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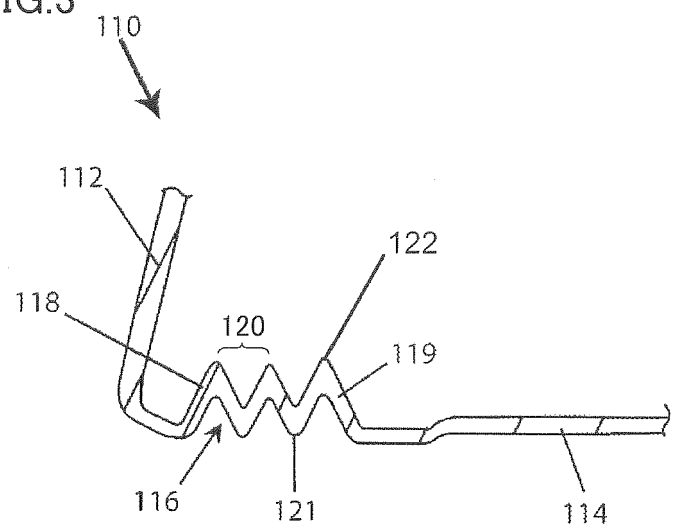
(54) Golf club head with a wave sole

(57) A golf club head (110) of the wood-type, including a body having a ball-striking face (112) and a sole (114) is disclosed. The sole includes a wave slot (116) for adding additional weight to the golf club head. The wave slot includes a front sidewall (118), a rear sidewall (119), and at least one wave (120). The wave is positioned between the front and rear sidewalls, and includes a valley portion (121) at the lowest point of the wave such that the valley portion does not protrude below the sole. The wave slot can also have two, three, or more waves, which can each be the same or different heights.

FIG.3



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Description

BACKGROUND

1. Field of the Invention

[0001] The invention relates generally to golf club heads and, more particularly, to a wood-type golf club head with a wave sole feature.

2. Description of Related Art

[0002] Current driver and fairway wood golf club heads are typically formed of steel or titanium alloys. Oversize driver heads exceeding 300 cc in volume, for example, are usually formed of a titanium alloy such as Ti-6A1-4V. Unless modified, however, oversize heads can have a relatively high center of gravity (COG), which can adversely affect launch angle, spin, and flight trajectory of a golf ball. Also, unmodified oversized heads tend to have a center of gravity that is located too far away from the face, which can also adversely affect launch angle, spin, and flight trajectory. Thus, many club heads have slots or weight pads, for example, cast into the head to lower the club head's center of gravity, and move it closer to the front of the club head (i.e., near the ball-striking face).

[0003] Several golf clubs currently on the market include sole features located proximate the face that are intended to improve golf ball launch conditions as well as lower the club head's center of gravity. These sole features are often slots or grooves having parallel side walls, as shown in FIGS. 1 and 2. In this example, the body of club head 10 may include a ball striking face 12, a sole 14, and a slot 16. The slot 16 has sidewalls 18 having a height 19, and an upper wall 20 having a width 21. Because it adds flexibility to the face 12, the slot 16 can also improve the coefficient of restitution (COR), which can result in improved ball launch properties.

[0004] Attempts to improve performance using this design have included adding weight directly to the sole 14 of the club head, or indirectly by increasing the slot height 19, the slot width 21, and/or increasing the thickness of the upper wall 20. Increases in the slot height 19, however, generally result in raising the club head's COG. Furthermore, this also increases the difficulty of removing the club head from the mold during the manufacturing process. Increasing the width 21, on the other hand, can increase the likelihood of unwanted turf interaction with the club head (e.g., snagging) during play. Increases in the thickness of the upper wall 20 or the sole 14 can cause manufacturing defects such as casting pin holes and/or uneven wall surfaces. Thus, this design may improve COR, it does so at the expense of control over the COG location and adds difficulty and expense to the manufacturing process.

[0005] These slot structures are typically selected for ease of manufacture, but they do not provide optimized ball launch conditions. Furthermore, as discussed above, the design of these slot structures is limited because attempting to cast a thicker wall or deeper slots, for example, can cause casting defects and other manufacturing issues. As a result of these limitations, traditional slot designs are limited in the extent to which they can improve the COR and move the COG.

[0006] What is needed, therefore, is a golf club head construction that provides improved golf ball launch conditions without creating production difficulties such as casting pin holes, wavy surfaces, and unstable thicknesses. Also, there is a need for a golf club head construction that offers greater control over the COG and COR. In addition, the golf club head should be easily castable using conventional casting techniques. Embodiments of the present invention address these needs and more.

BRIEF SUMMARY

[0007] Embodiments of the present invention relate to a wood-type golf club, and particularly to a golf club according to the present disclosure comprising a club head having a ball-striking face, a crown, and a sole. The sole can include a slot for adding additional weight to the club head of the golf club. A slot according to the present disclosure can include a wave feature having one or more wave shapes formed in the slot region of the sole.

[0008] In some embodiments, the golf club head can comprise a body defining an interior cavity and including a ball-striking face and a sole. In some embodiments, a wave slot can be located on the sole and can comprise a first sidewall, a second sidewall, and at least one wave. The first sidewall can extend substantially in a first generally upward direction and can be located proximate the ball-striking face, and the second sidewall can extend substantially in the second generally upward direction and can be located opposite to the ball-striking face when viewed from the first sidewall. In some embodiments, the first and second sidewalls can be disposed at an acute angle to one another. In some embodiments, the waves can be positioned between the first and second sidewalls, and can comprise a valley portion that does not protrude below the sole.

[0009] The first generally upward direction refers to a direction away from the ground (a direction away from the sole) when the golf club head is placed on the ground such that the sole is in contact with the ground, and may include a direction perpendicular to the ground and a direction inclined with respect to the ground. A direction away from the sole and also gradually away from the ball-striking face (a direction inclined toward the rear side with respect to the sole) may be used as the aforementioned first generally upward direction.

[0010] The second generally upward direction refers to a direction away from the ground (a direction away from the sole) when the golf club head is placed on the ground such that the sole is in contact with the ground, and may include a direction perpendicular to the ground and a direction inclined with respect to the ground. A

direction away from the sole and also gradually approaching the ball-striking face (a direction inclined toward the front side (the ball-striking face side) with respect to the sole) may be used as the aforementioned second generally upward direction.

[0011] In some embodiments, the wave slot can comprise two waves of substantially equal height. In some embodiments, a height of the first sidewall can be substantially equal to a height of the second sidewall. In other embodiments, the wave slot can comprise a first wave having a first height and a second wave having a second height, wherein the second height is greater than the first height. In some embodiments, the first wave can be located proximate the first sidewall and the second wave can be located proximate the second sidewall. In other embodiments, the second wave can be located proximate the first sidewall and the first wave can be located proximate the second sidewall.

[0012] In some embodiments, the height of the first sidewall can be greater than the height of the second sidewall, while in other embodiments the height of the second sidewall can be greater than the height of the first sidewall. In other embodiments, the height of first sidewall is substantially equal to the height of the second sidewall. Some embodiments of the present disclosure can comprise a damper attached to the wave slot portion of the golf club head such that it does not protruding below the sole. The damper can comprise, for example and not limitation, tungsten, plastic, aluminum, or steel. In some embodiments, the damper can be attached by, for example soldering, welding, gluing, clipping, or riveting.

[0013] The foregoing and other objects, features, aspects, and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

FIG. 1 is a cross-sectional view of a prior art golf club head having a first sole groove configuration.

FIG. 2 is a bottom, perspective view of the prior art golf club head of FIG. 1.

FIG. 3 is a cross-sectional view of a wood-type golf club head, in accordance with some embodiments of the present invention.

FIG. 4 is a bottom view of the wood-type golf club head of FIG. 3, in accordance with some embodiments of the present invention.

FIGS. 5A-5F are cross-sectional views of wood-type golf club heads with various wave designs, in accordance with some embodiments of the present invention.

FIG. 6 is a bottom view of a wood-type golf club head including a damper, in accordance with some embodiments of the present invention.

FIG. 7 is a bottom view of a modification of the wood-type golf club head of FIG. 3 in accordance with some embodiments of the present invention.

FIG. 8 is a bottom view of a golf club head of a comparative example.

FIG. 9 is a cross-sectional view of the golf club head of the comparative example.

FIG. 10 is a bottom view of a golf club head of an example.

FIG. 11 is a cross-sectional view of the golf club head of the example.

FIG. 12 is a side view of a golf club head for describing evaluation parameters.

FIG. 13 is a front view of the golf club head for describing the evaluation parameters.

[0015] The detailed description explains exemplary embodiments of the invention, together with advantages and features, by way of example with reference to the drawings.

DETAILED DESCRIPTION

[0016] Embodiments of the present invention relate generally to golf club heads, and more particularly to golf club heads having waves in a weight slot on a sole thereof. In some embodiments, the golf club head can have weight added to a bottom front region by using a weight slot. The weight slot can include, for example, wave shapes in order to increase the weight of the slot without adding to the thickness of the slot wall. In some embodiments, the weight slot may include two or more wave shapes.

[0017] Embodiments of the present invention can comprise a wave slot with a continuous wall that alternatively extends upward and downward in a wave, or zig-zag, shape. The wave can begin at the high point of a front slot sidewall, and end at the high point of a rear slot sidewall. The wave shape can enable a slot thickness to be consistent to accommodate existing manufacturing techniques. This wave shape can also increase the mass of the sole of the club head adjacent the ball-striking face in order to move the COG location towards the ball-striking face.

[0018] To simplify and clarify explanation, the invention is described herein as a wood-type golf club head. One

skilled in the art will recognize, however, that the invention is not so limited. The materials described hereinafter as making up the various elements of the present invention are intended to be illustrative and not restrictive. Many suitable materials that would perform the same or a similar function as the materials described herein are intended to be embraced within the scope of the invention. Such other materials not described herein can include, but are not limited to, materials that are developed after the time of the development of the invention.

[0019] As described above, a general problem with conventional golf club heads is that the use of a weight slot is limited by the ability to increase the thickness of the slot or the depth of the slot. This can be due to conventional manufacturing techniques, which restrict the thickness that can be used without manufacturing defects or limit the depth of the weight slot due to casting limitations. This limits the extent to which the COG can be moved forwards, without adding additional pieces or materials.

[0020] Figs. 3 and 4 illustrate an embodiment of a club head 110 according to some embodiments of the present disclosure. The club head 110 can include a ball-striking face 112, a sole 114, and a wave slot 116. In some embodiments, the wave slot 116 can comprise a front sidewall 118, a rear sidewall 119, and one or more waves 120. The wave slot 116 can be located on the sole 114 proximate the ball-striking face 112. The location of the wave slot 116 can impact the COG and COR of the club head 110, among other things.

[0021] By locating the wave slot 116 closer to the ball-striking face 112, for example, the COG can be moved both forward (i.e., towards the ball-striking face 112) and downward (i.e., towards the sole 114). The location of the COG can play a role in the spin producing characteristics of club head 110 (e.g., in reducing or increasing the spin imparted to the ball). As a result, the ability to move the COG forward and downward can provide a club head with improved spin characteristics.

[0022] Use of a wave slot feature 116, as compared to the more rectangular groove used in the prior art, can enable more weight to be added to the sole 114 of the club head 110 with a given thickness. This is because a bottom surface of the rectangular groove is substantially flat, whereas the wave slot 116 is provided with one or more waves 120, and thus, a volume of a shell of the club head 110 that forms the wave slot 116 is larger than a volume of the shell that forms the rectangular groove. Since the thickness may be practically limited by the manufacturing process, a wave slot 116 arrangement enables a greater range of club head weights and COG locations (e.g., lower and farther forward) than the prior art. In some embodiments, the number of waves 120 can be varied to control the weight of the wave slot 116, and by extension the weight and COG of the club head 110.

[0023] The use of wave slot 116 can also improve COR characteristics. As compared to a conventional club head, for example, the club head 110 can have an improved COR over a larger surface of the ball-striking face 112. The wave slot 116 can provide an area of reduced stiffness on the ball-striking face 112 and increase the trampoline effect as the wave slot 116 "accordions" on impact. In this manner, greater power can be imparted to the ball over a larger area of the face, improved hitting consistency. The result of improving the COR over a large area of the ball-striking face 112 is a larger "sweet spot," which can result in improved club head performance and require less user skill and precision to (re)produce the desired ball flight.

[0024] The change in COR can be controlled, for example, by modifying the number and dimensions of the wave slot 116 such as, for example and not limitation, the height of the wave 120 nearest ball striking face. Each wave 120 can have a valley 121, or low point, and a peak 122. In some embodiments, the height of the first wave (i.e., from the valley 121 to the peak 122) can be, for example, at or above 2.0 mm to provide a desired COR improvement and a larger sweet spot. The height of each sidewall 118, 119 can also be selected to create the desired COR improvement and COG location. For example, when a height (a distance from the valley 121 to the peak 122 in the vertical direction) of the wave is set at 2.0 mm or more, the coefficient of restitution at a position lower (on the ground side) than the center of the ball-striking face 112 can be effectively increased as compared with the case of not having the wave slot 116.

[0025] As shown in Fig. 4, the wave slot 116 may be arranged more forward (on the ball-striking face 112 side) than the center of a head width 130 of the club head 110. A length 132, in a toe-heel direction, of a front side portion 116a of the wave slot 116 located closest to the ball-striking face 112 and extending along the ball-striking face 112 may be 10 mm or more, and 20 mm or more. Front side portion 116a may be arranged to intersect with a sole center line 131 of the club head 110. Front side portion 116a may also be arranged such that the sole center line 131 passes through the center of the front side portion 116a in the toe-heel direction.

[0026] Figs. 5A-5F illustrate alternative wave shapes for a club head. Each unique shape can have different COG and COR properties as well as a different overall weight. Patterns such as those illustrated may be selected to provide a club head with the properties desired for a particular user or application. Figs. 5A-5F are provided simply to illustrate examples of how the dimensions and wave sizes could be modified and are not intended to limit embodiments of the present disclosure.

[0027] Some embodiments according to the present disclosure can comprise a club head 210, a ball-striking face 212, a sole 214, and a wave slot 216. The wave slot 216 can include a front sidewall 218, a rear sidewall 219, a first wave 222, and a second wave 223. Each wave 222, 223 can have a valley portion 221 at the low point of each wave and a peak 229 at the high point of each wave. The sidewalls 218, 219 and the waves 222, 223 of the wave slot 216 can each have a height 225, 226,

227, 228 associated with them. In some embodiments, for example, the height 225 of the front sidewall 218 can be substantially equal to the height 226 of the rear sidewall 219. Similarly, in some embodiments the height 227 of the first wave 222 can be substantially equal to the height 228 of the second wave 223.

[0028] In some embodiments, the wave slot 216 can comprise, for example, waves 222, 223 that both have a relatively small height, and are therefore lighter compared to other configurations (e.g., wave slots 316, 416, 516, 616, and 716). In Fig. 5B, the club head 310 is depicted with a ball-striking face 312, a sole 314, and a wave slot 316. In this configuration, the height of the first wave 322 can be substantially equal to the height of the first wave 222, but the height of the second wave 323 may be greater than the height of the second wave 223. Like the wave slot 216 in Fig. 5A, the wave slot 316 can have a front sidewall 318 that is substantially equal in height to the rear sidewall 319. Such an arrangement may result in similar COR performance between the club heads 210 and 310, for example, but with the COG of the club head 310 being closer to the ball striking face 112.

[0029] In some embodiments, as shown in Figs. 5A-5D, the front sidewall and the rear sidewall can be substantially equal in height. In other embodiments, as shown in Figs. 5E-5F, the front sidewall and the rear sidewall can be of different heights. By altering the heights of the sidewalls, the weight of the wave slot can be located closer to, or further from the ball-striking face of the club head. Embodiments of the present disclosure can include wave slot designs having one, two, three, or more waves. Additionally, embodiments according to the present disclosure can include wave slot designs having sidewall heights and wave heights that vary according to the desired weight, COR value, and COG location for the particular application.

[0030] Generally, embodiments of the present disclosure having taller front sidewalls and front waves can have a COG location that is closer to the ball striking face, and higher from the sole than a club head designed with a shorter front sidewall and a taller second or third wave. When the club head has a COG nearer the ball-striking face, it can tend to impart less spin to the ball than would a club head having a COG further away from the ball-striking face. Furthermore, the height of the club head's COG can change the location and size of the "sweet spot," which is the location on the ball-striking face that has the highest COR. These features can be tailored for a golfer who desires, for example, more or less spin.

[0031] In some embodiments, a shorter wave height can be between approximately 1.0 and 2.0 mm. A taller wave height can be between approximately 2.0 and 4.0 mm. Shorter wave heights for the wave closest to the ball-striking face, for example, may not substantially increase the COR of the lower portion of the ball-striking face, while a taller wave can potentially have such an effect. In some embodiments, design considerations such as desired club head weight and COG location can suggest particular wave sizes and designs.

[0032] In some embodiments, as shown in Fig. 6, the club head 810 can be equipped with a damper 24 to, for example and not limitation, control the hitting sound of the club head and minimize undesirable turf interaction (e.g., snagging and digging). Unmodified, depending on the design and materials, the club head 810 may produce an undesirable sound when striking the ball. The club head 810 may also interact with the turf on which a golf ball rests. Undesirable turf interaction such as snagging, catching, gouging, or the like may result in a misaligned swing, mis-hits, and even injury. To this end, the damper 24 may be employed to reduce the magnitude of these potentially undesirable effects. The damper 24 can be attached to the wave slot, and be sized so as to not protrude below the sole of club head 810.

[0033] In some embodiments, the damper 24 can comprise a particularly dense and heavy material, such as tungsten, to further lower the COG of the club head. In other embodiments, the damper 24 can comprise, for example and not limitation, plastic, aluminum, or steel. The damper 24 can be, for example and not limitation, soldered, welded, glued, clipped, or riveted to the sole 114.

[0034] As shown in Fig. 7, in a club head 910, a wave slot 916 formed in a sole 914, for example, may include a plurality of bent portions 916b, 916c, 916f, and 916g in planar view. Furthermore, the wave slot 916 may further include a front side portion 916a, first lateral portions 916d and 916e, and second lateral portions 916h and 916i connected by the aforementioned plurality of bent portions 916b, 916c, 916f, and 916g. Specifically, the front side portion 916a is located on the ball-striking face 912 side in planar view and extends along the ball-striking face 912. The first lateral portions 916d and 916e extending in the directions intersecting with the extension direction of the front side portion 916a are connected to the front side portion 916a by the bent portions 916b and 916c located at opposing ends of the front side portion 916a, respectively. The second lateral portions 916h and 916i are connected to the first lateral portions 916d and 916e by the bent portions 916f and 916g located at ends opposite to the ends connected to the front side portion 916a, respectively. The second lateral portions 916h and 916i extend in the directions different from the extension directions of the first lateral portions 916d and 916e, respectively.

[0035] From the different perspective, the wave slot 916 may have a planar shape bent along an outer perimeter of the club head 910. Ends 916j and 916k of the wave slot 916 may be located more rear than a center portion of the club head 910 in the front-back direction (in the horizontal direction in Fig. 7) of the club head 910.

[0036] The wave slot of the club head described above is provided with the two waves. However, the number of the waves may be three or more. For example, the

number of the waves may be three, four, or five or more.

(First Example)

[0037] For a club head of an example and a club head of a comparative example, the location of the center of gravity and the coefficient of restitution were examined by simulation.

<Sample>

[0038] A club head having a configuration shown in Figs. 8 and 9 was used as the club head of the comparative example. A club head having a configuration shown in Figs. 10 and 11 (a configuration having a wave slot formed in a sole) was used as the club head of the example. As can be seen from Figs. 8 to 11, the club head of the comparative example and the club head of the example have a similar basic shape. However, the wave slot 16 (see Figs. 10 and 11) is formed in the sole of the club head of the example, whereas a region 11, which corresponds to the position where the wave slot is formed in the aforementioned club head of the example, has a substantially flat sole surface in the club head of the comparative example. In addition, in order to substantially align the location of the center of gravity in the comparative example with that in the example, a weight 12 is arranged in the aforementioned region 11 in the club head of the comparative example, as can be seen from Fig. 9 and the like.

[0039] The club head of the comparative example and the club head of the example have basically the same configuration, other than the region where the wave slot 16 is formed or the region where the weight 12 is arranged.

<Calculation Method>

[0040] By using simulation software (Creo/Mechanica: PTC Inc.), the following were calculated for the club head of the comparative example and the club head of the example. Specifically, the location of the center of gravity (COG), the location of the sweet spot (SS), the coefficient of restitution at a center point (a first measurement point) of the ball-striking face, and the coefficient of restitution at a second measurement point located lower than the center of the ball-striking face toward the ground side and located at a distance of 12 mm from the ground were calculated.

[0041] As shown in Fig. 12, as to the location of a center of gravity 13, a height a from a ground 18 to the center of gravity 13 as well as a distance c from the sweet spot (SS14) to the center of gravity 13 were used as evaluation parameters. In addition, as to the sweet spot (SS14), a height b from the ground 18 to SS14 was used as an evaluation parameter.

[0042] Furthermore, as shown in Fig. 13, the center point (the first measurement point 15) of the ball-striking face was defined as a center point of an assumed rectangle that was in contact with an outer perimeter of the ball-striking face in a plane including the ball-striking face. The second measurement point 17 was defined as a position located at a distance of 12 mm from the ground 18 on a line segment passing through the first measurement point 15 and perpendicular to the ground 18 in the aforementioned plane including the ball-striking face. The second measurement point 17 was determined by assuming a position where the golfer actually hit the ball.

<Result>

[0043] In the club head of the example, the height a from the ground 18 to the center of gravity 13 was 15.7 mm, the distance c from SS 14 to the center of gravity 13 was 23.7 mm, and the height b from the ground 18 to SS14 was 26.3 mm. The coefficient of restitution (COR) at the first measurement point 15 in the club head of the example was 0.798.

[0044] In the club head of the comparative example, the height a from the ground 18 to the center of gravity 13 was 15.5 mm, the distance c from SS14 to the center of gravity 13 was 23.4 mm, and the height b from the ground 18 to SS14 was 26.8 mm. The coefficient of restitution (COR) at the first measurement point 15 in the club head of the comparative example was 0.799. As described above, the aforementioned height a, height b, distance c and coefficient of restitution at the first measurement point 15 in the example are substantially the same as those in the comparative example. Particularly, a difference in coefficient of restitution at the first measurement point 15 between the example and the comparative example is small, that is, 0.001.

[0045] On the other hand, the coefficient of restitution at the second measurement point 17 in the example was 0.780, whereas the coefficient of restitution at the second measurement point 17 in the comparative example was 0.770. A difference in coefficient of restitution at the second measurement point 17 between the example and the comparative example is 0.010. In other words, the difference in coefficient of restitution at the second measurement point 17 between the example and the comparative example is ten times as large as the difference in coefficient of restitution at the first measurement point 15 between the example and the comparative example.

[0046] This is because the club head of the example is provided with the wave slot 16, and thus, the coefficient of restitution at the second measurement point 17 in the example is larger than that in the comparative example. As described above, in the club head of the example, the region having a sufficient coefficient of restitution in the ball-striking face can be enlarged, while the location of the center of gravity 13 and the like are similar to those in the comparative example.

(Second Example)

<Sample>

[0047] In the configuration of the club head of the example in the first example, a height d of the wave on the ball-striking face side of the wave slot 16 shown in Fig. 11 was changed into 1.0 mm, 1.5 mm, 2.0 mm, 2.5 mm, and 3.5 mm to obtain configurations (sample 1 to sample 5). A height exhibiting the smaller value of the heights in the vertical direction from the valley located at the center portion of the wave to the peaks at opposing ends of the wave was used as the height d of the wave.

<Calculation Method>

[0048] By using the simulation software similar to that in the first example, the coefficients of restitution at the first measurement point 15 and the second measurement point 17 were calculated for each club head described above.

<Result>

[0049] The coefficient of restitution at the first measurement point 15 was 0.799 when the height d was 1.0 mm to 2.0 mm (sample 1 to sample 3), and 0.800 when the height d was 2.5 mm and 3.5 mm (sample 4 and sample 5). On the other hand, the coefficient of restitution at the second measurement point 17 was 0.771 when the height d was 1.0 mm (sample 1), 0.773 when the height d was 1.5 mm (sample 2), 0.780 when the height d was 2.0 mm (sample 3), 0.780 when the height d was 2.5 mm (sample 4), and 0.781 when the height d was 3.5 mm (sample 5).

[0050] As described above, when the height d is 2.0 mm or more, the coefficient of restitution at the second measurement point 17 can be increased to some extent.

[0051] The height d was defined as the height from the valley to the peak of the wave on the ball-striking face side. However, when heights to the respective peaks located on both sides of the valley in the wave are different from each other (in the case of the configurations shown in Figs. 5D to 5F, for example), height d may be defined as the smaller one of the heights from the valley to the two peaks.

[0052] While several embodiments according to the present disclosure have been described, it will be understood that those skilled in the art, both now and in the future, may make various improvements and enhancements that fall within the scope of the following claims.

REFERENCE SIGNS LIST

[0053] 11 region; 12 weight; 13 center of gravity; 14 sweet spot; 15 first measurement point; 17 second measurement point; 18 ground; 110, 210, 310, 410, 510, 610, 710, 810, 910 golf club head; 112, 212, 312, 912 ball-striking face; 114, 214, 314, 914 sole; 16, 116, 216, 316, 416, 516, 616, 716, 916 wave slot; 118, 218, 318 sidewall; 119, 219, 319 sidewall; 120, 222, 223, 322, 323 wave; 121, 221 valley; 116a, 916a front side portion; 916b, 916c, 916f, 916g bent portion; 916d, 916e first lateral portion; 916h, 916i second lateral portion; 916j, 916k end; 130 head width; 131 sole center line; 132 length.

Claims

1. A golf club head comprising:

   a body defining an interior cavity and including a ball-striking face and a sole;
   a wave slot located on the sole and comprising a first sidewall, a second sidewall, and at least one wave;
   wherein the first sidewall extends substantially in a first generally upward direction and is located proximate the ball-striking face, and the second sidewall extends substantially in a second generally upward direction and is located opposite to the ball-striking face when viewed from the first sidewall;
   wherein each wave is positioned between the first and second sidewalls, and comprises a valley portion.

2. The golf club head of claim 1, wherein the wave slot comprises two waves of substantially equal height.

3. The golf club head of claim 1, wherein a height of the first sidewall is substantially equal to a height of the second sidewall.

4. The golf club head of claim 1, wherein the wave slot comprises a first wave having a first height and a second wave having a second height, the second height being greater than the first height.

5. The golf club head of claim 4, wherein the first wave is located proximate the first sidewall, and the second wave is located proximate the second sidewall.

6. The golf club head of claim 4, wherein the second wave is located proximate the first sidewall, and the first wave is located proximate the second sidewall.

7. The golf club head of claim 4, wherein a height of first sidewall is greater than a height of the second sidewall.

8. The golf club head of claim 4, wherein a height of the second sidewall is greater than a height of the first sidewall.

9. The golf club head of claim 4, wherein a height of

first sidewall is substantially equal to a height of the second sidewall.

10. The golf club head of claim 1, further comprising a damper attached to the wave slot portion of the golf club head, and disposed such that it does not protrude below the sole.

11. The golf club head of claim 10, wherein the damper comprises one or more of tungsten, plastic, aluminum, and steel.

12. The golf club head of claim 11, wherein the damper is attached by one or more of soldering, welding, gluing, clipping, and riveting.

13. The golf club head of claim 1, wherein the wave slot comprises at least three waves.

FIG.1

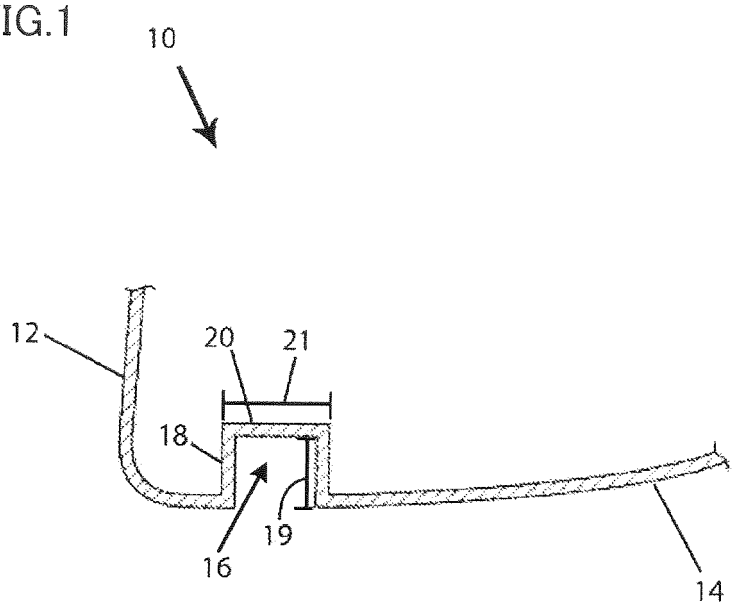


FIG.2

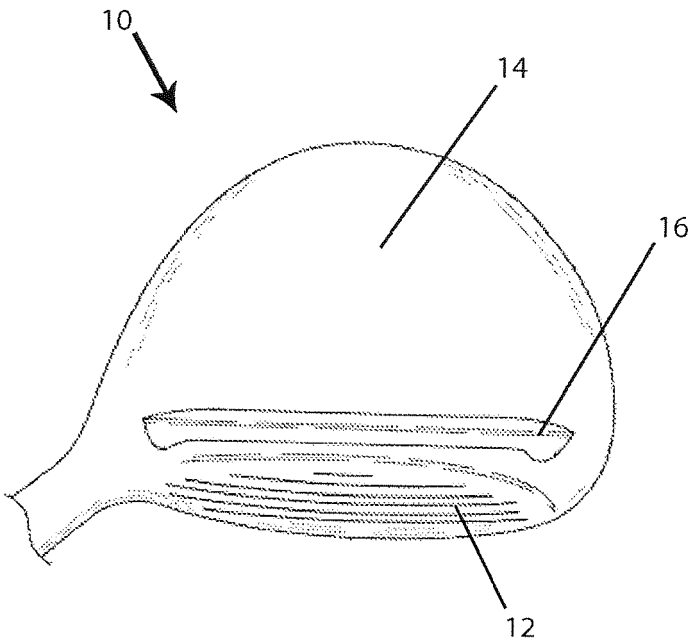
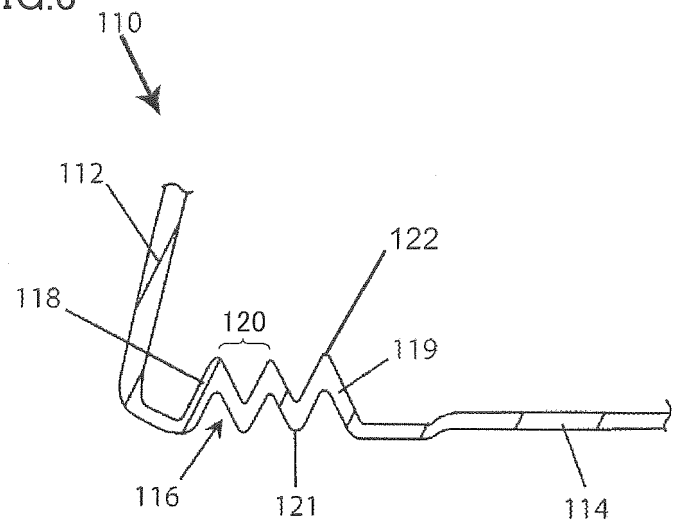


FIG.3


110
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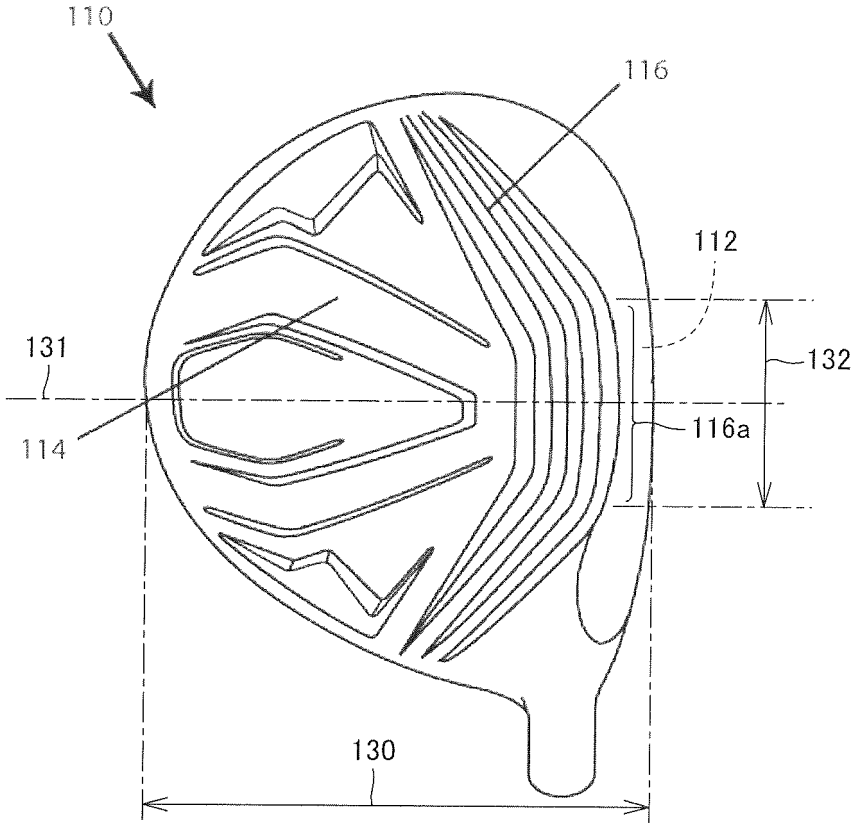
121
114

FIG.4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114
116a
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FIG.5A

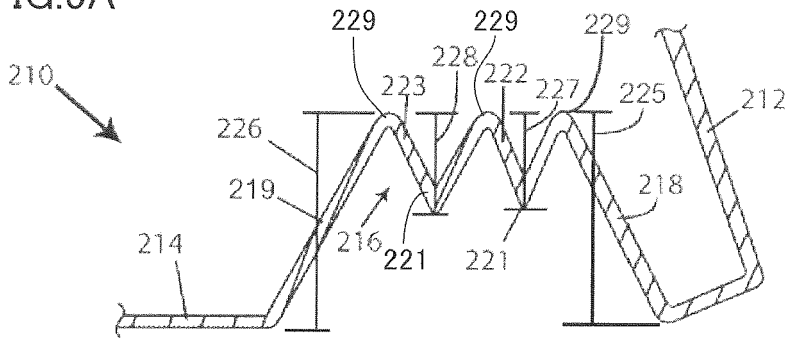


FIG.5B

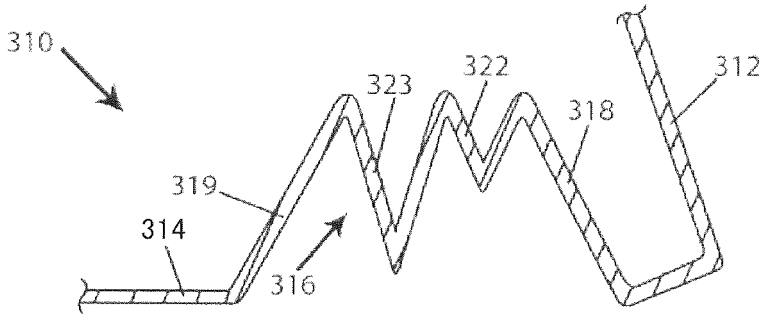


FIG.5C

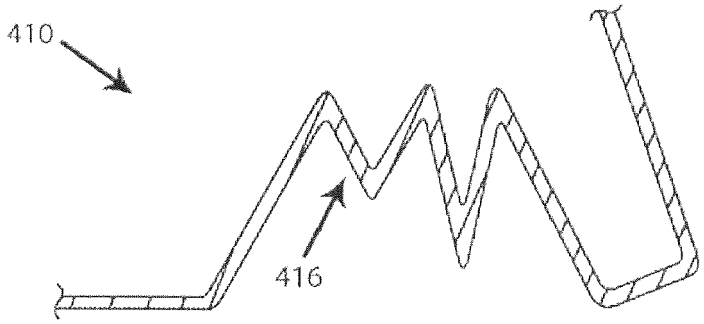


FIG.5D

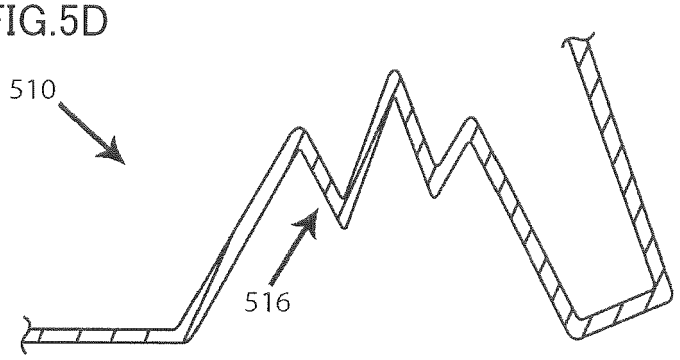


FIG.5E

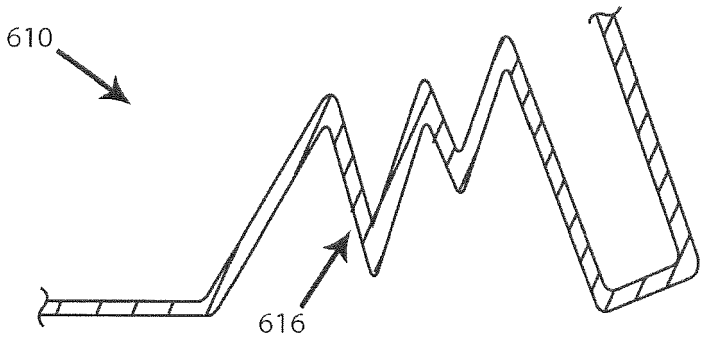


FIG.5F

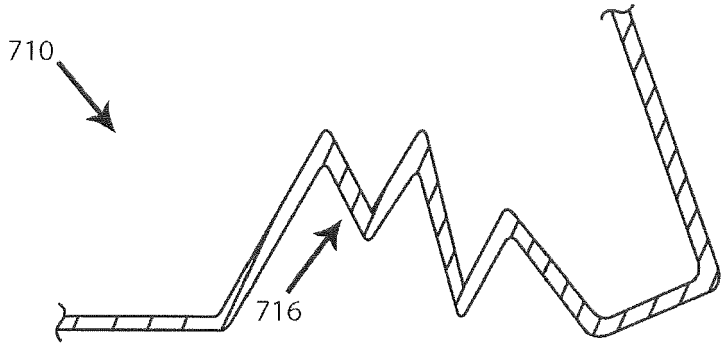


FIG.6

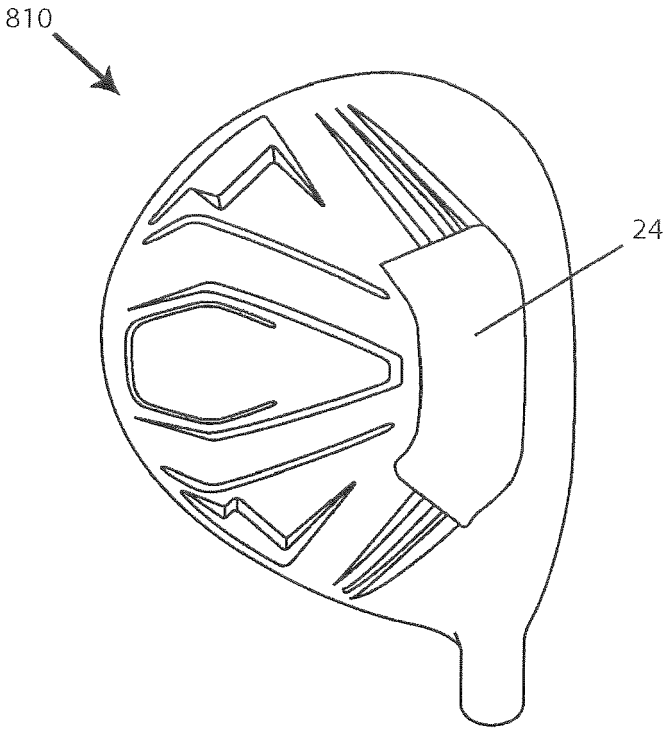
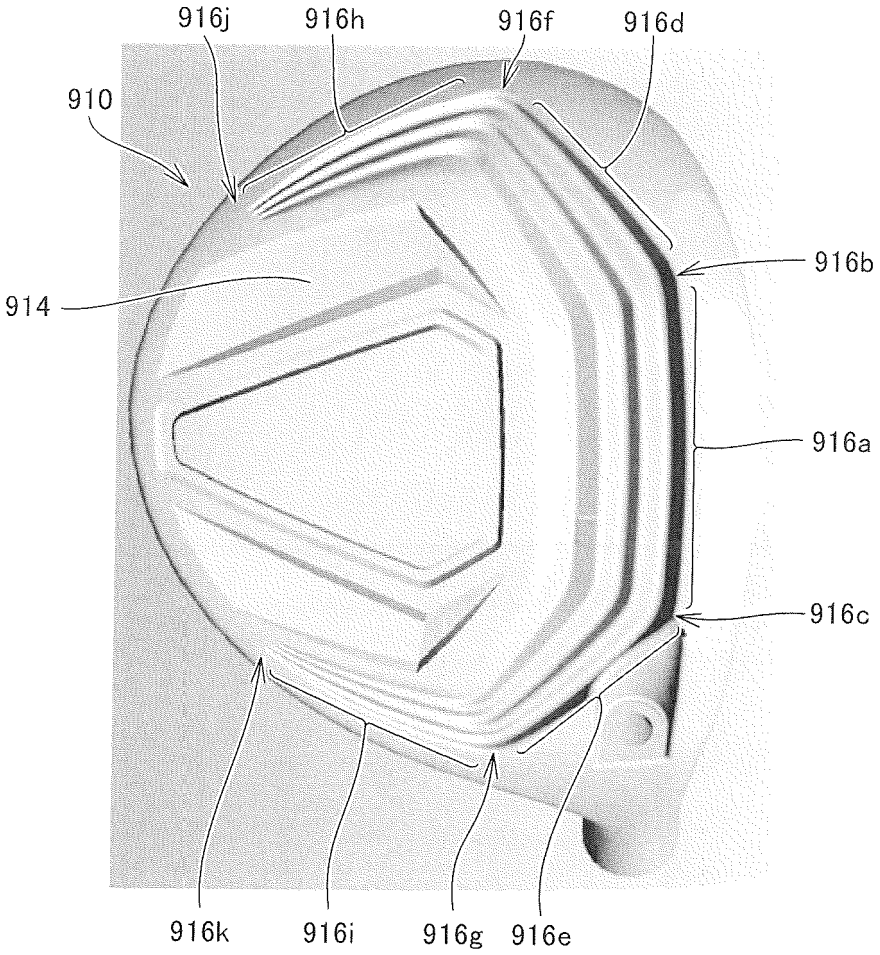


FIG.7


916j
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916b
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916a
916c
916k
916i
916g
916e

FIG.8

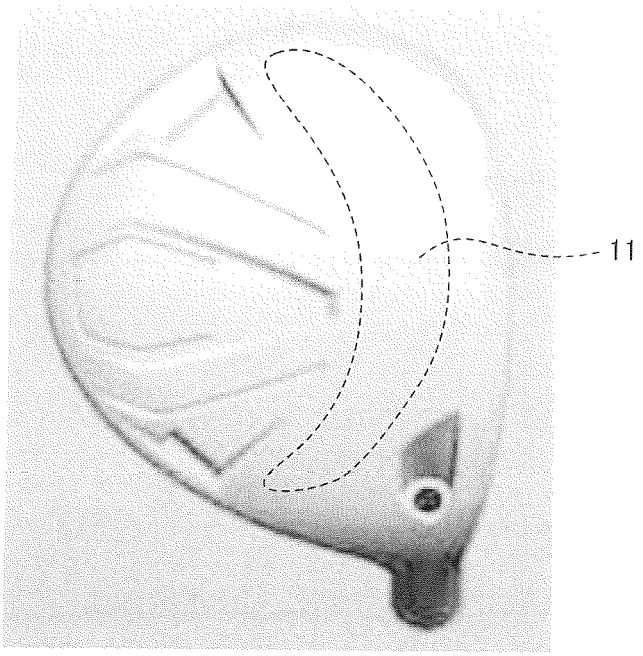


FIG.9

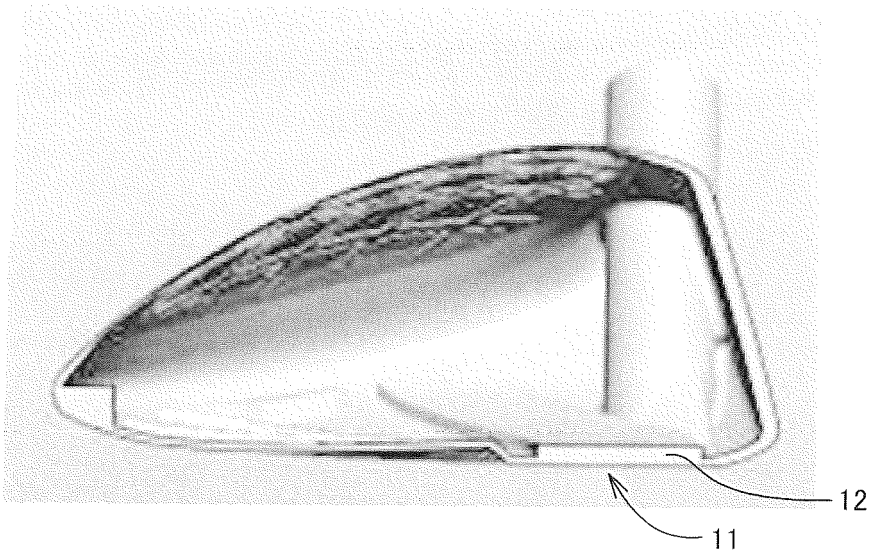


FIG.10

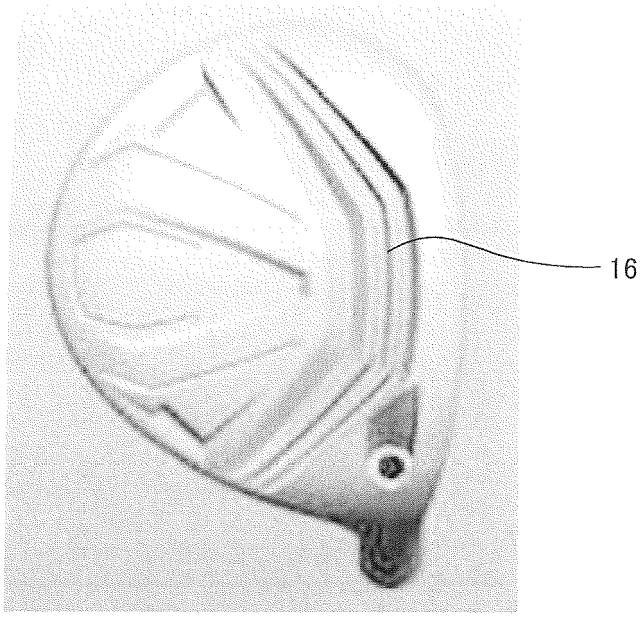


FIG.11

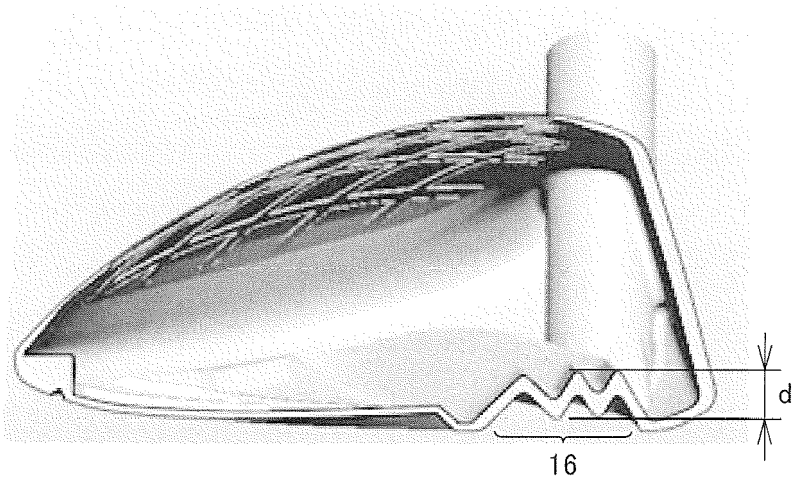


FIG.12

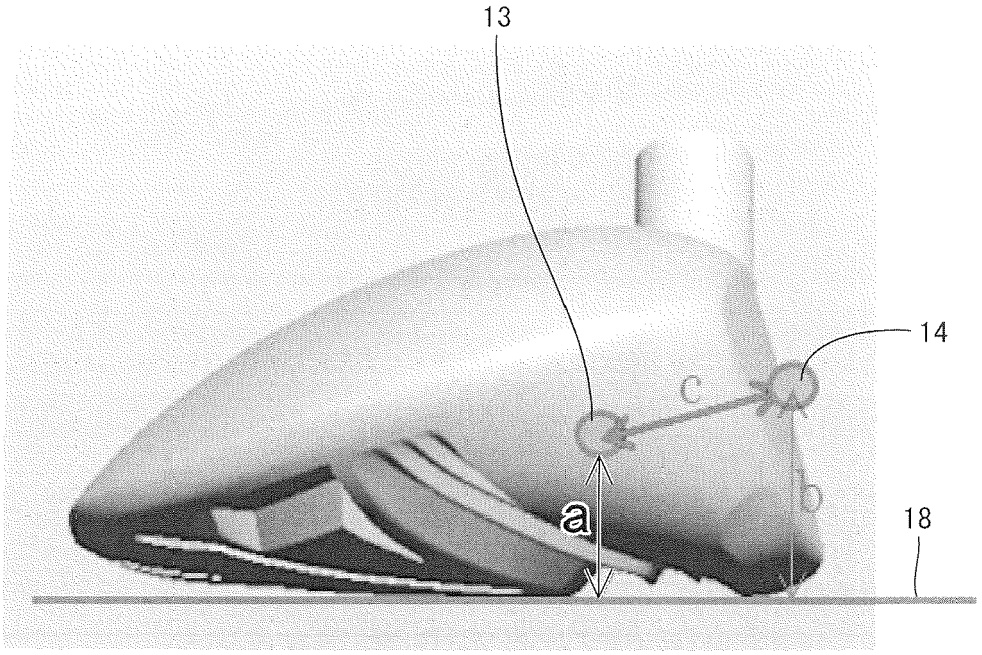
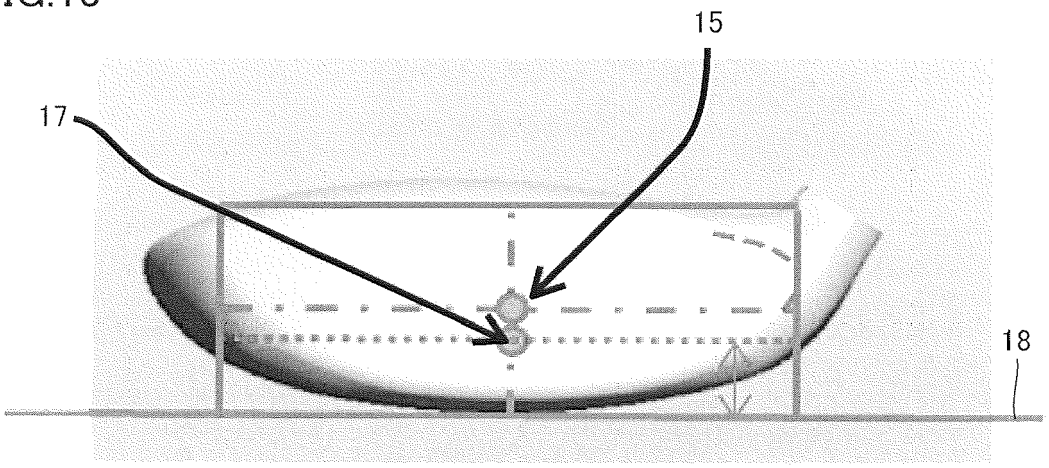


FIG.13



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X	US 2011/218053 A1 (TANG LARRY G [US] ET AL) 8 September 2011 (2011-09-08) * figure 6A *	1	
X	US 2004/176183 A1 (TSURUMAKI MASAEI [JP]) 9 September 2004 (2004-09-09) * figure 13 *	1	
X	US 2007/117648 A1 (YOKOTA MASATOSHI [JP]) 24 May 2007 (2007-05-24) * figures 8,10 *	1	
X	US 2013/331201 A1 (WAHL BRET H [US] ET AL) 12 December 2013 (2013-12-12) * figure 15c *	1	
A	US 2012/202615 A1 (BEACH TODD P [US] ET AL) 9 August 2012 (2012-08-09) * figures *	1	TECHNICAL FIELDS SEARCHED (IPC) A63B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	17 July 2015	Lundblad, Hampus

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