(12) **United States Patent**

(10) **Patent No.:** [redacted]

(45) **Date of Patent:** ***Oct. 20, 2020**

(54) **GOLF CLUB**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

[redacted]

(58) [redacted]

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,398,965 A	8/1983	Campau
4,438,931 A	3/1984	Motomiya
4,461,481 A	7/1984	Kim
4,511,145 A	4/1985	Schmidt

(Continued)

FOREIGN PATENT DOCUMENTS

CN	2436182	6/2001
CN	201353407	12/2009

(Continued)

OTHER PUBLICATIONS

Adams Golf Speedline F11 Ti 14.5 degree fairway wood, 2pp. (www.bombsquadgolf.com, posted Oct. 18, 2010).

(Continued)

Primary Examiner — Vishu K Mendiratta

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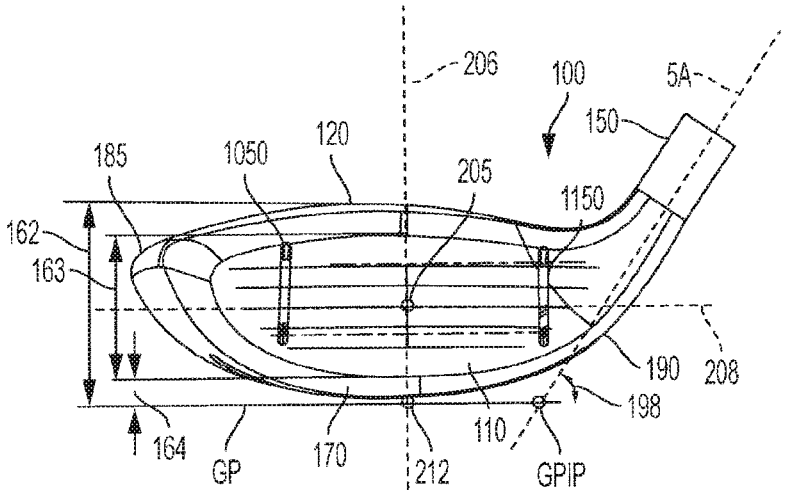
(57) **ABSTRACT**

A golf club head includes a golf club body, a hosel connected to a heel portion of the golf club body, a face connected to a front of the golf club body, the face including an inner surface, an outer surface, and at least one boundary condition feature.

15 Claims, 8 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

4,869,508	A	9/1989	Miller	
D307,455	S	4/1990	Boone	
D307,617	S	5/1990	Boone	
5,050,879	A	9/1991	Sun et al.	
5,133,553	A	7/1992	Divnick	
D331,087	S	11/1992	Fenton	
D339,397	S	9/1993	Iinuma	
D340,753	S	10/1993	Miesch	
D345,775	S	4/1994	Poincenot et al.	
D349,142	S	7/1994	Boone	
D350,581	S	9/1994	Boone	
D350,583	S	9/1994	Boone	
5,419,556	A	5/1995	Take	
D381,726	S	7/1997	Sugo	
5,681,227	A	10/1997	Sayrizi	
D388,143	S	12/1997	Huan-Chiang	
5,709,615	A	1/1998	Liang	
5,718,641	A	2/1998	Lin	
D398,353	S	9/1998	Wooten	
6,348,013	B1	2/2002	Kosmatka	
D464,387	S	10/2002	Rollinson et al.	
D464,693	S	10/2002	Rollinson et al.	
6,558,273	B2	5/2003	Kobayashi et al.	
6,605,007	B1	8/2003	Bissonnette	
6,638,180	B2	10/2003	Tsurumaki	
6,663,506	B2	12/2003	Nishimoto et al.	
D496,419	S	9/2004	Lang et al.	
D498,277	S	11/2004	Lang et al.	
6,835,145	B2	12/2004	Tsurumaki	
D501,903	S	2/2005	Tanaka	
6,887,165	B2	5/2005	Tsurumaki	
D512,757	S	12/2005	Cleveland et al.	
D518,123	S	3/2006	Jones et al.	
D526,038	S	8/2006	Kelley	
D532,848	S	11/2006	Cleveland et al.	
D537,894	S	3/2007	Cleveland et al.	
7,273,423	B2	9/2007	Imamoto	
D552,702	S	10/2007	Cameron	
D556,278	S	11/2007	Mahaffey et al.	
7,294,064	B2	11/2007	Tsurumaki et al.	
D563,497	S	3/2008	Mahaffey et al.	
D565,685	S	4/2008	Homma	
D574,456	S	8/2008	Chen et al.	
D589,107	S	3/2009	Oldknow	
7,500,924	B2	3/2009	Yokota	
7,530,901	B2	5/2009	Imamoto et al.	
7,563,175	B2	7/2009	Nishitani et al.	
7,572,193	B2	8/2009	Yokota	
7,582,024	B2	9/2009	Shear	
D611,555	S	3/2010	Oldknow	
D612,004	S	3/2010	Oldknow	
D612,440	S	3/2010	Oldknow	
D613,358	S	4/2010	Kim et al.	
D622,336	S	8/2010	Kohno	
D628,257	S	11/2010	Albertsen et al.	
7,857,711	B2 *	12/2010	Shear	A63B 53/0466 473/329
D630,278	S	1/2011	Albertsen et al.	
D630,696	S	1/2011	Albertsen et al.	
D631,119	S	1/2011	Albertsen et al.	
D655,363	S	3/2012	Vrska	
8,277,337	B2	10/2012	Shimazaki	
D675,272	S	1/2013	Greensmith et al.	
D686,679	S	7/2013	Greensmith et al.	
D691,685	S	10/2013	Cyrulik et al.	
D692,077	S	10/2013	Greensmith et al.	
D696,366	S	12/2013	Milo et al.	
D696,367	S	12/2013	Taylor et al.	
D697,152	S	1/2014	Harbert et al.	
D707,766	S	6/2014	Wolfe et al.	
D708,278	S	7/2014	Saliba et al.	
D708,279	S	7/2014	Saliba et al.	
D737,913	S	9/2015	Taylor et al.	
10,065,082	B2 *	9/2018	James	A63B 53/0466
2002/0055396	A1	5/2002	Nishimoto et al.	
2002/0123394	A1	9/2002	Tsurumaki	
2004/0176183	A1	9/2004	Tsurumaki	
2004/0192463	A1	9/2004	Tsurumaki et al.	
2007/0026961	A1	2/2007	Hou	
2007/0049417	A1	3/2007	Shear	
2010/0113176	A1	5/2010	Boyd et al.	
2011/0151989	A1	6/2011	Golden et al.	
2011/0151997	A1	6/2011	Shear	
2011/0218053	A1	9/2011	Tang et al.	
2011/0294599	A1	12/2011	Albertsen et al.	
2012/0270676	A1	10/2012	Burnett et al.	
2013/0331201	A1	12/2013	Wahl et al.	
2014/0256461	A1	9/2014	Beach et al.	

FOREIGN PATENT DOCUMENTS

JP	4180778	6/1992
JP	2000014841	1/2000
JP	2001054595	2/2001
JP	2001170225	6/2001
JP	2001204856	7/2001
JP	2001346918	12/2001
JP	2002003969	1/2002
JP	2002017910	1/2002
JP	2002052099	2/2002
JP	2002248183	9/2002
JP	2002253706	9/2002
JP	2003038691	2/2003
JP	2003126311	5/2003
JP	2003226952	8/2003
JP	2004174224	6/2004
JP	2004183058	7/2004
JP	2004-351173	12/2004
JP	2005028170	2/2005
JP	04128970	7/2008
JP	2009000281	1/2009

OTHER PUBLICATIONS

Non-Final Office action, U.S. Appl. No. 29/416,410, 9pp. (dated Nov. 23, 2012).

Non-Final Office action, U.S. Appl. No. 29/416,411, 9pp. (dated Nov. 21, 2012).

* cited by examiner

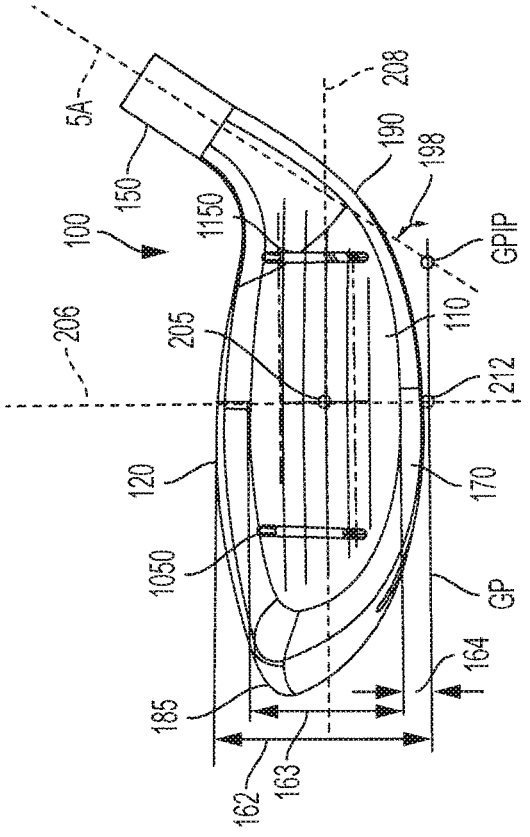


FIG. 1B

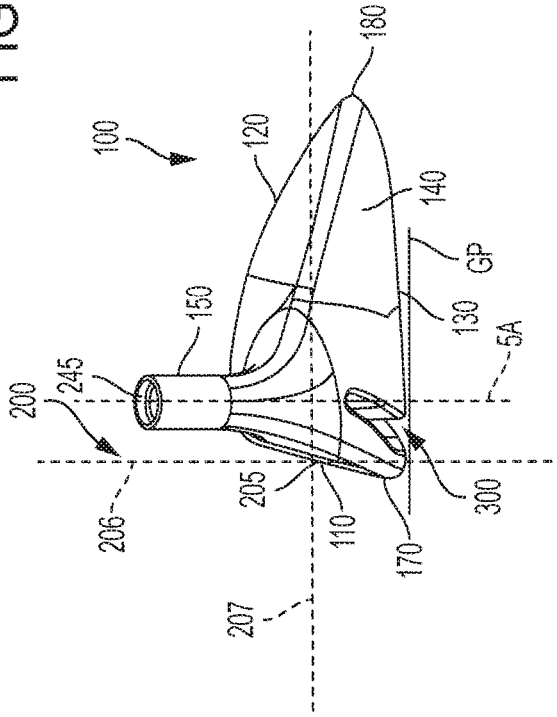


FIG. 1A

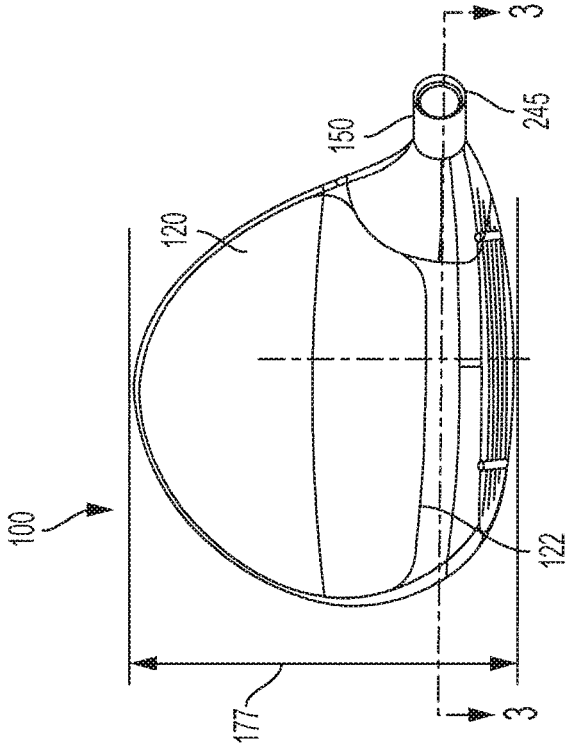


FIG. 1C

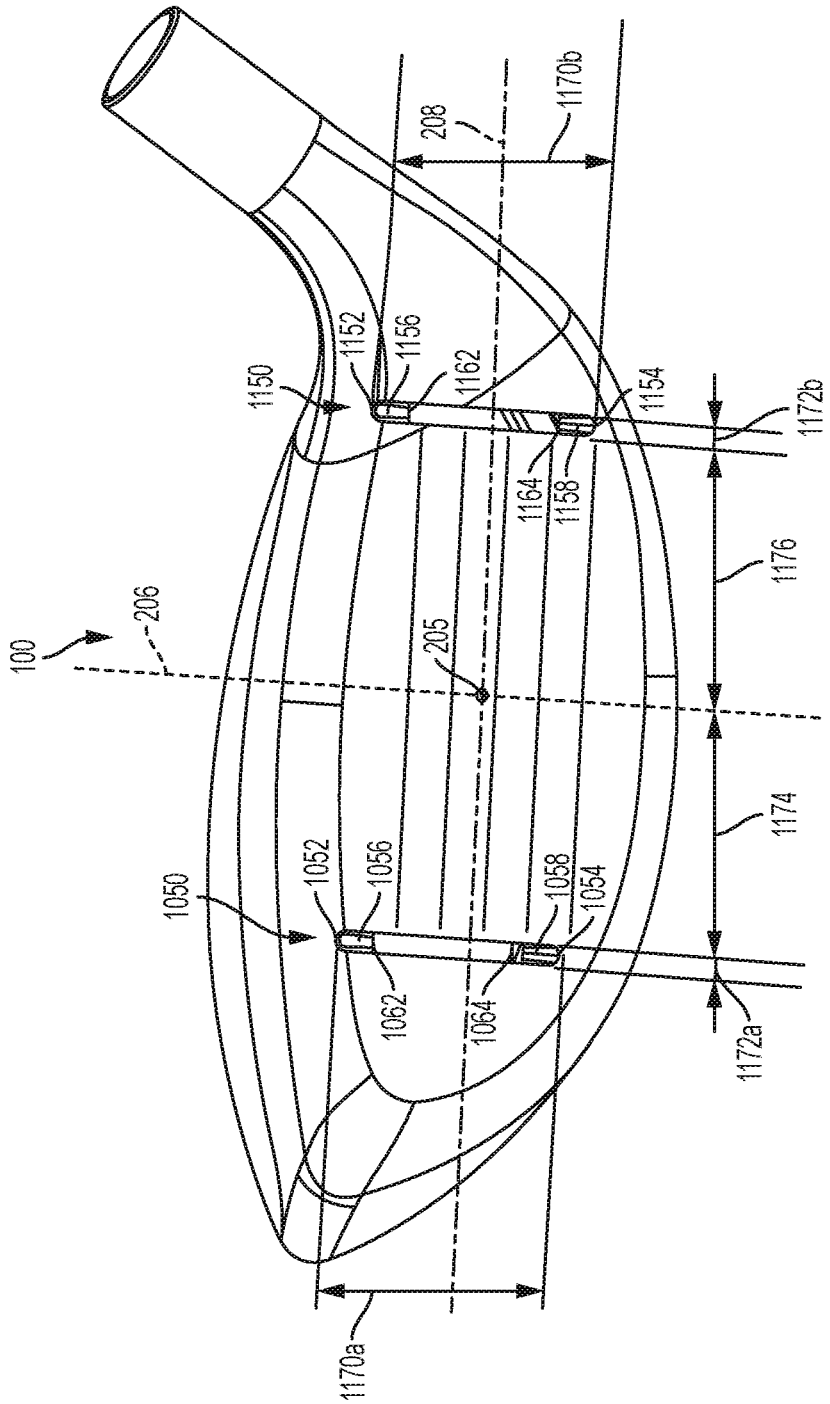

100
206
208
205
1150
1152
1156
1162
1154
1158
1164
1170b
1172b
1176
1174
1050
1052
1056
1058
1054
1062
1064
1172a
1170a

FIG. 2

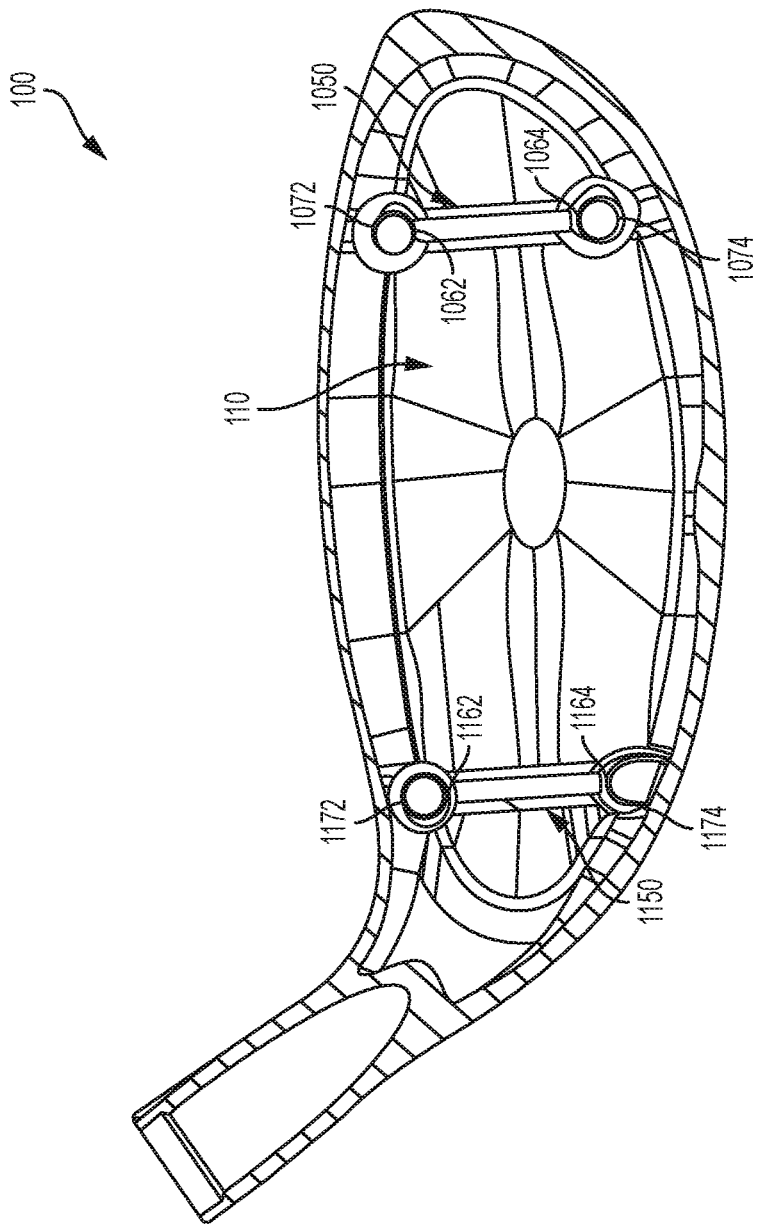


FIG. 3

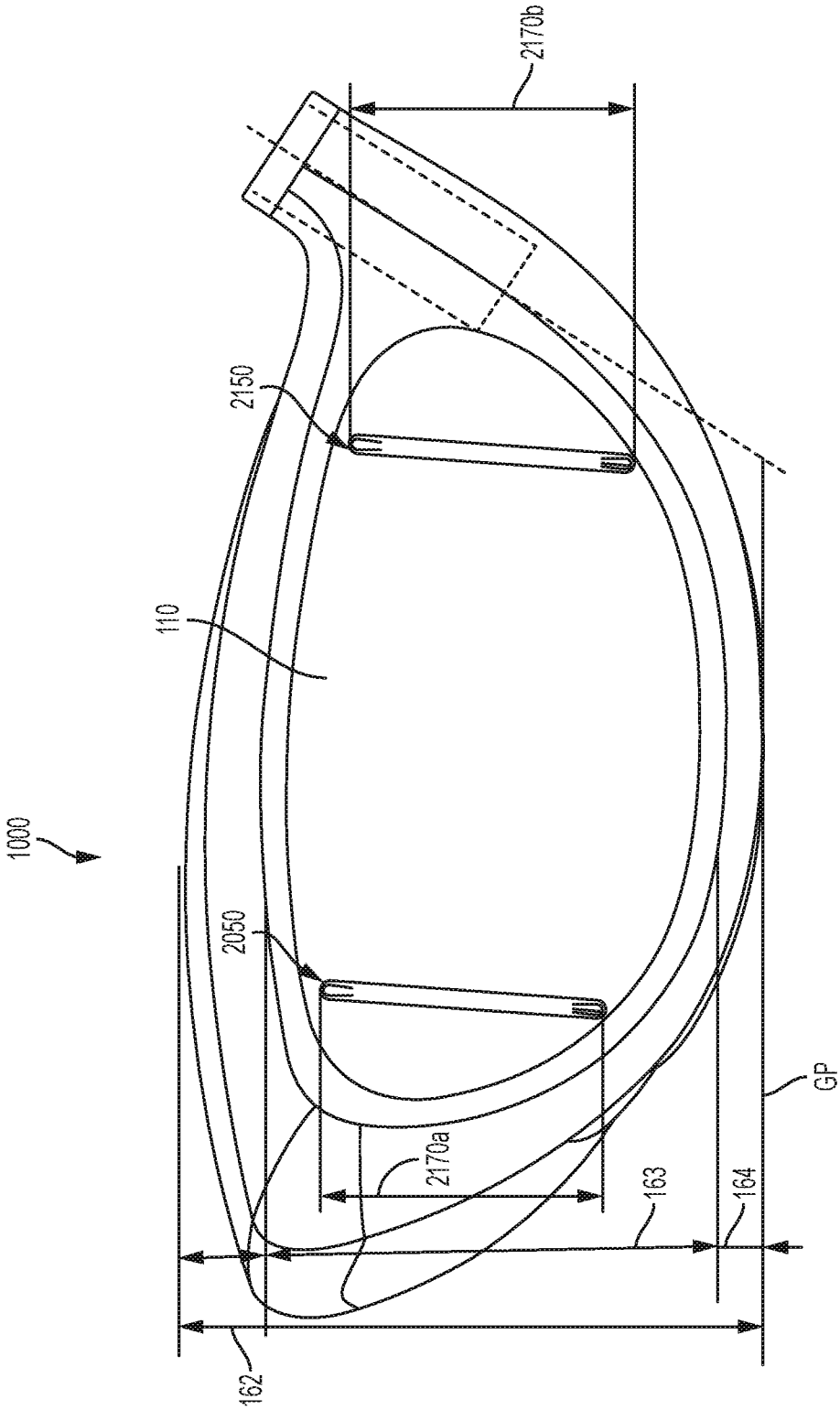


FIG. 4

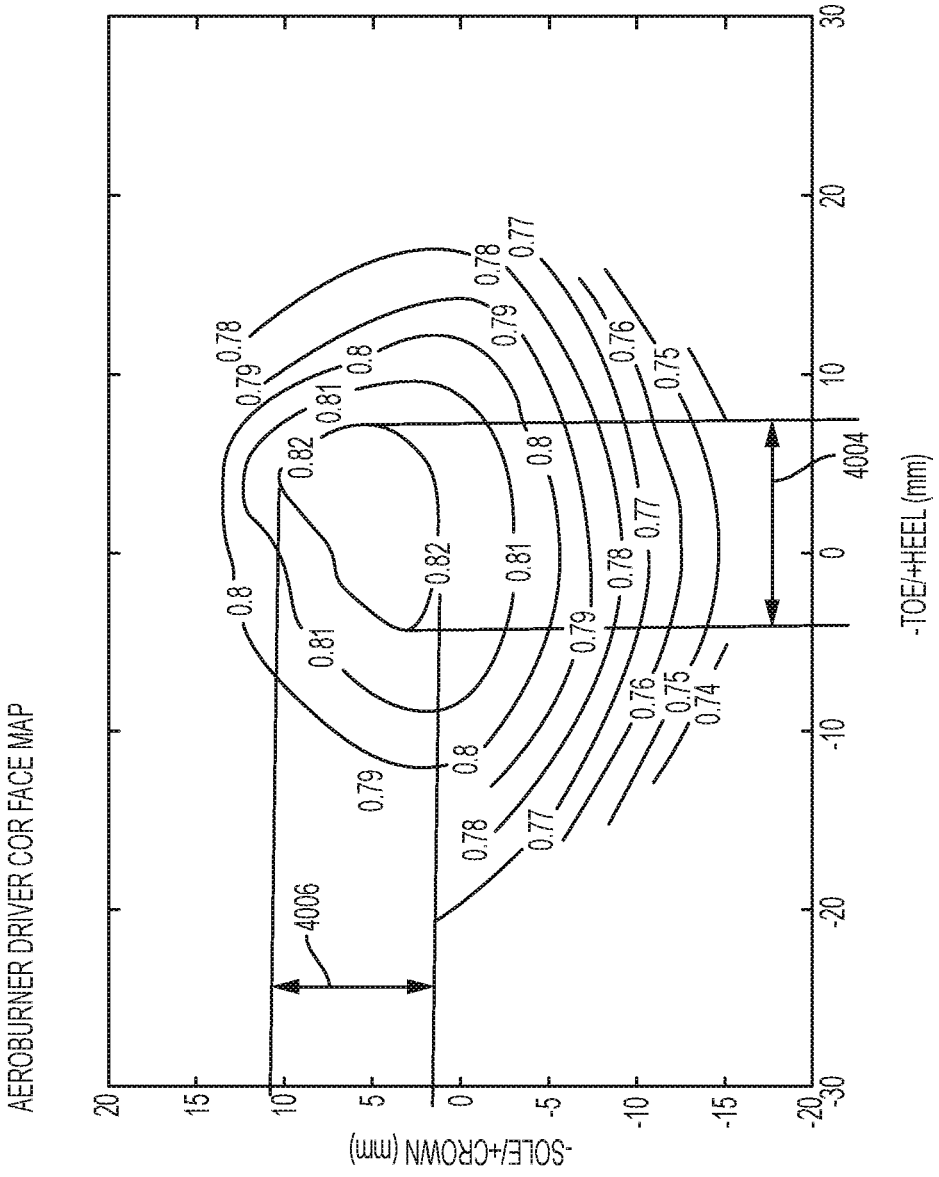

AEROBURNER DRIVER COR FACE MAP
-SOLE/+CROWN (mm)
-TOE/+HEEL (mm)
4004
4006
0.82
0.81
0.8
0.79
0.78
0.77
0.76
0.75
0.74

FIG. 5A

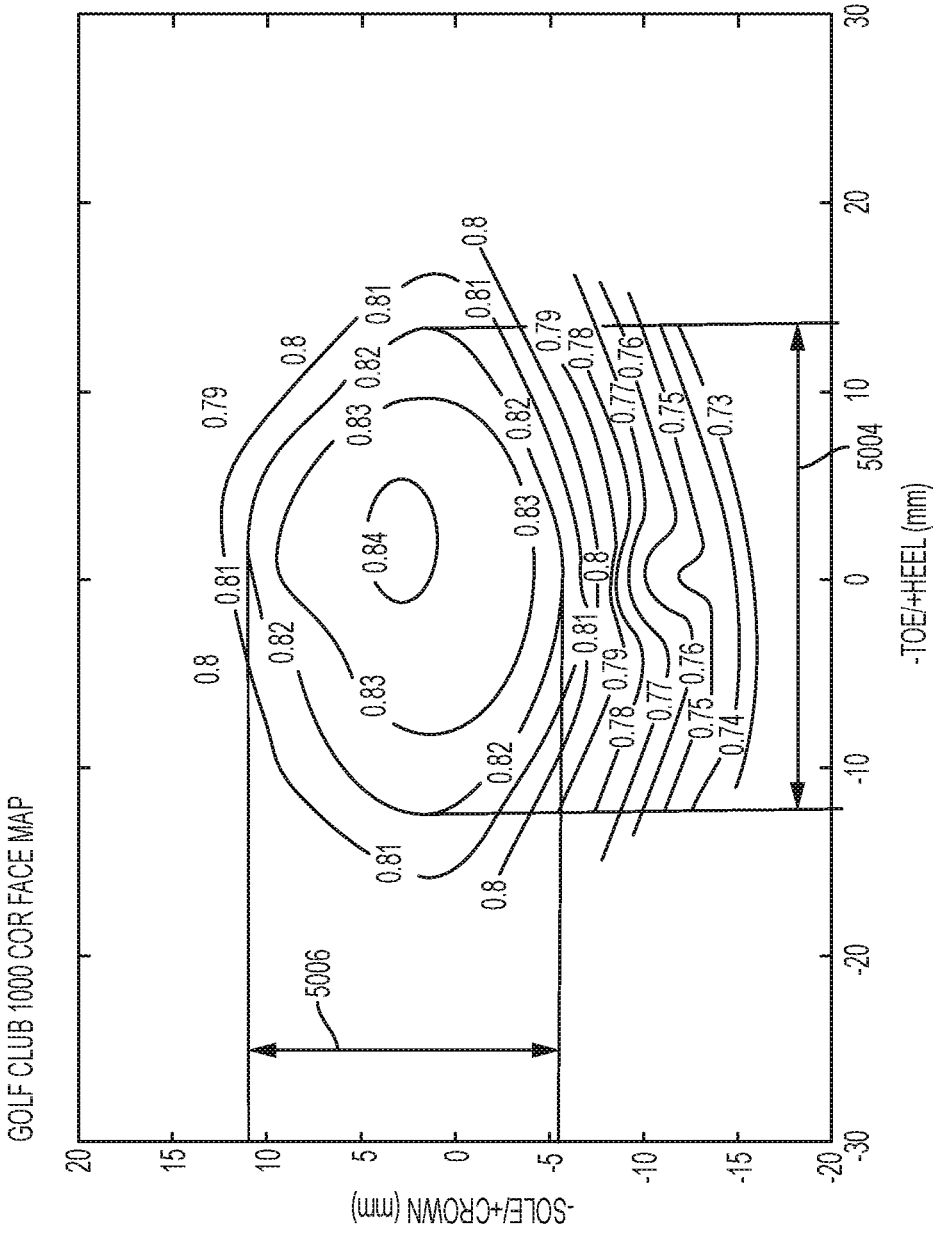

GOLF CLUB 1000 COR FACE MAP
-SOLE/+CROWN (mm)
-TOE/+HEEL (mm)
5006
5004
0.84
0.83
0.82
0.81
0.8
0.79
0.78
0.77
0.76
0.75
0.74
0.73

FIG. 5B

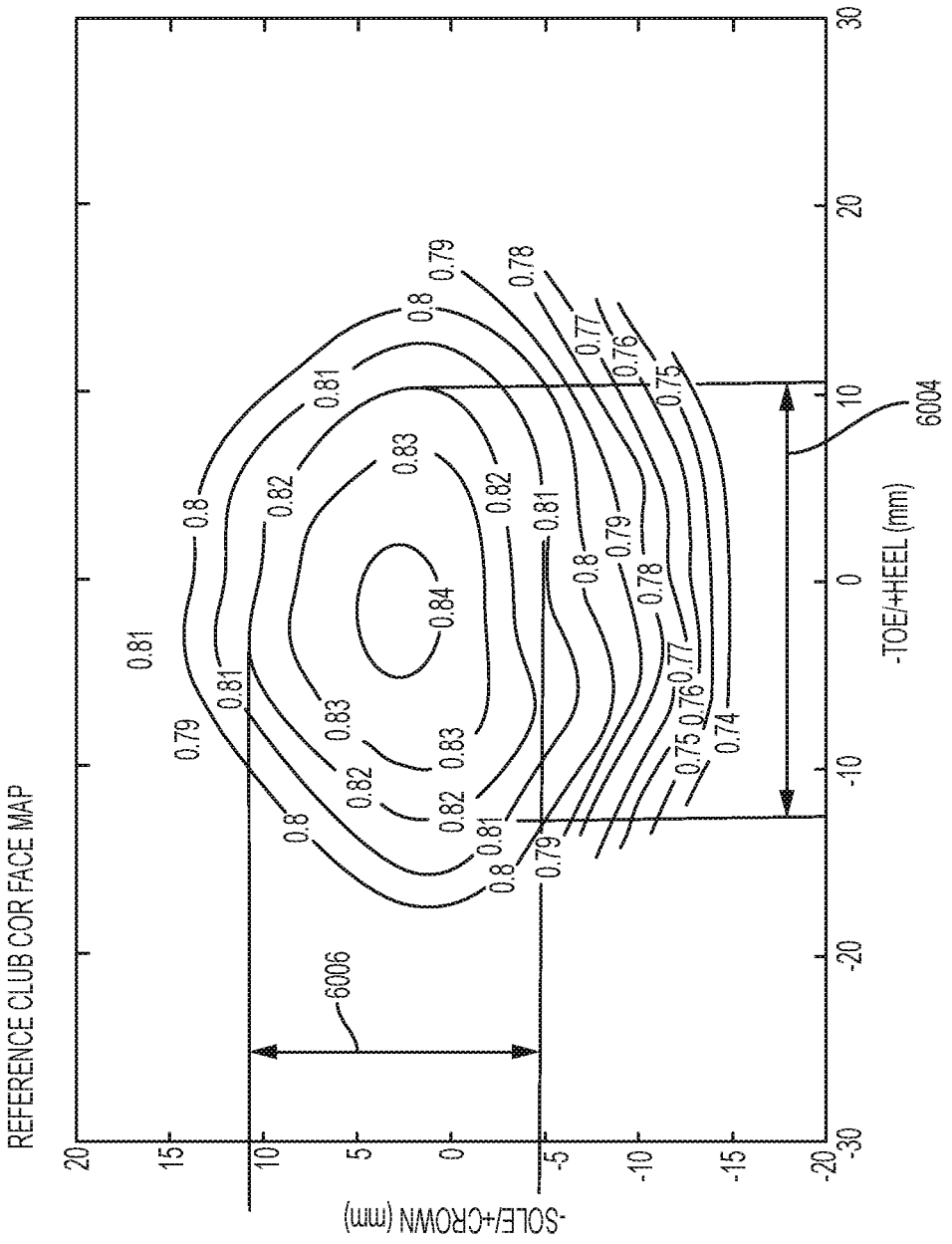

REFERENCE CLUB COR FACE MAP
-SOLE/+CROWN (mm)
-TOE/+HEEL (mm)
6006
6004
0.84
0.83
0.82
0.81
0.8
0.79
0.78
0.77
0.76
0.75
0.74

FIG. 5C

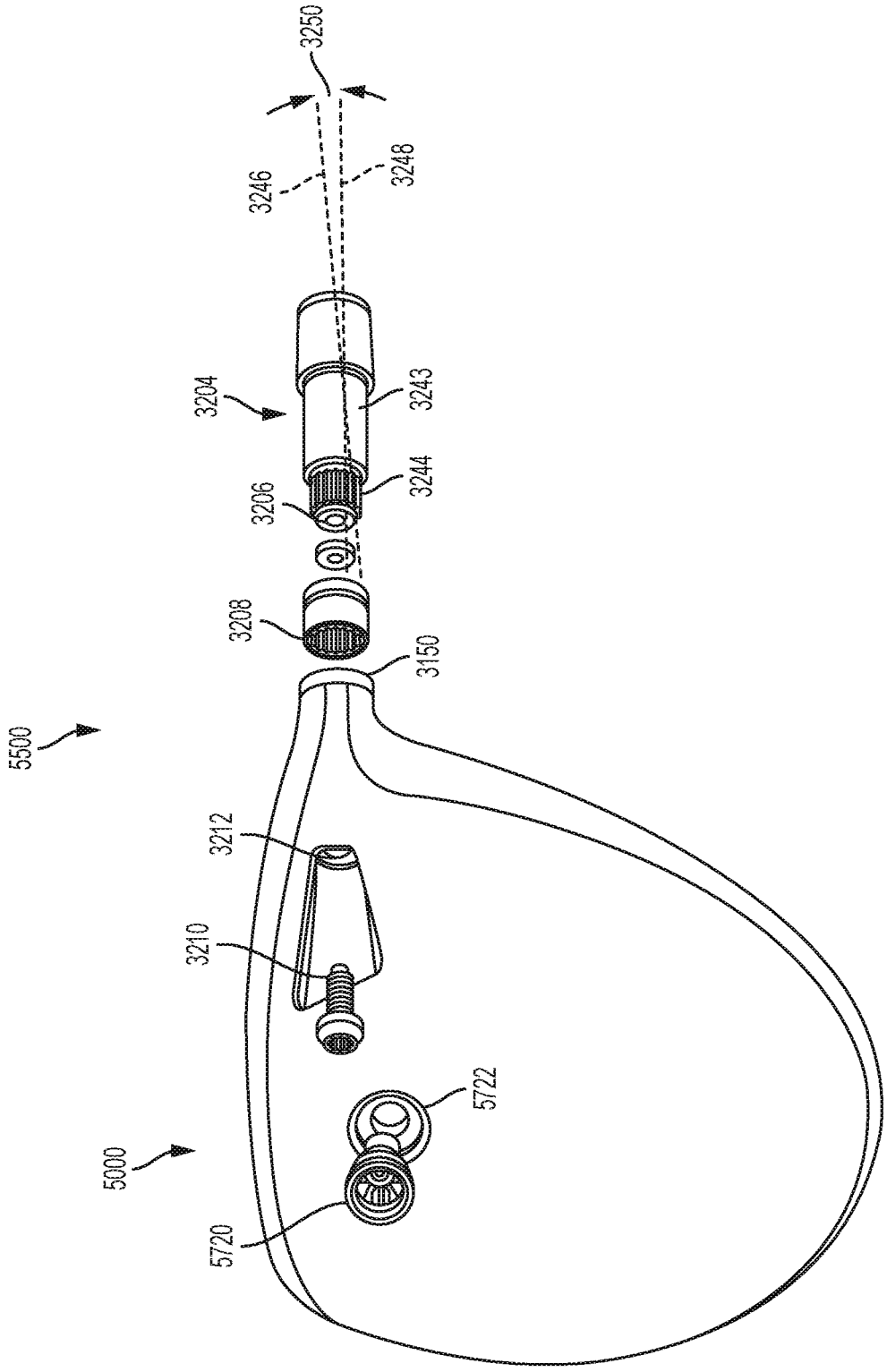

3250
3246
3248
3204
3243
3244
3206
3208
3150
5500
3212
3210
5722
5000
5720

FIG. 6

GOLF CLUB

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. patent application Ser. No. 14/812,737, which was filed on Jul. 29, 2015, which claims the benefit of U.S. Provisional Application No. 62/141,103, which was filed on Mar. 31, 2015, both of which are incorporated herein by reference in their entirety. This application references application for U.S. patent Ser. No. 14/145,761, entitled "GOLF CLUB," filed Dec. 31, 2014, which is incorporated by reference herein in its entirety and with specific reference to face slot technology. This application references U.S. Patent Application No. 62/027,692, filed on Jul. 22, 2014, and entitled "GOLF CLUB," which is incorporated by reference herein in its entirety. This application references application for U.S. patent Ser. No. 13/839,727, entitled "GOLF CLUB WITH COEFFICIENT OF RESTITUTION FEATURE," filed Mar. 15, 2013, which is incorporated by reference herein in its entirety and with specific reference to discussion of center of gravity location and the resulting effects on club performance. This application references U.S. Pat. No. 7,731,603, entitled "GOLF CLUB HEAD," filed Sep. 27, 2007, which is incorporated by reference herein in its entirety and with specific reference to discussion of moment of inertia. This application references U.S. Pat. No. 7,887,431, entitled "GOLF CLUB," filed Dec. 30, 2008, which is incorporated by reference herein in its entirety and with specific reference to discussion of adjustable loft and lie technology described therein and with reference to removable shaft technology and hosel sleeve connection systems. This application references application for U.S. patent Ser. No. 13/718,107, entitled "HIGH VOLUME AERODYNAMIC GOLF CLUB HEAD," filed Dec. 18, 2012, which is incorporated by reference herein in its entirety and with specific reference to discussion of aerodynamic golf club heads. This application references U.S. Pat. No. 7,874,936, entitled "COMPOSITE ARTICLES AND METHODS FOR MAKING THE SAME," filed Dec. 19, 2007, which is incorporated by reference herein in its entirety and with specific reference to discussion of composite face technology. This application references application for U.S. patent Ser. No. 14/144,105, entitled "GOLF CLUB," filed Dec. 30, 2013, which is incorporated by reference herein in its entirety and with specific reference to discussion of moment of inertia, center of gravity placement, and the effect of center of gravity placement on mechanics of golf club heads. This Application references application for U.S. patent Ser. No. 12/813,442, entitled "GOLF CLUB," filed Jun. 10, 2010, which is incorporated by reference herein in its entirety and with specific reference to discussion of variable face thickness. This Application references application for U.S. patent Ser. No. 12/791,025, entitled "HOLLOW GOLF CLUB HEAD," filed Jun. 1, 2010, and application for U.S. patent Ser. No. 13/338,197, entitled "FAIRWAY WOOD CENTER OF GRAVITY PROJECTION," filed Dec. 27, 2011, which are incorporated by reference herein in their entirety and with specific reference to slot technology and coefficient of restitution features. This Application references U.S. Pat. No. 6,773,360, entitled "GOLF CLUB HEAD HAVING A REMOVABLE WEIGHT," filed Nov. 8, 2002, which is incorporated by reference herein in its entirety and with specific reference to discussion of removable weight. This Application references U.S. Pat. No. 7,166,040, entitled "REMOVABLE WEIGHT AND KIT FOR GOLF CLUB HEAD," filed Feb. 23, 2004, which is a continuation-in-part of U.S. Pat. No. 6,773,360, entitled "GOLF CLUB HEAD HAVING A REMOVABLE WEIGHT," and which is incorporated by reference herein in its entirety and with specific reference to removable weight technology.

TECHNICAL FIELD

This disclosure relates to metal wood type golf club heads. More specifically, this disclosure relates to golf metal wood type golf club heads having features for increasing distance.

SUMMARY

A golf club head includes a golf club body, a hosel connected to a heel portion of the golf club body, a face connected to a front of the golf club body, the face including an inner surface, an outer surface, and at least one boundary condition feature.

BRIEF DESCRIPTION OF THE DRAWINGS

The features and components of the following figures are illustrated to emphasize the general principles of the present disclosure. Corresponding features and components throughout the figures may be designated by matching reference characters for the sake of consistency and clarity.

FIG. **1**A is a heel side view of a golf club head in accord with one embodiment of the current disclosure.

FIG. **1**B is a face side view of the golf club head of FIG. **1**A.

FIG. **1**C is a top view of the golf club head of FIG. **1**A.

FIG. **2** is a close-up face side view of the golf club head of FIG. **1**A

FIG. **3** is a cutaway view of the golf club head of FIG. **1**C taken in the plane indicated by line **3**-**3**.

FIG. **4** is a face side view of a golf club head in accord with one embodiment of the current disclosure

FIG. **5**A is a chart showing COR at various locations of the face of a golf club head in accord with one embodiment of the current disclosure.

FIG. **5**B is a chart showing COR at various locations of the face of a golf club head in accord with one embodiment of the current disclosure.

FIG. **5**C is a chart showing COR at various locations of the face of a golf club head in accord with one embodiment of the current disclosure.

FIG. **6** is a perspective view of a golf club assembly in accord with one embodiment of the current disclosure.

DETAILED DESCRIPTION

Disclosed is a golf club including a golf club head and associated methods, systems, devices, and various apparatus. It would be understood by one of skill in the art that the disclosed golf club is described in but a few exemplary embodiments among many. No particular terminology or description should be considered limiting on the disclosure or the scope of any claims issuing therefrom. For the sake of simplicity, standard unit abbreviations may be used, including but not limited to, "mm" for millimeters, "in." for inches, "lb." for pounds force, "mph" for miles per hour, and "rps" for revolutions per second, among others.

Portions of the following disclosure are coincident with application for U.S. patent Ser. No. 13/839,727, entitled "GOLF CLUB WITH COEFFICIENT OF RESTITUTION

FEATURE," filed Mar. 15, 2013, which is incorporated by reference herein in its entirety, and with application for U.S. patent Ser. No. 14/145,761, entitled "GOLF CLUB," filed Dec. 31, 2014, which is incorporated by reference herein in its entirety. Although portions of these overlapping disclosures have been omitted from the current disclosure in the interest of efficiency, one of skill in the art would understand that the features and designs disclosed in the referenced application would apply to the descriptions of the technology of the current disclosure, and the full incorporation of application for U.S. patent Ser. No. 13/839,727 and application for U.S. patent Ser. No. 14/145,761 is beneficial for a complete understanding of the scope of the current disclosure. Additionally, claimed subject matter may include features or descriptions supplied in more full detail by the incorporation of application for U.S. patent Ser. No. 13/839,727 and application for U.S. patent Ser. No. 14/145,761, and claims covering content in the reference application are related to the disclosure of these applications.

In the game of golf, when a player increases his or her distance with a given club, the result nearly always provides an advantage to the player. While golf club design aims to maximize the ability of a player to hit a golf ball as far as possible, the United States Golf Association—a rulemaking body in the game of golf—has provided a set of rules to govern the game of golf. These rules are known as The Rules of Golf and are accompanied by various Decisions on The Rules of Golf. Many rules promulgated in The Rules of Golf affect play. Some of The Rules of Golf affect equipment, including rules designed to indicate when a club is or is not legal for play. Among the various rules are maximum and minimum limits for golf club head size, weight, dimensions, and various other features. For example, no golf club head may be larger than 460 cubic centimeters in volume. No golf club face may have a coefficient of restitution (COR) of greater than 0.830, wherein COR describes the efficiency of the golf club head's impact with a golf ball.

COR is a measure of collision efficiency. COR is the ratio of the velocity of separation to the velocity of approach. In this model, therefore, COR is determined using the following formula:

$$COR=(v_{club\text{-}post}-v_{ball\text{-}post})\div(v_{ball\text{-}pre}-v_{club\text{-}pre})$$

where,

$v_{club\text{-}post}$ represents the velocity of the club after impact;

$v_{ball\text{-}post}$ represents the velocity of the ball after impact;

$v_{club\text{-}pre}$ represents the velocity of the club before impact (a value of zero for USGA COR conditions); and

$v_{ball\text{-}pre}$ represents the velocity of the ball before impact.

Although the USGA specifies the limit for maximum COR, there is no specified region in which COR may be maximized. While multiple golf club heads have achieved the maximum 0.830 COR, the region in which such COR may be found has generally been limited—typically, in a region at a geometric center of the face of the golf club head or in a region of maximum COR that is in relatively small proximity thereto. Many golf club heads are designed to launch a golf ball as far as possible within The Rules of Golf when properly struck. However, even the greatest of professional golfers do not strike each and every shot perfectly. For the vast majority of golfers, perfectly struck golf shots are an exception if not a rarity.

There are several methods to address a particular golfer's inability to strike the shot purely. One method involves the use of increased Moment of Inertia (MOI). Increasing MOI prevents the loss of energy for strikes that do not impact the center of the face by reducing the ability of the golf club head to twist on off-center strikes. Particularly, most higher-MOI designs focus on moving weight to the perimeter of the golf club head, which often includes moving a center of gravity of the golf club head back in the golf club head, toward a trailing edge.

Another method involves use of variable face thickness (VFT) technology. With VFT, the face of the golf club head is not a constant thickness across its entirety, but rather varies. For example, as described in application for U.S. patent Ser. No. 12/813,442, entitled "GOLF CLUB," filed Jun. 10, 2010—which is incorporated herein by reference in its entirety—the thickness of the face varies in an arrangement with a dimension as measured from the center of the face. This allows the area of maximum COR to be increased as described in the reference.

While VFT is excellent technology, it can be difficult to implement in certain golf club designs. For example, in the design of fairway woods, the height of the face is often too small to implement a meaningful VFT design. Moreover, there are problems that VFT cannot solve. For example, edges of the golf club face tend to be more rigid than the center of the golf club face because the edges include connection features to the sole, crown, or skirt of the golf club head. Because the edges of the typical golf club face are integrated (either through a welded construction or as a single piece), a strike that is close to an edge of the face necessarily results in poor COR as it is proximate the rigid edge. It is common for a golfer to strike the golf ball at a location on the golf club head other than the center of the face. Typical locations may be high on the face or low on the face for many golfers. Both situations result in reduced COR. However, particularly with low face strikes, COR decreases very quickly. In various embodiments, the COR for strikes 5 mm below center face may be 0.020 to 0.035 difference. Further off-center strikes may result in greater COR differences.

To combat the negative effects of off-center strikes, certain designs have been implemented. For example, as described in application for U.S. patent Ser. No. 12/791,025, entitled "HOLLOW GOLF CLUB HEAD," filed Jun. 1, 2010, and application for U.S. patent Ser. No. 13/338,197, entitled "FAIRWAY WOOD CENTER OF GRAVITY PROJECTION," filed Dec. 27, 2011—both of which are incorporated by reference herein in their entirety—coefficient of restitution features located in various locations of the golf club head provide advantages. In particular, for strikes low on the face of the golf club head, the coefficient of restitution features allow greater flexibility than would typically be seen otherwise from a region low on the face of the golf club head. In general, the low point on the face of the golf club head is not flexible and, although not entirely rigid, does not experience the COR that may be seen in the geometric center of the face.

Although coefficient of restitution features allow for greater flexibility, they can often be cumbersome to implement. For example, in the designs above, the coefficient of restitution features are placed in the body of the golf club head but proximal to the face. While the close proximity enhances the effectiveness of the coefficient of restitution features, it creates challenges from a design perspective. Manufacturing the coefficient of restitution features may be difficult in some embodiments. Particularly with respect to application for U.S. patent Ser. No. 13/338,197, entitled "FAIRWAY WOOD CENTER OF GRAVITY PROJECTION," filed Dec. 27, 2011, the coefficient of restitution feature includes a sharp corner at the vertical extent of the coefficient of restitution feature that experiences extremely

high stress under impact conditions. It may become difficult to manufacture such features without compromising their structural integrity in use. Further, the coefficient of restitution features necessarily extend into the golf club body, thereby occupying space within the golf club head. The size and location of the coefficient of restitution features may make mass relocation difficult in various designs, particularly when it is desirous to locate mass in the region of the coefficient of restitution feature.

In particular, one challenge with current coefficient of restitution feature designs is the ability to locate the center of gravity (CG) of the golf club head proximal to the face. As described in application for U.S. patent Ser. No. 13/839,727, entitled "GOLF CLUB WITH COEFFICIENT OF RESTITUTION FEATURE," filed Mar. 15, 2013 and application for U.S. patent Ser. No. 14/144,105, entitled "GOLF CLUB," filed Dec. 30, 2013, it has been discovered that it is desirous to locate the CG low in the golf club head. Such location of CG provides a low projection of CG onto the face of the golf club head, which results in reduced spin, leading to greater distance. In certain types of heads, it may still be the most desirable design to locate the CG of the golf club head as low as possible regardless of its location within the golf club head. However, for reasons explained in the references cited, it has unexpectedly been determined that a low and forward CG location may provide some benefits not seen in prior designs or in comparable designs without a low and forward CG.

For reference, within this disclosure, reference to a "fairway wood type golf club head" means any wood type golf club head intended to be used with or without a tee. For reference, "driver type golf club head" means any wood type golf club head intended to be used primarily with a tee. In general, fairway wood type golf club heads usually have lofts of greater than 14 degrees. In general, driver type golf club heads have lofts of 14 degrees or less, and, more usually, 12 degrees or less. In general, fairway wood type golf club heads have a length from leading edge to trailing edge of 73-97 mm. Various definitions distinguish a fairway wood type golf club head form a hybrid type golf club head, which tends to resemble a fairway wood type golf club head but be of smaller length from leading edge to trailing edge. In general, hybrid type golf club heads are 38-73 mm in length from leading edge to trailing edge. Hybrid type golf club heads may also be distinguished from fairway wood type golf club heads by weight, by lie angle, by volume, and/or by shaft length. Fairway wood type golf club heads of the current disclosure preferably are 16 degrees of loft. In various embodiments, fairway wood type golf club heads of the current disclosure may be from 15-19.5 degrees. In various embodiments, fairway wood type golf club heads of the current disclosure may be from 13-17 degrees. In various embodiments, fairway wood type golf club heads of the current disclosure may be from 13-19.5 degrees. In various embodiments, fairway wood type golf club heads of the current disclosure may be from 13-26 degrees. Additionally, most fairway wood type golf club heads are between 150 cc and 250 cc in volume as measured according to methods of the USGA. See U.S.G.A. "Procedure for Measuring the Club Head Size of Wood Clubs," Revision 1.0.0, Nov. 21, 2003, for the methodology to measure the volume of a wood-type golf club head. Exemplary fairway wood type golf club heads of the current disclosure may be between 180 cc and 240 cc. In various embodiments, fairway wood type golf club heads of the current disclosure are between 200 cc and 220 cc. Driver type golf club heads of the current disclosure preferably are 12 degrees or less of loft in various embodiments. Driver type golf club heads of the current disclosure may be 10.5 degrees or less in various embodiments. Driver type golf club heads of the current disclosure may be between 9 degrees and 14 degrees of loft in various embodiments. In various embodiments, driver type golf club heads may be as much as 16 degrees of loft. Additionally, most driver-type golf club heads are over 375 cc in volume. Exemplary driver-type golf club heads of the current disclosure may be over 425 cc in volume. In some embodiments, driver-type golf club heads of the current disclosure are between 440 cc and 460 cc in volume. In some embodiments, driver-type golf club heads of the current disclosure are between 430 cc and 470 cc in volume.

One embodiment of a golf club head **100** is disclosed and described with reference to FIGS. **1A-1C**. As seen in FIG. **1A**, the golf club head **100** includes a face **110**, a crown **120**, a sole **130**, a skirt **140**, and a hosel **150**. Major portions of the golf club head **100** not including the face **110** are considered to be the golf club body for the purposes of this disclosure. A boundary condition feature (BCF) **300** is seen in the sole **130** of the golf club head **100**. In various embodiments, the boundary condition feature **300** may be referenced as a "coefficient of restitution feature" (CORF). BCFs and CORFs are disclosed in further detail with reference to application for U.S. patent Ser. No. 13/839,727 and application for U.S. patent Ser. No. 14/145,761, both incorporated by reference herein in their entirety. One of skill in the art would understand that such BCFs and CORFs may be readily incorporated into the design of golf club head **100** without substantially deviating from the scope of the current disclosure. In various embodiments, CORFs and BCFs such as BCF **300** may be omitted. In various embodiments, the various different CORFs and BCFs may be included in various forms, shapes, sizes, and compositions. In various embodiments, modifications to BCF **300** may be included and would be understood by one of skill in the art to be intended to be included within the scope of the current disclosure.

A three dimensional reference coordinate system **200** is shown. An origin **205** of the coordinate system **200** is located at the geometric center of the face (CF) of the golf club head **100**. See U.S.G.A. "Procedure for Measuring the Flexibility of a Golf Clubhead," Revision 2.0, Mar. 25, 2005, for the methodology to measure the geometric center of the striking face of a golf club. The coordinate system **200** includes a z-axis **206**, a y-axis **207**, and an x-axis **208** (shown in FIG. **1B**). Each axis **206,207,208** is orthogonal to each other axis **206,207,208**. The golf club head **100** includes a leading edge **170** and a trailing edge **180**. For the purposes of this disclosure, the leading edge **170** is defined by a curve, the curve being defined by a series of forwardmost points, each forwardmost point being defined as the point on the golf club head **100** that is most forward as measured parallel to the y-axis **207** for any cross-section taken parallel to the plane formed by the y-axis **207** and the z-axis **206**. The face **110** may include grooves or score lines in various embodiments. In various embodiments, the leading edge **170** may also be the edge at which the curvature of the particular section of the golf club head departs substantially from the roll and bulge radii.

As seen with reference to FIG. **1B**, the x-axis **208** is parallel to a ground plane (GP) onto which the golf club head **100** may be properly soled—arranged so that the sole **130** is in contact with the GP. The y-axis **207** is also parallel to the GP and is orthogonal to the x-axis **208**. The z-axis **206** is orthogonal to the x-axis **208**, the y-axis **207**, and the GP. The golf club head **100** includes a toe **185** and a heel **190**.

The golf club head **100** includes a shaft axis (SA) defined along an axis of the hosel **150**. When assembled as a golf club, the golf club head **100** is connected to a golf club shaft (not shown). Typically, the golf club shaft is inserted into a shaft bore **245** defined in the hosel **150**. In various embodiments, a sleeve attachment may be included as disclosed in various references (incorporated by reference herein) to provide adjustable loft, lie, and face angle by varying connection of the SA with an axis of the hosel. The arrangement of the SA with respect to the golf club head **100** can define how the golf club head **100** is used. The SA is aligned at an angle **198** with respect to the GP. The angle **198** is known in the art as the lie angle (LA) of the golf club head **100**. A ground plane intersection point (GPIP) of the SA and the GP is shown for reference. In various embodiments, the GPIP may be used a point of reference from which features of the golf club head **100** may be measured or referenced. As shown with reference to FIG. **1**A, the SA is located away from the origin **205** such that the SA does not directly intersect the origin or any of the axes **206**,**207**,**208** in the current embodiment. In various embodiments, the SA may be arranged to intersect at least one axis **206**,**207**,**208** and/or the origin **205**. A z-axis ground plane intersection point **212** can be seen as the point that the z-axis intersects the GP.

As seen with reference to FIG. **1**A, the BCF **300** is shown defined in the sole **130** of the golf club head **100**. A modular weight port may be included in the sole **130** for placement of removable weights. Various embodiments and systems of removable weights and their associated methods and apparatus are described in greater detail with reference to U.S. Pat. No. 6,773,360, entitled "GOLF CLUB HEAD HAVING A REMOVABLE WEIGHT," filed Nov. 8, 2002, and U.S. Pat. No. 7,166,040, entitled "REMOVABLE WEIGHT AND KIT FOR GOLF CLUB HEAD," filed Feb. 23, 2004, which are incorporated by reference herein in their entirety. The top view seen in FIG. **1**C shows another view of the golf club head **100**. The shaft bore **245** can be seen defined in the hosel **150**.

With reference to FIGS. **1**A-**1**C, a crown height **162** is shown and measured as the height from the GP to the highest point of the crown **120** as measured parallel to the z-axis **206**. In the current embodiment, the crown height **162** is about 36 mm. In various embodiments, the crown height **162** may be 34-40 mm. In various embodiments, the crown height may be 32-44 mm. In various embodiments, the crown height may be 30-50 mm. The golf club head **100** also has an effective face height **163** that is a height of the face **110** as measured parallel to the z-axis **206**. The effective face height **163** measures from a highest point on the face **110** to a lowest point on the face **110** proximate the leading edge **170**. A transition exists between the crown **120** and the face **110** such that the highest point on the face **110** may be slightly variant from one embodiment to another. In the current embodiment, the highest point on the face **110** and the lowest point on the face **110** are points at which the curvature of the face **110** deviates substantially from a roll radius. In some embodiments, the deviation characterizing such point may be a 10% change in the radius of curvature. In the current embodiment, the effective face height **163** is about 27.5 mm. In various embodiments, the effective face height **163** may be 2-7 mm less than the crown height **162**. In various embodiments, the effective face height **163** may be 2-12 mm less than the crown height **162**. An effective face position height **164** is a height from the GP to the lowest point on the face **110** as measured in the direction of the z-axis **206**. In the current embodiment, the effective face position height **164** is about 4 mm. In various embodiments, the effective face position height **164** may be 2-6 mm. In various embodiments, the effect face position height **164** may be 0-10 mm. A length **177** of the golf club head **177** as measured in the direction of the y-axis **207** is seen as well with reference to FIG. **1**A. In the current embodiment, the length **177** is about 85 mm. In various embodiments, the length **177** may be 80-90 mm. In various embodiments, the length **177** may be 73-97 mm. The distance **177** is a measurement of the length from the leading edge **170** to the trailing edge **180**. The distance **177** may be dependent on the loft of the golf club head in various embodiments. In one embodiment, the loft of the golf club head is about 15 degrees and the distance **177** is about 91.6 mm. In one embodiment, the loft of the golf club head is about 18 degrees and the distance **177** is about 87.4 mm. In one embodiment, the loft of the golf club head is about 21 degrees and the distance **177** is about 86.8 mm. In various embodiments, a composite crown plate **122** may be included. In various embodiments, additional crown features such as composites may be omitted.

With returning reference to FIG. **1**B, the face **110** includes a pair of face-located boundary condition features **1050**, **1150**. A toe-located BCF **1050** in the current embodiment is a thru-slot extending from an outer surface of the face **110** to an inner surface of the face **110**. A heel-located BCF **1150** in the current embodiment is a thru-slot extending from an outer surface of the face **110** to an inner surface of the face **110**. As such, each of the BCFs **1050**, **1150** of the current disclosure are thru-slots in the face **110** located in locations proximate the boundaries of the face **110**. In the current disclosure, the BCFs **1050**, **1150** are arrange such that the extent of each BCF **1050**,**1150** is elongated in a direction parallel to the z-axis. It would be understood by one of ordinary skill in the art that various embodiments of BCFs may be utilized, including channels, weakened regions, detached portions, thinned regions, and various other arrangements, including those disclosed for other clubhead regions in the disclosures of application for U.S. patent Ser. No. 13/338,197, entitled "FAIRWAY WOOD CENTER OF GRAVITY PROJECTION," filed Dec. 27, 2011, application for U.S. patent Ser. No. 12/791,025, entitled "HOLLOW GOLF CLUB HEAD," filed Jun. 1, 2010, application for U.S. patent Ser. No. 13/839,727, entitled "GOLF CLUB WITH COEFFICIENT OF RESTITUTION FEATURE," filed Mar. 15, 2013, and application for U.S. patent Ser. No. 14/145,761, entitled "GOLF CLUB," filed Dec. 31, 2014, all of which are incorporated by reference herein in their entirety.

With reference to FIG. **2**, each BCF **1050**,**1150** includes a vertical extent **1170***a*,*b*. In the current embodiment, each BCF **1050**,**1150** is about 22.0 mm in vertical extent. In various embodiments, each BCF **1050**,**1150** may be of a vertical extent between 21-23 mm. In various embodiments, each BCF **1050**,**1150** may be of a vertical extent between 19.5-24.5 mm. In various embodiments, each BCF **1050**, **1150** may be of a vertical extent between 15 and 25 mm. In various embodiments, each BCF **1050**,**1150** may be of a vertical of at least 10 mm. In various embodiments, each BCF **1050**,**1150** may be of a vertical extent of up to 35 mm. Although each BCF **1050**,**1150** is shown in the current embodiment to be of about the same vertical extent **1170***a*,*b*, in various embodiments the vertical extents may be different. In various embodiments, one BCF **1050**,**1150** may be omitted, leaving only a single BCF in the face **110**. In various embodiments, multiple BCFs may be included in

addition to the BCFs **1050**,**1150**. In various embodiments, the BCFs may be of different arrangements, thicknesses, and dimensions.

In the current embodiment, each BCF **1050**, **1150** includes a width **1172***a,b*. As annotated, the vertical extent **1170***a,b* is measured parallel to the z-axis **206** and the thickness **1172***a,b* is measured parallel to the x-axis **208**. As shown, an innermost end of the BCF **1050** is measured a distance **1174** from the CF **205**. An innermost end of the BCF **1150** is measured a distance **1176** from the CF **205**. In the current embodiment, the distance **1174** is about 23 mm and the distance **1176** is about 27 mm. In various embodiments, the distances **1174**,**1176** may be equal to each other. In various embodiments, the distances **1174**, **1176** may each be 22-27 mm. In various embodiments, the distances **1174**,**1176** may each be 20-30 mm. In various embodiments, the distances **1174**,**1176** may each be 15-40 mm. In various embodiments, the distance **1174** may be larger than 1176, and in various embodiments, the distance **1176** may be larger than the distance **1174**. In various embodiments, the thicknesses **1172***a,b* may be as little as 0.5 mm and as large as 10 mm. In various embodiments, the thicknesses **1172***a,b* may be different from each other or may be the same. In various embodiments, the thicknesses **1172***a,b* may be 1-3 mm. in various embodiments, the thicknesses **1172***a,b* may be 0.5-2.5 mm. in various embodiments, the thicknesses **1172***a,b* may be 1.5-2.5 mm. Although the BCFs **1050**,**1150** are shown being about parallel, in various embodiments the BCFs may be arranged at angular arrangements with respect to the reference coordinate system **200**. In the current embodiment, the BCF **1050** includes a crownward end **1052** and a soleward end **1054**. Similarly, the BCF **1150** includes a crownward end **1152** and a soleward end **1154**. Each BCF **1050**,**1150** includes a recessed portion at each end **1052**, **1054**,**1152**,**1154**. Proximate to the crownward end **1052** is a recessed portion **1056** that is depressed from the surface of the face **110** but is not a thru-slot portion. A similar recessed portion **1058** is proximate the soleward end **1054**. Likewise, recessed portions **1156** and **1158** are located on the BCF **1150**. Internal ends **1062** and **1064** of the BCF **1050** are seen as the end of the thru-slot portions, and internal ends **1162**,**1165** of BCF **1150** are seen as ends of the thru-slot portions.

As seen with reference to FIG. **3**, the golf club head **100** includes a variable thickness face (VFT), in that the thickness of the face **110** is different at different locations of the face **110**. Some variable face thicknesses are described with reference to application for U.S. patent Ser. No. 12/813,442, entitled "GOLF CLUB," filed Jun. 10, 2010, which is incorporated by reference herein in its entirety.

The ends **1052**,**1054**,**1152**,**1154** of the BCFs **1050**,**1150** are contained within bosses **1072**,**1074**,**1172**,**1174**, respectively. The bosses **1072**,**1074**,**1172**,**1174** are thickened regions of the face **110** that encapsulate the ends **1052**,**1054**, **1152**,**1154** such that stress concentrations in the ends may be adequately addressed to avoid failure of the face **110** and/or cracking. In the current embodiment, the thickened region bosses **1072**,**1074**,**1172**,**1174** are about circular in shape and have a roughly cylindrical arrangement. However, various shapes and configurations may be utilized in various embodiments, including ribs, gradual thickening, mass pads, welding, annealing or other heat treating, or other methods to strengthen the region proximate the BCFs **1050**,**1150**, and, more specifically, proximate the ends **1052**,**1054**,**1152**, **1154**.

With reference to FIG. **4**, a golf club head **1000** is shown having various features as discussed elsewhere in this disclosure and in referencing disclosures. It should be noted that dimensions of the golf club head **1000** are generally different from those of golf club head **100**. In the current embodiment, the crown height **162** is about 64-65 mm. In various embodiments, the crown height **162** may be 60-70 mm. In various embodiments, the crown height may be 55-75 mm. In various embodiments, the crown height may be 50-80 mm. The golf club head **1000** also has an effective face height **163** of about 46.5 mm. In various embodiments, the effective face height **163** of golf club head **1000** is 45-48 mm. In various embodiments, the effective face height **163** of golf club head **1000** is 40-50 mm. In various embodiments, the effective face height **163** of golf club head **1000** is 35-55 mm. In various embodiments, the effective face height **163** of golf club head **1000** at least 42 mm. In various embodiments, the effective face height **163** may be 2-7 mm less than the crown height **162**. In various embodiments, the effective face height **163** may be 2-12 mm less than the crown height **162**. In the current embodiment, the effective face position height **164** is about 6.25 mm. In various embodiments, the effective face position height **164** may be 4-8 mm. In various embodiments, the effect face position height **164** may be 0-10 mm. In various embodiments, a composite crown plate may be included. In various embodiments, additional crown features such as composites may be omitted.

As seen with additional reference to FIG. **4**, a toe-located BCF **2050** and a heel-located BCF **2150** are located in the face **110** of the golf club head **1000**. Although score lines are not shown in the view of FIG. **4**, score lines and/or grooves may be included on the face **110** as would be understood by one of ordinary skill in the art. In various embodiments of driver-type golf club heads, score lines may be omitted without material alteration of the playing characteristics of the golf club head, such as in golf club head **1000**. Arrangement of the BCFs **2050**,**2105** is similar to the BCFs **1050**, **1150**, except that the dimensions of BCFs **2050**,**2150** are different in absolute terms and in comparison to the size of the face **110** of golf club head **1000** than BCFs **1050**,**1150**. Although the widths **1172***a,b* of the BCFs **2050**,**2150** may be about the same as the widths **1172***a,b* of the BCFs **1050**, **1150**, the vertical extents **2170***a,b* of the BCFs **2050**,**2150** may be different than the vertical extents **1170***a,b* of the BCFs **1050**,**1150**. In the current embodiment, the vertical extents **2170***a,b* are about 35 mm. In various embodiments, the vertical extents **2170***a,b* may be 34-40 mm. In various embodiments, the vertical extents **2170***a,b* may be 30-38 mm. In various embodiments, the vertical extents **2170***a,b* may be 30-42 mm. In various embodiments, the vertical extents **2170***a,b* may be at least 25 mm. In various embodiments, the vertical extents **2170***a,b* may be up to 50 mm. In various embodiments, the vertical extents **2170***a,b* may be 50.8 mm.

Ball speed at a given impact location is directly related to the COR value at that point. Increasing the COR value for off-center impacts therefore increases the resulting ball speed at these locations.

Data regarding COR of the various golf club heads is aggregated with reference to FIGS. **5**A-**5**C. For any area of the face **110**, golf club head **1000** tends to have higher COR as compared to the AeroBurner reference club and as compared to a golf club head **1000** without BCFs **2050**,**2150**. Each band of FIGS. **5**A-**5**C represents the approximate margin of the COR annotated. For example, for all area inside a band annotated as "0.8," the COR of the golf club

head is at least 0.800. Understanding the size of each COR band aids in understanding the area of the golf club face that is above a certain COR.

However, the shapes of the COR bands are not perfectly circular. Although COR area can likely be calculated by interpolation software, an exact measure of the face area above a certain COR may be difficult to accomplish. As such, an approximation of COR area can be taken.

In order to determine an approximation of the COR area for any band, a first extent of the band is taken parallel to the z-axis, and a second extent of the band is taken parallel to the x-axis. The first extent and second extent are maximum dimensions of the shape for which the COR is at least the required number. From each of the first extent and the second extent, a circle is made using each extent as a diameter. The area of each circle is calculated, and an average of the areas of the two circles provides an approximation of the area within the band, also known as an equivalent area and represented as $Area_{Equivalent}$. Formulas representing the procedure above are provided below. For the sake of the formulas, the first extent is annotated as Z_{Extent} and the second extent is annotated as X_{Extent}.

$$Area_{Equivalent} = \frac{Area_{Z-Extent} + Area_{X-Extent}}{2} \text{ wherein}$$

$$Area_{Z-Extent} = \pi\left(\frac{z_{Extent}}{2}\right)^2$$

-continued

$$Area_{X-Extent} = \pi\left(\frac{x_{Extent}}{2}\right)^2$$

As seen with particular reference to FIG. **5**A, a first extent **4004** and a second extent **4006** are seen for the COR having a value of at least 0.820. For the embodiment of the AeroBurner reference club, the first extent **4004** is about 11.25 mm and the second extent **4006** is about 8.75 mm for a COR of at least 0.820. The circular area relative to the first extent **4004** is about 99.4 mm^2 and the circular area relative to the second extent **4006** is about 60.1 mm^2. An average of the two areas representing an equivalent area is about $Area_{Equivalent}$=79.8 mm^2. Because such numbers are approximations, it is understood that a difference of up to 5% is within reasonable error of the measurement and calculation methodology. Similarly, if actual COR area is known, it will be understood that a calculation error of up to 10% is reasonable given the error of the measurements and calculation methodology.

With reference to FIG. **5**B—which represents golf club head **1000**—a first extent **5004** of an area for which the COR is at least 0.820 is about 25.0 mm and a second extent **5006** is about 15.7 mm. The circular area relative to the first extent **5004** is about 490.9 mm^2 and the circular area relative to the second extent **5006** is about 193.6 mm^2. As such, an average of the two areas representing an equivalent area is about $Area_{Equivalent}$=342.3 mm^2.

Similarly, with reference to FIG. **5**C—which represents a golf club head similar to golf club head **1000** but without BCFs **2050** and **2150**—a first extent **6004** of an area for which the COR is at least 0.820 is about 23.1 mm and a second extent **6006** is about 15.0 mm. The circular area relative to the first extent **6004** is about 419.1 mm^2 and the circular area relative to the second extent **6006** is about 176.7 mm^2. As such, an average of the two areas representing an equivalent area is about $Area_{Equivalent}$=297.9 mm^2. It should be noted that the golf club of FIG. **5**C includes boundary condition features at the junction between the face **110** and the golf club body such that the boundary conditions are more flexible than those of the AeroBurner reference club of FIG. **5**A. These features do provide a benefit over the AeroBurner reference club of FIG. **5**A, but these features are comparably less effective than the BCFs **2050**,**2150**, as seen with reference to the equivalent areas of various COR ranges.

With respect to the various measurements, Table 1 reproduces data of the interpolation charts for the first and second extents of each COR for each club, as shown.

TABLE 1

	AeroBurner Ref (FIG. 5A)			Golf Club 1000 (FIG. 5B)			Golf Club w/o Face Slots (FIG. 5C)		
COR	Z_{Extent}	X_{Extent}	$A_{Equivalent}$	Z_{Extent}	X_{Extent}	$A_{Equivalent}$	Z_{Extent}	X_{Extent}	$A_{Equivalent}$
0.840	0	0	0	3.13	6.56	20.7	4.38	6.88	26.1
0.830	0	0	0	13.8	18.1	203.3	10.3	16.9	153.6
0.820	11.3	8.75	79.8	15.7	25.0	342.2	15.0	23.1	297.9
0.810	15.0	18.1	217.4	19.4	31.9	546.4	19.4	28.1	458.0
0.800	18.8	23.8	359.6	ND	ND	ND	22.5	33.8	646.1
0.790	21.9	28.8	512.5	ND	ND	ND	ND	ND	ND

For Table 1, data points indicated with "ND" are meant to indicate that no data is collected for the data point. For the AeroBurner reference club, "0" is included wherein no area exists wherein the COR is above 0.820 as tested. As can be seen by comparing the reference club of FIG. **5**C with golf club head **1000** of FIG. **5**B, the Z_{Extent} is not tremendously different between the clubs for certain ranges. For example, at COR of 0.810, the Z_{Extent} of 19.4 mm is the same between the reference club and golf club head **1000**, but the X_{Extent} is larger for golf club head **1000**. As such, the benefit of BCFs **2050**,**2150** can be easily seen.

In testing, one methodology involves first finding the balance point of the club. Following such a determination, additional impact points that are coaxial with the balance point can be used as measured parallel to the x-axis and parallel to the z-axis. Tests may be performed along each of these axes to determine most closely the extent of a range having the desired COR. When the desired COR is determined in the ±x-axis and ±z-axis directions, these values may be substituted for the Z_{Extent} and X_{Extent} values to determine $A_{Equivalent}$. In many embodiments, the determined value will be within 10% measurement and calculation error of the actual value.

Although data is quantified for driver-type golf club heads, similar—and, in some cases, better—performance gains are seen in fairway wood-type golf club heads.

The embodiment shown in FIG. **6** includes an adjustable loft, lie, or face angle system that is capable of adjusting the loft, lie, or face angle either in combination with one another or independently from one another as described in detail in U.S. Pat. No. 7,887,431, entitled "GOLF CLUB," filed Dec. 30, 2008, which is incorporated by reference herein it its entirety. A shaft (not shown) is inserted into the sleeve bore and is mechanically secured or bonded to the sleeve **3204** for assembly into a golf club using a golf club head **5000**, which may be a golf club head of the current disclosure (golf club head **100** or golf club head **1000**). The sleeve **3204** further includes an anti-rotation portion **3244** at a distal tip of the sleeve **3204** and a threaded bore **3206** for engagement with a screw **3210** that is inserted into a sole opening **3212** defined in the golf club head **5000**. The anti-rotation portion **3244** of the sleeve **3204** engages with an anti-rotation collar **3208** which is bonded or welded within a hosel **3150** of the golf club head **5000**. Although not shown, the shaft and a grip may be included as part of a golf club assembly **5500** that includes the golf club head **5000** and the adjustable loft, lie, or face angle system. A first portion **3243** of the sleeve **3204**, the sleeve bore **3242**, and the shaft collectively define a longitudinal axis **3246** of the assembly. The sleeve **3204** is effective to support the shaft along the longitudinal axis **3246**, which is offset from a longitudinal axis **3248** of the hosel **3150** by offset angle **3250**. The longitudinal axis **3248** is intended to align with the SA (seen in FIG. **1**B, for example). The sleeve **3204** can provide a single offset angle **3250** that can be between 0 degrees and 4 degrees, in 0.25 degree increments. For example, the offset angle can be 1.0 degree, 1.25 degrees, 1.5 degrees, 1.75 degrees, 2.0 degrees or 2.25 degrees. The sleeve **3204** can be rotated to provide various adjustments to the golf club assembly **5500**. In various embodiments, the sleeve **3204** may be mechanically fastenable to the golf club head **5000** to secure the shaft in a variety of positions relative to the golf club head **5000**, thereby altering at least one of the loft angle, lie angle, and face angle of the golf club assembly **5500**. In various embodiments, the sleeve **3204** may be secured to the hosel or to another portion of the golf club head **5000** depending on arrangement. One of skill in the art would understand that using mechanical methods would be considered fastening to the hosel. In various embodiments, mechanical fastening may include, a variety of connection mechanisms, including screws, various threading arrangements, velcros and similar systems, and the use of glues and various other permanent fastening methods, among others. One of skill in the art would understand that the system described with respect to the current golf club assembly **5500** can be implemented the various embodiments of golf club heads (**100**, **1000**) of the current disclosure.

Because the BCFs of the current embodiment include through-slot embodiments (providing a void in the golf club body), it is advantageous to fill the BCFs with a plugging material to prevent introduction of debris and to provide separation between the interior and the exterior of the various golf club heads of the various embodiments. The plugging materials disclosed in application for U.S. patent Ser. No. 13/839,727 are generally suitable for BCFs of the current embodiments and are incorporated herein by reference.

As can be seen, the golf club head **5000** may include at least one weight **5720** that may be attachable to and removable from the golf club head **5000** in various embodiments. In various embodiments, the weight **5720** may be omitted. In various embodiments, multiple moveable weights may be included. The weight **5720** of the current embodiment is configured to be secured within a weight port **5722**. In various embodiments, discretionary mass may be moveable using various methods, including those described in U.S. Pat. No. 7,166,040, entitled "REMOVABLE WEIGHT AND KIT FOR GOLF CLUB HEAD," filed Feb. 23, 2004, and U.S. Pat. No. 6,773,360, entitled "GOLF CLUB HEAD HAVING A REMOVABLE WEIGHT," filed Nov. 8, 2002, which are incorporated by reference herein in their entirety.

One should note that conditional language, such as, among others, "can," "could," "might," or "may," unless specifically stated otherwise, or otherwise understood within the context as used, is generally intended to convey that certain embodiments include, while other embodiments do not include, certain features, elements and/or steps. Thus, such conditional language is not generally intended to imply that features, elements and/or steps are in any way required for one or more particular embodiments or that one or more particular embodiments necessarily include logic for deciding, with or without user input or prompting, whether these features, elements and/or steps are included or are to be performed in any particular embodiment.

It should be emphasized that the above-described embodiments are merely possible examples of implementations, merely set forth for a clear understanding of the principles of the present disclosure. Any process descriptions or blocks in flow diagrams should be understood as representing modules, segments, or portions of code which include one or more executable instructions for implementing specific logical functions or steps in the process, and alternate implementations are included in which functions may not be included or executed at all, may be executed out of order from that shown or discussed, including substantially concurrently or in reverse order, depending on the functionality involved, as would be understood by those reasonably skilled in the art of the present disclosure. Many variations and modifications may be made to the above-described embodiment(s) without departing substantially from the spirit and principles of the present disclosure. Further, the scope of the present disclosure is intended to cover any and all combinations and sub-combinations of all elements, features, and aspects discussed above. All such modifications and variations are intended to be included herein within the scope of the present disclosure, and all possible claims to individual aspects or combinations of elements or steps are intended to be supported by the present disclosure.

We claim:

1. A golf club head comprising:

a golf club body, the golf club body including a crown, a sole, and a skirt connecting the crown to the sole, the golf club body including a heel portion and a toe portion; and

a striking face connected to a front of the golf club body, the striking face including:

an inner surface and an outer surface defining a thickness, the thickness being measured as the distance between the inner surface and the outer surface;

a toe-located boundary condition feature;

a heel-located boundary condition feature; and

at least one variation in thickness formed by a boss that is proximate to at least one end of the toe-located boundary condition feature or the heel-located boundary condition feature, wherein the toe-located boundary condition feature and the heel-located boundary condition feature are elongated thru-slots,

the boss encapsulates the at least one end of at least one of the thru-slots in order to reduce at least one stress concentration, and wherein there are no thru-slots between the toe-located boundary condition feature and the heel-located boundary condition feature.

2. The golf club head of claim **1**, wherein the at least one variation in thickness is an increase in thickness relative to at least one portion of the striking face that is distal to the end.

3. The golf club head of claim **2**, further comprising a shaft connection system, the shaft connection system allowing adjustment of at least one of loft angle, lie angle, and face angle of the golf club head.

4. The golf club head of claim **1**, wherein the thru-slots have a length of about 10 to 50 mm.

5. The golf club head of claim **1**, wherein the boss is about cylindrical.

6. The golf club head of claim **1**, wherein the toe-located boundary condition feature and the heel-located boundary condition feature are elongated in a direction from crown-to-sole.

7. The golf club head of claim **6**, further comprising a shaft connection system, the shaft connection system allowing adjustment of at least one of loft angle, lie angle, and face angle of the golf club head.

8. The golf club head of claim **6**, wherein the heel-located boundary condition and toe-located boundary condition are each elongated in a z-direction.

9. The golf club head of claim **1**, further comprising a shaft connection system, the shaft connection system allowing adjustment of at least one of loft angle, lie angle, and face angle of the golf club head.

10. The golf club head of claim **1** wherein the toe-located boundary condition feature and heel-located boundary condition feature are each elongated in a z-direction.

11. The golf club head of claim **1**, wherein the thru-slots have a length of about 10 to 50 mm.

12. The golf club of claim **1**, wherein the golf club head further comprises a first extent that extends parallel to the z-axis and a second extent that extends parallel to the x-axis, the first extent and the second extent being defined by a region of COR having a value of at least 0.820.

13. The golf club of claim **12**, wherein the golf club head further comprises an $Area_{Z\text{-}Extent}$ associated with the first extent and an $Area_{X\text{-}Extent}$ associated with the second extent.

14. The golf club of claim **12** wherein the thru-slots each have a vertical extent of about 15 to 25 mm.

15. The golf club of claim **12** wherein the thru-slots have a width of about 1 to 3 mm.

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