GOLF CLUB WITH VIBRATION DAMPENING POCKET

Inventor: Thomas O. Bennett, Carlsbad, CA (US)

Correspondence Address:
HANIFY & KING PROFESSIONAL CORPORATION
1055 Thomas Jefferson Street, NW, Suite 400
WASHINGTON, DC 20007 (US)

Assignee: Acushnet Company

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ABSTRACT

A golf club head is disclosed. The golf club head has a body member and a face insert formed of different materials. The body material is relatively soft and ductile to allow the club to be customized, and the face insert member is relatively hard and wear resistant to ensure that the face groove geometry remains substantially unaltered through use. A bimetallic face insert may be used. The outer layer is hard and wear resistant, and the inner layer is softer and may include copper. The outer layer is thin, and the inner layer may be seen in the bottoms of the face grooves. A cavity may be provided underneath the face insert. This cavity may be either empty or filled, such as with a dampening member or a weight member.
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CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of U.S. patent application Ser. No. 10/639,632 filed on Aug. 13, 2003, now pending, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention
[0003] The present invention relates to a golf club head. In particular, the present invention relates to a golf club head having a body member and a face insert formed of different materials. More particularly, the present invention relates to a golf club head that allows for customization and provides adequate face wear resistance.

[0004] 2. Description of the Related Art
[0005] Golf clubs are typically fabricated having standard values for lie angle, loft angle, face offset, etc. Individual golfers, however, typically require clubs having different dimensions than the standard values. To customize these clubs, the hosel portion, which is a socket in the club head into which the shaft is inserted, is typically bent to change the standard dimensions of the club head. This need for club manipulation requires that the club head be formed of a relatively soft, malleable material.

[0006] The club head face, which strikes the golf ball during use, typically has grooves formed therein. These grooves grip the golf ball and impart spin thereto. This spinning enhances the aerodynamic effect of the golf ball dimples, and allows a skilled golfer to control the flight profile of the ball while airborne and the behavior of the ball after landing. Normally through regular use, the golf club face, including the grooves, experiences significant wear. This wearing away or erosion of the club head face is exaggerated and promoted by the soft material required for club head customization, and results in the groove volume decreasing and the groove edges becoming rounded. Since groove design is critical for ensuring proper spin is imparted to the golf ball, changes in groove geometry result in degraded performance.

[0007] Past attempts to improve the imparted ball spin or to improve face wear have included adding a coating to the club face. These coatings preserve surface roughness as they wear away. However, the coatings do not reduce the material wear from the face surface. Some tend to wear away relatively quickly through normal use, leaving the club head material exposed. Once exposed, the club head face material wears away and performance is compromised. Other attempts to reduce wear have included forming the entire club head of a wear-resistant material, such as a chrome plating. While these clubs are better at resisting face wear, they have the undesirable effect of effectively preventing club customization, since wear-resistant materials tend to have very low ductility and malleability.

[0008] Thus, what is needed is an improved golf club head that allows for customization and provides adequate face wear resistance and provides an improved touch and feel.

SUMMARY OF THE INVENTION

[0009] The golf club head of the present invention includes a body comprising a first material and an insert comprising a second material. The first material is softer than the second material. The golf club head includes a sole. The sole material is harder than the body material, and the sole material is preferably the same as the insert material. The golf club head is preferably for an iron-type golf club.

[0010] The second material preferably has a wear resistance from approximately 40 to 0. More preferably, the second material has a wear resistance of approximately 35 to 0. The first material preferably has an elongation of greater than approximately 13%, and an ultimate elongation of approximately 15% to approximately 21%.

[0011] The insert preferably includes a strike face having grooves therein. The grooves have a width. The width changes less than approximately 40% upon blast testing. More preferably, the width changes less than approximately 30% upon blast testing, and still more preferably less than approximately 25% upon blast testing.

[0012] The first material preferably has a Rockwell C hardness of at most approximately 30. The second material preferably has a Rockwell C hardness of approximately 50 to approximately 55.

[0013] The first and second materials may be steels. The second material may preferably include approximately 1.40% to approximately 1.75% carbon and approximately 10.0% to approximately 18.0% chromium. More preferably, the second material includes approximately 1.50% to approximately 1.65% carbon and approximately 15.5% to approximately 16.5% chromium. Alternatively, the second material preferably comprises a ratio of percentage chromium to percentage carbon from approximately 10:1 to approximately 11:1.

[0014] The insert is positioned within a first cavity on the club head body, preferably in a face region thereof. A second cavity may optionally be provided within the first cavity. This second cavity, which alters the club head center of gravity location and increases the club head moments of inertia, providing a larger sweet spot and increasing the forgiveness of the club head, can either be left empty to create an enclosed volume within the second cavity or have a second insert positioned therein. This second insert may be any desirable type of insert, such as a weight member or a dampening member.

DESCRIPTION OF THE DRAWINGS

[0015] The present invention is described with reference to the accompanying drawings, in which like reference characters reference like elements, and wherein:

[0016] FIG. 1 illustrates a golf club head of the present invention;
[0017] FIG. 2 illustrates a blast test configuration;
[0018] FIG. 3 shows a side view of a groove of a known golf club before blast testing;
[0019] FIG. 4 shows the groove of FIG. 3 after blast testing;
[0020] FIG. 5 shows a cross-sectional view through another golf club head of the present invention;
[0021] FIG. 5A shows a detailed view of region A of the club head of FIG. 5;
[0022] FIG. 6 shows another golf club head of the present invention; and
FIG. 7 shows a rear view of the golf club head of FIG. 6.

DETAILED DESCRIPTION OF THE INVENTION

Other than in the operating examples, or unless otherwise expressly specified, all of the numerical ranges, amounts, values and percentages such as those for amounts of materials, moments of inertia, center of gravity locations, loft angles and others in the following portion of the specification may be read as if prefaced by the word “about” even though the term “about” may not expressly appear with the value, amount or range. Accordingly, unless indicated to the contrary, the numerical parameters set forth in the following 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.

Notwithstanding that the numerical ranges and parameters set 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.

FIG. 1 shows a golf club head 1 of the present invention. Golf club head 1 is preferably an iron-type club head, and includes a body 10 having a heel 11, toe 12, crown 13, and sole 14. A hosel 15 is provided in heel 11. A shaft (not shown) is coupled to club head 1 within hosel 15. Club head 1 further includes a strike face 20. The angle between strike face 20 and the ground when club head 1 is placed on a level surface is the loft angle. The vertical elevation of a golf shot is predominantly determined by the loft angle. The angle between the axis of hosel 15 and the longitudinal axis of sole 14 is the lie angle. The horizontal distance between the axis of hosel 15 and a central axis of club head 1, if any, is the club offset.

While golf club heads are typically manufactured having standard values for loft angle, lie angle, offset, and other dimensions, individual golfers often require modification of the club heads to suit their particular swing. For example, a golfer’s swing may require his clubs to have a lie angle 2° greater than the standard value. To obtain the club dimensions required for an individual golfer, club head 1 is customized by altering the standard dimensions. This typically entails locking club head 1 in a vise or like device and bending hosel 15 to obtain the desired values for loft angle, lie angle, offset, etc. To facilitate this manipulation, club head 1 is formed of a first, relatively soft and malleable material.

Strike face 20 is used to contact golf balls during normal use. Strike face 20 includes grooves 22. Grooves 22 grip the golf ball and impart spin thereto. This spin enhances the aerodynamic effect of the golf ball dimples, and allows a skilled golfer to control the flight profile of the ball while airborne and the behavior of the ball after landing. Repeated contacts of strike face 20 through routine use cause it and grooves 22 to wear away. To delay the wearing away of strike face 20 and to help ensure that the geometry of grooves 22 remains unaltered, strike face 20 is formed of a second material that resists wear. If a material is wear-resistant, it tends to be less ductile. Since ductility is desired for the material forming body 10, strike face 20 preferably is an insert that is coupled to body 10. Any known coupling means may be used, with adhesion and brazing being preferred.

The first material is a relatively soft, ductile material, and may be a material typically used to form golf clubs. Iron-type golf clubs are typically manufactured from carbon steel or a relatively soft stainless steel. Preferred carbon steels include 1025, 8620, and S20C, and preferred stainless steels include 431, 303, 410, 403, and 329. Forming body 10 of one of these materials allows for customization of club head 1 to obtain the required dimensions for a user’s individual swing. These materials typically have an elongation of approximately 13% or more, and preferably within the range of approximately 15% to approximately 21%, when tested according to usual standards.

The second material is a wear-resistant material. A convenient method of categorizing and ranking material wear resistance is through ASTM G65, which is entitled “Standard Test Method for Measuring Abrasion Using the Dry Sand/Rubber Wheel Apparatus.” Procedure A, which is a relatively severe test for metallic materials, is the preferred procedure. This test characterizes materials in terms of weight loss under a controlled set of laboratory conditions. A material sample is held against a rubber wheel under a specified force. While the sample is pressed against the wheel, the wheel is rotated at a specified rate of rotation and aggregate material is introduced at a specified flow rate at the wheel-sample contact area. After a specified time has elapsed, the sample is withdrawn and measured to determine the volume loss. Test results are reported as volume loss in cubic millimeters. Materials of higher abrasion or wear resistance will have a lower volume loss. Thus, a lower wear resistance number indicates better wear resistance. Typical golf club materials include cast stainless steel, which have a wear resistance of about 200, and carbon steels, which have a wear resistance of about 80. The second material of the present invention preferably has a wear resistance of 40 or less, and more preferably has a wear resistance of 35 or less.

During development of the present invention, several clubs were subjected to blast testing. FIG. 2 illustrates the blast test configuration. A club head 100 was positioned and held in place with its face 102 being substantially vertical, or substantially perpendicular to a horizontal axis A1. Aggregate material was impacted against face 102 along a flow path FP at an angle α1 relative to horizontal axis A1. A Zero model Pulsar III blast cabinet from Cleemo Industries of Washington, Mo. was used for the tests. The machine was operated according to standard operating procedures using a quarter inch nozzle and an aggregate feed rate of 3.12 cubic feet per hour. Silica glass beads were used as the aggregate, and the blast pressure was 60 psi. The blast angle α was 20°, making a 70° angle of impact relative to face 102. The duration of the blast tests was 40 minutes. The groove width prior to and after blasting was measured.

The first club tested was a Vokey wedge with a raw finish. The Vokey wedge is formed from an 8620 carbon steel without a protective chrome finish. Drawing figures showing pre-blast and post-blast groove profiles for the Vokey wedge are provided for illustrative purposes. FIG. 3 shows a side view of a groove 50 of a Vokey wedge prior to blast testing.
The image has been magnified 80 times. Groove 50 has uniform dimensions and is generally U-shaped. A line F corresponding to the plane of the club face is shown for illustrative purposes. The width of groove 50 is 0.045". FIG. 4 shows a side view of groove 50 of the Vokey wedge after blast testing. Groove 50 has been enlarged considerably, especially at the groove-face transition, which is the portion of a groove that contacts and grips a golf ball during use. Groove 50 has a post-blast width of 0.082", an 82.2% increase.

The second club tested was a Vokey wedge with a chrome finish. This club had a pre-blast groove width of 0.051" and a post-blast groove width of 0.076", a 49.0% change.

The third club tested was a Ping wedge. The Ping wedge is formed from a typical 17-4PH stainless steel. This club had a pre-blast groove width of 0.049" and a post-blast groove width of 0.072", a 56.9% change.

The final club tested was a wedge of the present invention. This club had a pre-blast groove width of 0.030" and a post-blast groove width of 0.036", a 20.0% change.

These results are summarized in Table 1 below:

<table>
<thead>
<tr>
<th>Club</th>
<th>Pre-blast width (in.)</th>
<th>Post-blast width (in.)</th>
<th>Percent change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vokey wedge - raw finish</td>
<td>0.045</td>
<td>0.082</td>
<td>82.2%</td>
</tr>
<tr>
<td>Vokey wedge - chrome finish</td>
<td>0.051</td>
<td>0.076</td>
<td>49.0%</td>
</tr>
<tr>
<td>Ping wedge</td>
<td>0.049</td>
<td>0.072</td>
<td>56.9%</td>
</tr>
<tr>
<td>Present invention</td>
<td>0.030</td>
<td>0.036</td>
<td>20.0%</td>
</tr>
</tbody>
</table>

The grooves 22 of club head 1 of the present invention preferably have a change in width of less than approximately 40% upon blast testing. More preferably, grooves 22 have a change in width of less than approximately 30% upon blast testing. Still more preferably, grooves 22 have a change in width of less than approximately 25% upon blast testing.

During development of the present invention, a correlation between wear resistance and material hardness was discovered. A preferred material for the second material is disclosed in U.S. Pat. No. 5,370,750 to Novotny et al., which is incorporated herein by reference in its entirety. Novotny discloses a material exhibiting a preferred combination of hardness and corrosion resistance.

Novotny discloses that its unique hardness and corrosion resistance result predominantly from its controlled proportions of carbon and chromium. Carbon contributes to the high hardness, so at least about 1.40%, and more preferably at least about 1.50%, carbon is present. Too much carbon adversely affects the corrosion resistance, so more than about 1.75%, preferably not more than about 1.65%, carbon is present. For best results, the material contains about 1.58%-1.63% carbon. At least about 13.5%, preferably at least about 15.5%, chromium is present to benefit the corrosion resistance. Too much chromium adversely affects the hardness and restricts the solution treatment temperature to an undesirable narrow range, so not more than about 18.0%, preferably not more than about 16.5%, chromium is present. A summary of the preferred face composition is provided in Table 2, which was copied from table 1 of the Novotny reference.

The balance of the alloy is essentially iron, apart from the usual impurities.

Thus, the second material preferably includes approximately 1.40% to approximately 1.75% carbon and approximately 10.0% to approximately 18.0% chromium. More preferably, the second material includes approximately 1.50% to approximately 1.65% carbon and approximately 15.5% to approximately 16.5% chromium.

The carbon and chromium composition may also be expressed as a ratio. Per Novotny, the second material preferably comprises a ratio of percentage chromium to percentage carbon from approximately 10:1 to approximately 11:1. All percentages discussed herein are weight percentages.

As stated above, wear resistance has a correlation to material hardness. Thus, another way to categorize the first and second materials is by their absolute and relative hardneses. The first material is harder than the second material.

This relationship provides the needed face wear resistance while allowing club head customization to accommodate a golfer's unique swing. This relationship is opposite from most clubs with face inserts, which provide a softer face and a harder body.

Through testing, it was determined that a second material having a Rockwell C hardness of about 40 or greater would provide adequate face wear resistance. More preferably, face insert 20 has a Rockwell C hardness of about 50 to about 55. To allow for workability, the first material preferably has a Rockwell C hardness of about 30 or less.

Since sole 14 impacts the ground during normal use, it also experiences wear. Club head 1 may preferably include a sole insert 30 comprised of a third material. The third material is harder than the first material. The third material exhibits similar wear resistant properties and compositions as discussed above with respect to the second material. The third material may be substantially the same as the second material, or it may be different.

The strike face insert 20 may preferably include an outer metallic material and an inner metallic material coupled together. The two metallic materials may be joined together in any desired fashion. Braising, which is useful in joining materials that are not easily welded together, being a preferred method. Other exemplary methods include press-fitting and welding, and more than one method may be used. The outer material is harder than the inner material, as described above. In relative terms, the outer metallic material preferably has a Rockwell C hardness of greater than or equal to approximately 45, and the body 10 preferably has a Rockwell C hardness of less than or equal to approximately 25. The inner metallic material preferably includes copper, brass, iron, lead, bismuth, or aluminum, and preferably has a Rockwell C hardness of...
hardness of less than or equal to approximately 45, more preferably from 10 to 45. Alternatively, the inner metallic material preferably may have a Rockwell C hardness of less than or equal to approximately 25. Providing a hard outer layer and an inner layer including a softer metallic material such as copper or a copper alloy simultaneously provides the wear resistance discussed above and a soft feel to the club, which improves its playability. Additional information regarding multilayer face inserts is disclosed in U.S. Pat. No. 6,743,117, which is incorporated herein by reference in its entirety. The outer metallic material preferably has a wear resistance from approximately 40 to 0, and the inner metallic material preferably has a wear resistance greater than 40.

[0046] FIG. 5A shows a detailed view of region A of club head 4. A club head 4 includes a strike face 20 and a body 10 with strike face 20 having an outer layer 60 and an inner layer 62. Grooves 22 are provided in club head 4. As shown in FIG. 5A, grooves 22 have a depth that is the same or greater than the thickness of outer layer 60. Inner layer 62 preferably includes copper, brass, iron, lead, bismuth, or aluminum. Thus, inner and outer layers 60, 62 preferably are of differing colors, and inner layer 62 is visible in grooves 22, resulting in a golf club with a unique appearance. Using copper within inner layer 62 also has the benefit of maintaining or improving groove performance through the life of the club. Since copper is relatively soft and malleable, it will wear more quickly than steel, and grooves 22 may likely improve with the age of the club.

[0047] The inner layer 62 may extend from sole 14 to crown or top line 13. Since the color differentiation mentioned above may be distracting to some golfers while addressing a ball during play, inner layer 62 preferably does not extend all the way to crown or top line 13.

[0048] The United States Golf Association places limitations on golf club configurations and dimensions. One of these limitations is that the maximum depth of a groove is 0.020 inch (approximately 0.5 mm). The maximum depth of grooves 22 preferably is 0.02 inch, and the thickness of outer layer 60 preferably is less than or equal to 0.02 inch. Inner layer 62 preferably has a thickness that is in the range between 0.005 inch to 0.025 inch, and more preferably is about 0.01 inch. Using metric units, the maximum depth of grooves 22 preferably is 0.5 mm, and the thickness of outer layer 60 preferably is less than or equal to 1 mm, and more preferably less than or equal to 0.5 mm. Inner layer 62 preferably has a thickness that is in the range between 0.1 mm to 0.64 mm, and more preferably is about 0.25 mm.

[0049] FIG. 6 shows another golf club head 2 of the present invention. Golf club head 2 is similar to golf club head 1, but has been modified to include a second cavity. Like club head 1, club head 2 contains a body 10 defining a front surface 40, a crown or top line 13, a sole 14, a back 15, a heel 11, and a toe 12. Front surface 40 includes a first cavity 42 between heel 11 and toe 12 into which face insert 20 is positioned. First cavity 42 includes a surface 43 that is stepped-down from front surface 40. Face insert 20 includes a striking surface including to body 10 by positioning it within first cavity 42. When so positioned, at least a portion of the attachment surface contacts the first cavity surface 43.

[0050] Insert 20 may be coupled to body 10 in any desired fashion. Exemplary methods of coupling include press-fitting, welding, and braising. More than one coupling method may also be used to retain insert 20 within first cavity 42. [0051] Club head 2 further includes a second cavity 44 located within first cavity 42. Second cavity 44 may be formed during the manufacturing of club head 2, or it may be formed as a secondary step, such as by milling. Second cavity 44 includes a surface 45 that is stepped-down from first cavity surface 43. Second cavity 44 removes material from the central portion of the club head, inherently providing more of the club head mass towards the perimeter of the club head.

[0052] When face insert 20 is positioned within first cavity 42, insert 20 and body 10 create an enclosed volume within second cavity 44. This enclosed volume acts to improve the touch and feel of the club.

[0053] To further improve the feel of the club, an insert may be positioned within second cavity 44. This second insert may be any desirable type of insert, such as a weight member or a dampening member. Use of a dampening member is useful to diminish vibrations in club head 2, such as those generated during an off-center hit, and enhances feel and performance of the club. Preferred dampening materials include elastomers, polymers, ionomers, soft metals, foam, and movable media. Exemplary moveable media include sand, brass balls, etc. A combination of dampening materials may also be used.

[0054] The second insert may be placed within second cavity 44 prior to coupling face insert 20 to body 10. Alternatively, the second insert may be added afterward. If added afterward, body 10 preferably is provided with at least one hole 46 therethrough from back 15 to second cavity 44. FIG. 7 shows a rear view of club head 2. Two holes 46 are shown in the figures. Dampening material can be injected through holes 46 into second cavity 44. After injecting the dampening material, holes 46 can be plugged, with the dampening material or with another material or object, or left open.

[0055] While the preferred embodiments of the present invention have been described above, it should be understood that they have been presented by way of example only, and not of limitation. It will be apparent to persons skilled in the relevant art that various changes in form and detail can be made therein without departing from the spirit and scope of the invention. Aspects described as being provided in different golf club heads can be also be combined and provided in a single golf club head. Thus the present invention should not be limited by the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

1.27. (canceled)
28. A golf club head, comprising:
   a body defining a front surface, a top line, a sole, a back, a heel, and a toe, and comprising a first cavity located in the front surface between the heel and the toe;
   an insert positioned within the first cavity, wherein the insert comprises an outer metallic material and an inner metallic material coupled together, wherein the outer metallic material is harder than the inner metallic material, wherein the inner metallic material comprises copper, wherein the insert comprises grooves formed in the outer metallic material and extending into the inner metallic material, wherein the grooves have a width that changes less than approximately 40% upon blasting testing, and wherein the outer metallic material has a thickness less than approximately 0.5 mm; and
   a second cavity located within the first cavity.
29. The golf club head of claim 28, further comprising a second insert positioned within the second cavity.
30. The golf club head of claim 29, wherein the second insert is selected from the group consisting of an elastomer, a polymer, an ionomer, a foam, a movable media, and combinations thereof.

31. The golf club head of claim 28, wherein the body includes at least one hole in the back of the club head to the second cavity.

32. The golf club head of claim 28, further comprising a sole insert coupled to the body.

33. The golf club head of claim 28, wherein the body is formed of a material that is softer than the outer metallic material.

34. A golf club head, comprising:
   a body defining a front surface, a top line, a sole, a back, a heel, and a toe, and comprising:
   a first cavity located in the front surface between the heel and the toe;
   an insert positioned within the first cavity;
   a second cavity located within the first cavity; and
   at least one hole in the back of the club head extending to the second cavity.

35. The golf club head of claim 34, wherein the second cavity comprises an injectable dampening material.

36. The golf club head of claim 35, wherein the dampening material comprises an elastomer.

37. The golf club head of claim 34, wherein the insert comprises an outer metallic material and an inner metallic material coupled together.

38. The golf club head of claim 37, wherein the insert further comprises grooves formed in the outer metallic material that extend into the inner metallic material.

39. The golf club head of claim 34, wherein the at least one hole comprises a first material.

40. The golf club head of claim 39, wherein the second cavity comprises a second material.

41. The golf club head of claim 40, wherein the second material is different from the first material.

42. The golf club head of claim 40, wherein the first and second materials are the same.

43. A golf club head, comprising:
   a body defining a front surface, a top line, a sole, a back, a heel, and a toe, and comprising a first cavity located in the front surface between the heel and the toe, wherein the body is formed of a first material;
   an insert positioned within the first cavity, wherein the insert comprises a second material, wherein the second material is metallic and harder than the first material, wherein the insert comprises grooves formed in the second material, wherein the grooves have a width that changes less than approximately 40% upon blast testing, and wherein the second material has a thickness less than approximately 0.5 mm;
   a second cavity located within the first cavity; and
   at least one hole in the back of the club head extending to the second cavity.

44. The golf club head of claim 43, wherein the second cavity is smaller than the first cavity.

45. The golf club head of claim 43, wherein the body and the insert create an enclosed volume within the second cavity.

46. The golf club head of claim 45, wherein the enclosed volume is filled with an injectable dampening material.

47. The golf club head of claim 46, wherein the injectable dampening material is an elastomer.

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