



US 20130137532A1

(19) **United States**

(12) **Patent Application Publication**  
**Deshmukh et al.**

(10) **Pub. No.: US 2013/0137532 A1**

(43) **Pub. Date: May 30, 2013**

(54) **CO-FORGED GOLF CLUB HEAD AND METHOD OF MANUFACTURE**

*B21K 17/00* (2006.01)

*B23P 15/00* (2006.01)

(76) Inventors: **Uday V. Deshmukh**, Carlsbad, CA (US);  
**Ronald K. Hettinger**, Oceanside, CA (US);  
**Jonathan Hebreo**, San Diego, CA (US)

(52) **U.S. Cl.**  
USPC ..... **473/349; 72/352**

(57) **ABSTRACT**

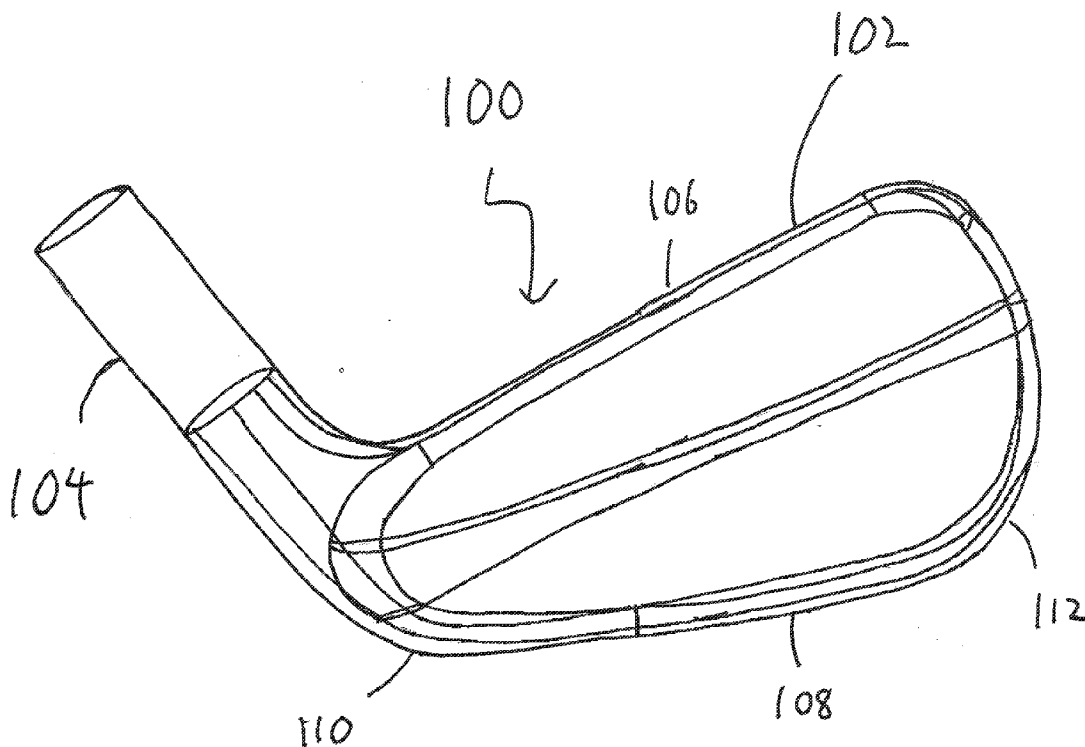
A co-forged iron type golf club is disclosed. More specifically, the present invention discloses a co-forged iron type golf club with the body portion made out of a first material and at least one weight adjustment portion monolithically encased within the body portion of the co-forged iron type golf club head without the need for secondary attachment or machining operations. The present invention creates of an iron type golf club head from a pre-form billet that already contains two or more materials before the actual forging process resulting in a multi-material golf club head that doesn't require any post manufacturing operations such as machining, welding, swaging, gluing, and the like.

(21) Appl. No.: **13/305,087**

(22) Filed: **Nov. 28, 2011**

**Publication Classification**

(51) **Int. Cl.**  
*A63B 53/04* (2006.01)  
*B21J 1/00* (2006.01)



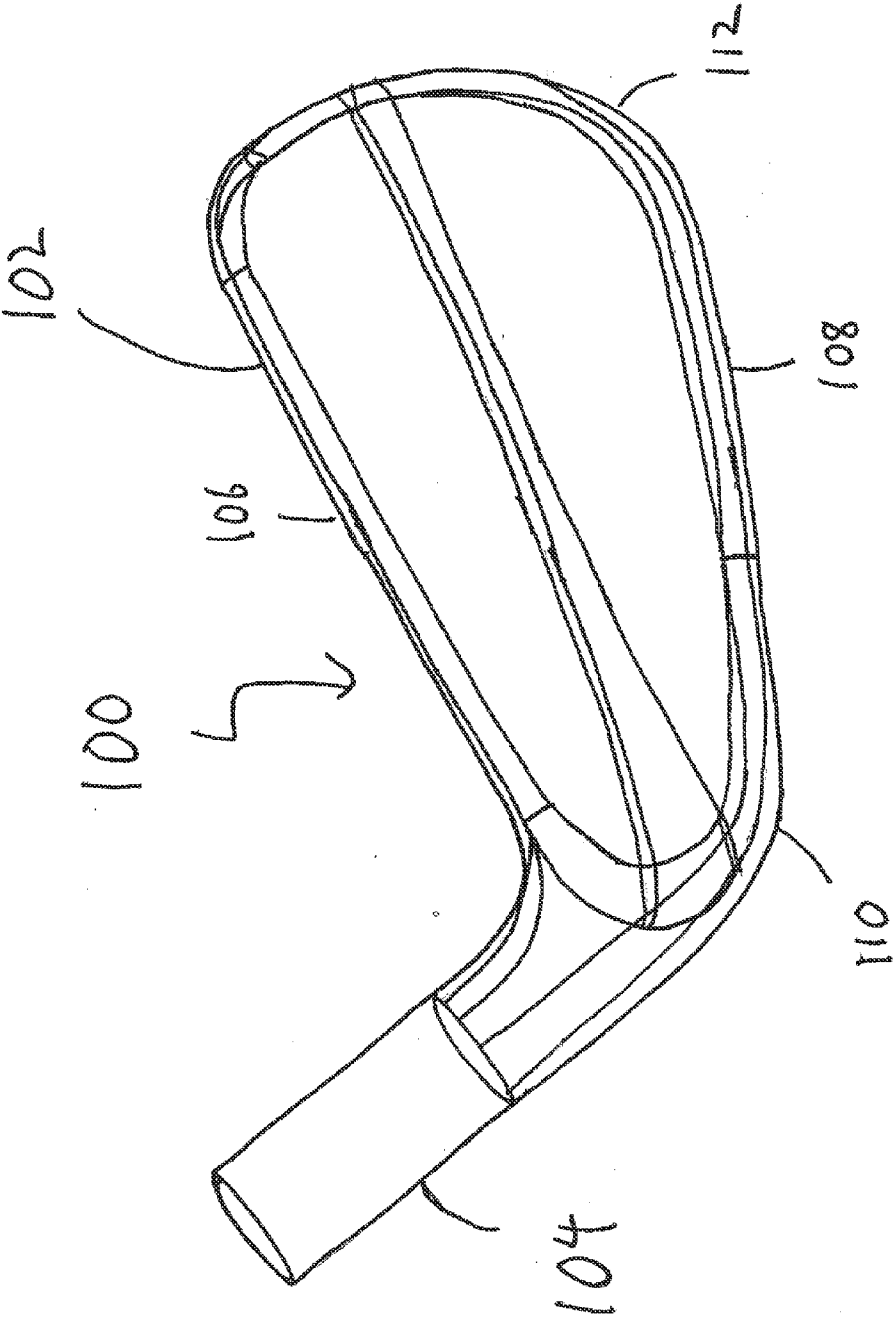
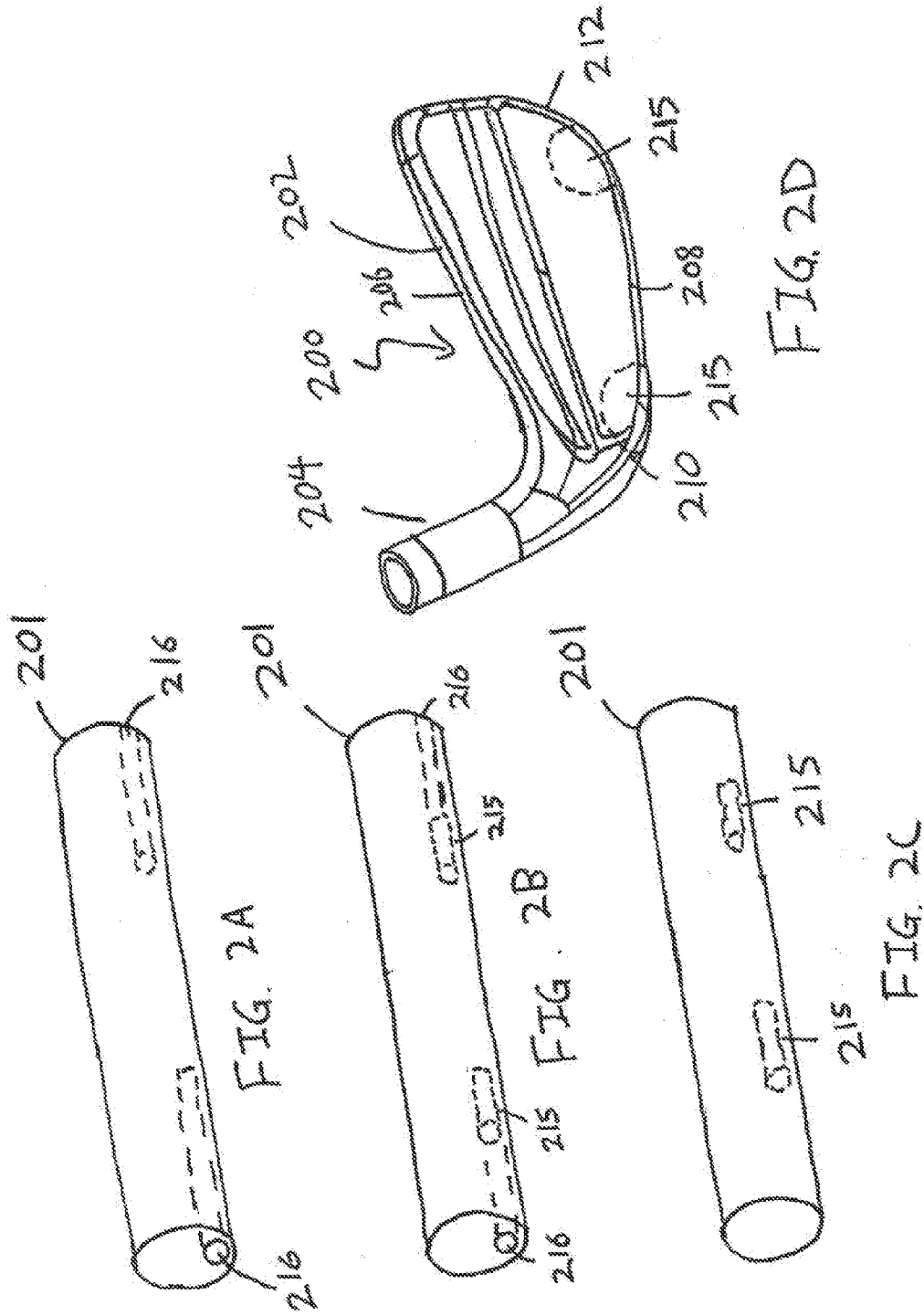
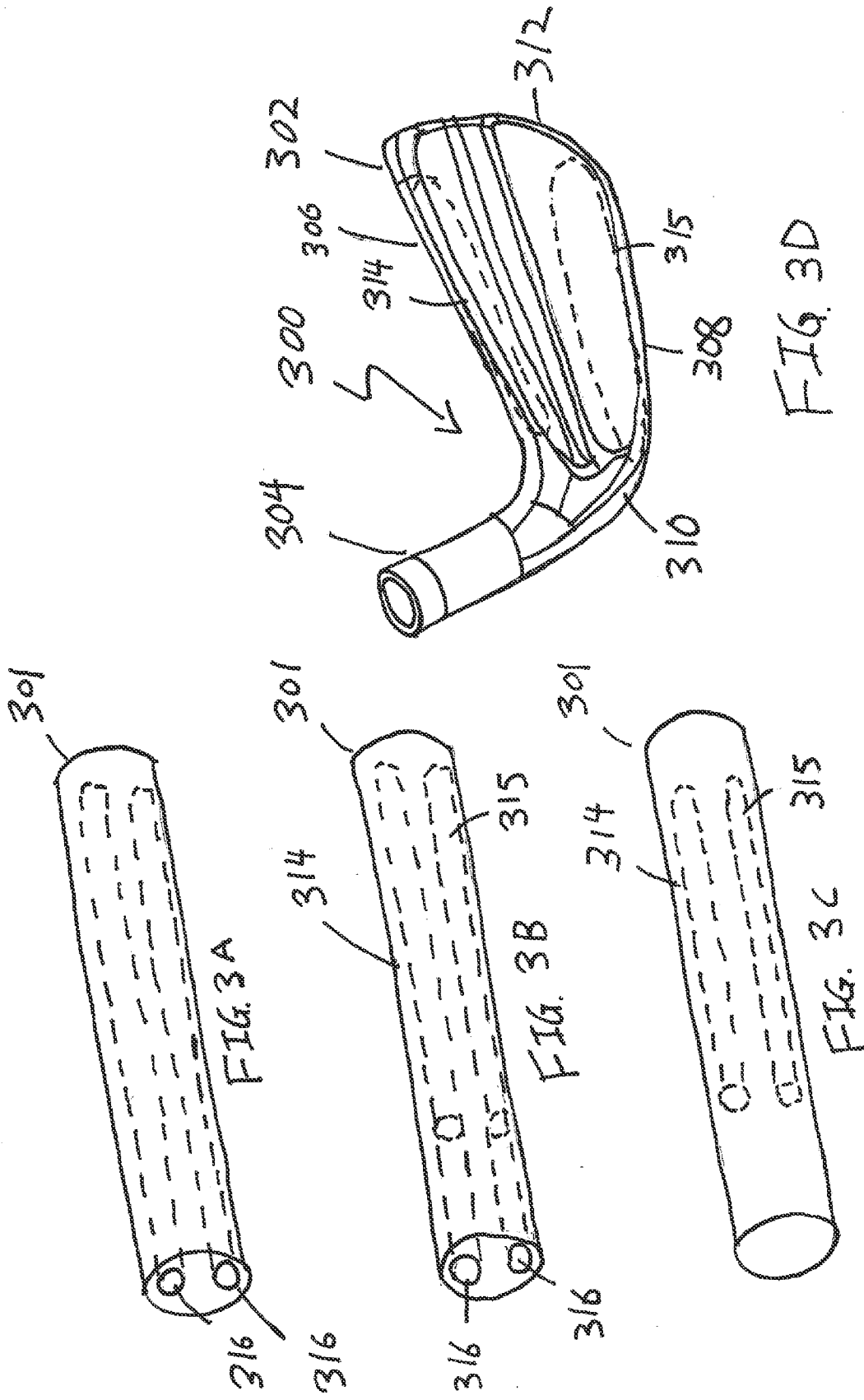
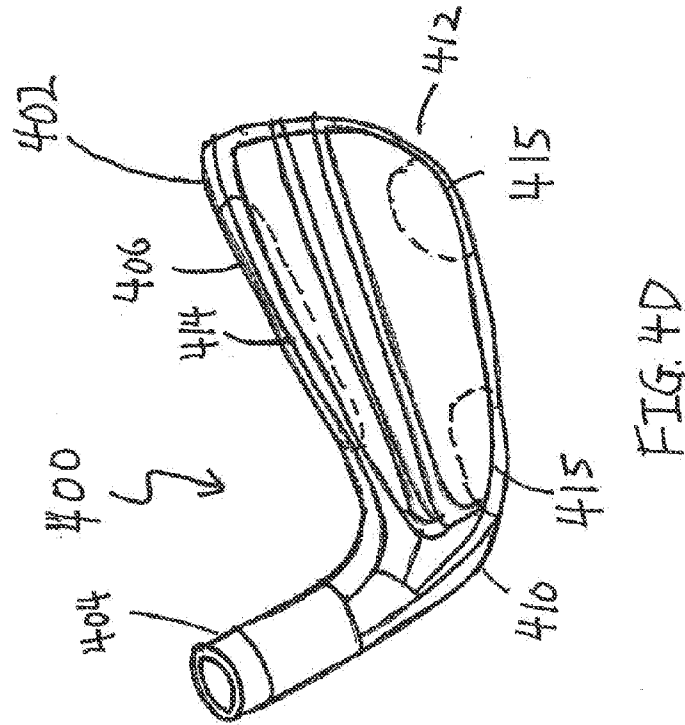
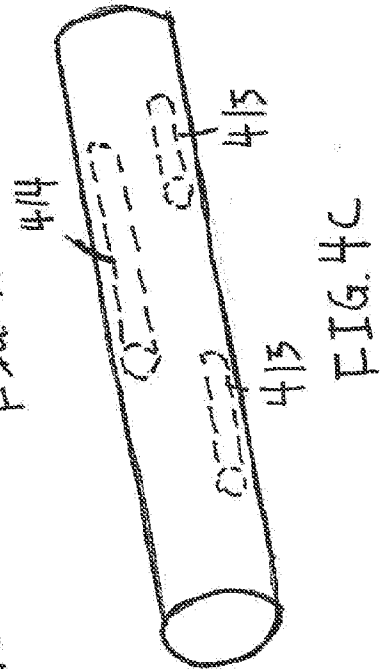
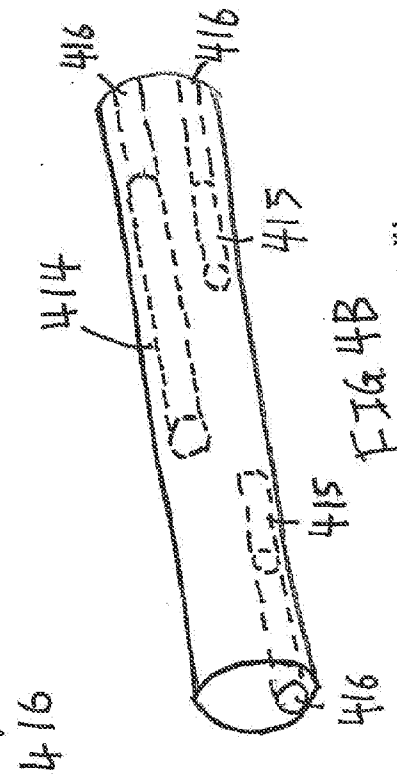
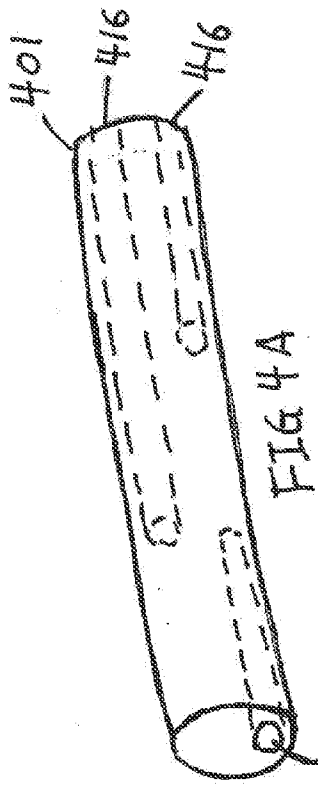


FIG. 1







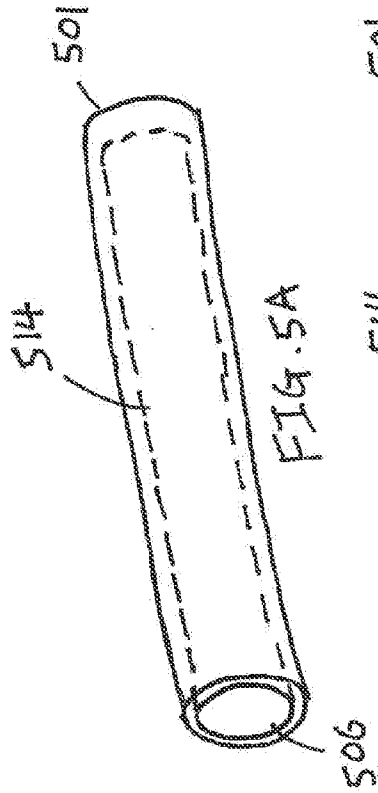


FIG. 5A

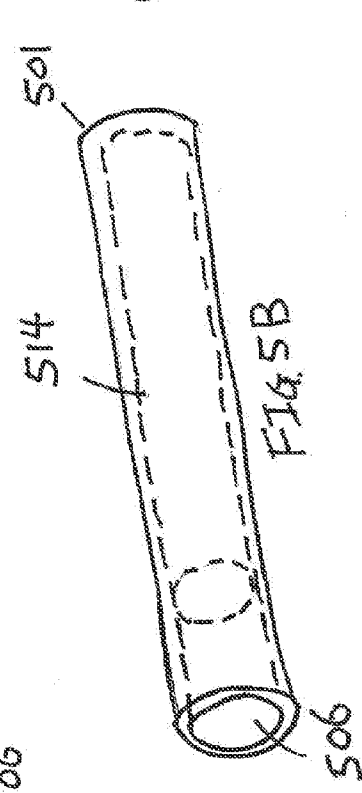


FIG. 5B

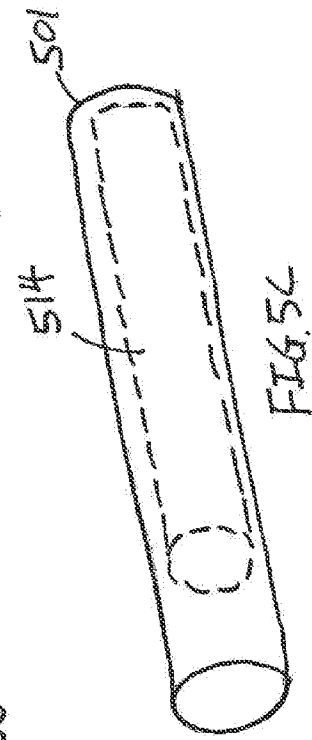


FIG. 5C

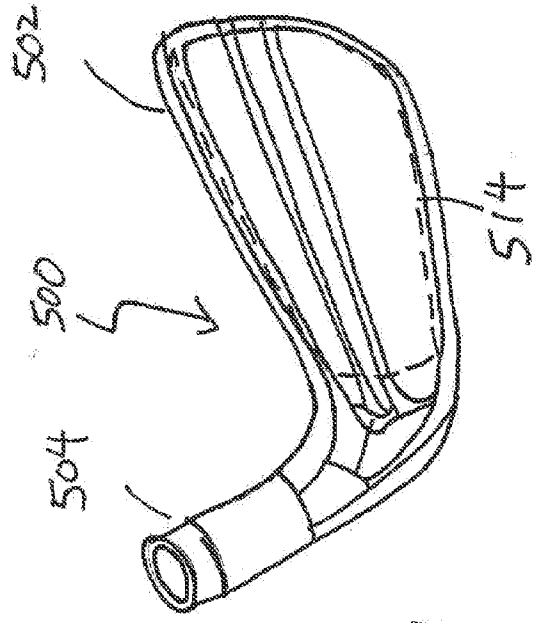


FIG. 5D

## CO-FORGED GOLF CLUB HEAD AND METHOD OF MANUFACTURE

### FIELD OF THE INVENTION

**[0001]** The present invention relates generally to a co-forged golf club head formed from two or more materials and the method of manufacture for such a golf club head. More specifically, the present invention relates to the creation of an iron type golf club head from a pre-form billet that already contains two or more materials before the actual forging process; resulting in a multi-material golf club head that doesn't require any post manufacturing operations such as machining, welding, swaging, gluing, and the like.

### BACKGROUND OF THE INVENTION

**[0002]** Golf is hard! When your average golfer swings a golf club, he or she may have dramatic variations in his or her golf swing, resulting in numerous off-center hits, which result in diminished performance when compared to a direct center hit. However, in an attempt to make this very difficult game more enjoyable for the average golfer, golf club designers have come up with unique golf club designs that will mitigate the harsh realities of a less than perfect golf swing.

**[0003]** In one early example, U.S. Pat. No. 4,523,759 to Igarashi discloses a perimeter weighted hollow golfing iron having a foam core with an effective hitting area concentrated toward the center of moment in an attempt to help make the game of golf easier. Distributing the weight of a golf club to the perimeter allow the moment of inertia (MOI) of a golf club head to be increased, reducing the undesirable twisting a golf club as it impacts a golf ball.

**[0004]** U.S. Pat. No. 4,809,977 to Doran et al. shows another example of an attempt to increase the moment of inertia of a golf club head by placing additional weights at the heel and toe portion of the golf club head. This increase in the moment of inertia of the golf club head achievable by increased heel and toe weighting could further prevent the golf club from twisting in a heel and toe direction, which mitigates the undesirable effect of sending a golf ball off the intended trajectory.

**[0005]** Although the initial attempts at increasing the forgiveness and playability of a golf club for an average golfer are admirable, it does not take advantage of the extreme forgiveness that can be achievable by utilizing different materials to form different portions of the golf club head. In one example, U.S. Pat. No. 5,885,170 to Takeda shows the advantage of using multi-materials to create more extreme adjustment of the mass properties. More specifically, U.S. Pat. No. 5,885,170 teaches a body having a face formed of one material while a hosel is formed from another material having different specific gravity from that of the head body. U.S. Pat. No. 6,434,811 to Helmstetter et al. shows another example of utilization of multiple materials to improve the performance of a golf club head by providing a golf club head with a weighting system that is incorporated after the entirety of the golf club head has been formed.

**[0006]** More recently, the improvements in incorporating multi-materials into a golf club head has matured significantly by incorporating numerous multiple materials of different characteristics by machining cavities into the golf club head. More specifically, U.S. Pat. No. 7,938,739 to Cole et al. discloses a golf club head with a cavity integral with the golf club head, wherein the cavity extends from the heel region to

the toe region; extending along a lower portion of the back face of the golf club head; extends approximately parallel to the strike face; and is approximately symmetrical about a centerline that bisects the golf club head between the heel region and the toe region.

**[0007]** However, as multiple materials are introduced into the golf club after the body has been completed, the tolerances of the interfaces between the different materials could potentially cause undesirable side effects of altering the feel of the golf club head. U.S. Pat. No. 6,095,931 to Hettinger et al. identifies this specific undesirable side effect of sacrifice in the feel by the usage of multiple different components. U.S. Pat. No. 6,095,931 addresses this issue by providing an isolation layer between the golf club head and the main body portion that comprises the striking front section.

**[0008]** U.S. Pat. No. 7,828,674 to Kubota recognizes the severity of this problem by stating that hollow golf club heads having viscoelastic element feels light and hollow to the better golfer, hence they do not prefer such a golf club. U.S. Pat. No. 7,828,674 address the deficiencies of such a multi-material golf club by incorporating a block of magnesium to be embedded and or press-fitted into the recess formed in the metal only to be sealed with a metallic cover.

**[0009]** Despite all of the above attempts to improve the performance of a golf club head all while trying to minimize the sacrifice in feel of a golf club, all of the methodologies require a significant amount of post manufacturing operation that creates cavities and recesses in the club head for the secondary material to be incorporated. These type of secondary operations are not only expensive, but the ability to maintain a tight enough tolerance between the various components make is very difficult to maintain the solid feel generally associated with an unitarily formed golf club head.

**[0010]** Hence, it can be seen from above, despite all the development in creating a golf club head that's more forgiving without sacrificing the feel associated with a conventional club head, the current art is incapable of creating such a club without utilizing severe post manufacturing machining that causes bad feel.

### BRIEF SUMMARY OF THE INVENTION

**[0011]** In one aspect of the present invention is a forged golf club head comprising a body portion having a striking surface made out of a first material, and at least one weight adjustment portion made out of a second material encased within the body portion; wherein the at least one weight adjustment portion is encased monolithically within the body portion of the golf club head without any secondary attachment operations.

**[0012]** In another aspect of the present invention is a method of forging a golf club head comprising of the steps of creating a cylindrical billet out of a first material, machining one or more cavities within the cylindrical billet, partially filling the one or more cavities with a second material to create a weight adjustment portion, filling the remaining volume of the one or more cavities with the first material to encase the weight adjustment portion, and forging the cylindrical billet to create a body portion of the golf club head; wherein the body portion monolithically encases the weight adjustment portion within a body of the golf club head without any secondary attachment operations.

**[0013]** In another aspect of the present invention is a forged golf club head comprising a body portion having a striking surface made out of first material, and at least one weight

adjustment portion made out of a second material encased within the body portion; wherein the at least one weight adjustment portion is encased monolithically within the body portion without any secondary attachment operations. The first material has a first flow stress at a first forging temperature and the second material has a second flow stress at a second forging temperature, wherein the first flow stress and the second flow stress are substantially similar to one another, and the first forging temperature and the second forging temperature are substantially similar to one another and the first forging temperature and the second forging temperature are substantially similar to one another. The first material has a first thermal expansion coefficient and the second material has a second thermal expansion coefficient, wherein the first thermal expansion coefficient is greater than or equal to the second thermal expansion coefficient.

[0014] 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 THE DRAWINGS

[0015] 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.

[0016] FIG. 1 of the accompanying drawings shows a perspective view of a co-forged golf club head in accordance with an exemplary embodiment of the present invention;

[0017] FIGS. 2A-2D shows perspective views of pre-formed billets used to create a golf club head in accordance with an exemplary embodiment of the present invention;

[0018] FIGS. 3A-3D shows perspective views of pre-formed billets used to create a golf club head in accordance with an exemplary embodiment of the present invention;

[0019] FIGS. 4A-4D shows perspective views of pre-formed billets used to create a golf club head in accordance with an exemplary embodiment of the present invention; and

[0020] FIGS. 5A-5D shows perspective views of pre-formed billets used to create a golf club head in accordance with an exemplary embodiment of the present invention.

#### DETAILED DESCRIPTION OF THE INVENTION

[0021] 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.

[0022] 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.

[0023] FIG. 1 of the accompanying drawings shows a perspective view of a golf club head 100 in accordance with an exemplary embodiment of the present invention. The golf club head 100 shown in FIG. 1 may generally comprise of a

body portion 102 and a hosel portion 104, with the body portion 102 having several individually identifiable components such as a topline portion 106, a sole portion 108, a heel portion 110, and a toe portion 112. The golf club head 100 in accordance with an exemplary embodiment of the present invention may generally be comprised of at least one weight adjustment portion that is encased within the body portion 102 of the golf club head 100. In a preferred embodiment, the weight adjustment portion may be monolithically encased within the body portion 102 to ensure that the weight adjustment portion is secured within the body portion 102 without departing from the scope and content of the present invention. Because the weight adjustment portion is monolithically encased within the body portion 102 of the golf club head 100, these weights are not visible in FIG. 1 of the accompanying drawings. However, these weight adjustment portions will be shown in more detail in later figures, when various different views are presented.

[0024] Before moving onto subsequent figures, it is worthwhile here to emphasize that the current golf club head 100 is created using a forging process and the weights are incorporated without any post finish machining operations. This is an important distinction to establish because the same result of a monolithically encasing a weight adjustment portion is extremely difficult to achieve using alternative manufacturing processes such as casting. “Monolithically encased”, as referred to in the current patent application, may generally be defined as a having a specific internal component placed inside a separate external component without joints or seams in the finished product. With respect to the current invention, having weight adjustment portions “monolithically encased” within the body portion 102 of the golf club head 100 may generally refer to the ability to have weight adjustment portions placed inside the body portion 102 of the golf club head without joints or seams that are generally required by post manufacturing processes such as milling, welding, brazing, gluing, or swaging.

[0025] It should also be noted here that a weight that is “monolithically encased” within the current definition of the present invention could potentially have certain aspect of the internal weights exposed in the finish product to illustrate the existence of a weight adjustment portion without departing from the scope and content of the present invention. More specifically, “monolithically encased” refers to the methodology used to create the ultimate product as described above, and may not necessarily be limited to visually concealing the weight adjustment member.

[0026] FIGS. 2A-2D illustrate the methodology used to create a co-forged golf club head 200 in accordance with an exemplary embodiment of the current invention. More specifically, FIGS. 2A-2D illustrate the steps involved in the forging of a golf club head from its rudimentary billet 201 shape into the final product of a golf club head 200.

[0027] FIG. 2A shows a pre-formed billet 201 in accordance with an exemplary embodiment of the present invention. As it can be seen from FIG. 2A, the pre-form billet 201 may generally begin as a cylindrical rod formed from a first material, as it is common with the forging of a golf club head 200. In order to create a weight adjustment portion 215 that can be monolithically encased within the body portion 202 of the golf club head 200, one or more cavities 216 are machined into the pre-form billet 201. In this current exemplary embodiment shown in FIG. 2A, two cavities 216 are machined into the terminal ends of the pre-form billet 201.



The location and geometry of the cavities 216 within the pre-form billet 201 are important, as it correlates directly with the ultimate location of the weight adjustment portion 215 in the golf club head 200 after forging.

[0028] Moving onto FIG. 2B, it can be seen that once the cavities 216 are machined, the cavities 216 are partially filled with a second material that has a density different from the density of the first material in order to create the weight adjustment portion. 215. Similar to the discussion above, the location, size, and shape of the weight adjustment portion 215 is just as critical as the location, size, and shape of the cavities 216, as the weight adjustment portion 215 within the pre-form billet 201 correlates with the ultimate resting place of the weight adjustment portion 215 in the golf club head.

[0029] Finally, FIG. 2C shows the final phase of the pre-form billet 201 as the remaining volume of the cavities 216 are filled with the first material and sealed through traditional joining methods such as welding, brazing, and swaging. Sealing the cavities 216 allows the weight adjustment portion 215 to be monolithically encased within the body of the pre-form billet 201, which will allow the same weight adjustment portion 215 to be monolithically encased in the body 202 of the golf club head 200 after the forging process. After the cavities 216 are filled, the pre-form billet 201 is subjected to the normal forging process associated with the forging of a golf club head 200. Although the basic steps involved in forging a golf club head 200 are important to the understanding of the current invention, it involves a relatively archaic and established technique, which the present application will not dive into much detail. More information regarding the steps involved in the forging of a basic golf club head without monolithically encased weight adjustment portions can be found in U.S. Pat. No. 3,825,991 to Cornell, and U.S. Pat. No. 6,666,779 to Iwata et al., the disclosure of which are all incorporated by reference in its entirety.

[0030] Although the above discussion regarding the forging of a golf clubs incorporated by reference do a good job describing the actual forging process, it fails to address the additional concerns with the co-forging process of the current invention wherein two different materials are involved in this forging process. More specifically, because a weight adjustment portion 215 is made out of a second material that could be different from the first material used to create remainder of the pre-form billet 201, special care must be taken to ensure that the different materials can be forged together to form a golf club head 200. Hence, in order to select two cohesive materials that are capable of being co-forged together, the first material and the second material may generally have to have very specific material properties requirements with respect to their flow stress and their thermal expansion coefficient. Although it is most preferential for the two materials to have identical material properties yielding in consistency in forging, the usage of identical materials may not offer any weight adjustment benefits required for the basis of the current invention.

[0031] First of, in order for metallic materials to have the capabilities of being co-forged together, the respective flow stress' of each of the materials needs to be properly considered. Flow stress of a material, may generally be defined as the instantaneous value of stress require for continued deforming the material (i.e. to keep the metal flowing); and the creation of a cohesive forged component from two different materials will require them to flow at relatively the same speed when subjected to the stresses of the forging process. It

is commonly known that the flow stress of a material is generally a function of the yield strength, the flow stress of a material may generally be summed up by Eq. (1) below.

$$Y_f = Ke^n \quad \text{Eq. (1)}$$

wherein

[0032]  $Y_f$ =Flow Stress (MPa)

[0033]  $K$ =Strain Coefficient (MPa)

[0034]  $N$ =Strain Hardening Exponent

[0035] In addition to the above equation, it is worthwhile to mention here that the flow stress of a material may not be construed in vacuum, but rather, it is a function of the forging temperature of the material as well. Hence, in a current exemplary embodiment of the present invention, a first flow stress of the first material at its first forging temperature is substantially similar but not identical to the second flow stress of the second material at its second forging temperature; with the first forging temperature and the second forging temperature being substantially similar. More specifically, in a more detailed embodiment, the first material may be 1025 steel having a first flow stress of about 10 ksi (kilo-pound per square inch) at a forging temperature of about 1,200° C., while the second material may a Niobium material having a second flow stress of also about 12 ksi at a forging temperature of about 1,100° C.

[0036] Although in the exemplary embodiment of the present invention described above, the first material may be a 1025 steel and the second material may be a Niobium material, various other materials may also be used without departing from the scope and content of the present invention so long as their flow stresses are similar at a similar forging temperature. Alternatively speaking, any two materials may be used in the current co-forging process so long as the second flow stress is no more than 20% greater or no less than 20% lesser than the first flow stress.

[0037] As mentioned before, other than flow stress, the thermal expansion coefficient of the first and second materials are also important to the proper co-forging of two distinct materials. More specifically, a first thermal expansion coefficient of the first material may generally need to be greater than or at least equal to the second thermal expansion coefficient of the second material. Because the thermal expansion coefficient also relate to the shrinkage of the material after forging, it is important that the first material that monolithically encases the second material have a higher thermal expansion coefficient to prevent gaps from forming at the interface portion of the materials. In a more detailed embodiment of the present invention, the first material may be 1025 steel having a thermal expansion coefficient of about 8.0  $\mu\text{in}/\text{in}^\circ\text{F}$ ., while the second material may be Niobium having a second thermal expansion coefficient of about 3.94  $\mu\text{in}/\text{in}^\circ\text{F}$ .

[0038] It should be noted that although in the above exemplary embodiment the second thermal expansion coefficient is smaller than the first thermal expansion coefficient, the numbers can be identical to achieve perfect mating of the two materials without departing from the scope and content of the present invention. In fact, in one exemplary embodiment of the present invention, it may be preferred for the first material and the second material to have the same thermal expansion coefficient, as excessive shrinkage of the outer material upon the inner material could potentially create additional stresses at the interface portions of the two materials.

[0039] Alternatively, in an attempt to provide different weighting characteristics, the second material could be made out of a 6-4 Titanium material to reduce the weight of the weight adjustment portion 215. The Titanium material may generally have a flow stress of about 10 ksi at a forging temperature of about 1,100° C. and a thermal expansion coefficient of about 6.1  $\mu\text{in/in}^\circ\text{F}$ .

[0040] Now that the forging process, and the specific concerns involving the co-forging of different materials have been discussed, FIG. 2D of the accompanying drawings shows a perspective view of a finished golf club head 200 created using the co-forging process above, wherein the golf club head 200 monolithically encases at least one weight adjustment portion 215 within the body portion 202. More specifically, in the current exemplary embodiment of the present invention, the weight adjustment portions 215 are placed near a heel portion 210 and a toe portion 212 of the golf club head 200. The placement of the weight adjustment portion 215 near a heel portion 210 and the toe portion 212 allow the golf club head 200 to have an increase in the Moment of Inertia (MOI) without the need for any secondary attachment operations; which will result in a more consistent feel upon impact with a golf ball.

[0041] Before moving onto a discussion regarding different embodiments of the present invention, it is worthwhile here to note that the exact placement of the weight adjustment portion 215 within the body portion 202 of the golf club head 200 is slightly different in every single different club head, this is the outcome of the current inventive co-forging process involves different materials. More specifically, the exact placement of the weight adjustment portion 215 may differ with each single golf club 200, as the flow stress of the first material and the second material will help determine the final location of the weight adjustment portion 215. In addition to the above, it should be noted that the interface between the weight adjustment portion 215 and the body portion 202 of the golf club head 200 may generally be an irregular interface, with the boundaries jagged to indicate that the entire golf club head 200 has been co-forged. This is dramatically different from a cavity created via a post machining secondary operations such as milling and drilling; which generally have clean bifurcation lines of the two different materials.

[0042] FIGS. 3A-3D of the accompanying drawings shows an alternative embodiment of the present invention wherein two separate weight adjustment portions 314 and 315 are placed at different portions of the pre-form billet 301 to create a golf club head 300 with a different performance criteria. More specifically, the golf club head 300 shown in FIG. 3D may have a lightweight weight adjustment portion 314 near a topline portion 306 of the golf club head 300 and a heavy-weight weight adjustment portion 315 near a sole 308 of the golf club head 300 to help shift the Center of Gravity (CG) of the golf club head 300 lower to help with launch and spin characteristics of the current inventive golf club head 300.

[0043] FIG. 3A-3C, similar to before, show the formation process of the current inventive golf club head 300, starting from a pre-form billet 301. More specifically, FIG. 3A shows a perspective view of a pre-form billet 301 in accordance with an exemplary embodiment of the present invention wherein a plurality of cavities 316 are drilled at strategic locations within the billet 301. It should be noted that in this current exemplary embodiment the plurality of cavities 316 are drilled near a top portion and a bottom portion of the pre-form billet 301 instead of at each of the terminal ends, as this

specific embodiment focuses on lowering the CG of the golf club head 300 by removing weight from the top line portion 306 of the golf club head 300 and shifting it towards a sole portion 308 of the golf club head 300.

[0044] FIG. 3B of the accompanying drawings shows two weight adjustment portions 314 and 315 being placed inside the cavities 316 created in FIG. 3A. Although it may generally be desirable to minimize the weight near a top portion of a golf club head 300 when one desires to lower the CG, top cavity 316 can not be left completely blank in this current embodiment of the present invention, as the entire pre-form billet 301 will eventually be forged into the shape of a golf club head 300, causing any empty cavity 316 to collapse upon itself. Hence, in this current exemplary embodiment of the present invention, the top cavity 316 may be filled with a lightweight weight adjustment portion 314, while the lower cavity 316 may be filled with a heavyweight weight adjustment portion 315. The lightweight weight adjustment portion 314 may generally be made out of a third material having a third density, wherein the heavyweight weight adjustment portion 315 may generally be made out of second material having a second density. In one exemplary embodiment of the present invention, the third density may generally be less than about 7.0 g/cc, wherein the second density may generally be greater than about 7.8 g/cc; while the first material used to form the body portion 302 of the golf club head 300 may generally have a first density of about 7.8 g/cc.

[0045] FIG. 3C of the accompanying drawings shows the final stage of the pre-form billet 301 that has monolithically encased the weight adjustment portions 314 and 315 within the internal cavities 316 of the pre-form billet 301. More specifically, the creation of the pre-form billet shown in FIG. 3C involves filling in the remaining volume of the cavities 316 with a first material to encase the weight adjustment portions 315 and 316 within the pre-form billet 301. Similar to the above discussion, the pre-form billet 301, is subsequently forged to create a golf club head 300 as shown in FIG. 3D, wherein the weight adjustment portions 314 and 315 are monolithically encased within the body portion 302 of the golf club head 300.

[0046] Similar to the methodology described above, the co-forging of the third material within the cavity created within the first material, the third material may generally need to have a third flow stress that is similar with the first flow stress of the first material and a third thermal expansion coefficient less than the first thermal expansion coefficient of the first material. More specifically, in one exemplary embodiment of the present invention, the third material may be a 6-4 Titanium material having a third flow stress of about 10 ksi at a forging temperature of about 1,100° C. and a third thermal expansion coefficient of about 6.1  $\mu\text{in/in}^\circ\text{F}$ .

[0047] Although FIGS. 2A-2D and FIGS. 3A-3D show different embodiments of the present invention used to achieve a higher MOI and a lower CG respectively, these features are not mutually exclusive from one another. In fact, in a further alternative embodiment of the present invention shown in FIGS. 4A-4D, features may be taken from both embodiments discussed above to create a co-forged golf club head with a higher MOI as well as a lower CG all without departing from the scope and content of the present invention. More specifically, in FIGS. 4A-4D, the steps needed to incorporate a lightweight weight adjustment portion 414 near a top portion 406 of a golf club 400 together with two or more heavyweight weight adjustment portions 415 near a toe por-

tion 412 and a heel portion 410 of the golf club head 400 to create a golf club with higher MOI and a lower CG.

[0048] FIG. 5A-5D of the accompanying drawings shows a further alternative embodiment of the present invention wherein the body portion 502 of the golf club head 500 may be comprised of a monolithically encased weight adjustment portion 514. In this current exemplary embodiment of the present invention, the weight adjustment portion 514 may be relatively large in size, allowing it to replace a majority of the body portion 502 of the golf club head 500 once the forging process is completely. In this current exemplary embodiment of the present invention, the monolithically encased weight adjustment portion 514 may generally be made out of a third material having a third density that is significantly lower than the first density of the first material used to form the body portion 502 of the golf club head 500; allowing weight to be taken out from the body portion 502 of the golf club head 500. Because the lightweight third material used to form the weight adjustment portion 514 may generally be relatively soft compare to the first material, it is generally desirable to monolithically encase the weight adjustment portion 514 within the internal body of the golf club head 500, allowing significant weight savings to be achieved without sacrificing feel.

[0049] More specifically FIG. 5A of the accompanying drawings shows a pre-form billet 501 similar to the previous figures. However, in this current exemplary embodiment, the cavity 506 is significantly larger within the pre-form billet 501 itself. This large cavity 506 can then be used in FIG. 5B to be filled with a weight adjustment portion 514 to adjust the weight, density, and overall feel of the golf club head 500. In FIG. 5C, similar to described above, the remaining volume of the cavity 516 is filled with the original first material before the entire pre-form billet 501 is subjected to the forging process to create a golf club head 500.

[0050] It is worth noting here that in this current exemplary embodiment, the hosel portion 504 of the golf club head 500 is deliberately made from the conventional first material, as the bending characteristics of the second material used to form the weight adjustment portion 514 may generally not be suitable for the bending requirements of an iron type golf club head 500. More specifically, the third material used to form the weight adjustment portion 514 could be a lightweight iron-aluminum material having a density of less than about 7.10 g/cc, more preferably less than about 7.05 g/cc, and most preferably less than about 7.00 g/cc, all without departing from the scope and content of the present invention. However, numerous other materials can also be used as the third material used to form the weight adjustment portion 514 without departing from the scope and content of the present invention so long as the third material has a density within the range described above.

[0051] 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 following 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.

[0052] 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.

[0053] 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 forged golf club head comprising:

a body portion having a striking surface made out of a first material; and

at least one weight adjustment portion made out of a second material encased within said body portion;

wherein said at least one weight adjustment portion is encased monolithically within said body portion without any secondary attachment operations.

2. The forged golf club head of claim 1, wherein an interface between said body portion and said at least one weight adjustment portion creates an irregular interface.

3. The forged golf club head of claim 2, wherein said at least one weight adjustment portion is located near a sole of said golf club head.

4. The forged golf club head of claim 3, wherein said at least one weight adjustment portion is located near a heel portion of said sole of said golf club head.

5. The forged golf club head of claim 3, wherein said at least one weight adjustment portion is located near a toe portion of said sole of said golf club head.

6. The forged golf club head of claim 1, wherein said first material has a first flow stress at a first forging temperature, and the said second material has a second flow stress at a second forging temperature;

wherein said first flow stress and said second flow stress are substantially similar to one another, and

wherein said first forging temperature and said second forging temperature being substantially similar to one another.

7. The forged golf club head of claim 6, wherein said first flow stress and said second flow stress are different from one another.

8. The forged golf club head of claim 6, wherein said first flow stress is about 10 ksi and said first forging temperature is about 1,200° C.; and said second flow stress is about 10 ksi and said second forging temperature is about 1,100° C.

9. The forged golf club head of claim 1, wherein said first material has a first thermal expansion coefficient, and the second material has a second thermal expansion coefficient; wherein said first expansion coefficient is greater than or equal to said second thermal expansion coefficient.

**10.** The forged golf club head of claim **9**, wherein said first thermal expansion coefficient is about  $8.0 \mu\text{in}/\text{in } ^\circ\text{F}$ ., and said second thermal expansion coefficient is about  $6.1 \mu\text{in}/\text{in } ^\circ\text{F}$ .

**11.** A method of forging a golf club head comprising:  
creating a cylindrical billet made out of a first material;  
machining one or more cavities within said cylindrical billet;

partially filling in said one or more cavities with a second material to create a weight adjustment portion;

filling in the remaining volume of said one or more cavities with said first material to encase said weight adjustment portion; and

forging said cylindrical billet to create a body portion of said golf club head,

wherein said body portion monolithically encases said weight adjustment portion within a body of said golf club head without any secondary attachment operations.

**12.** The method of forging a golf club head of claim **11**, wherein an interface between said body portion and said at least one weight adjustment portion creates an irregular interface.

**13.** The method of forging a golf club head of claim **11**, wherein said first material has a first flow stress at a first forging temperature, and the said second material has a second flow stress at a second forging temperature;

wherein said first flow stress and said second flow stress are substantially similar to one another, and

wherein said first forging temperature and said second forging temperature being substantially similar to one another.

**14.** The method of forging a golf club head of claim **13**, wherein said first flow stress and said second flow stress are different from one another.

**15.** The method of forging a golf club head of claim **13**, wherein said first flow stress is about 10 ksi and said first forging temperature is about  $1,200^\circ\text{C}$ .; and said second flow stress is about 10 ksi and said second forging temperature is about  $1,100^\circ\text{C}$ .

**16.** The method of forging a golf club head of claim **11**, wherein said first material has a first thermal expansion coefficient, and the second material has a second thermal expansion coefficient;

wherein said first expansion coefficient is greater than or equal to said second thermal expansion coefficient.

**17.** The method of forging a golf club head of claim **16**, wherein said first thermal expansion coefficient is about  $8.0 \mu\text{in}/\text{in } ^\circ\text{F}$ ., and said second thermal expansion coefficient is about  $6.1 \mu\text{in}/\text{in } ^\circ\text{F}$ .

**18.** A forged golf club head comprising:

a body portion having a striking surface made out of a first material; and

at least one weight adjustment portion made out of a second material encased within said body portion;

wherein said at least one weight adjustment portion is encased monolithically within said body portion without any secondary attachment operations;

wherein said first material has a first flow stress at a first forging temperature, and the said second material has a second flow stress at a second forging temperature;

said first flow stress and said second flow stress are substantially similar to one another, and

said first forging temperature and said second forging temperature being substantially similar to one another; and

wherein said first material has a first thermal expansion coefficient, and the second material has a second thermal expansion coefficient;

said first expansion coefficient is greater than or equal to said second thermal expansion coefficient.

**19.** The forged golf club head of claim **18**, wherein an interface between said body portion and said at least one weight adjustment portion creates an irregular interface.

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