The present invention discloses an iron-type golf club head having a face insert composed of a metal injection molded material. The face insert having a plurality of grooves disposed therein.
METAL INJECTION MOLDED GROOVED FACE INSERT

CROSS REFERENCES TO RELATED APPLICATIONS


STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not Applicable

BACKGROUND OF THE INVENTION

[0003] 1. Field of the Invention

[0004] The present invention relates to iron-type golf clubs heads with face inserts. More specifically, the present invention relates to iron-type golf clubs heads with metal injection molded face inserts.

[0005] 2. Description of the Related Art

[0006] Present day golf clubs are typically composed of titanium or steel, and either cast or forged. Various patents have disclosed the use of multiple material golf club heads, generally combining a metal with a non-metal. Various patents have also disclosed the use of metal injection molding for golf clubs.

[0007] Sanford et al., U.S. Pat. No. 5,665,014, for a Metal Golf Club Head And Method Of Manufacture, discloses a golf club head with two components with at least one of the components composed of a metal injection molded material.

[0008] Gressel et al., U.S. Pat. No. 6,478,842, for a Preparation Of Articles Using Metal Injection Molding, discloses an entire golf club head composed of a metal injection molded material having a stainless steel and tungsten alloy composition.

[0009] Gressel et al., U.S. Pat. No. 6,669,898, for a Preparation Of Articles Using Metal Injection Molding, discloses forming an entire golf club head composed of a metal injection molded material having a stainless steel and tungsten alloy composition.

[0010] Zhang et al., U.S. Pat. No. 6,767,418, for a Ti-Zr Type Alloy And Medical Appliance Formed Thereof, discloses a titanium-zirconium alloy that may be used for golf club components.


[0012] LaSalle et al., U.S. Pat. No. 6,322,746, for a Co-Sintering Of Similar Materials, discloses a process of fusing two dissimilar material parts through use of co-sintering including a golf putter.

[0013] Takahashi et al., U.S. Pat. No. 6,027,686, for a Method Of Manufacturing Sintered Compact, discloses sintering a green body formed by metal injection molding.

[0014] LaSalle et al., U.S. Pat. No. 5,989,493, for a Net Shape Hastelloy X Made By Metal Injection Molding Using An Aqueous Binder, discloses metal injecting a Hastelloy X powder.

[0015] Zedalis et al., U.S. Pat. No. 5,985,208, for a Process For Debinding And Sintering Metal Injection Molding Parts Made With An Aqueous Binder, discloses metal injection molding a 17-4PH stainless steel alloy.

[0016] Takahashi et al., U.S. Pat. No. 5,911,102, for a Method Of Manufacturing Sintered Compact, discloses sintering a green body formed by metal injection molding.

[0017] The prior art discloses various methods to manufacture golf club heads, especially iron-type golf club heads. For example, Rogers, U.S. Pat. No. 4,027,885 for Golf Iron Manufacture, discloses scoring grooves into a face for the club head.


[0019] Ribaudo, U.S. Pat. No. 4,529,203, for Golf Club discloses a golf club face having grooves to eliminate the slice or the hook of the golf ball.

[0020] Shin, U.S. Pat. No. 4,768,787, for a Golf Club Including High Friction Striking Face discloses grit blasting the horizontal grooves to provide a friction generating surface when the striking surface of the golf club head engages a ball. The metallic matrix of the golf ball striking face contains hard particles which are harder than the metallic matrix and protrude above the surface.

[0021] Sato, U.S. Pat. No. 5,354,059, for Golf Club Heads With Means For Improving Corrective Action, discloses a club head with at least two non-parallel sets of grooves.

[0022] Doolen, U.S. Pat. No. 6,179,725, for a Golf Club Having Angular Grooves discloses grooves oriented at various angles. The grooves across the golf club face are angled at an angle that is substantially non-parallel with the club sole. All grooves however are sloped in the same direction as one another.

[0023] Hirota, U.S. Pat. No. 6,193,615, for a Head Of Golf Clubs That Spins More, discloses a face having groves that allow for pressure to act specially on the edges of the grooves to increase ball spin.


[0025] Hettinger et al., U.S. Pat. No. 7,452,283, for a Putterhead With Dual Milled Face Pattern, discloses milling grooves into a face of a putter.


[0027] U.S. Patent Application Publication No. 2009/0264217 to Johnson et al., for Golf Club Head Having a Grooved Face, discloses a spin milling or fly cutting method for forming grooves. This manner allows for tighter draft angles, increases the rate of production, and allows for tighter tolerances than casting or forging.

[0028] U.S. Patent Application Publication No. 2009/0247318 to Ban et al., for Golf Club Head, discloses a plurality of striations formed on the face and extending from a toe side to a heel side, where the cross sectional shape of each striation is a triangle asymmetric with regard to the virtual center line in a width direction and the smallest interior angle of the three interior angles of the triangle being placed at the sole side of the golf club head.

[0029] Although these inventions have provided novel methods for forming grooves on the face of the golf club head, the prior art has not optimized groove formation.

[0030] Scoreline designs generally have a cross-section geometry that includes two edges, two side walls and a bottom. The side walls are at a predetermined angle from a vertical line. Usually, each wall has more than one section and
those sections are straight or curved. Alternatively, the score-line design is a “V” shape, in which case there is no bottom other than a vertex or fillet radius.

[0031] Iron-type golf clubs having scorelines with sharp edges and relatively vertical side walls are advantageous to golfers since such sharp edged grooves allow golfers to induce higher levels of spin on a ball struck with such an iron-type golf club having sharp edged grooves. Iron-type golf clubs without sharp edged grooves or essentially vertical side walls will induce less spin when impacting a golf ball, especially higher-lofted (40 degrees +) golf clubs.

[0032] The following requirements apply to apply to the collective set of grooves on any individual club head. Groove width (W) is measured per the USGA 30° method. Less than 50% of groove widths shall be greater than 0.035 inch and no single groove width shall be greater than 0.037 inch. Groove widths shall not vary by more than 0.010 inch from narrowest to widest. Groove depth (D) is measured per the USGA method from adjoining land areas. Less than 50% of groove depths shall be greater than 0.020 inch and no single groove depth shall be greater than 0.022 inch. Groove depths shall not vary by more than 0.010 inch from shallowest to deepest. Groove spacing (S) is measured per the USGA 30° method. Less than 50% of groove spaces shall be less than 0.075 inch or be less than three times the width of the widest amount adjacent groove. No single groove space shall be less than 0.073 inch or be less than three times the width of the widest adjacent groove minus 0.008 inch.

[0033] For heads other than drivers and putters, the area/pitch “AP” is measured per the USGA method from adjoining land areas. Less than 50% of AP values shall be greater than 0.0030 inch and no single AP value shall be greater than 0.0032 inch. For heads having loft equal or greater than 25°, the effective radius “ER” is measured per the USGA 0.0110 inch R circle method. Less than 50% of the grooves shall have more than 10° of effective radius greater than 0.0110 inch and no single groove shall have any amount of effective radius greater than 0.0113 inch.

[0034] Backspin is the primary mechanism by which a golfer can control a golf ball upon landing after being struck. Backspin is especially important for short shots where proximity to the hole is of greater consequence to the golfer. High lofted clubs (50 degrees to 75 degrees) have grooves designs which are meant to interact with the surface of a golf ball at impact and remove debris from the contacting surface in order to increase friction and thereby impart more spin on the ball. Unlike intermediate shafts whose spin can either be increased or decreased with increased friction, the high lofted club will almost always increase spin through increased friction. Traditionally groove designs have focused on increasing the groove area underneath the golf ball at impact.

[0035] Materials and processes typically used in fabrication of golf clubs are not amenable to precision control of a finely detailed groove profile. Forging, forming, casting and machining of metals all have practical limitations with regard to the feature size and profile tolerance that can be accurately and consistently replicated in mass production. Detailed features, tight profile tolerances and steep groove wall angles are not suitable for existing methods of manufacture using conventional materials such as stainless steel, carbon steel, titanium, aluminum and the like.

BRIEF SUMMARY OF THE INVENTION

[0036] An object of the present invention is to accomplish a method of manufacture and design such that grooves can be produced with detailed features, tight profile tolerances and steep groove wall angles on a face insert for an iron or wedge. The advantage in being able to do this is that spin will be enhanced for a variety of shot types and conditions when striking a urethane covered golf ball.

[0037] The present invention consists of using a specific manufacturing process, metal injection molding, “MIM”, to fabricate a face insert having integrally molded grooves. The grooved face plate is made from a metal material, most preferably made via injection molding using a fine particulate formulation of metallic and plastic particles (such as MIM 17-4PH provided by Kinetics) to enhance precise replication of the groove geometry. The groove geometry fabricated using this method can be controlled more precisely which enables increased engagement with the ball during impact, causing increased spin on the ball. The groove geometry is precision machined in a negative tool surface and the MIM material is formed against the tool surface and subsequently sintered to final form.

[0038] The grooved face plate, or insert, is then attached to an iron or wedge that has a matching recess in the face. The attachment is preferably by means of adhesively bonding the back surface and sides of the plate to the recess. Other methods such as pressing, brazing and welding may be used.

[0039] The advantages of using a MIM face insert groove profile include the fact that it can be replicated more consistently, essentially yielding tighter tolerances and allowing the nominal groove geometry to be designed closer to the allowable limits defined by the USGA.

[0040] The edge radii can be formed and controlled more accurately than other processes. Machining, for instance is not suitable for directly forming an edge radius and a less controllable secondary process such as media blasting is required to “break” the edge.

[0041] Steeper side wall angles are producible by MIM whereas other methods of manufacture are limited to side wall angles less than 18 deg.

[0042] One aspect of the present invention is an iron-type golf club head having a body with a recess formed therein. A face insert is disposed within the recess, the face insert being composed using metal injection molding. On the face insert is a plurality of grooves. Each groove preferably has a depth of at least 0.016 inch and each groove of the plurality of grooves is spaced at least 0.073 inch from any other groove of the plurality of grooves.

[0043] The iron-type golf club head has a body preferably composed of stainless steel, titanium alloy, Carpenter steel, or any combination thereof. The face insert is preferably composed of a stainless steel. The face insert has a thickness that preferably ranges from 0.026 inch to 0.125 inch. In one embodiment, the front surface and back surface of the face insert are parallel. However, in another embodiment, the front surface and the back surface of the face insert may be angled not more than 10 degrees such that the thickness at the bottom is greater than the thickness at the top.

[0044] Further, each groove of the plurality of grooves preferably has a width that ranges from 0.021 inch to 0.027 inch. Each groove of the plurality of grooves preferably has a side wall angle that ranges from 0 to 24 degrees. Additionally, each groove of the plurality of grooves has an edge radius that ranges from 0.004 inch to 0.010 inch.

[0045] Having briefly described the present invention, the above and further objects, features and advantages thereof will be recognized by those skilled in the pertinent art from
the following detailed description of the invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0046] FIG. 1 is a perspective view of an iron-type golf club head.
[0047] FIG. 2 is a front view of an iron-type golf club head.
[0048] FIG. 3 is a rear view of an iron-type golf club head.
[0049] FIG. 4 is a top plan view of an iron-type golf club head.
[0050] FIG. 5 is a bottom plan view of an iron-type golf club head.
[0051] FIG. 6 is a side view of an iron-type golf club head.
[0052] FIG. 7 is a side view of an iron-type golf club head.
[0053] FIG. 8 is an isolated and enlarged cross-sectional view of a groove.
[0054] FIG. 9 is an isolated and enlarged cross-sectional view of grooves on a face insert of an iron-type golf club head.
[0055] FIG. 10 is an isolated and enlarged cross-sectional view of the edge radius of a groove.
[0056] FIG. 11 is a cross-sectional view of the grooves on the face insert.
[0057] FIG. 11A is a cross-sectional view of one embodiment of the grooves.
[0058] FIG. 11B is a cross-sectional view of an alternative embodiment of the grooves.
[0059] FIG. 12 is an isolated view of the face insert.
[0060] FIG. 13 is an isolated view of an iron-type golf club head with a recess therein.
[0061] FIG. 14 is a view of the iron-type golf club head and face insert when assembled.
[0062] FIG. 15 is a cross-sectional view of FIG. 14 showing the face insert and body of the iron-type golf club head.
[0063] FIG. 16 is an isolated and enlarged view of the face insert.
[0064] FIG. 17 is an isolated view of a groove.

DETAILED DESCRIPTION OF THE INVENTION

[0065] As shown in the figures, an iron-type golf club is generally designated 20. The golf club head 20 includes a body 21 having a front wall 22 with a recess 23 formed therein. Disposed in the recess 23 is a face insert 24 having a plurality of grooves 25. The body 21 is preferably composed of a material such as titanium materials, stainless steel, car- penter steel, 1020 steel, amorphous metals and the like. The material of the body 21 preferably has a density between 4 g/cm² and 10 g/cm². Such titanium materials include pure titanium and titanium alloys such as 6-4 titanium alloy, 6-22-22 titanium alloy, 4-2 titanium alloy, SP-700 titanium alloy (available from Nippon Steel of Tokyo, Japan), DAT 55G titanium alloy available from Diado Steel of Tokyo, Japan, Ti 10-2-3 Beta-C titanium alloy available from RTI International Metals of Ohio, and the like. The body 21 is preferably manufactured through casting. Alternatively, the body 21 is manufactured through forging, forming, machining, powdered metal forming, metal-injection-molding, electrochemical milling, and the like.

[0066] The face insert 24 is composed using metal injection molding. The face insert has integrally formed grooves 25. The face insert 24 has a planar or multi-planar back surface that is bonded to the recessed portion 23 of the iron-type golf club head 20.

[0067] In general, the moment of inertia, Izz, about the Z-axis for the golf club head 20 preferably ranges from 2200 g-cm² to 3000 g-cm², more preferably from 2400 g-cm² to 2700 g-cm², and most preferably from 2472 g-cm² to 2617 g-cm². The moment of inertia, Iyy, about the Y-axis for the golf club head 20 preferably ranges from 400 g-cm² to 700 g-cm², more preferably from 500 g-cm² to 600 g-cm², and most preferably from 530 g-cm² to 570 g-cm². The moment of inertia, Ixx, about the X-axis for the golf club head 20 preferably ranges from 2450 g-cm² to 3200 g-cm², more preferably from 2500 g-cm² to 2900 g-cm², and most preferably from 2650 g-cm² to 2870 g-cm².

[0068] The face insert is preferably composed of a metal injection molded material. Preferably, the metal injection material comprises stainless steel and preferably has a density ranging from 7.00 grams per cubic centimeters ("g/cc") to 9.00 g/cc, and is most preferably 7.70 g/cc. Metal injection molding powders are commercially available. CATAMOLD materials from BASF is one such metal injection molding powder.

[0069] In a preferred embodiment of the present invention, an iron-type golf club head 20 comprises a body 21 having a front wall 22 with a recess 23 formed therein. A face insert 24 is disposed in the recess 23. The face insert 24 is composed of a metal injection molded material. The face insert 24 has a plurality of grooves 25, wherein each of the plurality of grooves 25 has a depth, D1, of at least 0.016 inch, each groove 25 of the plurality of grooves is spaced at least 0.073 inch from any other groove 25 of the plurality of grooves, and each groove 25 of the plurality of grooves has a width, W1, that ranges from 0.021 inch to 0.027 inch. Each groove 25 of the plurality of grooves has a side wall angle that is no greater than 24 degrees. Each groove of the plurality of grooves has an edge radius that ranges from 0.004 inch to 0.010 inch. The face insert 24 has a thickness that ranges from 0.026 inch to 0.125 inch. Preferably, the face insert 24 has a front 24a surface and a back surface 24b that are parallel. Alternatively, the face insert 24 has a front surface 24a and a back surface 24b that are angled no greater than 10 degrees such that a thickness at a bottom of the face insert 24 is greater than a thickness at a top of the face insert 24. The face insert 24 is composed of a metal injection molded material having a density that ranges from 7 g/cc to 9 g/cc.

[0070] In an alternative embodiment of the present invention, an iron-type golf club head 20 comprises a body 21 having a front wall 22 with a recess 23 disposed therein. A face insert 24 is disposed within the recess 23, the face insert 24 composed using metal injection molding. On the face insert is a first set of plurality of grooves 25 and a second set of plurality of grooves 25a. The first set of plurality of grooves has a depth of at least 0.016 inch and each groove 25 of the first set of plurality of grooves is spaced at least 0.073 inch from an adjacent groove 25 of the first set of plurality of grooves.

[0071] The face insert 24 is preferably composed of a stainless steel, such as MIM 17-4PH provided by Kinetics, and preferably has a density of 7.70 g/cc. The body 21 is preferably composed of stainless steel, titanium alloy, carpenter steel, or any combination thereof. As shown in FIG. 17, the face insert 24 has a thickness, t, that preferably ranges from 0.026 inch to 0.125 inch. In one embodiment, the face insert
24 has a front surface 24a and back surface 24b that are parallel, as shown in FIG. 12. In another embodiment, the face insert 23 has a front surface 23a and a back surface 23b that are angled at no greater than 10 degrees such that the thickness at the bottom is greater than the thickness at the top. The face insert 23 is preferably composed of a material having a density ranging from 7 g/cc to 9 g/cc.

Each groove 25 of the first set of plurality of grooves preferably has a width (W1) that ranges from 0.021 inch to 0.027 inch. Each groove 25 of the first set of plurality of grooves preferably has a side wall angle, θ, that ranges from 0 to 24 degrees. Further, each groove 25 of the first set of plurality of grooves has an edge radius, ER, that preferably ranges from 0.004 inch to 0.010 inch.

As shown in FIG. 8, a groove 25 of the first set of plurality of grooves has a width, W1, preferably ranging from 0.021 inch to 0.027 inch. The width is defined as the distance across a groove 25 from an inflection point of one end to an inflection point of the opposing end. Also, as shown in FIG. 8, a groove of the first set of plurality of grooves has a depth (D1) that preferably ranges from 0.016 inch to 0.022 inch. Further, as shown in FIG. 9, the distance between a groove 25 of the first set of plurality of grooves and the adjacent groove 25 of the first set of plurality of grooves is the spacing (S1) which preferably ranges from 0.073 inch to 0.083 inch.

As shown in FIG. 10, the edge radius (ER) of each groove 25 of the first set of plurality of grooves preferably ranges from 0.004 inch to 0.010 inch. The side wall angle, as shown in FIG. 17, in the first set of plurality of grooves preferably ranges from 0 degrees to 24 degrees.

As shown in FIG. 9-10, each of the grooves 25 of the second set of plurality of grooves has a depth (D2) of less than 0.001 inch. A groove 25 of the second set of plurality of grooves has a width, W2, preferably ranging from 0.001 inch to 0.010 inch. Further, as shown in FIG. 9, the spacing (S2) between each of the second plurality of grooves is spaced no more than 0.002 inch from an adjacent second plurality of grooves.

Additionally, each of the second plurality of grooves may have a V-like cross-sectional shape as shown in FIG. 11, square cross-sectional shape as shown in FIG. 11A, or U-like cross-sectional shape as shown in FIG. 11B.

As shown in FIG. 10, the effective radius ("ER") of a groove 25 is shown. The "ER" of a groove 25 of the first set of plurality of grooves preferably ranges from 0.004 inch to 0.010 inch. As shown in FIG. 11, a groove 25 in the first set of plurality of grooves may have a base ("B") which ranges from 0.005 inch to 0.009 inch.

Alternatively, the structure of the iron-type golf club is such as disclosed in Hettinger, et al., U.S. Pat. No. 6,093,116, which is hereby incorporated by reference in its entirety.

Alternatively, the structure of the iron-type golf club is such as disclosed in Schmidt, et al., U.S. Pat. No. 5,749,795, which is hereby incorporated by reference in its entirety.

Alternatively, the structure of the iron-type golf club is such as disclosed in Blough et al., U.S. Pat. No. 5,921,869, which is hereby incorporated by reference in its entirety.

Alternatively, the structure of the iron-type golf club is such as disclosed in Kosmatka, U.S. Pat. No. 6,045,455, which is hereby incorporated by reference in its entirety.

Alternatively, the structure of the iron-type golf club is such as disclosed in Erickson, et al., U.S. Pat. No. 6,210,290, which is hereby incorporated by reference in its entirety.

Alternatively, the structure of the iron-type golf club is such as disclosed in Reyes, et al., U.S. Pat. No. 7,144,336, which is hereby incorporated by reference in its entirety.

Alternatively, the structure of the iron-type golf club is such as disclosed in Deshmukh, U.S. Pat. No. 7,112,148, which is hereby incorporated by reference in its entirety.

Alternatively, the structure of the iron-type golf club is such as disclosed in Aguiñaldo, et al., U.S. Pat. No. 7,083,531, which is hereby incorporated by reference in its entirety.

Alternatively, the structure of the iron-type golf club is such as disclosed in Wieland, et al., U.S. Pat. No. 7,338,389, which is hereby incorporated by reference in its entirety.

Alternatively, the structure of the iron-type golf club is such as disclosed in Nycum, et al., U.S. Pat. No. 7,338,387, which is hereby incorporated by reference in its entirety.

Alternatively, the structure of the iron-type golf club is such as disclosed in Holt, et al., U.S. Pat. No. 7,326,126, which is hereby incorporated by reference in its entirety.

We claim as our invention the following:

1. An iron-type golf club head comprising:
a body having a front wall with a recess formed therein;
the face insert disposed in the recess, the face insert composed of a metal injection molded material, the face insert having a first plurality of grooves and a second plurality of grooves, wherein each groove of the first plurality of grooves has a depth of at least 0.016 inch and each groove of the first plurality of grooves is spaced at least 0.073 inch from any other groove of the first plurality of grooves, wherein each of the second plurality of grooves having a depth of less than 0.001 inch.

2. The iron-type golf club head according to claim 1 wherein the body is composed of stainless steel, titanium alloy, or any combination thereof.

3. The iron-type golf club head according to claim 1 wherein the face insert is also composed of an iron-alloy injection molded material.

4. The iron-type golf club head according to claim 1 wherein the face insert has a thickness that ranges from 0.026 inch to 0.125 inch.

5. The iron-type golf club head according to claim 1 wherein the face insert has a front surface and a back surface that are parallel.
6. The iron-type golf club head according to claim 1 wherein the face insert has a front surface and a back surface that are angled no greater than 10 degrees such that a thickness at a bottom of the face insert is greater than a thickness at a top of the face insert.

7. The iron-type golf club head according to claim 1 wherein the face insert is composed of a metal injection molded material having a density that ranges from 7 g/cc to 9 g/cc.

8. The iron-type golf club head according to claim 1 wherein each groove of the first plurality of grooves has a width that ranges from 0.021 inch to 0.027 inch.

9. The iron-type golf club head according to claim 1 wherein each groove of the first plurality of grooves has a side wall angle that is no greater than 24 degrees.

10. The iron-type golf club head according to claim 1 wherein each groove of the first plurality of grooves has an edge radius that ranges from 0.004 inch to 0.010 inch.

11. An iron-type golf club head comprising:
   a body having a front wall with a recess formed therein;
   a face insert disposed in the recess, the face insert composed of a metal injection molded material, the face insert having a plurality of grooves, wherein each of the plurality of grooves has a depth of at least 0.016 inch, each groove of the plurality of grooves is spaced at least 0.073 inch from any other groove of the plurality of grooves, and each groove of the plurality of grooves has a width that ranges from 0.021 inch to 0.027 inch.

12. The iron-type golf club head according to claim 1 wherein each groove of the plurality of grooves has a side wall angle that is no greater than 24 degrees.

13. The iron-type golf club head according to claim 11 wherein each groove of the plurality of grooves has an edge radius that ranges from 0.004 inch to 0.010 inch.

14. The iron-type golf club head according to claim 11 wherein the face insert has a thickness that ranges from 0.026 inch to 0.125 inch.

15. The iron-type golf club head according to claim 11 wherein the face insert has a front surface and a back surface that are parallel.

16. The iron-type golf club head according to claim 11 wherein the face insert has a front surface and a back surface that are angled no greater than 10 degrees such that a thickness at a bottom of the face insert is greater than a thickness at a top of the face insert.

17. The iron-type golf club head according to claim 11 wherein the face insert is composed of a metal injection molded material having a density that ranges from 7 g/cc to 9 g/cc.

18. An iron-type golf club head comprising:
   a body having a front wall with a recess formed therein; and
   a face insert disposed in the recess, the face insert composed of a metal injection molded material having a density between 7 g/cc and 9 g/cc and thickness that ranges from 0.026 inch and 0.125 inch, the face insert having a plurality of grooves.

19. The iron-type golf club head according to claim 18 wherein each groove of the plurality of grooves has a square cross-sectional shape.

20. The iron-type golf club head according to claim 18 wherein each groove of the plurality of grooves has a U-like cross-sectional shape.

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