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Golden et al.

(54) GOLF CLUB HEAD WITH NON-THREADED INTERNAL CAVITY CHAMBER

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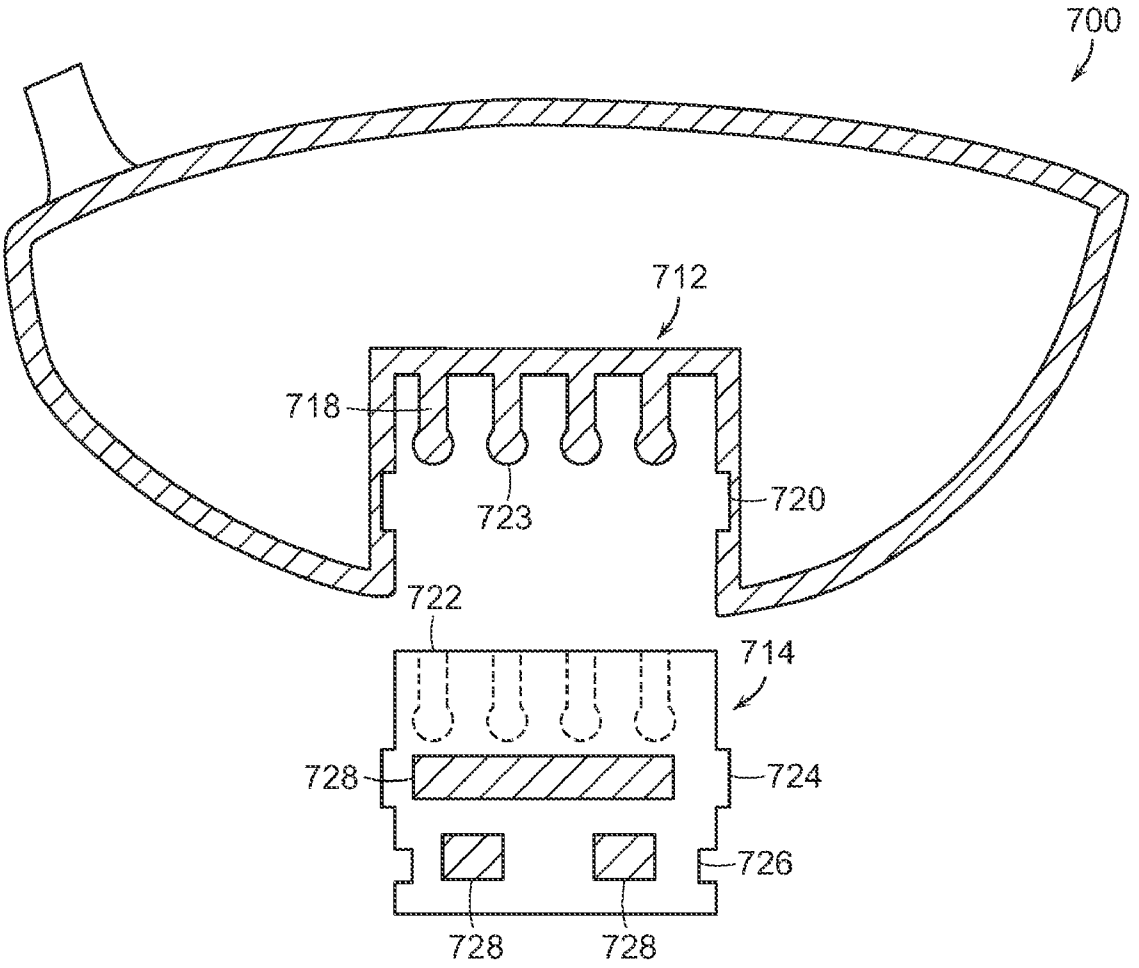
(57) **ABSTRACT**

A metal wood or utility type golf club head is disclosed in which the golf club head may have dynamic mass properties that are capable of being adjusted without utilizing a threaded mechanism. More specifically, the present invention discloses a golf club head that has an internal receptacle or cavity well that is strategically placed inside the metal wood or utility type golf club head to enable dynamic mass adjustments utilizing weight cards. Even more specifically, the weight cards may generally be flat and rectangular in shape to minimize weight at undesirable areas and may even contain a weighted portion having an increased density for further center of gravity adjustment.



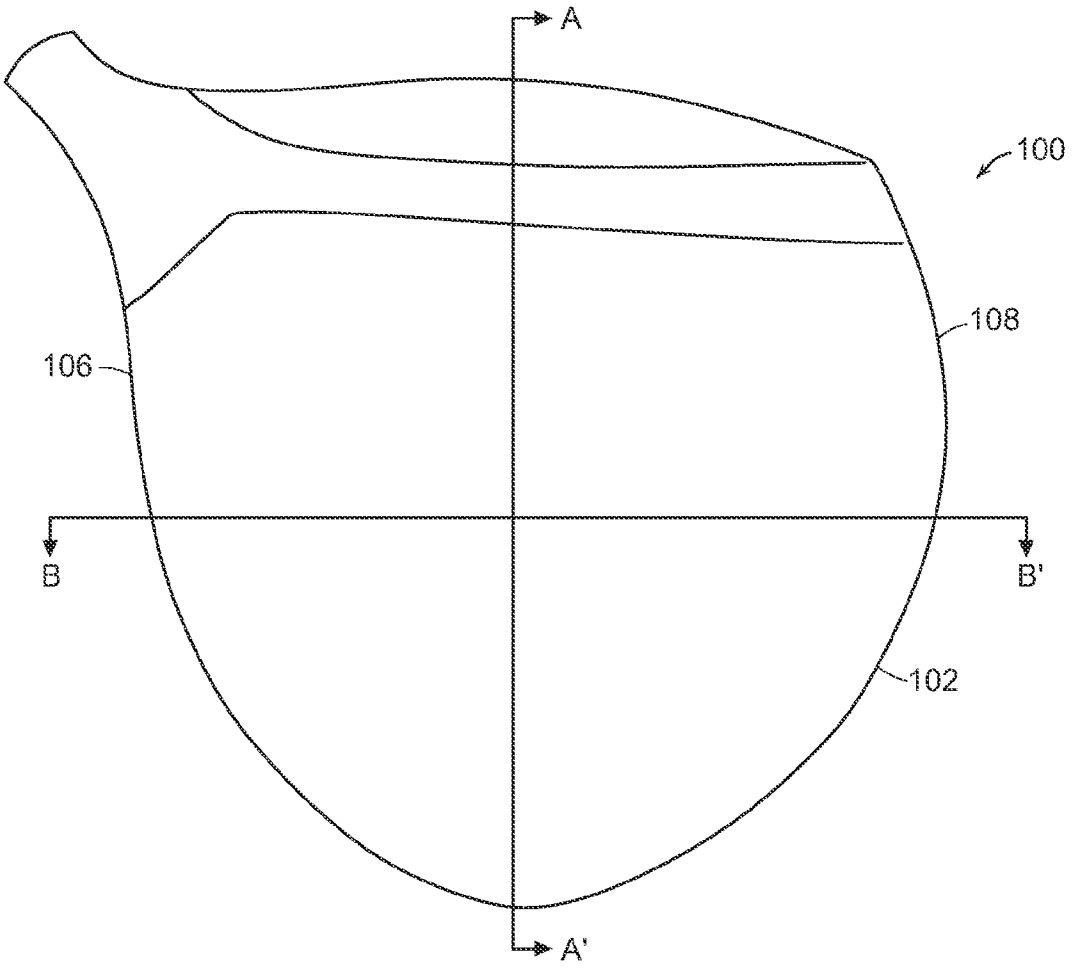


FIG. 1

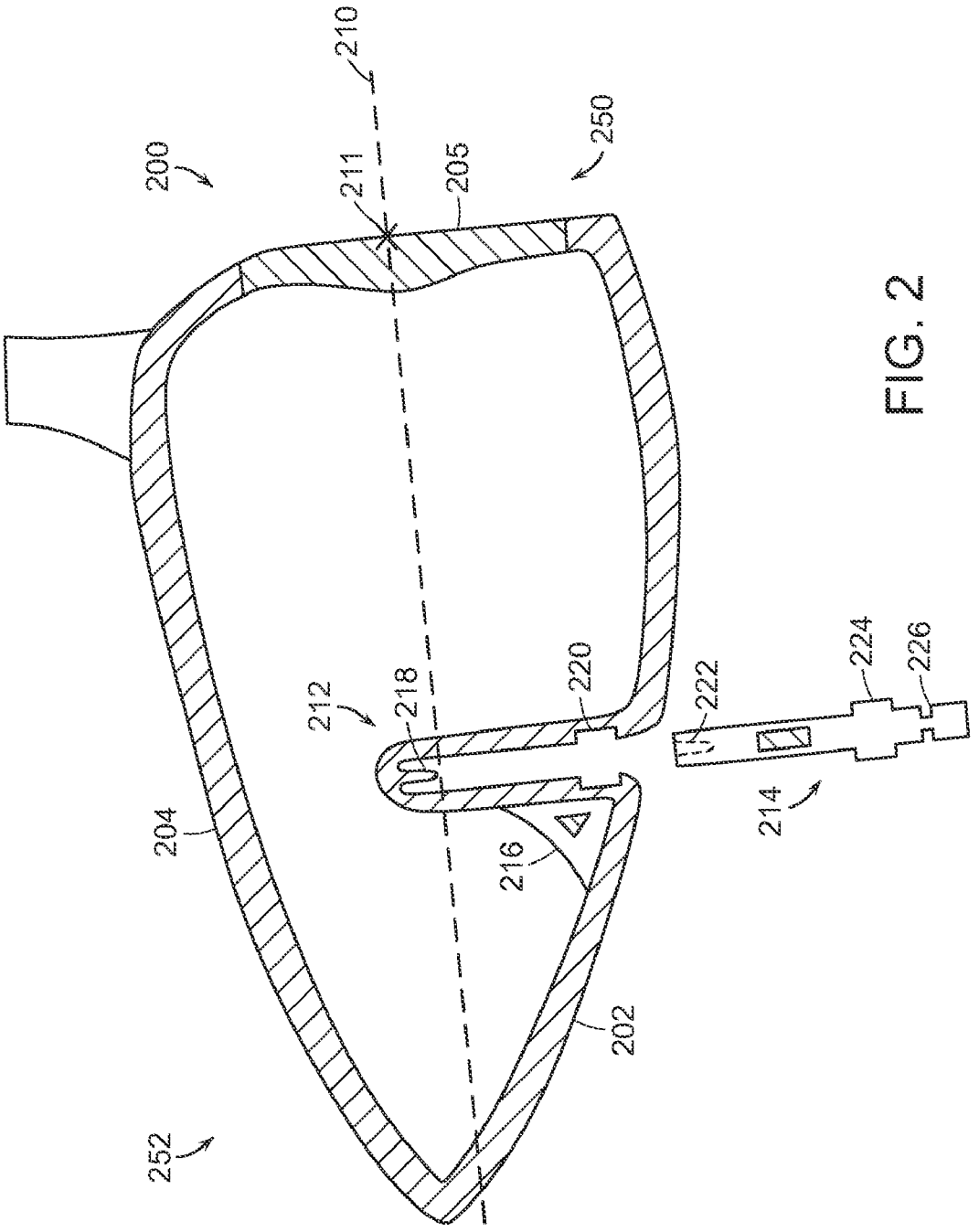


FIG. 2

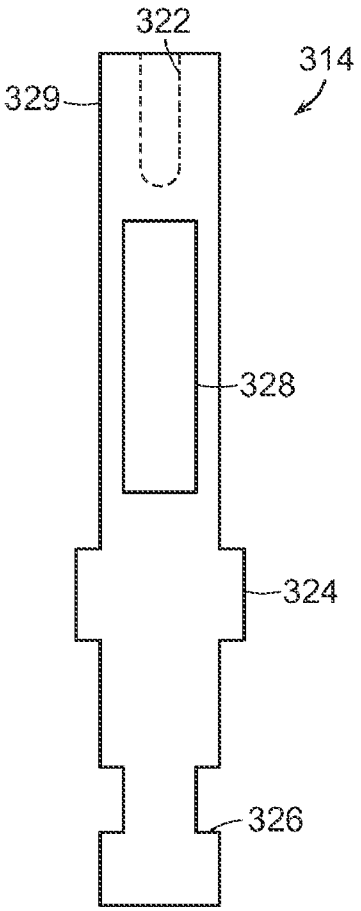


FIG. 3

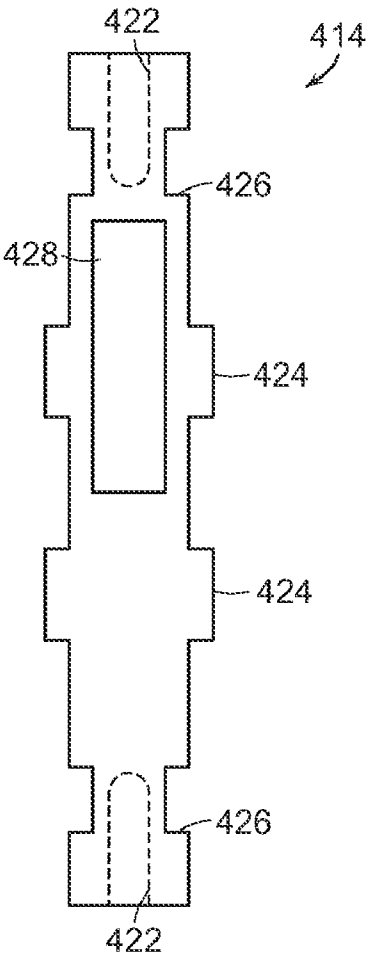


FIG. 4

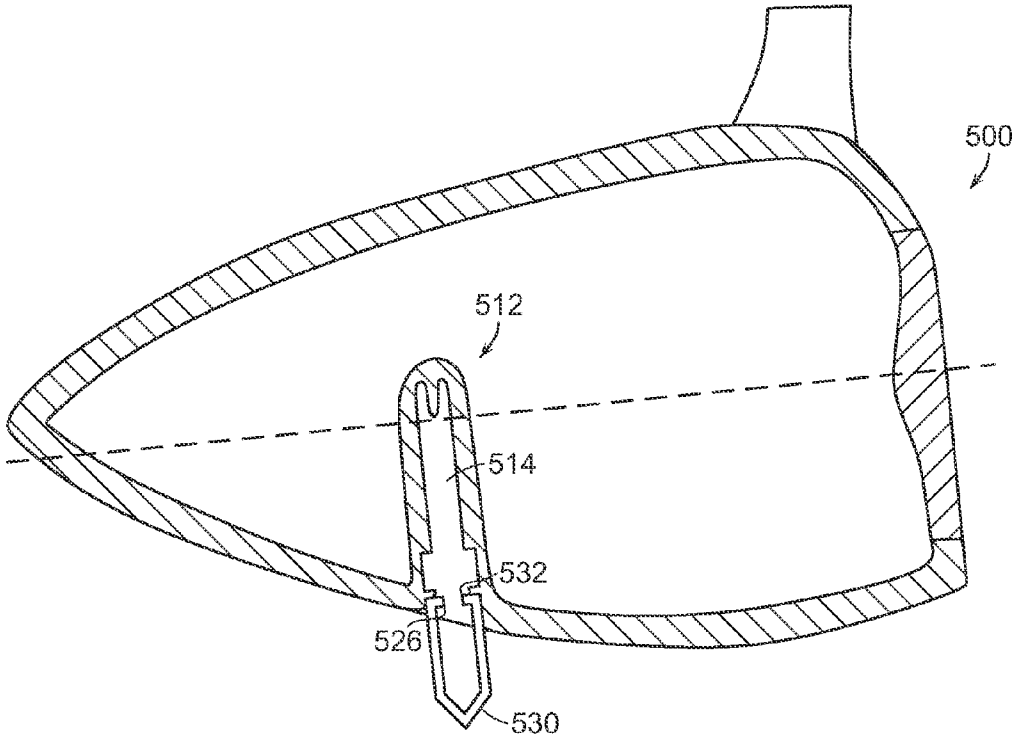


FIG. 5

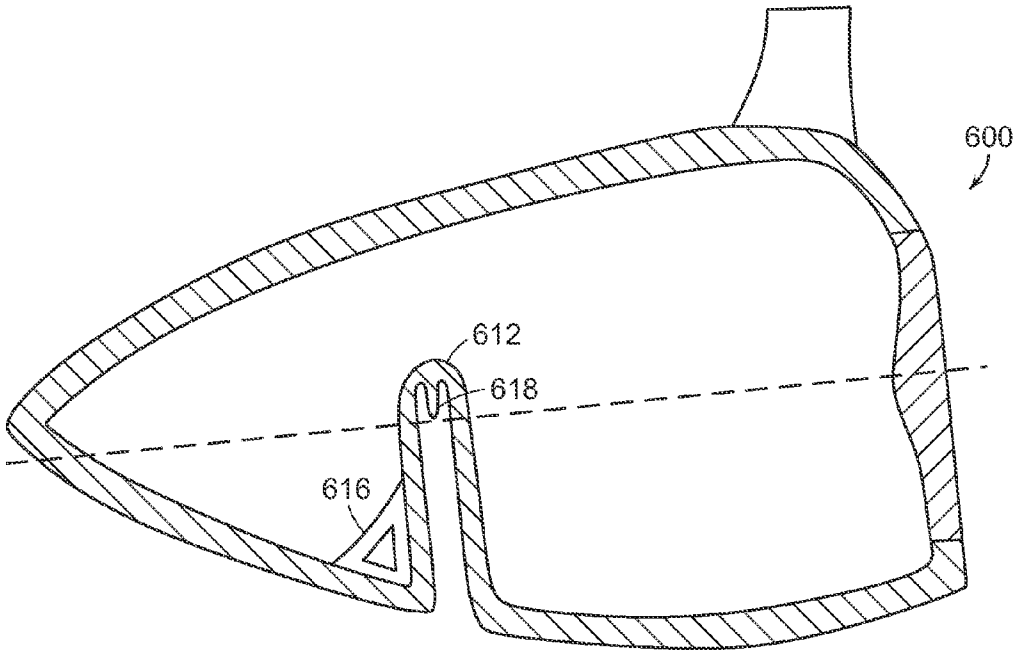


FIG. 6

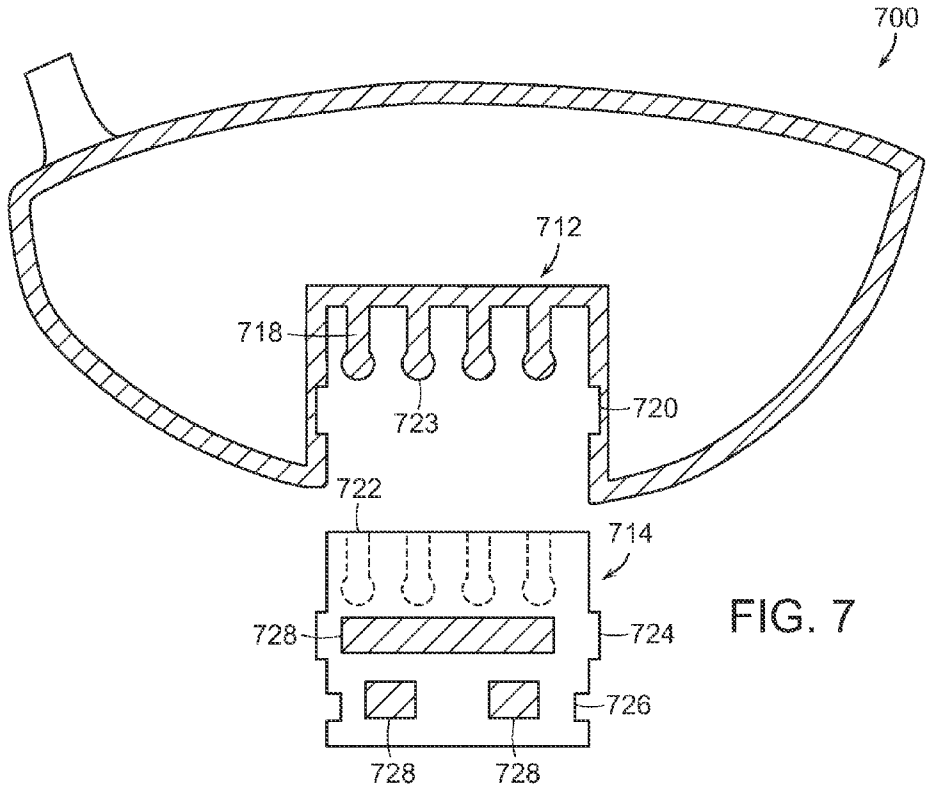


FIG. 7

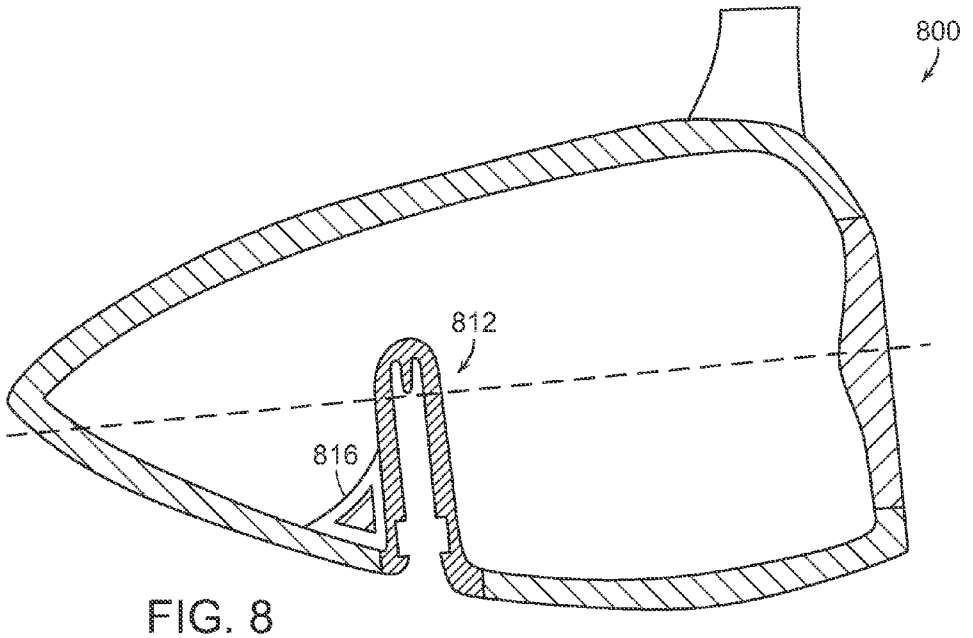


FIG. 8

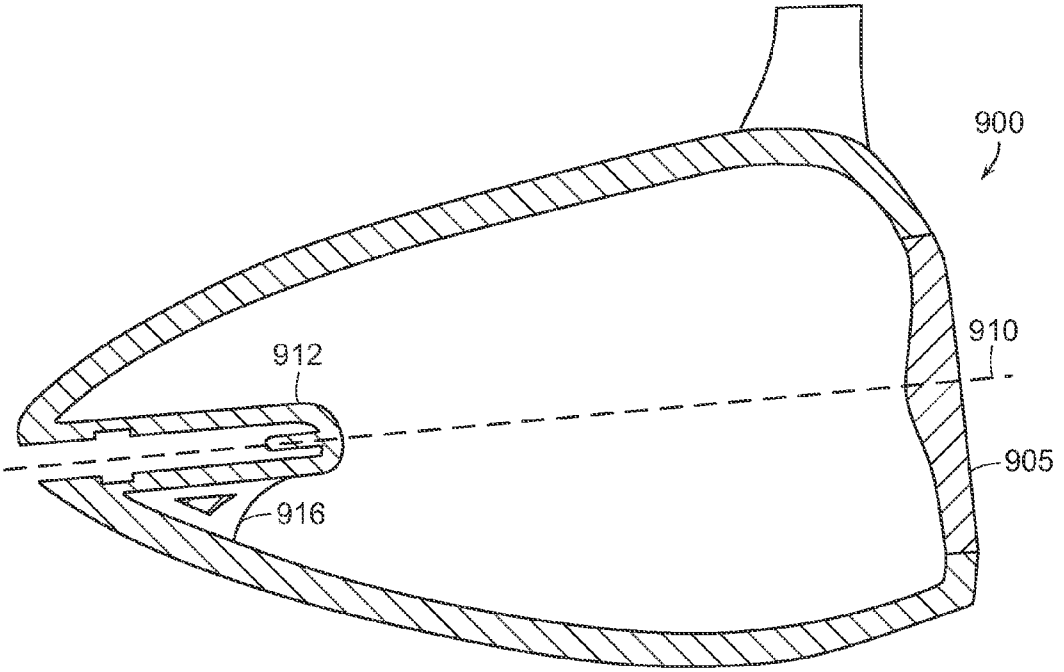


FIG. 9

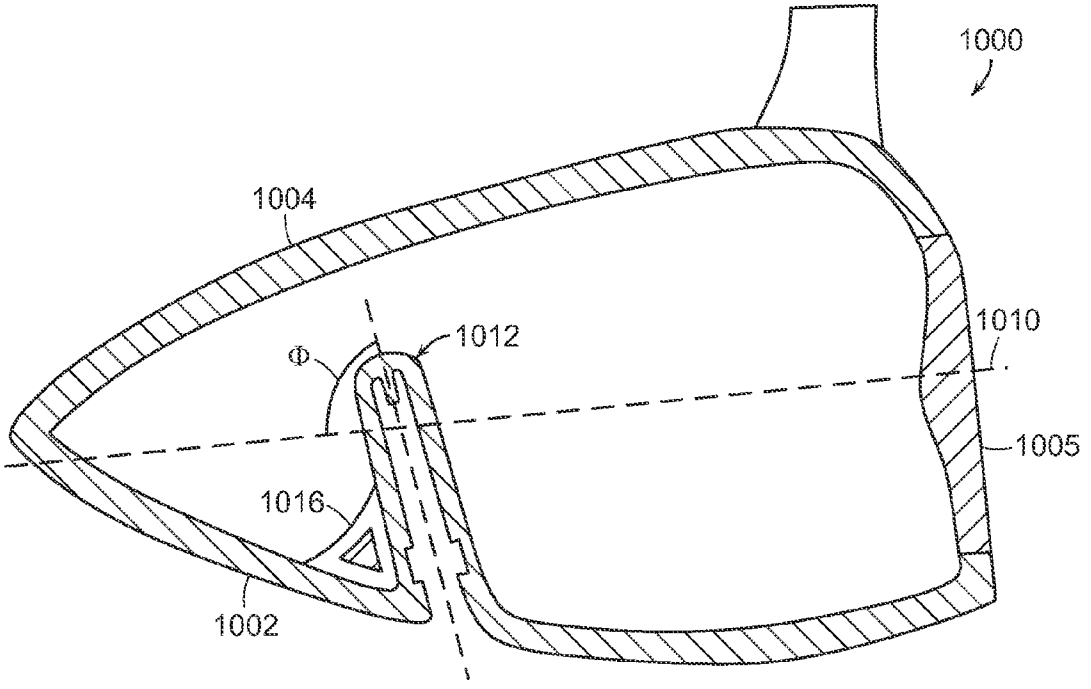


FIG. 10

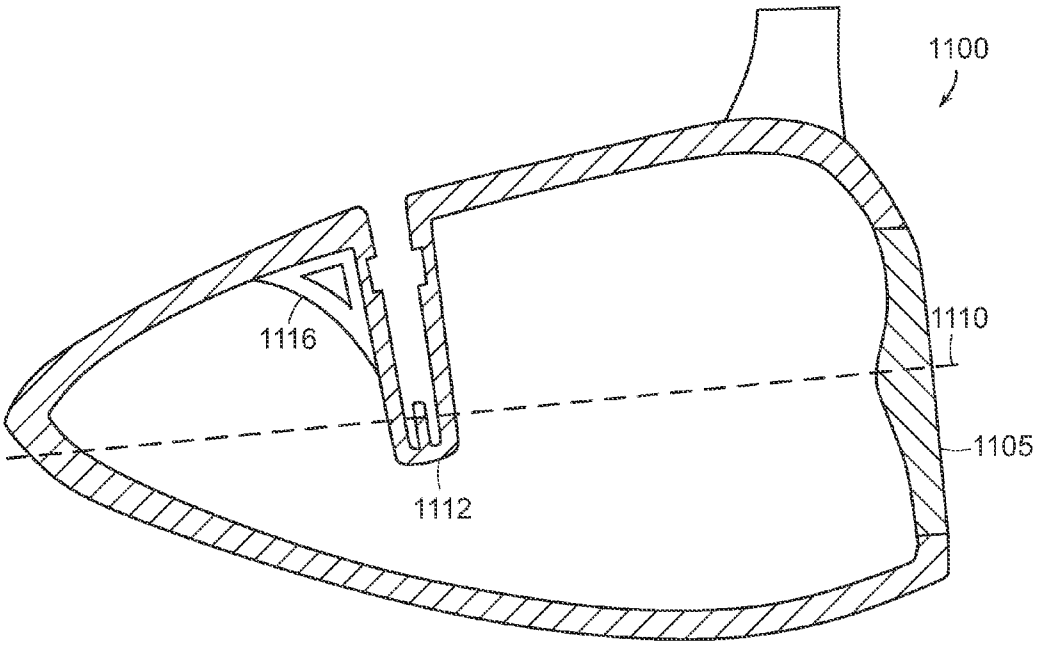


FIG. 11

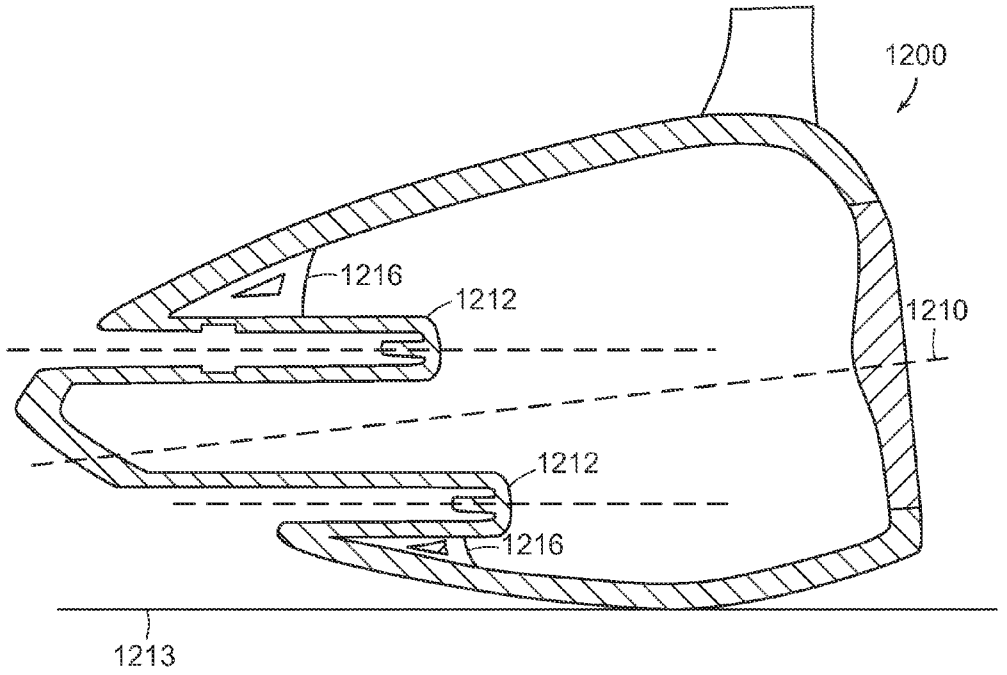


FIG. 12

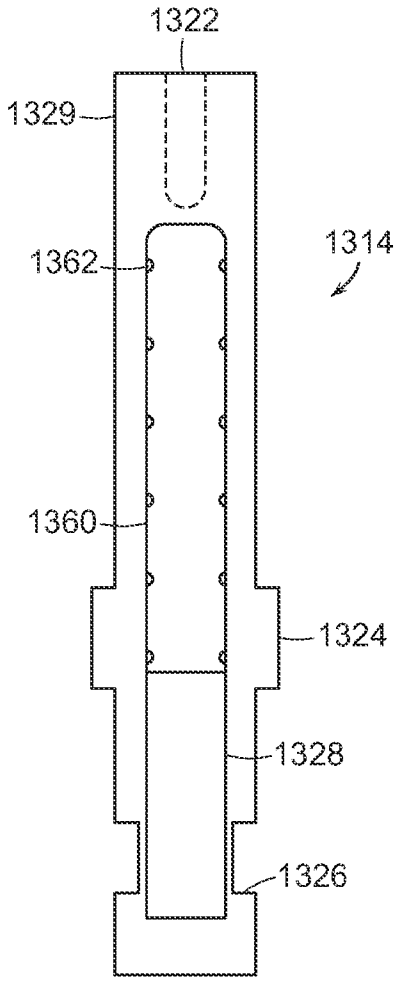

1322
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FIG. 13

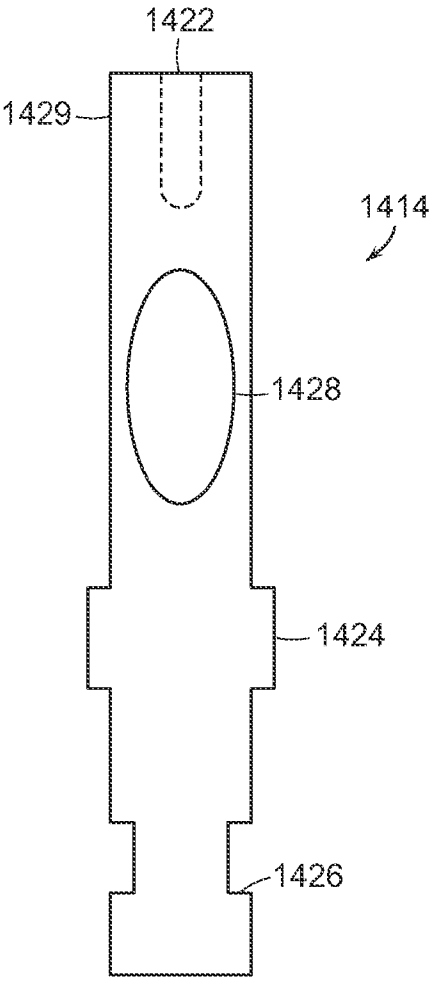
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FIG. 14

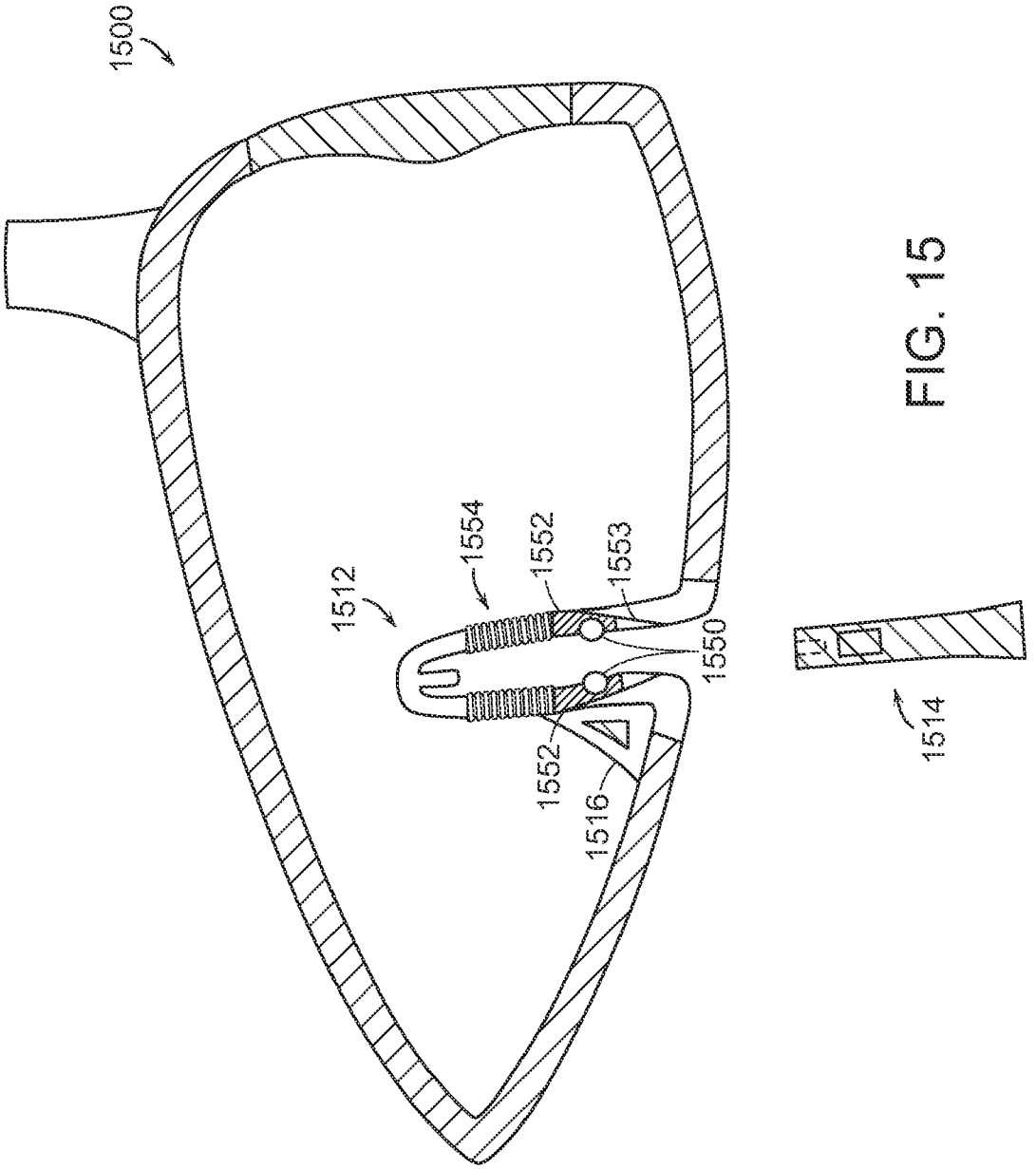

FIG. 15

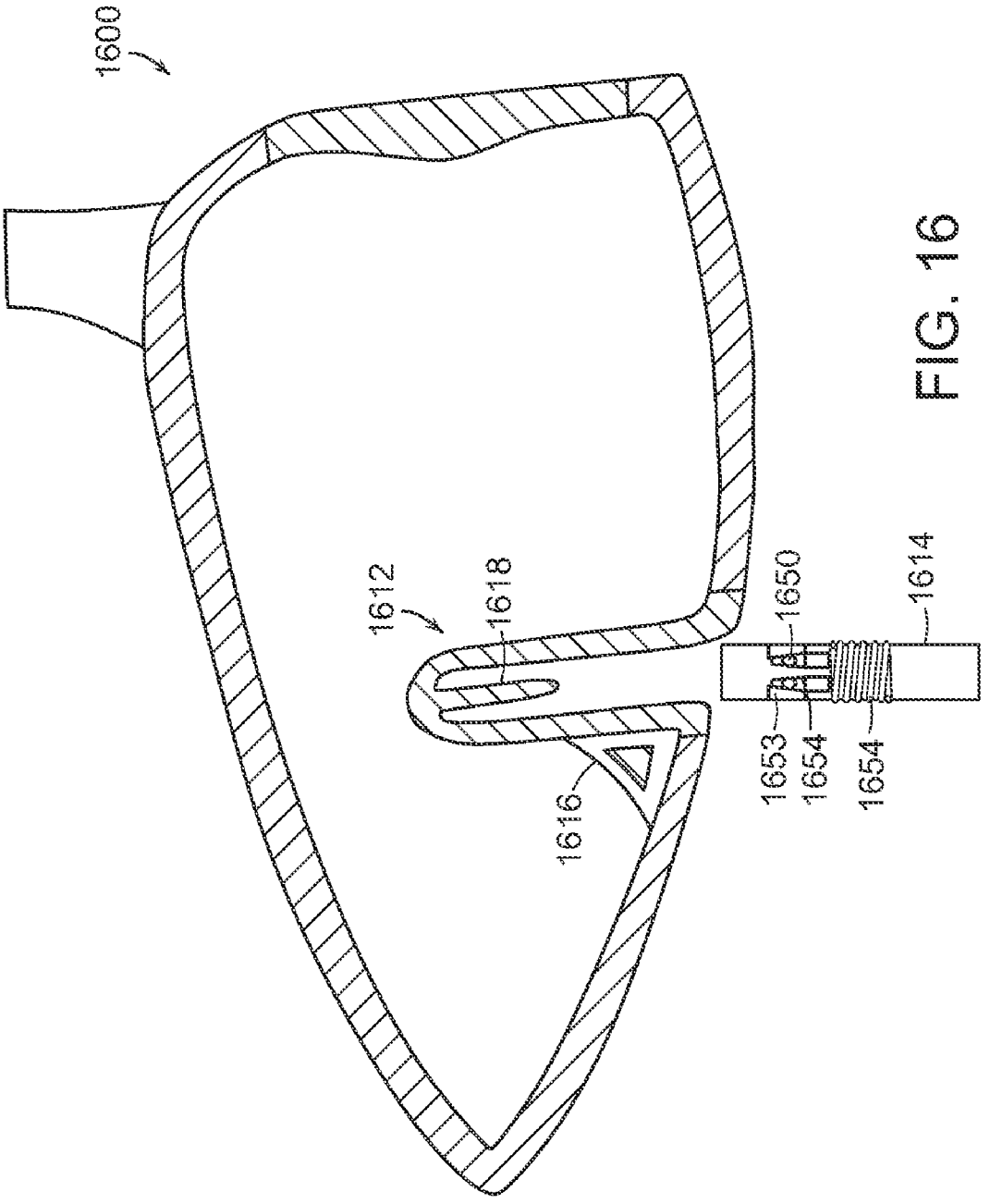

FIG. 16

GOLF CLUB HEAD WITH NON-THREADED INTERNAL CAVITY CHAMBER

FIELD OF THE INVENTION

[0001] The present invention relates to golf clubs, more particularly, to metal wood and utility-type golf clubs having dynamic mass properties. The present invention more specifically relates to a golf club head with one or more internal cavity chamber wherein a non-threaded weight card may be inserted into the cavity to adjust for different dynamic mass properties of the golf club head.

BACKGROUND OF THE INVENTION

[0002] Wood and utility-type golf club heads generally include a front or striking surface, a crown, a sole, and an arcuate skirt including a heel, a toe, and a back. The striking surface generally interfaces with and contacts the golf ball. A plurality of grooves, sometimes referred to as "score lines", may be provided on the face to assist in imparting spin to the ball and for decorative purposes. The crown is generally configured to have a particular look to the golfer and to provide structural rigidity for the striking surface. The sole of the golf club contacts and interacts with the ground during swing.

[0003] With a high percentage of amateur golfers constantly searching for more distance on their shots, particularly in their drives; the golf industry has responded by providing golf clubs specifically designed with distance and accuracy in mind.

[0004] In order to increase distance, the golfing industry has commonly decreased the wall thickness of a driver type golf club head while keeping the overall weight constant to even decreasing the overall weight of the driver type golf club head. More specifically, it has generally been known that the reduction of the face thickness will help increase the coefficient of restitution (COR) of the driver type golf club head face that results from impact with golf balls. This increase in COR may generally increase the distance of travel of a golf ball after it is struck by a driver type golf club head. The more a face rebounds upon impact, the more energy is imparted to the ball, thereby increasing the outgoing ball speed and the distance the ball travels.

[0005] In order to increase accuracy, the golfing industry has commonly increased the size of the golf club head in a driver type golf club. Bigger size driver type golf club heads with thinner wall thickness generally have more discretionary weighting available within the driver type golf club head that may be used to increase the moment of inertia (MOI) of the driver type golf club head. MOI generally refers to the ability of a driver type golf club head to resist twisting upon impact. An increase in MOI about the vertical axis may generally be achieved by having a center of gravity (CG) location further back within the driver type golf club head.

[0006] Known methods to enhance the weight distribution of wood-type club heads to reduce the club from twisting upon contact with the ball usually includes either the addition of weights to the body casting itself or strategically adding a weight elements at some point in the club. This methodology shifts the CG of a club head lower and back and increase the MOI of the golf club head. Efforts to incorporate weight elements in a golf club head have been discussed in patent literature. For instance, U.S. Pat. No. 1,518,316 ('316 patent) discloses a golf club having improved means whereby the weight of the head of the club may be varied and the distribution of the cylindrical weight adjusted to suit the requirement of the user.

[0007] Though the mass characteristics of the golf club may be manipulated by rearranging the moveable weights, the cylindrical shape of the weights and their respective housing that constraints the weights within the golf club unnecessarily moves a significant portion of the mass toward the center of the club head, which may not maximize the peripheral weight of the club head or the MOI. Moreover cylindrical weight members that are attached to the club head via threaded engagement may rotate and become unintentionally disengaged from the club head during normal play.

[0008] Alternative approaches for moving the CG of a golf club head rearward and downward in the club head utilizes composite structures. These composite structures utilize two or three, or even more materials that have different physical properties including different densities. By positioning materials that provide the desired strength characteristics with less weight near the crown or top line of a golf club head, a larger percentage of the overall weight of the golf club head may be shifted towards the sole of the club head. This results in the CG being moved downward and rearward. This approach is advantageous in iron clubs or fairway woods, as this will help to increase ball launch angle and increase outgoing ball speed. An example of this type of composite club head is shown in U.S. Pat. No. 5,720,674 ('674 patent) titled Golf Club Head to Galy. The club head of the '674 patent comprises an arcuate portion of high-density material bonded to a recess in the back-skirt. Because composite materials like those found in the '674 club head must be bonded together, for example by welding, swaging, or using bonding agents such as epoxy, they may be subject to delamination or corrosion over time. This delamination is undesirable as they can break down over time.

[0009] Lastly, in order to address the disadvantages associated with the weight screws, U.S. Pat. No. 6,458,044 ('044 patent) titled Golf Club Head and Method For Making It to Vincent et al. has utilized a cavity within the internal walls of the club head combined with a snap fit without the need for a screw attachment to adjust for the weight of the golf club head. More specifically, the '044 patent discloses a golf club head including a hollow main body having a sole, a crown, a heel, a toe, a ball-striking surface, and a rear wall, with the heel defining a hosel for receiving the lower end of a shaft, and the rear wall defining a rear wall cavity for receiving a special weight cartridge. The hollow main body defines a central axis along which the head is intended to move when being used to strike a golf ball. Even more specifically, a golf club head where the rear wall cavity is substantially aligned with the central axis and is sized and configured to comfortably and slidably receive the polymeric housing, along an axis substantially aligned with the central axis.

[0010] The golf club head found in the '044 patent, although effective in eliminating the disadvantages associated with weight screws, is ineffective in addressing the change in spin and inertia characteristics of the golf club head independently. The golf club head found in the '044 patent is ineffective in addressing the change in spin and inertia characteristics because it is located at the rear wall cavity and because it is aligned in parallel to the central axis along which the head is intended to move when being used to strike a golf ball.

[0011] Hence, it can be seen that there is a need in the field for a golf club that is capable of adjusting the spin and inertia characteristics of a golf club without utilizing an object that unnecessarily transfers weight into the center of the golf club head such as a screw. More specifically, there is a need in the field for a golf club that is capable of adjusting the spin and inertia characteristics utilizing receptacles within the cavity of the golf club wherein a weighted insert may be used to adjust for the total weight, the outgoing launch conditions, and the inertia characteristics of the golf club head independently.

BRIEF SUMMARY OF THE INVENTION

[0012] In one aspect of the present invention is a golf club head comprising of a forward portion containing a striking face where the striking face that is further comprised of a face center wherein the face center is located at the geometric center of the face. Moreover, the face center further helps define a neutral axis that is perpendicular to the striking surface passing through the face center. The golf club head of the present invention also comprises of an aft portion connected to the forward portion, a cavity well located within the aft portion of the golf club head, and a weight card that is configured to be embedded within the afore mentioned cavity well without the need of a threaded attachment. Lastly, the golf club head in accordance with this aspect of the present invention has a cavity well that has a ratio of volume to surface area of less than 0.5, wherein the ratio is defined as the volume divided by the surface area.

[0013] In another aspect of the present invention is a golf cub head comprising of a forward portion containing a striking surface that is further comprised of a face center wherein the face center is located at the geometric center of the face. Moreover, the face center further helps define a neutral axis that is perpendicular to the striking surface passing through the face center. The golf club head of the present invention also comprises of an aft portion connected to the forward portion, a cavity well located within the aft portion of the golf club head, and a weight card that is configured to be embedded within the afore mentioned cavity well without the need of a threaded attachment. Lastly, the golf club head in accordance with this aspect of the present invention has a cavity well that is perpendicular to the neutral axis.

[0014] In a further aspect of the present invention is a golf club head comprising of a forward portion containing a striking surface that is further comprised of a face center wherein the face center is located at the geometric center of the face. Moreover, the face center further helps define a neutral axis that is perpendicular to the striking face passing through the face center. The golf club head of the present invention also comprises of an aft portion connected to the forward portion, a cavity well located within the aft portion of the golf club head, and a weight card that is configured to be embedded within the afore mentioned cavity well without the needed of a threaded attachment. Lastly, the golf club head in accordance with this aspect of the present invention has a cavity well that is parallel to the neutral axis.

[0015] These and other features, aspects and advantages of the present invention will become better understood with references to the following drawings, description and claims.

BRIEF DESCRIPTION OF DRAWINGS

[0016] The foregoing and other features and advantages of the invention will be apparent from the following description of the invention as illustrated in the accompanying drawings. The accompanying drawings, which are incorporated herein and form a part of the specification, further serve to explain the principles of the invention and to enable a person skilled in the pertinent art to make and use the invention.

[0017] FIG. **1** shows a top view of a golf club head in accordance with an exemplary embodiment of the present invention;

[0018] FIG. **2** shows a cross-sectional view of a golf club head in accordance with an exemplary embodiment of the present invention;

[0019] FIG. **3** shows a enlarged top view of a weight card in accordance with an exemplary embodiment of the present invention;

[0020] FIG. **4** shows an enlarged top view of a weight card in accordance with an alternative embodiment of the present invention;

[0021] FIG. **5** shows a cross-sectional view of a golf club head in accordance with a further alternative embodiment of the present invention;

[0022] FIG. **6** shows a cross-sectional view of a golf club head in accordance with an even further alternative embodiment of the present invention;

[0023] FIG. **7** shows an alternative cross-sectional view of a golf club head in accordance with an even further alternative embodiment of the present invention;

[0024] FIG. **8** shows a cross-sectional view of a golf club head in accordance with an even further alternative embodiment of the present invention;

[0025] FIG. **9** shows a cross-sectional view of a golf club head in accordance with an even further alternative embodiment of the present invention;

[0026] FIG. **10** shows a cross-sectional view of a golf club head in accordance with an even further alternative embodiment of the present invention;

[0027] FIG. **11** shows a cross-sectional view of a golf club head in accordance with an even further alternative embodiment of the present invention;

[0028] FIG. **12** shows a cross-sectional view of a golf club head in accordance with an even further alternative embodiment of the present invention;

[0029] FIG. **13** shows an enlarged top view of a weight card in accordance with an even further alternative embodiment of the present invention; and

[0030] FIG. **14** shows an enlarged top view of a weight card in accordance with an even further alternative embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0031] The following detailed description is of the best currently contemplated modes of carrying out the invention. The description is not to be taken in a limiting sense, but is made merely for the purpose of illustrating the general principles of the invention, since the scope of the invention is best defined by the appended claims.

[0032] Various inventive features are described below that can each be used independently of one another or in combination with other features. However, any single inventive feature may not address any or all of the problems discussed above or may only address one of the problems discussed above. Further, one or more of the problems discussed above may not be fully addressed by any of the features described below.

[0033] The present invention generally relates to a golf club head that is capable of being customized in a way that adjusts the CG location as well as the overall weight of the golf club without the need for a threaded attachment element. More specifically, the present invention relates to a golf club head with a cavity well that is significantly rectangular in shape and has a ratio of volume to surface area less than 0.5. The current invention is unlike the prior art golf club heads wherein a threaded attachment mechanism such as a screw is used to adjust the center of gravity of a golf club head. The usage of a threaded attachment is undesirable because the shape of a threaded attachment requires a significant amount of weight to be shifted inside the golf club head as it is being threaded into the golf club head. This additional weight being shifted into the center of the club head may contribute to undesirable CG movement.

[0034] Turning now to FIG. **1** showing a top view of a golf club head **100** in accordance with an exemplary embodiment of the present invention. Golf club head **100** may contain a crown **102**, a sole (not shown), a heel **106**, and a toe **108**. Golf club head **100** may generally be a driver type head with a volume of about 380 cc to about 475 cc; however, golf club head **100** may also be a fairway type club, a utility type club, an iron type club, or even a putter type club all without departing from the scope and content of the present invention. Golf club head **100**, as shown in FIG. **1**, shows the lines, A-A' and B-B' that identify the potential cross-sectional views of the present invention that could better demonstrate the present invention.

[0035] FIG. **2** shows a cross-sectional exploded view of a golf club head **200** in accordance with an exemplary embodiment of the present invention taken along cross-sectional line A-A' as shown in FIG. **1**. The cross-sectional view of golf club head **200**, as shown in FIG. **2**, shows a golf club head **200** containing a sole **202**, a crown **204**, a striking surface **205**, a neutral axis **210**, a cavity well **212**, a weight card **214**, and an internal stabilizer **216**. It should be further noted that cavity well **212** may further comprise of at least one docking rod **218**, and a plurality of locking tab receptacles **220** used to mate with the weight card **214**. Correspondingly, weight card **214** may also further comprise of at least one docketing slot **222**, a plurality of locking tabs **224**, and a plurality of disengagement latches **226** that may be shown in more detail in FIG. **3**.

[0036] Golf club head **200**, as shown in the current exemplary embodiment may generally be divided into a forward portion **250** at the front end of the golf club head **200** and an aft portion **252** at a rear aft end of the golf club head **200**. Forward portion **250**, as shown in FIG. **2**, may generally contain the striking face **205**, from which a golf ball interacts with the golf club head **200**. Aft portion **252**, as shown in the current exemplary embodiment, may generally refer to the area containing the crown **204**, the sole **202**, and may even contain a skirt.

[0037] In the current exemplary embodiment shown in FIG. **2**, neutral axis **210** may generally pass through the center of striking surface **205**. More specifically, the neutral axis **210** may be defined as an oblique axis through the striking surface **205** where hits on either side of the neutral axis **210** cause the clubface to rotate in opposite directions as a result of impact. The neutral axis **210**, as defined by the current invention, does not run parallel to the ground and along the direction of travel of golf club head **200**, but rather is perpendicular to the angle of the striking face **205** passing through an impact point **211**. The neutral axis **210** is different from the central axis of the golf club head because a golf club head has a loft angle, and a neutral axis **210** that passes through the lofted striking face **205** will be at an inclined angle.

[0038] The cavity well **212** in this current exemplary embodiment may generally be placed in the sole **202** section of the golf club head **200** in order to allow for dynamic adjustment of the CG location of golf club head **200**; however cavity well **202** may also be placed at the crown **204**, the skirt, or any other location within the aft portion **252** that doesn't interfere with the performance characteristics all within the scope and content of the present invention.

[0039] FIG. **2** shows an exemplary embodiment of the present invention wherein the direction of the cavity well **212** may be perpendicular to the neutral axis **210** of golf club head **200**. It may be desirable to have the cavity well **212** perpendicular to the neutral axis **210** in a golf club head **200** because in this orientation, the weight card **214** may help adjust and shift the CG location perpendicular to the neutral axis **210**. It may also be desirable to shift the CG location perpendicular to the neutral axis **210** as such a change generally may result in a change in the backspin, launch angle, and ballspeed characteristics of a golf ball upon impact. Controlling backspin is an important objective of the present invention as it may affect the performance of a golf club head **200**. However, it should be noted that cavity well **212** does not need to be perpendicular to the neutral axis **210**, and could be parallel to the neutral axis **210** or arranged in any orientation within golf club head **200** all without departing from the scope and content of the present invention.

[0040] Having the cavity well **212** perpendicular to the neutral axis **210** may allow for specific adjustment of the amount of backspin of a golf club head **200**. Having the cavity well **212** being perpendicular to the neutral axis **210** allows weights to be placed in the weight card **214** in a way that it only affects the vertical location of the CG with respect to the neutral axis **210**. Isolated vertical CG changes directly affect the backspin characteristics of a golf club head **200**, as a lower CG location in drivers decreases backspin and higher CG locations increases backspin in drivers.

[0041] Golf club head **200** in this current exemplary embodiment may also contain an internal stabilizer **216** attached to an internal wall portion of cavity well **212**. Internal stabilizer **216**, as shown in the current exemplary embodiment, may be used to control the vibration of the cavity well **212** during impact of golf club head **200** with a golf ball. Because a tremendous amount of force and impact is generated during a golf swing, the golf club head **200** is subjected to tremendous amount of vibrations internally within golf club head **200**. Without an internal stabilizer **216**, the extensive amount of vibration could effectively dislodge weight card **214** from the cavity well **212**. However, it should be noted that the current invention may operate without an internal stabilizer **216**; as it is not essential to the proper functionality of the present invention.

[0042] Cavity well **212** in the current exemplary embodiment may generally be further comprised of one or more docking rods **218** as well as one or more locking tab receptacles **220** to help secure the weight card **214** within cavity well **212** inside of golf club head **200**. Docking rods **218** may generally be located at the deep end of cavity well **212**, and protrudes out into cavity well **212**. Docking rods **218** may generally connect with the docking slots **222** that are located on the weight card **214** to allow weight card **214** to tightly

connect to the cavity well **212**. The docking slots **222** may generally be located at a terminal end of weight card **214** to reach into the deep end of cavity well **212** to facilitate a proper connection between the weight card **214** and the cavity well **212**.

[0043] Cavity well **212**, as shown in the current exemplary embodiment may generally be rectangular in shape to resemble the shape of a thin credit card; however, cavity well **212** may also be circular in shape, triangular in shape, octagonal in shape, or any shape that has a low profile to accept a weight card **214** with a similar profile without departing from the scope and content of the present invention. Cavity well **212** may generally have a flat entry area that has a low height to minimize the horizontal affect on CG as well as a relatively deep internal area to maximize the vertical affect on CG to create the greatest CG adjustment along the desired direction while minimizing CG effect in the undesirable direction. This increase in surface area will also enhance the overall friction on the card, which will help secure the weight card **214** within the cavity well **212**. This low height and increased depth profile seen in FIG. **2** may generally have a ratio of volume to surface area

$$\left(\frac{\text{Volume}}{\text{Surface Area}}\right)$$

that is less than 0.6; more preferably less than 0.5, and most preferably less than 0.4. Cavity well **212** may generally have an increased depth in conjunction with a relative flat entry to allow the weight card **214** to be inserted into golf club head **200** with ease in accordance with the present invention.

[0044] Cavity well **212**, as shown in the current exemplary embodiment may generally have a depth of greater than about 5 mm, more preferably greater than about 7 mm, most preferably greater than about 9 mm. Additionally, in order to maintain the ratio of volume to surface area, cavity well **212** may generally have a thickness that is less than about 2 mm, more preferably less than about 1 mm, and most preferably less than about 0.5 mm. Finally, cavity well **212** may have a width that may generally be less than about 5 mm, more preferably less than about 4 mm, and most preferably less than about 3 mm all within volume to surface area ratio within the ranges in accordance with an exemplary embodiment of the present invention.

[0045] More specifically, utilizing the dimension ranges above, cavity well **212** may have a width of about 5 mm, a height of about 1 mm, and a depth of about 15 mm. The volume of the exemplary cavity well **212** may hence be about 75 mm^3, and the internal surface area of cavity well **212** may be about 190 mm^2. This exemplary volume and surface area may generally yield a ratio of about 0.39 in accordance with an exemplary embodiment of the present invention. Cavity well **212**, as shown in the current exemplary embodiment, may take on other dimensions without departing from the scope and content of the present invention so long as it maintains a volume to surface area ratio that is less than 0.6, more preferably less than 0.5, and most preferably less than 0.4.

[0046] Locking tab receptacles **220** within cavity well **212** may generally interact with locking tabs **224** located on the weight card **214** to further secure the weight card **214** into the cavity well **212** of golf club head **200**. Locking tab receptacles **220** may generally act to receive the locking tabs **224** when the weight card **214** is fully engaged within the cavity well **212** to prevent the weight card **214** from moving within the cavity well **212**.

[0047] Once the locking tab receptacles **220** receive the locking tabs **224**, they interlock may only be released utilizing a release tool (shown later in FIG. **5**) that connects the disengagement latches **226**. FIG. **2** also shows that the weight card **214** may have a plurality of disengagement latches **226** located at a exterior end of the weight card **214** to receive a removal tool (not shown) to remove the weight card **214** from the cavity well **212**.

[0048] FIG. **3** shows an enlarged view of a weight card **314** in accordance with an exemplary embodiment of the present invention. Weight card **314**, similar to weight card **214**, may contain one or more docking slot **322**, one or more locking tabs **324**, and one or more disengagement latches **326**. In addition to the above mentioned components, the enlarged view of weight card **314** in FIG. **3** may better illustrate the multi-material composition of weight card **314**.

[0049] Weight card **314** may generally be comprised of an internal weighted portion **328** and an external portion **329**. Internal weighted portion **328** may generally be comprised of tungsten for its enhanced density characteristics; however internal weighted portion **328** may also be comprised of steel, lead, magnesium, or any other material with an increased density that is capable of adjusting the weight properties of the weight card **314** without departing from the scope and content of the present invention. The material selected for internal weighted portion **328** may generally be comprised of a material that has a higher density than the golf club head **200** (shown in FIG. **2**). Moreover, internal weight portion **324** may generally have a higher density than the external portion **329** of the weight card **314** in order allow for CG location adjustment within the golf club head **200**. (shown in FIG. **2**)

[0050] External portion **329** of weight card **314** may generally be comprised of a urethane material, an aluminum material, a composite material, or any other material that is light in weight when compared to internal weighted portion **328** to create more discretionary weight that can be used to strategically adjust the CG location of golf club head **200**. (shown in FIG. **2**) Moreover, external portion **329** may also be comprised of, or coated with a material that has an increased coefficient of friction such as urethane to further improve the connection between weight card **314** and the cavity well **212** shown in FIG. **2**. Although FIG. **3** shows the external portion **329** enclosing one internal weighted portion **328**; the current invention could contain several internal weighted portions **328** strategically placed at various locations within weight card **314** all without departing from the scope of the present invention. Additionally, although the external portion **329** may increase the coefficient of friction between the weight card **314** and the cavity well **212**, (shown in FIG. **2**) as well as increasing more discretionary weight to improve the CG location, the current invention can be comprised of a single material to achieve the same CG movement without departing from the scope and content of the present invention. External portion **329** of the weight card **314**, as shown in the current exemplary embodiment, may also have different surface finish treatment such as sandblasting finish, milled finish to increase the coefficient of friction between the weight card **314** and the cavity well **212**, (shown in FIG. **2**).

[0051] FIG. **4** shows a further alternative embodiment of the present invention wherein a weight card **414** may be reversible, eliminating any directional restriction when

assembled within cavity well **212** (shown in FIG. **2**). Weight card **414**, as shown in the current exemplary embodiment, may have a plurality of docking slots **424**, a plurality of locking tabs **424**, and a plurality of disengagement latches **426** located at both ends of itself; allowing either end to be inserted into the cavity well **212**, as shown in FIG. **2**, without departing from the scope of the present invention. This weight card **414** may allow for dynamic adjustment of the CG locations of a golf club head **200** (shown in FIG. **2**) without the need for a separate weight card that has a different internal weighted portion **428** placement.

[0052] FIG. **5** shows a cross-sectional view of a golf club head **500** in accordance with the present invention taken along cross-sectional line A-A' as shown in FIG. **1**. The cross-sectional view of golf club head **500** shows the weight card **514** as assembled within cavity well **512**. More specifically, the cross-sectional view depicted in FIG. **5** also shows a removal tool **530** having a hooked portion **532** wherein the hooked portion **532** engages the disengagement latches **526** to allow the weight card **514** to separate from the cavity well **512**. Removal tool **530** may have generally have a plurality of hooked portions **532** that resembles a pair of tweezers for the purpose of disengaging the weight card **514** from cavity well **512**.

[0053] FIG. **6** shows a cross-sectional view cross-sectional view of golf club head **600** in accordance with a further alternative embodiment of the present invention taken along cross-sectional line A-A' as shown in FIG. **1**. Golf club head **600** in this current exemplary embodiment may generally have the locking tab receptacles (not shown) placed horizontally along the heel and toe direction of the cavity well relative to golf club head **600** instead of longitudinally. This alternative embodiment of golf club head **600**, may generally allow a larger sized weight card to be utilized, as more volume may be dedicated to the cavity well **612** without departing from the scope and content of the present invention. Because the weight card is placed along the heel and toe direction, the current cavity well **612** does not have any This exemplary embodiment may be better demonstrated via cross-sectional line B-B' as shown in FIG. **7**.

[0054] FIG. **7** shows a cross-sectional view of golf club head **700** in accordance with an even further alternative embodiment of the present invention taken along cross-sectional line B-B' as shown in FIG. **1**. Golf club head **700**, utilizing a horizontally placed locking tab receptacle **720**, may generally yield a higher volume available for a larger sized weight card **714**. A larger sized weight card **714** may be desirable during situations where extreme weight shift in CG location of golf club head **700** is required. FIG. **7** also shows multiple docking rods **718** within cavity well **712** to ensure sufficient connection and support for weight card **714**. Additionally, due to the increased size of weight card **714**, it may be possible for weight card **714** to contain multiple internal weight portions **728** within weight card **714** without departing from the scope and content of the present invention. It should be noted that although the current exemplary embodiment shown in FIG. **7** shows four docking rods **718** pairing with four docking slots **722**, any number of docking rods **718** and docking slots **722** may be used to securely attach the weight card **714** within the cavity well **712**.

[0055] The cross-sectional view of golf club head **700** shown in FIG. **7** also shows an alternative connection mechanism between the weight card **714** and the cavity well **712** incorporating a bulb **723** at the distal end of the docking rods **718** to create a more secure mechanism. Bulbs **723**, due to their inherent size and shape, may help secure the docking rods **718** into their respective position within the docking slots **722** by preventing the weight card **714** from sliding out of the cavity well **712**. It should be noted that the current exemplary embodiment shown in FIG. **7** may also work without the bulbs **723** so long as there is sufficient ability to retain the weight card **714** within the cavity well **712**.

[0056] FIG. **8** shows a cross-sectional view of a golf club head **800** in accordance with an even further alternative embodiment of the present invention taken along cross-sectional line A-A' as shown in FIG. **1**. Golf club head **800** in this present embodiment may have a cavity well **812** that is comprised of a different material than the remainder of golf club head **800**. Having cavity well **812** comprised of a different material may allow for a material that has a higher coefficient of friction to be used within the internal walls of cavity well **812**, thus further enhancing the connection between cavity well **812** and weight card **314** (shown in FIG. **3**). Cavity well **812** may be comprised of a urethane material, a rubber type material, or even a sand blast or laser milled so long as it can increase the coefficient of friction within the internal wall of cavity well **812** all without departing from the scope and content of the present invention.

[0057] In an even further alternative embodiment, cavity well **812** may also be comprised of a magnetic material to further enhance the connection between cavity well **812** and weight card **314** (shown in FIG. **3**). Weight card **314** (shown in FIG. **3**), may generally have a internal weighted portion **328** (shown in FIG. **3**) that is made out of a metallic material, causing it to enhance bonding strength with cavity well **812** if the cavity well **812** contains a magnetic material. However, it should be noted that the position of the magnetic material may be reversed, having the magnetic material within the weight card **314** (shown in FIG. **3**) and the cavity well **812** being of a metallic material to achieve the same increased bonding strength without departing from the scope and content of the present invention. Cavity well **812** may also be urethane in nature and contain metallic material to further increase the retention of weight card **314** within cavity well **812** without departing from the scope and content of the present invention.

[0058] FIG. **9** shows a cross-sectional view of a further golf club head **900** in accordance with an even further alternative embodiment of the present invention taken along cross-sectional line A-A' as shown in FIG. **1**. Golf club head **900**, in this current embodiment may have a cavity well **912** that is parallel to the neutral axis **910** in order to adjust the center of gravity (CG) to change the inertia properties of golf club head **900**. Because of the way golf club head **900** is set up, the neutral axis **910**, being parallel to striking surface **905**, the resulting in a cavity well **912** that may be located around the skirt of golf club head **900**; however, it should be noted that variations of striking surface **905** loft angles could result in a different neutral axis **910**, and the cavity well **912** could be located at the crown, the sole, or nay other location within golf club head **900** without departing from the scope and content of the present invention.

[0059] Having the cavity well **912** parallel to the neutral axis **910** may allow for specific adjustment of the amount of the moment of inertia of a golf club head **900**. Having the cavity well **912** being parallel to the neutral axis **910** allows weights to be placed in the weight card **914** in a way that it only affects the horizontal location of the CG with respect to the neutral axis **910**. Isolated horizontal CG changes directly

affect the inertia characteristics of a golf club head **900**, as CG that is placed further back increases the moment of inertia and a CG that is placed forward decreases the moment of inertia.

[0060] FIG. **10** shows a cross-sectional view of a further golf club head **1000** in accordance with an even further alternative embodiment of the present invention taken along cross-sectional line A-A' as shown in FIG. **1**. Golf club head **1000**, in this current embodiment may have a cavity well **1012** that is neither parallel nor perpendicular to the neutral axis **1010**. Although it may generally be advantageous to have a cavity well **1012** to be either parallel or perpendicular to the neutral axis **1010** in order to isolate the adjustments to either the spin rate or inertia properties; various other angles Φ may be utilized to adjust for the spin rate and inertia properties at the same time without departing from the scope and content of the present invention. Cavity well **1012**, as shown in the current exemplary embodiment may have an angle Φ of approximately 60 degrees; however numerous other angle degrees ranging from 10 degrees to 170 degrees may all be used without departing from the scope and content of the present invention. Golf club head **1000** may show the cavity well **1012** being located at the sole **1002** portion of golf club head **1000**, however cavity well **1012** may be located at the crown **1004**, the skirt, or any other location within golf club head **1000** without departing from the scope and content of the present invention.

[0061] FIG. **11** shows a cross-sectional view of a further golf club head **1100** in accordance with an even further alternative embodiment of the present invention taken along cross-sectional line A-A' as shown in FIG. **1**. Golf club head **1100**, in this current embodiment may have a cavity well **1112** located at the crown section of golf club head **1100** and perpendicular to neutral axis **1110** in order to adjust for the spin rate similar to golf club head **200** shown in FIG. **2**. Similar to golf club head **1000**, cavity well may also be angled with respect to the neutral axis.

[0062] Finally, FIG. **12** shows a cross-sectional view of a further golf club head **1200** in accordance with an even further alternative embodiment of the present invention taken along cross-sectional line A-A' as shown in FIG. **1**. Golf club head **1200**, in this current embodiment may show a plurality of two or more have cavity wells **1212** angled with respect to the neutral axis **1210** in a way to be parallel to a ground level **1213** to simultaneously adjust for the spin rate and inertia properties of golf club head **1200**. Having a plurality of two or more cavity wells **1212** allows for multiple adjustments utilizing various weight cards (not shown) that could achieve more various embodiments than could be possible with only one cavity well **1212**. Moreover, as it can be seen from FIG. **12**, the plurality of two or more cavity wells **1212** could be placed symmetrically away from the neutral axis **1210** along the crown sole direction. Having such a symmetrical placement of the cavity wells **1212** could be advantageous because it allows for adjustments of the inertia of the golf club head **1200** without affecting the CG location of the golf club head **1200**. It should be noted that the plurality of two or more cavity wells **1212** may be placed vertically instead of horizontally without departing from the scope and content of the present invention.

[0063] FIG. **13** shows an enlarged view of an alternative embodiment of the present invention wherein weight card **1314** may have an internal weighted portion **1328** placed at the opposite end of the weight card **1314** to allow more customization of the weight card **1314**. Weight card **1314**, as shown in the current exemplary embodiment, may even have a weighted portion **1328** that is slidably adjustable within the weight card **1314** to customize the location of the weighted portion. In one exemplary embodiment, weighted portion **1328** may travel along a weight slot **1360** having a plurality of notches **1362** that helps secure the weighted portion **1328** at various locations within the weight card **1314**.

[0064] FIG. **14** shows an enlarged view of a further alternative embodiment of the present invention wherein weight card **1414** may have an internal weighted portion **1428** that may be circular in shape instead of the rectangular shape also without departing from the scope and content of the present invention. Weighted portion **1428** may also be triangular in shape, rectangular in shape, octagonal in shape, or any other shape that is capable of providing a weighted portion **1428** within the weight card **1414** with an area of increased density all without departing from the scope and content of the present invention.

[0065] In a further alternative embodiment of the present invention wherein the weight card **1414** could be further comprised of a universal-serial-bus (USB) electronic connection assembly. Utilization of a USB type attachment may generally be taught in U.S. Pat. No. 6,902,432, and the disclosure of which is hereby incorporated by reference herein. More specifically, weight card **1414** may contain a memory device such as EEPROM, EPROM, or flash memory to store information relating to the impact between a golf club head and a golf ball. In one example, a sensor measuring torque and/or vibration can be inserted into the club head, preferably at the hitting face and measurements from the sensor can be written on the memory device through the USB connection by the controller. However, it should be noted that the measuring device could be incorporated within weight card **1414** in a way that no additional components may be required on the golf club head itself without departing from the scope and content of the present invention.

[0066] Weight card **1414** that may contain the USB connection that has received the measurement date from the measurement device may subsequently be removed and attached to a reader, such as a laptop or smart phone and the data can be conveyed to the golfer. High torque or high vibration may indicate off-center hits, and statistical analysis may be provided to the golfer. A suitable sensor can be a piezoelectric device comprising an accelerometer, described and claimed in commonly-owned, co-pending patent application Ser. No. 11/979,787 filed on Nov. 8, 2007, the disclosure of which is incorporated by reference in its entirety.

[0067] Turning now to FIG. **15** shows a golf club head **1500** in accordance with an even further alternative embodiment of the present invention wherein a completely different attachment mechanism is used in the cavity well **1512** to secure the weight card **1514** within the cavity well **1512**. More specifically, the cavity well **1512** may generally contain a fastening device that prevents the weight card **1514** from slipping out from the cavity well **1512** without a release tool. (not shown) The cavity well **1512** may generally contain a plurality of locking balls **1550** encompassed by an insert **1552** near the opening of the cavity well **1512**. The insert **1552** may generally be surrounded by an angled retention portion **1553** that gradually decreases the external diameter of the insert **1552** as the plurality of locking balls **1550** moves closer to the opening of the cavity well **1512**. Finally, the cavity well **1512** may generally have a spring **1554** near the terminal end of the

cavity well **1512** that pushes the insert **1552** outwards toward the opening along the narrowing angled retention portion **1553**.

[0068] Expanding on the process of insertion of the weight card **1514**, it can be seen from FIG. **15** that as weight card **1514** is being inserted into the cavity well **1512** the plurality of locking balls **1550** as well as the insert **1552** may get pushed up due to the friction generated between the weight card **1514** and the plurality of locking balls **1550**. As the friction between the weight card **1514** and the plurality of locking balls **1550** pushes the insert **1552** deeper into the cavity well **1512**, the plurality of locking balls **1550** gains additional room to move outward and expand the internal diameter of the cavity well due to the angled retention portion **1553**. This outward movement of the plurality of locking balls **1550** along the angled retention portion **1553** allows the weight card **1514** to be inserted deeper into the cavity well **1512** without increased friction between the weight card **1514** and the plurality of locking balls **1550**.

[0069] However, the process of removal of the weight card **1514** from the cavity well **1512** may generally be met with increased frictional resistance between the weight card **1514** and the plurality of locking balls **1550** as shown in FIG. **15**. Here in FIG. **15**, the spring **1554**, the insert **1552**, the plurality of locking balls **1550**, and the angled retention portion **1553** all work in conjunction to prevent the weight card **1514** from falling out of the cavity well **1512**. As it can be seen from FIG. **15**, the spring **1554** within the cavity well **1512** pushes the insert **1552** containing the plurality of locking balls **1550** against the angled retention portion **1553**. Thus, as the weight card **1514** begins to move outward from the cavity well **1512**, the friction between the plurality of locking balls **1550** and the weight card **1514** increases due to the lack of slack and give caused by the insert **1552** being pushed down against the angled retention portion **1553**. This increased friction makes it extremely difficult for the weight card **1514** to be removed from the cavity well **1512**.

[0070] In order to remove the weight card **1514** from the cavity well **1512**, a release tool (not shown) may need to be used that pushes the insert **1552** upwards and away from the angled retention portion **1553**, allowing the plurality of locking balls **1550** to move away from the weight card **1514**. The release tool (not shown) may be a mechanical release mechanism that physically pushes the insert **1512** upwards or may also be a magnetic mechanism that may also be capable of pushing the insert **1512** upwards without departing from the scope and content of the present invention. This retention process shown in FIG. **15** may be described in more detail in U.S. Pat. No. 3,911,534, the disclosure of which is incorporated by reference in its entirety.

[0071] FIG. **16** shows a further alternative embodiment of the present invention wherein the spring **1654**, the insert **1652**, the plurality of locking balls **1650**, and the angled retention portion **1653** may be placed on the weight card **1614** to mate with the docking rod **1618** utilizing the same retention concept without departing from the scope and content of the present invention. It may be desirable to have the spring **1654**, the insert **1652**, the plurality of locking balls **1650**, and the angled retention portion **1653** may be placed on the weight card **1614** to allow for ease of removal as a release tool may have easier time accessing the mechanism if it is located on the weight card **1614**.

[0072] Other than in the operating examples, or unless otherwise expressly specified, all of the numerical ranges, amount, values and percentages such as those for amounts of materials, moments of inertias, center of gravity locations, loft and draft angles, and other in the following portion of the specification may be read as if prefaced by the word "about" even though the term "about" may not expressly appear with the value, amount or range. Accordingly, unless indicated to the contrary, the numerical parameters set forth in the following specifications and attached claims are approximations that may vary depending upon the desired properties sought to be obtained by the present invention. At the very least, and not as an attempt to limit the application of the doctrine of equivalents to the scope of the claims, each numerical parameter should at least be construed in light of the number of reported significant digits and by applying ordinary rounding techniques.

[0073] Notwithstanding that the numerical ranges and parameters setting forth the broad scope of the invention are approximation, the numerical values set forth in the specific examples are reported as precisely as possible. Any numerical value, however, inherently contains certain errors necessarily resulting from the standard deviation found in their respective testing measurements. Furthermore, when numerical ranges of varying scope are set forth herein, it is contemplated that any combination of these values inclusive of the recited values may be used.

[0074] It should be understood, of course, that the foregoing relates to exemplary embodiments of the present invention and that modifications may be made without departing from the spirit and scope of the invention as set forth in the following claims.

What is claimed is:

1. A golf club head comprising:
- a forward portion containing a striking surface, said striking surface further comprising a face center at a geometric center of said face, and said face center further defining a neutral axis perpendicular to said striking surface passing through said face center;
- an aft portion connected to said forward portion;
- a cavity well located within said aft portion of said golf club head; and
- a weight card configured to be embedded within said cavity well without the need of a threaded attachment;
- wherein said cavity well has a ratio of volume to surface area less than 0.5.

2. The golf club head of claim **1**, wherein said cavity well is substantially rectangular in shape.

3. The golf club head of claim **2**, wherein said weight card further comprising:
- a first portion having a first density and a first coefficient of friction; and
- a second portion at least partially enclosed by said first portion having a second density and a second coefficient of friction;
- wherein said first portion further comprises a plurality of locking tabs located around a perimeter of said first portion, and a plurality of docking slots at a terminal end of said first portion to connect to said cavity well.

4. The golf club head of claim **3**, wherein said second density is greater than said first density.

5. The golf club head of claim **4**, wherein said first coefficient of friction is greater than said second coefficient of friction.

6. The golf club head of claim **4**, wherein said cavity well further comprises:

an internal wall profile having a third coefficient of friction; and

a plurality of docking rods protruding into said cavity well at a terminal end of said cavity well,

wherein said plurality of docking rods mate with said plurality of docking slots within said weight card to secure said weight card within said cavity well.

7. The golf club head of claim **6**, wherein said cavity well further comprises:

a plurality of locking tab receptacles located around a perimeter of said cavity well,

wherein said plurality of locking tab receptacles engages said plurality of locking tabs on said weight card to further secure said weight card to said cavity well.

8. The golf club head of claim **6**, wherein said first coefficient of friction of said weight card interacts with said third coefficient of friction of said internal wall profile of said cavity well to retain said weight card.

9. The golf club head of claim **8**, wherein said cavity well is perpendicular to said neutral axis.

10. The golf club head of claim **8**, wherein said cavity well is parallel to said neutral axis.

11. The golf club head of claim **6**, wherein said weight card further comprises a magnetic material.

12. A golf club head comprising:

a forward portion containing a striking surface, said striking surface further comprising a face center at a geometric center of said face, and said face center further defining a neutral axis perpendicular to said striking surface passing through said face center;

an aft portion connected to said forward portion;

a cavity well located within said aft portion of said golf club head; and

a weight card configured to be embedded within said cavity well without the need of a threaded attachment,

wherein said cavity well is perpendicular to said neutral axis.

13. The golf club head of claim **12**, wherein said cavity well has a ratio of volume to surface area less than 0.5.

14. The golf club head of claim **13**, wherein said cavity well is substantially rectangular in shape.

15. The golf club head of claim **14**, wherein said weight card further comprises:

a first portion having a first density; and

a second portion having a second density.

wherein said second portion is at least partially enclosed by said first portion, and

wherein said second density is higher than said first density.

16. A golf club head comprising:

a forward portion containing a striking surface, said striking surface further comprising a face center at a geometric center of said face, and said face center further defining a neutral axis perpendicular to said striking surface passing through said face center;

an aft portion connected to said forward portion;

a cavity well located within said aft portion of said golf club head; and

a weight card configured to be embedded within said cavity well without the need of a threaded attachment,

wherein said cavity well is parallel to said neutral axis.

17. The golf club head of claim **16**, wherein said cavity well has a ratio of volume to surface area less than 0.5.

18. The golf club head of claim **17**, wherein said cavity well is substantially rectangular in shape.

19. The golf club head of claim **18**, wherein said weight card further comprises:

a first portion having a first density; and

a second portion having a second density,

wherein said second portion is at least partially enclosed by said first portion, and

wherein said second density is higher than said first density.

* * * * *