(54) Title: HIGH DAMPING CAPACITY METAL STRIKING FACE FOR GOLF CLUBS

(57) Abstract

This invention is a golf club ball striking (6, 40) utilizing a metal with ten times or higher damping capacity compared to the steels presently in use for club faces. The metal has the strength near that of the steels. The preferred metal is of the class of shape memory metals of alloys including copper, nickel, aluminum, and manganese. The face is an insert plate (2, 42) secured into a cavity (12, 22, 46) formed in the club head where the plate (2, 42) may extend to nearly the entire thickness of the club head.
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HIGH DAMPING CAPACITY METAL STRIKING FACE
FOR GOLF CLUBS

FIELD OF THE INVENTION

The present invention relates generally to the material that forms the ball striking surface or face for gold clubs. More specifically, the present invention relates to inserts built into the face of golf clubs to provide better feel, better control and equal or better distance than the steel faces commonly used for golf club faces.

BACKGROUND OF THE INVENTION

Over the years there has been a search for golf clubs that hit the ball farther with more control and with more "feel". However, the ability to invent and apply new materials and technology to golf clubs has been limited by the golf rules as specified by the United States Golf Association (USGA). Within these rules, however, technology has entered the golf club world with inventive size and weight distribution of the club heads. But, recent changes in the USGA rules allow the use of different facing materials inserted into the body of the golf club head. The present invention is directed to this area of development.

Technical articles analyzing the performance of the face have suggested that the best materials were those having high elasticity and low damping capacity. One such article is a research report, entitled
"Advanced Materials to the Fore", by S.K. Liu, published in the November 1993 issue of the MRS BULLETIN. In the third column of the first page, Liu states that "the characteristics needed for a club head material to produce greater ball velocity and flight distance are high elasticity and low damping capacity." Liu in his Figure 3 lists twenty-four materials on a chart of material strength versus damping capacity. Liu discusses other important factors of elasticity, surface hardness and density (weight is controlled by the USGA golf rules), and Liu goes on to analyze composites, etc., but Liu predicts that the titanium alloys will be the popular choice for high performance club facings.

Among the twenty-four materials considered by Liu are metallic composites of manganese-copper, copper-aluminum-nickel, and copper-zinc-aluminum. These materials, according to Liu, would make poor golf club faces since these materials have high damping factors. In fact, these materials have higher damping factors than twenty of the other materials in Liu's analysis - and these materials have about 200-plus times the damping capacity of the titanium materials favored by Liu.

Liu states that the high internal damping capacity would reduce the distance achieved since the energy stored in the club head as the face elastically deforms as the face impacts the ball will be absorbed in the club head (and not returned to the ball) due to this high internal damping capacity.

It is an object of the present invention to provide a golf club face material with high damping capacity that provides better "feel" and control without a significant loss of distance.
SUMMARY OF THE INVENTION

In accordance with the present invention a golf club face comprising a shape memory metal is employed, where the shape memory metal has from 10 to 250 times the damping capacity compared to the steels commonly used for club head face. In a preferred embodiment the shape memory metal is formed from the copper alloys including zinc, aluminum, manganese, and combination thereof, 40-50% nickel/titanium alloys with or without small additions, less than ten percent (10%), of other metals and other such known shape memory alloys. It was found that such materials provided advantages in the "feel" and control of the club when striking the ball without a substantial distance penalty. Indeed the distance was retained or even improved upon with clubs (irons) made in accordance with the present invention, especially the irons. It is well known that "feel" and control contribute to the accuracy and precision of the irons, and that distance achieved with the irons is of a much lower priority compared to the driver or the other "woods".

In a preferred embodiment a golf club head comprises a body and a shape memory metal insert constructed into the body to provide the face. In a preferred embodiment the insert is a four sided plate, with a face and a back surface, with a bottom edge constructed to substantially follow the bottom edge of the club face, a top edge constructed to substantially follow the top edge of the club face, and where the two opposing side edges are beveled such that the insert face is narrower than the corresponding back surface, at least at some locations, and where the club head
body has a cutout or pocket formed to accept the insert where the cutout has mating beveled edges constructed to form an interference fit with the insert beveled edges such that the insert is retained in the cutout. In another preferred embodiment the insert and cutout have mating tongue and groove edges such that the insert is retained in the cutout.

In a preferred embodiment the two opposing side edges are wedge-shaped or are closer to each other at the top of the club face than at the bottom of the club face.

In another preferred embodiment, the plate thickness may be thin and of non-uniform thickness. But, in another preferred embodiment, the plate extends to substantially the entire club head thickness - allowing for the construction integrity of the particular club head.

In any of these embodiments, the insert may be attached to the club head body with an adhesive and/or screws/rivets or braze.

Other objects, features and advantages will be apparent from the following detailed description of preferred embodiments thereof taken in conjunction with the accompanying drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is a front, side and bottom view of an insert made in accordance with the present invention for an iron.

FIG. 1B is a bottom view of a tongue and groove edge insert made in accordance with the present invention for an iron.
Fig. 2A is a front view of a club face with an insert. Fig. 2B is a bottom view of the club head of Fig. 2A showing the cut-out profile for the insert. Fig. 3A is a front view of a club face with an insert of another preferred embodiment. Fig. 3B is a top view showing the cut-out profile. Fig. 4 is a graph of strength versus damping capacity of golf club face materials. Fig. 5A is a front view of another preferred embodiment showing the club face. Figs. 5B-D are cross sectional views showing different stages of making the club head of the present invention which is shown in Fig. 5A.

Detailed description of Preferred Embodiments

Fig. 1A shows an insert 2 that substantially follows the contours of a golf club iron. The insert is beveled 4 on all sides except the top. The bevel 4 is directed such that the face 6 is narrower than the back 8 of the insert. The bevel is provided such that when the insert is mounted into the club head mating cutout or pocket, the insert will be retained securely in the club head even during the violent swings encountered while playing golf. The bevel is at 45 degrees and extends around the bottom and the two sides adjacent to the bottom edge. The insert is a plate of 0.90 to 0.93 inches thick. In other preferred embodiments the insert is 0.010 inches thick, and in other preferred embodiments the insert is thicker and not of uniform thickness. Fig. 1B shows another preferred embodiment of the insert. Here the tongue 9 is formed on each side of the insert to hold the insert in a corresponding groove in the club face.
The club face 6 has grooves 10 that provide traction when striking the ball and so impart spin to the ball. The grooves may be of any type approved by the USGA rules. A textured finish, rather than grooves, can be used and has been found to provide an effective alternative to grooves.

The spin is a desired occurrence to provide control of where the ball stops. This is very important when using the irons, even more especially when using the short irons (often considered, but not limited to the seven iron through the wedges). This spin allows the golfer to have the ball stop nearly where the ball lands and so the ball does not have to experience the unknown local landing conditions.

FIG. 2A shows a pocket 12 formed in the face of a club head 14. The pocket is formed from the bottom of the club head and extends upwardly. However, the pocket does not extend to the top edge of the club head - there remains a narrow channel 16 between the top of the pocket and the top of the club head. The insert is wedge-shaped and the angle is preferably about two degrees.

Referring to FIG. 2B the pocket has a grooved edge 18 that extends around the three sides (left, right and top) of the pocket. The groove 18 is arranged to matingly accept the tongue 9 of an insert. The insert will be secured within the club head by cement, epoxy or such cements as are known in the art. In another preferred embodiment, the beveled edge of FIG. 1A is used.

FIG. 3A shows another club head 20 with a channel 22 that extends from the top to the bottom of the club head. In this instance, the insert forms part of the bottom and top edge of the club face. Grooved edges 24
retain the insert in the club head. The insert, from side to side, forms a wedge shape with the top edge slightly longer than the bottom edge - the angle shown is preferably about two degrees. Other preferred embodiments may use other angles.

Other preferred embodiments, not shown, have the shape metal forming a sleeve permanently encasing the club head face where the shape metal forms substantially the entire club face. Yet other preferred embodiments have pockets that extend from the top of the club face down but not through the bottom of the club face.

Shape memory metals demonstrate a martensitic transformation shape memory effect where the metal will "remember" and return to a former shape under certain known conditions. Such metals are well documented in the art.

In preferred embodiments the shape metal is selected from copper alloys. Particular copper alloys are those including aluminum, manganese and nickel, but other such metals are used in other preferred alloy embodiments. A copper, aluminum and nickel alloy has been found to be particularly useful. Also, a nickel, titanium alloy could be used, as could Beta Titanium (Titanium-Molybdenum-Aluminum, Titanium-Vanadium-Aluminum and Titanium-Niobium-Aluminum) and another is Copper-Zinc-Aluminum.

Specific examples of such alloys (out of the many which are possible and would be within the scope of the present invention) are:

a copper-aluminum-nickel is:

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<td>Ni</td>
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Cu balance
another alloy is:
Al 12.00 wt %
Ni 5.0 wt %
Mn 2.0 wt %
Ti 1.0 wt %
Cu balance
a nickel-titanium alloy is:
Ni 56.0 wt %
Ti balance
a beta titanium alloy is:
Mo 10.2 wt %
Nb 3.7 wt %
V 1.8 wt %
Al 2.8 wt
Ti balance

These metals are strong enough such that the faces are not permanently deformed by use, but these metals also provide a high internal damping with "feel" and control. Such damping capacities are from 10 to 300, and preferably from 100 to 200, times higher than the steels commonly used in golf club face. Although Liu indicated that such high damping will limit the distance achieved with such a club face material, it has been found that the distance is not limited, but, in fact, is often increased. It may be that such increases in distance is a result of the golfer's increased confidence due to the feel and control achieved with the present invention.

FIG. 4 is a graph of materials considered for golf club face materials. The strength and low damping materials are shown in the lower right areas 30. Metals with similar strength as those metals in area 30 but with 200 to 300 times higher damping capacity
are shown in upper right area 32. These materials are the shape memory metals of the present invention, but other such metals with characteristics in this area may be used to advantage. However, the surface hardness, density, and modulus of elasticity must be factored into the use of such materials.

FIG. 5A is a front view of a golf club face 40. An insert 42 covers the hitting area and the body of the club 44 forms a margin around the insert. FIG. 5B shows the body 44 as a casting in a preferred embodiment, although forged and machined club bodies can be used. The body 44 has a cavity 46 into which the insert 42 is placed. Ears 46 extend out from the club face as shown and the inserts have grooves 50 designed to receive the ears. The ears are swaged over into the grooves as shown in FIG. 5C. The rough edges are finished to form a smooth club face as shown in FIG. 5D.

It will now be apparent to those skilled in the art that other embodiments, improvements, details and uses can be made consistent with the letter and spirit of the foregoing disclosure and within the scope of this patent, which is limited only by the following claims, construed in accordance with the patent law, including the doctrine of equivalents.
CLAIMS

What is claimed is:

1. A golf club face material comprising a metal which is a shape memory alloy having a damping capacity of at least ten times that of steel.

2. A golf club face material as defined in claim 1 wherein said metal is selected from the group consisting of copper alloys.

3. A golf club face material as defined in claim 2 wherein said copper alloys are selected from the group consisting of copper-zinc alloy, manganese-copper alloy, copper-aluminum alloy, and copper-aluminum-zinc alloy.

4. A golf club face material as defined in claim 1 wherein said metal is selected from the group consisting of nickel-titanium alloy, beta titanium alloy and copper-zinc-aluminum alloy.

5. A golf club head comprising a body and an insert constructed into said head to provide the striking surface, and wherein the face material comprises a shape memory metal alloy having a damping capacity of at least ten times that of stainless steel.

6. A golf club head as defined in claim 5 wherein said insert comprises a four sided plate, with a striking surface and a back surface, with a bottom edge constructed to substantially follow the bottom edge of the club face, a top edge constructed to substantially
follow the top edge of the club face, and where the two opposing side edges are beveled such that the insert face is narrower than the corresponding back surface, and where the club head body has a cutout or pocket formed to accept the insert where the cutout has matingly beveled edges constructed to form an interference fit with the insert beveled edges such that the insert is retained in the cutout.

7. A golf club head as defined in claim 6 wherein the two opposing side edges are closer to each other at some position toward the bottom of the club face than at the top of the club face.

8. An insert as defined in claim 6 wherein the insert plate thickness is more than about 0.010 inch thick.

9. A golf club head comprising: a body having an insert which provides the striking surface made of a material which includes a shape memory metal alloy having a damping capacity of at least ten times that of stainless steel, the insert comprising a four sided plate, with a striking surface and a back surface, with a bottom edge constructed to substantially follow the bottom edge of the club face, a top edge constructed to substantially follow the top edge of the club face, and where the two opposing side edges are beveled such that the insert face is narrower than the corresponding back surface, and the insert plate thickness comprising substantially the entire thickness of the club head.

10. An insert as defined in claim 6 wherein the damping capacity is from about 10 to about 300 times
higher than that of stainless steel commonly used in club heads
FIG. 4
FIG. 5A

FIG. 5B
AS CAST BODY
(1.)ASSEMBLED

FIG. 5C
INSERT
(2.)SWAGED

FIG. 5D
(3.)FINISHED

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>JP 59-228875 A (SUMITOMO ELEC IND KK) 22 December 1984, abstract.</td>
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<td>X</td>
<td>US 5,261,663 A (ANDERSON) 16 November 1993, col. 2, lines 45-50.</td>
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<td>US 5,221,087 A (FENTON et al) 22 June 1993, Fig. 1.</td>
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- Further documents are listed in the continuation of Box C.
- See patent family annex.

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