(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 483 974 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
01.01.2025 Bulletin 2025/01

(21) Application number: **24184988.4**

(22) Date of filing: **27.06.2024**

(51) International Patent Classification (IPC):
A63B 53/04 *(2015.01)*

(52) Cooperative Patent Classification (CPC):
A63B 53/0466; A63B 53/0408; A63B 53/0416; A63B 53/0458

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

(30) Priority: **30.06.2023 US 202318346026**

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(54) **GOLF CLUB HEAD WITH IMPROVED STRIKING FACE**

(57) A golf club head with improved striking face is disclosed. More specifically, the present invention relates to a golf club head wherein the striking face further comprises a thickened central region, located near a geometric center of the striking face portion, a central transition region extending outward radially from the thickened central region, a thinned intermediate region, extending outward radially from the central transition region, a thickened stress reducing region, extending outward radially from the thinned intermediate region, and a thinned perimeter region, extending outward radially from the thickened stress reducing region, all of which combine to form the improved striking face.

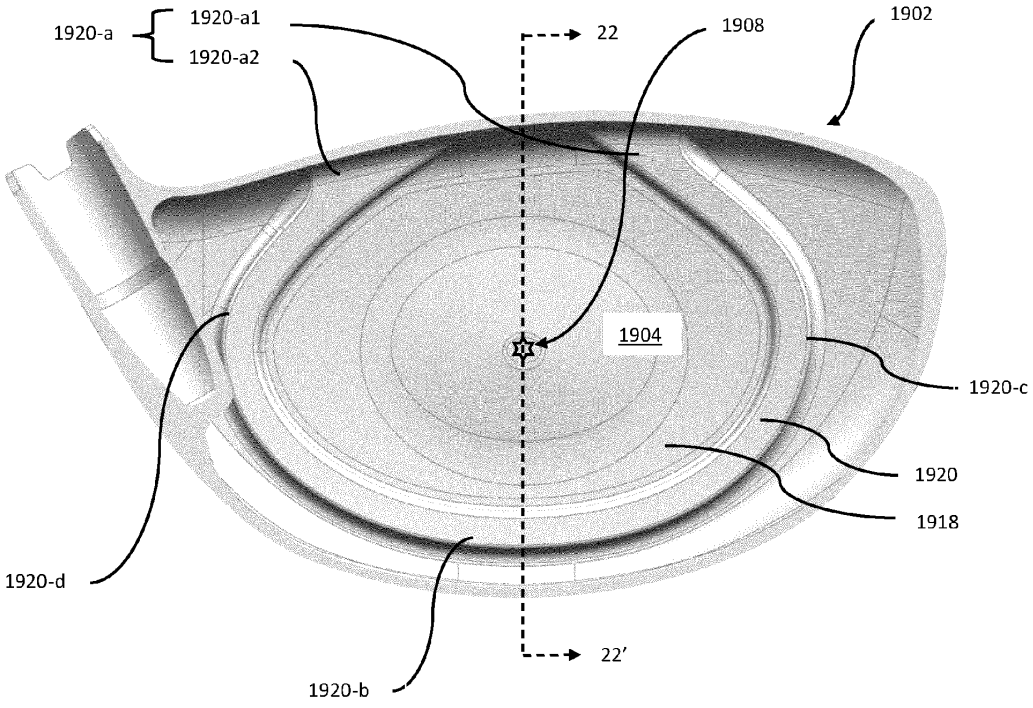

FIG. 19

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Description

FIELD OF THE INVENTION

[0001] The present invention relates generally to a golf club head with an improved striking face. More specifically, the present invention relates to a metalwood type golf club head, wherein the striking face is further comprised out of a thickened central region, located near a geometric center of the striking face portion, a central transition region extending outward radially from the thickened central region, a thinned intermediate region, extending outward radially from the central transition region, a thickened stress reducing region, extending outward radially from the thinned intermediate region, and a thinned perimeter region, extending outward radially from the thickened stress reducing region, all of which combine to form the improved striking face.

BACKGROUND OF THE INVENTION

[0002] The striking face of a golf club head is the singular component in a golf club head that experiences the highest level of stress when impacting a golf ball. Moreover, with the striking face being the only component that comes in contact with a golf ball, it is one of the key critical components to any golf club design.

[0003] In order to improve the performance of a golf club head via the striking face, golf club designers have tried to create an extremely thin striking face, allowing the striking face to elastically deform when impacting a golf ball, thus increasing the speed of a golf ball once it leaves the striking face of the golf club head; all while staying within the rules of golf. U.S. Patent No. 4,432,549 to Zebelean illustrates one of the earlier attempts to thin out the striking face of a golf club head by thinning out the upper portion of the striking face of a golf club head

[0004] Thinning out the face is not the only way to improve performance of the striking face of a golf club head, as more current improvements include the adjustment of the thickness of the various portions of the striking face to improve performance. Building upon the already thinned face, U.S. Patent No6,863,626 to Evans et al. illustrates one of the earlier attempts to vary the thickness of the striking face of a golf club head by disclosing a thickened central region that decreases outward from the center, to help slow down the speed of a golf ball at the center to create a larger area of improved speed and performance.

[0005] Further building upon the known technology of a thinned face that's combined with a thickened central portion, to further improvements to the performance of the golf club head U.S. Patent No. 10,758,789 to Bacon et al*,* adds a thickened perimeter region at the extremities of the striking face, which the inventors claim to improve durability, increase ball speed, and increase characteristic time. However, the addition of this, although beneficial, is not optimized because the benefit of a thickened perimeter region is generally localized and does not need to extend all the way to the perimeter of the striking face as shown by U.S. Patent No. 10,758,789.

[0006] Hence it can be seen that further improvements can be made to golf club heads that have a thinned face, thickened central region, and have a thickened perimeter region by removing unnecessary weight from the extremities of the perimeter of the striking face, and only localizing the thickened perimeter region at optimized locations that could benefit from such feature.

BRIEF SUMMARY OF THE INVENTION

[0007] One aspect of the present invention is a golf club head comprising of a striking face portion, located at a frontal portion of the golf club head, adapted to impact a golf ball, and a body portion attached to a rear of the striking face portion. The striking face portion further comprises a frontal striking surface, wherein the frontal striking surface is substantially planar, and an internal rear surface, wherein the frontal striking surface and the internal rear surface combine to further comprise, a thickened central region, located near a geometric center of the striking face portion, having a first thickness; a central transition region, extending outward radially from the thickened central region, having a variable thickness; a thinned perimeter region, extending outward radially from the central transition region, having a third thickness; a thickened stress reducing region, extending outward radially from the thinned intermediate region, having a fourth thickness; and a thinned perimeter region, extending outward radially from thickened stress reducing region, having a fifth thickness, wherein the thickened stress reducing region forms a ring protruding rearward from the internal rear surface of the striking face portion, and wherein the fourth thickness is greater than the first thickness.

[0008] In another aspect of the present invention is a golf club head comprising of a striking face portion, located at a frontal portion of the golf club head, adapted to impact a golf ball, and a body portion attached to a rear of the striking face portion. The striking face portion further comprises a frontal striking surface, wherein the frontal striking surface is substantially planar, and an internal rear surface, wherein the frontal striking surface and the internal rear surface combine to further comprise, a thickened central region, located near a geometric center of the striking face portion, having a first thickness; a central transition region, extending outward radially from the thickened central region, having a variable

thickness; a thinned perimeter region, extending outward radially from the central transition region, having a third thickness; a thickened stress reducing region, extending outward radially from the thinned intermediate region, having a fourth thickness; and a thinned perimeter region, extending outward radially from thickened stress reducing region, having a fifth thickness, wherein the thickened stress reducing region forms a ring protruding rearward from the internal rear surface of the striking face portion, wherein the fifth thickness is less than the fourth thickness, and wherein the third thickness of the thinned intermediate region is the thinnest portion of the striking face portion.

[0009] In another aspect of the present invention is a golf club head comprising of a striking face portion, located at a frontal portion of the golf club head, adapted to impact a golf ball, and a body portion attached to a rear of the striking face portion. The striking face portion further comprises a frontal striking surface, wherein the frontal striking surface is substantially planar, and an internal rear surface, wherein the frontal striking surface and the internal rear surface combine to further comprise a thickened stress reducing region, located proximate a perimeter of said striking face portion, wherein the thickened stress reducing region forms a ring protruding rearward from the internal rear surface of the striking face portion, and wherein the thickened stress reducing region is placed at a distance of between about 15 mm to about 30 mm from a geometric center of the striking face portion, measured across a vertical cross-section passing through the geometric center of the striking face portion.

[0010] In another aspect of the present invention the thickened stress reducing region forms at least a portion of a ring protruding rearward from the internal rear surface of the striking face portion.

[0011] In another aspect of the present invention, the internal rear surface can be divided into a clock grid comprising at least a 12 o'clock ray, a 1 o'clock ray, a 2 o'clock ray, a 3 o'clock ray, a 4 o'clock ray, a 5 o'clock ray, a 6 o'clock ray, a 7 o'clock ray, an 8 o'clock ray, a 9 o'clock ray, a 10 o'clock ray, and an 11 o'clock ray; wherein the thickened stress reducing region is located only at a region consisting of an upper region between the 9 o'clock ray and the 2 o'clock ray, and a lower region between the 9 o'clock ray and the 3 o'clock ray.

[0012] In another aspect of the present invention, the thickness stress reducing region has an area of reduced thickness between the 8 o'clock ray and the 10 o'clock ray forming a heel thickened stress reducing region.

[0013] In another aspect of the present invention, said thickened stress reducing region forms a horseshoe shaped ring.

[0014] In another aspect of the present invention is a golf club head further comprising of a striking face portion located at a frontal portion of the golf club head, adapted to impact a golf ball, a a body portion, attached to a rear of the striking face portion. The striking face portion further comprises of a perimeter region having a central opening, wherein the perimeter region further comprises a thickened stress reducing region, having a fourth thickness, and a face insert adapted to engage the central opening, wherein the face insert further comprises a thickened central region, located near a geometric center of the striking face portion, having a first thickness; wherein no part of the thickened stress reducing region engages the face insert, and where the fourth thickness is greater than the first thickness.

[0015] In another aspect of the present invention a top ledge of the central opening is located less than about 1.0 mm away from the crown leading edge of the striking face portion.

[0016] In another aspect of the present invention, the face insert has an aspect ratio of between about 1.3 to about 1.7.

[0017] In another aspect of the present invention, the top ledge of the central opening is located less than about 10 mm away from a crown apex.

[0018] These and other features, aspects and advantages of the present invention will become better understood with reference to the following drawings, description and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The foregoing and other features and advantages of the invention will be apparent from the following description of the invention as illustrated in the accompanying drawings. The accompanying drawings, which are incorporated herein and form a part of the specification, further serve to explain the principles of the invention and to enable a person skilled in the pertinent art to make and use the invention.

FIG. 1 of the accompanying drawings shows a frontal view of a golf club head in accordance with an exemplary embodiment of the present invention, allowing cross-sectional line **A-A'** to be shown;

FIG. 2 of the accompanying drawings shows a cross-sectional view of a golf club head in accordance with an exemplary embodiment of the present invention, taken along cross-sectional line **A-A'** shown in **FIG. 1;**

FIG. 3 of the accompanying drawings shows an enlarged cross-sectional view of a striking face portion of a golf club head in accordance with an exemplary embodiment of the present invention shown in **FIG. 2**;

FIG. 4 of the accompanying drawings, again, shows an enlarged cross-sectional view of a striking face portion of a golf club head in accordance with an exemplary embodiment of the present invention shown in **FIG. 2**, allowing different features to be highlighted;

FIG. 5 of the accompanying drawings, once again, shows an enlarged cross-sectional view of a striking face portion of a golf club head in accordance with an exemplary embodiment of the present invention shown in **FIG. 2**, allowing

different features to be highlighted;

FIGS. 6a of the accompanying drawing shows a representative cross-sectional view of a thickened stress reducing region accordance with an exemplary embodiment of the present invention;

FIG. 6b of the accompanying drawings shows a representative cross-sectional view of a thickened stress reducing region in accordance with an alternative embodiment of the present invention;

FIG. 6c of the accompanying drawings shows a representative cross-sectional view of a thickened stress reducing region in accordance with an even further alternative embodiment of the present invention;

FIG. 6d of the accompanying drawings shows a representative cross-sectional view of a thickened stress reducing region in accordance with an even further alternative embodiment of the present invention;

FIG. 6e of the accompanying drawings shows a representative cross-sectional view of a thickened stress reducing region in accordance with an even further alternative embodiment of the present invention;

FIG. 6f of the accompanying drawings shows a representative cross-sectional view of a thickened stress reducing region in accordance with an even further alternative embodiment of the present invention;

FIG. 6g of the accompanying drawings shows a representative cross-sectional view of a thickened stress reducing region in accordance with an even further alternative embodiment of the present invention;

FIG. 6h of the accompanying drawings shows a representative cross-sectional view of a thickened stress reducing region in accordance with an even further alternative embodiment of the present invention;

FIG. 6i of the accompanying drawings shows a representative cross-sectional view of a thickened stress reducing region in accordance with an even further alternative embodiment of the present invention;

FIG. 6j of the accompanying drawings shows a representative cross-sectional view of a thickened stress reducing region in accordance with an even further alternative embodiment of the present invention;

FIG. 6k of the accompanying drawings shows a representative cross-sectional view of a thickened stress reducing region in accordance with an even further alternative embodiment of the present invention;

FIG. 6L of the accompanying drawings shows a representative cross-sectional view of a thickened stress reducing region in accordance with an even further alternative embodiment of the present invention;

FIG. 7a of the accompanying drawings shows a rear shaded view of a striking face portion of a golf club head in accordance with an exemplary embodiment of the present invention;

FIG. 7b of the accompanying drawings shows a rear view of a striking face portion of a golf club head in accordance with an exemplary embodiment of the present invention;

FIG. 8 of the accompanying drawings shows a cross-sectional view of a golf club head in accordance with a further alternative embodiment of the present invention, taken along cross-sectional line **A-A'** shown in **FIG. 1**;

FIG. 9 of the accompanying drawings shows an enlarged cross-sectional view of a striking face portion of a golf club head in accordance with an alternative embodiment of the present invention shown in **FIG. 8**;

FIG. 10a of the accompanying drawings shows a rear shaded view of a striking face portion of a golf club head in accordance with an alternative embodiment of the present invention;

FIG. 10b of the accompanying drawings shows a rear view of a striking face portion of a golf club head in accordance with an alternative embodiment of the present invention;

FIG. 11 of the accompanying drawings shows an exploded view of a golf club head in accordance with an even further alternative embodiment of the present invention;

FIG. 12 of the accompanying drawings shows a cross-sectional view of a golf club head in accordance with the even further alternative embodiment of the present invention;

FIG. 13 of the accompanying drawings shows a partialcross-sectional view of a striking face portion of a golf club head in accordance with an even further alternative embodiment of the present invention;

FIG. 14 of the accompanying drawings shows a rear view of a striking face portion of a golf club head in accordance with a further alternative embodiment of the present invention;

FIG. 15 of the accompanying drawings shows a rear view of a striking face portion of a golf club head in accordance with a further alternative embodiment of the present invention;

FIG. 16 of the accompanying drawings shows an enlarged cross-sectional view of a striking face portion in accordance with an alternative embodiment of the present invention;

FIG. 17 of the accompanying drawings shows a rear view of a striking face portion of a golf club head in accordance with an even further alternative embodiment of the present invention;

FIG. 18 of the accompanying drawings shows an enlarged cross-sectional view of a striking face portion of a golf club head in accordance with an even further alternative embodiment of the present invention;

FIG. 19 of the accompanying drawings shows a rear view of a striking face portion of a golf club head in accordance with a further alternative embodiment of the present invention;

FIG. 20 of the accompanying drawings shows a rear view of a striking face portion of a golf club head with the face insert removed in accordance with a further alternative embodiment of the present invention;

FIG. 21 of the accompanying drawings shows an enlarged rear view of a face insert in accordance with a further

alternative embodiment of the present invention;

FIG. 22 of the accompanying drawings shows an enlarged cross-sectional view of a striking face portion in accordance with a further alternative embodiment of the present invention taken along cross-sectional line **22-22'** in **FIG. 19**; and

FIG. 23 of the accompanying drawings shows an exploded view of a golf club head in accordance with a further alternative embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0020] The following detailed description describes the best currently contemplated modes of carrying out the invention. The description is not to be taken in a limiting sense, but is made merely for the purpose of illustrating the general principles of the invention, since the scope of the invention is best defined by the appended claims.

[0021] Various inventive features are described below, and each can be used independently of one another or in combination with other features. However, any single inventive feature may not address any or all of the problems discussed above or may only address one of the problems discussed above. Further, one or more of the problems discussed above may not be fully addressed by any of the features described below.

[0022] **FIG. 1** of the accompanying drawings shows a frontal view of a golf club head **100** in accordance with an exemplary embodiment of the present invention. First and foremost, **FIG. 1** of the accompanying drawings shows a coordinate system **101,** which defines the orientation of the golf club head **100** along the x, y, and z axes. The x-axis shown here is horizontal and spans in a heel to toe direction, with the positive axis pointing to the heel of the golf club head **100**. The y-axis shown here is vertical and spans in a crown to sole direction, with the positive axis pointing to the crown of the golf club head **100**. Finally, the z-axis shown here refers to the axis that points in and out of the page, and spans in a forward and back direction, with the positive axis pointing towards the front of the golf club head **100**. This frontal view of the golf club head **100** shows the striking face portion **102**, which in this embodiment is further comprised out of a face insert **104** and a face perimeter **106**. **FIG. 1** of the accompanying drawings also shows a cross-sectional line **A-A'** vertically along the y axis, along the y-z plane, allowing the internal geometry of the striking face portion **102** to be shown more clearly.

[0023] **FIG. 2** of the accompanying drawings shows a cross-sectional view of a golf club head **200**, taken along cross-sectional line **A-A'** shown in **FIG. 1**. In this cross-sectional view of the golf club head **200** shown in **FIG. 2,** we can see that the golf club head **200** is has a striking face portion **202** and a rear body portion **203,** attached to the rear of the striking face portion **202**. The striking face portion **202**, as defined in the present invention, refers to the portion of the golf club head **200** that is substantially planar, and located at the frontal portion of the golf club head **200**, adapted to strike a golf ball. The striking face portion **202** is formed by the thickness created by a substantially planar frontal striking surface **210** and a rear internal surface **212** having a variable contour, thus creating a striking face portion with a variable face thickness profile. The demarcation between the striking face portion **202** and the rear body portion **203** occurs when the rear internal surface **212** deviates from a substantially planar vertical orientation towards a substantially horizontal orientation.

[0024] Finally, **FIG. 2** of the accompanying drawings shows that in this embodiment, a face insert **204** is used and it closes an opening in the striking face portion **202** created by the face perimeter **206.** In this embodiment of the present invention, the face insert **204** may generally be made from a titanium material for its light weight and high durability characteristics; and may generally be significantly thinner than traditional golf club heads having a similar construction due to the unique thickened stress reducing region **216** around the face perimeter **206.** In this embodiment of the present invention, the thickened stress reducing region **220** around the face perimeter **206** allows for the face insert **204** to be thinner and lighter, yielding a mass of less than about 25 grams, more preferably less than about 24 grams, and most preferably less than about 23 grams, all without departing from the scope and content of the present invention. Compared to a face insert installed without the thickened stress reducing region **220** around the face perimeter **206,** the mass of the face insert is decreased by approximately 12 grams.

[0025] In order to illustrate more detail regarding the thickened stress reducing region **220** around the face perimeter **206** together with the remainder of the striking face portion **202** geometry such as the thickened central region **214,** the central transition region **216**, the thinned intermediate region **216,** and the thinned perimeter region **222**, an enlarged view of the striking face portion **202** is provided in **FIG. 3.**

[0026] **FIG. 3** of the accompanying drawings shows an enlarged cross-sectional view of the striking face portion **202** of a golf club head **200.** This enlarged cross-sectional view allows the various heights of the striking face portion **202** to be shown more clearly, while **FIG. 4** of the accompanying drawings will illustrate the various thicknesses of the striking face portion **202**. In accordance with this shown exemplary embodiment of the present invention, the striking face portion **202** is further comprised of a thinned upper perimeter region **222-a** and a thinned lower perimeter region **222-b**, combining to form a thinned perimeter region **222**. Located inward from the thinned perimeter region, the striking face portion **202** has an upper thickened stress reducing region **220-a** and a lower thickened stress reducing region **220-b** combining to form a thickened stress reducing region **220**. Alternatively speaking, it can be said that the thickened stress reducing

region **220** forms a ring that protrudes rearward from the internal surface **212** of the striking face portion **202**. Located inward from the thickened stress reducing region, the striking face portion **202** has an upper thinned intermediate region **218-a** and a lower thinned intermediate region **218-b**, combining to form a thinned intermediate region **218.** Located inward from the thinned intermediate region, the striking face portion **202** has an upper central transition region **216-a** and a lower central transition region **216-b,** combining to form the central transition region **216**. Finally, the striking face portion **202** has a thickened central region **214** located inward of the central transition region **214.**

[0027] In this embodiment of the present invention shown in **FIG. 3**, the height **H1** of the thickened central region **214** may generally be between about 4.0 mm and about 15.0 mm, more preferably between about 4.0 mm and about 10.0 mm, and most preferably about 4.0 mm.

[0028] The height of the central transition region **216**, in accordance with this embodiment of the present invention, may also be greater below the thickened central region **214** than above the thickened central region **214.** Hence, in accordance with this embodiment, the height **H2-a** of the upper central transition region **216-a** is between about 7.0 mm and about 11.0 mm, more preferably between about 8.0 mm and about 10.0 mm, and most preferably about 9.0 mm. The height **H2-b** of the lower central transition region **216-b** may generally be between about 13.0 mm to about 17.0 mm, more preferably between about 14.0 mm to about 16.0 mm, and most preferably about 15.0 mm. However, it should be noted that in alternative embodiments, the height of the upper central transition region **216-a** and the lower central transition region **216-b** may be the same without departing from the scope and content of the present invention.

[0029] The height of the thinned intermediate region **218,** in accordance with this embodiment of the present invention, may also be greater below the thickened central region **214** than above the thickened central region **214**. Hence, in accordance with this embodiment, the height **H3-a** is generally between about 3.5 mm and about 5.5 mm, more preferably between about 4.0 mm and about 5.0 mm, and most preferably about 4.5 mm. The height **H3-b** of the lower central transition region **218-b** may generally be between about 6.5 mm to about 8.5 mm, more preferably between about 7.0 mm to about 8.0 mm, and most preferably about 7.5 mm. However, it should be noted that in alternative embodiments, the height of the upper central transition region **218-a** and the lower central transition region **218-b** may be the same without departing from the scope and content of the present invention.

[0030] The height of the thickened stress reducing region **220**, different from previous measurements, is the same measurement irrespective of whether the measurement is for the upper thickened stress reducing region **220-a** or the lower thickened stress reducing region **220-b.** Hence, in accordance with this embodiment, the height **H4-a** and **H4-b** are both between about 4.0 mm and about 6.0 mm, more preferably between about 4.5 mm and about 5.5 mm, and most preferably about 5.0 mm. Similar to the logic above, having different **H4-a** and **H4-b** values also does not deviate from the scope and content of the present invention, so long as both fall within the ranges articulated above. It is worth noting here that the height of the thickened stress reducing region **220** is critical to the proper functionality of the present invention, as it carefully balances the need to not add too much unnecessary mas to the striking face portion **202**, but also the need to provide enough structural rigidity to reduce the stress from the face perimeter **106** (shown in **FIG. 1**) to allow the remainder of the striking face portion **202** to be made thinner and more efficient. The height of the thickened stress reducing region **220,** combined with the thickness of the thickened stress reducing region **220** (to be discussed later in **FIG. 4**), will outline the optimized geometry to achieve the performance gains of the present invention.

[0031] Before moving on to a discussion regarding the thinned perimeter region **222,** it is important to note that the placement of the thickened stress reducing region **220** relative to the geometric face center **108** (shown in **FIG. 1**) is critical to the achieve the proper performance gains in the present invention. This is especially true along the vertical cross-sectional plane passing through the geometric face center **108** (shown in **FIG. 1**) as shown here in the enlarged cross-sectional view shown in **FIG. 3**. The criticality of this specific cross-section, and the placement of the thickened stress reducing region **220** along this cross-section, derives from the tendency of the striking face portion **202** to exhibit higher stress risers in the upper face portion along this plane; hence the addition of the thickened stress reducing region **220**. In this embodiment of the present invention, the thickened stress reducing region **220** may generally be placed at a distance of between about 15 mm to about 30 mm away from the geometric face center **108**, along the cross-sectional plane **A-A'**, more preferably placed at a distance of between about 17 mm to about 28 mm away from the geometric face center **108** (shown in **FIG. 1**), along the cross-sectional plane **A-A'**, and most preferably between about 20 mm to about 25 mm away from the geometric face center **108** (shown in **FIG. 1**), along the cross-sectional plane **A-A'**.

[0032] The height of the thinned perimeter region **222**, may also be greater below the thickened central region **214** than above the thickened central region **214.** Hence, in accordance with this embodiment, the height **H5-a** is between about 1.8 mm and about 2.8 mm, more preferably between about 2.1 mm and about 2.5 mm, and most preferably about 2.3 mm. The height **H5-b** may generally be between about 2.3 mm to about 3.3 mm, more preferably between about 2.6 mm to about 3.0 mm, and most preferably about 2.8 mm. However, it should be noted that in alternative embodiments, the height of the upper thinned perimeter region **222-a** and the lower thinned perimeter region **222-b** may be the same without departing from the scope and content of the present invention.

[0033] **FIG. 4** of the accompanying drawings shows another enlarged cross-sectional view of the striking face portion **202** of a golf club head **200.** In this cross-sectional view, the various thicknesses of the components of the striking face

portion **202** is shown in more detail. In this current embodiment of the present invention, the thickened central region **214** may generally have a thickness **T1** of less than about 3.6 mm, more preferably less than about 3.4 mm, and most preferably less than about 3.2 mm; as the goal of the present invention is to minimize the thickness of various components of striking face portion **202,** via the introduction of the thickened stress reducing region **220** that alleviate stress on the striking face portion **202.**

[0034] The thickness of the thinned intermediate region **218** may generally be the same irrespective of whether it's located at the upper thinned intermediate region **218-a** or the lower thinned intermediate region **218-b**. Hence, the thickness **T3-a** and **T3-b** are both less than about 2.5 mm, more preferably less than about 2.4 mm, and most preferably less than about 2.3 mm. However, in alternative embodiments of the present invention, **T3-a** and **T3-b** values may be slightly different from one another and will not deviate from the scope and content of the present invention, so long as both fall within the ranges articulated above.

[0035] The thicknesses of the thickened stress reducing region **220**, shown here as an upper thickened stress reducing region **220-a** having a thickness **T4-a** and lower thickened stress reducing region **220-b** having a thickness **T4-b,** combines with the width of the thickened stress reducing region **220** define a geometry that is critical to the improved performance of the striking face portion **202** of the golf club head. In this embodiment, the thicknesses **T4-a** and **T4-b,** for the upper thickened stress reducing region **220-a** and lower thickened stress reducing region **220-b** respectively, are both the same, hence yielding a thickness of between about 3.6 mm to about 4.4 mm, more preferably between about 3.8 mm top about 4.2 mm, and most preferably about 4.0 mm. However, in alternative embodiments of the present invention, the thicknesses **T4-a** and **T4-b** could deviate slightly from one another without departing from the scope and content of the present invention, so long as it does not fall outside the scope of the thickness ranges defined above.

[0036] Once the thickness **T4** and the height **H4** of the thickened stress reducing region 220 have been defined, a preferred geometric shape of the thickened stress reducing region 220 can be established as a ratio of the thickness and the height. The preferred geometric shape will have a T over H Ratio defined by Equation (1) below:

$$T\ over\ H\ Ratio = \frac{Thickness\ \boldsymbol{T4}\ of\ Thickened\ Stress\ Reducing\ Region}{Height\ \boldsymbol{H4}\ of\ Thickened\ Stress\ Reducing\ Region} \qquad \text{Eq. (1)}$$

[0037] The T over H Ratio of the thickened stress reducing region **220** of the striking face portion **202** in accordance with the present invention may generally be between about 0.6 to about 1.1, more preferably between about 0.7 to about 0.9, and most preferably about 0.8. Once again, as previously mentioned, this ratio is critical to achieving the stress reducing properties of the striking face portion **202**, all while minimizing the unnecessary mass added by the addition of this thickened stress reducing region **220.**

[0038] The thickness of the thinned perimeter region **222** may generally be the same irrespective of whether it's located at the upper thinned perimeter region **22-a** or the lower thinned perimeter region **222-b**. Hence, the thickness **T5-a** and **T5-b** are both less than about 3.0 mm, more preferably less than about 2.8 mm, and most preferably less than about 2.7 mm. However, in alternative embodiments of the present invention, **T5-a** and **T5-b** values may be slightly different from one another and will not deviate from the scope and content of the present invention, so long as both fall within the ranges articulated above.

[0039] Another important relationship worth highlighting here is the thickness **T4** of the thickened stress reducing region **720** versus the thickness **T1** of the thickened central region **714.** Because the introduction of the thickened stress reducing region **720** greatly decreases the overall thickness and mass of the entire striking face portion **702,** the resultant relationship between the two thicknesses is critically important to achieving the improved performance of the present invention. In this exemplary embodiment of the present invention, the ratio of **T4** divided by **T1** is generally greater than about 1, more preferably greater than about 1.15, and most preferably greater than about 1.375. Alternatively speaking, it can be said that the thickness **T4** of the thickened stress reducing region **220** is greater than a thickness **T1** of the thickened central region **214,** or any other location along the entirety of the striking face portion **202.** The thickest portion of the striking face portion **202** is located on the thickened stress reducing region **220.**

[0040] **FIG. 5** of the accompanying drawings shows that same enlarged cross-sectional view of the striking face portion **202** of a golf club head **200** as **FIGS. 3** and **4,** but this time focusing on the transition of the thickened stress reducing region **220** to its neighboring thinned intermediate region **218** and thinned perimeter region **222.** In this embodiment of the present invention, the various radii around the thickened stress reducing region **220** is also critical to the proper functionality of the present invention, as undesirable radii not only does not serve the purpose of reducing stress but could also add to the manufacturing challenges. On top of everything, the radii also needs to be a balance of, on one hand, minimizing the undesirable weight additions attributed to the addition of the thickened stress reducing region **220**, and on the other hand the stress and manufacturing challenges attributed to the thickened stress reducing region **220.**

[0041] Radius **R5-a** and Radius **R5-b** indicate the radius of curvature or the blend from the thickened stress reducing region **220-a** and **220-b** towards the thinned perimeter region **222-a** and **222-b**. **R5-a** and **R5-b** in this embodiment may

generally be the same number and is generally between about 1.0 mm and about 1.4 mm, more preferably between about 1.1 mm and about 1.3 mm, and most preferably about 1.2 mm. However, it should be noted that in alternative embodiments of the present invention **R5-a** and **R5-b** may be different from one another without departing from the scope and content of the present invention so long as it falls within the radius ranges articulated above.

[0042] Radius **R3-a** and Radius **R3-b** indicate the radius of curvature or the blend from the thickened stress reducing region **220-a** and **220-b** towards the thinned intermediate region **218-a** and **218-b**. **R3-a** and **R3-b** in this embodiment may generally be the same number and also the same as the **R5-a** and **R5-b** above between about 1.0 mm and about 1.4 mm, more preferably between about 1.1 mm and about 1.3 mm, and most preferably about 1.2 mm. However, it should be noted that in alternative embodiments of the present invention **R3-a** and **R3-b** may be different from one another without departing from the scope and content of the present invention so long as it falls within the radius ranges articulated above.

[0043] It is worth noting here that the radius of the blend from the thickened stress reducing region **220** towards the thinned perimeter region **222** and the thinned intermediate region **218**, shown as **R5** and **R3** respectively, may generally be the same as one another. However, as previously mentioned, in alternative embodiments of the present invention, these numbers could differ from one another without departing from the scope and content of the present invention so long as they fall within the ranges above.

[0044] **FIGS. 6a** through **6L** of the accompanying drawings shows alternate geometries for the thickened stress reducing region **220.** In **FIG. 6a,** a substantially rectangular design is shown here, like the design previously shown that added the transition radii. **FIG. 6b** of the accompanying drawings shows an alternate outward taper design of the thickened stress reducing region **220** in accordance with an alternative embodiment of the present invention. **FIG. 6c** of the accompanying drawings shows an alternate inward taper design of the thickened stress reducing region **220** in accordance with an alternative embodiment of the present invention. **FIG. 6d** of the accompanying drawings shows an alternate outward taper with constant offset design of the thickened stress reducing region **220** in accordance with an alternative embodiment of the present invention. **FIG. 6e** of the accompanying drawings shows an alternate outward taper with inner offset design of the thickened stress reducing region **220** in accordance with an alternative embodiment of the present invention. **FIG. 6f** of the accompanying drawings shows an alternate outward taper with outer offset design of the thickened stress reducing region **220** in accordance with an alternative embodiment of the present invention. **FIG. 6g** of the accompanying drawings shows an alternate triangular chevron design of the thickened stress reducing region **220** in accordance with an alternative embodiment of the present invention. **FIG. 6h** of the accompanying drawings shows an alternate inward offset triangular chevron design of the thickened stress reducing region **220** in accordance with an alternative embodiment of the present invention. **FIG. 6i** of the accompanying drawings shows an alternate outward offset triangular chevron design of the thickened stress reducing region **220** in accordance with an alternative embodiment of the present invention. **FIG. 6j** of the accompanying drawings shows an alternate hemisphere design of the thickened stress reducing region **220** in accordance with an alternative embodiment of the present invention. **FIG. 6k** of the accompanying drawings shows an alternate organic design of the thickened stress reducing region **220** in accordance with an alternative embodiment of the present invention. **FIG. 6L** of the accompanying drawings shows an alternate depression channel taper design of the thickened stress reducing region **220** in accordance with an alternative embodiment of the present invention.

[0045] **FIGS. 7a** and **7b** show a rear view of the striking face portion **702** of a golf club head in accordance with an exemplary embodiment of the present invention. In **FIG. 7a**, a view is presented to provide a better visual of the various components of the striking face portion 702. In **FIG. 7a**, a thinned perimeter region **722** forms the outer perimeter of the striking face portion **702**. Inward from the thinned perimeter region **722**, we can see the thickened stress reducing region **720**. Inward from the thickened stress reducing region **720** is the thinned intermediate region **718**. Inward from the thinned intermediate region **718** is the central transition region **716**. Finally, at the geometric center of the striking face portion **702** is the thickened central region **714**. In addition to illustrating the various components of the striking face portion **702, FIG. 7a** also illustrates how the height of the various components can vary depending on where it is located on the face, and the previous measurements of the various component heights were only referring to a cross-sectional plane along the geometric center of the face as shown in **FIG. 1**. In one example, once can see that the height of the intermediate transition region **718** is generally smaller at the crown and sole portion of the striking face portion **702** when compared to the height of the intermediate transition region **718** at the heel and toe portion of the striking face portion **702**.

[0046] Alternatively speaking, it can be said that the striking face comprises a thickened central region **714** located near a geometric center of the striking face portion **702**, a central region **716** extending outward radially from the thickened central region **714**, a thinned intermediate region **718**, extending outward radially from the thickened central region **714**, a thickened stress reducing region **720** extending outward radially from the thinned intermediate region **714**, and finally a thinned perimeter region **722** extending outward radially from the thickened stress reducing region **720**.

[0047] To better illustrate the differences of the height of the various components along different portions of the face, a non-shaded rear view of the striking face portion **702** is provided in **FIG. 7b**. In addition to the above, **FIG. 7b** allows the radial distances of the various components to be shown in more detail, as all measurements are taken from the

geometric face center **108** (shown in **FIG. 1**) of the face; like the previous discussion regarding the location of the thickened stress reducing region **220** in **FIG. 2**. However, the distances provided here are not constrained in any specific cross-sectional plane **A-A'** like the previous discussion in **FIG. 2**, but rather a measurement of the minimum and maximum distances in any radial direction. In this rear view of the striking face portion **702** shown in **FIG. 7b**, we can see that the outer perimeter of the thickened central region **714** is generally located within a projected distance **D1** of between about 4.00 mm and about 14.0 mm from a geometric face center across any radial direction. The outer perimeter of the central transition region **716** may generally be located at a distance **D2** of between about 13.0 mm and about 30.0 mm from the geometric face center across any radial direction. The outer perimeter of the thinned intermediate region **718** may generally be located at a distance **D3** of between about 17.0 mm and about 40.0 mm from the face center across any radial direction. The outer perimeter of the thickened stress reducing region **720** may generally be located at a distance **D4** of between about 15.0 mm and about 46.0 mm from the face center across any radial direction. Finally, the outer perimeter of the thinned perimeter region **722** may generally be located at a distance **D5** of between about 25.50 mm and about 55.5 mm from the face center across any radial direction.

[0048] **FIG. 8** of the accompanying drawings shows a cross-sectional view of a golf club head **800**, in accordance with an alternative embodiment of the present invention, taken along cross-sectional line **A-A'** shown in **FIG. 1**. In this cross-sectional view of the present invention, the shape and geometry of upper thickened stress reducing region **820-a** is changed to be different from the lower thickened stress reducing region **820-b** to help address high stress levels that generally occur in the upper crown region of the striking face portion **802**. In order to illustrate this difference in height and radius of curvature of the blend between the upper thickened stress reducing region **820-a** and the lower thickened stress reducing region **820-b,** an enlarged view of the striking face portion **802** is provided in **FIG. 9.**

[0049] **FIG. 9** of the accompanying drawings shows an enlarged view of the cross-sectional view of the striking face portion **802** of the golf club head **800** shown in **FIG. 8**. In this enlarged cross-sectional view, only the features that differentiate this embodiment of the present invention from prior embodiments have been highlighted. In this alternative embodiment of the present invention, the height **H4-a** of the upper thickened stress reducing region **820-a** is no longer the same as height **H4-b** of the lower thickened stress reducing region **820-b.** In fact, the height **H4-a** of the upper thickened stress reducing region **820-a** is reduced to address stress raisers that often arise in the upper part of the striking face portion **802**. Resultingly, due to the reduction in height **H4-a** of the upper thickened stress reducing region **820-a,** the height **H3-a** of the upper thinned intermediate region **818-a** is increased. In addition to the above, to further reduce the stress, the radius **R3-a** between the upper thickened stress reducing region **820-a** and the upper thinned intermediate region **818-a** is increased to create a more gradual blend at this location. Finally, unrelated to addressing the stress levels of the striking face portion **802**, the radius **R5-a** between the upper thickened stress reducing region **820-a** and the upper thinned perimeter region **822-a** is also increased to soften the blend to allow for ease of manufacturability.

[0050] Diving into the numbers, the height **H4-a** of the upper thickened stress reducing region **820-a** in accordance with this embodiment of the present invention, may generally be between about 3.1 mm to about 3.9 mm, more preferably between about 3.3 mm top about 3.7 mm, and most preferably about 3.5 mm, which is about 0.5 mm shorter than its counter part **H4-b** located at the lower thickened stress reducing region **820-b**. The height **H3-a** of the upper thinned intermediate region **818-a** in accordance with this current embodiment of the present invention, may generally be between about 6.5 mm to about 8.5 mm, more preferably between about 7.0 mm to about 8.0 mm, and most preferably about 7.5 mm, which makes it approximately the same as it's counter part **H3-b** located at the lower thinned intermediate region **818-b**.

[0051] In addition to changes in the height, the radius **R3-a** and **R5-a** of the upper thickened stress reducing region **820-a** have also been altered to be different from its counter part at the lower thickened stress reducing region **820-b**. By increasing the radius of curvature of **R3-a,** the more gradual transition between the two neighboring components help eliminate stress risers that could occur at that portion of the striking face portion **802.** The **R3-a** in accordance with this embodiment of the present invention may generally be greater than about 1.50 mm, more preferably greater than about 1.60 mm, and more preferably greater than about 1.70 mm. The radius of curvature **R5-a** on the other hand, is also increased to be more gradual, but this time for manufacturing reasons allowing for a less pronounced region of reduced casting flow. Thus **R5-a** in accordance with this embodiment of the present invention may generally be greater than about 1.50 mm, more preferably greater than about 1.60 mm, and more preferably greater than about 1.70 mm. Hence it is worth noting here that in this embodiment, it is critical that the radius of curvature of the transition of the upper thickened stress reducing region **820-a** be greater than a radius of curvature of the transition of the lower thickened stress reducing region **820-b,** as the striking face portion **802** often exhibits higher stress levels at that location.

[0052] **FIGS. 10a** and **10b** show a rear view of the striking face portion **1002** of a golf club head in accordance with an exemplary embodiment of the present invention. In **FIG. 10a,** a shaded view is presented to provide a better visual of the various components of the striking face portion **1002.** In this shaded view shown in **FIG. 10a** and the wireframe view shown in **FIG. 10b,** the adjustments to the upper thickened stress reducing region **1020-a** can be seen, and its height **H4-a** (shown in **FIG. 9**) is smaller when compared to the remaining portions of the thickened stress reducing

region **1020-a**. Another thing worth noting here that was previously not mentioned is that in the current exemplary embodiment of the present invention, the entire thickened stress reducing region **1020** takes on the shape of a ring encircles the central portion of the striking face portion **1002.** However, in alternative embodiments of the present invention, the thickened stress reducing region **1020** may not need to encircle the striking face portion **1002** completely and can partially surround the striking face portion without departing from the scope and content of the present invention. Alternatively speaking, the thickened stress reducing region **1020** may only encircle less than 360 degrees around the face, less than about 270 degrees around the face, less than 180 degrees around the face, all without departing from the scope and content of the present invention.

[0053] FIGS. 11 through 15 of the accompanying drawings shows a golf club head in accordance with a further alternative embodiments of the present invention, wherein the thickened stress reducing region is formed out of multiple materials to achieve the further improve upon the stress reducing capabilities of the thickened stress reducing region.

[0054] FIG. 11 of the accompanying drawings shows an exploded perspective view of a golf club head **1100** in accordance with a further alternative embodiment of the present invention, wherein the thickened stress reducing region is further formed out of multiple materials. In this exploded cross-sectional view of the golf club head **1100** shown in **FIG.** 11, the body portion **1103** has a pocket **1134** with a perimeter ledge **1132,** wherein the perimeter ledge **1132** helps receive a gasket **1130** and the gasket **1130** separates the face insert **1104** from the perimeter ledge 1132. The combination of the perimeter ledge **1132,** the gasket **1130,** and the perimeter of the face insert **1104** combine to create the thickened stress reducing region (shown in FIG. 12) in this embodiment of the present invention.

[0055] FIG. 12 of the accompanying drawings shows a cross-sectional view of a golf club head **1200** in accordance with an alternative embodiment of the present invention, taken along cross-sectional line A-A' shown in FIG. 1. In this cross-sectional view of the golf club head **1200,** we can see that the golf club head **1200,** similar to previous embodiments, can be split into a frontal striking face portion **1202** and a rear body portion 1203. The frontal striking face portion **1202** is further comprised out of an opening pocket **1234** adapted to receive a face insert **1204** like previous embodiments. However, in this embodiment of the present invention, instead of having the face insert **1204** being welded directly onto the perimeter of the opening pocket **1234** as it is commonly known in the industry, the opening pocket **1234** creates a perimeter ledge **1232** that is recessed from the external plane of the striking face, and the perimeter ledge **1232** is adapted to receive a gasket **1230** that separates the face insert **1204** from the perimeter ledge 1232. In this cross-sectional view of the present invention, we can clearly see that the combination of the perimeter ledge **1232,** the gasket **1230,** and the perimeter of the face insert **1204** combine to create the thickened stress reducing region 1220. The thickened stress reducing region **1220** in this embodiment may further be defined as an upper thickened stress reducing region **1220-a** and a lower thickened stress reducing region **1220-b,** both of which have dimensional measurements similar to previous embodiments described previously.

[0056] In this embodiment of the present invention, the face insert 1204, gasket 1230, and perimeter ledge 1232may generally be bonded together using some type of a glue adhesive. However, in alternative embodiments of the present invention, the three components that form the thickened stress reducing region 1220 that may have different material properties, may also rely on alternate bonding techniques such as brazing, swaging, or even mechanical fastening all without departing from the scope and content of the present invention so long as the face insert 1204 is not directly bonded to the perimeter ledge 1232 itself.

[0057] The material used to create the gasket **1230** is also critical in this embodiment of the present invention, as may help reduce stress around the perimeter of the frontal striking face portion 1202. In this embodiment, the material used to create the gasket may generally have a modulus of elasticity, or Young's modulus of between about 5 GPa and about 120 GPa, more preferably between about 10 GPa and about 80 GPa, and most preferably about 30 GPa. In addition to the above, the gasket 1230may also have density of less than about 2,000 g/cc, more preferably less than about 1,900 g/cc, and most preferably less than about 1,800 g/cc, all without departing from the scope and content of the present invention.

[0058] In order to illustrate some of the dimensions of the gasket **1230** itself, an enlarged cross-sectional view of the frontal striking face portion **1202** is provided in FIG. 13. In this view shown in FIG. 13, we can see that the gasket **1230** may have an upper gasket height H6-a and a lower gasket height H6-b that are approximately the same. **H6-a** and **H6-b** in accordance with this embodiment of the present invention may generally be between about 3.0 mm to about 7.0 mm, more preferably between about 4.0 mm to about 6.0 mm, and most preferably about 5.0 mm. FIG. 13 also shows the thickness T6 of the gasket, illustrated as an upper gasket thickness T6-a and a lower gasket thickness T6-b, both of which are approximately the same in this embodiment of the present invention. Hence, **T6-a** and **T6-b** in accordance with this embodiment of the present invention may generally be between about 0.3 mm to about 0.7 mm, more preferably between about 0.4 mm to about 0.6 mm, and most preferably about 0.5 mm.

[0059] Based on the thickness and height measurements above, it can be said that the gasket **1230** may have a T over H Ratio defined by Equation (2) below:

$$T\ over\ H\ Ratio = \frac{Thickness\ \boldsymbol{T6}\ of\ Gasket}{Height\ \boldsymbol{H6}\ of\ Gasket} \qquad \text{Eq. (2)}$$

[0060] The T over H Ratio of the gasket **1230** may generally be between about 0.04 and about 0.23, more preferably between about 0.06 to about 0.15, and most preferably about 0.1.

[0061] It should also be noted that although the thickness and height of the gasket **1230** is the same for the upper portion of the gasket **1230** and the lower portion of the gasket **1230,** the thickness and height of the gasket could be different from one another without departing from the scope and content of the present invention. In one exemplary embodiment, the upper portion of the gasket **1230** could be thicker while the lower portion of the gasket 1230 could be thinner, to help the striking face portion1202 deflect more downward upon impact with a golf ball to reduce lower launch and spin without departing from the scope and content of the present invention. Needless to say, if the thickness of the gasket **1230** are to be manipulated, the depth of the perimeter ledge **1232** is generally adjusted accordingly to create a seamless flush look of the golf club head in its resting neutral position. Alternatively, the thickness of the material could be maintained, but the modulus adjusted to achieve the same effects without departing from the scope and content of the present invention.

[0062] **FIG. 14** of the accompanying drawing shows a rear view of a striking face portion **1402** of a golf club head in accordance with a further alternative embodiment of the present invention. In this embodiment of the present invention shown in FIG. 14, we can see that the frontal striking face portion **1402** may have a thickened stress reducing region **1420** that only partially forms a portion of the ring as shown in previous embodiments. More specifically, the thickened stress reducing region **1420** shown in this embodiment of the present invention shown in FIG. 14 only exists in the upper crown region and the lower sole region via the upper thickened stress reducing region **1420-a** and the lower thickened stress reducing region **1420-b.**

[0063] The rear view of the striking face portion **1402** shown here in FIG. 14 illustrates the thickened central region **1414,** the central transition region **1416,** the thinned intermediate region **1418,** and the thinned perimeter region **1422,** in addition to the upper thickened stress reducing region **1420-a** and the lower thickened stress reducing region **1420-b.** This rear view of the striking face portion **1402** shows that the upper thickened stress reducing region **1420-a** and the lower thickened stress reducing region **1420-b** combining with one another to form only a portion of a ring geometry as shown previously in FIG. 7. Alternatively speaking, it can be said that the thickened stress reducing region **1420** only partially surrounds the thinned intermediate region **1418** instead of fully surrounding it. It can also be said that the thickened stress reducing region forms at less than 360 degrees radially around the perimeter of the thinned intermediate region **1418.**

[0064] In addition to highlighting the now split upper thickened stress reducing region **1420-a** and the lower thickened stress reducing region **1420-b** visually, **FIG. 14** of the accompanying drawings also creates a clock grid **1440** to more specifically identify the locations of the upper thickened stress reducing region **1420-a** and the lower thickened stress reducing region **1420-b** relative to the geometric face center **1408.** More specifically, the clock grid **1440** has a 12 o'clock ray **1440-12,** a 1 o'clock ray **1440-1,** a 2 o'clock ray **1440-2,** a 3 o'clock ray **1440-3,** a 4 o'clock ray **1440-4,** a 5 o'clock ray **1440-5,** a 6 o'clock ray **1440-6,** a 7 o'clock ray **1440-7,** an 8 o'clock ray **1440-8,** a 9 o'clock ray **1440-9,** a 10 o'clock ray **1440-10,** and an 11 o'clock ray **1440-11;** dividing the various portions of the striking face portion **1402** into twelve separate regions radially.

[0065] Once the clock grid **1440** is established, we can see that in this exemplary embodiment of the present invention the upper thickened stress reducing region 1420-a is positioned at an upper region located between the 10 o'clock ray **1440-10** and the 2 o'clock ray **1440-2.** The lower thickened stress reducing region **1420-b** is positioned at a lower region located between the 4 o'clock ray **1440-4** and the 8 o'clock ray **1440-8.** This range of location for the upper thickened stress reducing region **1420-a** and the lower thickened stress reducing region **1420-b** is critical to the present invention because it preserves the structural rigidity and reduces the stress levels of the striking face portion **1402** only at locations that have been identified to need it and eliminates it from locations that do not need such a feature.

[0066] Please note here that the boundaries of the clock grid is always referenced in a clockwise direction, as to avoid confusion when referencing the ranges in this application.

[0067] Alternatively speaking, it can be said that the thickened stress reducing region is located only at a region consisting of an upper region between the 10 o'clock ray **1440-10** and the 2 o'clock ray **1440-2** and a lower region between the 4 o'clock ray **1440-4** and the 8 o'clock ray **1440-8.**

[0068] **FIG. 15** of the accompanying drawings shows a rear view of a striking face portion **1502** of a golf club head in accordance with a further alternative embodiment of the present invention. In this embodiment of the present invention, the upper thickened stress reducing region **1520-a** is located at an upper region between the 9 o'clock ray **1540-9** and the 2 o'clock ray while the lower thickened stress reducing region **1520-b** is located at a lower region between the 3 o'clock ray **1540-3** and the 9 o'clock ray **1540-9** without departing from the scope and content of the present invention. It should be noted here that the boundaries of the upper thickened stress reducing region **1520-a** and the lower thickened

stress reducing region **1520-b** may have some overlap with one another, they are discrete components with separation to stay within the scope and content of the present invention.

[0069] Alternatively speaking, it can be said that the thickened stress reducing region is located only at a region consisting of an upper region between the 9 o'clock ray **1540-9** and the 2 o'clock ray **1540-2** and a lower region between the 3 o'clock ray **1540-3** and the 9 o'clock ray **1540-9.**

[0070] **FIG. 16** of the accompanying drawings shows an enlarged cross-sectional view of a striking face portion **1602** in accordance with an alternative embodiment of the present invention, allowing the non-360 degree thickened stress reducing region **1620** to be shown in more detail. In this view, we can see that the actual cross-sectional view of the striking face portion **1602** containing an upper thinned intermediate region **1618-a**, a lower thinned intermediate region **1618-b**, an upper thickened stress reducing region 1620-**a,** a lower thickened stress reducing region **1620-b**, an upper thinned perimeter region **1622-a,** and a lower thinned perimeter region **1622-b** does not look much different than the cross-sectional views of the striking face portion **802** shown in previous embodiments of the present invention in **FIG. 9**. However, a closer examination of the cross-sectional view of the striking face portion **1602** will show that an internal toe region of the striking face portion **1602** does not contain any feature that resembles a thickened stress reducing region **1620,** like the previous embodiments shown in **FIGS. 14** and **15.**

[0071] **FIG. 17** of the accompanying drawings shows a rear view of a striking face portion **1702** of a golf club head in accordance with a further alternative embodiment of the present invention. In this embodiment of the present invention, we can see the familiar clock grid **1740** having a 12 o'clock ray **1740-12**, a 1 o'clock ray **1740-1**, a 2 o'clock ray **1740-2**, a 3 o'clock ray **1740-3,** a 4 o'clock ray **1740-4**, a 5 o'clock ray **1740-5**, a 6 o'clock ray **1740-6**, a 7 o'clock ray **1740-7,** an 8 o'clock ray **1740-8**, a 9 o'clock ray **1740-9**, a 10 o'clock ray **1740-10,** and an 11 o'clock ray **1740-11;** dividing the various portions of the striking face portion **1702** into twelve separate regions radially. However, unlike previous embodiments wherein the thickened stress reducing region **1420** (shown in **FIG. 14**) completely disappears at the heel and toe portion of the striking face portion **1702,** the thickened stress reducing region **1720** shown in **FIG. 17** maintains a minimal amount of wall thickness at the heel and toe portions of the striking face portion **1702.**

[0072] In this embodiment of the present invention shown in **FIG. 17,** it can be said that the thickened stress reducing region **1720** is one continuous feature, having an upper thickened stress reducing region **1720-a**, a lower thickened stress reducing region **1720-b**, a toe thickened stress reducing region **1720-c**, and a heel thickened stress reducing region **1720-d**, wherein the toe thickened stress reducing region **1720-c** and the heel thickened stress reducing region **1720-d** have a relatively smaller thickness compared to the upper thickened stress reducing region **1720-a** and the lower thickened stress reducing region **1720-b.**

[0073] Alternatively speaking, it can be said that in this embodiment of the present invention, the thickened stress reducing region may have an area of reduced thickness between the 1 o'clock ray **1740-1** and the 4 o'clock ray **1740-4** forming the toe thickened stress reducing region **1720-c,** as well as an area of reduced thickness between the 8 o'clock ray **1740-8** and the 10 o'clock ray **1740-10** forming the heel thickened stress reducing region **1720-d.**

[0074] **FIG. 18** of the accompanying drawings shows an enlarged cross-sectional view of a striking face portion **1802** in accordance with an alternative embodiment of the present invention, allowing the reduced thickness thickened stress reducing region **1820** to be shown in more detail. Similar to previous embodiments, this cross-sectional view of the striking face portion **1802** contains an upper thinned intermediate region **1818-a,** a lower thinned intermediate region **1818-b,** an upper thickened stress reducing region **1820-a,** a lower thickened stress reducing region **1820-b,** an upper thinned perimeter region **1822-a,** and a lower thinned perimeter region **1822-b.** However, this view shown in **FIG. 18** allows the reduced thickness of the toe thickened stress reducing region **1820-c** to be shown.

[0075] **FIG. 19** of the accompanying drawings shows a rear view of a striking face portion **1902** of a golf club head in accordance with a further alternative embodiment of the present invention. In this embodiment of the present invention, the thickened stress reducing region **1920** that extends outward radially from said thinned intermediate region **1918.** However, in this embodiment of the present invention, the thickened stress reducing region **1920** has a horseshoe shape instead of a ring shape to help accommodate a different shaped face insert **1904** capable of improving the performance of the striking face portion **1902.** More specifically, it can be seen in **FIG. 19** that the thickened stress reducing region **1920** may have two upper stress reducing region **1920a,** designated as a toe side upper thickened stress reducing region **1920-a1** and a heel side upper thickened stress reducing region **1920-a2.** It should be noted that both the toe side upper thickened stress reducing region **1920-a1** and the heel side upper thickened stress reducing region **1920-a2** connects directly to the crown transition portion of the striking face portion **1902,** meaning that they do not directly connect with one another at the crown portion of the striking face portion **1902** to form a complete ring, rather it creates a discontinuity that forms an incomplete circle. Alternatively, it can be said that the thickened stress reducing region **1920** forms the horseshoe shaped described above. Consequently, the horseshoe shaped thickened stress reducing region **1920** creates an opening near an upper crown portion of the striking face portion **1902**.

[0076] The toe side upper thickened stress reducing region **1920-a1** here connects to the toe side thickened stress reducing region **1920-c** on the toe side of the striking face portion **1902,** which in turn connects to the lower thickened stress reducing region **1920-b** on the sole side of the striking face portion **1902,** which in turn connects to the heel side

thickened stress reducing region **1920-d**, but remains disconnected at the upper crown region of the striking face portion **1902** to accommodate a taller face insert **1904** that is designed to be taller at the central region of the face insert **1904** to help remove the weld line between the face insert **1904** and the perimeter region **1903** (shown in **FIG. 20**) further away from a location that generates high stresses in this current design. In order to further illustrate the shape of the perimeter region **1903** and the central opening **2050** (shown in **FIG. 20), FIG. 20** is provided with the face insert **1904** removed.

[0077] Finally, it can be seen here in **FIG. 20** that a cross-sectional line **22 - 22'** is drawn vertically through the striking face portion **1902** passing through the geometric face center **1908** of the striking face portion **1902.** The cross-sectional view of the striking face portion **1902** of the golf club head shown later **FIG. 22** allows the various dimensions of the striking face portion **1902** to be shown in more detail later.

[0078] **FIG. 20** of the accompanying drawings shows a rear view of a striking face portion **2002** of a golf club head in accordance with a further alternative embodiment of the present invention, but with the face insert **1904** (shown in **FIG. 19**) removed, allowing the central opening **2050** to be shown more clearly together with the boundaries of the face perimeter **2006.** The striking face portion **2002** shown here in **FIG. 20,** in order to pair with the horseshoe shaped thickened stress reducing region **2020,** has a central opening **2050** that substantially matches the internal circumference of the horseshoe shaped thickened stress reducing region **2020.** In addition to showing the boundaries of the central opening **2050**, **FIG. 20** of the accompanying drawings also shows a distance between a top ledge of the central opening **2050** to the crown leading edge of the striking face portion **2002,** as indicated by distance **D6** shown here. Distance **D6** shown in **FIG. 20** illustrates how that distance is reduced compared to a prior art golf club head, and may generally be less than about 1.25 mm, more preferably less than about 1.00 mm, and most preferably less than about 0.95 mm. The distance **D6** as shown in this embodiment of the present invention is generally taken as the y-axis shown in **FIG. 1,** taken at the geometric center **2008** of the face, illustrated by the broken line shown in **FIG. 20.**

[0079] Traditionally shaped face inserts **104** (shown in **FIG. 1**) may generally have a substantially oval shape designed to match the outline of the striking face portion **102** (shown in **FIG. 1**) having an aspect ratio of about 2.0. However, the face insert **2104** in accordance with this present embodiment of the present invention, due it's taller face, may have an aspect ratio between about 1.3 to about 1.7, more preferably between about 1.4 to about 1.6, and most preferably about 1.5. **FIG. 21** of the accompanying drawings shows a rear view of just the face insert **2102** in accordance with this alternative embodiment of the present invention. The aspect ratio of the face insert **2104** may generally be defined as the ratio of the width **D7** of the face insert **2104** divided by the height **D8** of the face insert **2104.** In this one exemplary embodiment of the present invention, the width **D7** of the face insert **2104** may generally be between about 60 mm to about 64 mm, more preferably between about 61 mm to about 63 mm, and most preferably about 62 mm. The height **D8** of the face insert **2104** may generally be between about 40 mm to about 44 mm, more preferably between about 41 mm to about 43 mm, and most preferably about 42 mm. Needless to say, because the central opening **2050** (Shown in **FIG. 20**)

[0080] Alternatively speaking, it can be said that the striking face portion **1902** can be located at a frontal portion of the golf club head that is adapted to impact a golf ball and a body portion that is attached to the rear of the striking face portion **1902.** The striking face portion **1902** has a face perimeter **2006** that has a central opening **2050** wherein the face perimeter **2006** has a horseshoe shaped thickened stress reducing region **2020** having a fourth thickness. The striking face portion **1902** further comprises a face insert **2104** adapted to engage the central opening **2050,** wherein the face insert **2104** has a thickened central region located near a geometric center **2108** of the face insert **2104** that defines a first thickness. The thickened stress reducing region **2020** within the face perimeter **2006** of the striking face portion **1902** is formed in a way such that no part of the thickened stress reducing region **2020** engages the face insert **2104.** The fourth thickness of the thickened stress reducing region **2020** in accordance with a preferred embodiment of the present invention is greater than a first thickness of the central region of the face insert **2104.**

[0081] **FIG. 22** of the accompanying drawings shows an enlarged cross-sectional view of a striking face portion **2202** of a golf club head taken along cross-sectional line **22-22'** shown in **FIG. 19.** In this cross-sectional view of the striking face portion **2202,** we can see that the face insert **2204** is located at a distance **D6** away from the crown leading edge of the striking face portion **2202.** The crown leading edge, as defined in the present invention, is the location of the striking face portion **2202** that begins to stop being substantially planar with the striking face plane, and begins transitioning into the crown. The values for distance **D6** has already been discussed above, thus won't need to be repeated here. In addition to distance **D6, FIG. 22** of the accompanying drawings also shows a distance **D9,** which measures the location of the top edge of the face insert **2204** as measured from a crown apex point **2252**. The crown apex point **2252** is generally defined as the highest point of the crown, occurring at the central cross-sectional plane **22-22'** shown in **FIG. 19**. Distance **D9** as shown in this exemplary embodiment of the present invention, may generally be less than about 10 mm, more preferably less than about 9 mm, and most preferably less than about 8 mm, all without departing from the scope and content of the present invention.

[0082] Because cross-sectional line **22-21'** is located at the geometric face center 1908 (shown in **FIG. 19**), it is bisecting the club head at a location wherein the thickened stress reducing region **2220** is discontinuous, thus no actual

thickness of the upper thickened stress reducing region can be shown in this cross-sectional view. **FIG. 22** does, however, show a thickness for the lower thickened stress reducing region **2220-b** having a thickness **T4-b** as in a similar thickness as previously discussed. On the top portion of the club head, despite not being able to se the upper thickened stress reducing region **1920-a** (shown in **FIG. 19**) thickness, the toe side upper thickened stress reducing region **2220-a1** can be seen in the background being directly connected to the crown transition portion.

[0083] **FIG. 22** of the accompanying drawings also shows a thickness of the upper thinned perimeter region **2218-a** having a thickness **T3-a** that is different from the prior embodiments of the present invention. The increased thickness of the upper thinned perimeter region **2218-a** is necessary to alleviate some of the higher stresses at that specific location on the striking face portion **2202** when it impacts a golf ball. Thickness **T3-a** in accordance with this alternative embodiment of the present invention may generally be between 2.3 mm to about 2.6 mm, more preferably between about 2.4 mm to about 2.5 mm, and most preferably about 2.45 mm, all without departing from the scope and content of the present invention. This location of the upper thinned perimeter region **2218-a** may generally extend further up the striking face portion **2202** than in other embodiment wherein a thickened stress reducing region **2220** forms an entire ring.

[0084] **FIG. 23** of the accompanying drawings shows an exploded perspective view of a golf club head **2300** in accordance with this alternative embodiment of the present invention. In the exploded view shown in **FIG. 23**, the face insert **2304** has been moved away from the face perimeter **2306** exposing the central opening **2350,** allowing the relationship between these joined components to be shown more clearly. In addition to the above, the exploded view of the golf club head **2300** shown in **FIG. 23** allows the distance **D6** between the top ledge of the central opening and the crown leading edge to be shown in another perspective.

[0085] It should be noted that most of the embodiments discussed here aims to create a releasable hosel hole cover, however, all of these embodiments may include glue to make the hosel hole cover stay within the hosel hole, removing the ability to remove the hosel hoe cover without departing from the scope and content of the present invention.

[0086] Other than in the operating example, or unless otherwise expressly specified, all of the numerical ranges, amounts, values and percentages such as those for amounts of materials, moment of inertias, center of gravity locations, loft, draft angles, various performance ratios, and others in the aforementioned portions of the specification may be read as if prefaced by the word "about" even though the term "about" may not expressly appear in the value, amount, or range. Accordingly, unless indicated to the contrary, the numerical parameters set forth in the above 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.

[0087] Notwithstanding that the numerical ranges and parameters setting forth the broad scope of the invention are approximations, the numerical values set forth in the specific examples are reported as precisely as possible. Any numerical value, however, inherently contains certain errors necessarily resulting from the standard deviation found in their respective testing measurements. Furthermore, when numerical ranges of varying scope are set forth herein, it is contemplated that any combination of these values inclusive of the recited values may be used.

[0088] It should be understood, of course, that the foregoing relates to exemplary embodiments of the present invention and that modifications may be made without departing from the spirit and scope of the invention as set forth in the following claims.

Claims

1. A golf club head comprising:

a striking face portion, located at a frontal portion of said golf club head, adapted to impact a golf ball; and
a body portion, attached to a rear of said striking face portion,
wherein said striking face portion further comprises;

a frontal striking surface, wherein said frontal striking surface is substantially planar, and
an internal rear surface,
wherein said frontal striking surface and said internal rear surface combine to further comprises;

a thickened central region, located near a geometric center of said striking face portion, having a first thickness,
a central transition region, extending outward radially from said thickened central region, having a variable thickness,
a thinned intermediate region, extending outward radially from said central transition region, having a

third thickness,
a thickened stress reducing region, extending outward radially from said thinned intermediate region, having a fourth thickness, and
a thinned perimeter region, extending outward radially from said thickened stress reducing region, having a fifth thickness,

wherein said thickened stress reducing region forms a horseshoe shaped ring, protruding rearward from said internal rear surface of said striking face portion, and
wherein said fourth thickness is greater than said first thickness.

2. A golf club head according to claim 1, wherein an opening in said horseshoe shaped ring is located near a crown transition portion of said striking face portion.

3. A golf club head according to claim 1 or 2, wherein said thickened stress reducing region further comprises;

a toe side upper thickened stress reducing region,
a toe side thickened stress reducing region,
a lower thickened stress reducing region,
a heel side thickened stress reducing region, and
a heel side upper thickened stress reducing region,
wherein said toe side upper thickened stress reducing region and said heel side upper thickened stress reducing region are discontinuous from one another.

4. A golf club head according to claim 3 when dependent on claim 2, wherein said toe side upper thickened stress reducing region connects directly to said crown transition portion.

5. A golf club head according to claim 4 or claim 3 when dependent on claim 2, wherein said heel side upper thickened stress reducing region connects directly to said crown transition portion.

6. A golf club head according to any of claims 1-5, wherein said thickened stress reducing region has a T over H ratio of between about 0.6 to 1.1, said T over H ratio defined as;

$$T\ over\ H\ Ratio = \frac{Thickness\ \boldsymbol{T4}\ of\ Thickened\ Stress\ Reducing\ Region}{Height\ \boldsymbol{H4}\ of\ Thickened\ Stress\ Reducing\ Region}.$$

7. A golf club head according to claim 6, wherein said T over H ratio is between about 0.7 to about 0.9.

8. A golf club head according to claim 7, wherein said T over H ratio is about 0.8.

9. A golf club head according to any of the preceding claims wherein said striking face portion further comprises;

a central opening,
and wherein said golf club head further comprises
a face insert adapted to engage said central opening,
wherein no part of said thickened stress reducing region engages said face insert.

10. A golf club head according to claim 9, wherein a top ledge of said central opening is located less than about 1.5 mm away from a crown leading edge of said striking face portion or less than about 1.0 mm away from said crown leading edge of said striking face portion or less than about 0.9 mm away from said crown leading edge of said striking face portion.

11. A golf club head according to claim 9 or 10, wherein said face insert has an aspect ratio of between about 1.3 to about 1.7 or between about 1.4 to about 1.6 or of about 1.5.

12. A golf club head according to any of claims 9-12, wherein a top ledge of said central opening is located less than about 10 mm away from a crown apex or less than about 9 mm away from a crown apex or less than about 8 mm away from a crown apex.

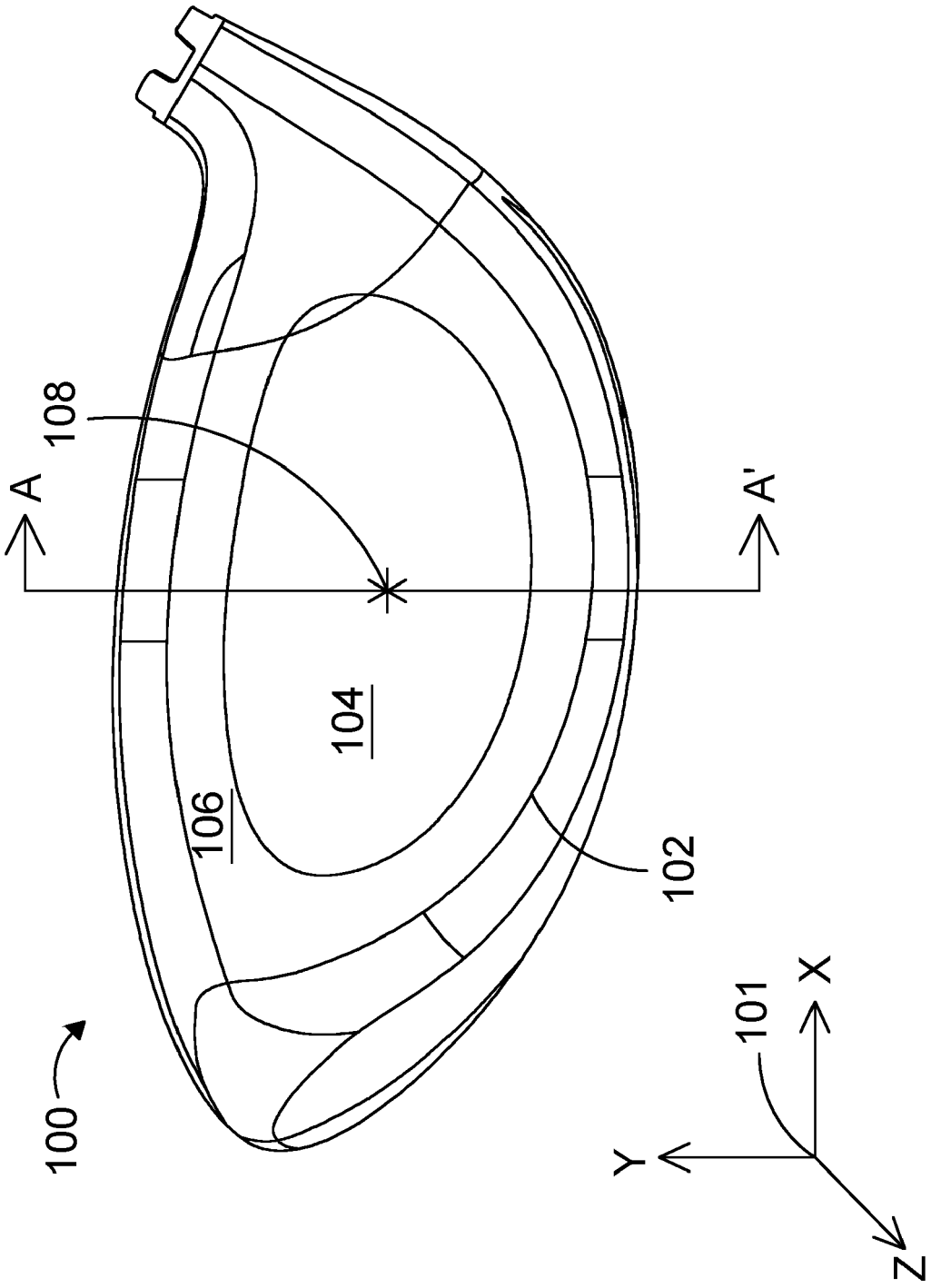


FIG. 1

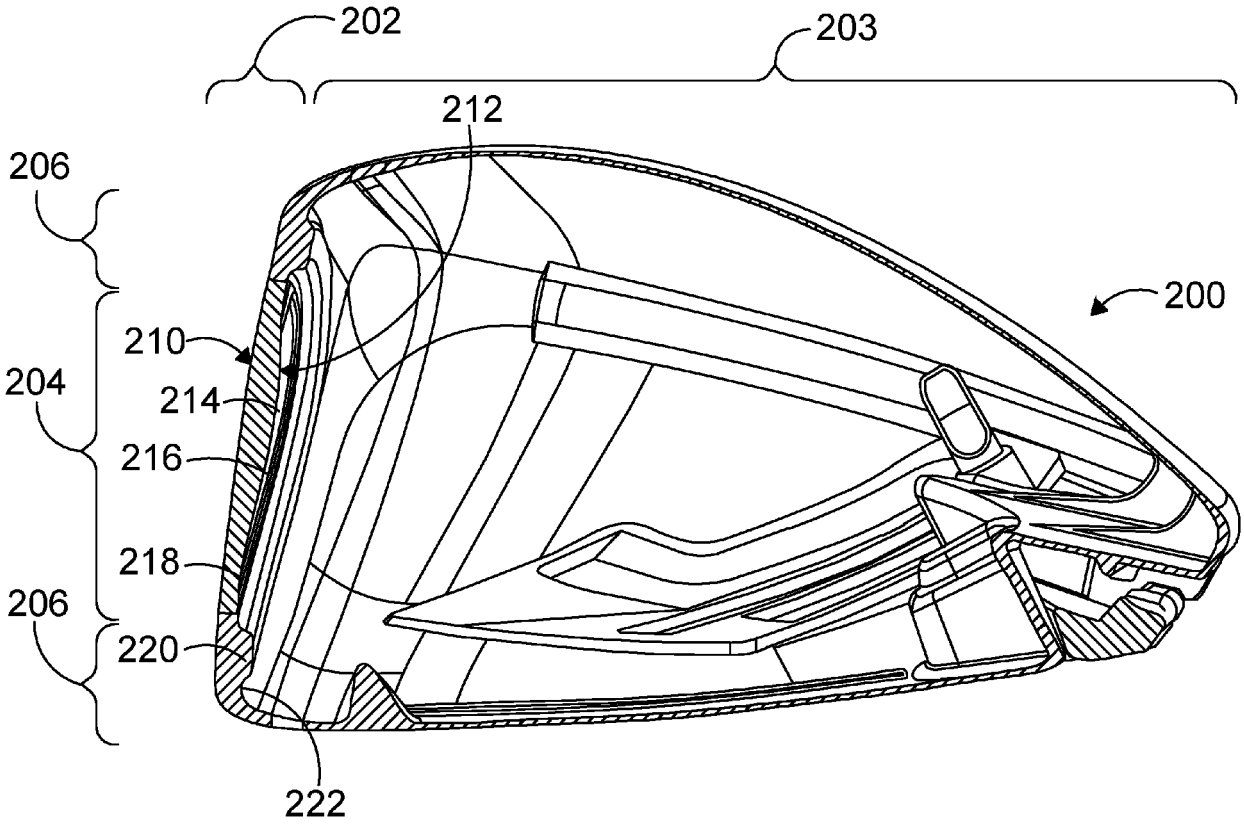
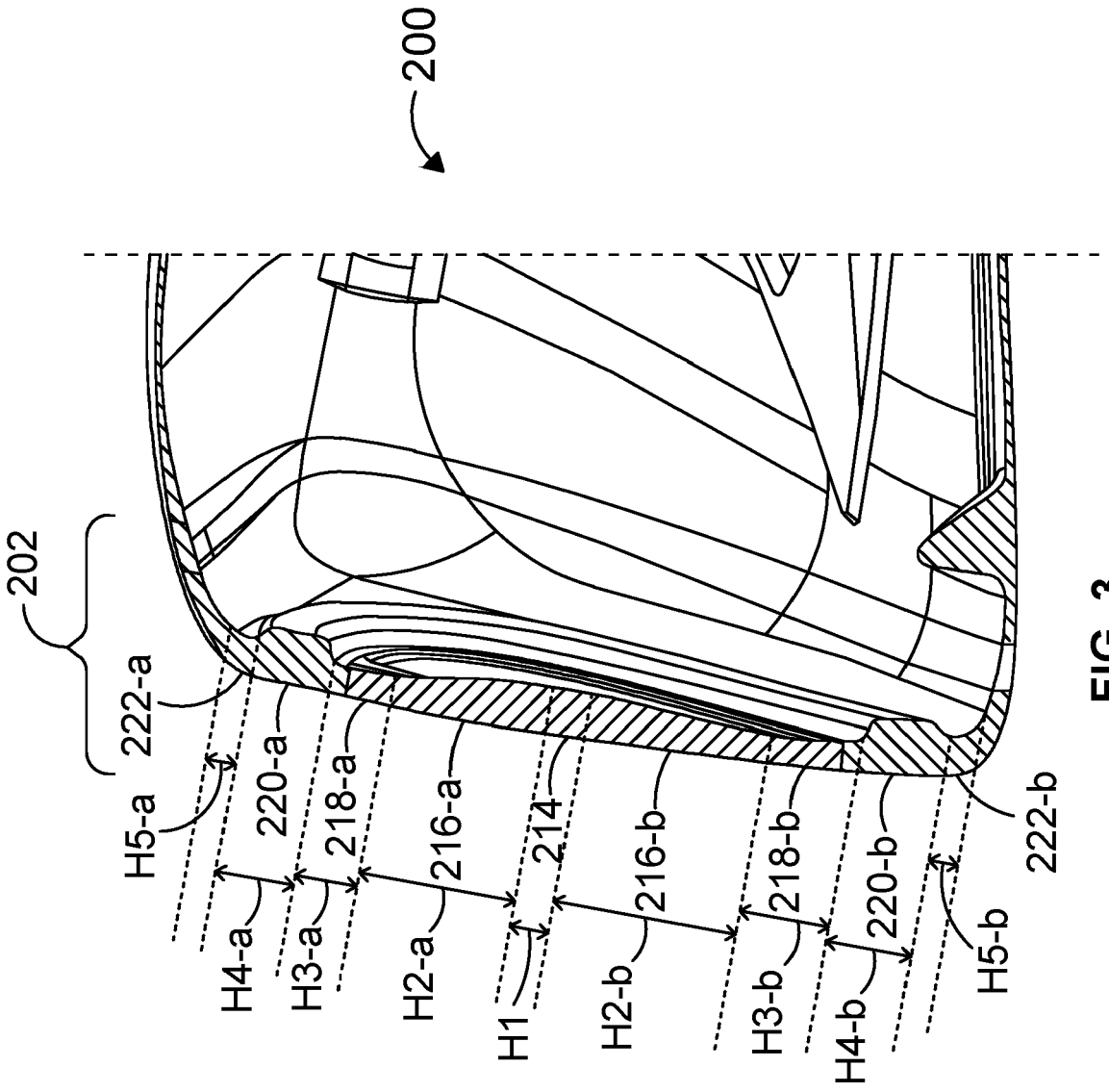


FIG. 2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202
222-a
220-a
218-a
216-a
214
216-b
218-b
220-b
222-b
H5-a
H4-a
H3-a
H2-a
H1
H2-b
H3-b
H4-b
H5-b

FIG. 3

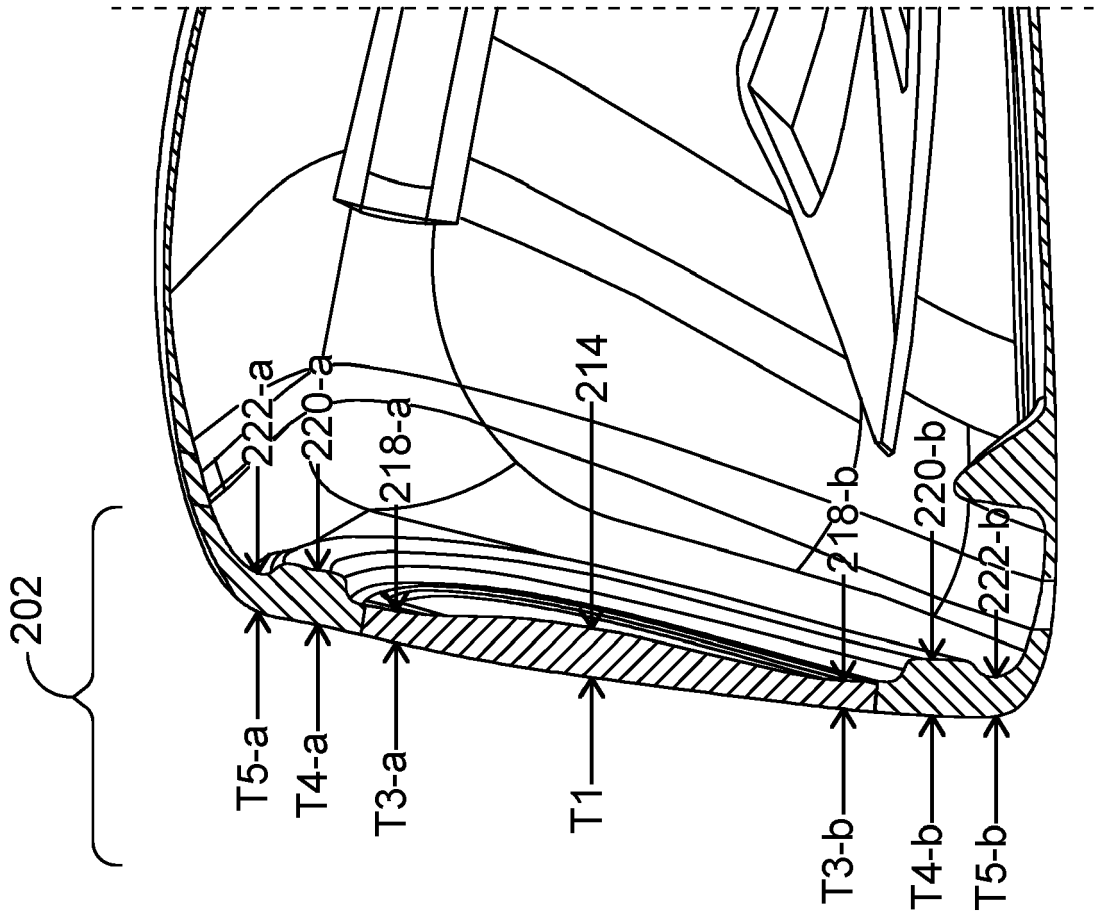

202
T5-a
T4-a
T3-a
T1
T3-b
T4-b
T5-b
222-a
220-a
218-a
214
218-b
220-b
222-b

FIG. 4

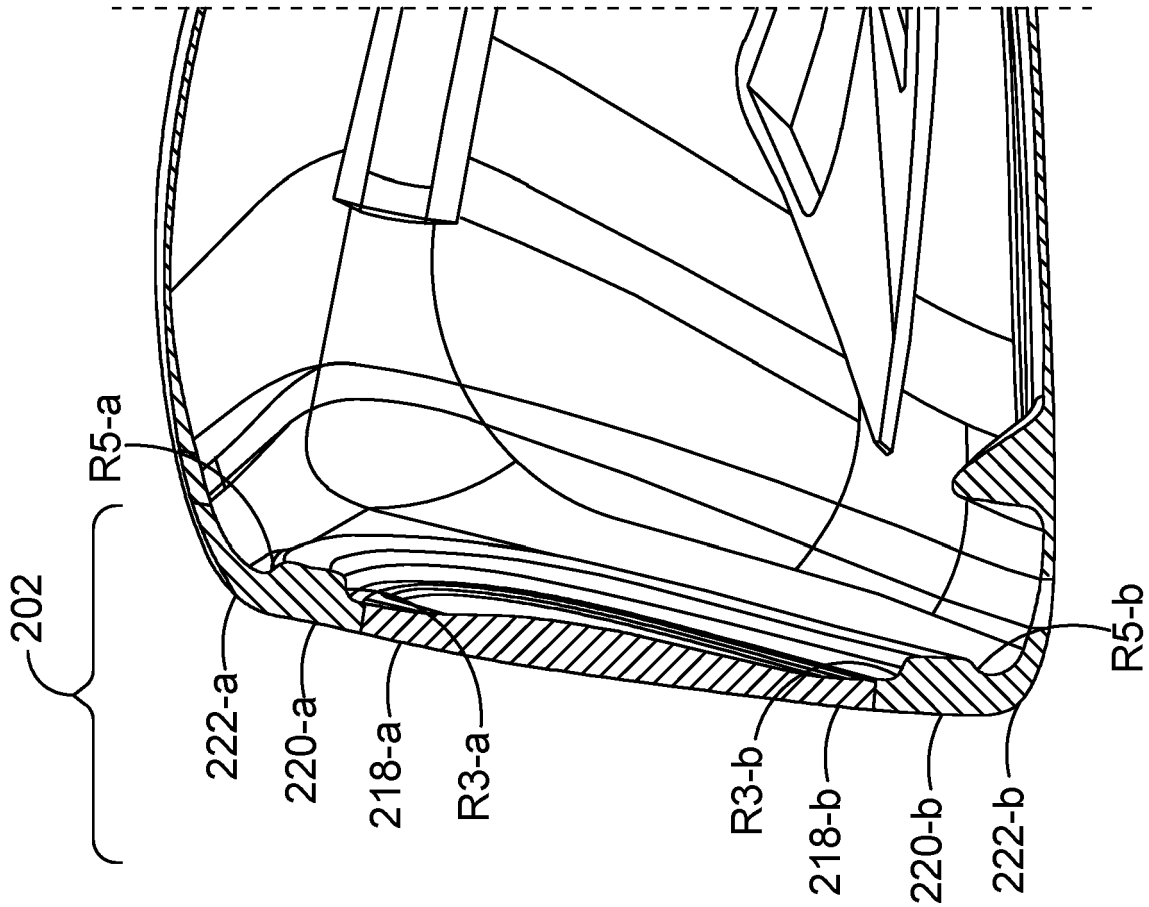


FIG. 5

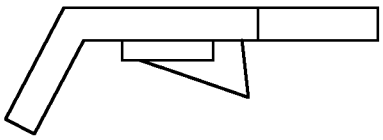


FIG. 6f

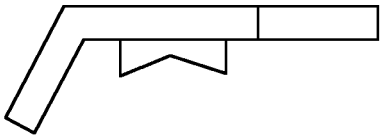


FIG. 6L

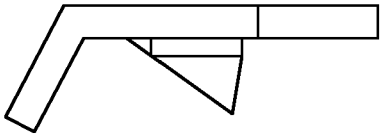


FIG. 6e

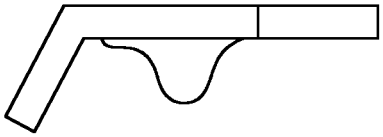


FIG. 6k

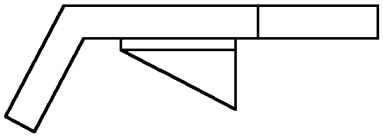


FIG. 6d

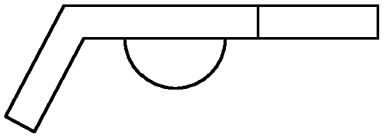


FIG. 6j

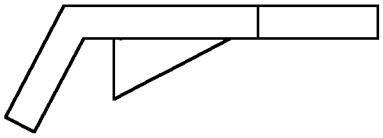


FIG. 6c

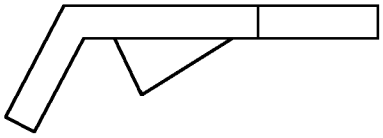


FIG. 6i

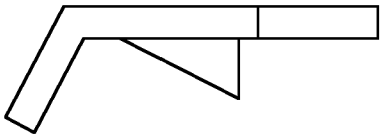


FIG. 6b

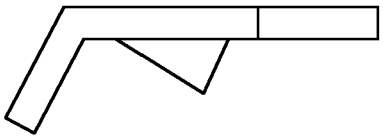


FIG. 6h

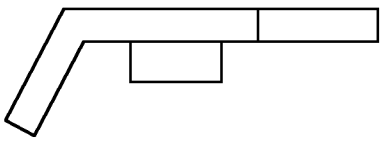


FIG. 6a

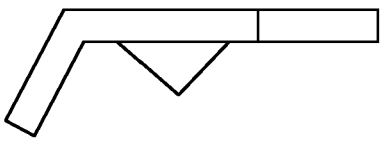


FIG. 6g

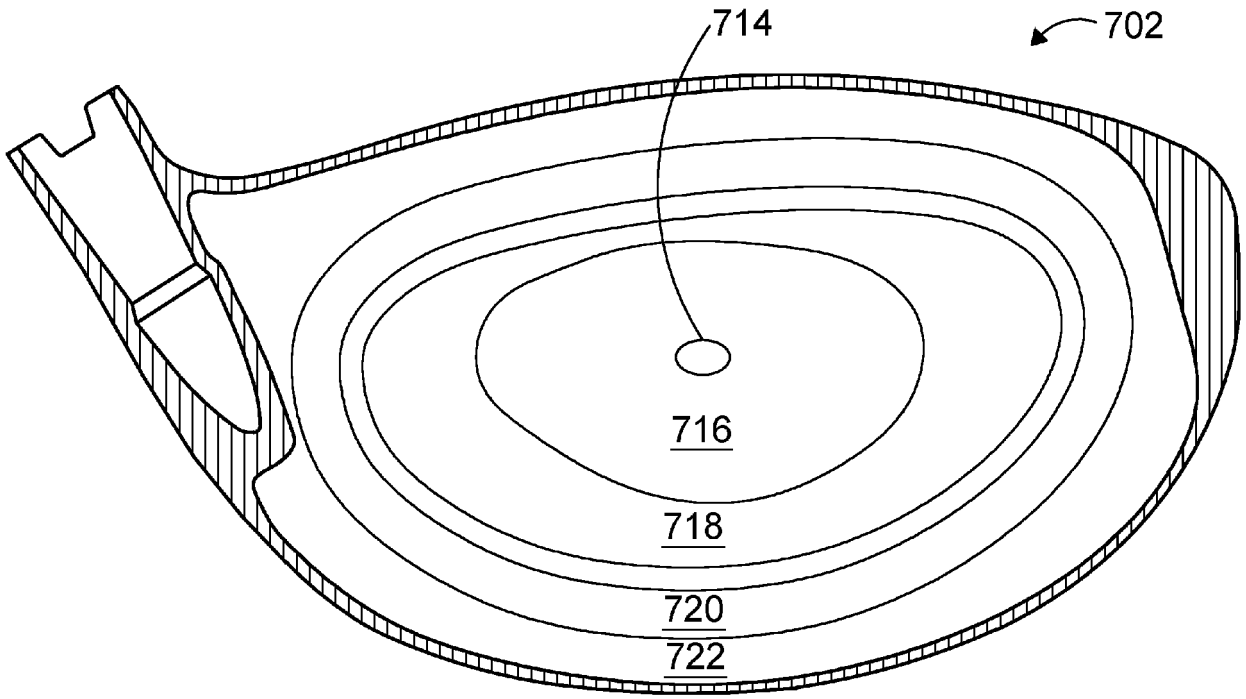


FIG. 7a

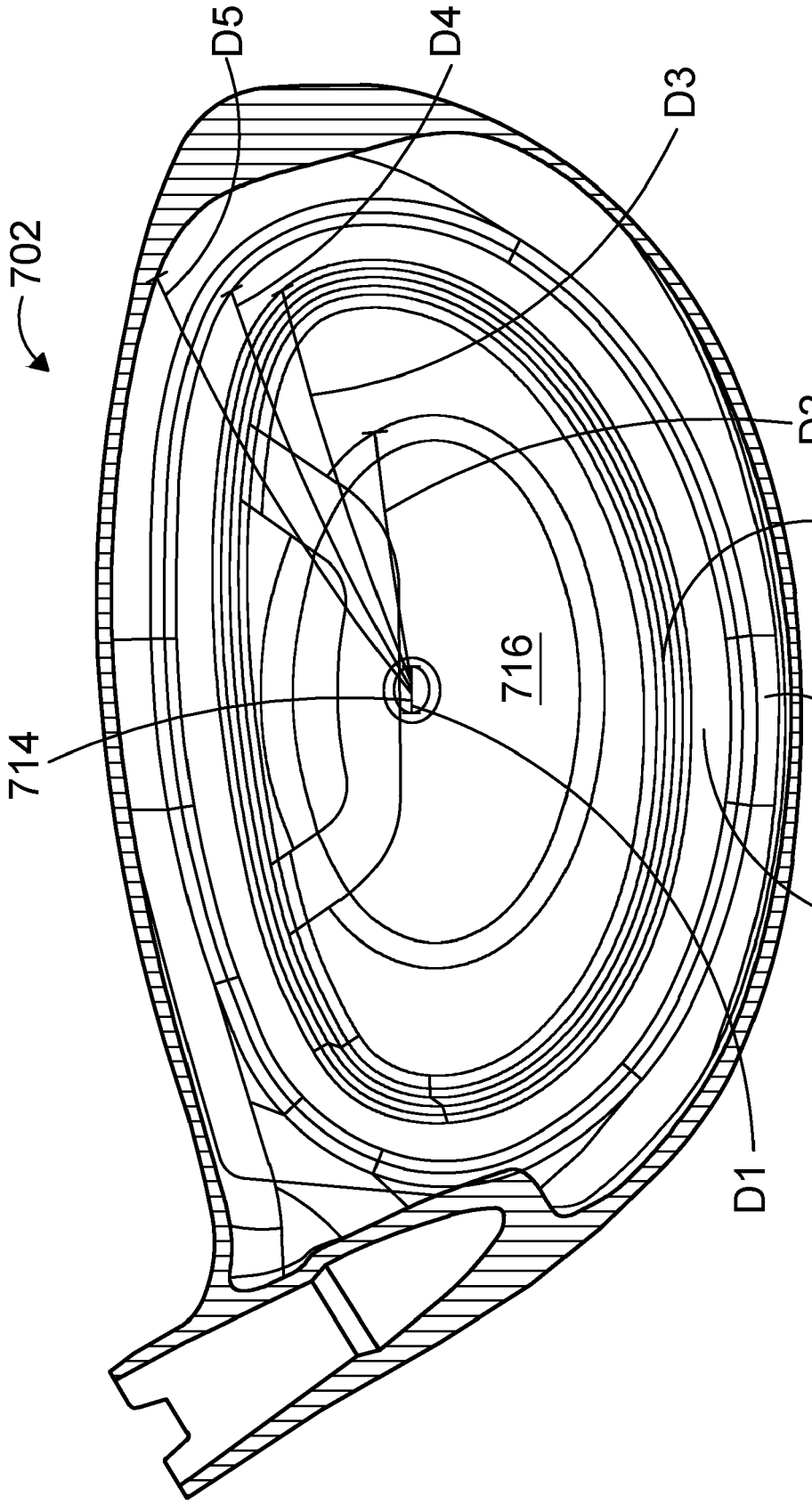


FIG. 7b

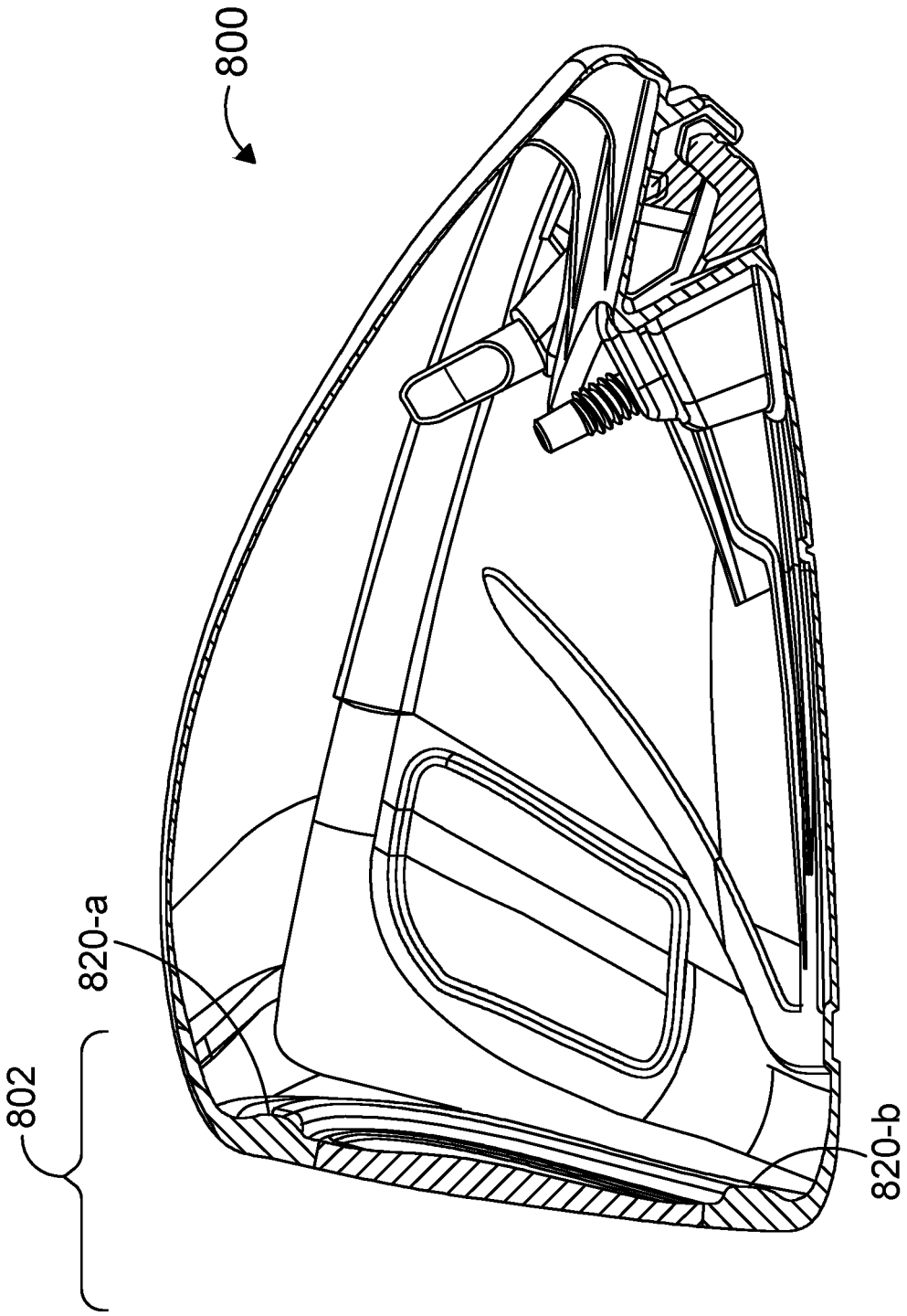


FIG. 8

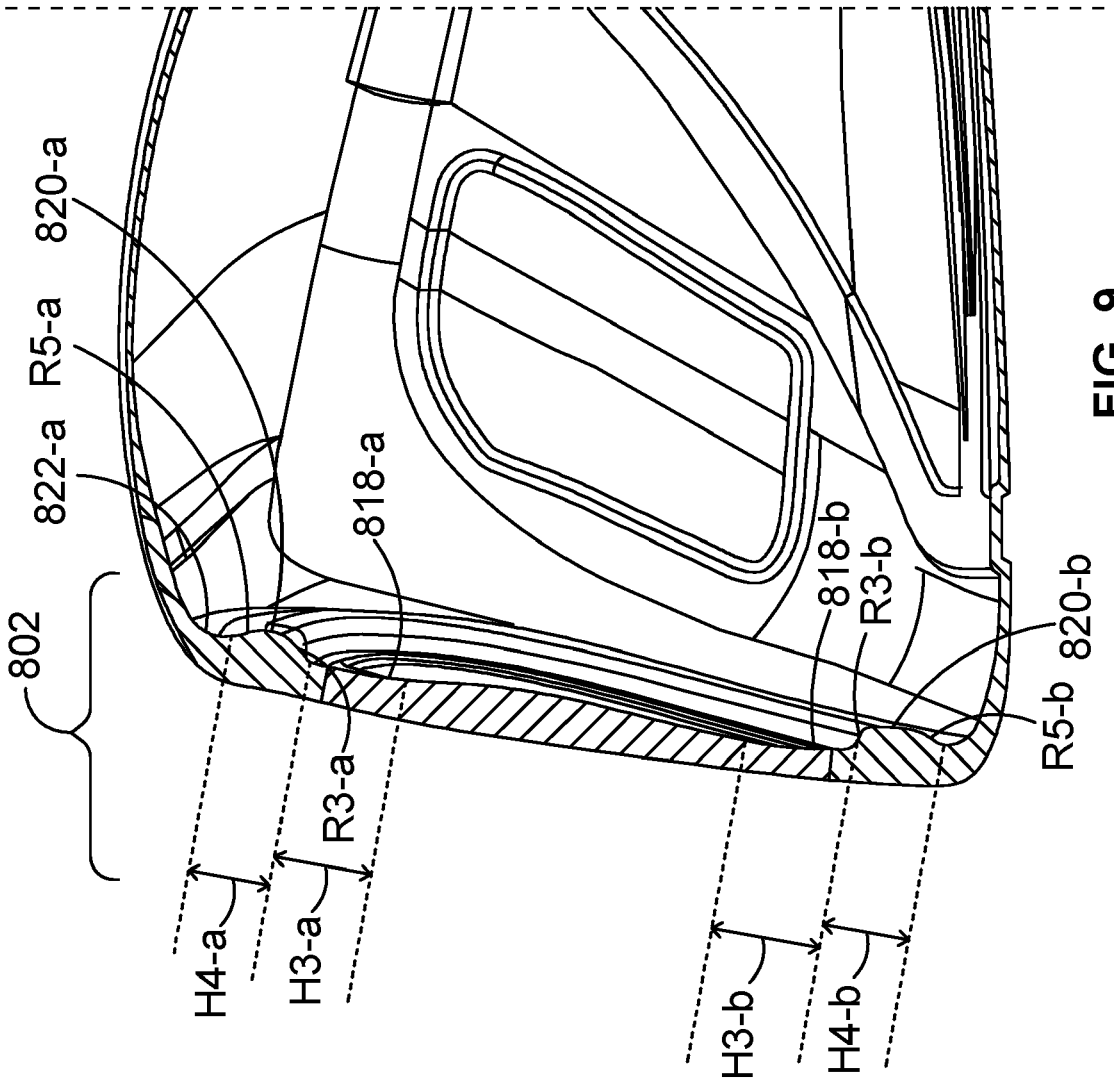


FIG. 9

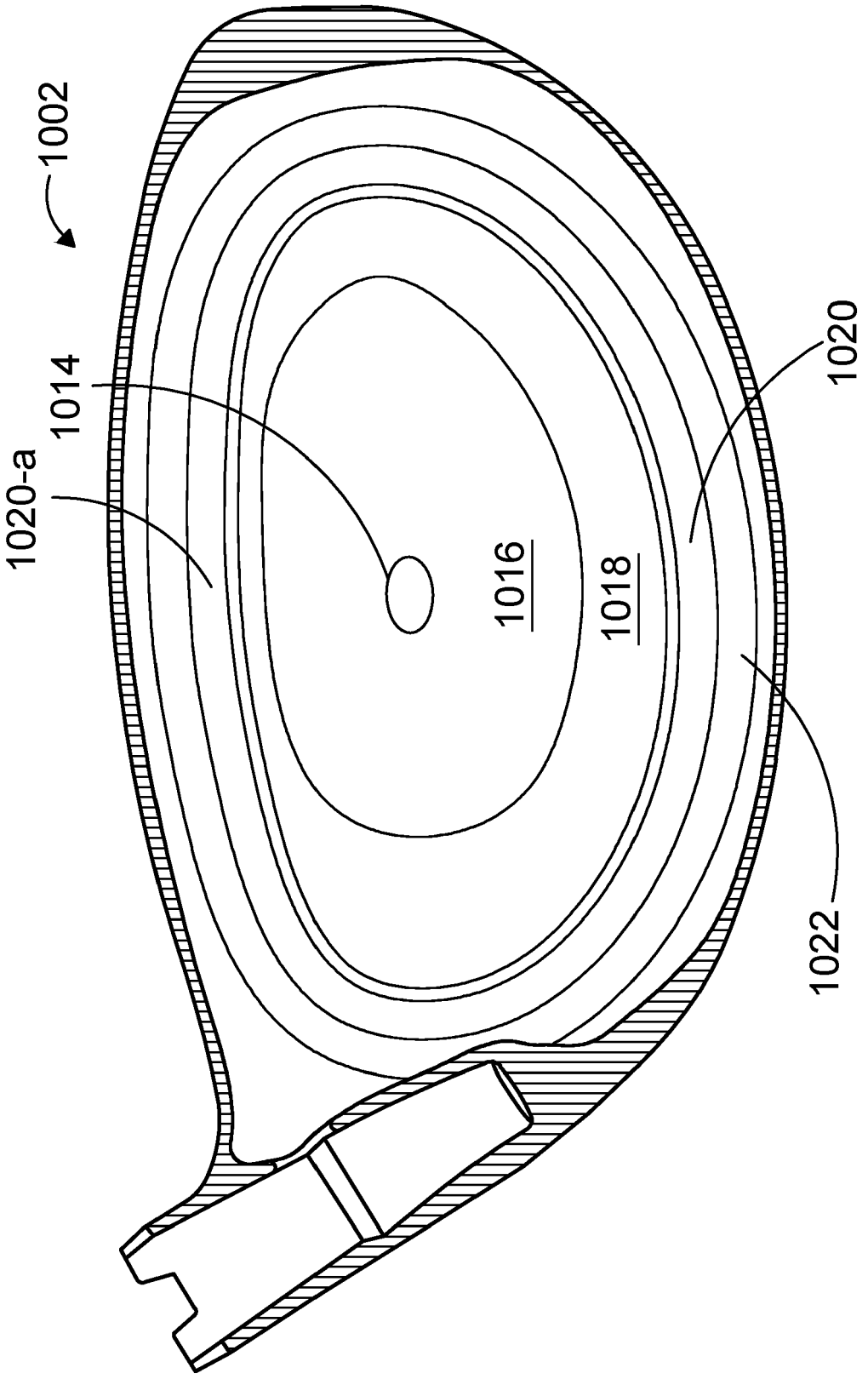


FIG. 10a

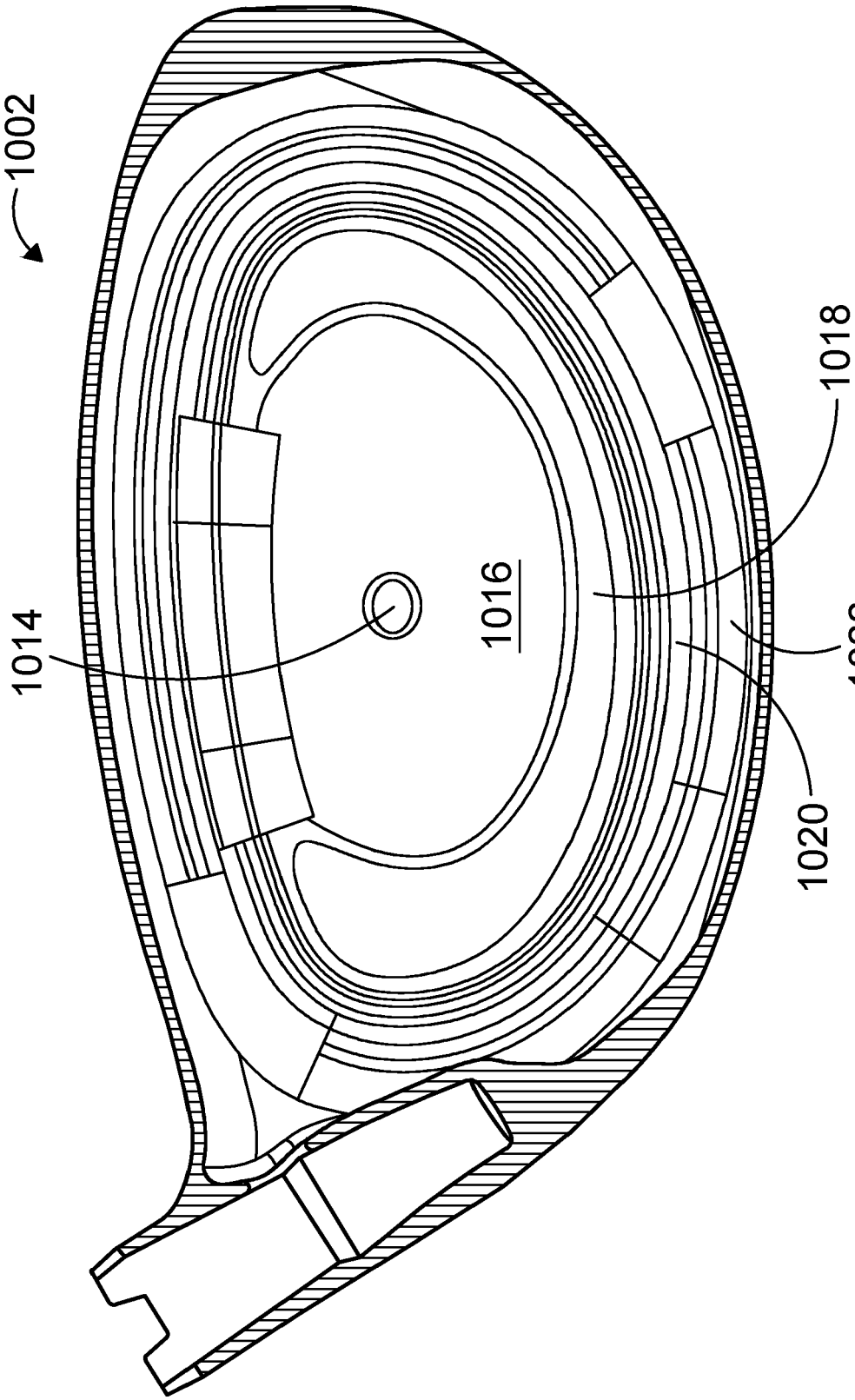


FIG. 10b

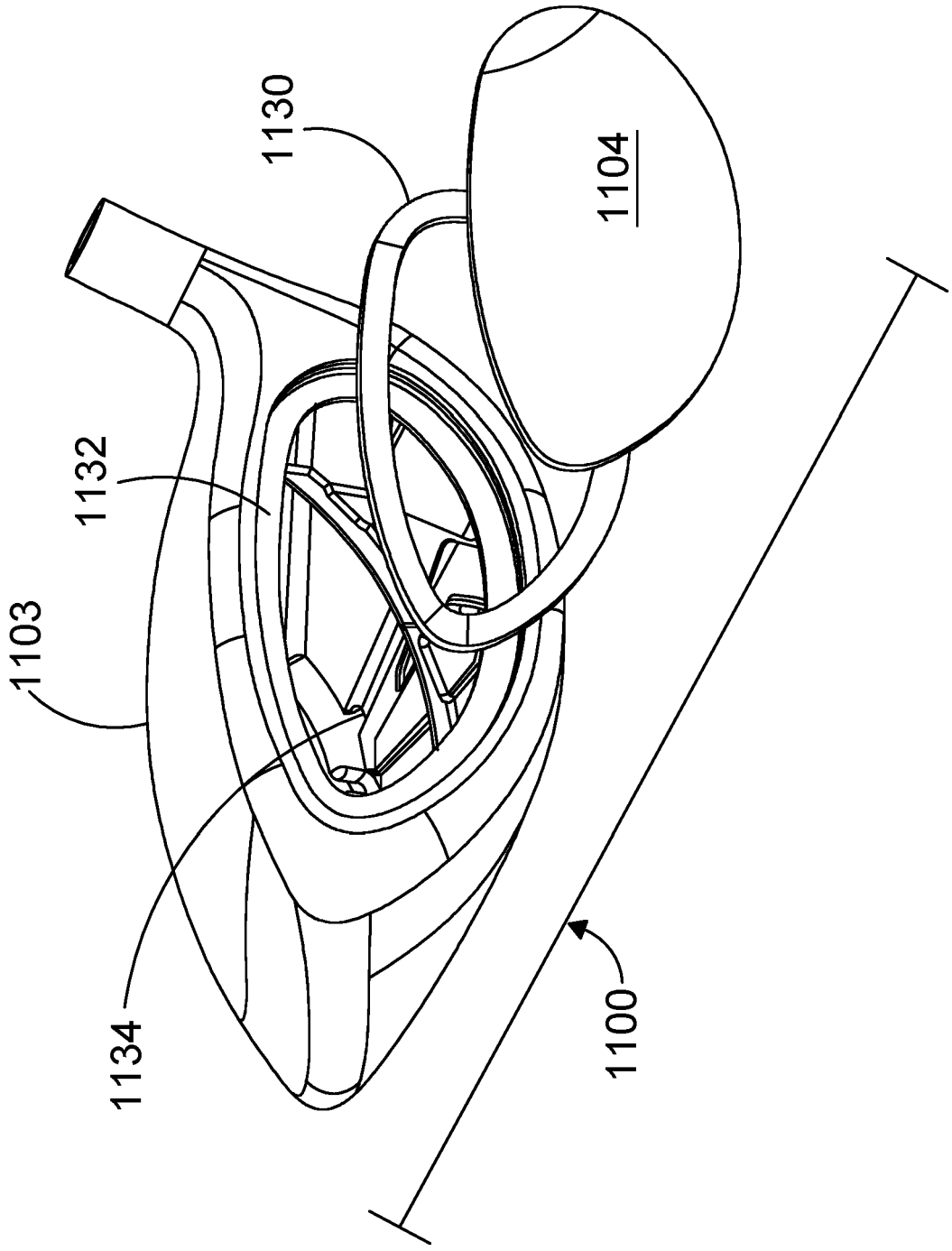


FIG. 11

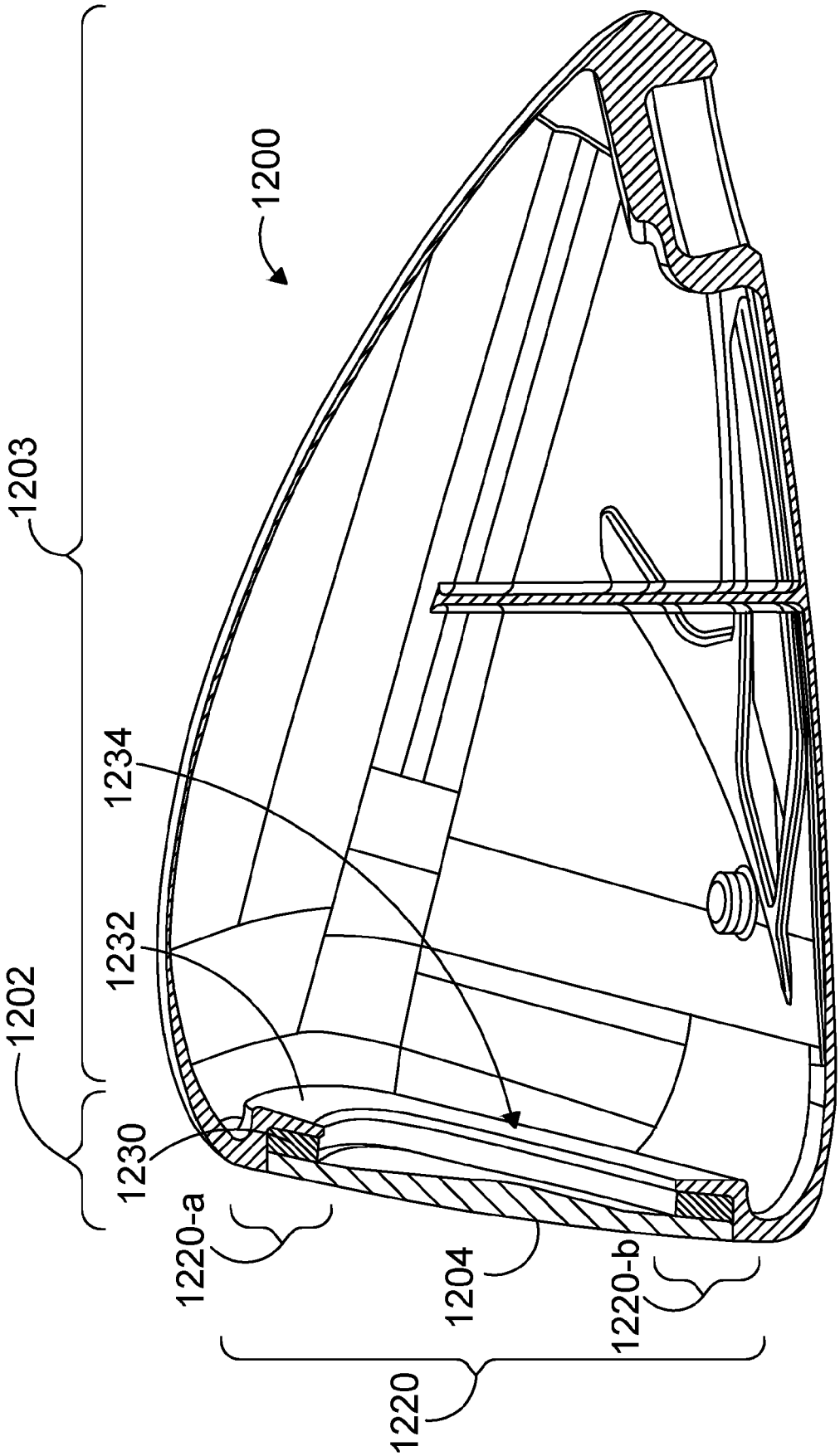


FIG. 12

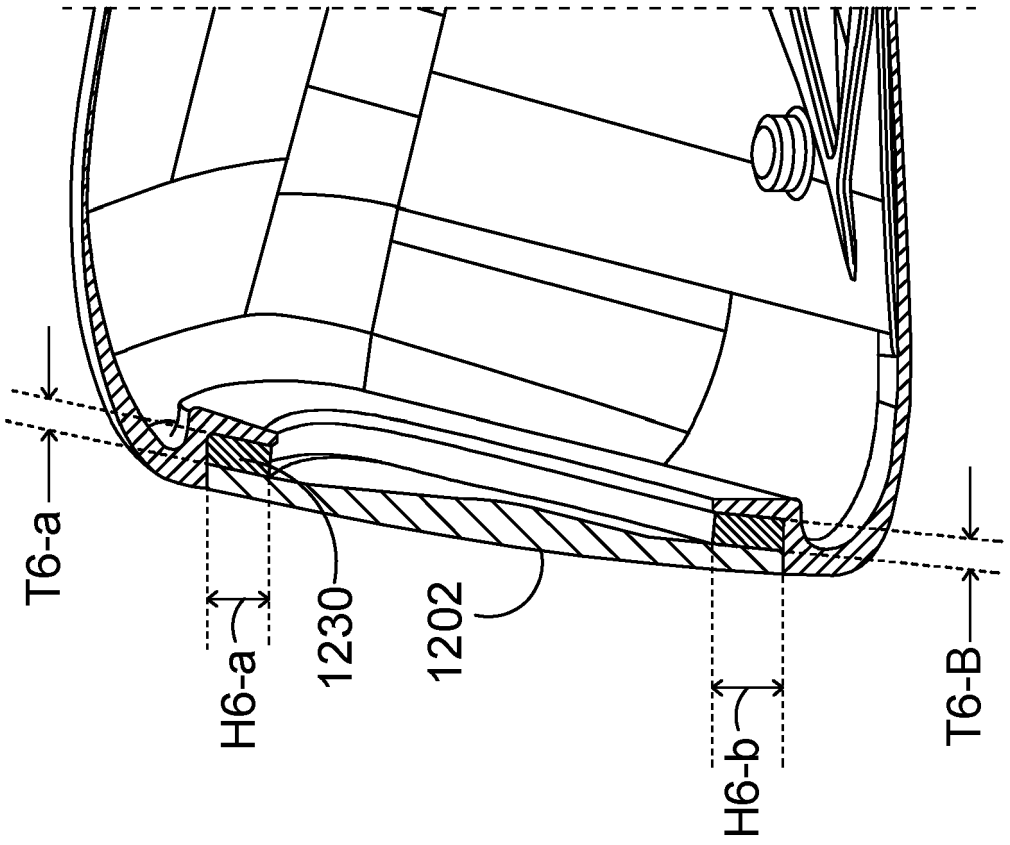
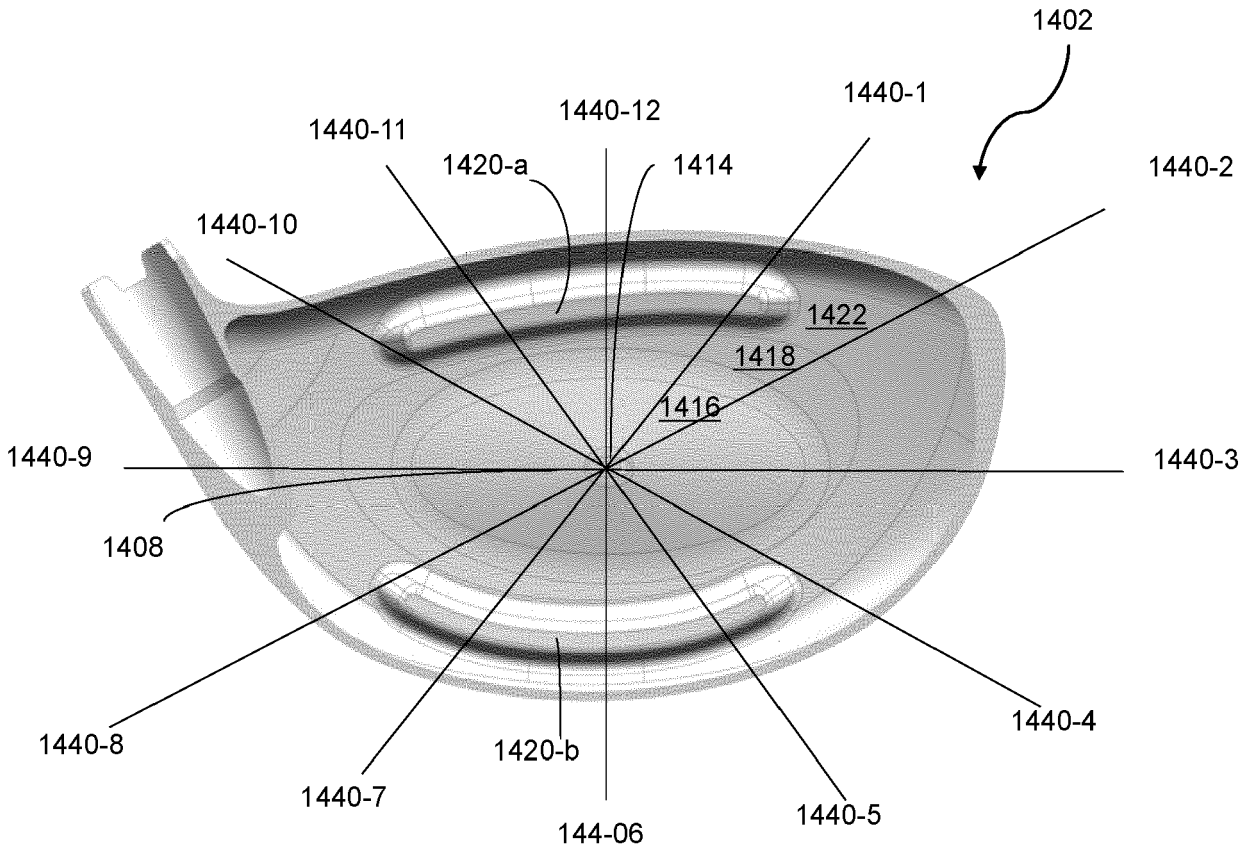


FIG. 13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1440-12
1440-11
1420-a
1414
1440-2
1440-10
1422
1418
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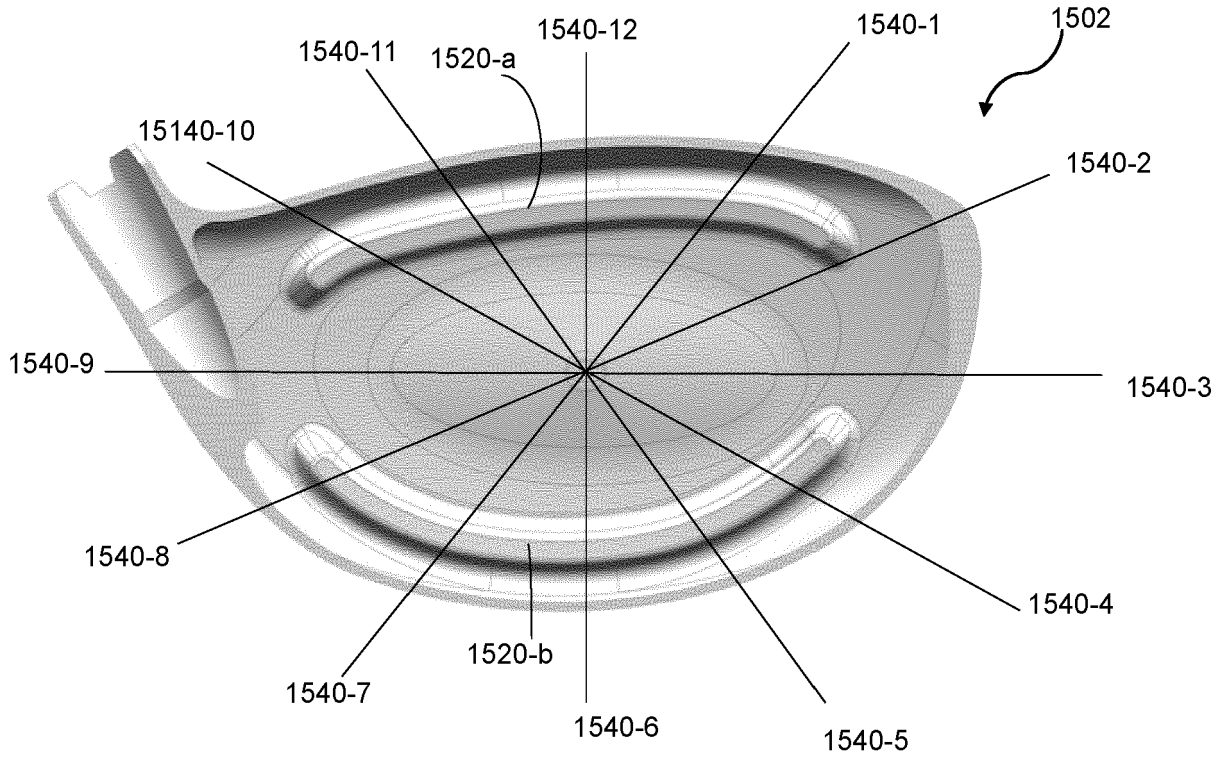
1420-b
1440-7
1440-5
144-06

Fig. 14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1540-6
1540-5

Fig. 15

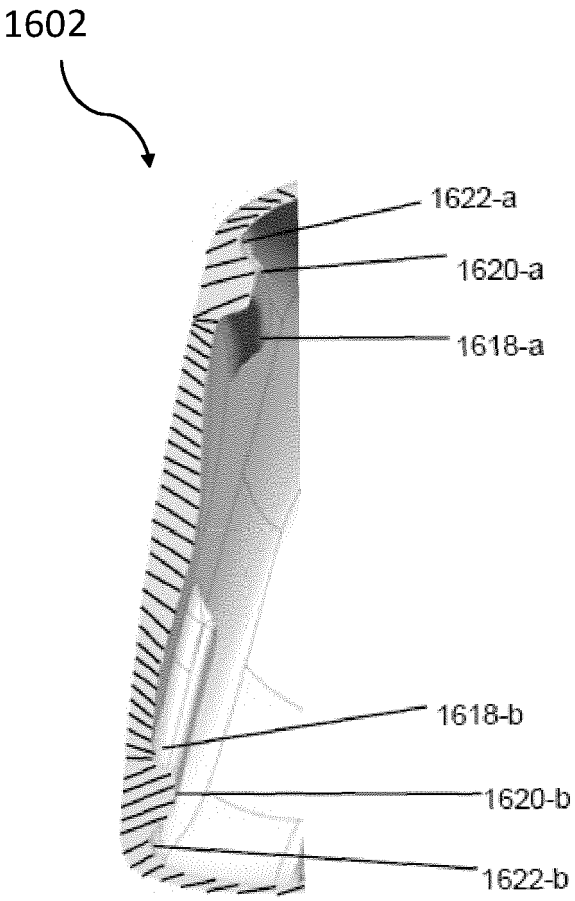

Fig. 16

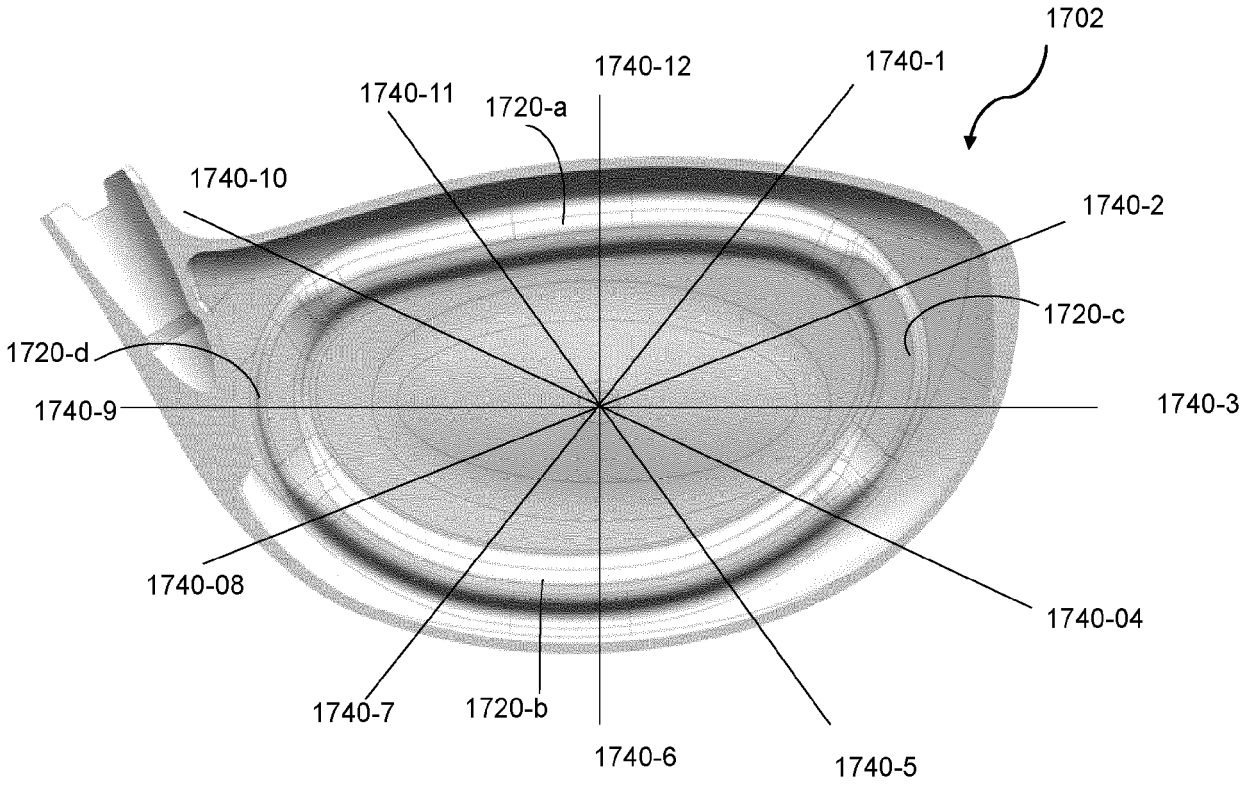
1702
1740-12
1740-1
1740-11
1720-a
1740-10
1740-2
1720-c
1720-d
1740-9
1740-3
1740-08
1740-04
1740-7
1720-b
1740-6
1740-5

Fig. 17

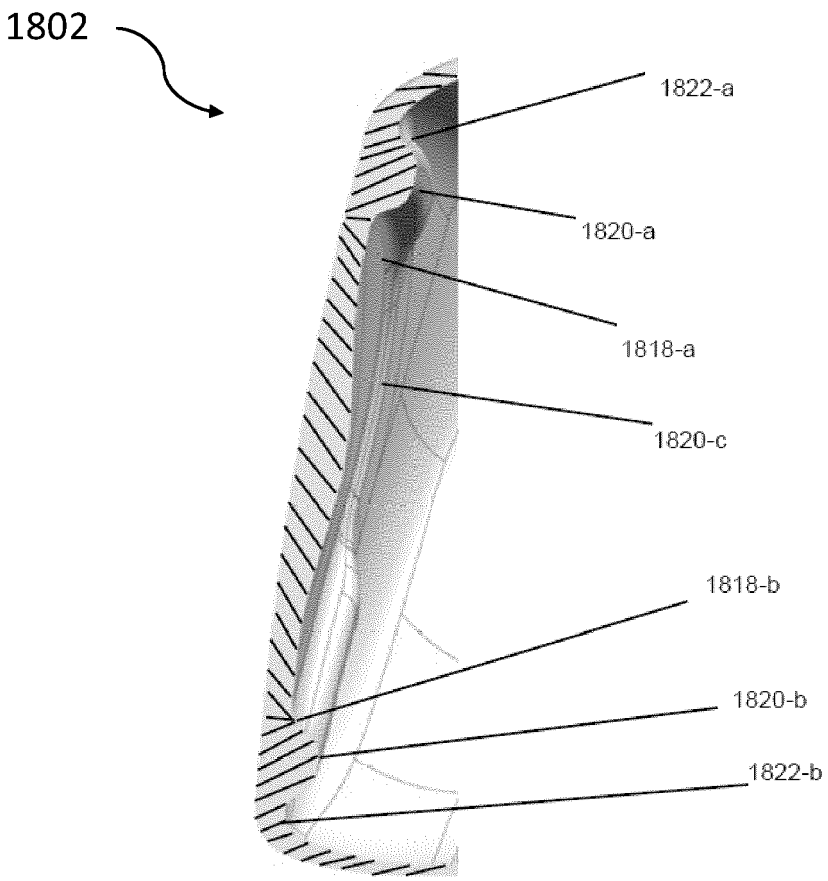

Fig. 18

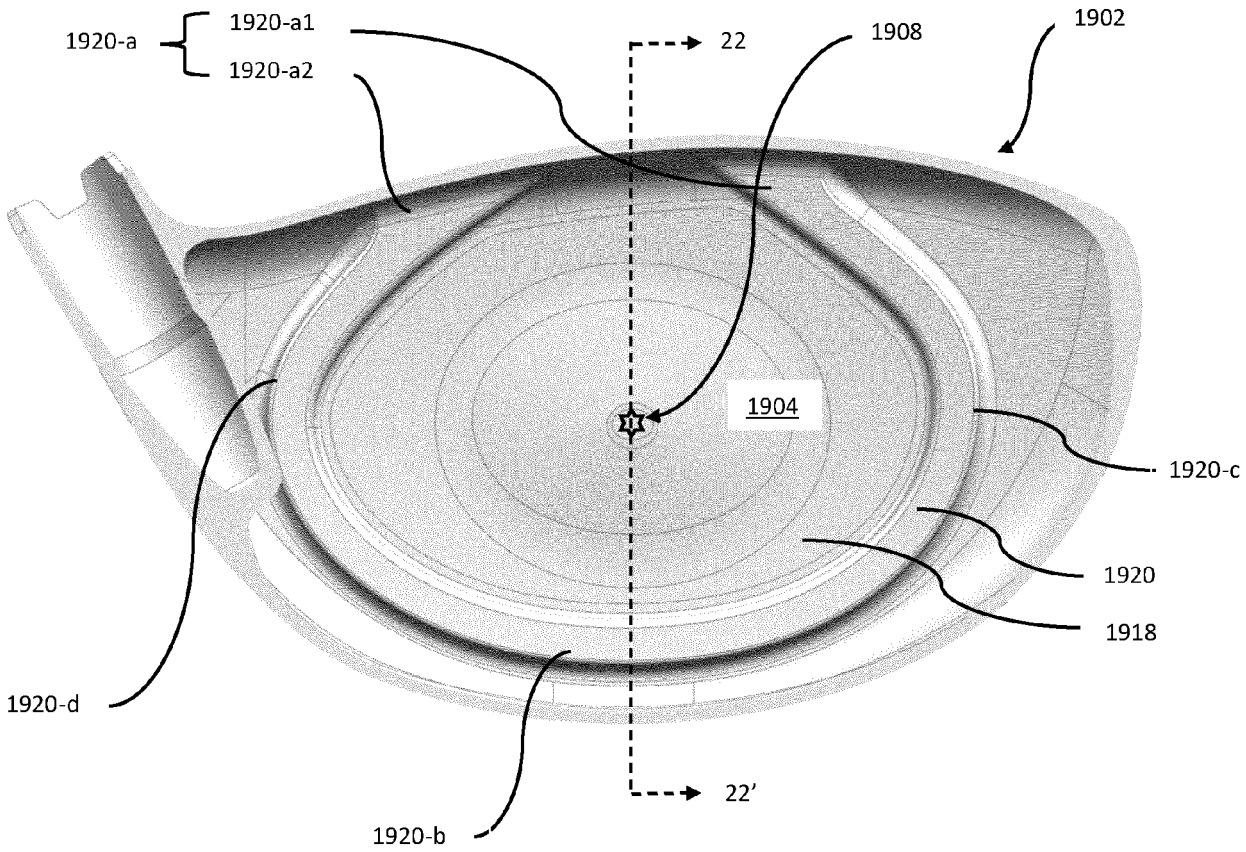
1920-a
1920-a1
1920-a2
22
1908
1902
1904
1920-c
1920
1918
1920-d
22'
1920-b

FIG. 19

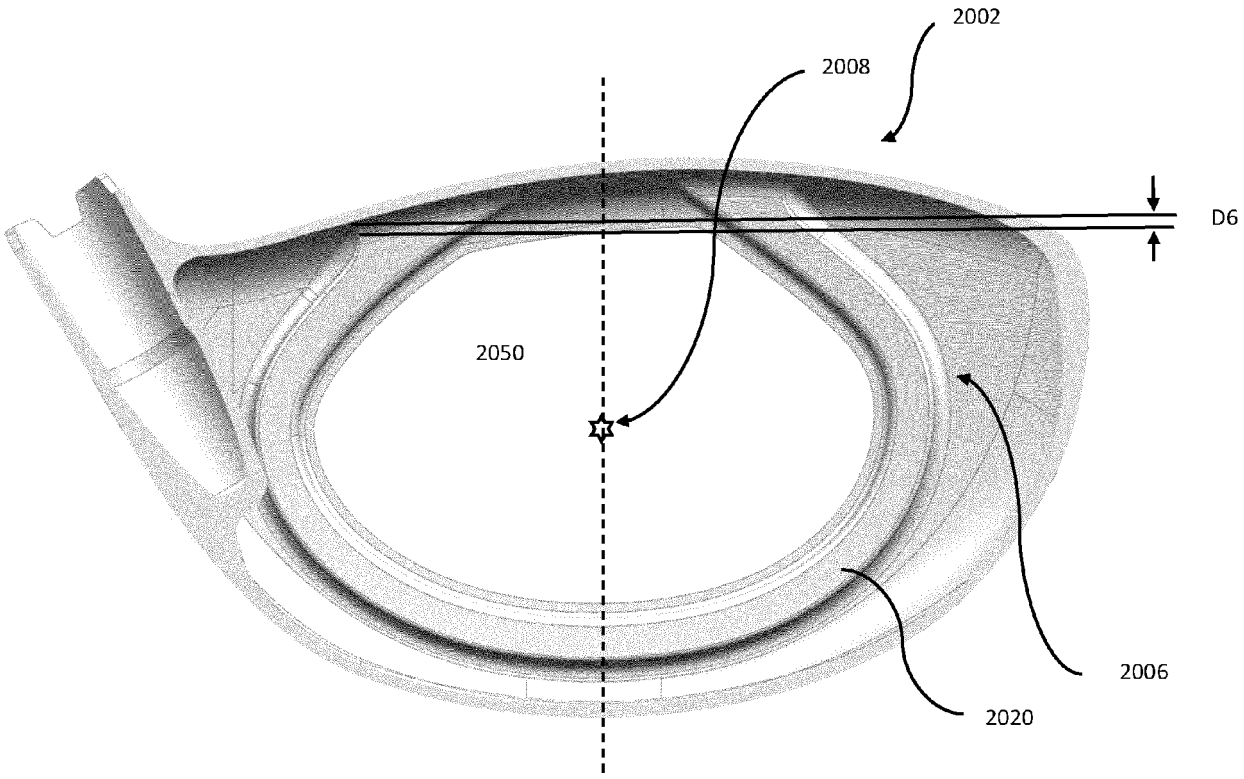

FIG. 20

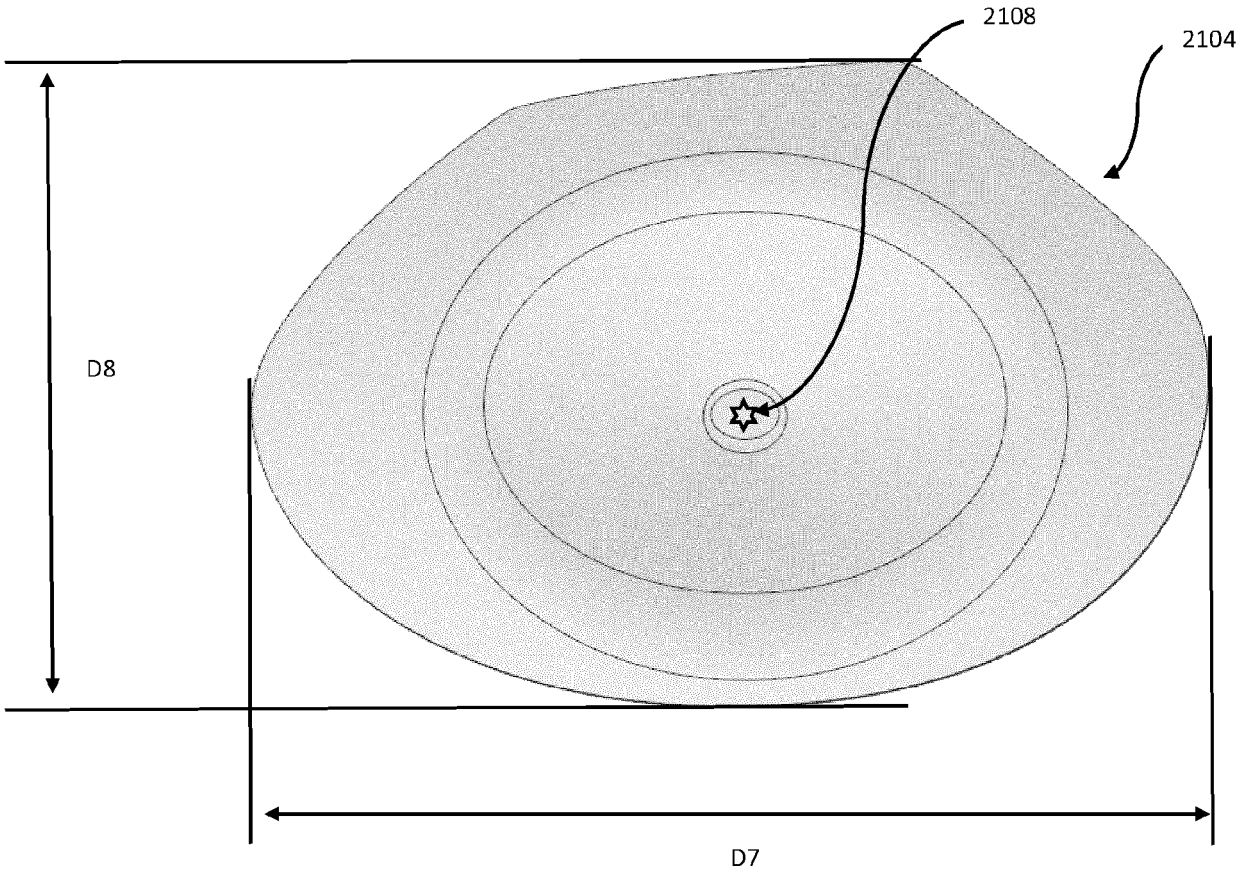

FIG. 21

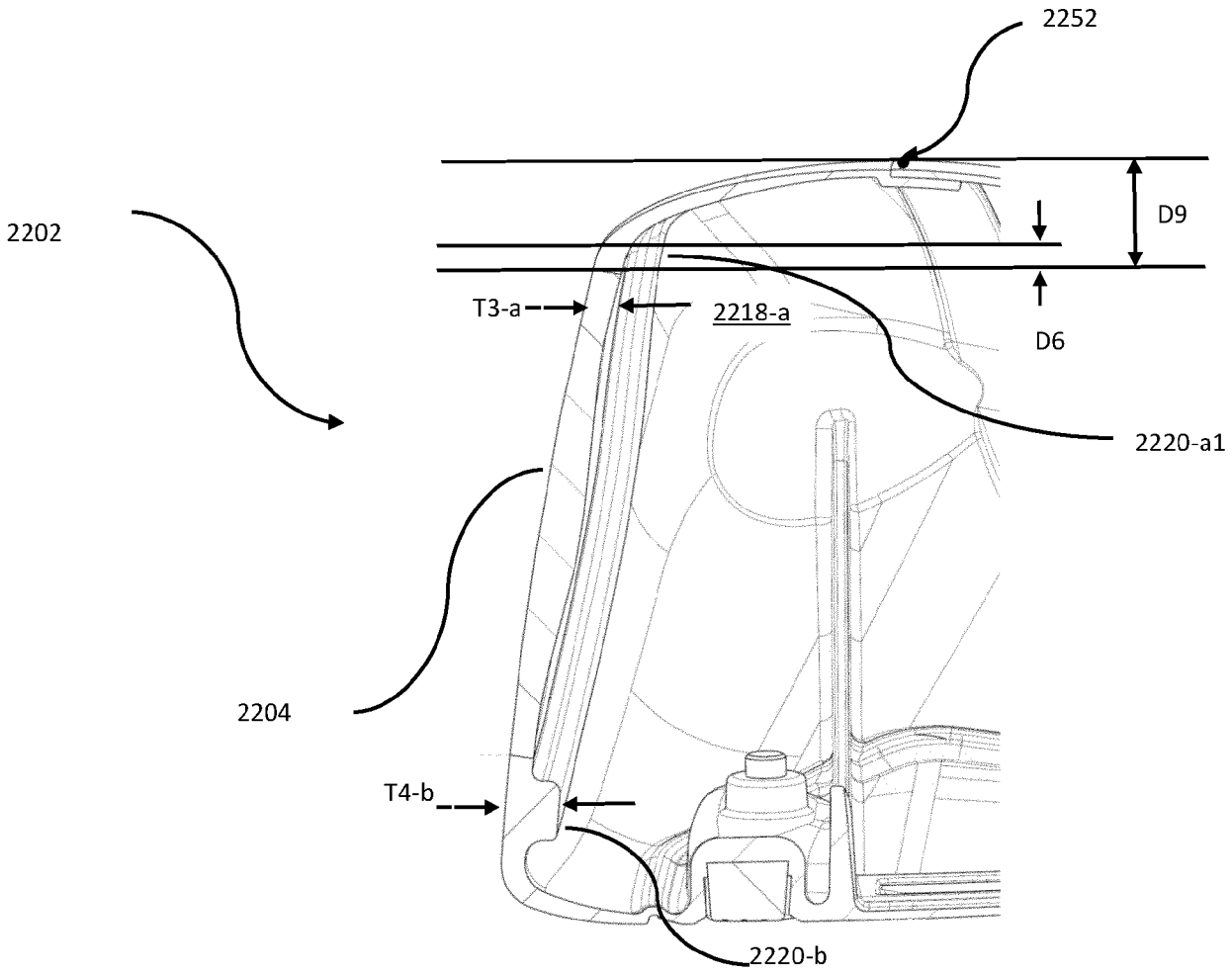

FIG. 22

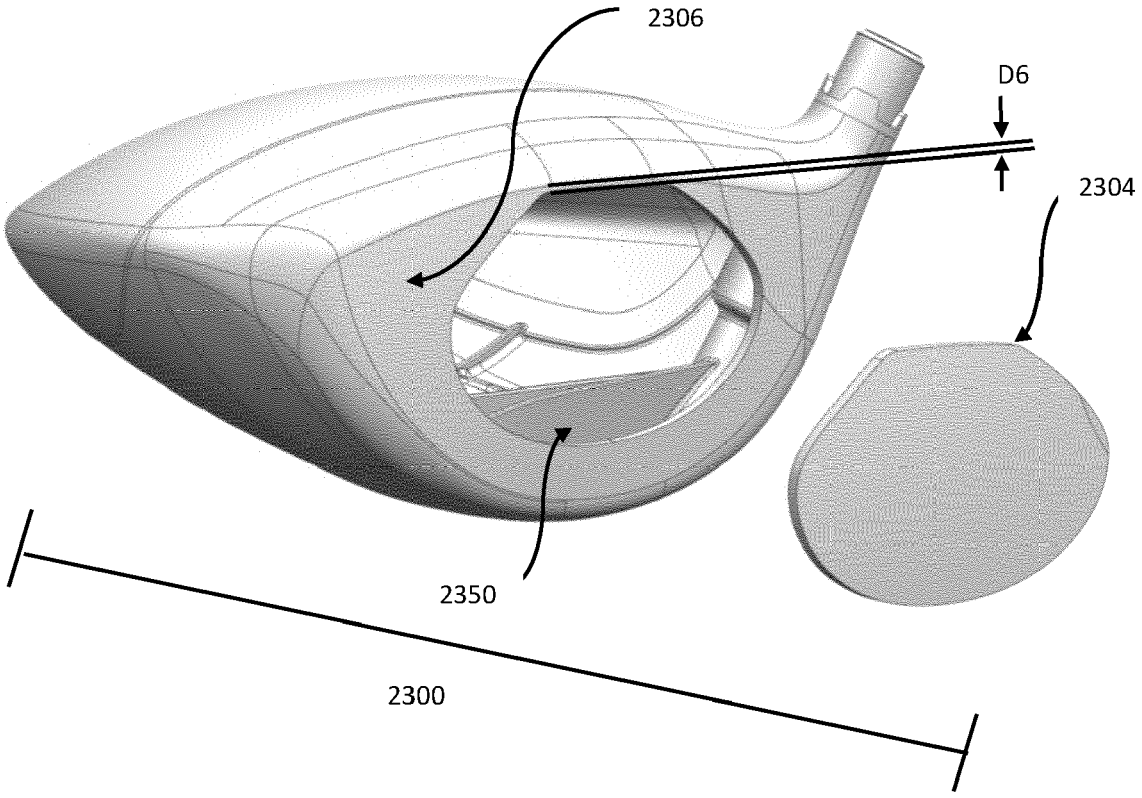

FIG. 23

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EUROPEAN SEARCH REPORT

Application Number
EP 24 18 4988

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X Y A	US 2023/075696 A1 (CARR KYLE A [US] ET AL) 9 March 2023 (2023-03-09) * paragraph [0060] - paragraph [0065]; figure 4 * * paragraph [0078]; figure 10b * * paragraph [0079] - paragraph [0099]; figures 11-17 *	1-3,6-9 10-12 4,5	INV. A63B53/04
X Y A	US 2023/072146 A1 (CARR KYLE A [US] ET AL) 9 March 2023 (2023-03-09) * paragraph [0044] - paragraph [0048]; figure 3 * * paragraph [0054] - paragraph [0057] * * paragraph [0000] - paragraph [0000] * * paragraph [0062] - paragraph [0068] * * paragraph [0074] - paragraph [0076]; claims 1-20; figures 4-7b, 9, 10b, *	1-3,6-9 10-12 4,5	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	15 October 2024	Brumme, Ion

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