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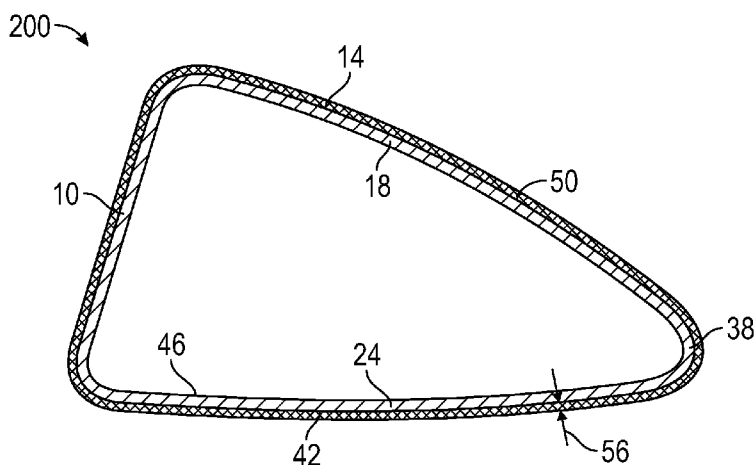


FIG. 3

(57) Abstract: Embodiments of a golf club head comprising a body having a body material density, a strike face having a strike face material density, and a coating comprising a coating material having a coating material density greater than the body material density or the strike face material density are described herein.



HIGH DENSITY OUTER LAYER OF A GOLF CLUB HEAD

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This claims the benefit of U.S. Provisional Patent Application N. 62/163,888, filed on May 19, 2015, which is incorporated fully herein by reference.

FIELD OF INVENTION

[0002] The present disclosure relates to golf clubs having golf club heads with a high density thin outer layer. Specifically, the present disclosure relates to wood-type golf club heads, iron-type golf club heads, wedge-type golf club heads, and putter-type golf club heads.

BACKGROUND

[0003] Golf club heads may include wood-type club heads (e.g., drivers and fairway woods), iron-type club heads (e.g., irons and wedges), and putter-type club heads. Golf club head designs vary and generally aim to optimize head center of gravity position and increase club head moment of inertia. The head center of gravity position affects performance characteristics of the golf club including direction, trajectory, distance, and spin of the golf ball. Increased club head moment of inertia increases the consistency of ball trajectory and direction for off-center hits. Many golf club heads are designed to optimize head center of gravity position and increase club head moment of inertia by using weighting ports or inserts. These designs may require complicated manufacturing and assembly processes and do not easily allow for optimization of head center of gravity position with precision. In addition, use of weighting ports can affect the overall aerodynamics of the club head. Therefore, there is a need in the art for the ability to distribute weight of golf club heads more precisely to optimize center of gravity positions and increase club head moment of inertia.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Fig. 1 illustrates a perspective view of a golf club head.

[0005] Fig. 2 illustrates a cross-sectional view of the golf club head of Fig. 1 taken along line A-A.

[0006] Fig. 3 illustrates a cross-sectional view of one embodiment of a golf club head having a coating.

[0007] Fig. 4 illustrates a cross-sectional view of another embodiment of a golf club head having a coating.

[0008] Fig. 5 illustrates a cross-sectional view of another embodiment of a golf club head having a coating.

[0009] Fig. 6 illustrates a cross-sectional view of another embodiment of a golf club head having a coating.

[0010] Fig. 7 illustrates a cross-sectional view of another embodiment of a golf club head having a coating.

[0011] Fig. 8 illustrates a cross-sectional view of another embodiment of a golf club head having a coating.

[0012] Fig. 9 illustrates a cross-sectional view of another embodiment of a golf club head having a coating.

[0013] Fig. 10A illustrates a top view of another embodiment of a golf club head having a coating.

[0014] Fig. 10B illustrates a bottom view of the golf club head of Fig. 10A

[0015] Fig. 11 illustrates a bottom view of another embodiment of a golf club head having a coating.

[0016] Fig. 12 illustrates a bottom view of another embodiment of a golf club head having a coating.

[0017] Fig. 13 illustrates a bottom view of another embodiment of a golf club head having a coating.

[0018] Fig. 14 illustrates a bottom view of another embodiment of a golf club head having a coating.

[0019] Fig. 15 illustrates a cross-sectional view of one embodiment of a golf club head having a first coating and a second coating.

[0020] Fig. 16 illustrates a cross-sectional view of another embodiment of a golf club head having a first coating and a second coating.

[0021] Fig. 17 illustrates a cross-sectional view of another embodiment of a golf club head having a first coating and a second coating.

[0022] Fig. 18 illustrates a cross sectional view of another embodiment of a golf club head having a first coating and a second coating.

[0023] Fig. 19 illustrates a method of manufacturing a golf club head having a coating.

[0024] For illustrative purposes, the drawings described above may not represent actual scaling of the size of the coating or plurality of coatings relative to the club head size. For example, the coating thickness to club head thickness ratio may be shown as larger in the drawings than the actual coating thickness to club head thickness ratio per the dimensions disclosed within the detailed description.

[0025] Other aspects of the disclosure will become apparent by consideration of the detailed description and accompanying drawings.

[0026] 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 present disclosure. 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 disclosure. The same reference numerals in different figures denote the same elements.

DETAILED DESCRIPTION

[0027] In the embodiments described below, a high density thin outer layer of material or coating is applied to a golf club head. By distributing a high density thin outer layer of material over a portion or the entire golf club head, the weight distribution of the golf club head can be controlled. This strategic placement of high density coating materials on the golf club head maximize distribution of the weight to the outermost perimeter of the club away from the center of gravity thereby maximizing the ability to increase the moment of inertia. The coating of high density material may be at any thickness or depth, but is suitable for very thin layers between 0.10 inches to as thin as 0.00001 inches. The coating of high density material can be applied to a surface of the club head by vapor deposition, plasma spray, plating, or spotting. Therefore, greater precision can be achieved for particular weight placement on the golf club head at a desired depth or thickness using a variable set of metal alloy materials. Being able to control these variables using high density materials can be used to optimize the head center of gravity and maximize the club head moment of inertia to achieve desired performance characteristics of the club head.

[0028] 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.

[0029] 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

apparatus, methods, and/or articles of manufacture described herein are, for example, capable of operation in other orientations than those illustrated or otherwise described herein.

[0030] Discretionary weight, as described herein, refers to a portion of the total weight of the club head that can be positioned to optimize performance without impacting the structural integrity of the club head.

[0031] Before any embodiments of the disclosure are explained in detail, it is to be understood that the disclosure is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The disclosure is capable of other embodiments and of being practiced or of being carried out in various ways.

[0032] Figs. 1-2 illustrate an embodiment of a golf club head 100 having a strike face 10 and a body 14 including a crown 18, a sole 24 opposite the crown 18, a heel 28, a toe 34 opposite the heel 28, and a back end 38. The body 14 and the strike face 10 together form the club head 100 having an outer surface 42 and an inner surface 46, as illustrated in the cross-sectional view of the club head 100 taken along line A-A in Fig. 2.

[0033] The body 14 of the club head 100 comprises a body material having a body material density. The body material may be any suitable material including titanium, stainless steel, tungsten, aluminum, other metals, composites, metal alloys, or any other material. In some embodiments, the body 14 of the club head 100 comprises different materials having different densities. For example, the crown 18 may comprise a crown material having a crown material density and the sole 24 may comprise a sole material having a sole material density, wherein the sole material and sole material density are different than the crown material and crown material density, respectively. In this example, the crown material density may be greater than the sole material density, or the crown material density may be less than the sole material density. In embodiments where the body 14 comprises different materials having different densities, the densities of each body material may be averaged to represent the body material density.

[0034] The strike face 10 of the club head 100 comprises a strike face material having a strike face material density. The strike face material may be any suitable material including

titanium, stainless steel, tungsten, aluminum, other metals, composites, metal alloys, or any other material. In other embodiments, the strike face 10 may comprise different materials having different densities. When the strike face 10 comprises different materials having different densities, the densities of each strike face material may be averaged to represent the strike face material density.

[0035] The body material may be the same as the strike face material, or the body material may be different than the strike face material. Further, the body material density may be the same as the strike face material density, or the body material density may be different than the strike face material density. For example, the strike face material density may be higher than the body material density, or the strike face material density may be lower than the body material density. The club head 100 may further include a coating or plurality of coatings 50, as described in further detail in the embodiments of Figs. 3-18 below.

[0036] In some embodiments, the club head 100 can include one coating 50 comprising a coating material having a coating material density (e.g. the embodiments of the club head illustrated Figs. 3-14 and described in further detail below). In some embodiments, the club head can include more than one coating. For example, in some embodiments the club head 100 can include a first coating 50₁ comprising a first coating material having a first coating density, and a second coating 50₂ comprising a second coating material having a second coating density (e.g. the embodiments of the club head illustrated Figs. 15-18 and described in further detail below).

[0037] In many embodiments, the coating 50 has a surface area, a weight, and a thickness 56 defining a thickness profile. The surface area of the coating 50 defines a perimeter 62 (illustrated in Figs 10-14) when specific portions of the club head 100 are covered by the coating 50. In embodiments where the coating 50 includes a plurality of coatings 50, the plurality of coatings can include a first coating 50₁ and a second coating 50₂, the first coating 50₁ having a first surface area, a first weight, and a first thickness 56₁ defining a first thickness profile, and the second coating 50₂ having a second surface area, a second weight, a second thickness 56₂ defining a second thickness profile. The coating or plurality of coatings 50 can be applied to the club head 100 in various positions or plurality of positions, as described further in the embodiments of Figs. 3-14 below.

[0038] Fig. 3 illustrates an embodiment of the club head 200 having a strike face 10 and a body 14 including a crown 18, a sole 24 opposite the crown 18, a heel 28, a toe 34 opposite the heel 28, and a back end 38. The body 14 and the strike face 10 together form the club head 200 having an outer surface 42 and an inner surface 46. The club head 200 further includes a coating 50.

[0039] Referring to Fig. 3, in the illustrated embodiment, the coating 50 is positioned on the outer surface 42 of the club head 200. Further, the coating 50 covers or is positioned over the entire outer surface 42 of the club head 200 including the strike face 10 and the body 14. Accordingly, in the illustrated embodiment, the strike face 10, the crown 18, the sole 24, the heel 28, the toe 34, and the back end 38 of the club head 200 are covered by the coating 50. In the illustrated embodiment, the thickness 56 of the coating 50 is approximately constant. For example, the thickness 56 of the coating 50 on the crown 18 is approximately the same as the thickness on the sole 24, the heel 28, the toe 34, the back end 38, and the strike face 10.

[0040] Fig. 4 illustrates another embodiment of the club head 300 having a strike face 10 and a body 14 including a crown 18, a sole 24 opposite the crown 18, a heel 28, a toe 34 opposite the heel 28, and a back end 38. The body 14 and the strike face 10 together form the club head 300 having an outer surface 42 and an inner surface 46. The club head 300 further includes a coating 50.

[0041] Referring to Fig. 4, in the illustrated embodiment, the coating 50 is positioned on the outer surface 42 of the club head 200. Further, in the illustrated embodiment, the coating 50 covers or is positioned over a portion of the outer surface 42 of the club head 300. Specifically, the coating 50 covers or is positioned over the body 14 of the club head 300 including the crown 18, the sole 24, the heel 28, the toe 34, and the back end 38. Accordingly, the crown 18, the sole 24, the heel 28, the toe 34, and the back end 38 are covered by the coating 50. The strike face 10 is not covered by the coating 50.

[0042] Further referring to Fig. 4, in the illustrated embodiment, the thickness 56 of the coating 50 is approximately constant. For example, the thickness 56 of the coating 50 on the crown 18 is approximately the same as the thickness on the sole 24, the heel 28, the toe 34, and the back end 38. Further, the thickness 56 of the coating 50 tapers or decreases near the edges

of the coating 50 (e.g. near the periphery of the strike face 10). For example, in the illustrated embodiment, the thickness of the coating 50 tapers or decreases near the strike face 10 of the club head 200.

[0043] Fig. 5 illustrates another embodiment of the club head 400 having a strike face 10 and a body 14 including a crown 18, a sole 24 opposite the crown 18, a heel 28, a toe 34 opposite the heel 28, and a back end 38. The body 14 and the strike face 10 together form the club head 400 having an outer surface 42 and an inner surface 46. The club head 400 further includes a coating 50.

[0044] In the illustrated embodiment, the coating 50 is positioned on the outer surface 42 of the club head 400. Further, in the illustrated embodiment, the coating 50 covers or is positioned over a portion of the outer surface 42 of the club head 400. Specifically, the coating 50 covers or is positioned over the strike face 10 of the club head 400. Further, in the illustrated embodiment, the thickness 56 of the coating 50 is approximately constant. For example, the thickness 56 of the coating 50 on the strike face 10 near the heel 28, the toe 34, the crown 18, or the sole 24 is approximately the same. Further, the thickness 56 of the coating 50 tapers or decreases near the edges of the coating 50. For example, the thickness of the coating 50 tapers or decreases near the periphery of the strike face 10.

[0045] Fig. 6 illustrates another embodiment of the club head 500 having a strike face 10 and a body 14 including a crown 18, a sole 24 opposite the crown 18, a heel 28, a toe 34 opposite the heel 28, and a back end 38. The body 14 and the strike face 10 together form the club head 500 having an outer surface 42 and an inner surface 46. The club head 500 further includes a coating 50.

[0046] Referring to Fig. 6, in the illustrated embodiment, the coating 50 is positioned on the outer surface 42 of the club head 500. Further, in the illustrated embodiment, the coating 50 covers or is positioned over a portion of the outer surface 42 of the club head 500. Specifically, the coating 50 covers or is positioned over at least a portion of the back end 38 of the club head 500. In some embodiments, the coating 50 can extend along the entire back end 38 from the heel 28 to the toe 34 of the club head 500. Further, in some embodiments, the coating 50 can extend along a portion of the back end 38 of the club head 500. For example, in some embodiments, the

coating 50 can extend along the back end 38 from near the heel 28 to near the toe 34 of the club head 500.

[0047] Further referring to Fig. 6, in the illustrated embodiment, the thickness 56 of the coating 50 is greatest near the rearward most part of the back end 38 and gradually tapers or decreases near the edges of the coating 50 toward the crown 18 and the sole 24. For example, the thickness of the coating 50 tapers or decreases near the crown 18 and the sole 24 of the club head 500.

[0048] Fig. 7 illustrates another embodiment of the club head 600 having a strike face 10 and a body 14 including a crown 18, a sole 24 opposite the crown 18, a heel 28, a toe 34 opposite the heel 28, and a back end 38. The body 14 and the strike face 10 together form the club head 600 having an outer surface 42 and an inner surface 46. The club head 600 further includes a coating 50.

[0049] Referring to Fig. 7, in the illustrated embodiment, the coating 50 is positioned on the outer surface 42 of the club head 600. Further, in the illustrated embodiment, the coating 50 covers or is positioned over a portion of the outer surface 42 of the club head 600. Specifically, the coating 50 covers or is positioned over a portion of the sole 24 near the back end 38 of the club head 600. In some embodiments, the coating 50 can extend along the entire length of the sole 24 from near the heel 28 to near the toe 34 of the club head 600. Further, in some embodiments, the coating 50 can extend along only a portion of the sole 24. In the illustrated embodiment, the thickness 56 of the coating 50 gradually tapers or decreases near the edges of the coating 50 toward the back end 38 and the strike face 10.

[0050] Fig. 8 illustrates another embodiment of the club head 700 having a strike face 10 and a body 14 including a crown 18, a sole 24 opposite the crown 18, a heel 28, a toe 34 opposite the heel 28, and a back end 38. The body 14 and the strike face 10 together form the club head 700 having an outer surface 42 and an inner surface 46. The club head 700 further includes a coating 50 having more than one discrete portion.

[0051] Referring to Fig. 8, in the illustrated embodiment, the coating 50 is positioned on the outer surface 42 of the club head 700. Further, in the illustrated embodiment, the coating 50

covers or is positioned over a portion of the outer surface 42 of the club head 700. Specifically, the coating 50 includes a first portion that covers or is positioned over a portion of the sole 24 near the back end 38 of the club head 600, and a second portion that covers or is positioned over a portion of the crown 18 near the back end 38 of the club head. In some embodiments, the first portion of the coating 50 can extend along the entire length of the sole 24 from near the heel 28 to near the toe 34 of the club head 700. Further, in some embodiments, the second portion of the coating 50 can extend along only a portion of the crown 18 from near the heel 28 to near the toe 34 of the club head 700. In the illustrated embodiment, the thickness 56 of the coating 50 gradually tapers or decreases near the edges of the first portion of the coating 50 on the sole 24 and near the edges of the second portion of the coating 50 on the crown 18.

[0052] Fig. 9 illustrates another embodiment of club head 800 having a strike face 10 and a body 14 including a crown 18, a sole 24 opposite the crown 18, a heel 28, a toe 34 opposite the heel 28, and a back end 38. The body 14 and the strike face 10 together form the club head 800 having an outer surface 42 and an inner surface 46. The club head 800 further includes a coating 50.

[0053] Referring to Fig. 9, in the illustrated embodiment, the coating 50 is positioned on the outer surface 42 of the club head 800. Further, in the illustrated embodiment, the coating 50 covers or is positioned over a portion of the outer surface 42 of the club head 800. Specifically, the coating 50 covers or is positioned over at least a portion of the back end 38 of the club head 800. In some embodiments, the coating 50 can extend along the entire back end 38 from the heel 28 to the toe 34 of the club head 800. Further, in some embodiments, the coating 50 can extend along a portion of the back end 38 of the club head 800. For example, in some embodiments, the coating 50 can extend along the back end 38 from near the heel 28 to near the toe 34 of the club head 800.

[0054] Further referring to Fig. 9, in the illustrated embodiment, the thickness 56 of the coating 50 varies defining a thickness profile. The thickness profile illustrated can be a bowtie contour of the coating 50 at the back end 38 of the club head 800. In the illustrated embodiment, the thickness 56 of the coating 50 gradually increases and then decreases in a direction from the back end 38 toward the crown 18 of the club head 800. Further, in the illustrated embodiment,

the thickness 56 of the coating 50 gradually increases and then decreases in a direction from the back end 38 toward the sole 24 of the club head 800.

[0055] Figs. 10A and 10B illustrate another embodiment of the club head 900 having a strike face 10 and a body 14 including a crown 18, a sole 24 opposite the crown 18, a heel 28, a toe 34 opposite the heel 28, and a back end 38. The body 14 and the strike face 10 together form the club head 900 having an outer surface 42 and an inner surface 46. The club head 900 further includes a coating 50 having more than one discrete portion.

[0056] Referring to Figs. 10A and 10B, in the illustrated embodiment, the coating 50 is positioned on the outer surface 42 of the club head 900. Further, in the illustrated embodiment, the coating 50 covers or is positioned over a portion of the outer surface 42 of the club head 700. Specifically, in the illustrated embodiment, the coating 50 includes a first portion that covers or is positioned over the entire crown 18 (Fig. 10A) and a second portion that covers or is positioned over the entire sole 24 (Fig. 10B) of the club head 900. In the illustrated embodiment, the thickness 56 of the first portion of the coating 50 positioned on the crown 18 is approximately constant. Further, in the illustrated embodiment, the thickness 56 of the second portion of the coating 50 positioned on the sole 24 is approximately constant.

[0057] Fig. 11 illustrates another embodiment of the club head 1100 having a strike face 10 and a body 14 including a crown 18, a sole 24 opposite the crown 18, a heel 28, a toe 34 opposite the heel 28, and a back end 38. The body 14 and the strike face 10 together form the club head 1100 having an outer surface 42 and an inner surface 46. The club head 1100 further includes a coating 50.

[0058] Referring to Fig. 11, in the illustrated embodiment, the coating 50 is positioned on the outer surface 42 of the club head 1100. Further, in the illustrated embodiment, the coating 50 covers or is positioned over a portion of the outer surface 42 of the club head 600. Specifically, the coating 50 covers or is positioned over a portion of the sole 24 near the center region of the back end 38 of the club head 600. In some embodiments, the coating 50 covers a portion of the club head 600 having a weight pad or weight member. In the illustrated embodiment, the perimeter 62 of the coating 50 defines a trapezoidal shape, corresponding to the shape of the weight pad or weight member. The shape of the coating 50 can correspond to any weight pad or

weight member that can be any shape such as a trapezoidal, square, hexagonal, circular, triangular, or any other polygon or shape with at least one curved surface. Further, in the illustrated embodiment, the thickness 56 of the coating 50 is approximately constant.

[0059] Fig. 12 illustrates another embodiment of the club head 1200 having a strike face 10 and a body 14 including a crown 18, a sole 24 opposite the crown 18, a heel 28, a toe 34 opposite the heel 28, and a back end 38. The body 14 and the strike face 10 together form the club head 1200 having an outer surface 42 and an inner surface 46. The club head 1200 further includes a coating 50 having more than one discrete portion.

[0060] Referring to Fig. 12, in the illustrated embodiment, the coating 50 is positioned on the outer surface 42 of the club head 1200. Further, in the illustrated embodiment, the coating 50 covers or is positioned over a portion of the outer surface 42 of the club head 1200. Specifically, the coating 50 includes a first portion that covers or is positioned over a portion of the sole 24 near the toe 34 and a second portion that covers or is positioned over a portion of the sole 24 near the heel 28 of the club head 1200. In the illustrated embodiment, the perimeter 62 of the first portion of the coating 50 defines a rectangular shape, and the perimeter 62 of the second portion of the coating 50 defines a rectangular shape. Further, in the illustrated embodiment, the thickness 56 of the coating 50 is approximately constant.

[0061] Fig. 13 illustrates another embodiment of the club head 1300 having a strike face 10 and a body 14 including a crown 18, a sole 24 opposite the crown 18, a heel 28, a toe 34 opposite the heel 28, and a back end 38. The body 14 and the strike face 10 together form the club head 1300 having an outer surface 42 and an inner surface 46. The club head 1300 further includes a coating 50.

[0062] Referring to Fig. 13, in the illustrated embodiment, the coating 50 is positioned on the outer surface 42 of the club head 1300. Further, in the illustrated embodiment, the coating 50 covers or is positioned over a portion of the outer surface 42 of the club head 1300. Specifically, the coating 50 is positioned over a portion of the sole 24 near the heel 28 of the club head 1200. In the illustrated embodiment, the perimeter 62 of the coating 50 defines a rectangular shape. Further, in the illustrated embodiment, the thickness 56 of the coating 50 is approximately constant.

[0063] Fig. 14 illustrates another embodiment of the club head 1400 having a strike face 10 and a body 14 including a crown 18, a sole 24 opposite the crown 18, a heel 28, a toe 34 opposite the heel 28, and a back end 38. The body 14 and the strike face 10 together form the club head 1400 having an outer surface 42 and an inner surface 46. The club head 1400 further includes a coating 50.

[0064] Referring to Fig. 14, in the illustrated embodiment, the coating 50 is positioned on the outer surface 42 of the club head 1400. Further, in the illustrated embodiment, the coating 50 covers or is positioned over a portion of the outer surface 42 of the club head 1400. Specifically, the coating 50 is positioned over the entire sole 24 of the club head 1400. In the illustrated embodiment, the thickness 56 of the coating 50 is approximately constant.

[0065] Fig. 15 illustrates an embodiment of the club head 2000 having a strike face 10 and a body 14 including a crown 18, a sole 24 opposite the crown 18, a heel 28, a toe 34 opposite the heel 28, and a back end 38. The body 14 and the strike face 10 together form the club head 2000 having an outer surface 42 and an inner surface 46. The club head 2000 further includes a first coating 50₁ and second coating 50₂.

[0066] Referring to Fig. 15, in the illustrated embodiment, the first coating 50₁ is positioned on the outer surface 42 of the club head 2000. Further, the first coating 50₁ covers or is positioned over the entire outer surface 42 of the club head 2000 including the strike face 10 and the body 14. Accordingly, in the illustrated embodiment, the strike face 10, the crown 18, the sole 24, the heel 28, the toe 34, and the back end 38 of the club head 2000 are covered by the first coating 50₁. In the illustrated embodiment, the thickness 56₁ of the first coating 50₁ is approximately constant. For example, the thickness 56₁ of the first coating 50₁ on the crown 18 is approximately the same as the thickness 56₁ on the sole 24, the heel 28, the toe 34, the back end 38, and the strike face 10.

[0067] Further referring to Fig. 15, in the illustrated embodiment, the second coating 50₂ covers or is positioned over the first coating 50₁ of the club head 2000. In the illustrated embodiment, the thickness 56₂ of the second coating 50₂ is approximately constant. For example, the thickness 56₂ of the second coating 50₂ on the crown 18 is approximately the same

as the thickness 56₂ on the sole 24, the heel 28, the toe 34, the back end 38, and the strike face 10.

[0068] Fig. 16 illustrates another embodiment of the club head 2100 having a strike face 10 and a body 14 including a crown 18, a sole 24 opposite the crown 18, a heel 28, a toe 34 opposite the heel 28, and a back end 38. The body 14 and the strike face 10 together form the club head 2100 having an outer surface 42 and an inner surface 46. The club head 2100 further includes a first coating 50₁ and second coating 50₂.

[0069] Referring to Fig. 16, in the illustrated embodiment, the first coating 50₁ is positioned on the outer surface 42 of the club head 2100. Further, in the illustrated embodiment, the first coating 50₁ covers or is positioned over a portion of the outer surface 42 of the club head 2100. Specifically, the first coating 50₁ covers or is positioned over a portion of the crown 18 near the back end 38 of the club head 2100. In some embodiments, the first coating 50₁ can extend along the entire length of the crown 18 from near the heel 28 to near the toe 34 of the club head 2100. In the illustrated embodiment, the thickness 56₁ of the first coating 50₁ gradually tapers or decreases near the edges of the first coating 50₁ on the crown 18.

[0070] Further referring to Fig. 16, in the illustrated embodiment, the second coating 50₂ is positioned on the outer surface 42 of the club head 2100. Further, in the illustrated embodiment, the second coating 50₂ covers or is positioned over a portion of the outer surface 42 of the club head 2100. Specifically, the second coating 50₂ covers or is positioned over a portion of the sole 24 near the back end 38 of the club head 2100. In some embodiments, the second coating 50₂ can extend along the entire length of the sole 24 from near the heel 28 to near the toe 34 of the club head 2100. In the illustrated embodiment, the thickness 56₂ of the second coating 50₂ gradually tapers or decreases near the edges of the second coating 50₂ on the sole 24.

[0071] Fig. 17 illustrates another embodiment of the club head 2200 having a strike face 10 and a body 14 including a crown 18, a sole 24 opposite the crown 18, a heel 28, a toe 34 opposite the heel 28, and a back end 38. The body 14 and the strike face 10 together form the club head 2200 having an outer surface 42 and an inner surface 46. The club head 2200 further includes a first coating 50₁ and second coating 50₂.

[0072] Referring to Fig. 17, in the illustrated embodiment, the first coating 50₁ is positioned on the outer surface 42 of the club head 2200. Further, the first coating 50₁ covers or is positioned over the entire body 14 of the club head 2200. Accordingly, the crown 18, the sole 24, the heel 28, the toe 34, and the back end 38 of the club head 2200 are covered by the first coating 50₁. In the illustrated embodiment, the thickness 56₁ of the first coating 50₁ is approximately constant. For example, the thickness 56₁ of the first coating 50₁ on the crown 18 is approximately the same as the thickness 56₁ on the sole 24, the heel 28, the toe 34, the back end 38, and the strike face 10.

[0073] Further referring to Fig. 17, in the illustrated embodiment, the second coating 50₂ covers or is positioned over a portion of the first coating 50₁ of the club head 2200 near the back end 38. In some embodiments, the second coating 50₂ can extend along the entire back end 38 from the heel 28 to the toe 34 of the club head 2200. Further, in some embodiments, the second coating 50₂ can extend along a portion of the back end 38 of the club head 2200. For example, in some embodiments, the second coating 50₂ can extend along the back end 38 from near the heel 28 to near the toe 34 of the club head 2200. In the illustrated embodiment, the thickness 56₂ of the second coating 50₂ is greatest near the rearward most part of the back end 38 and gradually tapers or decreases near the edges of the second coating 50₂. For example, the thickness of the second coating 50₂ tapers or decreases near the crown 18 and the sole 24 of the club head 2200.

[0074] Fig. 18 illustrates another embodiment of the club head 2300 having a strike face 10 and a body 14 including a crown 18, a sole 24 opposite the crown 18, a heel 28, a toe 34 opposite the heel 28, and a back end 38. The body 14 and the strike face 10 together form the club head 2300 having an outer surface 42 and an inner surface 46. The club head 2300 further includes a first coating 50₁ and second coating 50₂.

[0075] Referring to Fig. 18, in the illustrated embodiment, the first coating 50₁ is positioned on the outer surface 42 of the club head 2300. Further, the first coating 50₁ covers or is positioned over a portion of the club head 2300 including the back end 38. In the illustrated embodiment, the thickness 56₁ of the first coating 50₁ is greatest near the rearward most part of the back end 38 and gradually tapers or decreases near the edges of the first coating 50₁. For

example, the thickness of the first coating 50₁ tapers or decreases near the crown 18 and the sole 24 of the club head 2300.

[0076] Further referring to Fig. 18, in the illustrated embodiment, the second coating 50₂ covers or is positioned over a portion of the first coating 50₁ and the outer surface 42 of the club head 2300. In the illustrated embodiment, the thickness 56₂ of the second coating 50₂ is approximately constant and tapers toward the edges of the second coating 50₂.

[0077] Further referring to Fig. 18, in some embodiments, the first and second coatings 50₁, 50₂ can extend along the entire back end 38 from the heel 28 to the toe 34 of the club head 2300. Further, in some embodiments, the first and second coatings 50₁, 50₂ can extend along a portion of the back end 38 of the club head 2300. For example, in some embodiments, the first and second coatings 50₁, 50₂ can extend along the back end 38 from near the heel 28 to near the toe 34 of the club head 2200.

[0078] As described above, Figs. 3-18 illustrate various embodiments of the club head having a coating or plurality of coatings 50 (e.g. club head 200, 300, 400, 500, 600, 700, 800, 900, 1100, 1200, 1300, 1400, 2000, 2100, 2200, or 2300). The embodiments of the club head having the coating or plurality of coatings 50 described herein are not limited by position. In other embodiments, the coating 50 can be positioned anywhere on the club head. For example, the coating 50 can cover at least a portion of the crown 18, the sole 24, the heel 28, the toe 34, the back end 38, the strike face 10, or any combination thereof on the outer surface 42 of the club head. For further example, the coating 50 can cover at least a portion of the crown 18, the sole 24, the heel 28, the toe 34, the back end 38, the strike face 10, or any combination thereof on the inner surface 46 of the club head.

[0079] Further, the embodiments of the club head having one or more coatings 50 (e.g. club head 200, 300, 400, 500, 600, 700, 800, 900, 1100, 1200, 1300, 1400, 2000, 2100, 2200, or 2300) described herein are not limited by number of discrete coating portions. For example, in other embodiments, each of the plurality of coatings 50 can have any number of discrete portions such as 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, or any other number of discrete portions.

[0080] Further, the embodiments of the club head having the coating or plurality of coatings 50 (e.g. club head 200, 300, 400, 500, 600, 700, 800, 900, 1100, 1200, 1300, 1400, 2000, 2100, 2200, or 2300) described herein are not limited by number of coatings. For example, in other embodiments, the one or more coatings 50 can include 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, or any other number of coatings.

[0081] As described above, Figs. 15-18 illustrate various embodiments of the club head 2000, 2100, 2200, 2300 having a plurality of coatings 50 including a first coating 50₁ and a second coating 50₂ positioned in various locations. In other embodiments, the first coating 50₁ and the second coating 50₂ can be positioned anywhere on the club head. For example, the first coating 50₁ can cover at least a portion of the crown 18, the sole 24, the heel 28, the toe 34, the back end 38, the strike face 10, the hosel 40, or any combination thereof on the outer surface 42 of the club head. For further example, the first coating 50₁ can cover at least a portion of the crown 18, the sole 24, the heel 28, the toe 34, the back end 38, the strike face 10, the hosel 40, or any combination thereof on the inner surface 46 of the club head. In addition, the second coating 50₂ can cover at least a portion of the crown 18, the sole 24, the heel 28, the toe 34, the back end 38, the strike face 10, the hosel 40, or any combination thereof on the outer surface 42 of the club head. Further, the second coating 50₂ can cover at least a portion of the crown 18, the sole 24, the heel 28, the toe 34, the back end 38, the strike face 10, the hosel 40, or any combination thereof on the inner surface 46 of the club head. The second coating 50₂ may be applied to the club head 200 in the same position as the first coating 50₁, or the second coating 50₂ may be applied to the club head 200 in a different position than the first coating 50₁. Further, the second coating 50₂ may be applied to at least a portion of the same position as the first coating 50₁.

[0082] Referring to Figs. 3-14, the embodiments of the club head having one or more coatings 50 (e.g. club head 200, 300, 400, 500, 600, 700, 800, 900, 1100, 1200, 1300, 1400, 2000, 2100, 2200, or 2300) described herein are not limited by coating shape. For example, in other embodiments, the perimeter 62 of the coating 50 can define any shape such as a circle, ellipse, triangle, square, rectangle, or any other polygon or shape with at least one curved surface.

[0083] As described above, Figs. 15-18 illustrate various embodiments of the club head 2000, 2100, 2200, 2300 having a plurality of coatings 50 including a first coating 50₁ and a second coating 50₂ having various shapes. In some embodiments, the first coating 50₁ and the second coating 50₂ have similar shapes. In other embodiments, the first coating 50₁ and the second coating 50₂ can have different shapes. For example, the perimeter 62 of the first coating 50₁ can define any shape such as a circle, ellipse, triangle, square, rectangle, or any other polygon or shape with at least one curved surface. For further example, the perimeter 62 of the second coating 50₂ can define any shape such as a circle, ellipse, triangle, square, rectangle, or any other polygon or shape with at least one curved surface.

[0084] Referring to Figs. 3-14, the embodiments of the club head having one or more coatings 50 (e.g. club head 200, 300, 400, 500, 600, 700, 800, 900, 1100, 1200, 1300, 1400, 2000, 2100, 2200, or 2300) described herein are not limited by thickness profile. In other embodiments, the coating can have any thickness profile, such as constant, linear, quadratic, sinusoidal, exponential, or any other suitable profile. For example, thickness 56 of the coating 50 may increase when moving away from the perimeter 62 or the thickness 56 of the coating 50 may decrease when moving away from the perimeter 62. Further, the thickness 56 of the coating 50 may be greatest at any position or plurality of positions on the club head (e.g. club head 200, 300, 400, 500, 600, 700, 800, 900, 1100, 1200, 1300, 1400, 2000, 2100, 2200, or 2300), such as, for example, the crown 18, the sole 24, the heel 28, the toe 34, the back end 38, the strike face 10, the hosel 40, or any combination of the described positions.

[0085] In embodiments of the club head 2000, 2100, 2200, 2300 having a plurality of coatings 50 including a first coating 50₁ and a second coating 50₂, the first thickness 56₁ of the first coating 50₁ can have the same thickness profile as the second thickness 56₂ of the second coating 50₂, or the first thickness 56₁ of the first coating 50₁ can have a different thickness profile than the second thickness 56₂ of the second coating 50₂.

[0086] In many embodiments (e.g. club head 100, 200, 300, 400, 500, 600, 700, 800, 900, 1100, 1200, 1300, 1400, 2000, 2100, 2200, 2300), the surface area of the coating 50 may range from approximately 0 – 70 square inches (in²). For example, the surface area of the coating 50 may be approximately 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, or 70 in². The surface

area of the coating may cover any percentage (i.e. 0% - 100%) of the club head surface area. For example, the surface area may cover approximately 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, or 100% of the surface area of the club head 100.

[0087] As described above, the surface area of the coating 50 can comprise a single, discrete portion, such as, for example when the coating 50 covers the entire club head (e.g. club head 200) or when the coating 50 covers at least a portion of the crown 18, the sole 24, the heel 28, the toe 34, the back end 38, or the strike face 10 (e.g. club head 300, 400, 500, 600, 800, 1100, 1300, 1400). Conversely, the surface area of the coating 50 can comprise a plurality of discrete portions when the coating 50 includes more than one portion (e.g. club head 700, 900, 1200). For example, the surface area of the coating 50 comprises a plurality of discrete portions when the coating 50 includes a first portion that covers at least a portion of the crown 18 and a second portion that covers at least a portion of the sole 24 (e.g. club head 900). When the coating 50 is divided into a plurality of portions, the sum of the surface areas of each portion define the surface area of the coating 50. In these or other embodiments, the surface area of the coating 50 may range from approximately 0 – 70 in². For example, the surface area of the coating 50 may be approximately 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, or 70 in². Further, the surface area of the coating 50 may cover any percentage (i.e. 0% - 100%) of the club head surface area. For example, the surface area of the coating 50 may cover approximately 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, or 100% of the surface area of the club head.

[0088] As described above, Figs. 15-18 illustrate various embodiments of a club head 2000, 2100, 2200, 2300 having a plurality of coatings 50 including a first coating 50₁ and a second coating 50₂ positioned in various locations. In these or other embodiments, the first surface area of the first coating 50₁ may range from approximately 0 – 70 square inches (in²). For example, the first surface area of the first coating 50₁ may be approximately 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, or 70 in². Further, the first surface area of the first coating 50₁ may cover any percentage (i.e. 0% - 100%) of the club head surface area. For example, the first surface area of the first coating 50₁ may cover approximately 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, or 100% of the surface area of the club head.

[0089] Further, in these or other embodiments, the second surface area of the second coating 50₂ may range from approximately 0 – 70 square inches (in²). For example, the second surface area of the second coating 50₂ may be approximately 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, or 70 in². For example, the second surface area of the second coating 50₂ may be approximately 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, or 70 in². Further, the second surface area of the second coating 50₂ may cover any percentage (i.e. 0% - 100%) of the club head surface area. For example, the second surface area of the second coating 50₂ may cover approximately 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, or 100% of the surface area of the club head. Further still, in these or other embodiments, the first surface area of the first coating 50₁ can be the same as the second surface area of the second coating 50₂, or the first surface area of the first coating 50₁ can be different than the second surface area of the second coating 50₂.

[0090] Referring to Table 1 below, the coating material can be any material capable of being applied to the club head (e.g. club head 200, 300, 400, 500, 600, 700, 800, 900, 1100, 1200, 1300, 1400, 2000, 2100, 2200, or 2300) in a thin layer between 0.10 inches and 0.00001 inches in thickness or depth 56. The coating material can be a particular metal alloy having a coating material density. The density of the coating material can be between 100 g/in³ to 400 g/in³. For example, the coating material density may be 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300, 310, 320, 330, 340, 350, 360, 370, 380, 390, or 400 g/in³. In many embodiments, the coating material density is greater than at least one of the body material density or the strike face material density. For example, in some embodiments, the coating material density is greater than the body material density. For further example, in some embodiments, the coating material density is greater than the strike face material density. For further example, in some embodiments, the coating material density is greater than both the body material density and the strike face material density.

[0091] The density of the coating material applied to the body 14 of the club head (e.g. club head 200, 300, 400, 500, 600, 700, 800, 900, 1100, 1200, 1300, 1400, 2000, 2100, 2200, or 2300) can be 1.0 times, 1.25 times, 1.50 times, 2.0 times, 2.25 times, 2.50 times, 2.75 times, 3.0 times or higher than the body material density. The density of the coating material applied to the strike face 10 of the club head (e.g. club head 200, 300, 400, 500, 600, 700, 800, 900, 1100,

1200, 1300, 1400, 2000, 2100, 2200, or 2300) can be 1.0 times, 1.25 times, 1.50 times, 2.0 times, 2.25 times, 2.50 times, 2.75 times, 3.0 times or higher than the strike face material density.

Further referring to Table 1, the coating material may be beryllium based alloy, a copper based alloy, a palladium based alloy, a tungsten based alloy, a rhenium based alloy, a cobalt based alloy, a rhodium based alloy, a ruthenium based alloy, a molybdenum based alloy, a nickel based alloy, an iron based alloy, or cadmium based alloy. The coating material may be a pure-based metal such as pure beryllium, pure copper, pure palladium, pure tungsten, pure rhenium, pure cobalt, pure rhodium, pure ruthenium, pure molybdenum, pure nickel, pure iron, or pure cadmium. Table 1 illustrates exemplary coating materials and their densities. The coating material may be any alloy including, but not limited to, cobalt, beryllium, copper alloy, a tungsten carbide alloy, or a tungsten, rhenium alloy.

Table 1: Exemplary coating materials and associated coating material densities

Exemplary Coating Materials	Coating Material Density (g/in³)
Cobalt Beryllium Copper	144.70
Pure Palladium	199.27
Tungsten Carbide	256.13
Tungsten Rhenium	314.96
Pure Tungsten	316.27

[0092] The thickness 56 of the coating 50 applied to the body 14 of the club head (e.g. club head 200, 300, 400, 500, 600, 700, 800, 900, 1100, 1200, 1300, 1400, 2000, 2100, 2200, or 2300) can range from approximately 0.00001 – 0.10 inches to add approximately 1 – 25 grams, 1 – 20 grams, 1 – 15 grams, or 1 – 10 grams of discretionary weight to the club head 100. The thickness 56 of the coating 50 can be approximately 0.00001 inches (.254 μm), 0.000025 inches (.635 μm), 0.00005 inches (1.27 μm), 0.000075 inches (1.905 μm), 0.0001 inches (2.54 μm), 0.00025 inches (6.35 μm), 0.0005 inches (12.7 μm), 0.00075 inches (19.05 μm), 0.001 inches (25.4 μm), 0.0025 inches (63.5 μm), 0.005 inches (127 μm), 0.0075 inches (190.5 μm), 0.01 inches (254 μm), 0.025 inches (635 μm), 0.05 inches (1270 μm), 0.075 inches (1905 μm), or 0.10 inches (2540 μm). The thickness 56 of the coating 50 can range from approximately 0.00001 inches (.254 μm) to 0.0075 inches (190.5 μm), 0.00025 inches (.635 μm) to 0.075 inches (1905

μm), 0.00075 inches (1.905 μm) to 0.05 inches (1270 μm), 0.001 inches (25.4 μm) to 0.025 inches (635 μm), 0.0025 inches (63.5 μm) to 0.01 inches (254 μm), or 0.005 inches (127 μm) to 0.0075 inches (190.5 μm). The thickness 56 of the coating 50 may add approximately 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, or 25 grams of discretionary weight to the club head 100.

[0093] In embodiments of the club head 2000, 2100, 2200, 2300 having a plurality of coatings 50 including a first coating 50₁ and a second coating 50₂. The first coating 50₁ can have the same or a different thickness than the second coating 50₂. The first thickness 56₁ of the first coating 50₁ may range from approximately 0.00001 – 0.10 inches to add approximately 1 – 25 grams, 1 – 20 grams, 1 – 15 grams, or 1 – 10 grams of discretionary weight to the club head 200. For example, the first thickness 56₁ of the first coating 50₁ can be approximately 0.00001 inches (.254 μm), 0.000025 inches (.635 μm), 0.00005 inches (1.27 μm), 0.000075 inches (1.905 μm), 0.0001 inches (2.54 μm), 0.00025 inches (6.35 μm), 0.0005 inches (12.7 μm), 0.00075 inches (19.05 μm), 0.001 inches (25.4 μm), 0.0025 inches (63.5 μm), 0.005 inches (127 μm), 0.0075 inches (190.5 μm), 0.01 inches (254 μm), 0.025 inches (635 μm), 0.05 inches (1270 μm), 0.075 inches (1905 μm), or 0.10 inches (2540 μm). The thickness 56 of the first coating 50₁ can range from approximately 0.00001 inches (.254 μm) to 0.0075 inches (190.5 μm), 0.00025 inches (.635 μm) to 0.075 inches (1905 μm), 0.00075 inches (1.905 μm) to 0.05 inches (1270 μm), 0.001 inches (25.4 μm) to 0.025 inches (635 μm), 0.0025 inches (63.5 μm) to 0.01 inches (254 μm), or 0.005 inches (127 μm) to 0.0075 inches (190.5 μm). For further example, the first coating 50₁ may add approximately 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, or 25 grams of discretionary weight to the club head.

[0094] Further, the second thickness 56₂ of the second coating 50₂ may range from approximately 0.00001 – 0.10 inches to add approximately 1 – 25 grams, 1 – 20 grams, 1 – 15 grams, or 1 – 10 grams of discretionary weight to the club head 200. For example, the second thickness 56₂ of the second coating 50₂ may be approximately 0.00001 inches (.254 μm), 0.000025 inches (.635 μm), 0.00005 inches (1.27 μm), 0.000075 inches (1.905 μm), 0.0001 inches (2.54 μm), 0.00025 inches (6.35 μm), 0.0005 inches (12.7 μm), 0.00075 inches (19.05 μm), 0.001 inches (25.4 μm), 0.0025 inches (63.5 μm), 0.005 inches (127 μm), 0.0075 inches (190.5 μm), 0.01 inches (254 μm), 0.025 inches (635 μm), 0.05 inches (1270 μm), 0.075 inches

(1905 μm), or 0.10 inches (2540 μm). The thickness 56 of the second coating 50₂ can range from approximately 0.00001 inches (.254 μm) to 0.0075 inches (190.5 μm), 0.00025 inches (.635 μm) to 0.075 inches (1905 μm), 0.00075 inches (1.905 μm) to 0.05 inches (1270 μm), 0.001 inches (25.4 μm) to 0.025 inches (635 μm), 0.0025 inches (63.5 μm) to 0.01 inches (254 μm), or 0.005 inches (127 μm) to 0.0075 inches (190.5 μm). For further example, the second coating 50₂ may add approximately 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, or 25 grams of discretionary weight to the club head. Additional layers including a third coating 50₃, fourth coating 50₄, or fifth coating 50₅ can have similar thicknesses and relationships to the other coating layers as the first 50₁ and second coating 50₂. In these or other embodiments, the first coating 50₁ and the second coating 50₂ may be applied to the club head (e.g. club head 2000, 2100, 2200, 2300) such that the first weight of first coating 50₁ and the second weight of the second coating 50₂ together add a desired discretionary weight of the club head. The total weight of the coating or plurality of coatings 50 (e.g. sum of the first weight and the second weight) can range from approximately 1 – 25 grams, 1 – 20 grams, 1 – 15 grams, or 1 – 10 grams. For example, the sum of the first weight and the second weight can be approximately 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, or 25 grams.

[0095] In many embodiments, the coating or plurality of coatings 50, as described herein, may be used to position discretionary weight to achieve specific head center of gravity positions. For example, the coating 50 may be applied to the club head (e.g. club head 200, 300, 400, 500, 600, 700, 800, 900, 1100, 1200, 1300, 1400, 2000, 2100, 2200, or 2300) at the back end 38 to shift the center of gravity of the club head toward the back end 38. For further example, the coating 50 may be applied to the club head 100, 200 on the sole 24 to shift the center of gravity toward the sole 24. Further still, the coating 50 may be applied to the back end 38 and the sole 24 of the club head to shift the head center of gravity toward the back end 38 and the sole 24. While the examples described herein illustrate the coating 50 positioned to shift the head center of gravity toward the back end 38 and/or the sole 24 of the club head, the coating 50 may be positioned anywhere on the club head to shift the center of gravity in any direction, including toward the crown 18, toward the sole 24, toward the heel 28, toward the toe 34, toward the strike face 10, toward the back end 38, towards at least a portion of the hosel 40, or in any combination of the described directions of the club head to optimize the performance characteristics of the

club head. The ability to apply the coating 50 uniformly over the club head or in specific portions of the club head at a micro level allows for precise control of the head center of gravity position.

[0096] In many embodiments, the center of gravity of the of club head having coating 50 (e.g. club head 200, 300, 400, 500, 600, 700, 800, 900, 1100, 1200, 1300, 1400, 2000, 2100, 2200, or 2300), can shift by up to approximately 0.05 inches, 0.15 inches, 0.25 inches, 0.35 inches, 0.45 inches, 0.55 inches, 0.65 inches, 0.75 inches, or up to 85 inches in a direction toward the heel 28, toward the toe 34, toward the sole 24, toward the crown 18, toward the strike face 10, toward the back end 38, or any combination of the described directions, compared to a similar club head without a coating.

[0097] In many embodiments, the coating 50, as described herein, can also increase the moment of inertia of the club head about an x-axis extending through the center of gravity from the heel 28 to the toe 34, and/or about the y-axis extending through the center of gravity from the crown 18 to the sole 24. In general, club head moment of inertia increases as weight or mass is distributed farther from the head center of gravity. Applying the coating 50 as described herein, allows for positioning of discretionary weight at increased or maximized distances from the head center of gravity. Therefore, the coating 50 of the club head (e.g. club head 200, 300, 400, 500, 600, 700, 800, 900, 1100, 1200, 1300, 1400, 2000, 2100, 2200, or 2300) may be used to increase and/or maximize the moment of inertia of the club head. Increasing the moment of inertia of the club head results in increased consistency in ball direction, trajectory, and distance. Therefore, off-center hits will behave more similarly to on-center hits for the club head having the coating 50.

[0098] In many embodiments, the moment of inertia about the x-axis of the club head having the coating 50 (e.g. club head 200, 300, 400, 500, 600, 700, 800, 900, 1100, 1200, 1300, 1400, 2000, 2100, 2200, or 2300) can be increased by up to approximately 2.5%, 5%, 7.5%, 10%, 12.5%, 15%, 17.5%, or 20%, compared to a similar club head without a coating. In other embodiments, the moment of inertia about the x-axis of the club head having the coating 50 can be increased by approximately 1% to 9%, 2.5% to 5%, 5% to 10%, 5% to 15%, or 10% to 20%, compared to a similar club head without a coating. In many embodiments, the moment of inertia about the y-axis of the club head 100, 200 having the coating 50 can be increased by up to

approximately 2.5%, 5%, 7.5%, 10%, 12.5%, 15%, 17.5%, or 20%. In other embodiments, the moment of inertia about the y-axis of the club head having the coating 50 can be increased by approximately 1% to 11%, 2.5% to 5%, 5% to 10%, 5% to 15%, or 10% to 20% compared to a similar club head without a coating.

[0099] Referring to Tables 2-4 below, the coating material, in combination with the surface area and thickness 56, may be designed to add a desired discretionary weight to the club head (e.g. club head 100, 200, 300, 400, 500, 600, 700, 800, 900, 1100, 1200, 1300, 1400, 2000, 2100, 2200, 2300). For example, Table 2 illustrates exemplary coatings 50 having varying coating material densities, position on the club head (related to surface area), and thicknesses 56 required to add 1 gram of discretionary weight to the club head. For a further example, Table 3 illustrates exemplary coatings 50 having varying coating material densities, positions on the club head (related to surface area), and coating thicknesses 56 required to add 5 grams of discretionary weight to the club head. For a further example, Table 4 illustrates exemplary coatings 50 having varying coating material densities, positions on the club head (related to surface area), and thicknesses 56 required to add 10 grams of discretionary weight to the club head. While the examples illustrated in Tables 2-4 provide exemplary discretionary weights, coating materials, positions, and thicknesses 56 of the coating 50, the same principles apply to add any amount of discretionary weight to the club head, such as, for example, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, or 25 grams of discretionary weight. Further, the thickness 56 of the coating 50 may be varied for any coating position to adjust the relationship between the coating thickness 56 and coating material, position, and/or discretionary weight.

Table 2: Exemplary coating thicknesses for varying coating materials and positions to add 1 gram of discretionary weight to the club head

Coating Material	Coating Material Density (g/in ³)	Coating Position on Club Head and thickness (inches) required for a coating weight of 1 gram					
		Entire Club Head	Strike face	Body	Crown	Sole	Portion of the sole over a sole weight
Ti 8-1-1	71.45	0.00027	0.00233	0.00030	0.00078	0.00078	0.00350
Cobalt Beryllium	144.70	0.00013	0.00115	0.00015	0.00038	0.00038	0.00173

Copper							
Pure Palladium	199.27	0.00010	0.00084	0.00011	0.00028	0.00028	0.00125
Tungsten Carbide	256.13	0.00008	0.00065	0.00008	0.00022	0.00022	0.00098
Tungsten Rhenium	314.96	0.00006	0.00053	0.00007	0.00018	0.00018	0.00079
Pure Tungsten	316.27	0.00006	0.00053	0.00007	0.00018	0.00018	0.00079

Table 3: Exemplary coating thicknesses for varying coating materials and positions to add 5 grams of discretionary weight to the club head

Coating Material	Coating Material Density (g/in ³)	Coating Position on Club Head and thickness (inches) required for a coating weight of 5 grams					
		Entire Club Head	Strike face	Body	Crown	Sole	Portion of the sole over a sole weight
Ti 8-1-1	71.45	0.00135	0.01166	0.00152	0.00389	0.00389	0.01749
Cobalt Beryllium Copper	144.70	0.00066	0.00576	0.00075	0.00192	0.00192	0.00864
Pure Palladium	199.27	0.00048	0.00418	0.00055	0.00139	0.00139	0.00627
Tungsten Carbide	256.13	0.00038	0.00325	0.00042	0.00108	0.00108	0.00488
Tungsten Rhenium	314.96	0.00031	0.00265	0.00035	0.00088	0.00088	0.00397
Pure Tungsten	316.27	0.00030	0.00263	0.00034	0.00088	0.00088	0.00395

Table 4: Exemplary coating thicknesses for varying coating materials and positions to add 10 grams of discretionary weight to the club head

Coating Material	Coating Material Density (g/in ³)	Coating Position on Club Head and thickness (inches) required for a coating weight of 10 grams					
		Entire Club Head	Strike face	Body	Crown	Sole	Portion of the sole over a sole weight
Ti 8-1-1	71.45	0.00269	0.02333	0.00304	0.00788	0.00778	0.03499
Cobalt Beryllium Copper	144.70	0.00133	0.01152	0.00150	0.00384	0.00384	0.01728

Pure Palladium	199.27	0.00097	0.00836	0.00109	0.00279	0.00279	0.01255
Tungsten Carbide	256.13	0.00075	0.00651	0.00085	0.00217	0.00217	0.00976
Tungsten Rhenium	314.96	0.00061	0.00529	0.00069	0.00176	0.00176	0.00794
Pure Tungsten	316.27	0.00061	0.00527	0.00069	0.00176	0.00176	0.00790

[00100] As illustrated in Tables 2-4, the coating 50 having a lower coating material density will require a greater thickness 56 than the coating 50 having a higher coating material density to add the same discretionary weight over the same surface area to the club head. Similarly, the coating 50 having a higher material coating density will require less thickness 56 than the coating 50 having a lower coating material density to add the same discretionary weight over the same surface area to the club head. In general, the coating material density, thickness 56, and/or surface area of the coating 50 may be increased to increase the amount of discretionary weight added to the club head by the coating 50. Similarly, the coating material density, thickness 56, and/or surface area of the coating 50 may be decreased to decrease the amount of discretionary weight added to the club head by the coating 50.

[00101] Referring to Tables 2-4, the thickness 56 of the coating 50 may range from approximately 0.00001 – 0.10 inches to add approximately 1 – 25 grams, 1 – 20 grams, 1 – 15 grams, or 1 – 10 grams of discretionary weight to the club head 100. For example, the thickness 56 of the coating 50 may be approximately 0.00001, 0.000025, 0.00005, 0.000075, 0.0001, 0.00025, 0.0005, 0.00075, 0.001, 0.0025, 0.005, 0.0075, 0.01, 0.025, 0.05, 0.075, or 0.10 inches. For further example, the thickness 56 of the coating 50 may add approximately 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, or 25 grams of discretionary weight to the club head 100.

[00102] Fig. 19 illustrates a method of manufacturing the club head (e.g. club head 100, 200, 300, 400, 500, 600, 700, 800, 900, 1100, 1200, 1300, 1400, 2000, 2100, 2200, 2300). The method includes providing a club head having a strike face 10 and a body 14 with a crown 18, a sole 24 opposite the crown 18, a heel 28, a toe 34 opposite the heel 28, and a back end 38, and applying at least one coating 50 to at least a portion of the club head 100. The coating 50 may be

applied to a surface of the club head by vapor deposition, plasma spray, plating, or spoting. The process of applying the coating 50 may involve spraying the club head with a powdered material under high pressure at approximately room temperature. Further, the coating 50 may be applied to the club head using any other process capable of applying the coating 50 to the club head in a thin layer.

[00103] The method of manufacturing club head may also be used to manufacture club head 200 by repeating the process of applying the coating for the second coating, third coating, fourth coating, and/or fifth coating of the club head. Further, the method of manufacturing the club head is merely exemplary and is not limited to the embodiments presented herein. The method can be employed in many different embodiments or examples not specifically depicted or described herein. In some embodiments, the processes of the method described can be performed in any suitable order. In other embodiments, one or more of the processes may be combined, separated, or skipped.

[00104] In the illustrated embodiments, the club heads (e.g. club head 100, 200, 300, 400, 500, 600, 700, 800, 900, 1100, 1200, 1300, 1400, 2000, 2100, 2200, 2300) are shown as a wood-type club head. However, the club head may be any type of club head including a wood-type club head (e.g., driver or fairway wood), an iron-type club head (e.g., iron or wedge), or a putter-type club head. Further, the embodiments described herein illustrate the club head having the coating on the outer surface 42 of the club head. In other embodiments, the coating may be applied to the inner surface 46 of the club head to achieve similar results.

EXAMPLES

Example 1

[00105] Referring to Figs. 10A and 10B, an exemplary club head 900 having the coating 50 comprising tungsten carbide (density of approximately 256.13 g/in³), with a first portion positioned over the entire crown 18 and a second portion positioned over the entire sole 24, each portion having a thickness 56 of approximately 0.001 inches, and adding a total of approximately

9.9 grams of weight to the club head 900 shifted the center of gravity approximately 0.076 inches toward the toe 34, approximately 0.050 inches toward the crown 18, and approximately 0.020 inches toward the back end 38, compared to a similar club head without the coating. Further, in this example, the coating 50 increased the moment of inertia about the x-axis by approximately 5.3%, and increased the moment of inertia about the y-axis by approximately 4.5%, compared to a similar club head without the coating.

Example 2

[00106] Referring to Fig. 11, an exemplary club head 1100 having the coating 50 comprising tungsten carbide (density of approximately 256.13 g/in^3), positioned over the entire sole 24, having a thickness 56 of approximately 0.009 inches, and adding approximately 11.4 grams of weight to the club head 1100 shifted the center of gravity by approximately 0.014 inches toward the toe 34, approximately 0.055 inches toward the sole 24, and approximately 0.085 inches toward the back end 38, compared to a similar club head without the coating. Further, in this example, the coating 50 increased moment of inertia about the x-axis by approximately 8.1%, and increased the moment of inertia about the y-axis by approximately 8.6%, compared to a similar club head without the coating.

Example 3

[00107] Referring to Fig. 12, an exemplary club head 1200 having the coating 50 comprising tungsten carbide (density of approximately 256.13 g/in^3), with a first portion positioned over the a portion of the sole 24 near the toe 34 and a second portion positioned over a portion of the sole 24 near the heel 28, each portion having a thickness 56 of approximately 0.006 inches, and adding a total of approximately 8.2 grams of weight to the club head shifted the center of gravity by approximately 0.045 inches toward the toe 34, approximately 0.010 inches toward the sole 24, and approximately 0.020 inches toward the back end 38, compared to a similar club head without the coating. Further, in this example, the coating 50 increased the moment of inertia about the x-axis by approximately 2.2%, and increased the moment of inertia about the y-axis by approximately 3.5%, compared to a similar club head without the coating.

Example 4

[00108] Referring to Fig. 13, an exemplary club head 1300 having the coating 50 comprising tungsten carbide (density of approximately 256.13 g/in^3), positioned over a portion of the sole 24 near the heel 28, having a thickness 56 of approximately 0.009 inches, and adding approximately 9.0 grams of weight to the club head 1300 shifted the center of gravity by approximately 0.082 inches toward the heel 28, approximately 0.010 inches toward the sole 24, and approximately 0.190 inches toward the strike face 10, compared to a similar club head without the coating. Further, in this example, the coating 50 increased the moment of inertia about the x-axis by approximately 5.5%, and increased the moment of inertia about the y-axis to approximately 2.7%, compared to a similar club head without the coating.

Example 5

[00109] Referring to Fig. 14, an exemplary club head 1400 having the coating 50 comprising tungsten carbide (density of approximately 256.13 g/in^3), positioned over the entire sole 24, having a thickness 56 of approximately 0.002 inches, and adding approximately 10.3 grams of weight to the club head 1300 shifted the center of gravity by approximately 0.010 inches toward the toe 34, approximately 0.055 inches toward the sole 24, and approximately 0.050 inches toward the back end 38, compared to a similar club head without the coating. Further, in this embodiment, the coating 50 increased the moment of inertia about the x-axis by approximately 4.2%, and increased the moment of inertia about the y-axis by approximately 4.4%, compared to a similar club head without the coating.

[00110] Replacement of one or more claimed elements constitutes reconstruction and not repair. Additionally, benefits, other advantages, and solutions to problems have been described with regard to specific embodiments. The benefits, advantages, solutions to problems, and any element or elements that may cause any benefit, advantage, or solution to occur or become more pronounced, however, are not to be construed as critical, required, or essential features or elements of any or all of the claims.

[00111] As the rules to golf may change from time to time (e.g., new regulations may be adopted or old rules may be eliminated or modified by golf standard organizations and/or

governing bodies such as the United States Golf Association (USGA), the Royal and Ancient Golf Club of St. Andrews (R&A), etc.), golf equipment related to the apparatus, methods, and articles of manufacture described herein may be conforming or non-conforming to the rules of golf at any particular time. Accordingly, golf equipment related to the apparatus, methods, and articles of manufacture described herein may be advertised, offered for sale, and/or sold as conforming or non-conforming golf equipment. The apparatus, methods, and articles of manufacture described herein are not limited in this regard.

[00112] While the above examples may be described in connection with a driver-type golf club, the apparatus, methods, and articles of manufacture described herein may be applicable to other types of golf club such as a fairway wood-type golf club, a hybrid-type golf club, an iron-type golf club, a wedge-type golf club, or a putter-type golf club. Alternatively, the apparatus, methods, and articles of manufacture described herein may be applicable other type of sports equipment such as a hockey stick, a tennis racket, a fishing pole, a ski pole, etc.

[00113] Moreover, embodiments and limitations disclosed herein are not dedicated to the public under the doctrine of dedication if the embodiments and/or limitations: (1) are not expressly claimed in the claims; and (2) are or are potentially equivalents of express elements and/or limitations in the claims under the doctrine of equivalents.

[00114] Various features and advantages of the disclosure are set forth in the following claims.

CLAIMS

1. A golf club head comprising:
 - a body comprising a body material having a body material density, the body including:
 - a crown,
 - a sole opposite the crown,
 - a heel,
 - a toe opposite the heel, and
 - a back end;
 - a strike face made of a strike face material having a strike face material density;
 - an outer surface;
 - an inner surface; and
 - a coating comprising a coating material having a coating material density,
 - wherein the coating material density is greater than the body material density or the strike face material density.
2. The golf club head of claim 1, wherein the strike face material is the same as the body material, and the coating material is different than the strike face material and the body material.
3. The golf club head of claim 1, wherein the strike face material is different than the body material, and the coating material is different than the strike face material or the body material.
4. The golf club head of claim 1, wherein the coating is positioned on the outer surface of the club head on at least a portion of the crown, the sole, the heel, the toe, the strike face, the back end, or the hosel.
5. The golf club head of claim 1, wherein the coating is positioned on the outer surface of the club head on at least one of the crown, the sole, the heel, the toe, the strike face, the back end, or the hosel.
6. The golf club of claim 1, wherein the coating further comprises a surface area ranging from approximately 0 – 70 in².

7. The golf club of claim 1, wherein the coating further comprises a thickness ranging from approximately 0.00001 – 0.10 inches.
8. The golf club of claim 1, wherein the weight of the coating ranges from approximately 1 – 15 grams.
9. The golf club head of claim 1, wherein the coating comprises cobalt beryllium copper, pure palladium, tungsten carbide, tungsten rhenium, or pure tungsten.
10. The golf club head of claim 1, wherein the at least one coating includes:
 - a first coating made of a first coating material having a first coating material density; and
 - a second coating made of a second coating material having a second coating material density, wherein the second coating material density is different than the first coating material density.
11. The golf club of claim 10, wherein the first coating further comprises a first surface area ranging from approximately 0 – 70 in².
12. The golf club of claim 10, wherein the second coating further comprises a second surface area ranging from approximately 0 – 70 in².
13. The golf club of claim 10, wherein the first coating further comprises a first thickness ranging from approximately 0.00001 – 0.10 inches.
14. The golf club of claim 10, wherein the second coating further comprises a second thickness ranging from approximately 0.00001 – 0.10 inches.
15. The golf club of claim 10, wherein the combined weight of the first coating and the second coating ranges from approximately 1 – 15 grams.
16. The golf club head of claim 10, wherein the first coating is made of cobalt beryllium copper, pure palladium, tungsten carbide, tungsten rhenium, or pure tungsten.

17. The golf club head of claim 10, wherein the second coating is made of cobalt beryllium copper, pure palladium, tungsten carbide, tungsten rhenium, or pure tungsten.
18. A method of manufacturing a golf club head having a coating, the method including:
providing a club head having a strike face and a body, the body having a crown, a sole opposite the crown, a heel, a toe opposite the heel, and a back end;
and
applying the coating or plurality of coatings to at least a portion of the club head.
19. A golf club head comprising
a body comprising a body material having a body material density, the
body including:
a crown,
a sole opposite the crown,
a heel,
a toe opposite the heel, and
a back end;
a strike face made of a strike face material having a strike face material density;
an outer surface;
an inner surface; and
a coating comprising a coating material having a coating material density,
wherein the coating material density is greater than the body material density
or the strike face material density, and
wherein the coating comprises a thickness ranging from 0.001 inches (25.4 μm) to
0.025 inches (635 μm) to provide 10 grams of discretionary weight to the club
head.
20. The golf club head of claim 19, wherein the coating includes:
a first coating made of a first coating material having a first coating material
density; and

a second coating made of a second coating material having a second coating material density, wherein the second coating material density is different than the first coating material density.

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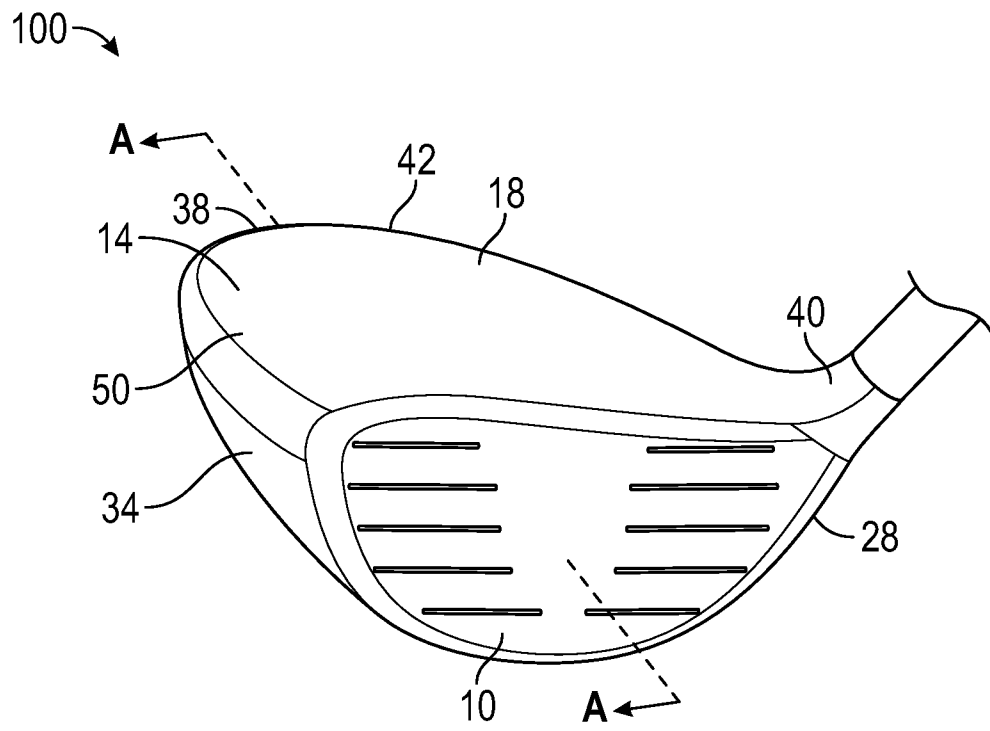


FIG. 1

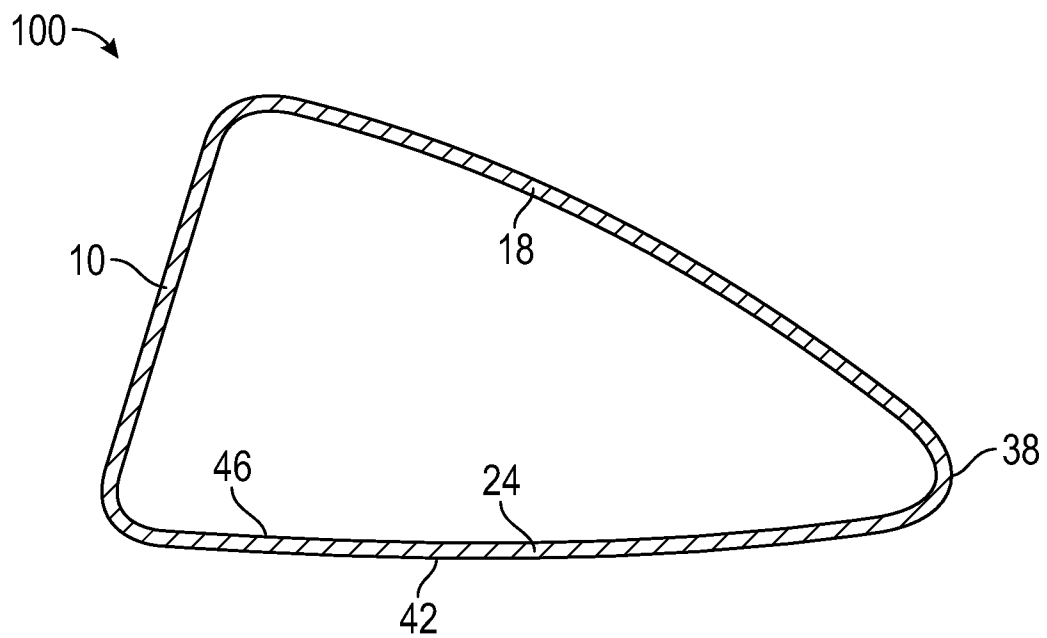


FIG. 2

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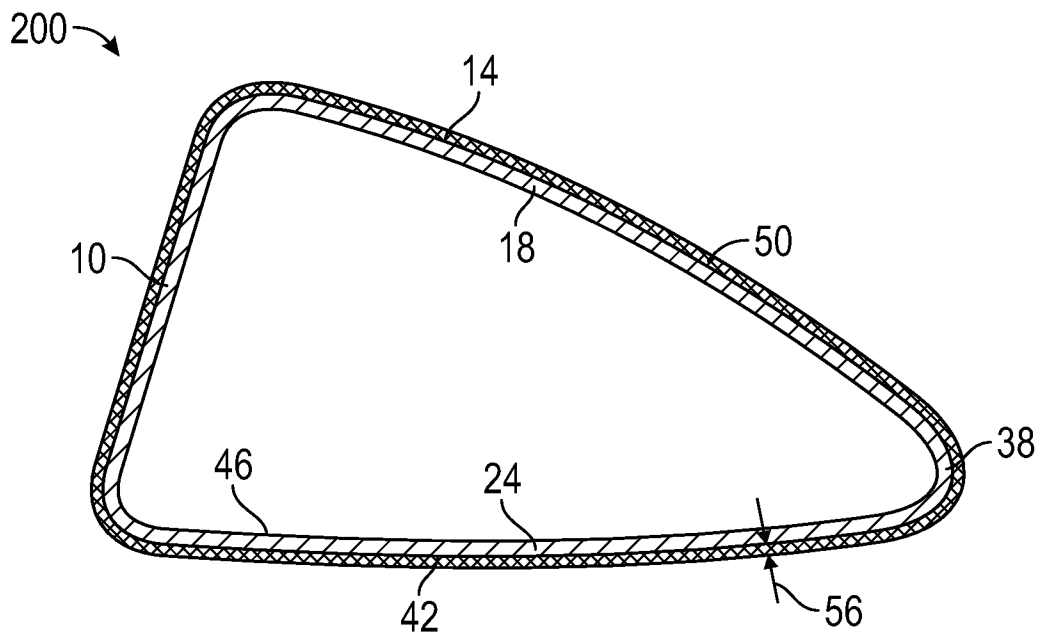


FIG. 3

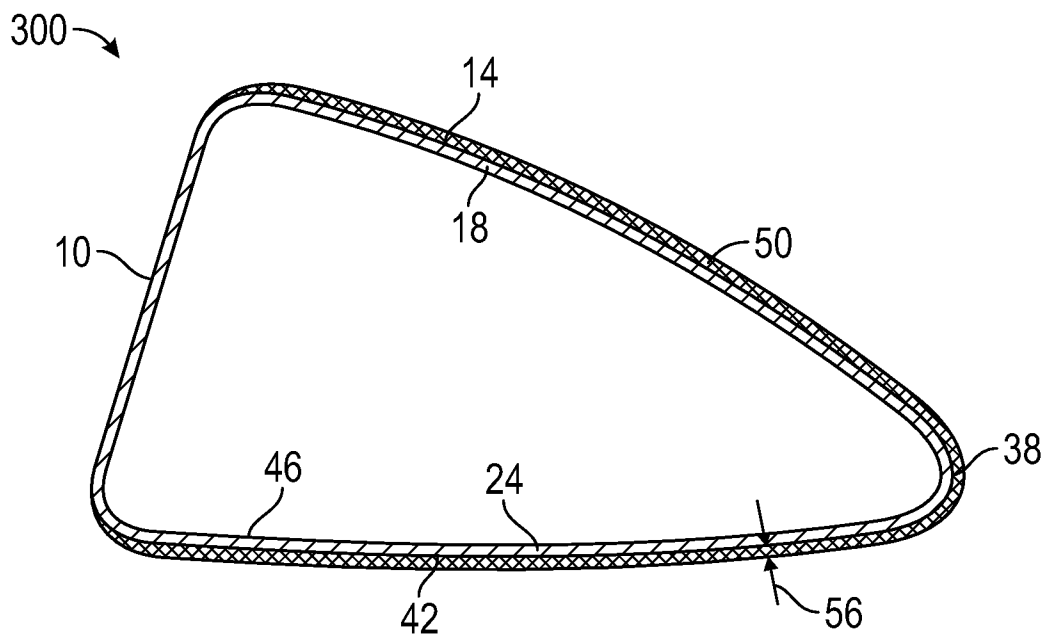


FIG. 4

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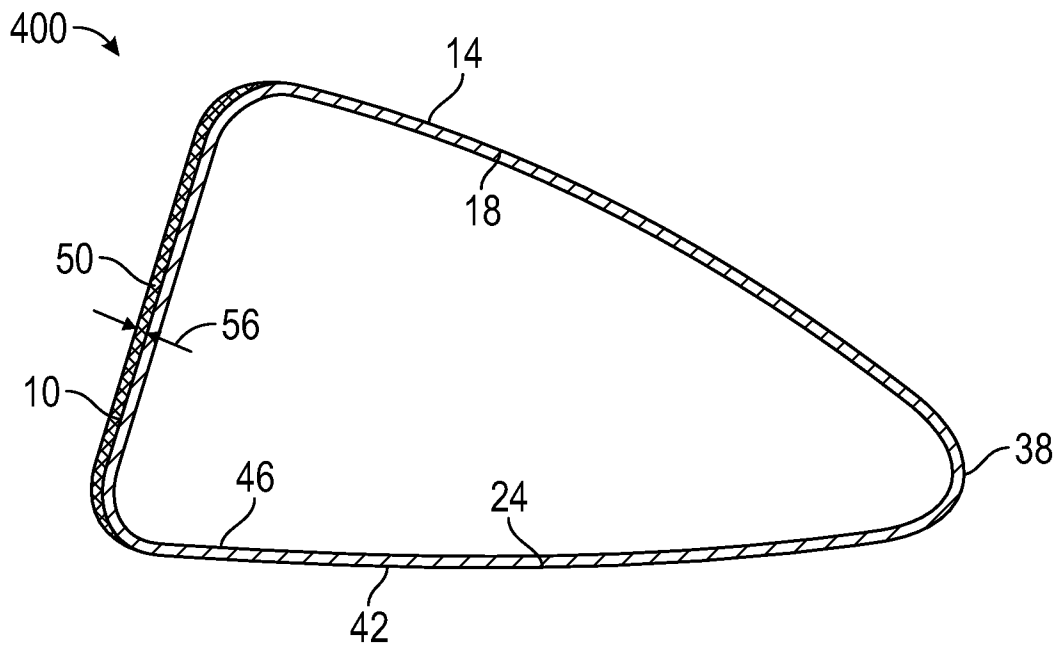


FIG. 5

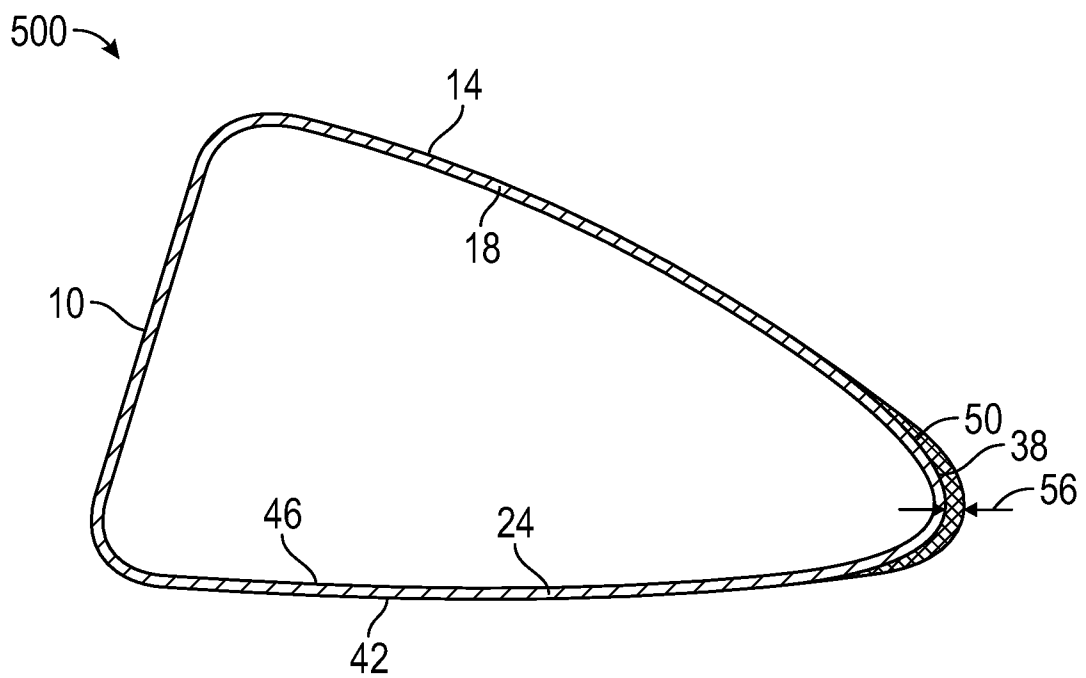


FIG. 6

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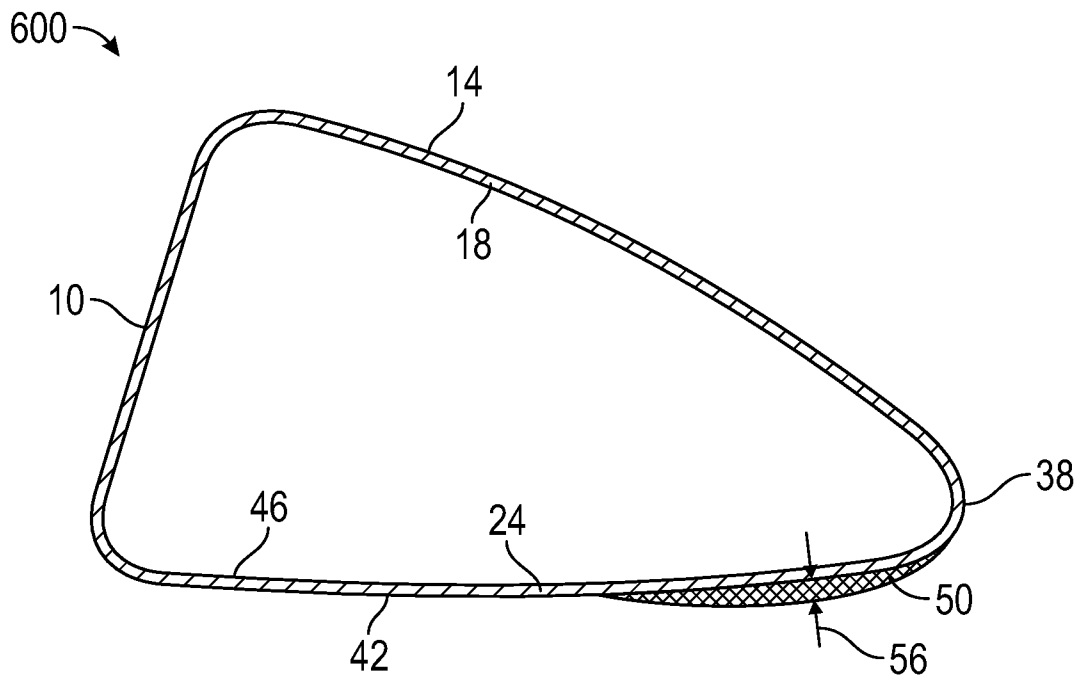


FIG. 7

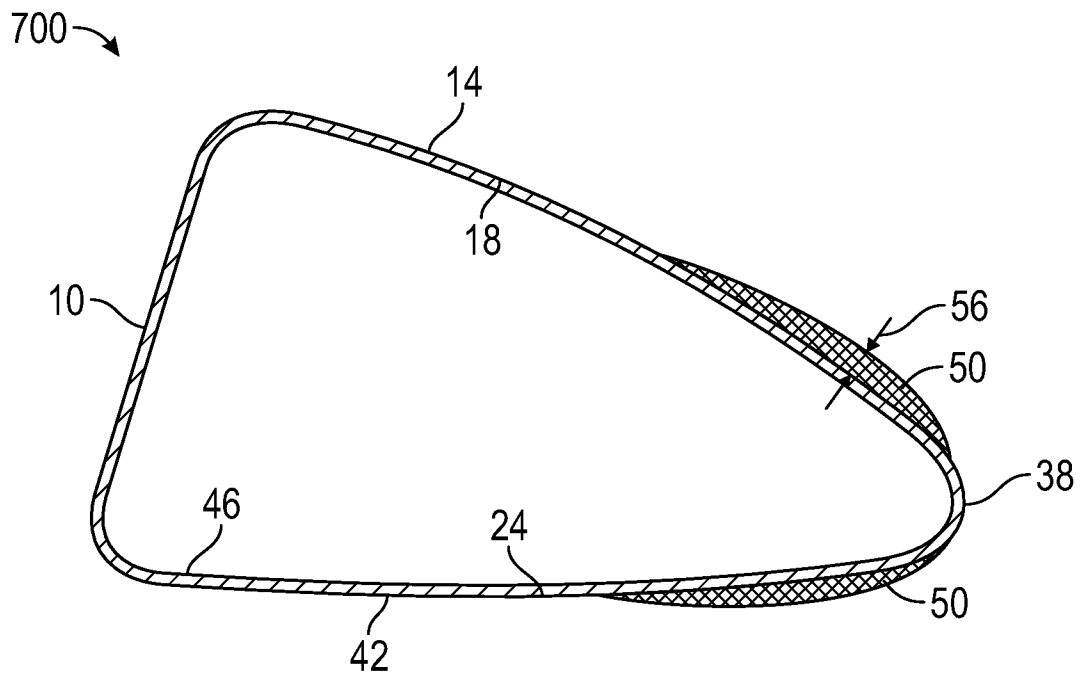


FIG. 8

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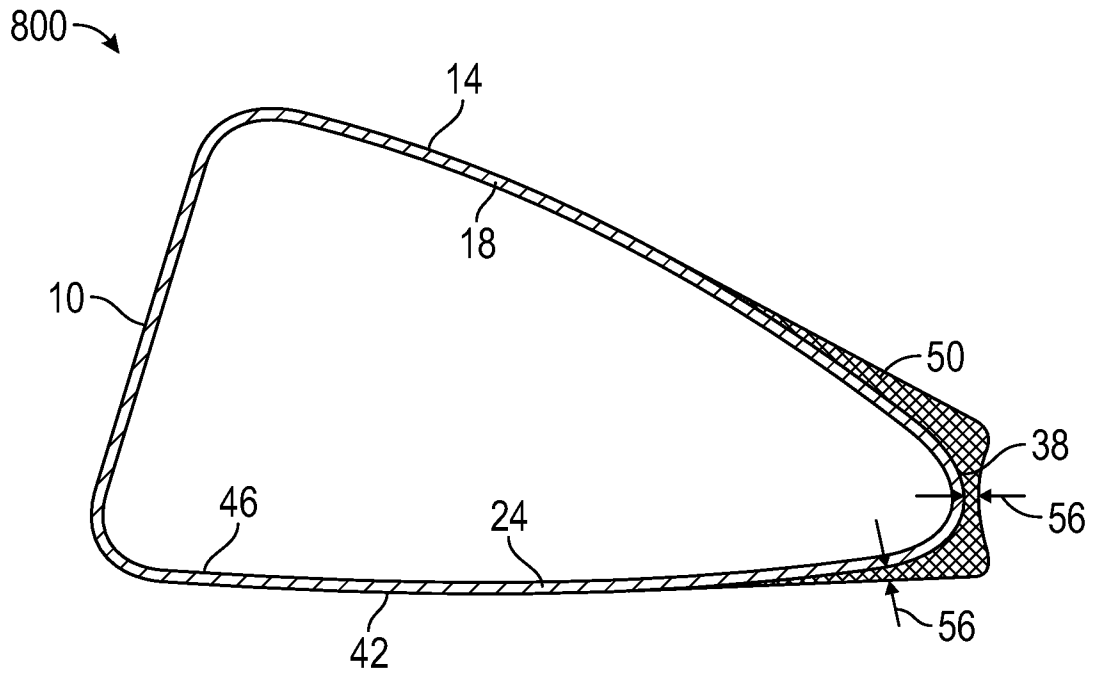


FIG. 9

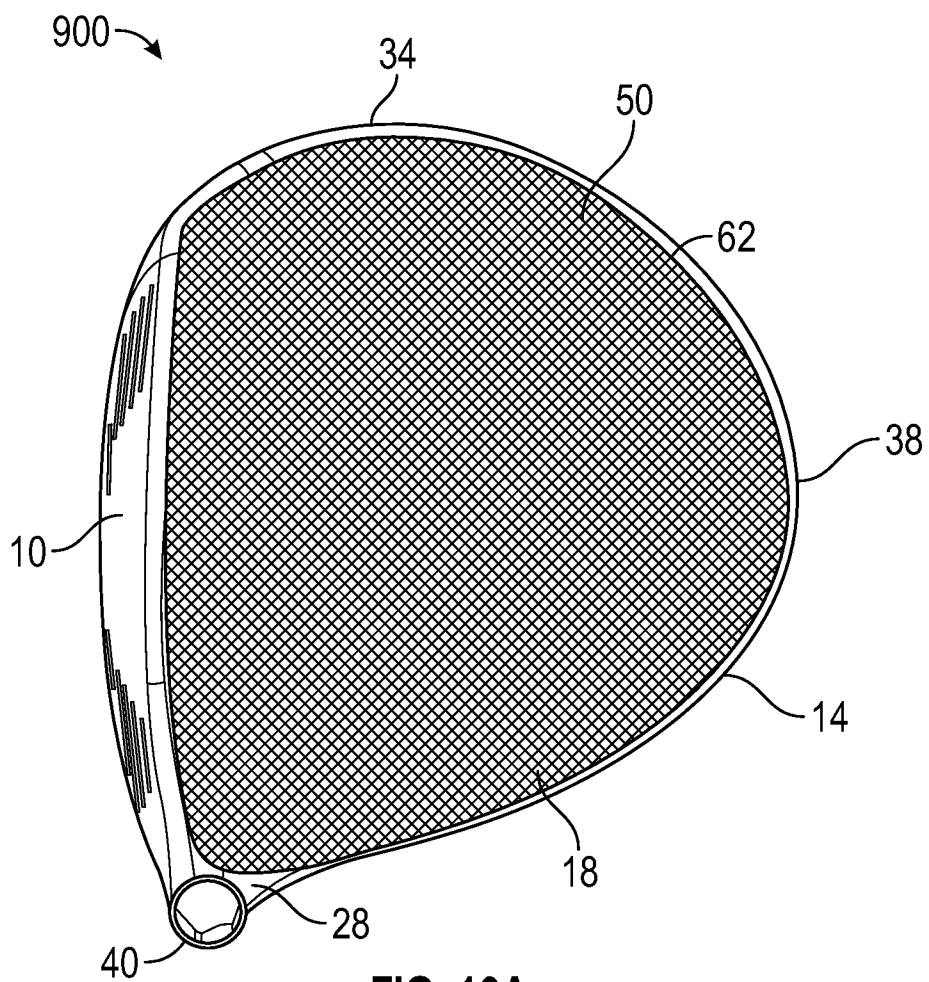


FIG. 10A

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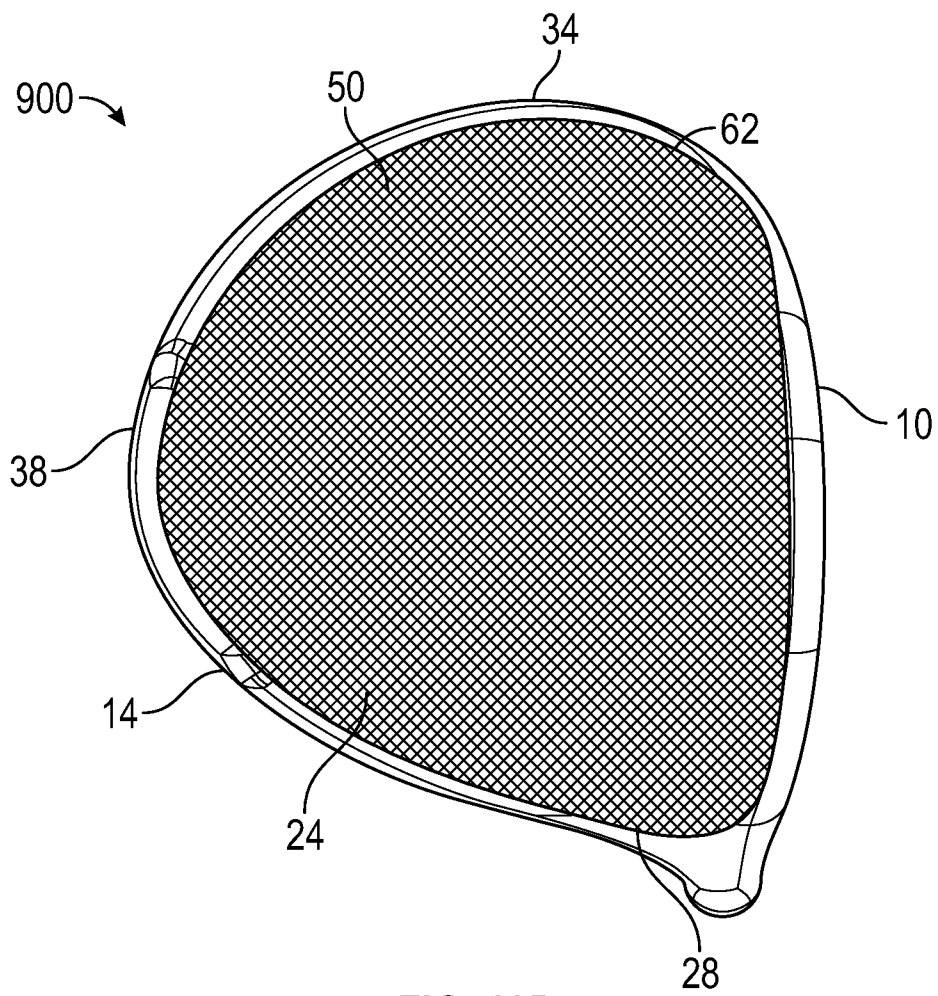


FIG. 10B

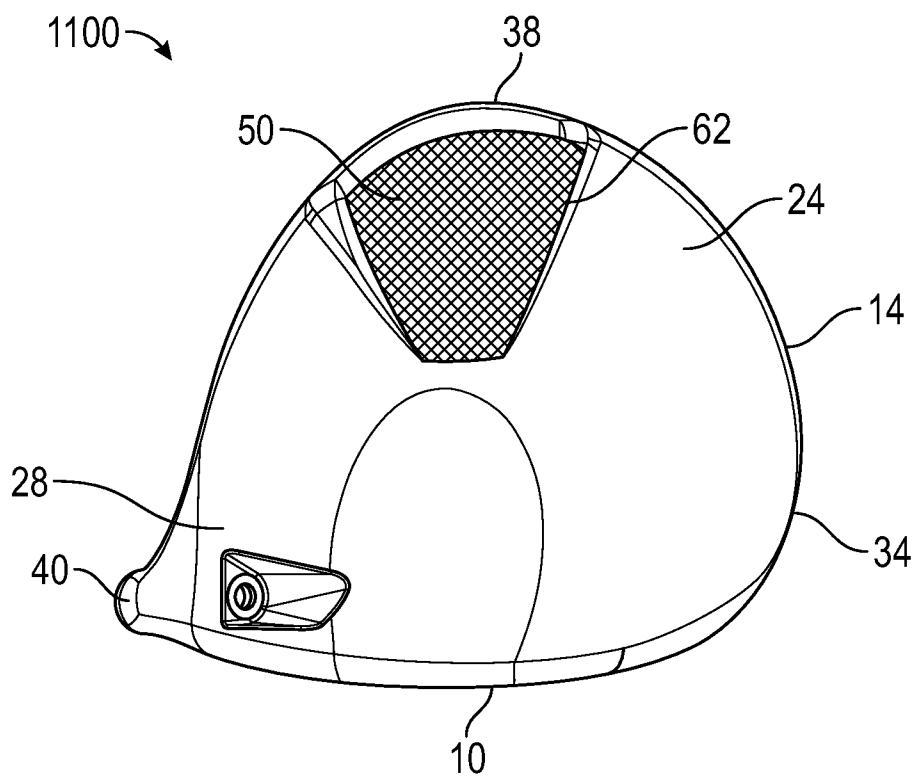


FIG. 11

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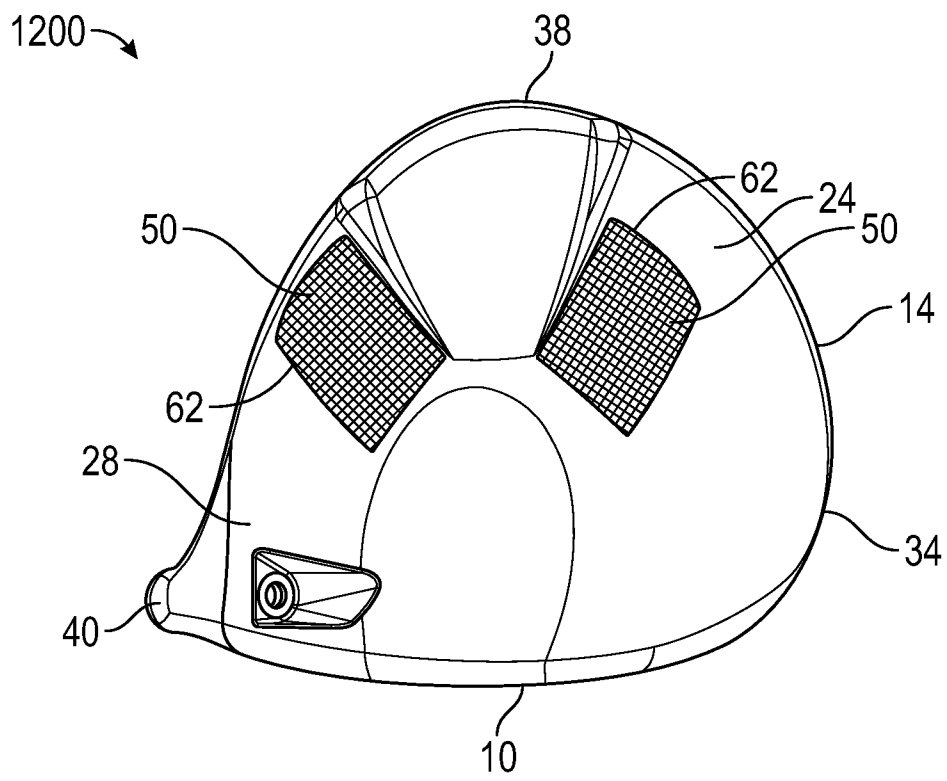


FIG. 12

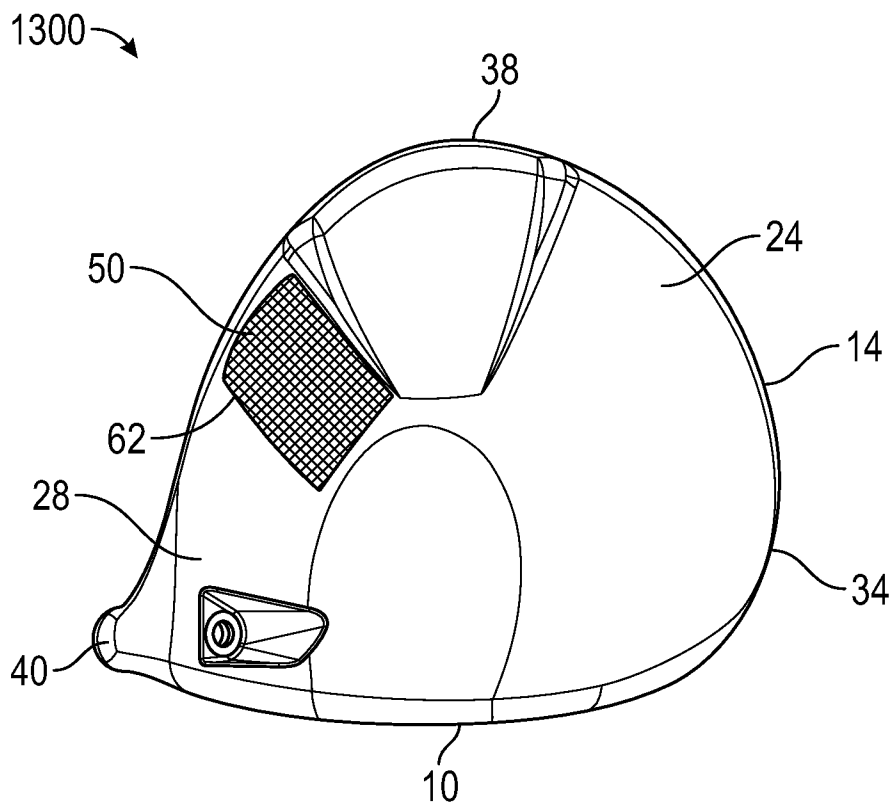


FIG. 13

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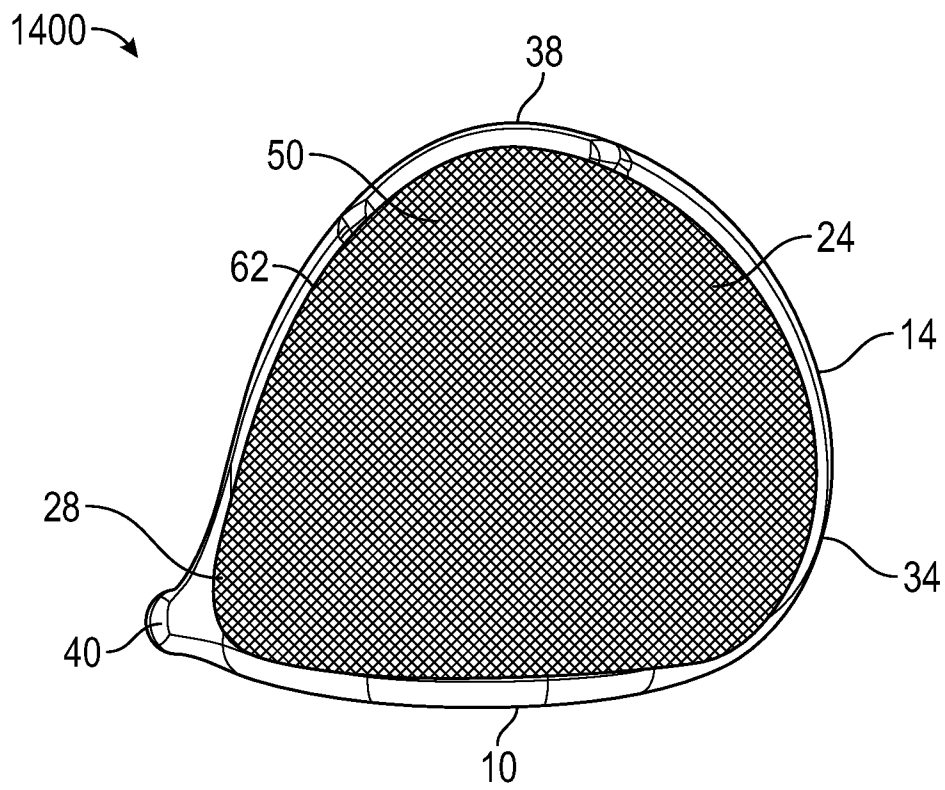


FIG. 14

2000

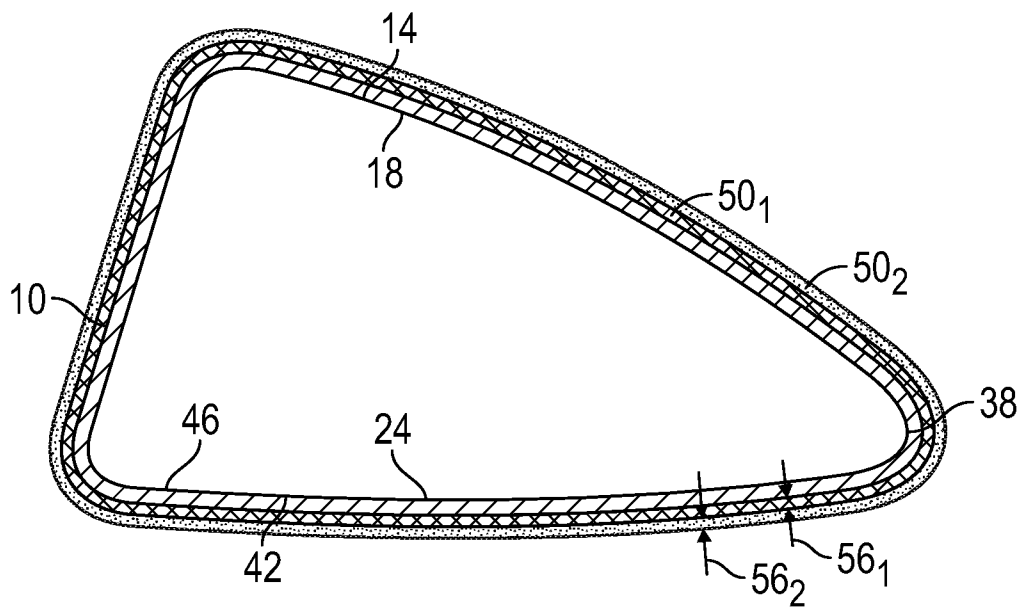


FIG. 15

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2100

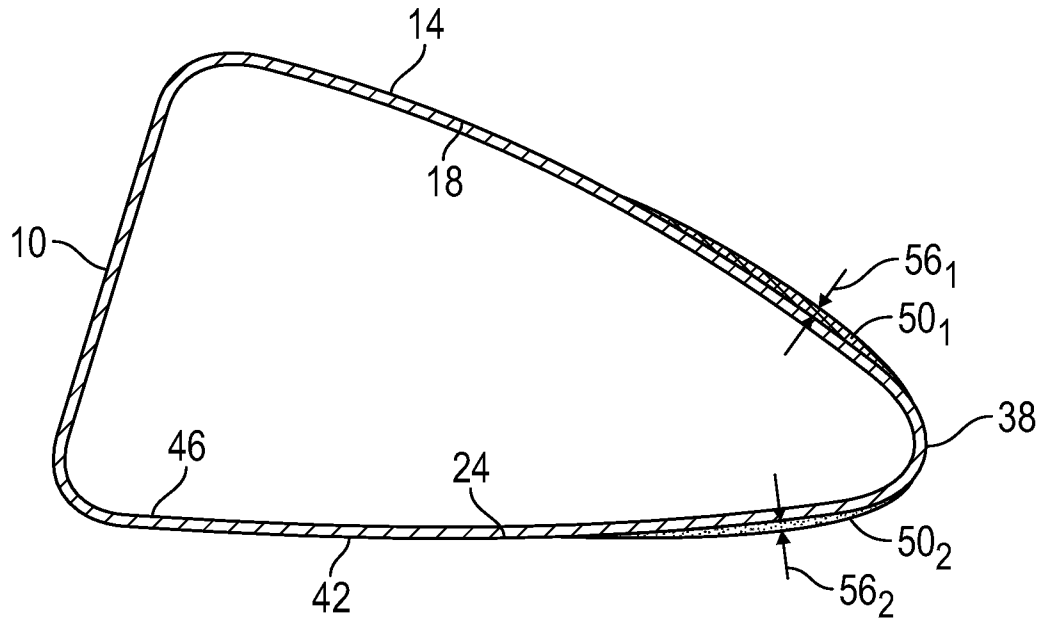


FIG. 16

2200

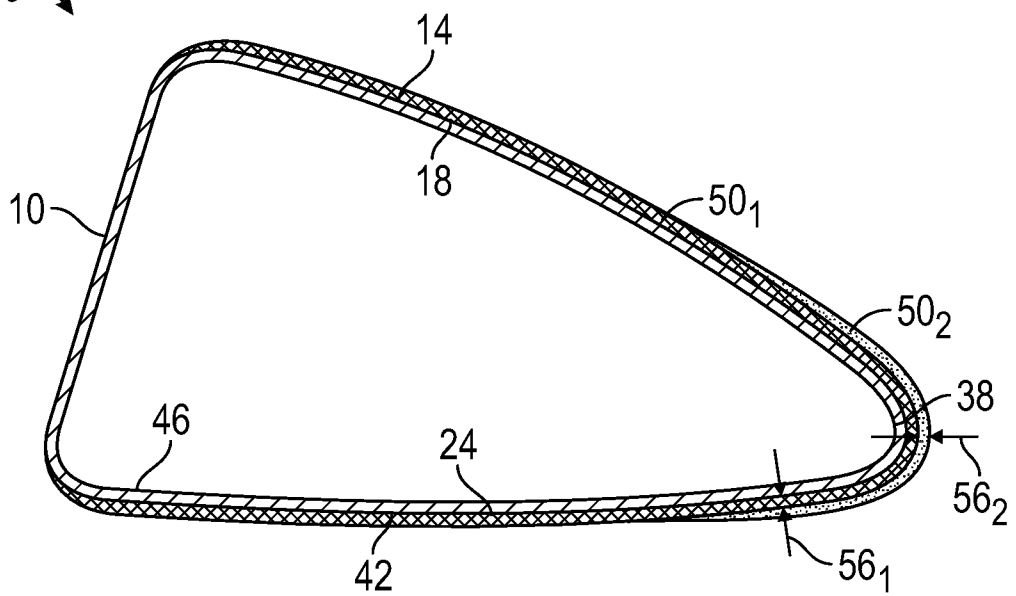


FIG. 17

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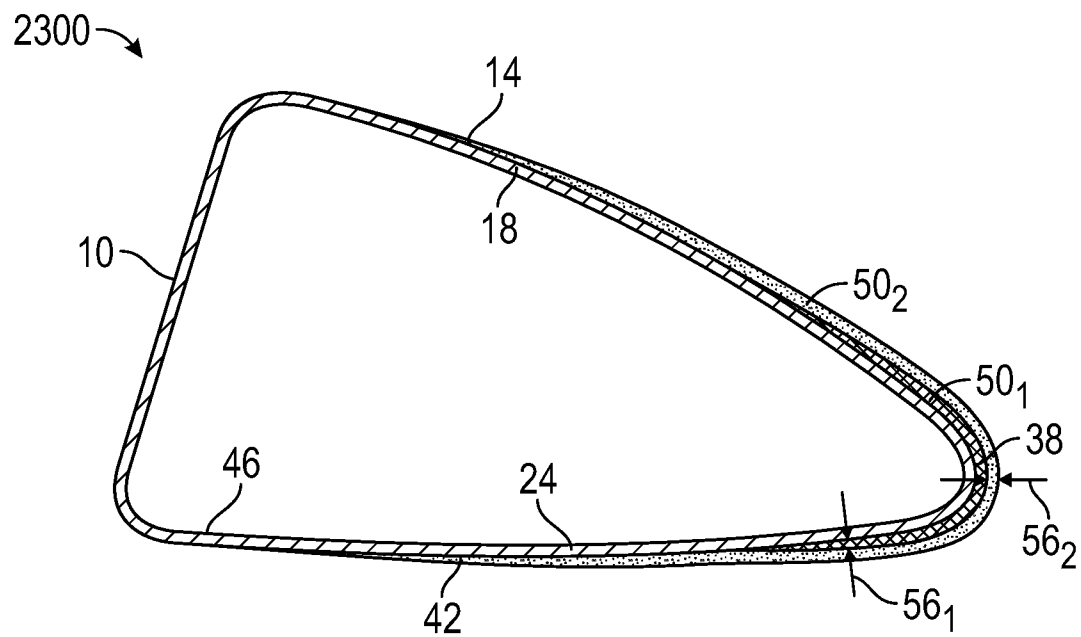


FIG. 18

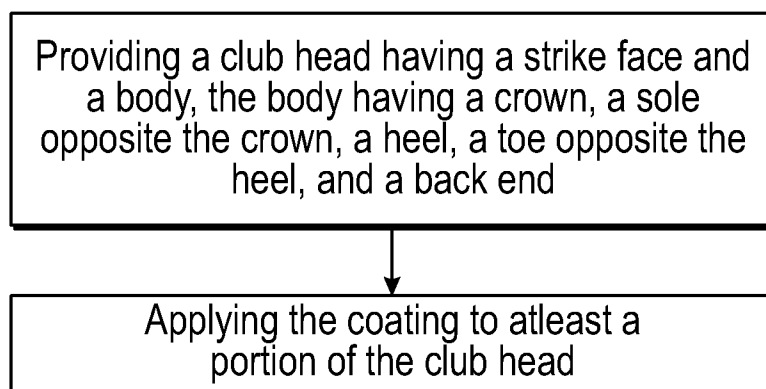


FIG. 19

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US16/33344

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A63B 53/04 (2016.01)

CPC - A63B 53/04

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)

IPC(8) Classifications: A63B 53/00, 53/04 (2016.01)

CPC Classifications: A63B 53/04, 2053/042, 2053/0425, 2053/0429

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

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

PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, INPADOC Data); golf, club, head, face, plate, striking face, striking plate, coating, layer, PVD, deposition, tungsten, high density, palladium, tungsten carbide, tungsten rhenium, cobalt beryllium copper, weight, gram

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2013/0065706 A1 (PARK S. J. et al.) March 14, 2013; figures 2, 2a; paragraphs [0025], [0036]-[0040]	1-7, 9-14, 16-20 --- 15, 19, 20
X -- Y	US 2006/0211514 A1 (DESHMUKH U. V.) September 21, 2006; figures 1, 3; paragraphs [0023], [0027]-[0029]	1, 8, 19 --- 15, 19, 20
X	US 6,059,670 A (MOGAN G. D.) May 9, 2000; figures 1, 3-5; column 3, lines 5-10	1
X	US 2014/0100052 A (TAYLOR MADE GOLF COMPANY INC) April 10, 2014; figures 1, 2; paragraphs [0015], [0026]	1
X	WO 2005/089884 A1 (BUCHANAN D. B.) September 29, 2005; page 4, lines 15-20, page 5, lines 1-10; claims 12, 13	1, 4, 5, 6, 9
A	US 7,083,525 B2 (POND B. et al.) August 1, 2006; entire document	1-20
A	US 6,193,614 B1 (SASAMOTO A. et al.) February 27, 2001; entire document	1-20



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

"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

15 July 2016 (15.07.2016)

Date of mailing of the international search report

31 AUG 2016

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