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GOLF CLUB HEAD WITH IMPROVED PERFORMANCE

Abstract

A golf club head with an improved Center of Gravity (CG) location is disclosed. More specifically, the present invention relates to a metalwood type golf club head with improved performance via shifting the CG towards a location that reduces spin, at the same time, without sacrificing launch angle and the forgiveness of the golf club head. This golf club head may generally have a unique construction capable of achieving a low and forward CG location that is less than 40 mm from the face center along a Z-axis, a CG height that is no more than 2 mm above the neutral axis, and a MOI-Y of greater than about 4,000 g-cm.sup.2.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] The present application is a Continuation (CON) of U.S. patent application Ser. No. 18/320,316, filed May 19, 2023, which is a CON of U.S. patent application Ser. No. 17/381,458, filed on Jul. 21, 2021, now U.S. Pat. No. 11,691,055 the disclosure of which are both incorporated by reference in their entirety.

FIELD OF THE INVENTION

[0002] The present invention relates generally to a metalwood type golf club head with improved performance via shifting of the Center of Gravity (CG) towards a location that reduces spin, at the same time without sacrificing launch angle and the forgiveness of the golf club head. More specifically, the present invention relates to a metalwood type golf club head with an unique construction that allows the golf club head to have a low and forward CG location that is less than 40 mm from the face center along a Z-axis, a CG height that is no more than 2 mm above the neutral axis, and a MOI-Y of greater than about 4,000 g-cm.sup.2.

BACKGROUND OF THE INVENTION

[0003] In order to move the center of gravity around in a golf club to more desirable locations to improve performance, golf club designers often experiment with utilization of multiple materials of different density.

[0004] In one early example, the basic concept of using multiple materials in a golf club head is shown U.S. Pat. No. 5,154,425 to Niskanen et al wherein composite type material is introduced to a golf club head using different joining techniques involving a metal matrix, a composite matrix, and/or even a ceramic matrix in a golf club head.

[0005] U.S. Pat. No. 4,793,616 to Fernandez teaches the utilization of a lightweight composite material to remove excess weight from undesirable portions of a golf club head. More specifically, U.S. Pat. No. 4,793,616 talks about using lightweight composite material that is molded to a hard, high density material, to provide selected distribution and localization of mass within the golf club head.

[0006] U.S. Pat. No. 6,409,612 to Evans et al. teaches the utilization of plurality of high density members that are tungsten spheres to shift weight to a desirable portion of a golf club head.

[0007] Combining all of the teachings known, it can be seen that by utilizing multiple materials that can be both lightweight and high density, the properties of the golf club head could be significantly manipulated. How to manipulate these properties to achieve the best performing golf club head, on the other hand, is the true challenge.

[0008] One of the known ways to manipulate the property of a golf club head is to shift the center of gravity lower on a golf club head to help promote higher launch. U.S. Pat. No. 6,074,310 to Ota illustrates this concept despite not using multiple materials by manipulating the wall thickness of various portions of a golf club head to create a center of gravity that is relatively low.

[0009] Another way to manipulate the property of a golf club head is to shift the center of gravity deep towards the back of the golf club head to promote not only high launching golf club heads, but also ones that can be forgiving. U.S. Pat. No. 6,676,535 to Sheets et al. illustrates this with a title of a Golf Club Head Having a Low and Deep Weight Distribution achieved via manipulation of the sole contours of the golf club head.

[0010] However, these type of low and deep center of gravity locations, although may be capable of achieving golf club heads with high launch and good forgiveness, sacrifice distance because it

contains too much spin, which is a function of the CG location relative to the neutral axis. In order to reduce the spin, the CG location needs to be brought forward, which often comes at an expense of performance in other areas. Moreover, merely moving the CG forward within itself will not improve the performance of the golf club head, but rather, it is the ability to move the CG both forward and low that will result in overall performance of the golf club head without giving up performance elsewhere.

[0011] Unfortunately, in order to move the CG of the golf club head forward and low, it involves the manipulating the leading edge of a golf club head, a portion of the golf club head that is extremely sensitive to changes, as it experiences high stresses when in contact with a golf ball, and can often yield undesirable sacrifices in the coefficient of restitution of the face portion of the golf club head.

[0012] Hence, based on the above, it can be seen that there is a need in the art for a golf club head that is capable of utilizing multi-material technology in a golf club head that can achieve a low and forward CG location without sacrifices to the other performance criteria of the golf club head.

BRIEF SUMMARY OF THE INVENTION

[0013] One aspect of the present invention is a golf club head comprising of a striking face portion located at a frontal portion of the golf club head, and a body portion, made out of a first material having a first density, attached to the rear of the striking face portion. The striking face portion further comprising of an upper striking face portion located above a geometric center of the striking face portion and a lower striking face portion located below the geometric enter of the striking face portion, wherein at least a portion of the striking face portion further comprises of a weighting mechanism that encompasses a leading edge portion of the golf club head. The golf club head has a CG-Z-FC of less than about 40 mm from a face center, a CG-NA of less than about 2 mm above a neutral axis, and a MOI-Y of greater than about 4,000 g-cm.sup.2.

[0014] In another aspect of the present invention is a golf club head a striking face portion located at a frontal portion of the golf club head, and a body portion, made out of a first material having a first density, attached to the rear of the striking face portion. The striking face portion further comprising of an upper striking face portion located above a geometric center of the striking face portion and a lower striking face portion located below the geometric enter of the striking face portion, wherein at least a portion of the striking face portion further comprises of a weighting mechanism. The weighting mechanism further comprises of a high density member, made out of a second material having a second density, and an attachment member, adapted to engage an opening in the high density member, wherein the second density is greater than a first density, wherein the attachment member secures the high density member to a leading edge portion of the golf club head, and wherein the weighting mechanism encompasses a portion of the leading edge portion of the golf club head.

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

Description

BRIEF DESCRIPTION OF THE 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** of the accompanying drawings shows a perspective view of a golf club head in accordance with an exemplary embodiment of the present invention;

[0018] FIG. **2** of the accompanying drawings shows an exploded view of a golf club head in accordance with an exemplary embodiment of the present invention;
[0019] FIG. **3** of the accompanying drawings shows a frontal view of a golf club head in accordance with an exemplary embodiment of the present invention, showing cross-sectional lines **4-4′** and **6-6′**;
[0020] FIG. **4** of the accompanying drawings shows a cross-sectional view of a golf club head in accordance with an exemplary embodiment of the present invention taken along cross-sectional line **4-4′** shown in FIG. **3**;
[0021] FIG. **5** of the accompanying drawings shows an enlarged cross-sectional view of a leading edge portion of a golf club head shown as circular region A in FIG. **4**, in accordance with an exemplary embodiment of the present invention;
[0022] FIG. **6** of the accompanying drawings shows a cross-sectional view of a golf club head in accordance with an exemplary embodiment of the present invention taken along cross-sectional line **6-6′** shown in FIG. **4**;
[0023] FIG. **7** of the accompanying drawings shows a frontal view of a golf club head in accordance with an alternative embodiment of the present invention, showing cross-sectional lines **8-8′** and **9-9′**;
[0024] FIG. **8** of the accompanying drawings shows a cross-sectional view of a golf club head in accordance with an alternative embodiment of the present invention along cross-sectional line **8-8′** shown in FIG. **7**;
[0025] FIG. **9** of the accompanying drawings shows a cross-sectional view of a golf club head in accordance with an alternative embodiment of the present invention along cross-sectional line **9-9′** shown in FIG. **7**;
[0026] FIG. **10** of the accompanying drawings shows a perspective view of a golf club head in accordance with a further alternative embodiment of the present invention;
[0027] FIG. **11** of the accompanying drawings shows an exploded view of a golf club head in accordance with a further alternative embodiment of the present invention;
[0028] FIG. **12** of the accompanying drawings shows a frontal view of a golf club head in accordance with a further alternative embodiment of the present invention, showing cross-sectional lines **13-13′** and **14-14′**;
[0029] FIG. **13** of the accompanying drawings shows a cross-sectional view of a golf club head in accordance with a further alternative embodiment of the present invention taken along cross-sectional line **13-13′** shown in FIG. **12**; and
[0030] FIG. **14** of the accompanying drawings shows a cross-sectional view of a golf club head in accordance with a further alternative embodiment of the present invention taken along cross-sectional line **14-14′** shown in FIG. **12**.

DETAILED DESCRIPTION OF THE INVENTION

[0031] The following detailed description describes 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, and each can 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] FIG. **1** of the accompanying drawings shows a perspective frontal view of a golf club head **100** in accordance with an exemplary embodiment of the present invention. More specifically, a closer examination of FIG. **1** shows several sub-components of the golf club head **100** that's made mainly from a frontal striking face portion **104** and a body portion **102**, with the body portion **102**

attached to a rear of the striking face portion **104**. The striking face portion **104**, although shown in FIG. **1** as being located at a face insert portion of a golf club head **100**, is not limited to the face insert. In fact, the striking face portion **104** refers generally to the portion of the golf club head **100** that is adapted to make contact with a golf ball, and refers to the portion of the golf club head **100** that is substantially planar at the frontal portion of the golf club head **100**. In a face insert type of construction as shown in FIG. **1**, the striking face portion **104** includes the face insert itself as well as the surrounding flange portion of the cast body without departing from the scope and content of the present invention. In an alternative embodiment of the present invention where a face cup type construction is used, the striking face portion **104** may exclude the return portion of the face cup and refer purely to the substantially planar portion of the golf club head **100**.

[0034] FIG. **1** of the accompanying drawings also highlights a geometric face center **106**, which is located at a geometric center of the striking face portion **104**, at the frontal most surface of the striking face portion **104** of the golf club head **100**. Finally, FIG. **1** also shows a weighting mechanism **108** located at lower striking face portion of said striking face portion. The discussion of the distinction between the upper and lower striking face portion will be covered in more detail later in FIG. **3**, but for now, it is suffice to say that the striking face portion **104** could be split up into an upper striking face portion and a lower striking face portion, separated from one another at the geometric face center **106**. Hence, alternatively speaking, it can be said that the lower striking face portion of the striking face portion **104** further comprises a weighting mechanism **108**. The weighting mechanism **108** shown here in this embodiment if further comprised out of a high density member **110**, a toe biased attachment member **112**, and a heel biased attachment member **114**. The toe biased attachment member **112** and the heel biased attachment member **114** work in conjunction to connect the high density member **110** to a leading edge portion of the lower striking face portion of the golf club head **100**. In this embodiment of the present invention, because the high density member **110** is secured to the golf club head **100** via a mechanical lock mechanism, the high density member **110** could be made from a high density tungsten material with a density of greater than about 14 g/cm.sup.3, more preferably greater than about 15 g/cm.sup.3, and most preferably greater than about 17 g/cm.sup.3. In another alternative embodiment of the present invention, the high density member may be made out of a steel type material with a density of greater than about 7.5 g/cm.sup.3, more preferably greater than about 7.65 g/cm.sup.3, and most preferably greater than about 7.8 g/cm.sup.3. Hence it can be seen that numerous types of material could be used to form the high density member **110** so long as it is capable of achieving the performance properties of the golf club head **100** to be set fourth later all without departing from the scope and content of the present invention.

[0035] Before moving on to FIG. **2**, it should be noted that FIG. **1** also shows a coordinate system **101**, illustrating the orientation of the golf club head **100** relative to the coordinate system **101**. More specifically, the x-axis spans in a heel to toe direction, with the positive direction pointed towards the toe. The y-axis spans in a direction of crown to sole, with the positive direction pointed towards the crown. Finally, the z-axis spans the direction of front to back, with the positive direction pointed towards the front of the golf club head **100**. This coordinate system of references is applicable to all subsequent discussions of various other embodiments of the present invention.

[0036] In order to better illustrate the various components of the weighting mechanism **108** previously shown, an exploded view of a golf club head **200** is provided in FIG. **2**. FIG. **2** of the accompanying drawings that provides an exploded view of the golf club head **200** wherein the various components of the weighting mechanism **208** and their relationship with one another are shown here. In FIG. **2**, the face insert of the striking face portion **204** is exploded out from the surrounding flange portion to allow the internals of the golf club head **200** to be shown. With the face insert out of the way, we can see that both the toe biased attachment member **212** and the heel based attachment member **214** have an enlarged screw head portion located inside the golf club head **200**, and an elongated threaded member that protrude out from toe biased opening **216** and

heel biased opening **218** respectively. The toe biased opening **216** and the heel biased opening **218** are both formed within the weight port **220**, with the weight port **220** adapted to engage the high density member **210**. It is worth noting here that the material used to form the toe biased attachment member **212** and the heel biased attachment member **214** may generally be made out of same high density material with a density of greater than about 15 g/cm.sup.3 as previously defined for the high density member **210**, so they could be welded to one another to further enhance the bond of the weighted member **210** to the leading edge of the golf club head **100**; however, in other embodiments, the material could be different and have higher or lower densities than the high density member **210** without departing from the scope and content of the present invention. Moreover, if different materials are used to create the high density member **210** and the attachment members **212** and **214**, those material may not be directly weldable to one another, thus the strength of the bond may rely purely on the mechanical thread, swaging techniques, brazing techniques, gluing techniques, or other types of attachment mechanism also without departing from the scope and content of the present invention.

[0037] When the elongated protrusions of the toe biased attachment member **212** and the elongated protrusions of the heel biased attachment member **214** extend beyond the periphery of the high density member **210** itself via the openings previously discussed, the extra material can be removed and the terminal end of the elongated protrusions can be welded to the high density member **210** to provide the mechanical lock previously described. In addition to the above, the toe biased opening **216** and the heel biased opening **218**, together with their corresponding openings in the high density member **210** could be threaded to accept the threaded elongated protrusion component of the toe biased attachment member **212** and the heel biased attachment member **214** respectively, further enhancing the strength of the bond between the various components. It should be noted here that although a threaded attachment mechanism is disclosed here is to be combined with welding to achieve the highest level of bond between the various components, various combination of the attachment methods such as threaded, welded, swaged, brazed, glued, or any combination thereof all without departing from the scope and content of the present invention. In some of these other embodiments, the threaded elongate protrusions may not even be threaded, and could just be simple posts that utilizes other attachment methods without threads to also be without departing from the scope and content of the present invention.

[0038] FIG. **3** of the accompanying drawings shows a frontal face on view of a golf club head **300** in accordance with an exemplary embodiment of the present invention. The frontal view of the golf club head **300** allows the cross-sectional lines **4**-**4**′ and **6**-**6**′ to be shown more clearly for subsequent figures. Cross-sectional line **4**-**4**′ passes through the golf club head **300** vertically through the geometric face center **306**, cutting across the middle of the golf club head **300**. Cross-sectional line **6**-**6**′ on the other hand, is another vertical cross-sectional line that passes through the middle of the heel biased attachment member **314** to allow the relationship between the various weighting mechanism **308** to be illustrated more clearly.

[0039] FIG. **4** of the accompanying drawings shows a cross-sectional view of a golf club head **400** taken along a cross-sectional line **4**-**4**′ shown in FIG. **3** that passes through the geometric face center **406** in a forward and rear orientation. This cross-sectional view of the golf club head **400** allows numerous key components of the golf club head **400** to be shown more clearly, along with other measurements relating to the performance of the golf club head **400**. First and foremost, we can see the distinction of the striking face portion **404** and the body portion **402** loosely defined in this view, allowing the separation to be more clearly shown in this orientation, affirming the definition above wherein the striking face portion **404** referring to the portion of the golf club head **400** that is substantially planar, and all portions of the golf club head **400** rearward of that substantially planar portion would be considered the rear body portion **402**.

[0040] The cross-sectional view of the golf club head **400** shown here in FIG. **4** also allows the two sub-components of the striking face portion **404** previously discussed to be shown. More

specifically, the striking face portion **404** can be separated into an upper striking face portion **404***a* and a lower striking face portion **404***b*, with the separation occurring at the geometric face center **406**, where any portion of the striking face portion **404** that is above the geometric face center **406** along the y-axis would be considered the upper striking face portion **404***a*, and any portion of the striking face portion blow the geometric face center **406** along the y-axis would be considered the lower striking face portion **404***b*.

[0041] In addition to the above, FIG. **4** of the accompanying drawings also shows a Center of Gravity (CG) **421** location of the golf club head **400** and its relative position in the y-z plane as shown in this cross-sectional view. The location of the CG **421** in critical to the performance of the present inventive golf club head **400**, as the weighting mechanism **408** located at the bottom of the lower striking face portion **404***b* shifts the CG **421** to a location previously unachievable without sacrifices to the Moment of Inertia (MOI) performance of the golf club head **400**. The MOI numbers of the golf club head **400** in accordance with the present invention will be discussed in more detail in the subsequent disclosure. The CG **421** of the golf club head **400**, in accordance with this exemplary embodiment of the present invention, is located at a distance d**1** away from the geometric face center **406** along the z-axis as shown in this embodiment of the present invention. Distance d**1**, also referred to as CG-Z-FC, generally relates to the front to back location of the CG **421** of the golf club head **400**, which generally affects the amount of spin a golf ball may exhibit when impacting the golf club head **400**. Distance d**1** may generally be less than about 40 mm, more preferably less than about 37.50 mm, and most preferably less than about 35.00 mm, all without departing from the scope and content of the present invention.

[0042] Having a forward CG **421** location is not the only thing that contributes to the improved performance of the golf club head **400**. In addition to having a forward CG **421**, the current inventive golf club head **400** may also have a low CG **421** location, which can be defined relative to a neutral axis **422** or a ground plane **424**, and can be helpful in promoting a higher launching golf ball. In order to define CG **421** relative to the neutral axis **422**, as depicted by distance d**2** shown in FIG. **3**, one needs to define the neutral axis **422** of the golf club head **400**, which is defined as an axis that is perpendicular to the striking face portion **404** at the geometric face center **406** of the golf club head **400** as shown in FIG. **3**. Distance d**2**, also defined as CG-NA, may be no more than about 2.0 mm above the neutral axis **422**, more preferably no more than about 1.50 mm above the neutral axis **422**, and most preferably no more than about 1.0 mm above the neutral axis **422**. It should be noted here that in FIG. **3**, the CG **421** location is actually shown to be less than 0 mm and below the neutral axis, and distance d**2** is about −0.50 mm, which still conforms to the ranges above without departing from the scope and content of the present invention. Another way to quantify a low CG **421** location is to define it relative to the ground plane **424**, as shown by distance d**3** in FIG. **3**. This CG **421** height relative to the ground plane **424**, which is also known as CG-Y-G, may generally be less than about 27.5 mm, more preferably less than about 27.1 mm, and most preferably less than about 26.7 mm, also without departing from the scope and content of the present invention.

[0043] As previously mentioned, the shifting of the CG **421** forward and lower, although critical to the present invention, does not paint the entire picture regarding the present invention. In fact, merely shifting the CG **421** within itself does not significantly improve the performance of the golf club head **400**. The present invention not only achieves the current CG **421** criteria set fourth previously, but further improves upon the performance of the golf club head **400** by maintaining a high MOI along several key axes. The MOI-Y, which measures the MOI of the golf club head **400** about the y-axis, of the golf club head **400** in accordance with the present invention may generally be greater than about 4,000 g-cm.sup.2, more preferably greater than about 4,500 g-cm.sup.2, and most preferably greater than about 5,000 g-cm.sup.2. The MOI-X, which measures the MOI of the golf club head **300** about the x-axis, of the golf club head **400** may generally be greater than 3,000 g-cm.sup.2, more preferably greater than about 3,100 g-cm.sup.2, and most preferably greater than

about 3,200 g-cm.sup.2.
[0044] Finally, the cross-sectional view of the golf club head **400** shown in FIG. **4** of the accompanying drawings allows the weighting mechanism **408** and its attachment to the lower striking face portion **404***b* to be shown. However, due to the intricate components of the weighting mechanism **408**, an enlarged figure of circular region A shown in FIG. **4** is provided as FIG. **5** to better illustrate the weighting mechanism **408**.
[0045] FIG. **5** of the accompanying drawings shows an enlarged cross-sectional view of the weighting mechanism **408** in more detail, allowing for the various key features of the weighting mechanism **408** to be shown. First and foremost, we can see that the weighting mechanism **408** is located at a bottom of the lower striking face portion **404***b*, as previously described. However, the enlarged view of the weighting mechanism **408** allows us to see that the location of the weighting mechanism **408** is so low on the lower striking face portion **404***b*, it forms the leading edge of the golf club head **400** itself. The leading edge of a golf club head **400**, as generally known in the golf club industry, is lowest front most boundary of the striking face portion **404** where the striking face portion **404** meets the sole, but is can be more broadly defined as the entire curved surface of that leading edge of the golf club head **400** without departing from the scope and content of the present invention.
[0046] First and foremost, it is critical to note that the high density member **410** shown here is non-load-bearing, and is merely attached to a now chamfered leading edge **436** that bears the load and impact stressed when the golf club head **400** impacts a golf ball. Having the high density member **410** be non-load-bearing is critical to the present invention because material that have high density may generally not do well under high stress conditions, and preserving the ability to bear that high level of stress within the body portion will eliminate potential failure of the material.
[0047] In order to promote the non-load-bearing feature of the high density member **410**, a gap **432** is provided around the perimeter of the high density member **410**. In this enlarged cross-sectional view of the lower striking face portion **404***b*, the gap **432** appears both in front and behind the high density member **410**, but in actuality, it exists completely around a perimeter of the high density member **410** in accordance with this embodiment of the present invention. However, in alternative embodiments of the present invention, the gap **432** may only partially encircle the perimeter of the high density member **410**, or even eliminated completely so long as the high density member **410** is non-load-bearing all without departing from the scope and content of the present invention.
[0048] The high density member **410** in this embodiment, as previously described, is attached to the lower striking face portion **404***b* via attachment members **414** that utilizes oversized screwheads within the internal cavity of the golf club head **400** and elongate protrusions to engage the high density member **410**. Here, shown in FIG. **5**, the oversized screwhead of the heel biased attachment member **414** directly contacts an internal surface of the chamfered leading edge **436**, while the high density weight member **410** directly contacts an internal surface of the chamfered leading edge **436**.
[0049] The chamfered leading edge **436** shown here in this enlarged cross-sectional view of the golf club head **400** is also critical to the proper functioning of the present invention. As previously mentioned, due to the fact that the high density member **410** is non-load-bearing, the chamfered leading edge **436** of the present invention actually takes the entirety of the load generated when the golf club head **400** impacts a golf ball. In order to accommodate this, not only is the chamfer angle α critically important, but a separate lower chamfered wall angle β is introduced here to create a tapered chamfered leading edge **436** quantified by taper angle θ to help the chamfered leading edge **436** absorb the impact stresses at the lower striking face portion **404***b*. In this exemplary embodiment of the present invention, the chamfer angle α may generally be between about 60 degrees and about 70 degrees, more preferably between about 63 degrees and about 69 degrees, and most preferably between about 66 degrees and about 68 degrees, all without departing from the scope and content of the present invention. The lower chamfered wall angle β in accordance with

the present invention may generally be between about 57 degrees and about 67 degrees, more preferably between about 60 degrees and about 66 degrees, and most preferably between about 63 degrees and about 65 degrees also without departing from the scope and content of the present invention. Finally, the taper angle θ in accordance with the present invention may generally be between about 1 degree and about 5 degrees, more preferably between about 2 degrees and about 4 degrees, and most preferably about 3 degrees.

[0050] FIG. **6** of the accompanying drawings shows a cross-sectional view of a golf club head **600**, taken along cross-sectional line **6**-**6**′ shown in FIG. **3**, allowing the heel biased attachment member **614** to be shown. In this embodiment of the present invention, the heel biased attachment member **614** is installed in the weighting mechanism **608** to help retain the high density member **610** in the lower striking face portion **604***b* of the golf club head **600**. As previously mentioned, the present invention mechanically secures the high density member **610** to the chamfered leading edge **636** via the attachment member **614** with a gap to ensure that it is non-load-bearing, and this cross-sectional view of the golf club head **600** shown in FIG. **6** illustrates this.

[0051] FIG. **7** of the accompanying drawings shows a frontal view of a golf club head **700** in accordance with an alternative embodiment of the present invention. In this alternative embodiment of the present invention, the golf club head **700** has two weighting mechanisms **708***a* and **708***b* that are located along a toe and heel portion of the leading edge of the lower striking face portion of the golf club head **700**. More specifically, the toe weighting mechanism **708***a* has a toe biased location along the leading edge of the lower striking face portion, while the heel weighting mechanism **708***b* has a heel biased location along the leading edge of the lower striking face portion. The toe weighting mechanism **708***a* shown in this embodiment also only has one toe attachment member **713***a* instead of the two previously shown, and the high density member **710***a* only has one opening to accommodate the singular attachment member **713***a*. Similarly, the heel weighting mechanism **708***b* shown in this embodiment mirrors the toe weighting mechanism **708***a* in its components, and only requires one heel attachment member **713***b* and one high density member **710***b*. Having two weighting mechanisms **708***a* and **708***b* that are now located on the heel and toe portion of the leading edge instead of the one may further help increase the MOI of the golf club head **700** but may not have achieve as low of a CG location.

[0052] It should be noted here that although the term “leading edge” used in the golfing industry refers to the lowest frontal boundary of a golf club head **700**, the present invention utilizes a slightly broader definition that is still consistent with the general definition and understanding outlined above. More specifically, the term “leading edge” as used in the present disclosure, includes the entirety of the curved surface that forms the lowest frontal boundary of the golf club head **700**, and toe weighting mechanism **708***a* and heel weighting mechanism **708***b* are also considered to be placed on the “leading” edge of the golf club head **700** within the context of the present invention.

[0053] In addition to the differences identified above, this alternative embodiment of the present invention shown in FIG. **7** may further differ from prior embodiments in that the attachment members **713***a* and **713***b* may not need to be a secondary piece having an oversized screwhead. In fact, attachment members **713***a* and **713***b* may be built right into the casting of the chamfered leading edge without departing from the scope and content of the present invention. In order to illustrate this feature, cross-sectional views of the golf club head **700** along cross-sectional lines **8**-**8**′ and **9**-**9**′ are presented as FIG. **8** and FIG. **9** respectively.

[0054] FIGS. **8** and **9** of the accompanying drawings show cross-sectional views of a golf club head **700** taken along cross-sectional line **8**-**8**′ and **9**-**9**′ respectively shown in FIG. **7**. In this cross-sectional view of the invention, we can see that the attachment members **713***a* and **713***b* is formed directly into the body of the casting and is part of the chamfered leading edge **736** without departing from the scope and content of the present invention. This embodiment of the present invention shown in FIGS. **8** and **9** differs from previous embodiments in that the attachment

members **713***a* and **713***b* are no longer formed out of a secondary piece such as a screw having an oversized screw head and elongate protrusion, thus reducing the number of components of golf club head **700**. The attachment members **713***a* and **713***b* can be directly used to secure the high density member **710***a* and **710***b* respectively to form the weighting mechanism **708***a* and **708***b* at the lower striking face portion **704***b* of the golf club head **700** without departing from the scope and content of the present invention.

[0055] FIG. **10** of the accompanying drawings shows a perspective view of a golf club head **1000** in accordance with a further alternative embodiment of the present invention. Golf club head **1000** similar to above, is comprised out of a striking face portion **1004** and a body portion **1002**, wherein the lower portion of the striking face portion **1004** includes a weighting mechanism **1008** attached to the leading edge of the golf club head **1000**. The leading edge of the golf club head **1000**, as previously discussed, is located at the bottom portion of the striking face portion **1004**, with the top and bottom portion of the striking face portion **1004** separated by the geometric face center **1006** along the y-axis. (The coordinate system as well as the x, y, and z axes are the same throughout this disclosure. See coordinate system **101** in FIG. **1**). This golf club head **1000**, however, is different from previous embodiments in that the entirety of the leading edge portion of the golf club head **1000** is formed out of a secondary material to create the weighting mechanism **1008**. In order to illustrate the various components, an exploded view of the golf club head **1100** is shown in FIG. **11**.

[0056] FIG. **11** of the accompanying drawings shows an exploded view of a golf club head **1100** in accordance with an alternative embodiment of the present invention. In this alternative embodiment of the present invention, the golf club head is separated into three components, the body portion **1102**, the weighting mechanism **1108**, and the frontal upper portion **1140**. The weighting mechanism **1108** in this embodiment of the present invention, as previously discussed, may be made entirely out of the high density member **1110** to create extreme CG locations that is extremely low and extremely forward, all while preserving MOI properties. In this embodiment of the present invention, the high density member **1110** used to create the entirety of the weighting mechanism **1108** may be secured to the frontal upper portion **1140** of the golf club head **1100** via mechanical attachment mechanisms to ensure a solid bond between these two components; and these two components may be attached to the rear body portion **1102** via alternative bonding mechanisms methods that may or may not include the use of glue. It should be noted here that the specific attachment means to secure the various components of this golf club head **1100** can be shown in more detail in subsequent cross-sectional views of the present embodiment.

[0057] In order to provide cross-sectional views of golf club head **1100** in accordance with this embodiment of the present invention, a frontal view of the golf club head **1200** is shown with cross-sectional lines **13-13′** and **14-14′** highlighted here in FIG. **12**. It should be noted here that cross-sectional line **13-13′** passes vertically through the geometric center **1206** of the striking face portion **1204**, while cross-sectional line **14-14′** passes through a plane containing a toe joint mechanism (to be shown later).

[0058] FIG. **13** of the accompanying drawings shows a cross-sectional view of a golf club head **1300** in accordance with an exemplary embodiment of the present invention taken along cross-sectional line **13-13′** shown in FIG. **12**. In this cross-sectional view, we can see that the striking face portion **1304** is located at a frontal portion of the golf club head **1300**, while the body portion **1302** is attached to the rear of the striking face portion **1304**. The striking face portion **1304**, similar to the discussion previously, relates to the portion of the golf club head **1300** that is substantially perpendicular to the ground plane, and stops being the striking face portion **1304** once it deviates from that plane. The striking face portion **1304**, like previously mentioned, can be separated into an upper striking face portion **1304***a* and a lower striking face portion **1304***b*, having the geometric face center **1306** be the demarcation point between the two sub-components. However, in this embodiment, unlike the previous embodiment, the entirety of the leading edge of the golf club head **1300** is formed out of the high density member **1310** to create the weighting mechanism **1308**

without the need of screws or posts. This type of construction is achievable because various other joint mechanisms are used to secure this weighting mechanism to **1308** to the golf club head **1300**.
[0059] Unlike previous embodiments of the present invention wherein the weighting mechanisms (previously shown as **108** in FIG. **1**) utilizes mechanical sub-components to achieve the high density member (previously shown as **110** in FIG. **1**) to the golf club head (previously shown as **100** in FIG. **1**), the present embodiment uses non-mechanical joining methods to secure the weighting mechanism **1308** to the frontal upper portion **1340**. More specifically, in one example, the high density member **1310** could be formed of a weldable material that has a density higher than the frontal upper portion **1340** and attached directly to the frontal upper portion **1340** via welding. In other examples, the high density member **1310** may be swaged together with the frontal upper portion **1340** or brazed together with the frontal upper portion **1340** all without departing from the scope and content of the present invention. In a further alternative example, the entirety of the striking face portion **1304** may be formed via Direct Metal Laser Sintering (DMLS), 3D printing, or any other type of additive manufacturing techniques to include the different materials for the high density member **1310** and the frontal upper portion **1340**, also without departing from the scope and content of the present invention. Alternatively, it can be said that the bond between the high density member **1310** and the frontal upper portion **1340** of the striking face portion **1304** of the golf club head **1300** could be formed by any non-mechanical methods of joining all without departing from the scope and content of the present invention.
[0060] In this alternative embodiment of the present invention, due to the fact that the upper frontal portion **1340** and the weighting mechanism **1308** formed out of the high density member **1310** are joined together to form a face cup, the joint between the front and rear of the golf club head **1300** also needs to be addressed. Central joint mechanism **1342** shown here in this cross-sectional view of the present invention in FIG. **13** illustrates how the frontal portion of the golf club head, which includes the upper frontal portion **1340** an the weighting mechanism **1308** made out of a high density member **1310**, is joined to the rear portion of the golf club head **1300**. In this embodiment of the present invention shown in FIG. **13**, the golf club head **1300** utilizes a central joint mechanism **1342** is formed within the rear portion of the golf club head **1300** and may clamp onto the weighting mechanism **1308** to provide a means of attachment.
[0061] In addition to the central joint mechanism **1342**, the golf club head could also include additional mechanical joints in the heel and toe sections of the golf club head **1300**. FIG. **14** of the accompanying drawings illustrates the additional mechanical toe joint **1444** by providing a cross-sectional view of a golf club head **1400** along cross-sectional line **14**-**14**′ shown in FIG. **12**. In this cross-sectional view, the toe joint mechanism **1444**, which is identical to the heel joint mechanism (not shown), provides an additional bond between the frontal upper portion **1440** and the weighting mechanism **1408** to further secure these two components together without departing from the scope and content of the present invention.
[0062] It should be noted that most of the embodiments discussed here aims to create a releasable hosel hole cover, however, all of these embodiments may include glue to make the hosel hole cover stay within the hosel hole, removing the ability to remove the hosel hoe cover without departing from the scope and content of the present invention.
[0063] Other than in the operating example, or unless otherwise expressly specified, all of the numerical ranges, amounts, values and percentages such as those for amounts of materials, moment of inertias, center of gravity locations, loft, draft angles, various performance ratios, and others in the aforementioned portions of the specification may be read as if prefaced by the word “about” even though the term “about” may not expressly appear in the value, amount, or range. Accordingly, unless indicated to the contrary, the numerical parameters set forth in the above specification 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.
[0064] Notwithstanding that the numerical ranges and parameters setting forth the broad scope of the invention are approximations, 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.
[0065] 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.

Claims

1. A golf club head comprising: a striking face portion located at a frontal portion of said golf club head; a body portion, made out of a first material having a first density, attached to a rear of said striking face portion, wherein said striking face portion further comprises; an upper striking face portion located above a geometric center of said striking face portion, and a lower striking face portion located below a geometric center of said striking face portion, and wherein at least a portion of said lower striking face portion has a higher density than said upper striking face portion.
2. The golf club head of claim 1, wherein said lower striking face portion further comprises a weighting mechanism, wherein said weighting mechanism encompasses a portion of a leading edge portion of said golf club head.
3. The golf club head of claim 2, wherein said weighting mechanism further comprises; a high density member, made out of a second material having a second density, wherein said second density is greater than said first density.
4. The golf club head of claim 3, wherein said second density is greater than about 7.5 g/cm.sup.3.
5. The golf club head of claim 4, wherein said second density is greater than about 14 g/cm.sup.3.
6. The golf club head of claim 3, wherein said weighting mechanism further comprises; an attachment member, adapted to engage an opening in said high density member, wherein said attachment member secures said high density member to said leading edge portion of said golf club head.
7. The golf club head of claim 1, wherein said lower striking face portion further comprises a leading edge portion, wherein said leading edge portion further comprises a chamfered leading edge, and wherein said chamfered leading edge has a chamfer angel of between about 60 degrees to about 70 degrees.
8. The golf club head of claim 7, wherein said chamfered leading edge is adapted to engage a weighting mechanism, said weighting mechanism further comprises; a high density member, made out of a second material having a second density, wherein said second density is greater than said first density.
9. The golf club head of claim 8, wherein said golf club head has a CG-Z-FC less than about 40 mm from a face center, wherein said golf club head has a CG-NA of less than about 2 mm above a neutral axis, and wherein said golf club head has a MOI-Y of greater than about 4,000 g-cm.sup.2.
10. A golf club head comprising: a striking face portion located at a frontal portion of said golf club head; a body portion, made out of a first material having a first density, attached to a rear of said striking face portion, wherein said striking face portion further comprises; an upper striking face portion located above a geometric center of said striking face portion, and a lower striking face portion located below a geometric center of said striking face portion further comprising a leading edge portion, and wherein said golf club head has a CG-Z-FC less than about 40 mm from a face center, wherein said golf club head has a CG-NA of less than about 2 mm above a neutral axis, and

wherein said golf club head has a MOI-Y of greater than about 4,000 g-cm.sup.2.
11. The golf club head of claim 10, wherein at least a portion of said leading edge portion has a higher density than said upper striking face portion.
12. The golf club head of claim 10, wherein said golf club head has a CG-Z-FC of less than about 37.5 mm from said face center, said CG-NA of less than about 1.50 mm above said neutral axis, and said MOI-Y of greater than about 4,500 g-cm.sup.2.
13. The golf club head of claim 12, wherein said golf club head has a CG-Z-FC of less than about 30.0 mm from said face center, said CG-NA of less than about 1.00 mm above said neutral axis, and said MOI-Y of greater than about 5,000 g-cm.sup.2.
14. The golf club head of claim 13, wherein said CG-NA is less than 0 mm.
15. The golf club head of claim 10, wherein said lower striking face portion further comprises a weighting mechanism, wherein said weighting mechanism encompasses a portion of a leading edge portion of said golf club head.
16. The golf club head of claim 15, wherein said weighting mechanism further comprises; a high density member, made out of a second material having a second density, wherein said second density is greater than said first density.
17. The golf club head of claim 16, wherein said second density is greater than about 7.5 g/cm.sup.3.
18. The golf club head of claim 17, wherein said second density is greater than about 14 g/cm.sup.3.