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(54) **ADJUSTABLE WEIGHT CLUB HEAD**

(57) Embodiments of golf club heads having adjustable weighting systems with a plurality of discrete attachment locations capable of receiving one or more weights are described herein. The golf club heads described herein provide user adjustability of club head center of gravity to adjust ball flight while maintaining a high moment of inertia and low and back center of gravity position.

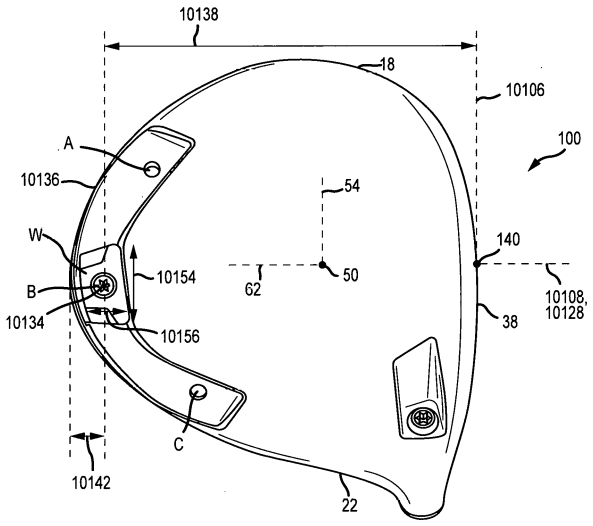

FIG.5

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Description

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This claims the benefit of U.S. Provisional Patent Appl. No. 62/545,770, filed on August 15, 2017, and U.S. Provisional Patent Appl. No. 62/628,803, filed on February 9, 2018, all of which are incorporated herein by reference in their entirety.

FIELD OF INVENTION

[0002] The present disclosure relates to a golf club head, and more specifically to a golf club head having an adjustable weighting system.

BACKGROUND

[0003] Various characteristics of a golf club can affect the performance of the golf club. For example, the center of gravity and the moment of inertia of the golf club head are characteristics that can affect performance.

[0004] The center of gravity and moment of inertia of the golf club head are functions of the distribution of mass of the golf club head. In particular, distributing mass of the club head to be closer to a sole portion of the club head, closer to a strike face of the club head, and/or closer to a toe portion and heel portion of the club head can alter the center of gravity and/or the moment of inertia of the club head. Altering the moment of inertia of the club head can in turn alter the forgiveness of the golf club, flight direction of the golf ball, and/or flight angle of the golf ball.

[0005] Many weighting systems in current golf club heads require bulky and complex internal structures that reduce club head moment of inertia and move the club head center of gravity up (toward the crown) and forward (toward the face). There is a need in the art for a club head that provides user adjustability of club head weighting and center of gravity position to affect ball flight (trajectory and/or spin), without negatively impacting moment of inertia or center of gravity positon.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006]

FIG. 1 is a front perspective view of a golf club head.

FIG. 2 is a front view of the golf club head of FIG. 1 showing a y-axis.

FIG. 3 is a top view of the golf club head of FIG. 1 showing an x-axis, and a z-axis.

FIG. 4 is a side cross-sectional view of the golf club head of FIG. 1.

FIG. 5 is a bottom view of the golf club head of FIG. 1.

FIG. 6 is a rear perspective view of another golf club head.

FIG. 7 is a bottom view of the golf club head of FIG. 6.

FIG. 8 is a bottom perspective view of an alternative embodiment of FIG. 6.

FIG. 9 is a rear view of another golf club head.

FIG. 10 is a close-up perspective view of the rear of the golf club head of FIG. 9.

FIG. 11 is bottom perspective of another golf club head.

FIG. 12 is another bottom perspective view of the golf club head of FIG. 11.

FIG. 13 is a cross-sectional view of an aperture and tensioner of the golf club head of FIG. 11.

FIG. 14 is a front perspective view of a tensioner of the golf club head of FIG. 11.

FIG. 15 is a bottom view of another embodiment of a golf club head.

FIG. 16 is a bottom perspective view of the golf club head of FIG. 15.

[0007] Described herein are various embodiments of golf club heads having adjustable weighting systems. The adjustable weighting systems include a plurality of discrete attachment locations capable of receiving one or more weights. Each weight can be coupled to and shifted between any of the discrete attachment locations on the club head. Accordingly, the adjustable weighting system provides user adjustability of club head weighting and center of gravity position to change ball flight (i.e. ball spin or trajectory).

[0008] In many embodiments, the adjustable weighting systems described herein protrude from the external contour of the club head, or are minimally insert from the external contour of the club head. Further, in many embodiments the adjustable weighting systems described herein are positioned near the perimeter of the club head. The positioning of the adjustable weighting systems maximizes perimeter weighting and low and back weight positioning, thereby maximizing club head moment of inertia for forgiveness on off-center hits and positioning the club head center of gravity low and back to increase launch angle and reduce backspin. Accordingly, the golf club heads described herein provide user adjustability of club head center of gravity to adjust ball flight, while maintaining optimal design and performance characteristics (high moment of inertia and low and back center of gravity position).

[0009] Many embodiments described herein include adjustable weighting systems having one or more platforms, ledges, recesses or channels, without requiring significant internal structures that would adversely affect moment of inertia and head center of gravity position.

[0010] 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.

[0011] 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.

[0012] The terms "couple," "coupled," "couples," "coupling," and the like should be broadly understood and refer to connecting two or more elements, mechanically or otherwise. Coupling (whether mechanical or otherwise) may be for any length of time, e.g., permanent or semi-permanent or only for an instant.

[0013] Other features and aspects will become apparent by consideration of the following detailed description and accompanying drawings. Before any embodiments of the disclosure are explained in detail, it should be understood that the disclosure is not limited in its application to the details or embodiment and the arrangement of components as set forth in the following description or as illustrated in the drawings. The disclosure is capable of supporting other embodiments and of being practiced or of being carried out in various ways. It should be understood that the description of specific embodiments is not intended to limit the disclosure from covering all modifications, equivalents and alternatives falling within the spirit and scope of the disclosure. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting.

[0014] For ease of discussion and understanding, and for purposes of description only, the following detailed description illustrates golf club heads 100, 11010, 12010, 13010, and 6810 as woods. It should be appreciated that the woods are provided for purposes of illustration of one or more embodiments of the adjustable weighting systems as disclosed herein. However, the disclosed embodiments of the adjustable weighting systems can be used on any desired wood, iron, hybrid, or other golf club where adjustable weighting is desired. For example, the club head may include, but is not limited to, a driver, a fairway wood, a hybrid, a one-iron, a two-iron, a three-iron, a four-iron, a five-iron, a six-iron, a seven-iron, an eight-iron, a nine-iron, a pitching wedge, a gap wedge, a utility wedge, a sand.wedge, a lob wedge, and/or a putter.

[0015] FIGS. 1-3 illustrate a golf club head 100. The golf club head 100 includes a body 14 having a toe or toe end 18 opposite a heel or heel end 22. The body 14 also includes a crown or top 26 opposite a sole or bottom 30 and a back or rear or back end 34 opposite a club face or face or strike face or strike plate 38. The club head further includes a perimeter or skirt or trailing edge 24 located at a junction or intersection between the crown 26 and the sole 30 extending

from near the heel 22 to near the toe 18. The club head 100 further includes an adjustable weighting system. At least a portion of the adjustable weighting system can be positioned on the sole 30, the skirt 24, the heel 22, the toe 18, or any combination of the described locations.

[0016] The golf club head 100 also includes a hosel 42 having a hosel axis 46 (shown in FIG. 2) that extends through the center of the hosel 42. The hosel 42 is configured to receive a golf club shaft (not shown) that carries a grip (not shown). A golfer grasps the grip (not shown) while swinging the golf club.

[0017] In many embodiments, the golf club head 100 comprises a driver-type club head. In these embodiments, the loft angle of the club head 100 can be less than approximately 16 degrees, less than approximately 15 degrees, less than approximately 14 degrees, less than approximately 13 degrees, less than approximately 12 degrees, less than approximately 11 degrees, or less than approximately 10 degrees. Further, in these embodiments, the volume of the club head 100 can be greater than approximately 400 cc, greater than approximately 425 cc, greater than approximately 450 cc, greater than approximately 475 cc, greater than approximately 500 cc, greater than approximately 525 cc, greater than approximately 550 cc, greater than approximately 575 cc, greater than approximately 600 cc, greater than approximately 625 cc, greater than approximately 650 cc, greater than approximately 675 cc, or greater than approximately 700 cc. In some embodiments, the volume of the club head can be approximately 400cc - 600cc, approximately 500cc - 600cc, approximately 500cc - 650cc, approximately 550cc - 700cc, approximately 600cc - 650cc, approximately 600cc - 700cc, or approximately 600cc - 800cc.

[0018] In some embodiments, the club head can comprise a fairway wood-type club head. In these embodiments, the loft angle of the club head 100 can be less than approximately 35 degrees, less than approximately 34 degrees, less than approximately 33 degrees, less than approximately 32 degrees, less than approximately 31 degrees, or less than approximately 30 degrees. Further, in these embodiments, the loft angle of the club head 100 can be greater than approximately 12 degrees, greater than approximately 13 degrees, greater than approximately 14 degrees, greater than approximately 15 degrees, greater than approximately 16 degrees, greater than approximately 17 degrees, greater than approximately 18 degrees, greater than approximately 19 degrees, or greater than approximately 20 degrees. Further, in these embodiments, the volume of the club head 100 can be less than approximately 400 cc, less than approximately 375 cc, less than approximately 350 cc, less than approximately 325 cc, less than approximately 300 cc, less than approximately 275 cc, less than approximately 250 cc, less than approximately 225 cc, or less than approximately 200 cc. For example, the volume of the club head can be approximately 300cc - 400cc, approximately 325cc - 400cc, approximately 350cc - 400cc, approximately 250cc - 400cc, approximately 250 - 350 cc, or approximately 275-375 cc.

[0019] In some embodiments, the club head can comprise a hybrid type club head. In these embodiments, the loft angle of the club head 100 can be less than approximately 40 degrees, less than approximately 39 degrees, less than approximately 38 degrees, less than approximately 37 degrees, less than approximately 36 degrees, less than approximately 35 degrees, less than approximately 34 degrees, less than approximately 33 degrees, less than approximately 32 degrees, less than approximately 31 degrees, or less than approximately 30 degrees. Further, in these embodiments, the loft angle of the club head 100 can be greater than approximately 16 degrees, greater than approximately 17 degrees, greater than approximately 18 degrees, greater than approximately 19 degrees, greater than approximately 20 degrees, greater than approximately 21 degrees, greater than approximately 22 degrees, greater than approximately 23 degrees, greater than approximately 24 degrees, or greater than approximately 25 degrees. Further, in these embodiments, the volume of the club head 100 can be less than approximately 200 cc, less than approximately 175 cc, less than approximately 150 cc, less than approximately 125 cc, less than approximately 100 cc, or less than approximately 75 cc. For example, the volume of the club head can be approximately 100cc - 150cc, approximately 75cc - 150cc, approximately 100cc - 125cc, or approximately 75cc - 125cc. In other embodiments, the golf club head 100 can comprise any type of golf club head.

[0020] A plurality of grooves or primary grooves 40 (shown in FIG. 2) are positioned on the club face 38. The strike face 38 of the club head 100 defines a geometric center 140. In some embodiments, the geometric center 140 can be located at the geometric centerpoint of a strike face perimeter, and at a midpoint of face height. In the same or other examples, the geometric center 140 also can be centered with respect to engineered impact zone, which can be defined by a region of grooves on the strike face. As another approach, the geometric center 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). For example, the geometric center 140 of the strike face 38 can be determined in accordance with Section 6.1 of the USGA's Procedure for Measuring the Flexibility of a Golf Clubhead (USGA-TPX3004, Rev. 1.0.0, May 1, 2008) (available at http://www.usga.org/equipment/testing/protocols/ Procedure-For-Measuring-The-Flexibility-Of-A-Golf-Club-Head/) (the "Flexibility Procedure").

[0021] The club head 100 defines a loft plane 10102 tangent to the geometric center 140 of the strike face 38. The club head 100 further defines a coordinate system having an origin located at the geometric center 140 of the strike face 38. The coordinate system has an x' axis 10106, a y' axis 10104, and a z' axis 10108. The x' axis 10106 extends through the geometric center 140 of the strike face 38 in a direction from the heel 22 to the toe 18 of the club head 100. The y' axis 10104 extends through the geometric center 140 of the strike face 38 in a direction from the crown 26 to the sole

30 of the club head 100 and perpendicular to the x' axis 10106. The z' axis 10108 extends through the geometric center 140 of the strike face 38 in a direction from the face 38 to the back end 34 of the club head 100 and is perpendicular to the x' axis 10106 and the y' axis 10104.

[0022] The coordinate system defines an x'y' plane 10124 extending through the x' axis 10106 and the y' axis 10104; an x'z' plane 10126 extending through the x' axis 10106 and the z' axis 10108; and a y'z' plane 10128 extending through the y' axis 10104 and the z' axis 10108, wherein the x'y' plane 10124, the x'z' plane 10126, and the y'z' plane 10128 are all perpendicular to one another and intersect at the origin of the coordinate system located at the geometric center 140 of the strike face 38. The x'y' plane 10124 extends parallel to the hosel axis 46 and is positioned at an angle corresponding to the loft angle of the club head 100 from the loft plane 10102. Further, the x' axis 10106 is positioned at a 60 degree angle to the hosel axis 46 when viewed from a direction perpendicular to the x'y' plane 10124.

[0023] In these or other embodiments, the club head 100 can be viewed from a front view (FIG. 2) when the strike face 38 is viewed from a direction perpendicular to the x'y' plane 10124. Further, in these or other embodiments, the club head 100 can be viewed from a side view or side cross-sectional view (FIG. 4) when the heel 22 is viewed from a direction perpendicular to the y'z' plane 10128.

[0024] Referring to FIGS. 2 and 3, the golf club head 100 further includes a center of gravity or CG 50 (shown in FIGs. 3, 4, and 5) that defines an origin of a coordinate system including an x-axis 54, a y-axis 58, and a z-axis 62. The y-axis 58 (shown in FIGs. 2 and 164) extends through the club head 100 center of gravity 50 from the crown or top 26 to the sole or bottom 30, is parallel to the hosel axis 46 when viewed from the side view, and is positioned at a 30 degree angle from the hosel axis 46 when viewed from a front view (FIGs. 2). The x-axis 54 (shown in FIG. 3 and 5) extends through the club head center of gravity 50 from the toe or toe end 18 to the heel or heel end 22, perpendicular to y-axis 58 when viewed from a front view and parallel to the x'y' plane 10124. The z-axis 62 (shown in FIGs. 3-5) extends through the center of gravity 50 of the club head 100 from the club face 38 to the back end 34 and perpendicular to the x-axis 54 and the y-axis 58. The x-axis 54 extends through the head CG 50 from the toe or toe end 18 to the heel or heel end 22 and parallel to the x' axis 10106. The y-axis 58 extends through the head CG 50 from the crown or top 26 to the sole or bottom 30 parallel to the y' axis 10104. The z-axis 62 extends through the head CG 50 from the club face 38 to the back end 34 and parallel to the z' axis 10108.

[0025] As shown in FIG. 4, the club head 100 further comprises a head depth plane 10120 and a head depth axis 10122, wherein the head depth plane 10120 extends through the geometric center 140 of the strike face 38, perpendicular to the loft plane 10102, in a direction from the heel 22 to the toe 18 of the club head 100, and the head depth axis 10122 extends through the geometric center 140 of the strike face 38, perpendicular to the loft plane 10102. In many embodiments, the head CG 50 is located at a head CG depth 10130 from the x'y' plane 10124, measured in a direction perpendicular to the x'y' plane 10124. In some embodiments, the head CG 50 can be located at a head CG depth 10130 from the loft plane 10102, measured in a direction perpendicular to the loft plane 10102. The head CG 50 is further located at a head CG height 10132 from the head depth plane 10120, measured in a direction perpendicular to the head depth plane 10120. Further, the head CG height 10132 is measured as the offset distance of the head CG 50 from the head depth plane 10120 in a direction perpendicular to the head depth plane 10120 toward the crown 26 or toward the sole 30.

[0026] For additional guidance in describing the innovation herein, the x-axis 54 and the z-axis 62 are arranged to coincide with numbers on an analog clock in FIG. 3. The z-axis 62 extends between 12 o'clock ("12" through the club face 38) and 6 o'clock ("6" through the back 34), and the x-axis 54 extends between 3 o'clock ("3" through the toe end 18) and 9 o'clock ("9" through the heel end 22).

[0027] Various golf club head parameters are important in achieving desired performance characteristics, such as club head moment of inertia, club head center of gravity position, and club head center of gravity adjustability. High club head moment of inertia results in increased club head forgiveness for off-center hits. A club head center of gravity positioned low and back (i.e. toward the sole and rear of the club head) beneficially increases moment of inertia, reduces backspin, and increases launch angle of a golf ball on impact. Club head center of gravity adjustability allows for desired trajectory tuning of a club head by an end user. Each of these parameters are important in golf club design to achieve desired or optimal performance characteristics. However, including all of these parameters on a golf club head presents a design challenge, as many current center of gravity adjustability mechanisms (1) lower club head moment of inertia and/or (2) shift the club head center of gravity up and toward the front of the club head due to internal and/or bulky weight structures, and/or non-optimal weight structure positioning.

[0028] The embodiments of the golf club heads described below include adjustable weighting systems while maintaining or preventing a significant reduction in club head moment of inertia, and low and back club head center of gravity positioning. For example, many embodiments below describe low profile adjustable weighting systems and/or optimally positioned adjustable weighting systems to maintain a high club head moment of inertia and low and back club head center of gravity position, similar to a club head devoid of an adjustable weighting system, while providing user adjustability of ball flight and/or trajectory. Maintaining a high club head moment of inertia about the club head CG results in increased forgiveness for off-center hits, and maintaining a high club head moment if inertia about the hosel axis results in increased

rotational stability during a swing. Further, maintaining a low and back club head center of gravity beneficially increases club head moment of inertia about the head CG and reduces backspin.

[0029] The club head 100 comprises a moment of inertia about the x-axis I_{xx} (i.e. crown-to-sole moment of inertia), a moment of inertia about the y-axis I_{yy} (i.e. heel-to-toe moment of inertia), and a moment of inertia about the hosel axis 46 I_{hh}.

[0030] The club heads comprising the adjustable weighting systems described herein can have a moment of inertia about the x-axis I_{xx} greater than 3100 g· cm^2, greater than 3200 g· cm^2, greater than 3300 g· cm^2, greater than 3400 g· cm^2, greater than 3500 g· cm^2, greater than 3600 g· cm^2, greater than 3700 g· cm^2, greater than 3800 g· cm^2, greater than 3900 g· cm^2, greater than 4000 g· cm^2, greater than 4100 g- cm^2, greater than 4200 g· cm^2, greater than 4300 g· cm^2, greater than 4400 g· cm^2, or greater than 4500 g· cm^2. In some embodiments, the club heads comprising the adjustable weighting systems described herein have a moment of inertia about the x-axis I_{xx} between 3100 and 4000 g· cm^2, between 3100 and 3800 g· cm^2, between 3200 and 4000 g· cm^2, between 3200 and 4000 g- cm^2, between 3300 and 4000 g· cm^2, between 3400 and 4000 g· cm^2, or between 3500 and 4000 g· cm^2.

[0031] Further, the club heads comprising the adjustable weighting systems described herein can have a moment of inertia about the y-axis I_{yy} greater than 4700 g· cm^2, greater than 4800 g· cm^2, greater than 4900 g· cm^2, greater than 5000 g· cm^2, greater than 5100 g· cm^2, greater than 5200 g· cm^2, greater than 5300 g· cm^2, greater than 5400 g· cm^2, greater than 5500 g· cm^2, greater than 5600 g· cm^2, greater than 5700 g· cm^2, greater than 5800 g· cm^2, greater than 5900 g· cm^2, or greater than 6000 g· cm^2. In some embodiments, the club heads comprising the adjustable weighting systems described herein have a moment of inertia about the y-axis I_{yy} between 4800 and 6000 g· cm^2, between 4900 and 6000 g· cm^2, between 5000 and 6000 g· cm^2, between 5100 and 6000 g· cm^2, between 5200 and 6000 g· cm^2, between 5300 and 6000 g· cm^2, or between 5400 and 6000 g· cm^2.

[0032] Further still, the club heads comprising the adjustable weighting systems described herein can have a moment of inertia about the hosel-axis I_{hh} greater than 7500 g· cm^2, greater than 8000 g· cm^2, greater than 8250 g· cm^2, greater than 8500 g· cm^2, greater than 8750 g· cm^2, greater than 9000 g· cm^2, greater than 9050 g· cm^2, or greater than 10000 g· cm^2. In some embodiments, the club heads comprising the adjustable weighting systems described herein have a moment of inertia about the hosel-axis I_{hh} between 7500 and 10000 g· cm^2, between 8000 and 10000 g· cm^2, between 8500 and 10000 g· cm^2, or between 9000 and 10000 g· cm^2.

[0033] Referring to Relation 1 below, many embodiments of the club heads with adjustable weighting systems comprise a combined moment of inertia about the head CG (MOI_{CG}) defined as the sum of the moment of inertia about the x-axis and the moment of inertia about the y-axis.

$$MOI_{CG} = I_{xx} + I_{yy} \qquad \text{Relation 1}$$

[0034] The combined moment of inertia about the head center of gravity MOI_{CG} can be greater than 7600 g· cm^2, greater than 7700 g· cm^2, greater than 7800 g· cm^2, greater than 7900 g· cm^2, greater than 8000 g· cm^2, greater than 8100 g- cm^2, greater than 8200 g· cm^2, greater than 8300 g· cm^2, greater than 8400 g· cm^2, greater than 8500 g· cm^2, greater than 8600 g· cm^2, greater than 8700 g· cm^2, greater than 8800 g· cm^2, greater than 8900 g· cm^2, greater than 9000 g· cm^2, greater than 9100 g· cm^2, greater than 9200 g· cm^2, or greater than 9300 g· cm^2. For example, the combined moment of inertia about the club head head center of gravity MOI_{CG} can be between 7700 and 9500 g· cm^2, between 7800 and 9500 g· cm^2, between 7900 and 9500 g· cm^2, between 8000 and 9500 g· cm^2, between 8100 and 9500 g· cm^2, between 8200 and 9500 g· cm^2, or between 8300 and 9500 g· cm^2.

[0035] Referring to Relation 2 below, many embodiments of the club heads with adjustable weighting systems comprise a combined moment of inertia about the head CG and hosel (MOI_{CG-H}), defined as the sum of the moment of inertia about the x-axis, the moment of inertia about the y-axis, and the moment of inertia about the hosel axis.

$$MOI_{CG-H} = I_{xx} + I_{yy} + I_{hh} \qquad \text{Relation 2}$$

[0036] The combined moment of inertia about the head CG and hosel MOI_{CG-H} can be greater than 14800 g· cm^2, greater than 14900 g· cm^2, greater than 15000 g· cm^2, greater than 15100 g· cm^2, greater than 15200 g· cm^2, greater than 15300 g· cm^2, greater than 15400 g· cm^2, greater than 15500 g· cm^2, greater than 15600 g· cm^2, greater than 15700 g· cm^2, greater than 15800 g· cm^2, greater than 15900 g· cm^2, greater than 16000 g· cm^2, greater than 16200 g· cm^2, greater than 16400 g· cm^2, greater than 16600 g· cm^2, greater than 16800 g· cm^2, greater than 17000 g· cm^2, greater than 17200 g· cm^2, greater than 17400 g· cm^2, greater than 17600 g· cm^2, greater than 17800 g· cm^2, greater than 18000 g· cm^2, greater than 18400 g· cm^2, greater than 18800 g· cm^2, greater than 19000 g· cm^2, greater than 19200 g· cm^2, or greater than 19400 g· cm^2. For example, the combined moment of inertia about the head CG and hosel MOI_{CG-H} can be between 15000 and 19500 g· cm^2, between 15000 and 19000 g· cm^2, between 15000 and 18000 g· cm^2, between 16000 and 19500 g· cm^2, between 16000 and 19000 g· cm^2, or between 16000 and 18000 g- cm^2. In

these embodiments, the combined moment of inertia about the head CG and hosel MOICG-H can be greater than 15000 g· cm^2 for club heads with adjustable weighting systems having a volume between 425 and 450 cubic centimeters (cc), and the combined moment of inertia about the head CG and hosel MOI_{CG-H} can be greater than 17000 g· cm^2 for club heads with adjustable weighting systems having a volume between 450 and 500 cubic centimeters (cc).

[0037] The club heads comprising the adjustable weighting systems described herein can have a head CG depth 10130 greater than 1.6 inches, greater than 1.65 inches, greater than 1.7 inches, greater than 1.75 inches, greater than 1.8 inches, greater than 1.85 inches, greater than 1.9 inches, greater than 1.95 inches, or greater than 2.0 inches. For example, the club head having the adjustable weighting systems can have a head CG depth 10130 between 1.61 and 2.0 inches, between 1.65 and 2.0 inches, between 1.7 and 2.0 inches, between 1.8 and 2.0 inches, between 1.61 and 3.0 inches, between 1.65 and 3.0 inches, between 1.7 and 3.0 inches, between 1.8 and 3.0 inches, between 1.9 and 3.0 inches, or between 2.0 and 3.0 inches.

[0038] Further, the club heads comprising the adjustable weighting systems described herein can have a head CG height 10132 located below the head depth plane 10120 (i.e. located between the head depth plane 10120 and the sole 30 of the club head). Further, the club heads comprising the adjustable weighting systems described herein can have a head CG height 10132 located within 0.10 inch, within 0.09 inch, within 0.08 inch, within 0.07 inch, within 0.06 inch, within 0.05 inch, or within 0.04 inch of the head depth plane 10120 toward the crown 26 or toward the sole 30 of the club head.

[0039] In many embodiments, the adjustable weight system includes one or more weights that are repositionable to a plurality of discrete portions or attachment locations of the club head to adjust the head CG position. Adjusting the head CG position using the adjustable weight systems described herein can affect ball trajectory and/or spin characteristics of the club head at impact, while maintaining a high club head moment of inertia.

[0040] In many embodiments, the adjustable weighting system can comprise two or more discrete attachment locations for receiving the one or more weights. In many embodiments, the adjustable weight system includes two, three, four, or five discrete attachment locations. For example, in embodiments of the adjustable weighting system having two discrete attachment locations, the attachment locations can include a first attachment location positioned toward the back end 34 and the toe 18 and a second attachment location positioned toward the back end 24 and the heel 22 of the club head. In these embodiments, a distance between the first attachment location and the second attachment location can be greater than 0.8 inch, greater than 0.9 inch, greater than 1.0 inch, greater than 1.1 inches, greater than 1.2 inches, or greater than 1.3 inches. For example, the distance between the first attachment location and the second attachment location can be between 0.8-1.3 inches, between 0.9-1.3 inches, between 1.0-1.3 inches, or between 1.1-1.3 inches.

[0041] For further example, in embodiments of the adjustable weighting system having three discrete attachment locations (e.g. FIG. 5), the attachment locations can include a first attachment location A positioned toward the back end 34 and the toe 18, a second attachment location C positioned toward the back end 34 and the heel 22, and a third attachment location B. In these embodiments, the third attachment location B can be positioned centrally and toward the back end 34 of the club head, generally aligned with or adjacent to the head depth axis 10122, and/or between the first and second attachment locations A, C. In these embodiments, a distance between adjacent attachment locations (e.g. the distance between the first attachment A location and the third attachment location B, or the distance between the second attachment location C and the third attachment location B) can be greater than 0.5 inch, greater than 0.6 inch, greater than 0.7 inch, greater than 0.8 inch, greater than 0.9 inch, or greater than 1.0 inch. For example, the distance between adjacent attachment locations (e.g. the distance between the first attachment location A and the third attachment location B, or the distance between the second attachment location C and the third attachment location B) can be between 0.5-1.0 inch, between 0.6-1.0 inch, between 0.7-1.0 inch, or between 0.8-1.0 inch.

[0042] In other embodiments, the adjustable weighting system can include any number of discrete attachment locations greater than one, such as, two, three, four, five, six, seven, eight, or more discrete attachment locations. In embodiments where the adjustable weighting system includes four discrete attachment locations, a distance between adjacent attachment locations can be greater than 0.4 inch, greater than 0.5 inch, greater than 0.6 inch, greater than 0.7 inch, greater than 0.8 inch, or greater than 0.9 inch. For example, in embodiments including four discrete attachment locations, the distance between adjacent attachment locations can be between 0.4-0.9 inch, between 0.5-0.9 inch, between 0.6-0.9 inch, or between 0.7-0.9 inch. In embodiments where the adjustable weighting system includes five discrete attachment locations, a distance between adjacent attachment locations can be greater than 0.3 inch, greater than 0.4 inch, greater than 0.5 inch, greater than 0.6 inch, greater than 0.7 inch, or greater than 0.8 inch. For example, in embodiments including four discrete attachment locations, the distance between adjacent attachment locations can be between 0.3-0.8 inch, between 0.4-0.8 inch, between 0.5-0.8 inch, or between 0.6-0.8 inch.

[0043] The plurality of discrete attachment locations of the club heads having adjustable weighting systems described herein can comprise various features including protruding bodies, apertures, recesses or ports capable of receiving a fastener, notches or tabs or cutout regions, ribs or grooves, pegs, hooks, magnets, programmable magnets, or any other suitable attachment means. In many embodiments having apertures or recesses or ports capable of receiving a fastener, the fastener can comprise the same material as the body, or a material having a lighter density than the body, such that

the fastener does not contribute to the adjustable weighting properties of the club head. Further, in some embodiments, the apertures or recesses or ports can be threaded to receive a threaded fastener. In many embodiments, the adjustable weighting system is devoid of multiple and/or deep ports or recesses that require significant internal structure required to secure one or more weights within the ports or recesses.

[0044] The adjustable weighting system further comprises one or more weights positionable at the plurality of discrete attachment locations. The one or more weights can have a height 10152 measured in a crown to sole direction, parallel to the y-axis 58, when the weight is coupled to one or more of the attachment locations, a width 10154 measured in a heel to toe direction, parallel to the x-axis 54, when the weight is coupled to one or more of the attachment locations, and a depth 10156 measured in a front to back direction, parallel to the z-axis 62, when the weight is coupled to one or more of the attachment locations. In many embodiments, the height 10152 can be less than 0.5 inch, less than 0.4 inch, less than 0.3 inch, less than 0.25 inch, less than 0.2 inch, less than 0.18 inch, less than 0.16 inch, less than 0.14 inch, less than 0.12 inch, or less than 0.10 inch. In many embodiments, the width 10154 can be 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, less than 0.8 inch, less than 0.7 inch, less than 0.6 inch, less than 0.5 inch, or less than 0.4 inch. In many embodiments, the depth 10156 can be less than 1.0 inch, less than 0.9 inch, less than 0.8 inch, less than 0.7 inch, less than 0.6 inch, less than 0.5 inch, less than 0.4 inch, less than 0.3 inch, less than 0.2 inch, or less than 0.1 inch. In many embodiments, one or more of the weights can have a surface area in contact with the club head body when the weight is coupled to any of the attachment. In many embodiments, the surface area of the weight in contact with the club head can be less than 0.75 $inch^2$, less than 0.7 $inch^2$, less than 0.65 $inch^2$, less than 0.6 $inch^2$, less than 0.55 $inch^2$, less than 0.5 $inch^2$, less than 0.45 $inch^2$, less than 0.4 $inch^2$, less than 0.35 $inch^2$, less than 0.3 $inch^2$, or less than 0.25 $inch^2$.

[0045] In many embodiments, the adjustable weighting system includes a first weight W positionable in the plurality of discrete attachment locations on the club head. In some embodiments, the adjustable weight system can further comprise additional weights, such as a second weight, a third weight, a fourth weight, and a fifth weight positionable in the plurality of discrete attachment locations on the club head. In these embodiments, each weight of the plurality of weights can be positioned in a different discrete attachment location on the club head. Further, in these embodiments, each weight of the plurality of weights can be removed and replaced or repositioned in different discrete attachment locations on the club head. While the embodiments of the adjustable weight system described herein include up to five weights, other embodiments can include adjustable weighting systems having any number of weights.

[0046] In many embodiments, the first weight is heavier than the remaining weights (e.g. the second weight, the third weight, the fourth weight, and/or the fifth weight). The first weight can comprises a mass greater than 10 grams, greater than 12 grams, greater than 14 grams, greater than 16 grams, greater than 18 grams, greater than 20 grams, greater than 22 grams, greater than 24 grams, greater than 26 grams, greater than 28 grams, or greater than 30 grams. For example, first weight can comprises a mass between 6 and 50 grams, between 10 and 50 grams, between 15 and 50 grams, between 20 and 50 grams, between 15 and 40 grams, between 20 and 40 grams, between 25 and 35 grams, between 10 and 25 grams, between 15 and 25 grams, between 10 and 20 grams, or between 15 and 20 grams. The remaining weights (e.g. the second weight, the third weight, the fourth weight, and/or the fifth weight) can comprise a mass less than 20 grams, less than 18 grams, less than 16 grams, less than 14 grams, less than 12 grams, less than 10 grams, less than 8 grams, less than 6 grams, less than 4 grams, or less than 2 grams. For example, the remaining weights can comprise a mass between 0.10 and 15 grams, between 0.25 and 10 grams, between 0.5 and 7 grams, or between 1 and 10 grams.

[0047] The first weight can be positioned in any of the discrete attachment locations. In embodiments having an adjustable weighting system comprising two discrete attachment locations, the first weight can be positioned in the first attachment location positioned near the toe 18 or the second attachment location positioned near the heel 22. In these embodiments, shifting the first weight from the first attachment location to the second attachment location shifts the head CG toward the heel 22, and shifting the first weight from the second attachment location to the first attachment location shifts the head CG toward the toe 18. In these embodiments, the remaining attachment location can be devoid of a weight, or the remaining attachment location can comprise an additional weight (e.g. the second weight).

[0048] In embodiments having an adjustable weighting system comprising three discrete attachment locations, the first weight W can be positioned in the third attachment location B positioned centrally, thereby generating a neutral head CG position. The first weight can be shifted from the third attachment location B to the first attachment location A, positioned toward the toe 18, thereby shifting the head CG 50 toward the toe 18 by a distance. The first weight W can be shifted from the third attachment location B to the second attachment location C, positioned toward the heel 22, thereby shifting the head CG 50 toward the heel 22 by a distance. In these embodiments, the remaining locations can be devoid of weights, or the remaining locations can comprise additional weights (e.g. the second weight and/or the third weight).

[0049] Shifting the first weight W from an attachment location nearest the toe 18 to an attachment location nearest the heel 22 can shift the head CG 50 by a distance of at least 0.10 inch, at least 0.15 inch, at least 0.20 inch, at least 0.25 inch, or at least 0.30 inch, in a direction extending parallel to the x-axis 54. For example, in many embodiments,

shifting the first weight W from an attachment location nearest the toe 18 to an attachment location nearest the heel 22 can shift the head CG 50 by a distance between 0.10 and 0.30 inch, between 0.15 and 0.30 inch, between 0.20 and 0.30 inch, between 0.15 and 0.25 inch, or between 0.20 and 0.25 inch.

[0050] In these or other embodiments, shifting the head CG 50 toward the toe 18 can generate a fade or correct for a hook. Conversely, shifting the head CG 50 toward the heel 22 can generate a draw or correct for a slice. In the embodiments of the adjustable weighting system described below, shifting head CG 50 in a direction extending parallel to the x-axis 54 between 0.10 and 0.30 inch can result in a change in shot bend of 4.6 to 13.9 yards.

[0051] Other embodiments can include one or more discrete attachment locations positioned toward the strike face 38 of the club head 100. In these embodiments, shifting one or more weights to an attachment location(s) near the back end 34 of the club head 100 from an attachment location near the strike face 38 can increase the club head moment of inertia about the head CG MOI_{CG} and increase dynamic loft or launch angle of a golf ball. Conversely, shifting one or more weights to an attachment location(s) near the strike face 38 of the club head 100 from an attachment location near the back end 34 can reduce dynamic loft or launch angle of a golf ball.

[0052] The embodiments of the club heads having adjustable weighting systems described herein maximize head CG depth 10130 and club head moment of inertia (or minimize the reduction in head CG depth 10130 and club head moment of inertia typically associated with introducing adjustability compared to a non-adjustable club head). In many embodiments, the maximized head CG depth and club head moment of inertia are achieved with first adjustable weight having a relatively low mass, thereby increasing the efficiency of the design to maintain club head performance characteristics (e.g. forgiveness, low back spin, high launch), while enabling user adjustability of ball spin and/or trajectory.

[0053] Referring to Relation 3 below, the club heads having adjustable weighting systems comprise a depth to mass ratio of the head CG depth 10130 to the mass of the first weight W_m. In many embodiments, the depth to mass ratio of the club head can be greater than 0.060 inch/gram, greater than 0.070 inch/gram, greater than 0.080 inch/gram, greater than 0.090 inch/gram, greater than 0.100 inch/gram, greater than 0.110 inch/gram, greater than 0.120 inch/gram, or greater than 0.130 inch/gram. In some embodiments, the depth to mass ratio can be between 0.070 and 0.13 inch/gram, between 0.080 and 0.13 inch/gram, between 0.090 and 0.13 inch/gram, between 0.070 and 0.11 inch/gram, between 0.080 and 0.11 inch/gram, or between 0.090 and 0.11 inch/gram. In these embodiments, the mass of the first weight can be less than 25 grams, less than 24 grams, less than 23 grams, less than 22 grams, less than 20 grams, less than 19 grams, less than 18 grams, less than 17 grams, less than 16 grams, or less than 15 grams. In some embodiments, the mass of the first weight can be between 10 and 20 grams, between 12 and 20 grams, between 14 and 20 grams, between 16 and 20 grams, between 10 and 18 grams, between 12 and 18 grams, or between 14 and 18 grams.

$$Depth\ to\ Mass\ Ratio = Head\ CG\ Depth / W_m \qquad \text{Relation 3}$$

[0054] Referring to Relation 4 below, the club heads having adjustable weighting systems can comprise a first inertia to mass ratio defined as the combined moment of inertia about the head CG MOI_{CG} to the mass of the first weight W_m. In many embodiments, the first inertia to mass ratio can be greater than 400 cm^2, greater than 410 cm^2, greater than 420 cm^2, greater than 430 cm^2, greater than 440 cm^2, greater than 450 cm^2, greater than 460 cm^2, greater than 470 cm^2, greater than 480 cm^2, greater than 490 cm^2, greater than 500 cm^2, greater than 510 cm^2, greater than 520 cm^2, greater than 530 cm^2, greater than 540 cm^2, or greater than 550 cm^2. In some embodiments, the first inertia to mass ratio can be between 400 and 550 cm^2, between 410 and 550 cm^2, between 420 and 550 cm^2, between 430 and 550 cm^2, between 440 and 550 cm^2, between 450 and 550 cm^2, between 400 and 500 cm^2, between 410 and 500 cm^2, between 420 and 500 cm^2, between 430 and 500 cm^2, between 440 and 500 cm^2, or between 450 and 500 cm^2. In these embodiments, the mass of the first weight can be less than 25 grams, less than 24 grams, less than 23 grams, less than 22 grams, less than 20 grams, less than 19 grams, less than 18 grams, less than 17 grams, less than 16 grams, or less than 15 grams. In some embodiments, the mass of the first weight can be between 10 and 20 grams, between 12 and 20 grams, between 14 and 20 grams, between 16 and 20 grams, between 10 and 18 grams, between 12 and 18 grams, or between 14 and 18 grams.

$$First\ Inertia\ to\ Mass\ Ratio = MOICG / W_m \qquad \text{Relation 4}$$

[0055] The embodiments of the club heads having adjustable weighting systems described herein maximize the total shift in head CG as achievable by adjusting the one or more weights to the plurality of discrete attachment locations. In many embodiments, the maximized total shift in head CG is achieved with first adjustable weight having a relatively low mass, thereby increasing the efficiency of the design to maintain club head performance characteristics (e.g. forgiveness, low back spin, high launch) while enabling user adjustability of ball spin and/or trajectory.

[0056] Referring to Relation 5 below, the club heads having adjustable weighting systems comprise a head CG to

mass ratio defined as the total shift in head CG or maximum head CG shift to the mass of the first weight. In many embodiments, the head CG to mass ratio can be greater than 0.008 inch/gram, greater than 0.009 inch/gram, greater than 0.010 inch/gram, greater than 0.011 inch/gram, greater than 0.012 inch/gram, greater than 0.013 inch/gram, greater than 0.014 inch/gram, or greater than 0.015 inch/gram. In some embodiments, the head CG to mass ratio can be between 0.008 and 0.015 inch/gram, between 0.009 and 0.015 inch/gram, between 0.010 and 0.015 inch/gram, between 0.008 and 0.013 inch/gram, between 0.009 and 0.013 inch/gram, or between 0.010 and 0.013 inch/gram. In these embodiments, the mass of the first weight can be less than 25 grams, less than 24 grams, less than 23 grams, less than 22 grams, less than 20 grams, less than 19 grams, less than 18 grams, less than 17 grams, less than 16 grams, or less than 15 grams. In some embodiments, the mass of the first weight can be between 10 and 20 grams, between 12 and 20 grams, between 14 and 20 grams, between 16 and 20 grams, between 10 and 18 grams, between 12 and 18 grams, or between 14 and 18 grams.

$$\text{Head CG to Mass Ratio} = \text{Maximum Head CG Shift} / W_m \qquad \text{Relation 5}$$

[0057] The one or more weights of the adjustable weighting system comprise a weight CG 10134. In many embodiments, the weight CG is positioned near a rear perimeter or skirt 10136 of the club head when viewed from a top or bottom view (FIG. 5), and at a maximized distance 10138 from the geometric center 140 of the strike face 38. Positioning the weight CG 10134 near the rear perimeter 10136 of the club head 100 or away from the strike face 38 can increase perimeter weighting and club head moment of inertia, thereby resulting in increased club head forgiveness for off center hits, compared to adjustable weights positioned closer to the strike face. Further, positioning the weight CG 10134 near the rear perimeter 10136 or away from the strike face 38 can result in a head CG position that is lower and farther back, thereby increasing club head moment of inertia and reducing back spin, back compared to adjustable weights positioned closer to the strike face.

[0058] In these embodiments, the weight CG 10134 of one or more of the weights is positioned at a distance 10142 from the rear perimeter 10136 of the club head 100 when the weight is positioned at one or more of the plurality of discrete attachment locations on the club head 100. The distance 10142 can be measured as the projected distance from the weight CG to the perimeter 10136 when the club head is viewed from a bottom view, perpendicular to the x'z' plane 10126, when the weight is positioned at one or more of the plurality of discrete attachment locations on the club head 100. Further, the distance 10142 can be measured in a direction parallel to the x'z' plane 10126, when the weight is positioned at one or more of the plurality of discrete attachment locations on the club head 100. For example, the weight CG 10134 of one or more of the weights can be positioned within 0.7 inch, within 0.65 inch, within 0.6 inch, within 0.55 inch, within 0.5 inch, within 0.45 inch, within 0.4 inch, within 0.35 inch, within 0.3 inch, within 0.25 inch, or within 0.2 inch of the rear perimeter 10136 of the club head 100. For further example, the weight CG 10134 of one or more of the weights can be positioned between 0.10 and 0.50 inch, between 0.25 and 0.5 inch, between 0.10 and 0.25 inch, between 0.10 and 0.35 inch, or between 0.10 and 0.45 inch from the rear perimeter 10136 of the club head 100.

[0059] Further, in these embodiments, the weight CG 10134 of one or more of the weights is positioned at a distance 10138 from the geometric center 140 of the strike face 38 of the club head 100 when the weight is positioned at one or more of the plurality of discrete attachment locations on the club head 100. For example, the weight CG 10134 of one or more of the weights can be positioned at a distance 10138 greater than 2.0 inches, greater than 2.25 inches, greater than 2.5 inches, greater than 2.75 inches, greater than 3.0 inches, greater than 3.25 inches, greater than 3.5 inches, or greater than 3.75 inches from the geometric center of the strike face. For further example, the weight CG 10134 of one or more of the weights can be positioned at a distance 10138 between 2.0 and 3.5 inches, between 2.5 and 3.5 inches, between 2.0 and 3.0 inches, between 2.5 and 3.0 inches, between 2.5 and 4.0 inches, between 3.0 and 3.75 inches, between 3.0 and 4.0 inches, between 3.2 and 4.0 inches, or between 3.5 and 4.0 inches from the geometric center 140 of the strike face 38. Positioning the weight CG 10134 away from the geometric center 140 of the strike face 38 can increase perimeter weighting and club head moment of inertia, thereby resulting in increased club head forgiveness for off center hits, compared to adjustable weights positioned closer to the strike face. Further, positioning the weight CG 10134 away from the geometric center 140 of the strike face 38 can result in a head CG position that is lower and farther, thereby increasing club head moment of inertia and reducing back spin, back compared to adjustable weights positioned closer to the strike face.

[0060] In many embodiments, the weight CG 10134 protrudes from an external contour or outer surface 10146 of the sole 30, is positioned flush with the external contour 10146 of the sole 30, and/or is positioned minimally inset relative to the external contour 10146 of the sole 30. Positioning the weight CG 10134 minimally inset, flush with, or external relative to the external contour 10146 of the sole 30 requires less structural support material to receive the one or more weights, thereby maintaining a low profile adjustable weighting system. Accordingly, positioning the weight CG 10134 minimally inset, flush with, or external relative to the external contour 10146 of the sole 30 can increase perimeter weighting and club head moment of inertia, thereby resulting in increased club head forgiveness for off center hits,

compared to internal adjustable weights or adjustable weights recessed into the club head. Further, positioning the weight CG 10134 minimally inset, flush with, or external relative to the external contour 10146 of the sole 30 can result in a head CG position that is lower and farther back, thereby increasing club head moment of inertia and reducing back spin, back compared to internal adjustable weights or adjustable weights recessed into the club head.

[0061] In these embodiments, the weight CG 10134 of one or more of the weights is positioned at a distance 10148 from the external contour 10146 of the sole 30 when the weight is positioned at one or more of the plurality of discrete attachment locations on the club head 100, wherein the distance 10148 is measured in a direction parallel to the y-axis 58. For example, the weight CG 10134 of one or more of the weights can protrude from the external contour 10146 of the sole by up to 0.10 inch, up to 0.15 inch, up to 0.20 inch, up to 0.25 inch, or up to 0.30 inch. In some embodiments, the weight CG 10134 of the one or more weights protrudes from the external contour 10146 of the sole 30 by 0.10 to 0.25 inch, by 0.15 to 0.25 inch, by 0.15 to 0.25 inch, or by 0.15 to 0.30 inch. For further example, the weight CG 10134 can be inset relative to the external contour 10146 of the sole 30 by a distance 10148 of less than 0.15 inch, less than 0.14 inch, less than 0.13 inch, less than 0.125 inch, less than 0.12 inch, less than 0.11 inch, less than 0.10 inch, less than 0.09 inch, less than 0.08 inch, or less than 0.07 inch. In some embodiments, the weight CG 10134 of the one or more weights is inset relative to the external contour 10148 of the sole 30 by a distance 10148 between 0.05 and 0.15 inch, between 0.05 and 0.125 inch, between 0.05 and 0.15 inch, between 0.10 and 0.15 inch, between 0.10 and 0.125 inch, or between 0.10 and 0.15 inch.

[0062] FIGS. 6 and 7 illustrate a club head 11010 similar to club head 100 described above. The club head 11010 having a club head body 11014 includes an adjustable weighting system 11066 located on a sole 11030 that is adjustable by an end user to modify the club head 11010 center of gravity and/or moment of inertia and/or heel/toe bias to achieve desired performance characteristics (e.g., forgiveness, spin, trajectory) under various circumstances. The club head 11010 can be similar in many respects to club head 100, with similar or identical numbers referencing similar or identical components. The adjustable weighting system 11066 is a low profile system and thereby does not significantly shift or change the MOI of the club head 11010 when compared to a club head devoid of the adjustable weighting system 11066. Further, the low profile adjustable weighting system 11066 ensures that shifts in the club head 11010 CG occur mainly in a heel end 11022 to toe end 11018 direction keeping the overall CG of the club head 11010 in a low and back location. The center of gravity position and MOI of club head 11010 can be similar or identical to the center of gravity position and MOI of club head 100 described above.

[0063] Referring to FIGS. 6 and 7, the adjustable weighting system 11066 can comprise a recessed portion 11080. The recessed portion 11080 comprises a recessed surface 11081 configured to include a plurality of discrete attachment locations. The plurality of discrete attachment locations can comprise various features including protruding bodies, apertures, recesses or ports capable of receiving a fastener, notches or tabs or cutout regions, ribs or grooves, pegs, hooks, magnets, programmable magnets, or any other suitable attachment means. In the illustrated embodiment, the adjustable weighting system 11066 includes a recessed surface 11081 comprising three discrete attachment locations 11070A, 11070B, and 11070C. The three discrete attachment locations comprise feature 11070A, 11070B, and 11070C. The features 11070A, 11070B, and 11070C can comprise any of the features discussed above. The attachment locations and corresponding features 11070A, 11070B, and 11070C are configured to receive one or more weights 11082.

[0064] Referring again to FIGS. 6 and 7, the recessed portion 11080 defines a groove, channel, and/or recessed track that extends along the sole or bottom 11030 of the club head 11010, adjacent a trailing edge 11072 or a rear perimeter 10136, and extends generally in an arcuate configuration from the toe or toe end 11018 to the heel or heel end 11020. The recessed portion 11080 generally follows the contour of the trailing edge 11072, wherein the recessed portion 11080 can be slightly offset from the trailing edge 11072 or rear perimeter 10136 between the heel end 11022 and the toe end 11018. The recessed portion 11080 comprises a recessed surface 11081 being offset from the sole 11030 of the club head 11010 by a first wall 11083. A portion of the recessed surface 11081 can further be offset from the sole 11030 by a second wall 11084, wherein the second wall 11084 is opposite the first wall 11083, proximate to the trailing edge 11072 or rear perimeter 10136. Generally, the recessed surface 11081 extends substantially parallel to the sole 11030 of the club head 11010, while the first and second walls 11083, and 11084 generally extend substantially perpendicular to the recessed surface 11081 and/or the sole 11030. In other embodiments, the first wall 11083 and the second wall 11084 can extend at a non-perpendicular angle between the recessed surface 11081 and the sole 11030.

[0065] The recessed portion 11081 includes a depth measured as the distance from the recessed surface 11081 to the sole 11030 in a direction parallel to the recessed surface 11081. In the illustrated embodiment, the recessed portion 11080 has a varying depth such that it is deeper in some areas than in other areas (e.g., may have a continuously or intermittently changing depth). For example, in some embodiments, the recessed portion 11080 can have an increasing, decreasing and/or constant depth along its length from the toe end 11018 to the heel end 11022. Thus, when a weight 11082 is coupled to the club head 11010 in one region of the recessed portion 11080, the weight 11082 may be concealed by the wall 11083 and flush with the sole 11030. When the weight 11082 is coupled to the club head 11010 in a different region of the recessed portion 11080, a portion of the weight 11082 may protrude outward from the wall 11083. As illustrated in FIGS. 6-8, the recessed portion 11080 comprises a first region 11077 at a toe end 11018 of the club head

110 10, a second region 11076 at the heel end 11022 of the club head 11010, and a third region 11078 disposed between the heel end 11022 and the toe end 11022 along or near the back end 11034. Referring to FIG. 6, the depth at the first region 11077 (and similarly the depth at the second region 11076) of the recessed portion 11080 is less than the depth at the third region. Accordingly, the depth of the recessed portion 11080 increases from the first and second regions 11077, 11076 toward the third region 11078, such that the third region 11078 has a constant larger depth than the first and second regions 11077, 11076. In this exemplary embodiment, the weight 11082 can be concealed by the first wall 11083 (e.g., as viewed along the y-axis 58 in FIG. 2) when the weight 11082 is coupled to the third region 11078, and the weight 11082 can be at least partially exposed or can at least partially protrude from the contour of the sole 11030 in the first and second regions 11077, 11076. In other embodiments, the first region 11077, the second region 11076, and the third region 11078 can have a constant depth, such that the weight 11072 is concealed by the wall 11083 when the weight 11082 is coupled to any of the first, second and/or third regions 11077, 11076, 11078. In other embodiments, the recessed portion 11080 includes other numbers and locations of regions than that illustrated. For example, in some embodiments, the recessed portion 11080 can include more than one region where the weight 11082 is concealed when coupled. For example, the recessed portion 11080 can comprise 1 region, 2 regions, 3 regions, 4 regions, 5 regions, 6 regions, 7 regions, or 8 regions.

[0066] In many embodiments, the recessed portion 11080 has a shallow depth ensuring the adjustable weight system 11066 remains low profile. For example, in some embodiments, the recessed portion 11080 has a maximum depth of 0.25 inches. In other embodiments, the recessed portion 11080 can have a maximum depth of 1.5, 1.25, 1.0, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2, or 0.1 inches. In other embodiments, the depth of the recessed portion 11080 can vary within the range of 0.05 to 0.25, 0.1 to 0.4, 0.1 to 0.6, 0.1 to 0.8, 0.2 to 0.4, 0.2 to 0.6, 0.2 to 0.8, 0.3 to 0.7, 0.3 to 0.9, 0.4 to 0.8, 0.4 to 1.2, 0.5 to 1.0, 0.5 to 1.5, or 1.0 to 1.5 inches. Additionally, the recessed portion 11080 includes a width measured as the distance between the first wall 11083 and the trailing edge 11072 or second wall 11084. In the illustrated embodiments, the recessed portion 11080 includes a varying width. In some embodiments, the first region 11077 has an increasing width from the toe end 11018 towards the center or third region 11078, the second region 11076 comprises an increasing width from the heel end 11022 towards the center and or third region 11078, and the third region 11078 comprises a constant width which is smaller than the average width of the first and or second regions 11077, 11076. In other embodiments as illustrated in FIGS. 6-8, the width of the recessed portion 11080 can increase from the center or third region 11078 toward the first region 11077, and toward the second region 11076. In other embodiments, the recessed portion 11080 can have an increasing, decreasing and/or constant width. In many embodiments, the width can be less than 2.0 inches. For example, in some embodiments, the width can be less than 2.0, 1.75, 1.5, 1.25, 1.0, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, or 0.2 inches. In other embodiments, the width can vary between 0.1 to 0.5, 0.3 to 0.7, 0.5 to 0.9, 0.7 to 1.1, 0.9 to 1.3, 1.1 to 1.5, 1.3 to 1.7, or 1.5 to 2.0 inches.

[0067] Referring again to FIGS. 6 and 7, the recessed portion 11080 can include one or more features 11070 defining one or more discrete attachment locations for securing a weight 11082 to the club head 11010. The club head 11010 having one or more discrete attachment locations is different than other adjustable weighting systems, wherein the weight can be coupled at any, or at an infinite, or at an unlimited number of locations on the club head. Referring to FIGS. 6 and 7, in the illustrated embodiment, the recessed portion 11080 can include three features or attachment locations 11070A, B, C. The features 11070A, B, C are shown as apertures configured to receive a screw fastener 11085. The screw fastener 11085 can be comprised of a material having a density which is the same or less than the density of the club head 11010. In other embodiments, the features 11070A, B, C, can be a protruding body, aperture, recess, ports capable of receiving a fastener, notches, tabs, cutout regions, ribs, grooves, pegs, hooks, magnets, programmable magnets or any other suitable attachment means. In other embodiments, the recessed portion 11080 can comprise one, two, three, four, five, six, seven, eight, nine or ten features 11070.

[0068] As illustrated, the features 11070A, B, C are disposed within the recessed portion 11080 along the recessed surface 11081 such that one or more weights 11082 may be releasably or removably coupled to the club head 11010 along the recessed portion 11080. More specifically, a first feature 1 1070A is positioned along the first region 11077 of the recessed portion 11080 near the toe end 11018, a second feature 11070C is positioned along the second region 11076 of the recessed portion near the heel end 11022, and a third feature 11070B is positioned along a third region 11078 of the recessed portion 11080 between the toe and heel end 11018, 11022. In some embodiments, one or more of the features 11070A, B, C can be positioned on the first wall 11083, second wall 11084, and/or the recessed surface 11081 of the recessed portion 11080.

[0069] With continued reference to FIGS. 6-8, the weights 11082 can have a generally trapezoidal shape. In other embodiments, the weights 11082 can have a circular, ovular, triangular, trapezoidal, polygonal or any other suitable shape configured to fit within the recessed portion 11080. In the illustrated embodiment, the adjustable weighting system 11066 comprises one weight 11082 capable of removably coupling to the features 11070A, B, C. In other embodiments, the adjustable weighting system 11066 can comprise any number of weights 11082 corresponding with the number of features 11070A, B, C. In other embodiments, the adjustable weighting system 11066 can comprise more or less weights 11082 than the number of features 11070A, B, C. For example, the adjustable weighting system 11066 can comprise

one, two, three, four, five, six, seven, eight, nine, or ten weights 11082.

[0070] In the illustrated embodiment, the weights 11082 comprise apertures extending entirely through the weight 11082 that are sized and configured to receive a threaded fastener or screw fastener 11085. The screw fastener 11085 can be threaded through the weight 11082 into the corresponding feature 11070A, B, C, thus securing the weight 11082 to the recessed portion 11080. In some embodiments, the weight 11082 can comprise a recessed or inset portion for receiving the top portion of the screw fastener 11085, and therefore the screw fastener 11085 can sit flush with an outer portion of the weight 11082. In other embodiments, the weights 11082 can be configured to be couple to the features 11070 A, B, C through a friction fit, a snap-fit mechanism, with a set-screw, or with any other suitable structure.

[0071] In embodiments where the adjustable weight system 11066 comprises more than one weight 11082, each of the weights 11082 can have the same shape and size. In other embodiments, the weights 11082 can vary in shape and size, resulting in weights 11082 having varying masses. Further, in some embodiments, the weights 11082 can comprise different materials such that they vary in mass. For example, one weight 11082 can comprise a high density material, such as tungsten, and the remaining weights 11082 can comprise a less dense material, such as polyurethane or another plastic. In other embodiments, the weights 11082 can comprise the same or different material and can have different sizes or volumes such that they vary in mass. For example, one weight 11082 can have a greater volume than the remaining weights 11082. In some embodiments, each of the weights 11082 can vary in volume from one another and thus vary in mass. In some embodiments, the weights 11082 can vary in both volume and material from one another. In some embodiments, one of the structures labeled as 11082 is not a weight, but rather a light-weight (e.g., light-weight plastic) cover that snap-fits or otherwise couples to one of the features 1 1070A, B, C.

[0072] In some embodiments, the weights 11082 can vary between 0.1-50g. For example, in embodiments having a plurality of weights 11082, one or more of the weights 82 can vary between 0-10g, one or more of the weights 11082 can vary between 10-20g, one or more of the weights 11082 can vary between 20-30, one or more of the weights 11082 can vary between 30-40g, and one or more of the weights 11082 can vary between 40-50g. In some embodiments, a first weight 11082 can vary between 0-10g, a second weight 11082 can vary between 10-20g, and a third weight 11082 can vary between 20-30g. In other embodiments, a first weight 11082 can vary between 1-5g, and a second and third weight 11082 can vary between 5-30g. In other embodiments, a first weight 11082 can vary between 40-50 g, a second weight 11082 can vary between 30-40 g, and a third weight can vary between 20-30 g. In other embodiments, a first and second weight 11082 can vary between 1-10g, and a third 11082can vary between 5-25g. In some embodiments, a first weight 11082 has a mass of 8.5 grams, and a second and third weight 11082 each have a mass of 1.5 grams. In other embodiments, a first weight 11082 has a mass of 12 grams, and a second and third weight 11082 each have a mass of 1.5 grams. In other embodiments, a first weight 11082 has a mass of 8.5 grams, and a second and third weight 11082 each have a mass of 0.75 grams. In other embodiments, a first weight can have a mass of 10-20g, 10- 25g, or 15-25g, and the remaining weight (e.g. second, third, fourth, fifth weight) can have a mass of 0.25-2.5g, 0.25-5g, 0.25-7.5g, or 0.25 to 10g. In other embodiments, the first weight can have a mass of 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29 or 30 grams and the remaining weights can have a mass of 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10 grams. In other embodiments, any number of weights may have the same mass or may have a varying mass between 0.1-50g.

[0073] With continued reference to FIG. 6, in the illustrated embodiment, one of the features 11070A, B, C can receive a weight 11082, while the remaining features 11070A, B, C can be bare and uncovered, devoid of a weight, or can be covered with another material or structure. In other embodiments as illustrated in FIG. 7, each of the features 11070A, B, C can receive a weight 11082. In some embodiments, one or more of the features 11070A, B, C can receive a weight 11082. In some embodiments, one or more of the features 11070A, B, C do not extend past an outer profile of the club head 11010, such that even if the feature 11070A, B, C is left bare and uncovered, the features 11070A, B, C, and or recessed portion 11080 will not interfere with, or disrupt a golfer's swing.

[0074] The weights 11082 may be strategically positioned on the features 11070A, B, C to achieve a desired club head 11010 center of gravity position and/or moment of inertia and/or heel/toe bias. For example, in some embodiments, a heavier weight 11082 is positioned on the feature 11070B, located between the toe end 11018 and the heel end 11022, while lighter weights are positioned on the features 11070A, and C at the toe end 11018 and the heel end 11022. The aforementioned weight 11082 positions results in the center of gravity remaining centered while being shifted towards the back end 11034 of the club head 11010. In some embodiments, a heavier weight 11082 can be positioned on the feature 11070C at the heel end 11022, while lighter weights 11082 are positioned on the feature 6270A, and B near the toe end 11018 and at the center located between the toe end 6318 and the heel end 6322. The aforementioned weight 11082 positions results in the center of gravity being shifted towards the heel end 11022 of the club head 11010. In some embodiments, a heavier weight 11082 is positioned on the feature 11070A at the toe or toe end 11018, while lighter weights 11082 are positioned on the features 6270C at the heel end 11022 and on the feature 11070B that is located between the toe end 11018 and the heel end 11022. The aforementioned weight 11082 positions results in the center of gravity being shifted towards the toe end 11018 of the club head 11010. In many embodiments, one or more of the features 11070A, B, C can be of equal size and shape, such that one weight may be interchangeably used with

each of the features 11070A, B, C. In some embodiments, one or more of the features 1 1070A, B, C can have a differing size and shape, such that each features 11070A, B, C can have its own corresponding weight 11082 or set of weights 11082. Further, adjustment of the position of the weights 11082 on the features 11070 A, B, C can also effect the spin imparted on the ball after impact.

[0075] Referring to FIG. 8, in some embodiments, club head 11010 can further comprise contoured recesses 11031 located on the sole 11030. The contour recesses 11031 can comprise a higher elevation (i.e., less depth) than the recessed portion 11080 having the plurality of discrete attachment locations. The contoured recesses 11031 extend from the recessed portion 11080 toward the strike face 38 of the golf club head 11010.

[0076] The adjustable weighting system 11066 of golf club head 11010 maintains or prevents a significant reduction in club head moment of inertia, and low and back club head center of gravity positioning, compared to a club head devoid of an adjustable weighting system. The adjustable weighting system 11066 of golf club head 11010 maintains a high club head moment of inertia and a low and back club head CG position due to the low profile of the weighting system and the perimeter positioning of the one or more weights. The club head 11010 having the adjustable weighting system 11066 can have similar or identical parameters and measurements as club head 100 described above.

[0077] FIGS. 9 and 10 illustrate a club head 12010 similar to club head 100 described above. Club head 12010 having a club head body 12014 includes an adjustable weighting system 12066 that is adjustable by an end user to modify the club head 12010 center of gravity and/or moment of inertia and/or heel/toe bias to achieve desired performance characteristics (e.g., forgiveness, spin, trajectory) under various circumstances. The club head 12010 can be similar in many respects to club head 100 and 11010, with similar or identical numbers referencing similar or identical components. The adjustable weighting system 12066 is a low profile system and thereby does not significantly shift or change the MOI of the club head 12010 when compared to a club head devoid of the adjustable weighting system 12066. Further, the low profile adjustable weighting system 12066 ensures that shifts in the club head 12010 CG occur mainly in a heel end 12022 to toe end 12018 direction keeping the overall CG of the club head 12010 in a low and back location. The center of gravity position and MOI of club head 12010 can be similar or identical to the center of gravity position and MOI of club head 100 and 11010 described above.

[0078] Referring to FIGS. 9 and 10, the adjustable weighting system 12066 can comprise a channel or recessed portion 12013 positioned on the sole 12030 or in the trailing edge 12072 of the club head 12010. The recessed portion 12013 can comprise a plurality of discrete attachment locations. The plurality of discrete attachment locations can comprise various features including protruding bodies, apertures, recesses or ports capable of receiving a fastener, notches or tabs or cutout regions, ribs or grooves, pegs, hooks, magnets, programmable magnets, or any other suitable attachment means. In the illustrated embodiment, the adjustable weighting system 12066 includes three discrete attachment locations. The three discrete attachment locations comprise features 12070A, 12070B, and 12070C. The features 12070A, 12070B, and 12070C can comprise any of the features discussed above. The attachment locations and corresponding features 12070A, 12070B, and 12070C are configured to receive one or more weights 12082.

[0079] In some embodiments, the recessed portion 12080 defines a groove, channel, and/or recessed track that extends within and along the skirt or trailing edge 12072 or rear perimeter 10136, and extends generally in an arcuate configuration from the toe or toe end 12018 to the heel or heel end 12020. The channel 12013 is defined by a first surface 12073 (FIG. 9), a second surface 12074 (FIGS. 9 and 10) disposed opposite the first surface 12073, and a third surface 12075 (FIGS. 9 and 10) that extends perpendicular between the first surface 12073 and the second surface 12074. In many embodiments, the first surface 12073 comprises an upper wall of the channel 12013, the second surface 12074 comprises a lower wall of the channel 12013, and the third surface 12075 comprises a base or bottom wall of the channel 12013. In some embodiments, the first surface 12073 extends parallel to the second surface 12074, and perpendicular to the third surface 12075. Further, in some embodiments, the first and second surfaces 12073, 12074 of the recessed portion 12080 extend in a direction generally perpendicular to the loft plane of the club head 12010, and the third surface 12075 of the recessed portion 12080 extends in a direction generally parallel to the loft plane of the club head 12010. The channel 12013 is further defined in part by additional end surfaces 12079 that directly intersect the first surface 12073, the second surface 12074, and the third surface 12075. The end surfaces 12079 can provide added support and/or provide an abutment region or edge against which the weights 12082 may rest. In some embodiments, the end surfaces 12079 can also allow the weights 12082 to appear flush with an outer surface 12090 of the club head. The flush surfaces may improve air flow characteristics during a swing to improve the club head 12010 aerodynamics.

[0080] The channel 12013 includes a depth measured from the third surface 12075 to the sole 12030 in a direction perpendicular to the third surface 12075. In the illustrated embodiment, the channel 12013 can have a varying depth such that it is deeper in some areas than in other areas (e.g., may have a continuously or intermittently changing depth). In other embodiments, the depth of the channel 12013 can have an increasing, decreasing and/or constant depth along its length from the toe end 12018 to the heel end 12022. Thus, when a weight 12082 is coupled to the club head 12010 in one region of the channel 12013, the weight 12082 can fit flush in the channel 12013 and/or be concealed by the first and/or second surfaces 12073, 12074. When the weight 12082 is coupled to the club head 12010 in a different region of the channel 12013, a portion of the weight 12082 can protrude beyond the first and/or second surfaces 12073, 12074.

In other embodiments, the weight 12082 can be recessed within the channel 12013, sit flush within the channel 12013, or protrude beyond the channel 12013 in any position.

[0081] As illustrated in FIG. 9, the channel 12013 can comprise a first region 12077 at a toe end 12018 of the club head 12010, a second region 12076 at a heel end 12022 of the club head 12010, and a third region 12078 disposed between the heel or heel end 12022 and the toe or toe end 12018, along a rear or back end 12034. In some embodiments, the first region 12077, second region 12076 and third region 12078 can be parallel to the contour of the trailing edge 12072. In other embodiments, any of the first, second, and/or third region 12077, 12076, and/or 12078 can be parallel and/or angled relative to the contour of the trailing edge 12072. In one example as illustrated in FIG. 9, the first region 12077, and the second region 12076 can be angled upward toward the trailing edge 12072, extending toward the third region 12078; while the third region is parallel with the contour of the trailing edge 12072. In this embodiment, the transition between the first region 12077, third region 12078, and second region 12076 can be smooth and devoid of hard edges

[0082] In some embodiments, the first region 12077 (and similarly the second region 12076) of the channel 12013 can have a shallow depth, such that a portion of the weight 12082 protrudes out past the first surface 12073 and the second surface 12074 when the weight 12082 is coupled to the first region 12077. However, due to the end surfaces 12079, the weight 12082 can appear flush to the rest of the sole 12030, toe end 12018, or heel end 12022 of the club head 12010. In contrast, the third region 12078 can have a larger depth, such that the weight 12082 is concealed by the first surface 12073 and the second surface 12074 (e.g., as viewed along the y-axis 58 in FIG. 2) when the weight 12082 is coupled to the third region 12078. In other embodiments, the depth of the first, second, and third regions 12077, 12076, and 12078 can comprise the same depth. Further, the transition regions between the first and third regions 12077, and 1278, and the second and third regions 12076, and 12078 can be more shallow than the depth of the first, second, and third regions 12077, 12076, and 12078. In other embodiments, the channel 12013 can include other numbers and locations of regions than those illustrated. For example, in some embodiments, the channel 12013 can include more than one region where the weight 12082 is concealed when coupled. In some embodiments, the channel 12013 can include a region or regions at the heel end 12022 and/or the toe end 12018 where the weight 12082 is concealed when coupled. In some embodiments, the channel 12013 includes a region or regions at the rear or back end 12034 where a portion of the weight 12082 protrudes beyond the first surface 12073 and/or the second surface 12074 when coupled.

[0083] In many embodiments, the channel 12013 has a shallow depth ensuring the adjustable weight system 12066 remains low profile. For example, in some embodiments, the channel 12013 has a maximum depth of 0.25 inches. In other embodiments, the channel 12013 can have a maximum depth of 1.5, 1.25, 1.0, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2, or 0.1 inches. In other embodiments, the depth of the channel 12013 can vary within the range of 0.05 to 0.25, 0.1 to 0.4, 0.1 to 0.6, 0.1 to 0.8, 0.2 to 0.4, 0.2 to 0.6, 0.2 to 0.8, 0.3 to 0.7, 0.3 to 0.9, 0.4 to 0.8, 0.4 to 1.2, 0.5 to 1.0, 0.5 to 1.5, or 1.0 to 1.5 inches. Additionally, the channel 12013 includes a width measured as the distance between the first surface 12073 and the second surface 12074. In the illustrated embodiments, the channel 12013 includes a constant width. In other embodiments, the channel 12013 can have an increasing, decreasing and/or constant width. In many embodiments, the width can be less than 2.0 inches. For example, in some embodiments, the width can be less than 2.0, 1.75, 1.5, 1.25, 1.0, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, or 0.2 inches. In other embodiments, the width can vary between 0.1 to 2.0, 0.1 to 0.5, 0.3 to 0.7, 0.5 to 0.9, 0.7 to 1.1, 0.9 to 1.3, 1.1 to 1.5, 1.3 to 1.7, or 1.5 to 2.0 inches.

[0084] Referring again to FIGS. 9 and 10, the channel 12013 can include one or more features 12070A, B, C defining one or more discrete attachment locations for securing a weight 12082 to the club head 12010. The club head 12010 having one or more discrete attachment locations is different than other adjustable weighting systems, wherein the weight can be coupled at any location, or at an infinite, or at an unlimited number of locations on the club head. In the illustrated embodiment, the adjustable weighting system 12066 can comprise 3 features 12070A, B, C. In some embodiments, the features 12070A, B, C can be one of a protruding body, aperture, recess, ports capable of receiving a fastener, notches, tabs, cutout regions, ribs, grooves, pegs, hooks, magnets, programmable magnets or any other suitable attachment means. In other embodiments, the channel 12013 can comprise one, two, three, four, five, six, seven, eight, nine or ten features 12070. As illustrated in FIG. 9, the third surface 12075 of the channel 12013 can comprise the three discrete attachment locations feature 12070A, B, C. The features 12070A, B, C can be any of the features discussed above. In other embodiments, the features 12070A, B, C can be positioned on the first, second and/or third surface 12073, 12074, 12075 of the channel 12013.

[0085] For the purposes of this example, in the illustrated embodiment, the features 12070 A, B, C can be apertures configured to receive a screw. The screw can be comprised of a material having density, which is the same or less than the density of the club head 12010. As illustrated, the features 12070 A, B, C are disposed within the channel 12013 along the third surface 12075 such that one or more weights 12082 may be releasably or removably coupled to the club head 12010 along the channel 12013. More specifically, a first feature 12070A is positioned along the first region 12077 of the channel 12013 near the toe end 12018, a second feature 12070C is positioned along the second region 12076 of the channel 12013 near the heel end 12022, and a third feature 12070B is positioned along a third region 12078 of the channel 12013 between the toe and heel end 12018, 12022. In some embodiments, one or more of the features

12070A, B, C can be positioned on the first wall 12083, second wall 12084, and/or the recessed surface 12081 of the recessed portion 11080.

[0086] With continued reference to FIGS. 9 and 10, the weights 12082 can have a generally elongated oval shape corresponding with the shape of the channel 12013. In other embodiments, the weights 12082 can have a circular, ovular, rectangular, triangular, trapezoidal, polygonal or any other suitable shape configured to fit within the channel 12013. In the illustrated embodiment of FIG. 9, the adjustable weighting system 12066 comprises three weights 12082 capable of removably coupling to the features 12070A, B, C in any configuration. In this embodiment, the number of weights 12082 corresponds with the number of features 12070A, B, C. In the illustrated embodiment of FIG. 10, the adjustable weighting system 12066 comprises one weight 12082 capable of removably coupling to any of the features 12070A, B, C. In other embodiments, the adjustable weighting system 12066 can comprise more or less weights 12082 than the number of features 12070A, B, C. For example, the adjustable weighting system 12066 can comprise one, two, three, four, five, six, seven, eight, nine, or ten weights 12082.

[0087] In the illustrated embodiment, the weights 12082 comprise apertures extending entirely through the weight 12082 that are sized and configured to receive a threaded fastener or screw (not shown). The screw can be threaded through the weight 12082 into the corresponding feature 12070A, B, C, thus securing the weight 12082 to the channel 12013. In some embodiments, the weight 12082 can comprise a recessed or inset portion for receiving the top portion of the screw and therefore the screw can sit flush with the outer portion of the weight 12082. In other embodiments, the weight 12082 can comprise a blind aperture not extending entirely through the weight 12082. In other embodiments, the weight 12082 can be devoid of an aperture. In other embodiments, the weights 12082 can be configured to be couple to the features 12070 A, B, C through a friction fit, a snap-fit mechanism, with a set-screw, or with any other suitable structure.

[0088] Referring again to FIG. 9, in the illustrated embodiment each of the features 12070A, B, C can receive a weight 12082. In other embodiments, one or more of the features 12070A, B, C can receive a weight 12082, while the remaining features 12070A, B, C are bare and uncovered, devoid of a weight, or are covered with another material or structure. In some embodiments, one or more of the features 12070A, B, C receives a weight 12082. In some embodiments, one or more of the features 12070A, B, C does not extend past an outer profile of the club head 10, such that even if the feature 12070A, B, C is left bare and uncovered, the feature 12070A, B, C and or channel 12013 will not interfere with or disrupt a golfer's swing.

[0089] In the illustrated embodiment, each of the weights 12082 is illustrated having the same shape and size. In other embodiments, the weights 12082 can vary in shape and size, resulting in different weights 12082 having varying masses. Further, in some embodiments, the weights 12082 can comprise different materials such that they vary in mass. For example, one weight 12082 can comprise a high density material, such as tungsten, and the remaining weights 12082 can comprise a less dense material, such as polyurethane or another plastic. In other embodiments, the weights 12082 can comprise the same or different material and can have different sizes or volumes such that they vary in mass. For example, one weight 12082 can comprise a greater volume than the remaining weights 12082. In some embodiments, each of the weights 12082 can vary in volume from one another and thus vary in mass. In some embodiments, the weights 12082 can vary in both volume and material from one another. In some embodiments, one of the structures labeled as 12082 is not a weight, but rather a light-weight (e.g., light-weight plastic) cover that snap-fits or otherwise couples to one of the features 12070A, B, C.

[0090] In some embodiments, the weights 12082 can vary between 0.1-50g. For example, in embodiments having a plurality of weights 12082, one or more of the weights 12082 can vary between 0-10g, one or more of the weights 12082 can vary between 10-20g, one or more of the weights 12082 can vary between 20-30, one or more of the weights 12082 can vary between 30-40g, and one or more of the weights 12082 can vary between 40-50g.In some embodiments, a first weight 12082 can vary between 0-10g, a second weight 12082 can vary between 10-20g, a third weight 12082 can vary between 20-30, a fourth weight 82 can vary between 30-40g, and a fifth weight 12082 can vary between 40-50g. In other embodiments, a first weight 12082 can vary between 1-5g, and a second and third weight 12082 can vary between 5-30g. In other embodiments, a first and second weight 12082 can vary between 1-10g, and a third and fourth weight 12082, can vary between 5-25g. In some embodiments, a first weight 12082 has a mass of 8.5 grams, and a second and third weight 12082 each have a mass of 1.5 grams. In other embodiments, a first weight 12082 has a mass of 12 grams, and a second and third weight 12082 each have a mass of 1.5 grams. In other embodiments, a first weight 12082 has a mass of 8.5 grams, and a second and third weight 12082 each have a mass of 0.75 grams. In other embodiments, a first weight can have a mass of 10-20g, 10- 25g, or 15-25g, and the remaining weight (e.g. second, third, fourth, fifth weight) can have a mass of 0.25-2.5g, 0.25-5g, 0.25-7.5g, or 0.25 to 10g. In other embodiments, a first weight, can have a mass of 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29 or 30 grams and the remaining weights can have a mass of 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10 grams. In other embodiments, any number of weights can have the same mass or may have a varying mass between 0.1-50g.

[0091] The weights 12082 may be strategically positioned on the features 12070A, B, C to achieve a desired club head 12010 center of gravity position and/or moment of inertia and/or heel/toe bias. For example, in some embodiments,

a heavier weight 12082 is positioned on the feature 12070B, located between the toe or toe end 12018 and the heel or heel end 12022, while lighter weights, or no weights, are positioned on the features 12070A, C near the toe or toe end 12018 and the heel or heel end 12022. The aforementioned weight 12082 placement can result in the center of gravity remaining centered while being shifted towards the back end 12034 of the club head 12010. In some embodiments, a heavier weight 12082 is positioned on the features 12070C near the heel or heel end 12022, while lighter weights 12082, or no weights, are positioned on the feature 12070A near the toe or toe end 12018 and on the feature 12070B that is located between the toe or toe end 12018 and the heel or heel end 12022. The aforementioned weight 12082 placement can result in the center of gravity being shifted towards the heel end 12022 of the club head 12010. In some embodiments, a heavier weight 12082 is positioned on the feature 12070A near the toe or toe end 12018, while lighter weights 12082, or no weights, are positioned on the feature 12070C near the heel or heel end 12022 and on the feature 12070B that is located between the toe or toe end 12018 and the heel or heel end 12022. The aforementioned weight 12082 placement can result in the center of gravity being shifted towards the toe end 12018 of the club head 12010. In many embodiments, one or more of the features 12070A, B, C are of equal size and shape, such that one weight may be interchangeably used with each of the features 12070A, B, C. In some embodiments, one or more of the features 12070A, B, C can have a differing size and shape, such that each feature 12070A, B, C has its own corresponding weight 12082 or set of weights 12082.

[0092] The adjustable weighting system 12066 of golf club head 12010 maintains or prevents a significant reduction in club head moment of inertia, and low and back club head center of gravity positioning, compared to a club head devoid of an adjustable weighting system. The adjustable weighting system 12066 of golf club head 12010 maintains a high club head moment of inertia and a low and back club head CG position due to the low profile of the weighting system and the perimeter positioning of the one or more weights. The club head 12010 having the adjustable weighting system 12066 can have similar or identical parameters and measurements as club head 100 described above.

[0093] FIGS. 15 and 16 illustrate a club head 6810 having a club head body 6814. The club head body 6814 includes an adjustable weighting system 6866 that is adjustable by an end user to modify the club head 6810 center of gravity and/or moment of inertia and/or heel/back bias to achieve desired performance characteristics (e.g., forgiveness, spin, trajectory) under various circumstances. The club head 6810 can be similar in many respects to club heads 100, 11010, and 12010 with similar or identical numbers referencing similar or identical components. The adjustable weighting system 6866 is a low profile system and thereby does not significantly shift or change the moment of inertia of the club head 6810 when compared to a club head devoid of the adjustable weighting system 6866. Further, the low profile adjustable weighting system 6866 ensures that shifts in the club head 6810 CG occur mainly down, at the back end 6834, and small shift to the heel end 6822 direction thereby keeping the overall CG of the club head 6810 in a low and back location. The center of gravity position and MOI of club head 6810 can be similar or identical to the center of gravity position and MOI of club head 100 described above.

[0094] Referring to FIGS. 15 and 16, the adjustable weighting system 6866 can comprise a recessed portion 6880. The recessed portion 6880 comprises a recessed surface 6881 configured to include a plurality of discrete attachment locations. The plurality of discrete attachment locations can comprise various features including protruding bodies, apertures, recesses or ports capable of receiving a fastener, notches or tabs or cutout regions, ribs or grooves, pegs, hooks, magnets, programmable magnets, or any other suitable attachment means. In the illustrated embodiment, the adjustable weighting system 6866 includes a recessed surface 6881 comprising three discrete attachment locations. The three distinct attachment locations can each include a feature 6870A, B, C. The features 6870A, B, C can be any of the features discussed above. The attachment locations and corresponding features 6870A, B, C are configured to receive one or more weights 6882.

[0095] Referring again to FIGS. 15 and 16, the recessed portion 6880 defines a groove, channel, and/or recessed track that extends along the sole or bottom of the club head 6810. The recessed portion 6880 extends from the back end 6834 (a standard position) to a sole center 6832 (a low spin position) to the heel end 6822 (a straight flight position to combat slicing) in a V-shaped configuration. The V-shaped configuration is located closer to the heel end 6822 than the toe end 6818 of the golf club body 6814. The recessed portion 6880 is defined by a recessed surface 6881 being indented or inset into the sole 6830. The recessed portion 6880 further includes an outer wall or first wall 6883 extending the entire length of the recessed portion 6880 and an inner wall or second wall 6884 extending the entire length of the recessed portion 6880. In the illustrated embodiment, the first wall 6883 and the second wall 6884 extend substantially perpendicular to the recessed surface 6881 and/or the sole 6830. In other embodiments, the first wall 6883 and second wall 6884 can extend at an angle between the recessed surface 6881 and/or the sole 6830.

[0096] As illustrated in FIGS. 15 and 16, the recessed portion 6880 comprises a first region 6877 near the back end 6834 and rear perimeter 10136 (the standard position) of the club head 6810, a second region 6876 near the sole center 6832 (the low spin position) of the club head 6810, and a third region 6878 near the heel end 6822 and rear perimeter 10136 (the straight flight position to combat slicing). The regions, however, are not isolated and are not generally distinguishable, other than the presence of attachment means. When a weight 6882 is coupled to the club head 6810 in one region of the recessed portion 6880, the weight 6882 may be flush with the sole 6830. When the weight 6882 is

coupled to the club head 6810 in a different region of the recessed portion 6880, a portion of the weight 6882 may protrude outward from the sole 6830, a portion of the weight 6882 may sink inward or be recessed from the sole 6830, or a portion of the weight 6882 may be flush with the sole 6830.

[0097] The recessed portion 6881 includes a depth measured as the distance from the recessed surface 6881 to the sole 6830 in a direction perpendicular to the recessed surface 6881. In the illustrated embodiment, the recessed portion 6880 has a constant depth. In other embodiments, the recessed portion 6880 can have an increasing, decreasing, varying, and/or constant depth along its length from the back end 6834 to the sole center 6832, and/or from the sole center 6832 to the heel end 6822.

[0098] In many embodiments, the recessed portion 6881 has a shallow depth ensuring the adjustable weight system 6866 remains low in profile. The recessed portion 6881 can have an increasing, decreasing, varying, and/or constant the depth between the first region 6877 and the second region 6876, and/or between the second region 6876 and the third region 6878. For example, in some embodiments, the recessed portion 6880 has a maximum depth of 0.50 inches. In other embodiments, the recessed portion 6880 can have a maximum depth of 1.5, 1.25, 1.0, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2, or 0.1 inches. In other embodiments, the depth of the recessed portion 6880 can vary within the range of 0.05 to 0.25, 0.1 to 0.4, 0.1 to 0.6, 0.1 to 0.8, 0.2 to 0.4, 0.2 to 0.6, 0.2 to 0.8, 0.3 to 0.7, 0.3 to 0.9, 0.4 to 0.8, 0.4 to 1.2, 0.5 to 1.0, 0.5 to 1.5, or 1.0 to 1.5 inches.

[0099] Further, the recessed portion 6880 includes a cross sectional shape and a cross sectional area. In some embodiments, the cross sectional shape of the channel 6813 can comprise a cylindrical shape, a circular shape, a rectangular shape, a triangular shape, a polygonal shape, or a trapezoidal shape. The recessed portion 6880 can have a varying and/or constant cross sectional shape between the first region 6877 and the second region 6876, and/or between the second region 6876 and the third region 6878. The recessed portion 6880 can have an increasing, decreasing, varying, and/or constant cross sectional area between the first region 6877 and the second region 6876, and/or between the second region 6876 and the third region 6878.

[0100] Additionally, the recessed portion 6880 includes a width measured as the distance between the first wall 6883 and second wall 6884. In some embodiments, the width between the first region 6877 and the second region 6876 is different from the width between the second region 6876 and the third region 6878. In some embodiments, the width between the first region 6877 and the second region 6876 is greater than the width between the second region 6876 and the third region 6878. In other embodiments, the width between the first region 6877 and the second region 6876 is less than the width between the second region 6876 and the third region 6878. In other embodiments, the recessed portion 6880 can have an increasing, decreasing, varying, and/or constant width between the first region 6877 and the second region 6876, and/or between the second region 6876 and the third region 6878. In many embodiments, the width can be less than 2.0 inches. For example, in some embodiments, the width can be less than 2.0, 1.75, 1.5, 1.25, 1.0, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, or 0.2 inches. In other embodiments, the width can vary between 0.1 to 0.5, 0.3 to 0.7, 0.5 to 0.9, 0.7 to 1.1, 0.9 to 1.3, 1.1 to 1.5, 1.3 to 1.7, or 1.5 to 2.0 inches.

[0101] Referring again to FIGS. 15 and 16, the recessed portion 6880 can include one or more features 6870A, B, C defining a discrete attachment location for securing a weight 6882 to the club head 6810. The club head 6810 having one or more discrete attachment locations is different than other adjustable weighting systems, wherein the weight can be coupled at any, or at an infinite, or at an unlimited number of locations across the club head. Referring to FIGS. 15 and 16, in the illustrated embodiment, the recessed portion 6880 includes three features 6870A, B, C. The features 6870A, B, C are shown as apertures configured to receive a threaded fastener or screw fastener 6885. A weight of the screw fastener 6885 can be the same as or less than the amount of weight removed to form the features 6870A, B, C. Further, the screw fastener 6885 can comprise a material having a density the same as or less than the density of the material of the club head body. The screw fastener 6885 is configured for attaching a weight 6882 to the features 6870A, B, C. In other embodiments, the features 6870A, B, C can be a protruding body, aperture, recess, ports capable of receiving a fastener, notches, tabs, cutout regions, ribs, grooves, pegs, hooks, magnets, programmable magnets or any other suitable attachment means. In the illustrated embodiment, the adjustable weighting system 6866 includes three features 6870A, B, C. In other embodiments, the recessed portion 6880 can comprise any number of features, including one, two, three, four, five, six, seven, eight, nine or ten features 6870.

[0102] As illustrated, the features 6870A, B, C are disposed within the recessed portion 6880 along the recessed surface 6881 such that one or more weights 6882 may be removably or releasably coupled to the club head 6810 along the recessed portion 6880. More specifically, a first feature 6870A is positioned at the first region 6877 of the recessed portion 6880 near the back end 6834, a second feature 6870B is positioned at the second region 6876 of the recessed portion near the sole center 6832, a third feature 6870C is positioned at a third region 6878 of the recessed portion 6880 near the heel end 6822. In other embodiments, one or more of the features 6870A, B, C can be positioned on the first wall 6883, the second wall 6884, and/or the recessed surface 6881 of the recessed portion 6880.

[0103] With continued reference to FIGS. 15 and 16, the weights 6882 have a generally rectangular shape. In other embodiments, the weights 6882 can have a circular, ovular, triangular, trapezoidal, polygonal or any other suitable shape configured to fit within the recessed portion 6880. In the illustrated embodiment, the adjustable weighting system 6866

comprises one weight 6882. The weight 6882 may vary between 0.1-50g. In some embodiments, the weight 6882 may vary between 0.1-0.5g, 0.5g-1g, 1-5g, 5-10g, 10-20g, 20-30g, 30-40g, 40-50g. For example, the weight 6882 can be 0.1, 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 8, 10, 20, 30, 40, or 50 grams. In other embodiments, the adjustable weighting system 6866 can comprise three weights 6882 corresponding with the number of features 6870A, B, C. In other embodiments, the adjustable weighting system 6866 can comprise more or less weights 6882 than the number of features 6870A, B, C. For example, the adjustable weighting system 6866 can comprise one, two, three, four, five, six, seven, eight, nine or ten weights 6882.

[0104] In the illustrated embodiment, the weights 6882 comprise apertures extending entirely through the weight 6882 that are sized and configured to receive a threaded fastener or screw fastener 6885. The screw fastener 6885 can be threaded through the weight 6882 into the corresponding feature 6870A, B, C thus securing the weight 6882 to the recessed portion 6880. In some embodiments, the weight 6882 can comprise a recessed or inset portion for receiving the top portion of the screw fastener 6885 and therefore the screw fastener 6885 can sit flush with the outer portion of the weight 6882. In other embodiments, the weights 6882 can be configured to be couple to the features 6870A, B, C through a friction fit, a snap-fit mechanism, with a set-screw, or with any other suitable structure.

[0105] In embodiments where the adjustable weight system 6866 comprises more than one weight 6882, each of the weights 6882 can have the same shape and size. In other embodiments, the weights 6882 can vary in shape and size, resulting in weights 6882 having varying masses. Further, in some embodiments, the weights 6882 are made of different materials such that they vary in mass. For example, one weight 6882 may be made of a high density material, such as tungsten, and the remaining weights 6882 may be made of a less dense material, such as polyurethane or another plastic. In other embodiments, the weights 6882 can comprise the same or different materials and can have different sizes or volumes such that they vary in mass. For example, one weight 6882 may have a greater volume than the remaining weights 6882. In some embodiments, each of the weights 6882 may vary in volume from one another and thus vary in mass. In some embodiments, the weights 6882 may vary in both volume and material from one another. In some embodiments, one of the structures labeled as 6882 is not a weight, but rather a light-weight (e.g., light-weight plastic) cover that snap-fits or otherwise couples to one of the features 6870A, B, C.

[0106] In some embodiments, the weights 6882 may vary between 0.1-50g. For example, in embodiments having a plurality of weights 6882, one or more of the weights 6882 may vary between 0-10g, one or more of the weights 6882 may vary between 10-20g, one or more of the weights 6882 may vary between 20-30, one or more of the weights 6882 may vary between 30-40g, and one or more of the weights 6882 may vary between 40-50g. In some embodiments, a first weight 6882 may vary between 0-10g, a second weight 6882 may vary between 10-20g, and a third weight 6882 may vary between 20-30g. In other embodiments, a first weight 6882 may vary between 1-5g, and a second and third weight 6882 may vary between 5-30g. In other embodiments, a first and second weight 6882 may vary between 1-10g, and a third and fourth weight 6882, may vary between 5-25g. In some embodiments, a first weight 6882 has a mass of 8.5 grams, and a second and third weight 6882 each have a mass of 1.5 grams. In other embodiments, a first weight 6882 has a mass of 12 grams, and a second and third weight 6882 each have a mass of 1.5 grams. In other embodiments, a first weight 6882 has a mass of 8.5 grams, and a second and third weight 6882 each have a mass of 0.75 grams. In other embodiments, a first weight can have a mass of 10-20g, 10- 25g, or 15-25g, and the remaining weight (e.g. second and third weight) can have a mass of 0.25-2.5g, 0.25-5g, 0.25-7.5g, 0.25 to 10g. In other embodiments, a first weight, can have a mass of 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29 or 30 grams and the remaining weights can have a mass of 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10 grams. In other embodiments, any number of weights may have the same mass or may have a varying mass between 0.1-50g.

[0107] With continued reference to FIGS. 15 and 16, in the illustrated embodiment one of the features 6270A, B, C receives a weight 6882, while the remaining features 6870A, B, C are bare and uncovered, devoid of a weight, or are covered with another material or structure. In other embodiments, each of the features 6870A, B, C receives a weight 6882. In some embodiments, one or more of the features 6870A, B, C can receive a weight 6882. In some embodiments, one or more of the features 6870A, B, C does not extend past an outer profile of the club head 6810, such that even if the feature 6870A, B, C is left bare and uncovered, the feature 6870A, B, C and or recessed portion 6880 will not interfere with or disrupt a golfer's swing.

[0108] The weights 6882 may be strategically positioned on the features 6870A, B, C to achieve a desired club head 6810 center of gravity position and/or moment of inertia and/or heel/back bias. For example, in some embodiments, a heavier weight 6882 is positioned on the feature 6870A, located near the back end 6834, while lighter weights are positioned on the features 6870B, C near the sole center 6832 and the heel end 6822. The aforementioned weight 6882 positions results in the center of gravity being shifted towards the back end 6834 of the club head 6810.

[0109] In some embodiments, a heavier weight 6882 is positioned on the feature 6870C near the heel end 6822, while lighter weights 6882 are positioned on the feature 6270A near the back end 6834 and 6870B located near the sole center 6832. The aforementioned weight 6882 positions results in the center of gravity being shifted towards the heel end 6822 of the club head 6810.

[0110] In some embodiments, a heavier weight 6882 is positioned on the feature 6870B located at the sole center

6832, while lighter weights 6882 are positioned on the feature 6870A near the back end 6834 and on the feature 6870C near the heel end 6822. The aforementioned weight 6882 positions results in the center of gravity being centered on the club head 6810.

[0111] In many embodiments, one or more of the features 6870A, B, C are of equal size and shape, such that one weight may be interchangeably used with each of the features 6870A, B, C. In some embodiments, one or more of the features 6870A, B, C can have a differing size and shape, such that each features 6870A, B, C has its own corresponding weight 6882 or set of weights 6882. Further, adjustment of the position of the weights 6882 on the features 6870A, B, C can also effect the spin imparted on the ball after impact.

[0112] The adjustable weighting system 6866 of golf club head 6810 maintains or prevents a significant reduction in club head moment of inertia, and low and back club head center of gravity positioning, compared to a club head devoid of an adjustable weighting system. The adjustable weighting system 6866 of golf club head 6810 maintains a high club head moment of inertia and a low and back club head CG position due to the low profile of the weighting system and the perimeter positioning of the one or more weights.

[0113] FIGS. 11 and 12 illustrate a club head 13010 similar to the golf club head 100 described above, with similar or identical numbers referencing similar or identical components. The club head 13010 having a club head body 13014 includes an adjustable weighting system 13066 comprising a cable 13069 and a tensioner 13067 that is adjustable by an end user to modify the club head 13010 center of gravity and/or moment of inertia and/or heel/toe bias to achieve desired performance characteristics (e.g., forgiveness, spin, trajectory) under various circumstances. The adjustable weighting system 13066 is a low profile system and thereby does not significantly shift or change the MOI of the club head 13010 when compared to a club head not including the adjustable weighting system 13066. Further, the low profile adjustable weighting system 13066 ensures that shifts in the club head 13010 CG occur mainly in a heel end 13022 to toe end 13018 direction keeping the overall CG of the club head 13010 in a low and back location. The center of gravity position and MOI of club head 13010 can be similar or identical to the center of gravity position and MOI of club head 100 described above.

[0114] The adjustable weighting system 13066 is positioned on a sole 13030 of the club head 13010. As illustrated in FIGS. 11 and 12, the sole 13030 comprises a recessed portion 13080 having a recessed surface 13081. The recessed portion 13080 can be substantially rectangular in shape and can be positioned near a rear 13023, extending from near the toe end 13018 and rear perimeter 10136 to near the heel end 13022 and rear perimeter 10136. In the illustrated embodiment, the recessed portion 13080 extends generally parallel to a strike face 38. In other embodiments, the recessed portion 13080 can be placed anywhere on the sole 13030 and form any shape. The recessed portion 13080 is recessed from the outer surface 13074 of the sole 13030 by a wall 13083. In the illustrated embodiment, the wall 13083 is perpendicular to the recessed surface 13081 or the outer surface 13074 of the sole 13030. In other embodiments, the wall 13083 can be inclined or declined at a non-perpendicular angle to the recessed surface 13081 or the outer surface 13074 of the sole 13030. In the embodiment as illustrated in FIGS. 11 and 12, the wall 13083 can border an entire perimeter of the recessed portion 13080. In other embodiments, the wall 13083 can border a portion of the recessed portion 13080.

[0115] In many embodiment, the wall 13083 can include a first wall portion 13089 located toward the strike face 38 of the club head 13010, a second wall portion 13090 located opposite the first wall portion 13089 and toward a rear end 13023 of the club head 13010, a first end wall 13091 located toward the toe end 13018 of the club head 13010, and a second end wall 13092 located opposite the first end wall 13091 and toward the heel end 13022 of the club head 13010. Generally, the recessed surface 13081 extends substantially parallel to the sole 13030 of the club head 13010, while the first and second wall portions 13083, 13084 and the first and second end walls 13091, 13092 generally extend substantially perpendicular to the recessed surface 13081 and/or the sole 13030. In other embodiments, the first and second wall portions 13083, 13084 and/or the first and second end walls 13091, 13092 can extend at a non-perpendicular angle between the recessed surface 13081 and the sole 13030.

[0116] In many embodiments as illustrated in FIGS. 11 and 12, the sole 13030 can further comprise one or more apertures 13085 extending from the outer surface 13074 of the sole 13030, into the club head body and into the recessed portion 13080. In some embodiments, the sole 13030 can comprise 1 aperture, 2 apertures, 3 aperture, 4 apertures, or 5 apertures 13085. In the illustrated embodiment of FIGS. 11 and 12, the sole 13030 comprises two apertures 13085. In the illustrated embodiment, the apertures 13085 are located on opposite sides of the recessed portion 13080. The apertures 13085 are positioned on the outer surface 13074 of the sole, and extend into the recessed portion 13080 of the adjustable weighting system. In the illustrated embodiment, the apertures 13085 extend into the first and second end walls 13091, 13092 of the recessed portion 13080. The apertures 13085 are configured to house the tensioner 13067 of the adjustable weighting system 13066. As illustrated in FIG. 13, the apertures 13085 comprise a threaded end 13086 adjacent the recessed portion 13080, and a head or receiving end 13087 adjacent the outer surface 13074 of the sole 13030.

[0117] In the illustrated embodiment, the recessed portion 13080 can further comprise a plurality of discrete attachment locations. The plurality of discrete attachment locations can comprise various features 13070 including protruding bodies,

apertures, recesses or ports capable of receiving a fastener, notches or tabs or cutout regions, ribs or grooves, pegs, hooks, magnets, programmable magnets, or any other suitable attachment means. The features 13070 define discrete attachment locations for securing one or more weights 13082 to the club head 13010. The club head 13010 having one or more discrete attachment locations is different than other adjustable weighting systems, wherein the weight can be coupled at any, or at an infinite, or at an unlimited number of locations across the club head. In the illustrated embodiment, the features 13070 are straight wall-like protrusions or ribs 13070 extending from the recessed portion 13080, generally perpendicular relative to the strike face 38. In other embodiments, the features 13070 can be protrusions extending from the recessed portion 13080 at any angle, and in any shape (e.g., circular pegs, hourglass-shape pegs, square pegs, etc.)

[0118] As illustrated in FIGS. 11 and 12, the recessed portion 13080 comprises five features 13070, a first feature 13070A near the toe end 13018, a second feature 13070E near the heel end 13022, a third feature 13070C between the first feature 13070A and the second feature 13070E, a fourth feature 13070B between the first feature 13070A and the third feature 13070C, and a fifth feature 13070D between the second feature 13070E and the third feature 13070C. In other embodiments, the recessed portion 13080 can comprise any numbers of features 13070. For example, the recessed portion 13080 can comprise one feature 13070, two features 13070, three features 13070, four features 13070, five features 13070, six features 13070, seven features 13070, or eight features 13070. In some embodiments, each of the features 13070 are spaced generally equidistant from one another. In other embodiments, each of the features 13070 can be spaced at any distance apart from one another. In some embodiments, the features 13070 form square-shaped openings (or pockets) in between each feature 13070. In other embodiments, the features 13070 can form any shaped pocket (e.g. polygonal or any shape with at least one curved surface) between each feature 13070.

[0119] The weights 13082 are configured to be received by the features 13070 within the recessed portion 13080. The weights 13082 each have a general cross-sectional shape and size (e.g., cylindrical, cubicle, rectangular, trapezoidal, etc.) corresponding to the cross sectional shape of the recessed portion 13080. As illustrated in FIGS. 11 and 12, the weights 13082 can have a rectangular cross-sectional shape. The weights 13083 can further comprise a notch 13084 positioned on a bottom surface of the weight 13083. The notch 13084 on the weights 13083 is configured to mate with the features 13070 in the recessed portion 13080. In many embodiments, the shape of the notch 13084 on the weighs 13082 corresponds to the shape of the features 13070 in the recessed portion 13080.

[0120] The weights 13082 can further comprise a through hole 13071 configured to house the cable 13069 of the adjustable weighting system 13066. The through hole 13071 can extend through the weight 13082 in a direction from the heel end 13022 to the toe end 13018 of the club head 13010 when the weight 13082 is positioned within the recessed portion 13080. When assembled the through hole 13071 is parallel to the recessed surface 13081. In other embodiments, the weights 13082 can be devoid of the through hole 13071. In these or other embodiments, the weights 13082 can comprise a groove (not pictured) positioned on a top surface of the weights 13082, configured to receive the cable 13069.

[0121] The weights 13082 further comprise a mass. The mass of the weights 13082 can range from 3 grams to 35 grams, 3 grams to 12 grams, 5 grams to 18 grams, 8 grams to 23 grams, 12 grams to 25 grams, 18 grams to 27 grams, 20 grams to 30 grams, 25 grams to 33 grams, or 28 grams to 35 grams. For example, the weights 13082 can be 1 gram, 2 grams, 3 grams, 6 grams, 9 grams, 12 grams, 15 grams, 18 grams, 21 grams, 24 grams, 27 grams, 30 grams, 33 grams, or 35 grams. In embodiments wherein the club head 13010 comprises multiple weights 13082, the weights 13082 can all comprise the same mass, or all have different masses. For example, the club head 13010 comprises three weights 13082 with the first weight 13082 having a mass of 12 grams, and both the second and third weights 13082 having a mass of 5 grams. In another example, the club head 13010 comprises five weights 13082 with the first weight 13082 having a mass of 20 grams, the second weight 13082 having a mass of 15 grams, the third weight 13082 having a mass of 10 grams, the fourth weight 13082 having a mass of 7 grams, and the fifth weight 1082 having a mass of 3 grams.

[0122] The adjustable weighting system 13066 comprising the tensioner 13067 and the cable 13069 is configured to couple the weights 13082 to the club head 13010. The tensioner 13067 of the adjustable weighting system 13066 comprises a fastener 13067A and a washer 13067B. In some embodiments as illustrated in FIG. 14, the tensioner 13067 can be a clutch brake cable adjuster, wherein a notch 13068 is cut into the fastener 13067A (extending the entire length of the fastener 13067A) and the washer 13067B. The notch 13068 of the fastener 13067A and the washer 13067B allow for the cable 13069 to be coupled to the fastener 13067. In other embodiments, the tensioner 13067 can be any type of fastener and washer having a notch configured to receive the cable 13069.

[0123] As illustrated in FIGS. 12 and 13, the tensioner 13067 is configured to be received within the aperture 13085 of the sole 13030. The tensioner 13067 can be inserted into the receiving end 13087 of the aperture, wherein a threaded end of the fastener 13067A mates with the threaded end 13086 of the aperture 13085, and the washer 13067B remains in the receiving end 13087 of the aperture. In some embodiments, the adjustable weighting system 13066 can comprise more than one tensioner 13067. For example, the adjustable weighting system 13066 can comprise one tensioner, two tensioners, three tensioners, or four tensioners 13067. In many embodiments, the number of tensioners 13067 corresponds to the number of apertures 13085 configured to receive the tensioners 13067. For example as illustrated in FIGS. 11 and 12, the sole 13030 comprises a first aperture 13085 near the toe end 13018 configured to receive a first tensioner 13067, and a second aperture 13085 near the heel end 13022 configured to receive a second tensioner 13067. In many

embodiments, when the tensioner 13067 is housed within the aperture 13085, the tensioner 13067 does not extend past the outer surface 13074 of the sole 13030.

[0124] The cable 13069 of the adjustable weighting system 13066 is configured to be received by the tensioner 13067, and positioned within the recessed portion 13080. The cable 13069 can be coupled to the tensioner 13067 via the notch 13068 of the fastener 13067A and washer 13067B, wherein the washer 13067B then rotates to secure the cable 13069 within the fastener 13067A. An end of the cable 13069 comprises a width greater than a width of the notch 13068, which prevents the cable 13069 from dislodging from the fastener 13067A when tension is applied to the cable 13069. In some embodiments, the adjustable weighting system 13066 comprises one tensioner 13067, wherein one end of the cable 13069 is configured to be coupled to the tensioner 13067, and the other end of the cable 13069 is configure to be attached/fixed at an opposite end of the club head 13010 from the tensioner 13067. In other embodiments, the adjustable weighting system comprises two tensioners 13067, wherein one end of the cable 13069 can be configured to couple to a first tensioner 13067, and the other end of the cable 13069 can be configured to couple to the second tensioner 13067. For example, as illustrated in FIG. 11 and 12, the one end of the cable 13069 can be coupled to the first tensioner 13067 near the heel end 13022, and the other end of the cable 13069 can be coupled to the second tensioner 13067 near the toe end 13018.

[0125] The cable 13069 can be a metallic material (e.g., steel wire rope, aluminum wire rope, copper wire rope, tungsten wire rope, nickel wire rope, silver wire rope, or any other metallic wire rope), or a non-metallic material such as a fiber, a polymer, a plastic, or a composite type rope. For example, the cable 13069 can comprise baling twine, parachute cord material, nylon, Kevlar, polymer tweed, steel wire with polymer coating, any metallic wire with polymer coating, high modulus polyethylene fiber, polycarbonate, polyoxymethylene, and/or nylon with polyamide.

[0126] The tensioner 13067, when received within the aperture 13085 of sole 13030, can be rotated (i.e., twisted) to adjust the tension in the cable 13069. The notch 13068 of the tensioner 13067 allows the cable 13069 to couple to the tensioner 13067 in such a way that when the tensioner 13067 rotates, the cabled 13069 remains stationary, and does not rotate with the tensioner 13067. The washer 13067B of the tensioner 13067 acts as a stop within the aperture 13085, preventing the fastener 13067A of the tensioner 13067 from moving within the aperture 13085 during a swing and/or impact. When the tensioner 13067 is rotated clockwise, the tensioner 13067 recedes deeper into the aperture 13085, and the cable is loosened. With the cable 13069 loosened, the weight 13082 can be lifted from the feature 13070 within the recessed portion 13080, and moved (or the weight 13082 having the through hole 13071 can slide along the cable 13069) to another feature 13070. Further, when the cable 13069 is loosened, additional weights 13082 comprising grooves (not pictured) can be positioned onto the features 13070 and under the cable 13069 to increase weight. Repositioning the weights 13082 reconfigures the CG of the club head 13010. For example, the weight 13082 can be repositioned from the first feature 13070A near the toe end 13018 to the second feature 13070E near the heel end 13022, wherein the CG shift toward the heel end 13022 helps correct ball trajectory for players who tend to slice the ball and/or generate a draw. In other embodiments, the cable 13069 can be loosened by other means other than by the tensioner 13067.

[0127] The tensioner 13067 can be rotated (i.e., twisted) counterclockwise to tighten the tension within the cable 13069, wherein the washer 13067B prevents the fastener 13067A of the tensioner 13067 from moving within the aperture 13085. When the tensioner 13067 is rotated counterclockwise, the tensioner 13067 positioned in the aperture 13085 extends outward toward the outer surface 13074 of the sole 13030, wherein the tensioner 13067 is flush with the outer surface 13074 to indicate the cable 13069 reached maximum tension. As illustrated in FIG. 12, when the cable 13069 is tightened, and the cable 13069 presses on the weights 13082 (i.e., presses on against the through hole 13071, or the groove) creating a force against the features 13070 of the recessed portion 13080 to secure the weights 13082. When the weights 13082 abut against the features 13070, the weights 13082 are flush with the outer surface 13074 of the sole 13030. In other embodiments, when the weights 13082 abut against the features 3270, the weights 13082 can extend past the outer surface 13074 of the sole 3230, however, the weights 13082 do not extend past a lowest point of the club head 13010 when at address. In other embodiments still, when the weights 13082 abut against the features 13070, the weights 13082 can be recessed from and not extending to, or past the outer surface 13074 of the sole 3230. In other embodiments, the cable 13069 can be retracted by means other than by the tensioner 13067.

[0128] The club head 13010 having the adjustable weighting system 13066 comprising the tensioner 13067 (or other cable adjustment means) and the cable 13069 described above can optimize the performance of the golf club. The adjustable weighting system 13066 allows for the club head 13010 to adjust the weight of a low center of gravity club head about the x-axis (heel-to-toe end) without having to sacrifice a high moment of inertia (MOI), similar to that of a club head devoid of an adjustable weight system. Shifting the CG about the x-axis allows players to correct a slice or a hook in ball trajectory.

[0129] The club head 13010 having the adjustable weight system 13066 with the tensioner 13067 and the cable 13069 further has a utility regarding ease of manufacturing, compared to club heads with more complex structures to house a weight (e.g., deep weight ports, multiple weight ports, rail systems, weight covers/caps). The weight(s) 13082 coupled to the club head body 13014 are secured by the tension of the cable 13069, which creates a force on the weight(s)

13082 onto the feature(s) 13070 of the club head 13010. The tension produced force eliminates the need for the club head 13010 to be manufactured with a weight housing structure having complex internal/external geometries in order to secure the weight(s) 13082. Accordingly, the material and mass associated with the complex weight housing structure can be reduced. The mass saved using the low profile adjustable weighting system can then be positioned elsewhere on the club head to increase strength and/or MOI, and to improve CG positioning. The tension created force of the cable 13069 further eliminates the need for screw-type fasteners, thus the weight(s) 13082 and the club head 13010 do not require manufacturing a threaded aperture and receiving geometry to receive the fastener. The lack of the fastener and threaded aperture reduces the cost of manufacturing and improves the ease of production.

[0130] Further, the cable 13069 of the adjustable weighting system 13066 is lightweight, strong, and can be incorporated in a number of different patterns on recessed portion 13080 of the club head 13010. The different patterns allow for the weight(s) 13082 to be place in a number of different locations on the sole 13030 because the weight(s) 13082 are not limited to specific weight housing structures. The number of different weight positions can help fine tune the CG placement to adjust the ball spin and trajectory for individual players. The cable 13069 can further be strategically placed in such a pattern that the cable can reinforce specific locations on the club head 13010. The material and pattern of the cable 13069 can further act as a sound dampener and absorb vibrations experienced by the club head 13010 during impact, thereby reducing unwanted sound, and unwanted stress during a game.

[0131] The adjustable weighting system 13066 of golf club head 13010 maintains or prevents a significant reduction in club head moment of inertia, and low and back club head center of gravity positioning, compared to a club head devoid of an adjustable weighting system. The adjustable weighting system 13066 of golf club head 13010 maintains a high club head moment of inertia and a low and back club head CG position due to the low profile of the weighting system and the perimeter positioning of the one or more weights. The club head 13010 having the adjustable weighting system 13066 can have similar or identical parameters and measurements as club head 100 described above.

[0132] In some embodiments, one or more of the other adjustable weights described herein (e.g., weights 11082, 6882, 12082, and/or 13082) can be positioned at a minimum distance from a center of gravity (CG) of their associated club head ranging from approximately 1.0 inches to 2.6 inches (e.g. approximately 1.0 inches, approximately 1.2 inches, approximately 1.4 inches, approximately 1.6 inches, approximately 1.8 inches, approximately 2.0 inches, approximately 2.2 inches, approximately 2.4 inches, or approximately 2.6 inches). In some embodiments, one or more of the other adjustable weights described herein (e.g., weights 11082, 6882, 12082, and/or 13082) can also be positioned within a maximum distance of approximately 0.450 inches to approximately 0.550 inches inward from a perimeter of their associated club head when viewed from a top or side view (e.g., the maximum distance from the perimeter can be approximately 0.450 inches, approximately 0.460 inches, approximately 0.470 inches approximately 0.480 inches approximately 0.490 inches approximately 0.500 inches approximately 0.510 inches approximately 0.520 inches approximately 0.530 inches approximately 0.540 inches, or approximately 0.550 inches). Other embodiments include different values and ranges.

[0133] In some embodiments, the weight or weights described herein (e.g., 11082, 6882, 12082, and/or 13082) can comprise at least partially of a high density metal, metal alloy or any other material (e.g., plastic or composite with high density metal beads or powder). In some embodiments, the weights 11082, 6882, 12082, and/or 13082) can comprise at least partially of steel, tungsten, aluminum, titanium, vanadium, chromium, cobalt, nickel, other metals, metal alloys, or any combination thereof.

[0134] In many embodiments, the cable 13069 can comprise a thickness between 0.020 inch and 0.125 inch. For example, in some embodiments, the thickness of the cable 13069 can be between 0.021 inch and 0.041 inch, between 0.037 inch and 0.057 inch, between 0.053 inch and 0.073 inch, between 0.068 inch and 0.088 inch, between 0.084 inch and 0.104 inch, between 0.099 inch and 0.119 inch, or between 0.115 inch and 0.135 inch.

[0135] In some embodiments, the cable can withstand a tensile load up to 1500 Newtons (N). For example, in many embodiments, the cable can withstand a tensile load between 200 N and 1500 N. For example, in some embodiments, cable can withstand a tensile load up to 200 N, up to 300 N, up to 400 N, up to 500 N, up to 600 N, up to 700 N, up to 800 N, up to 900 N, up to 1000 N, up to 1100 N, up to 1200 N, up to 1300 N, up to 1400 N, or up to 1500 N. Other embodiments can include different range and values.

[0136] In some embodiments, one or more of the club heads described herein may include more than one tensioner. For example, in some embodiments, the club head 13010 may include two or more tensioners (e.g., along a single recessed portion or separate recessed portions of the club head) that are each coupled to one or more cables. In some embodiments, one tensioner tensions a first set of cables to hold a weight or weights against the club head, and another tensioner tensions a second set of cables to hold a weight or weights against the club head.

[0137] While some of the embodiments described herein include a single cable, whereas other embodiments include multiple cables, any of the embodiments described herein may include a single or multiple cables associated with one or more tensioners.

[0138] While some of the embodiments described herein include a single channel or recessed portion that guides a cable and/or provides a feature or features for positioning a weight or weights, and other embodiments described above include a distinct network of channels that guide one or more cables and/or provide features for positioning one or more

weights, any of the embodiments described herein may include a single channel or network of channels. Additionally, while certain networks of channels are illustrated, any of the club heads described herein may include any arrangement, pattern, or size of channels.

[0139] While various grooves (not pictured) in the weights are described above, other embodiments include different numbers, sizes, and shapes of grooves to accommodate a cable. For example, in some embodiments, one or more of the weights 13082 include a groove or track that has a C-shaped contour (as opposed to a U-shaped or V-shaped contour), such that the cable or cables may "snap" into the groove and generally be held in place the groove, while still allowing the weight to slide along the cable. In some embodiments, one or more of the channels for the cable or cables has a C-shaped (or other shape) contour or track (as opposed to a U-shaped or V-shaped contour), such that the cable or cables may "snap" into the channel and generally be held in place in the channel, while still allowing the cable to move within the channel. In some embodiments, the channels include tracks or other contours that hold or restrain the cables, for example as the channels curve along the club head body, such that the cables do not come out of the channels during tensioning of the cables.

[0140] In some embodiments, one or more of the weights described herein (e.g., 11082, 6882, 12082, and/or 13082) is attracted to the club head 11010, 12010, and 13010 via a magnetic force, such that the weight or weights can be held against the club head at least partially by the magnetic force. For example, in some embodiments, one or more of the features 11070, 6870, and 12070 is a protruding body or notch that is comprised at least partially of a metallic material, and one or more of the weights 11082, 6882, 12082, and/or 13082 is comprised at least partially of a magnetic material. The weight or weights can be held in place at least partially by the magnetic attractive force between the magnet or magnets and the feature or features, as well as by one or more of the other structures described herein (e.g., threaded protruding post, ribs, etc.) In some embodiments, the weight or weights can snap into place over a protruding body or into a notch, and are held against the club head at least partially by a frictional force, as well as by the magnetic force. In some embodiments, the weight or weights can be held in place solely by the magnetic force. In yet other embodiments, one or more of the weight or weights 11082, 6882, 12082, and/or 13082 is comprised at least partially of the metallic material, and one or more of the features 11070, 6870, 12070, and 13070 is comprised at least partially of the magnetic material.

[0141] In some embodiments, one or more of the weights described herein (e.g., 13082) is pressed against and held to the club head 13010 via tension alone in a cable or cables. Thus, at least in some embodiments, the club head does not include separates notches or protrusions or other features that are sized and shaped to accommodate a single weight. Rather, the club head includes a larger surface (e.g., a recessed surface) and a tensioner and one or more cables that are coupled to (e.g., pressed against) one or more of the weights. The tension of the cable or cables alone via activation of the tensioner is sufficient to hold the weight or weights against the club head in a desired position or location. When the tension is released in the tensioner, the weight or weights may then be moved to a different location along the surface.

[0142] In some embodiments, one or more of the weights described herein (e.g., 11082, 6882, 12082, and/or 13082) includes a rail or rails (e.g., a T-shaped rail, etc.) along a portion of the weight. Additionally, one or more channels (e.g., a network of channels) can be formed in the club head that are sized and shaped to receive the rails, such that the weight or weights may slide along the channels from one position to another along the club head. In some embodiments, at least one tensioner and cable, and/or at least one magnet, may also be provided to help secure the weight or weights in various positions along the club head (e.g., along the channels).

[0143] In some embodiments, one or more of the weights described herein (e.g., 11082, 6882, 12082, and/or 13082) can include a port or hole to receive a protrusion from the club head body, or the weight includes a protrusion or screw to be received in a hole or port in the club head body (e.g., in a recessed region of the club head body).

[0144] Additionally, while some of the embodiments described above are described in the context of having a recessed region and/or a recessed surface on the sole of the club head body, in some embodiments the club head body may also include a recessed region, including a recessed surface, along a crown or top of the club head. Thus, while generally described above as being primarily disposed on a sole of a club head, in some embodiments the adjustable weighting systems 11066, 6866, 12066, and 13066 may instead be primarily disposed on a crown, skirt, heel, toe, or toe of the club head.

[0145] While various protrusions are illustrated and described herein as being used to couple a weight to a club head, the specific shapes and sizes of the protrusions are not limiting. Thus, varying geometries of the protrusions (e.g. tapered protrusions, or protrusions of varying sizes and shapes) may be used, including cylindrical, rectangular, square, helical, trapezoidal, pyramid, etc. Protrusions and/or corresponding apertures may be keyed to fit one another. Some of the protrusions may be wings or tabs that extend away from the club head, or may be posts. Various other types of protrusions may also be used.

[0146] While various covers, sole plates, geometric patterns, tensioners, cables, guides, clips, elongate channels, additional channels, screw apertures, and other features are described above in conjunction with a particular embodiment or embodiments, in yet other embodiments one or more of these features may be combined with a different embodiment,

or with one or more of the other features described herein, on a golf club head.

[0147] While not illustrated, in some embodiments one or more of the club heads described herein can also include additional apertures that can be filled with polymer glue or other material for additional weighting.

[0148] In some embodiments, a tool can be used to tighten, loosen, and/or remove one or more of the weights described herein. For example, in some embodiments one or more of the weights may include a specially designed or custom hole, or a specially designed socket, of sufficient size to engage with a portion of a tool (e.g., torque wrench) to facilitate engagement of the torque wrench with the weight. The hole or socket can be any suitable shape, such as star, triangle, square, slot, Phillips®, Torx®, POSIDRIV®, SUPADRIVE®, pentagon, hexagon, or any other suitable polygon or other keyed shape.

Example 1 -Adjustable Weighting System for a Driver

[0149] According to one example of the golf club head 12010 illustrated in FIGs. 9 and 10, the club head 12010 comprises a volume of 457 cubic centimeters (cc). The exemplary club head 12010 includes a recessed portion 12013 comprising a channel positioned in the trailing edge 12072 along the rear perimeter 10136. The recessed portion 12013 comprises a bottom wall or third surface 12075 having three attachment locations or features comprising threaded apertures. The attachment locations include a first attachment location or feature 12070A near the toe end 12018, a second attachment location or feature 12070C near the heel end 12022, and third attachment location or feature 12070B between the toe end 12018 and the heel end 12022.

[0150] The adjustable weighting system 12066 of the exemplary club head 12010 further comprises a first weight 12082 having a mass of 18 grams. The first weight 12082 has a height 10152 of 0.33 inch, a width 10154 of 1.18 inch, and a depth of 0.29 inch. The first weight 12082 comprises an aperture corresponding to a plurality of apertures defining the discrete attachment locations on the club head 12010. The first weight 12082 is secured to the discrete attachment location using a fastener positioned through the aperture in the first weight 12082 and the aperture in club head 12010. The fastener comprises the same material or a material having a lower density than the density of the body, such that the fastener does not significantly contribute to the club head weighting.

[0151] The first weight 12082 is positionable at the first attachment location near the toe, the second attachment location near the heel, or the third attachment location between the toe and the heel. Referring to Table 1 below, the weight center of gravity 10134 of the first weight is positioned at a distance 10142 of 0.19 inch to 0.22 inch from the rear perimeter 10136 of the club head 6710 when the first weight is positioned at the first, second, or third attachment location. Further, the weight center of gravity 10134 of the first weight is positioned at a distance 10138 of 3.26 inches to 4.41 inches from the geometric center 140 of the strike face 38 when the first weight is positioned at the first, second, or third attachment location.

[0152] Further referring to Table 1 below, the club head 6710 includes a head CG depth 10130 between 1.59 inches and 1.71 inches, and a head CG height 10132 of 0.088 inch to 0.108 inch above the head depth plane 10120. The exemplary club head 6710 further includes a moment of inertia about the x-axis I_{xx} between 3,090 and 3,770 g·cm^2, a moment of inertia about the y-axis I_{yy} between 4,936 and 5,383 g·cm^2, and a moment of inertia about the hosel axis I_{hh} between 8,815 and 10,359 g·cm^2. The combined moment of inertia of the exemplary club head 6766 about the club head CG (i.e. the sum of the moment of inertia about the x-axis and the moment of inertia about the y-axis) is between 8,023 and 9,153 g·cm^2. The combined moment of inertia of the exemplary club head 6766 about the club head CG and the hosel axis (i.e. the sum of the moment of inertia about the x-axis, the moment of inertia about the y-axis, and the moment of inertia about the hosel axis) is between 16,841 and 19,237 g·cm^2.

[0153] Further referring to Table 1 below, the exemplary club head having the adjustable weighting system 6766 has a depth to mass ratio of the club head CG depth to the mass of the first weight between 0.099 inch and 0.106 inch. Further, the exemplary club head having the adjustable weighting system 6766 has a first inertia to mass ratio of the combined moment of inertia of the club head about the head CG to the mass of the first weight between 446 and 508 cm^2. Further still, the exemplary club head having the adjustable weighting system 6766 has a head CG to mass ratio of the maximum shift in head CG to the mass of the first weight of 0.015 inch/gram. Accordingly, the adjustable weighting system 6766 of the exemplary club head 6710 maximizes head CG depth, moment of inertia, and head CG shift by a user, without the use of a large and heavy weight necessitating sizeable weight structures.

Table 1: Weighting Properties of Exemplary Golf Club Head 6710

First weight position	First position (toe)	Second position (heel)	Third position (center)
W_{CG}-perimeter 10142 (inch)	0.19	0.22	0.21
W_{CG}-face center 10138 (inch)	4.19	3.26	4.41
CG_D 10130 (inch)	1.67	1.59	1.72

(continued)

First weight position	First position (toe)	Second position (heel)	Third position (center)
CG_H 10132 (inch above head depth plane 10120)	0.108	0.088	0.086
I_{xx} (g·cm^2)	3457	3090	3770
I_{yy} (g·cm^2)	5369	4936	5383
I_{hh} (g·cm^2)	10359	8815	10084
$I_{xx}+I_{yy}$ (g·cm^2)	8826	8026	9153
$I_{xx}+I_{yy}+I_{hh}$ (g·cm^2)	19185	16841	19237
CG_D/mass (inch/g)	0.104	0.099	0.106
$I_{xx}+I_{yy}$/mass (cm^2)	490	446	508
Max CG shift/mass (in/g)	0.015	0.015	0.015

[0154] Moving the weight between the first, second, and third discrete attachment locations results in a maximum shift in the club head center of gravity of 0.27 inch. The maximum shift in center of gravity of the exemplary club head 6710 results in a total trajectory change of up to 12.4 yards (i.e. when shifting the first weight from the first to the second attachment location, or from the second to the first attachment location). Accordingly, shifting the weight from the third attachment location to the second attachment location can change the trajectory of a golf ball 6.2 yards to correct for a slice or generate a draw. Further, shifting the weight from the third attachment location to the first attachment location can change the trajectory of a golf ball 6.2 yards to correct for a hook or generate a fade.

[0155] Clause 1: A golf club head comprising a club head body having a toe end, a heel end located opposite the toe end, a crown, a sole located opposite the crown, a strike face, a back end located opposite the strike face, and a perimeter positioned at a junction between the crown and the sole extending from near the heel end to near the toe end, and an adjustable weighting system positioned on the sole, the perimeter, or a combination thereof, the adjustable weighting system including: a recessed portion having an arcuate shape, generally following the contour of the perimeter of the golf club head, the recessed portion comprising a maximum depth of 0.25 inch; a plurality of discrete attachment locations positioned on the recessed portion; and one or more weights, each having a weight center of gravity, wherein each weight is configured to be coupled to one of the plurality of discrete attachment locations, and each weight is configured to be moveable between the plurality of discrete attachment locations to shift a center of gravity of the club head; wherein: the one or more weights are positioned within 0.50 inch of the perimeter of the club head when the weight is coupled to at least one of the discrete attachment locations; the one or more weights are positioned such that the weight center of gravity of each weight is inset from the external contour of the club head by a distance less than 0.125 inch; and a combined moment of inertia of the club head about the club head center of gravity, defined as the sum of a crown-to-sole moment of inertia and a heel-to-toe moment of inertia, is greater than 8,000 g·cm^2.

[0156] Clause 2: The golf club head of clause 1, wherein the plurality of discrete attachment locations are selected from the group consisting of: a plurality of protruding bodies, a plurality of recesses, a plurality of apertures, a plurality of notches, a plurality of tabs, a plurality of cutout regions, a plurality of ribs, a plurality of grooves, and a plurality of hooks.

[0157] Clause 3: The golf club head of clause 2, wherein the plurality of discrete attachment locations comprise a plurality of threaded apertures configured to receive a fastener.

[0158] Clause 4: The golf club head of clause 1, wherein the one or more weights comprise a first weight between 10 grams and 20 grams.

[0159] Clause 5: The golf club head of clause 1, wherein the adjustable weighting system further comprises a first attachment location positioned toward the back end and the toe end, a second attachment location positioned toward the back end and the heel end, and a third attachment location positioned centrally and toward the back end.

[0160] Clause 6: The golf club head of clause 5, wherein shifting the first weight from the first attachment location to the second attachment location shifts the center of gravity of the club head by a distance of at least 0.10 inch.

[0161] Clause 7: The golf club head of clause 6, wherein the center of gravity of the club head is greater than 1.65 inch when the first weight is positioned in any of the first attachment location, the second attachment location, and the third attachment location.

[0162] Clause 8: The golf club head of clause 1, further comprising a depth to mass ratio defined as the ratio of the combined moment of inertia to the mass of the first weight, wherein the depth to mass ratio is greater than 0.060 inch/gram.

[0163] Clause 9: The golf club head of clause 1, wherein the recessed portion comprises a channel extending in a direction from near the toe end to near the heel end of the club head.

[0164] Clause 10: The golf club head of clause 9, wherein a depth of the channel varies from near the toe end to near the heel end of the club head.

[0165] Clause 11: The golf club head of clause 9, wherein a width of the channel varies from near the toe end to near the heel end of the club head.

[0166] Clause 12: A golf club head comprising a club head body having a toe end, a heel end located opposite the toe end, a crown, a sole located opposite the crown, a strike face, a back end located opposite the strike face, and a perimeter positioned at a junction between the crown and the sole extending from near the heel end to near the toe end, and an adjustable weighting system positioned on the sole, the perimeter, or a combination thereof, the adjustable weighting system including: a recessed portion extending in a V-shape and comprising a maximum depth of 0.25 inch; a plurality of discrete attachment locations positioned on the recessed portion; and one or more weights, each having a weight center of gravity, wherein each weight is configured to be coupled to one of the plurality of discrete attachment locations, and each weight is configured to be moveable between the plurality of discrete attachment locations to shift a center of gravity of the club head; wherein: the one or more weights are positioned within 0.50 inch of the perimeter of the club head when the weight is coupled to at least one of the discrete attachment locations the one or more weights are positioned such that the weight center of gravity of each weight is inset from the external contour of the club head by a distance less than 0.125 inch; and a combined moment of inertia of the club head about the club head center of gravity, defined as the sum of a crown-to-sole moment of inertia and a heel-to-toe moment of inertia, is greater than 8,000 $g \cdot cm^2$.

[0167] Clause 13: The golf club head of clause 12, wherein the plurality of discrete attachment locations are selected from the group consisting of: a plurality of protruding bodies, a plurality of recesses, a plurality of apertures, a plurality of notches, a plurality of tabs, a plurality of cutout regions, a plurality of ribs, a plurality of grooves, and a plurality of hooks.

[0168] Clause 14: The golf club head of clause 13, wherein the plurality of discrete attachment locations comprise a plurality of threaded apertures configured to receive a fastener.

[0169] Clause 15: The golf club head of clause 12, wherein the one or more weights comprise a first weight between 10 grams and 20 grams.

[0170] Clause 16: The golf club head of clause 12, wherein the adjustable weighting system further comprises a first attachment location positioned near the back end, a second attachment location positioned at a center of the sole, and a third attachment location positioned near the heel end.

[0171] Clause 17: The golf club head of clause 16, wherein shifting the first weight from the first attachment location to the second attachment location shifts the center of gravity of the club head by a distance of at least 0.10 inch.

[0172] Clause 18: The golf club head of clause 17, wherein the center of gravity of the club head is greater than 1.65 inch when the first weight is positioned in any of the first attachment location, the second attachment location, and the third attachment location.

[0173] Clause 19: The golf club head of clause 12, further comprising a depth to mass ratio defined as the ratio of the combined moment of inertia to the mass of the first weight, wherein the depth to mass ratio is greater than 0.060 inch/gram.

[0174] Clause 20: The golf club head of clause 12, wherein the recessed portion comprises a channel extending in a direction from near the toe end to near the heel end of the club head.

[0175] Clause 21: The golf club head of clause 20, wherein a depth of the channel varies from near the toe end to near the heel end of the club head.

[0176] Clause 22: The golf club head of clause 20, wherein a width of the channel varies from near the toe end to near the heel end of the club head.

[0177] Clause 23: A golf club head comprising a club head body having a toe end, a heel end located opposite the toe end, a crown, a sole located opposite the crown, a strike face, a back end located opposite the strike face, and a perimeter positioned at a junction between the crown and the sole extending from near the heel end to near the toe end, and an adjustable weighting system positioned on the sole, the perimeter, or a combination thereof, the adjustable weighting system including: a recessed portion having a rectangular shape, extending from the toe end to the heel end, the recessed portion comprising a maximum depth of 0.25 inch; a plurality of discrete attachment locations positioned on the recessed portion; a cable; a tensioner positioned within an aperture of the sole, operable to increase or decrease tension in the cable, and one or more weights coupled to the cable, each weight having a weight center of gravity, wherein each weight is configured to be coupled to one of the plurality of discrete attachment locations, and each weight is configured to be moveable between the plurality of discrete attachment locations to shift a center of gravity of the club head; wherein: the one or more weights are positioned such that the weight center of gravity of each weight is inset from the external contour of the club head by a distance less than 0.125 inch; and a combined moment of inertia of the club head about the club head center of gravity, defined as the sum of a crown-to-sole moment of inertia and a heel-to-toe moment of inertia, is greater than 8,000 $g \cdot cm^2$.

[0178] Clause 24: The golf club head of clause 23, further comprising a first attachment location positioned near the toe end, a second attachment location positioned near the heel end, and a third attachment location positioned between the first and second attachment locations.

[0179] Clause 25: The golf club head of clause 23, wherein the tensioner comprises a fastener having a notch to receive the cable.

[0180] Clause 26: The golf club head of clause 23, wherein the cable comprises a metallic material selected from the group consisting of steel wire rope, aluminum wire rope, copper wire rope, tungsten wire rope, nickel wire rope, steel wire with polymeric coating, and silver wire rope.

[0181] Clause 27: The golf club head of clause 23, wherein the cable comprises a non-metallic material selected from the group consisting of baling twine, parachute cord material, nylon, Kevlar, and polymer tweed.

[0182] Clause 28: The golf club head of clause 23, wherein the one or more weights comprise a through hole configured to house the cable.

[0183] Clause 29: The golf club head of clause 23, wherein the tensioner is flush with an outer surface of the sole when the cable has reached maximum tension.

[0184] 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, unless such benefits, advantages, solutions, or elements are expressly stated in such claims.

[0185] 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.

[0186] While the above examples may be described in connection with a wood-type golf club, the apparatus, methods, and articles of manufacture described herein may be applicable to a variety of types of golf clubs including drivers, fairway woods, hybrids, crossovers, or any hollow body type golf clubs. Alternatively, the apparatus, methods, and articles of manufacture described herein may be applicable to other types of sports equipment such as a hockey stick, a tennis racket, a fishing pole, a ski pole, etc.

[0187] 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.

[0188] Although the invention has been described in detail with reference to certain preferred embodiments, variations and modifications exist within the scope and spirit of one or more independent aspects of the invention as described.

Claims

1. A golf club head comprising:

a club head body having a toe end, a heel end located opposite the toe end, a crown, a sole located opposite the crown, a strike face, a back end located opposite the strike face, and a perimeter positioned at a junction between the crown and the sole extending from near the heel end to near the toe end; and
an adjustable weighting system positioned on the sole, the perimeter, or a combination thereof, the adjustable weighting system including:

a recessed portion having an arcuate shape, generally following the contour of the perimeter of the golf club, the recessed portion comprising three discrete attachment locations; and
one weight configured to be coupled to one of the three discrete attachment locations, and the weight is configured to be moveable between the three discrete attachment locations to shift a center of gravity of the club head;

wherein:

the one or more weights are positioned within 0.50 inch of the perimeter of the club head when the weight is coupled to at least one of the discrete attachment locations; and
a combined moment of inertia of the club head about a club head center of gravity, defined as the sum of a crown-to-sole moment of inertia and a heel-toe-toe moment of inertia, is greater than 8,000 g cm^2.

2. The golf club head of claim 1, wherein the discrete attachment locations are selected from the group consisting of: protruding bodies, recesses, apertures, notches, tabs, cutout regions, ribs, grooves, and hooks.

3. The golf club head of claim 2, wherein the discrete attachment locations comprise threaded apertures configured to receive a fastener.

4. The golf club head of claim 3, wherein the fastener comprises the same material as the body.

5. The golf club head of claim 3, wherein the fastener comprises a material having a lighter density than the body.

6. The golf club head of claim 1, wherein the weight comprises a mass between 10 grams to 20 grams.

7. The golf club head of claim 1, wherein the weight is flush with the external contour of the sole.

8. The golf club head of claim 1, wherein the adjustable weighting system further comprises a first attachment location positioned toward the back end and the toe end, a second attachment location positioned toward the back end and the heel end, and a third attachment location positioned centrally and towards the back end.

9. The golf club head of claim 5, wherein shifting the weight from the first attachment location to the second attachment location shifts the center of gravity of the club head by a distance of at least 0.10 inch.

10. The golf club head of claim 1, wherein a weight center of gravity is positioned at a distance greater than 2.5 inches from a geometric center of the strike face.

11. The golf club head of claim 1, wherein a head CG depth is greater than 1.6 inches.

12. The golf club head of claim 1, further comprising a depth to mass ratio defined as the ratio of a head CG depth to the mass of the weight, wherein the depth to mass ratio is greater than 0.060 inch/gram.

13. The golf club head of claim 1, the distance between adjacent discrete attachment locations is greater than 0.4 inch.

14. The golf club head of claim 1, further comprising an inertia to mass ratio defined as the ratio of the combined moment of inertia to the mass of the weight, wherein the inertia to mass ratio is greater than 400 cm^2.

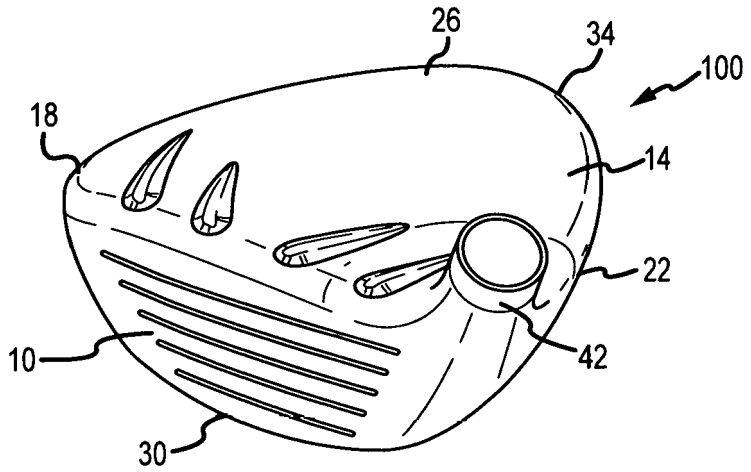


FIG.1

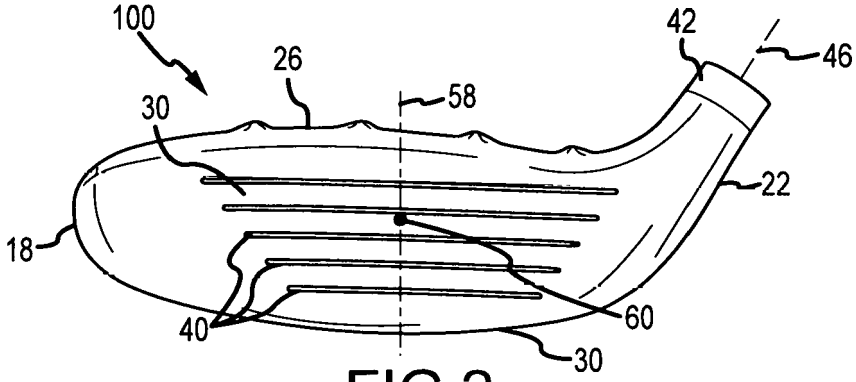
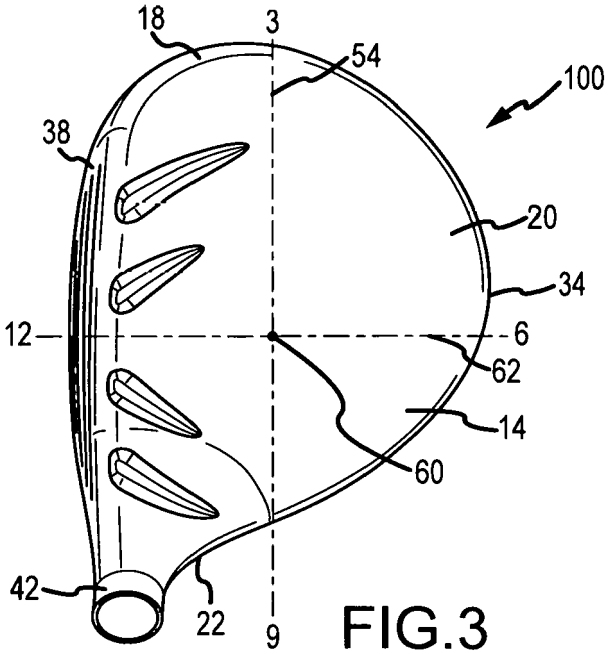


FIG.2



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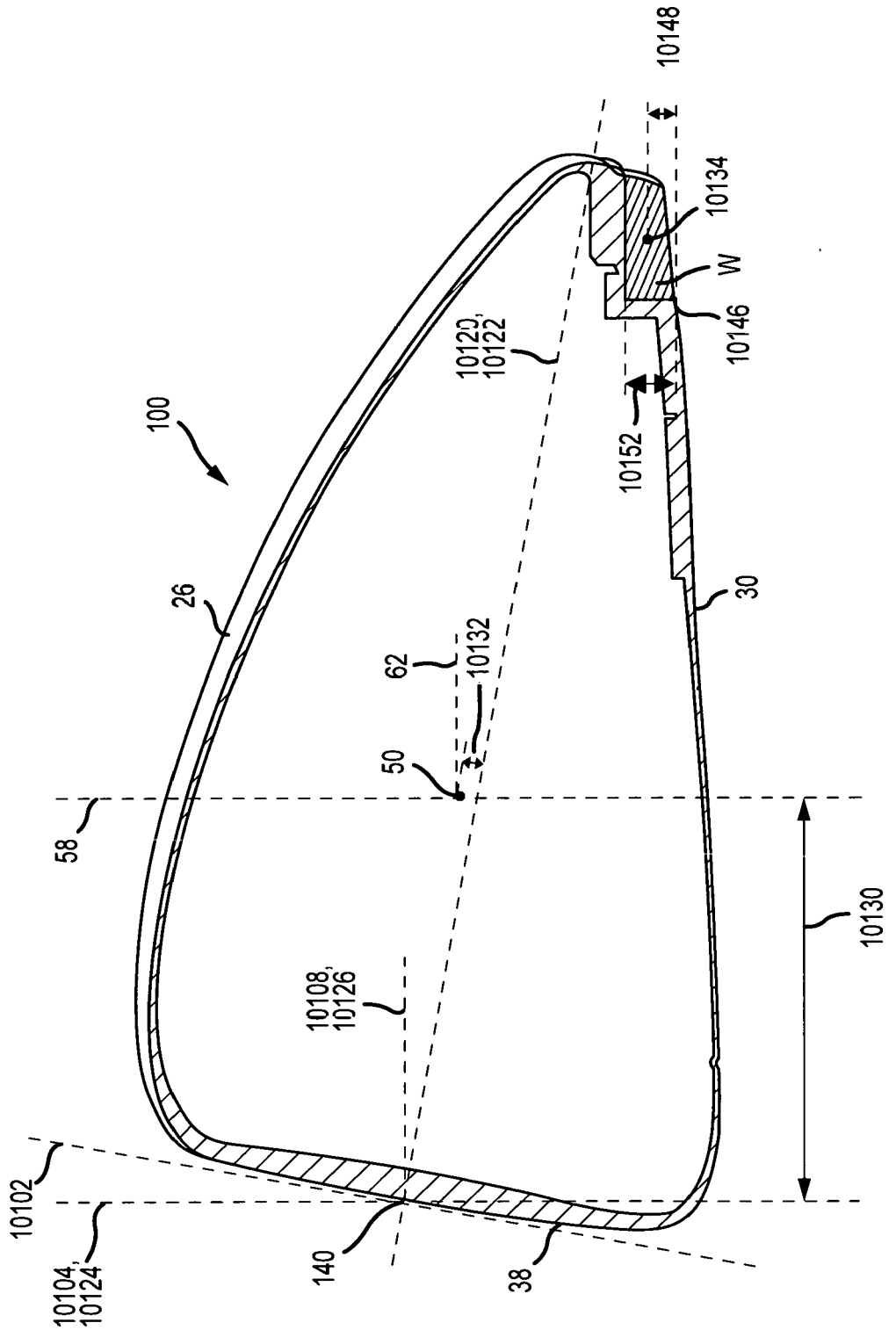
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FIG.4

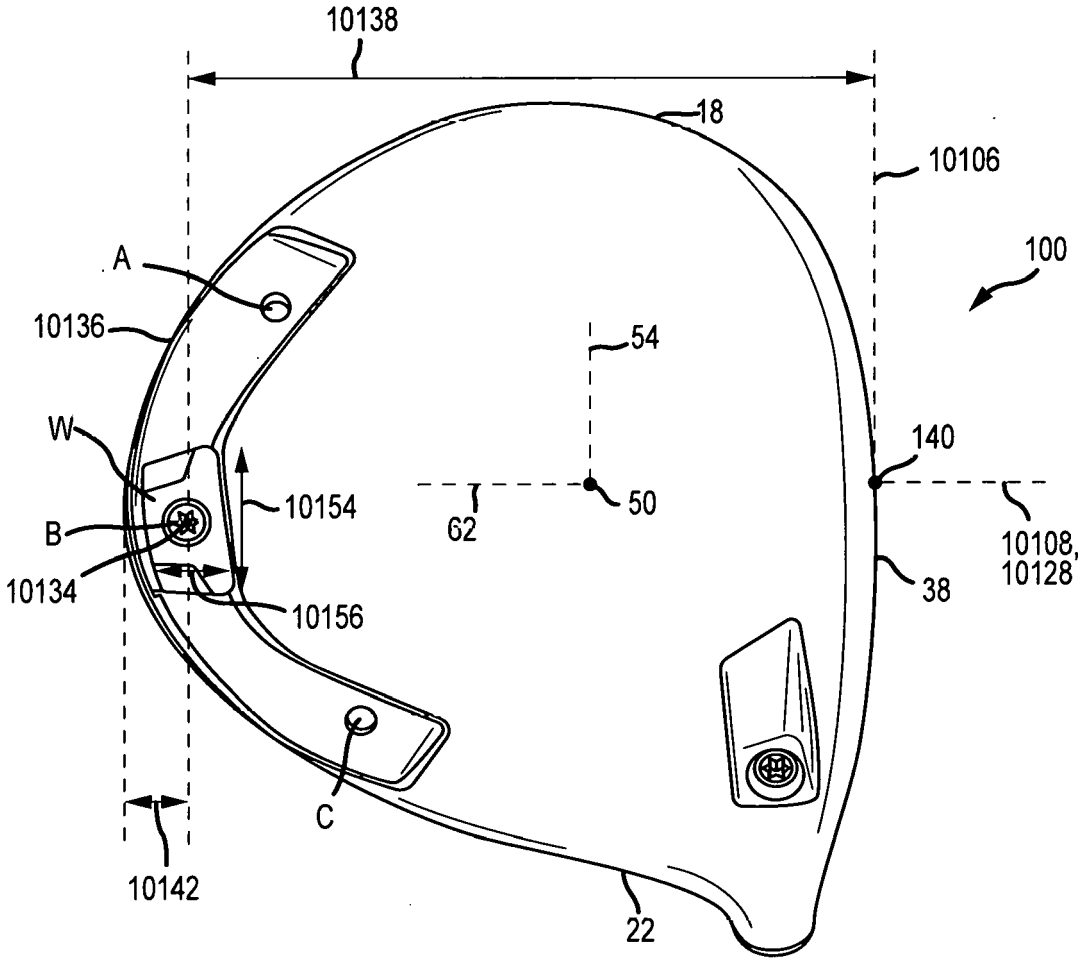
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FIG.5

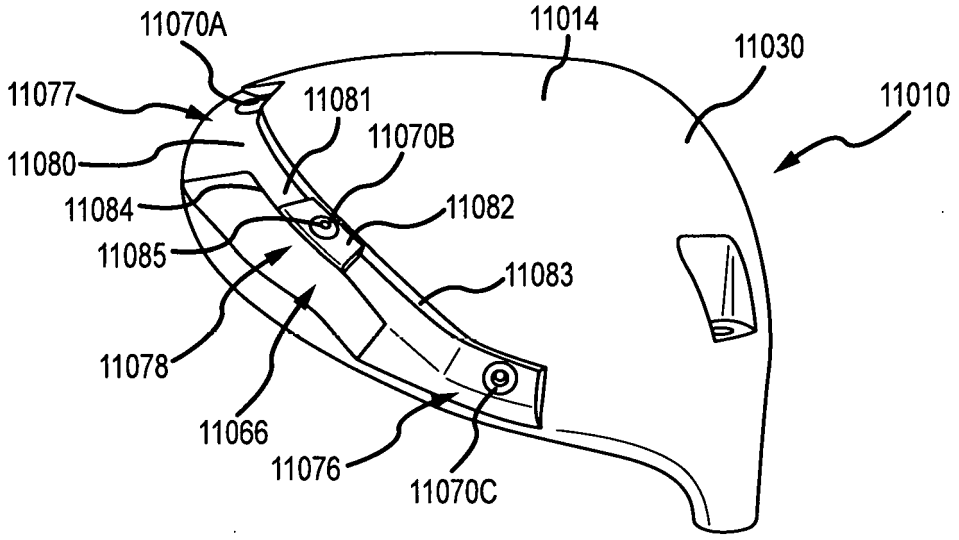
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FIG.6

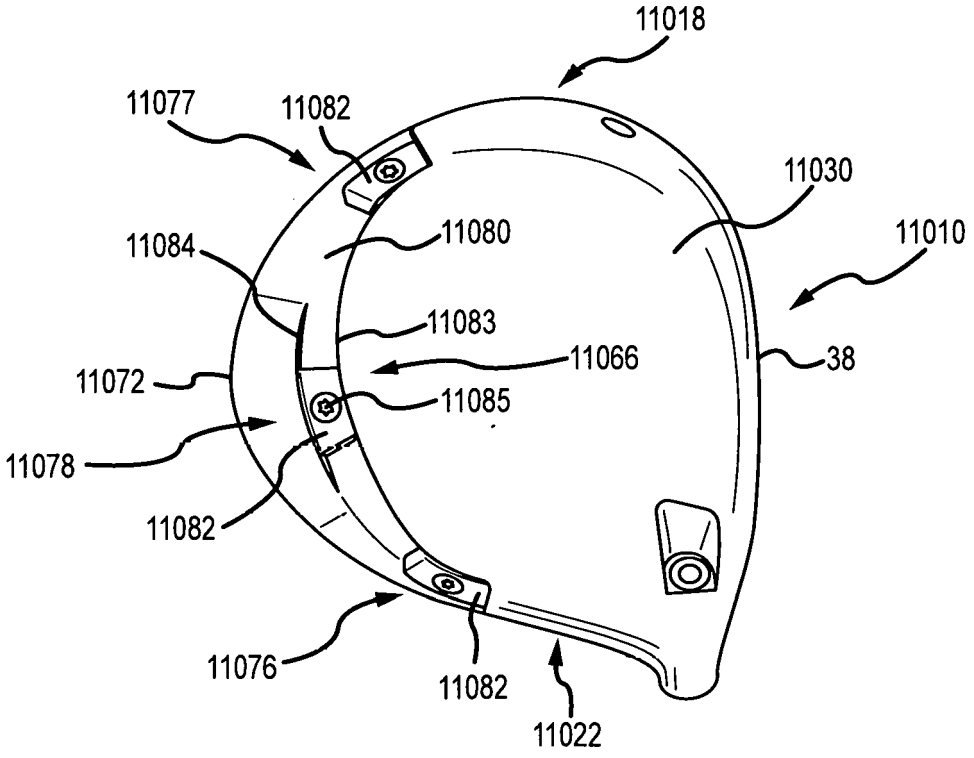
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FIG.7

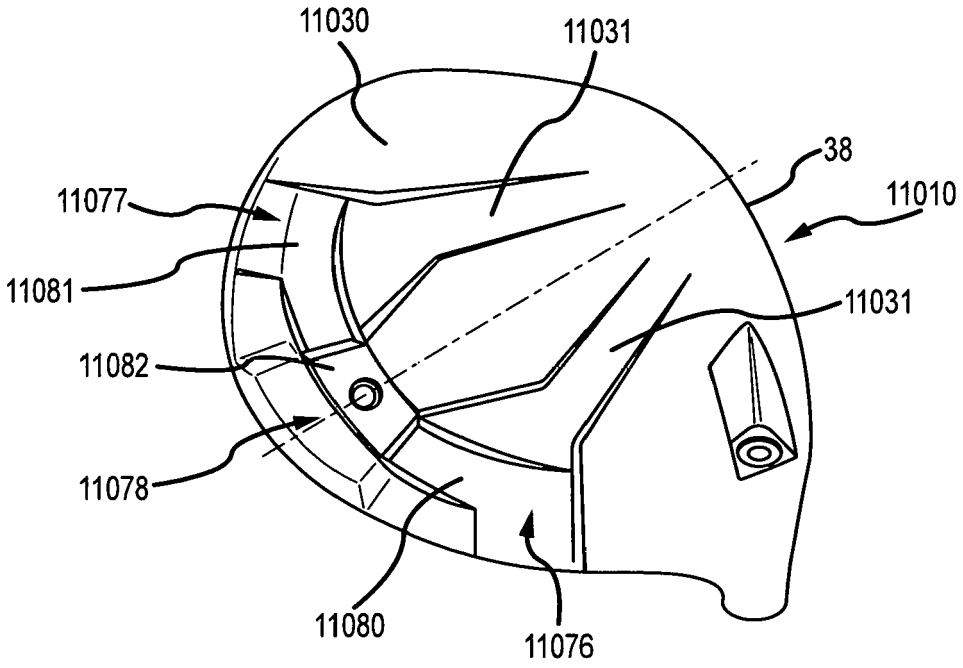
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FIG.8

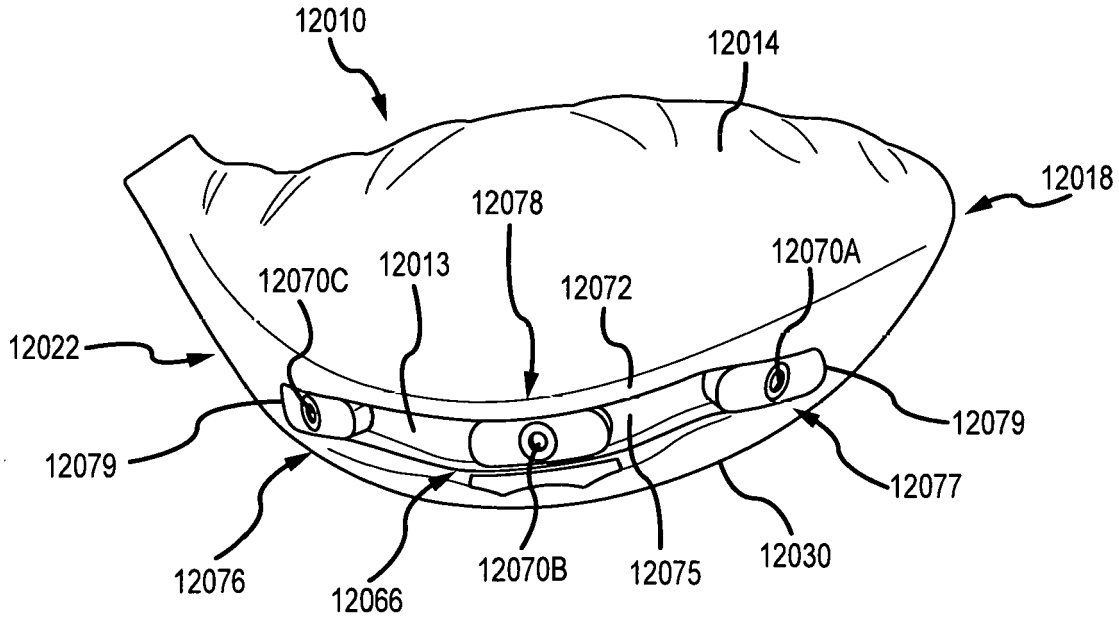
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FIG.9

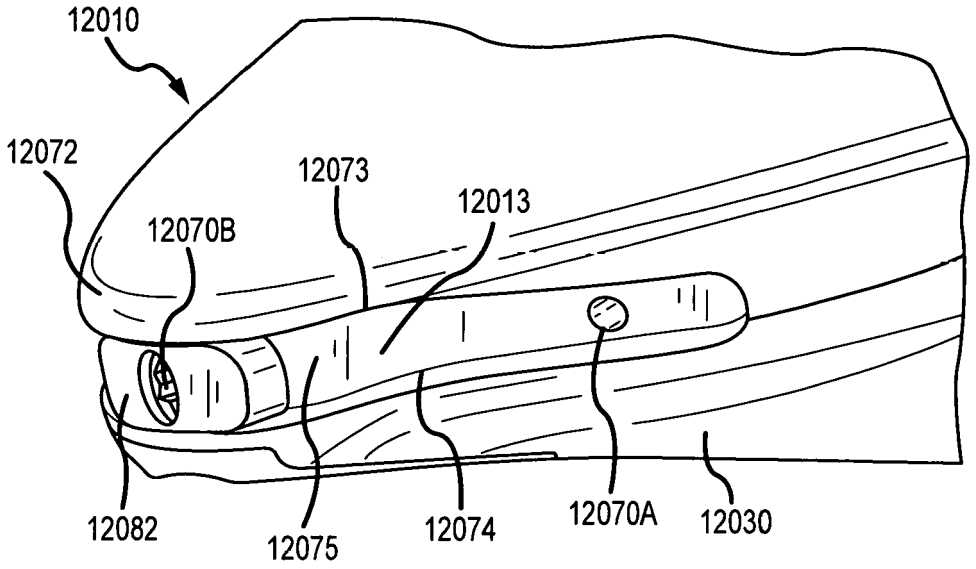
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FIG.10

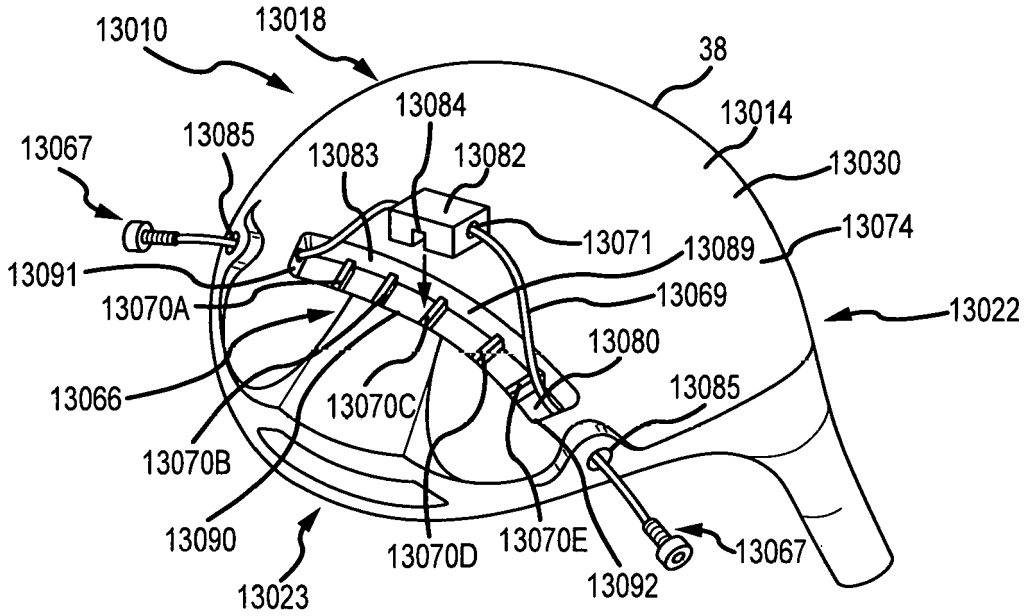
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FIG.11

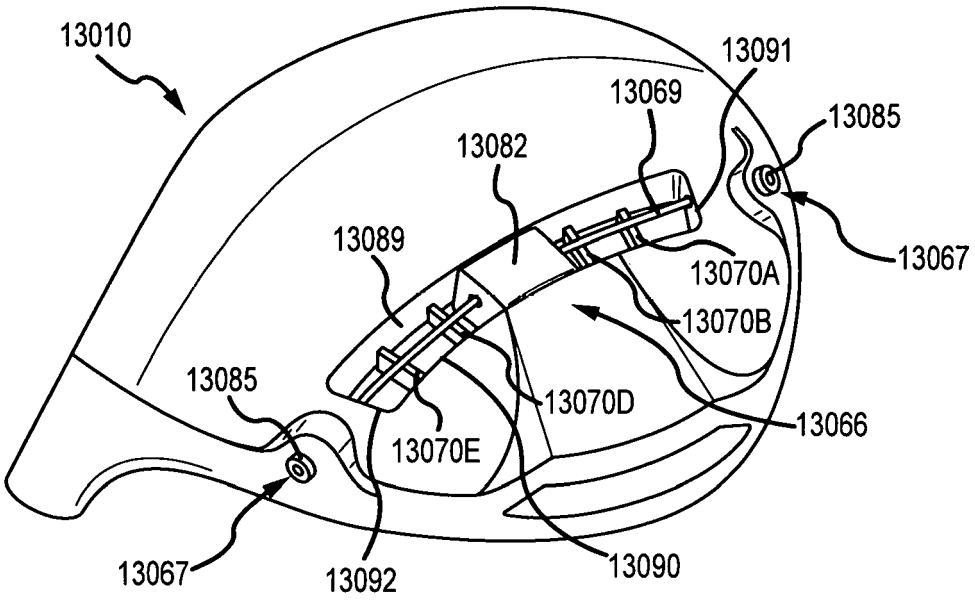
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FIG.12

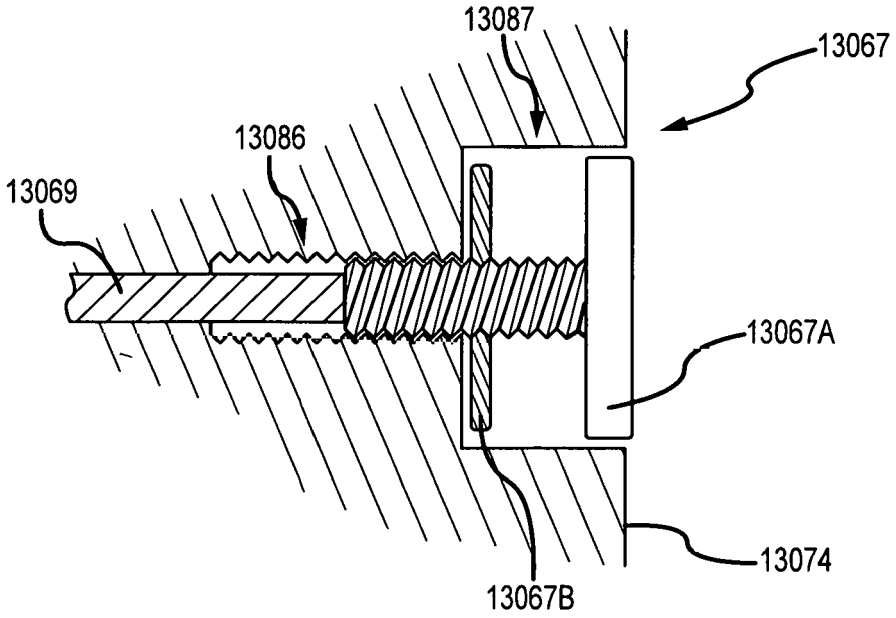
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FIG.13

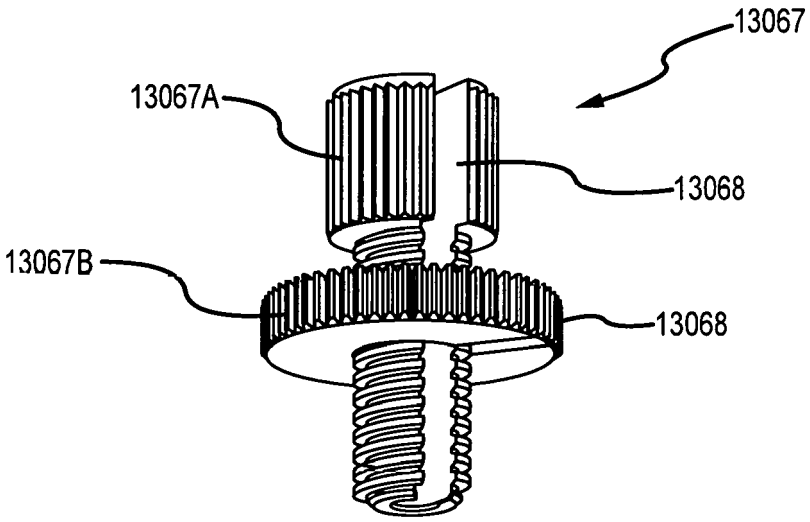

FIG.14

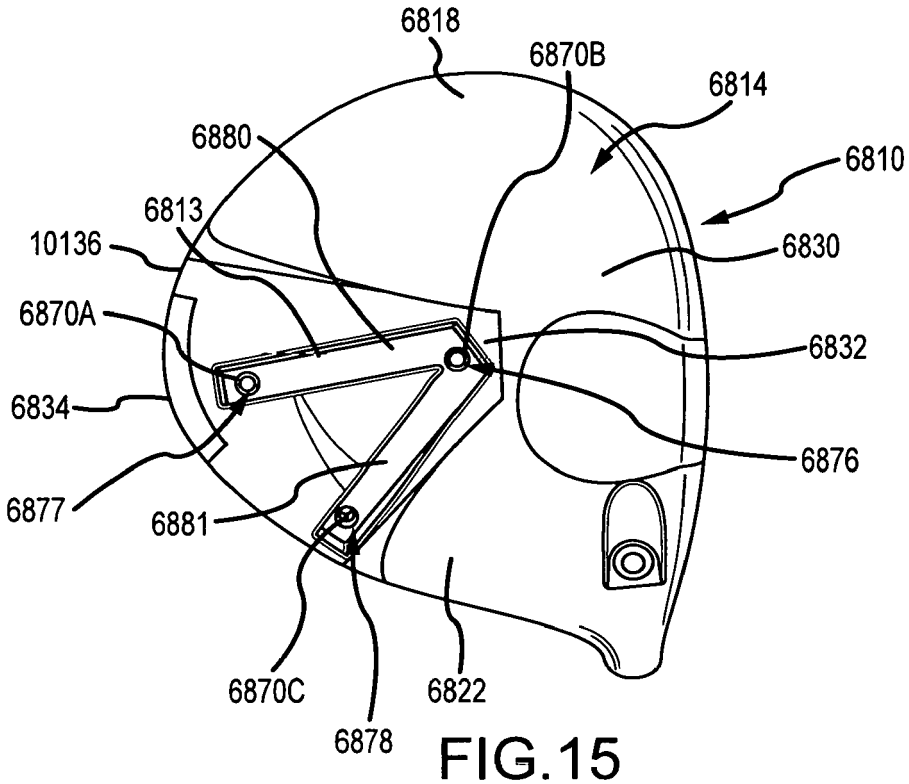
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FIG.15

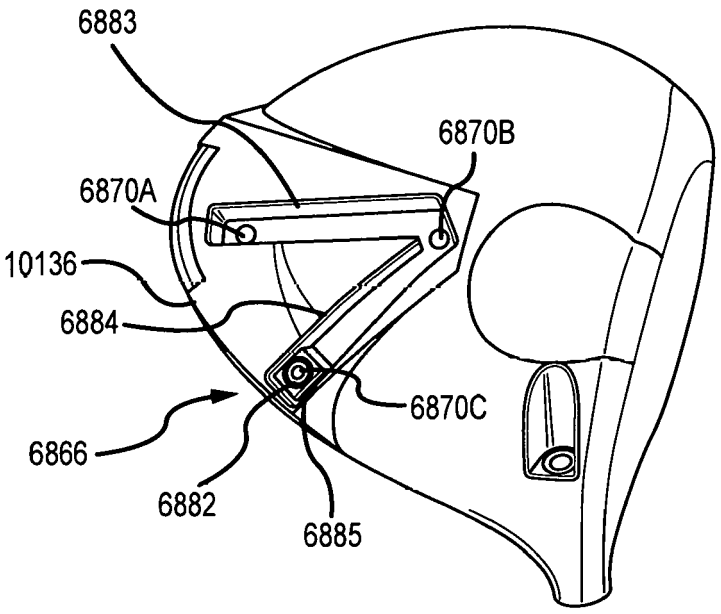
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FIG.16

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EUROPEAN SEARCH REPORT

Application Number
EP 23 16 9250

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Y	* claim 1; figures 1-4B *	3-5	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	20 June 2023	Roche, Olivier

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