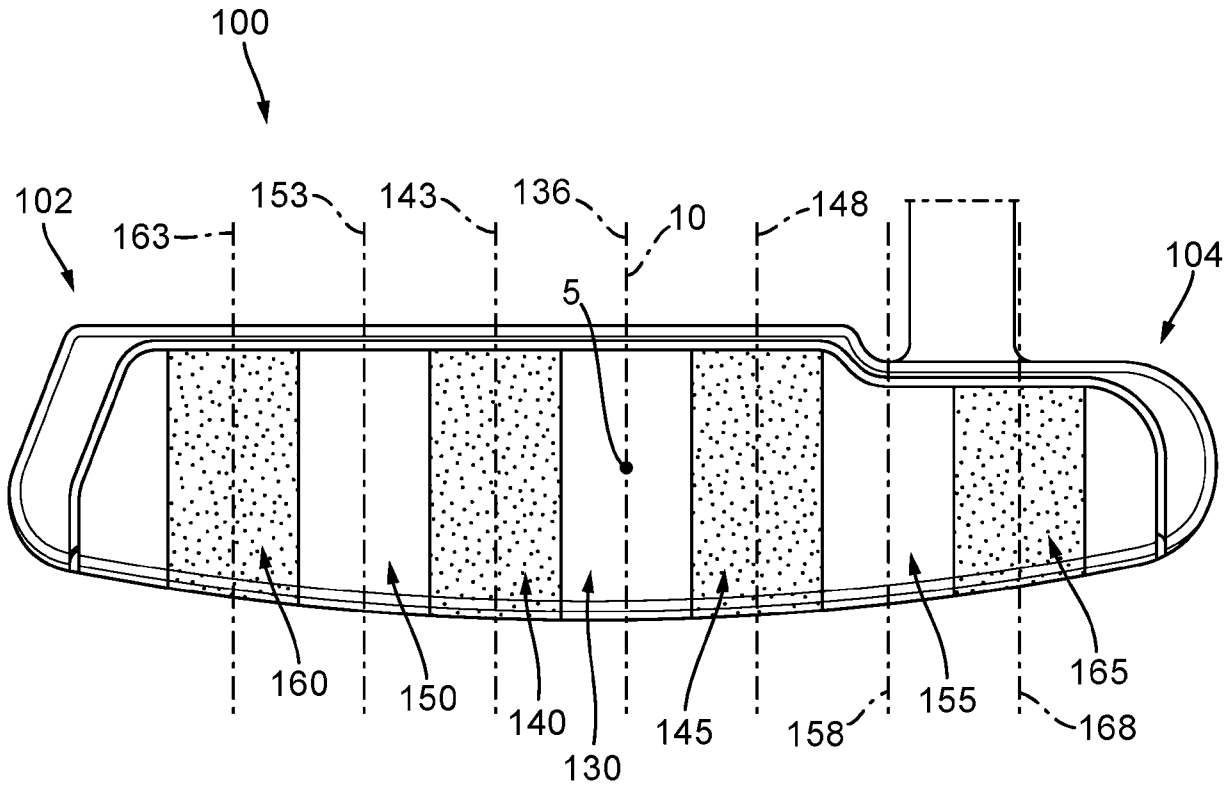
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FIG. 5

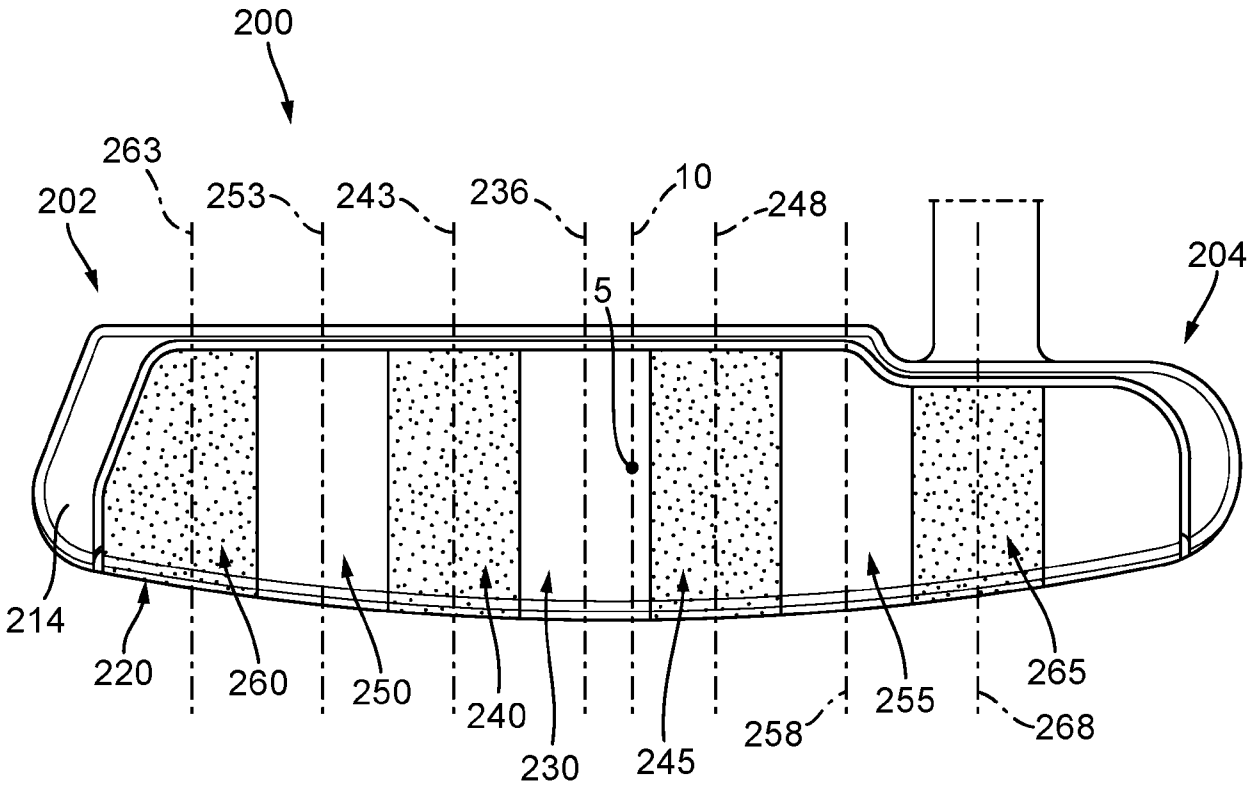
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FIG. 6

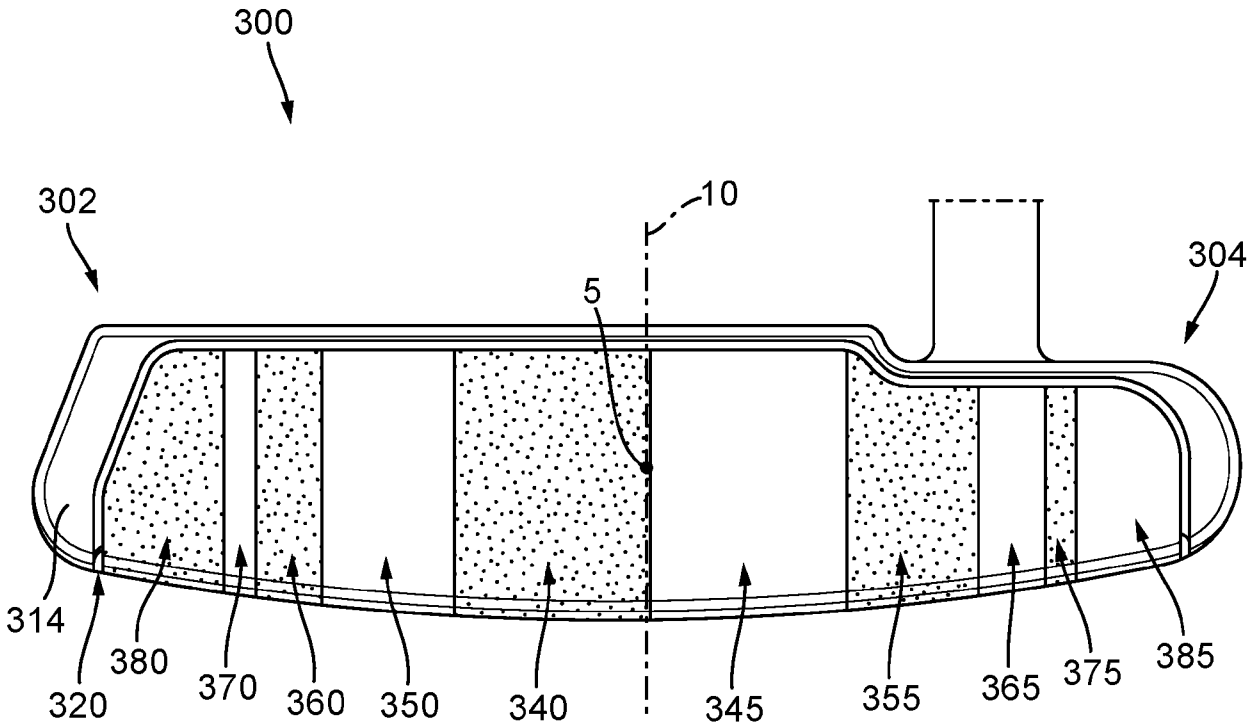

FIG. 7

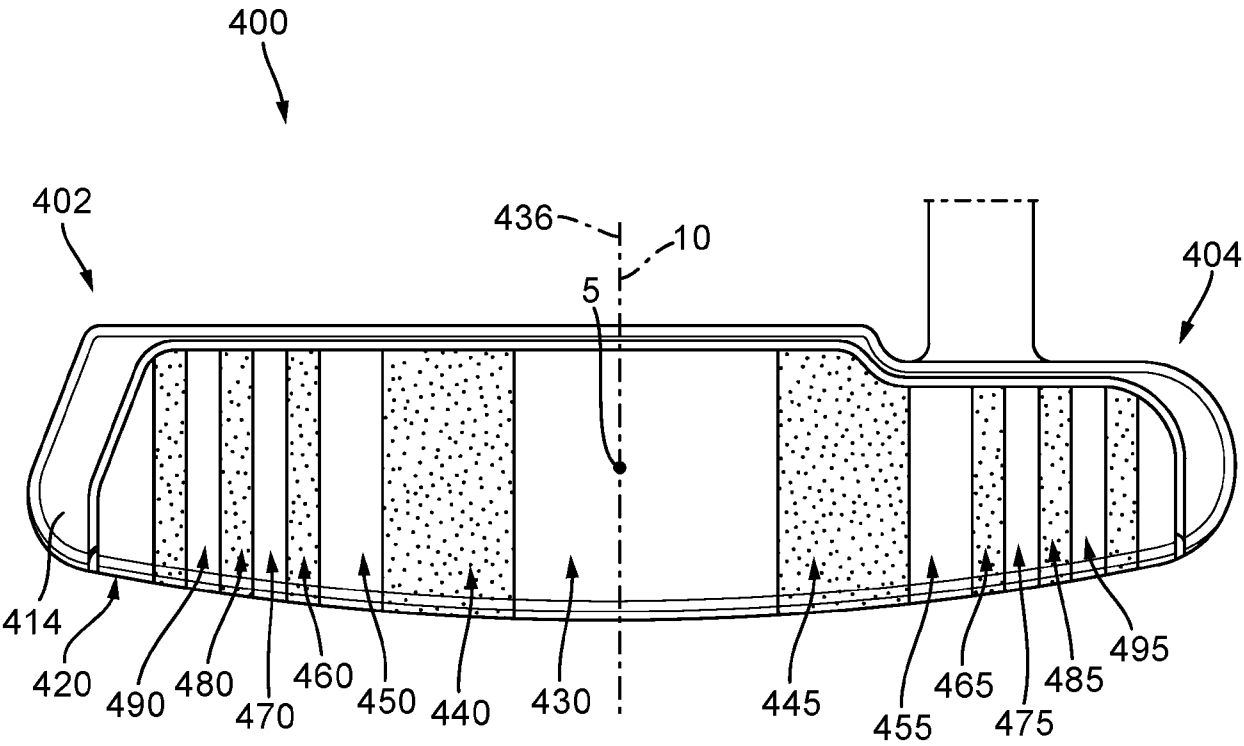
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FIG. 8

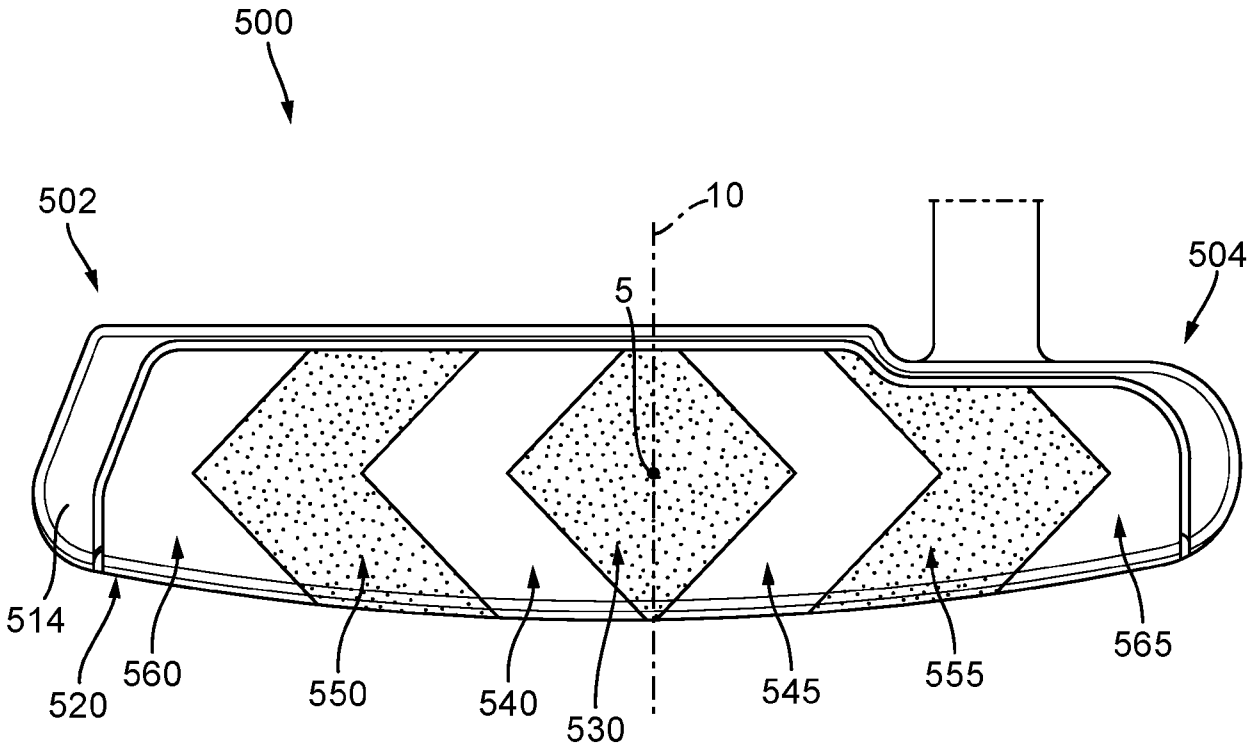

FIG. 9

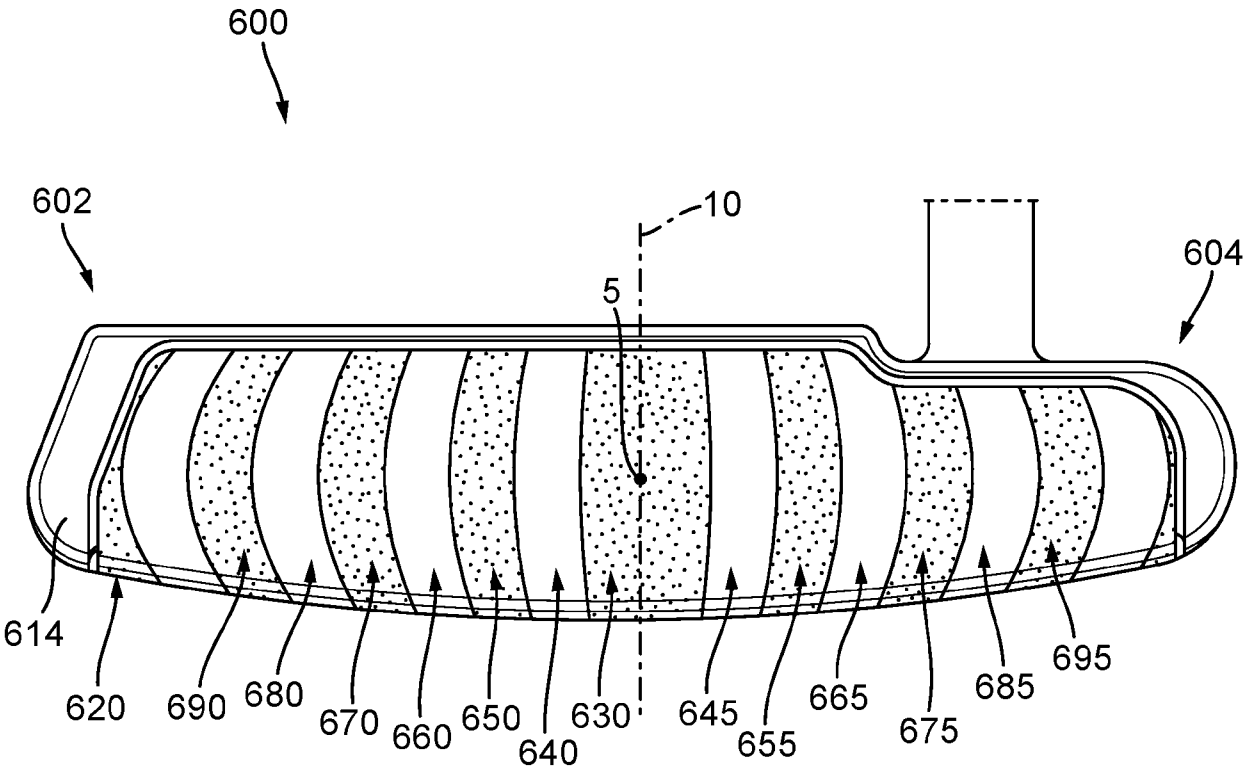
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FIG. 10

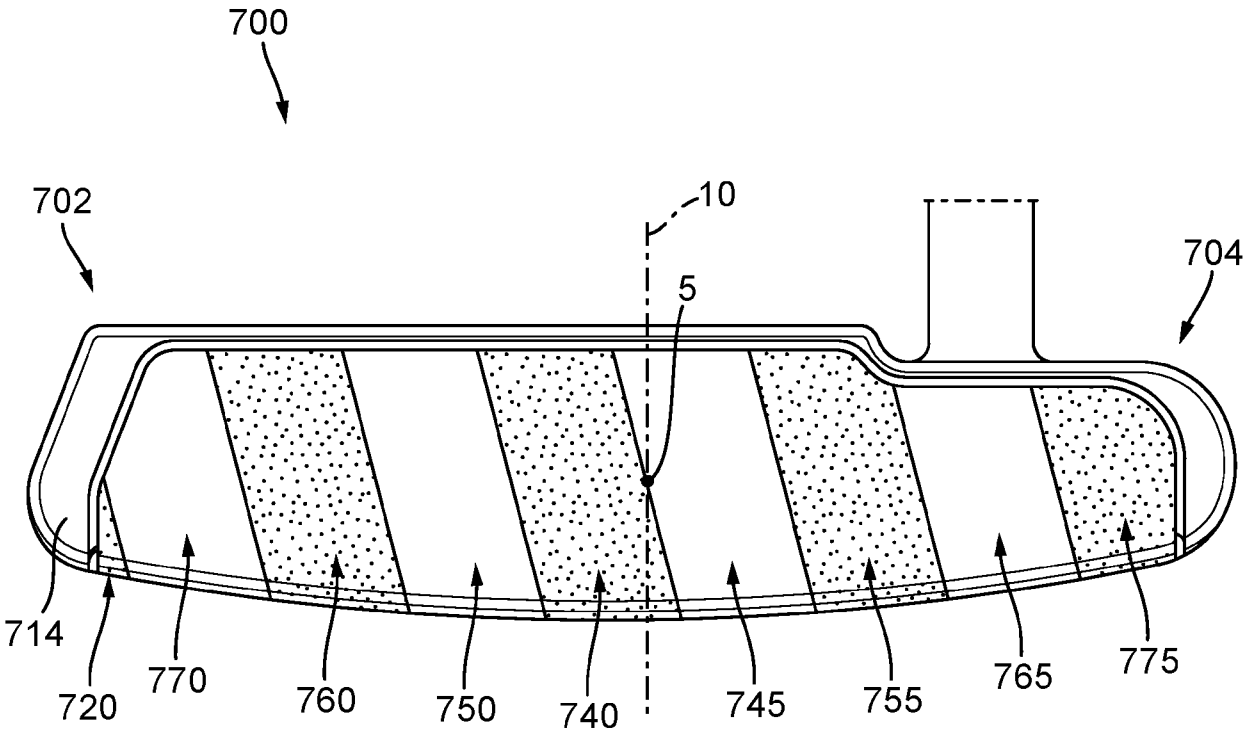

FIG. 11

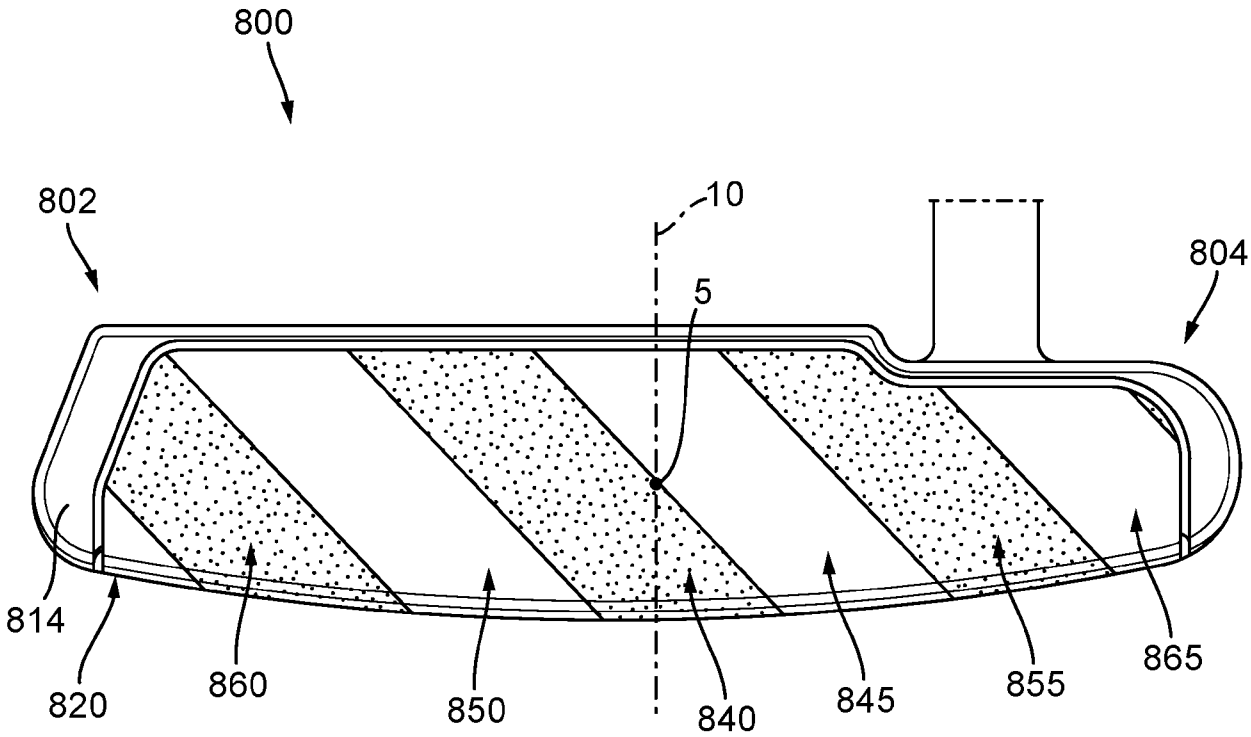

FIG. 12

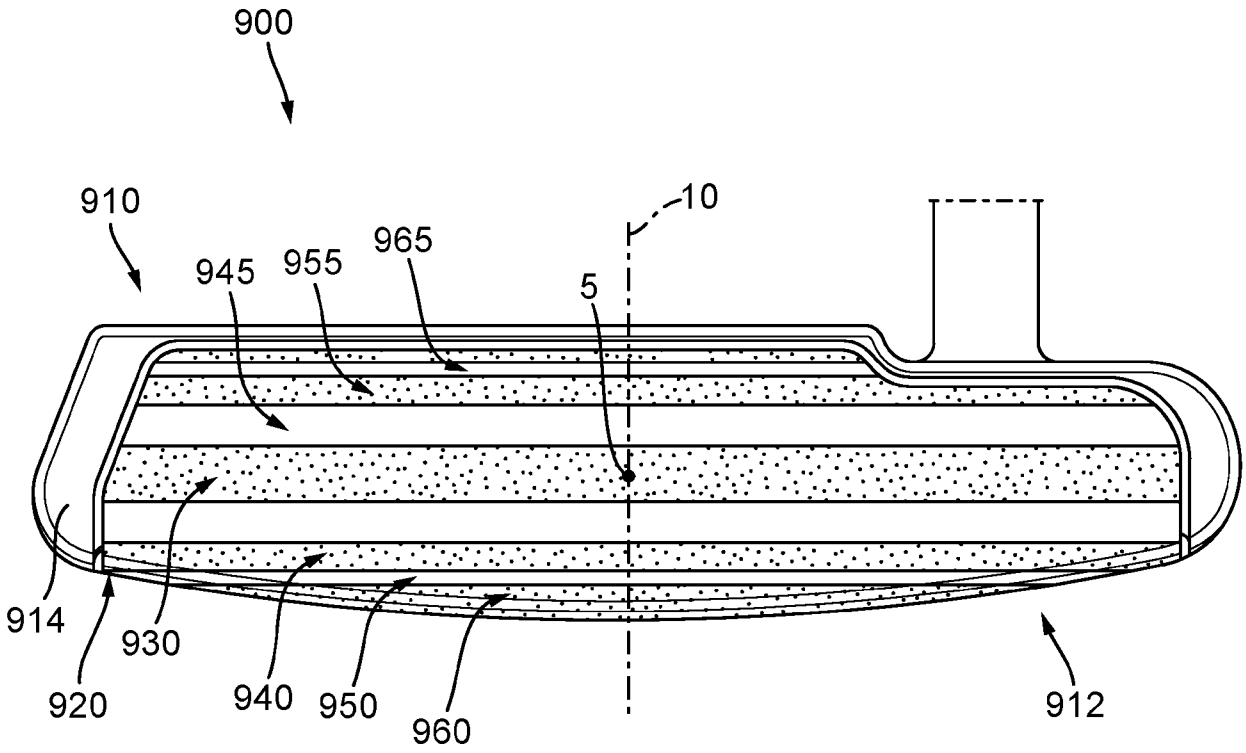

FIG. 13

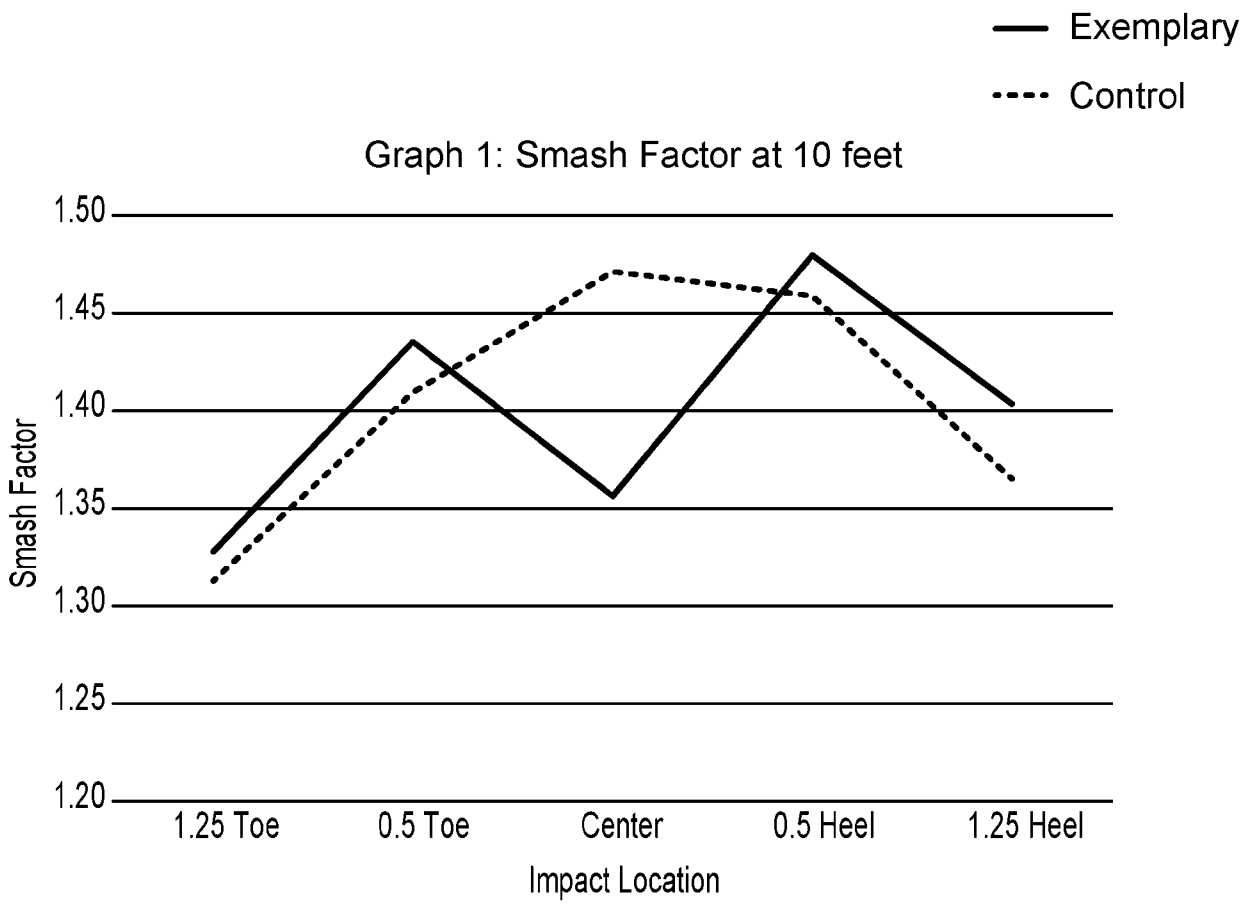
Exemplary
Control
Graph 1: Smash Factor at 10 feet
1.50
1.45
1.40
1.35
1.30
1.25
1.20
Smash Factor
1.25 Toe
0.5 Toe
Center
0.5 Heel
1.25 Heel
Impact Location

FIG. 14

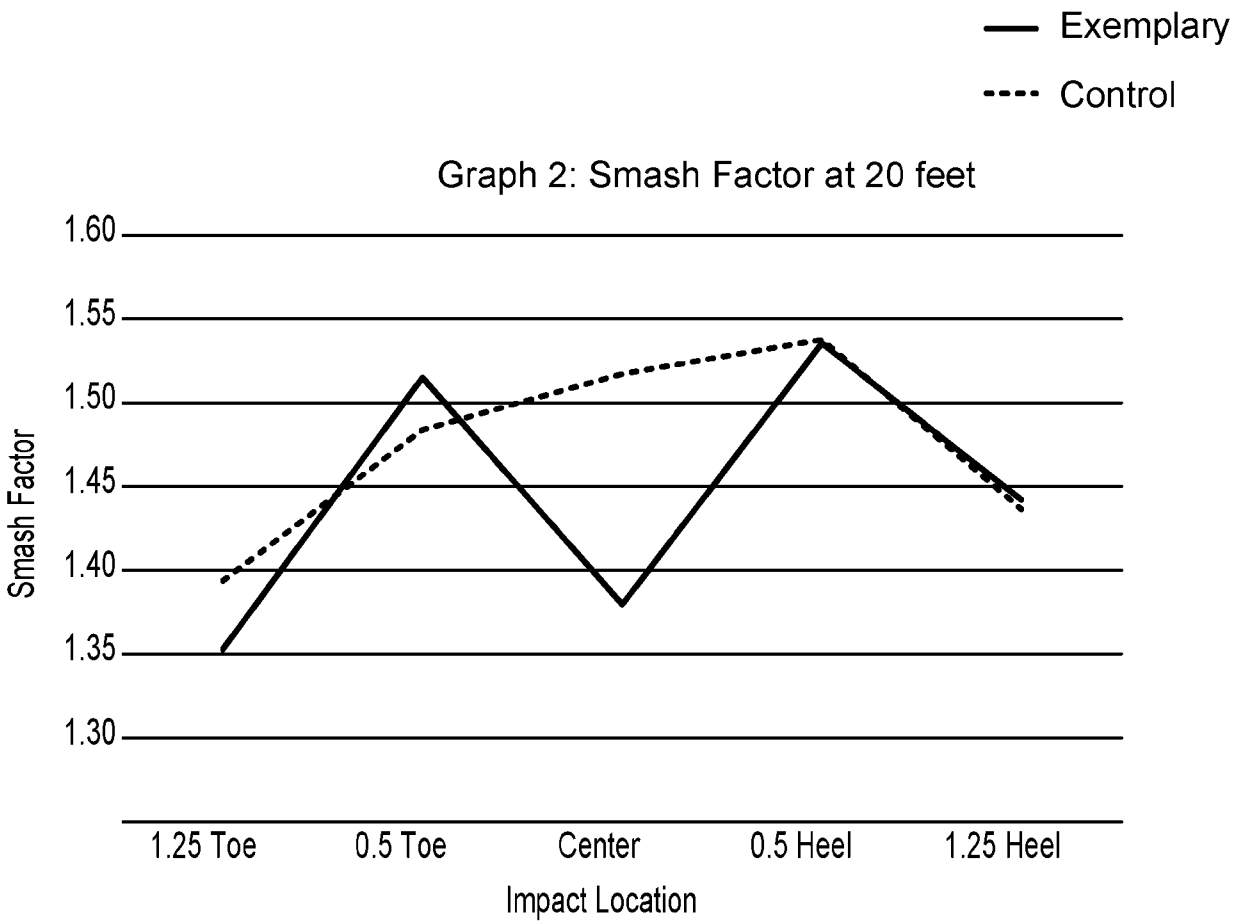
Exemplary
Control
Graph 2: Smash Factor at 20 feet
1.60
1.55
1.50
1.45
1.40
1.35
1.30
Smash Factor
1.25 Toe
0.5 Toe
Center
0.5 Heel
1.25 Heel
Impact Location

FIG. 15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2024/031901

A. CLASSIFICATION OF SUBJECT MATTER

IPC: ***A63B 53/04*** (2024.01); ***A63B 53/08*** (2024.01); *G01N 3/40* (2024.01)

CPC: ***A63B 53/0429; A63B 53/0487; A63B 53/042; A63B 53/08;*** *A63B 53/0445; G01N 3/40*

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History Document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

See Search History Document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History Document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,405,136 A (HARDMAN) 11 April 1995 (11.04.1995) entire document	1-12
Y	US 9,566,484 B1 (CALLAWAY GOLF COMPANY) 14 February 2017 (14.02.2017) entire document	1-12
A	US 2022/0362637 A1 (KARSTEN MANUFACTURING CORPORATION) 17 November 2022 (17.11.2022) entire document	1-12
A	US 2011/0319189 A1 (NARITA et al.) 29 December 2011 (29.12.2011) entire document	1-12
A	US 2010/0087269 A1 (SNYDER et al.) 08 April 2010 (08.04.2010) entire document	1-12

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"D" document cited by the applicant in the international application

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 August 2024 (13.08.2024)	**27 August 2024 (27.08.2024)**

Name and mailing address of the ISA/US	Authorized officer
Mail Stop PCT, Attn: ISA/US **Commissioner for Patents** **P.O. Box 1450, Alexandria, VA 22313-1450**	**MATOS** **TAINA**
Facsimile No. **571-273-8300**	Telephone No. **571-272-4300**