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(54) **MULTI-MATERIAL GOLF CLUB HEAD**

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(73) Assignee: **Acushnet Company**, Fairhaven, MA (US)

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(63) Continuation-in-part of application No. 18/491,185, filed on Oct. 20, 2023, which is a continuation-in-part of application No. 17/675,554, filed on Feb. 18, 2022, which is a continuation-in-part of application No. 17/225,862, filed on Apr. 8, 2021, which is a continuation-in-part of application No. 17/205,678, filed on Mar. 18, 2021, which is a continuation-in-part of application No. 17/205,376, filed on Mar. 18, 2021, now Pat. No. 11,766,592.

(60) Provisional application No. 63/106,248, filed on Oct. 27, 2020, provisional application No. 63/112,551, filed on Nov. 11, 2020, provisional application No. 63/119,121, filed on Nov. 30, 2020.

Publication Classification

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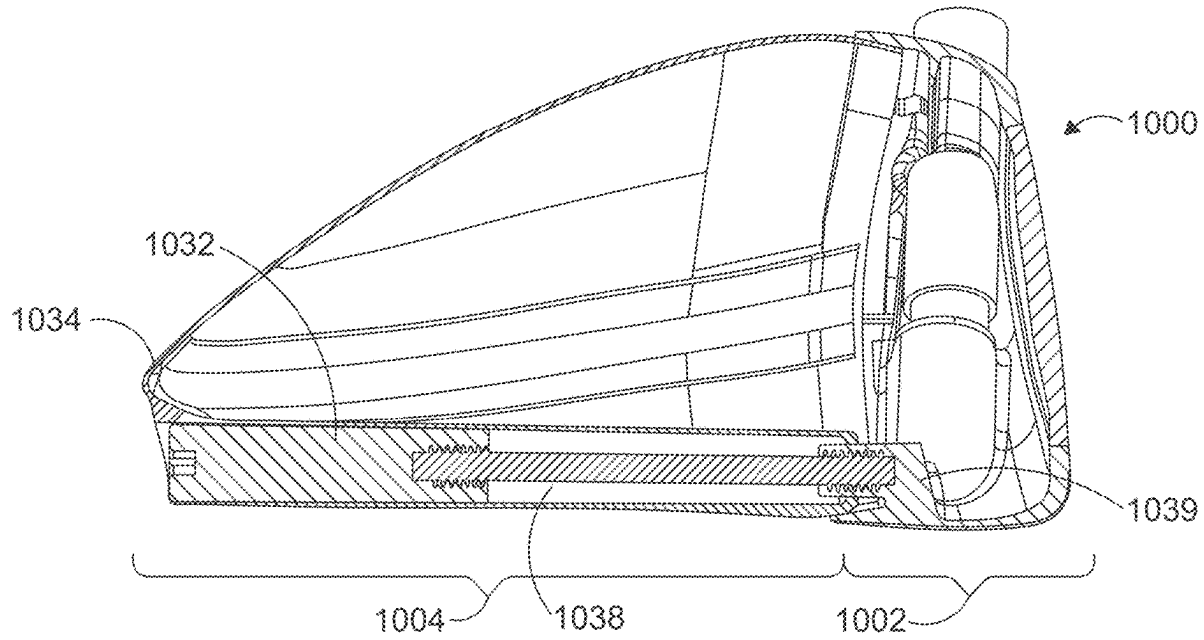
(52) **U.S. Cl.**
CPC ***A63B 53/08*** (2013.01); ***A63B 53/045*** (2020.08); *A63B 2053/0491* (2013.01)

(57) **ABSTRACT**

A multi-material golf club head having an improved performance is disclosed. More specifically, the present invention relates to a multi-material golf club head having a metallic frontal portion and a lightweight aft portion with an addition of an internal ribbon support member. The lightweight aft portion could be formed of a multi-layered sandwich material with at least one layer having low damping properties. The lightweight aft portion may be formed out of a lightweight crown sub-shell and a lightweight sole sub-shell, both of which combine to receive a weighting system.



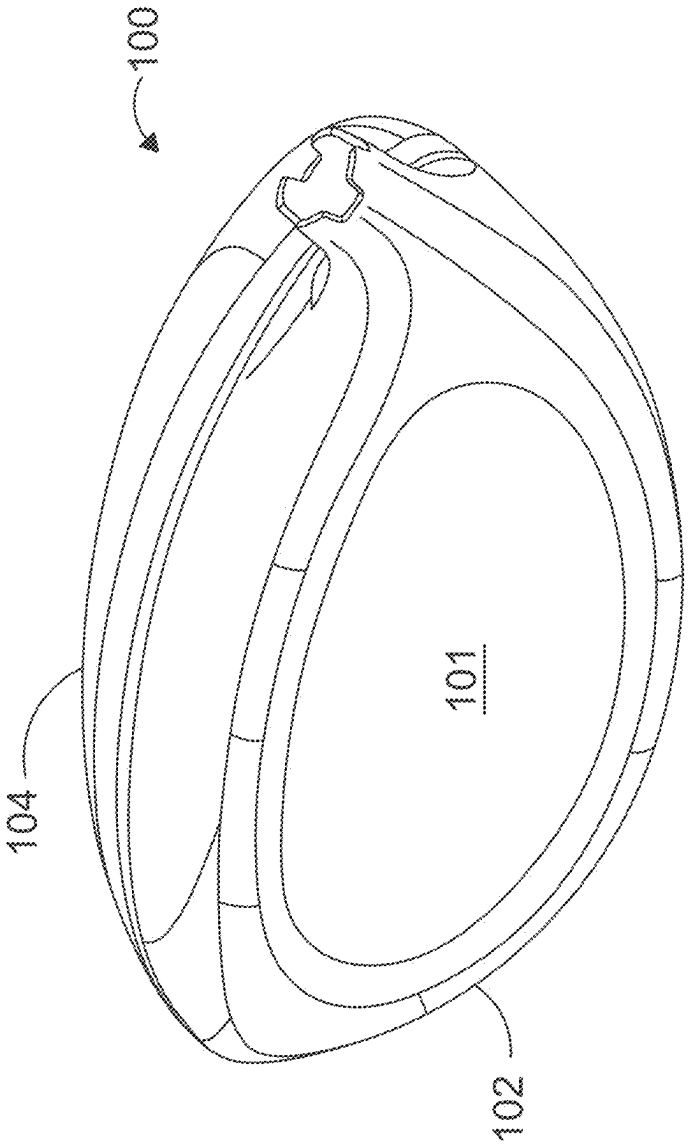


FIG. 1

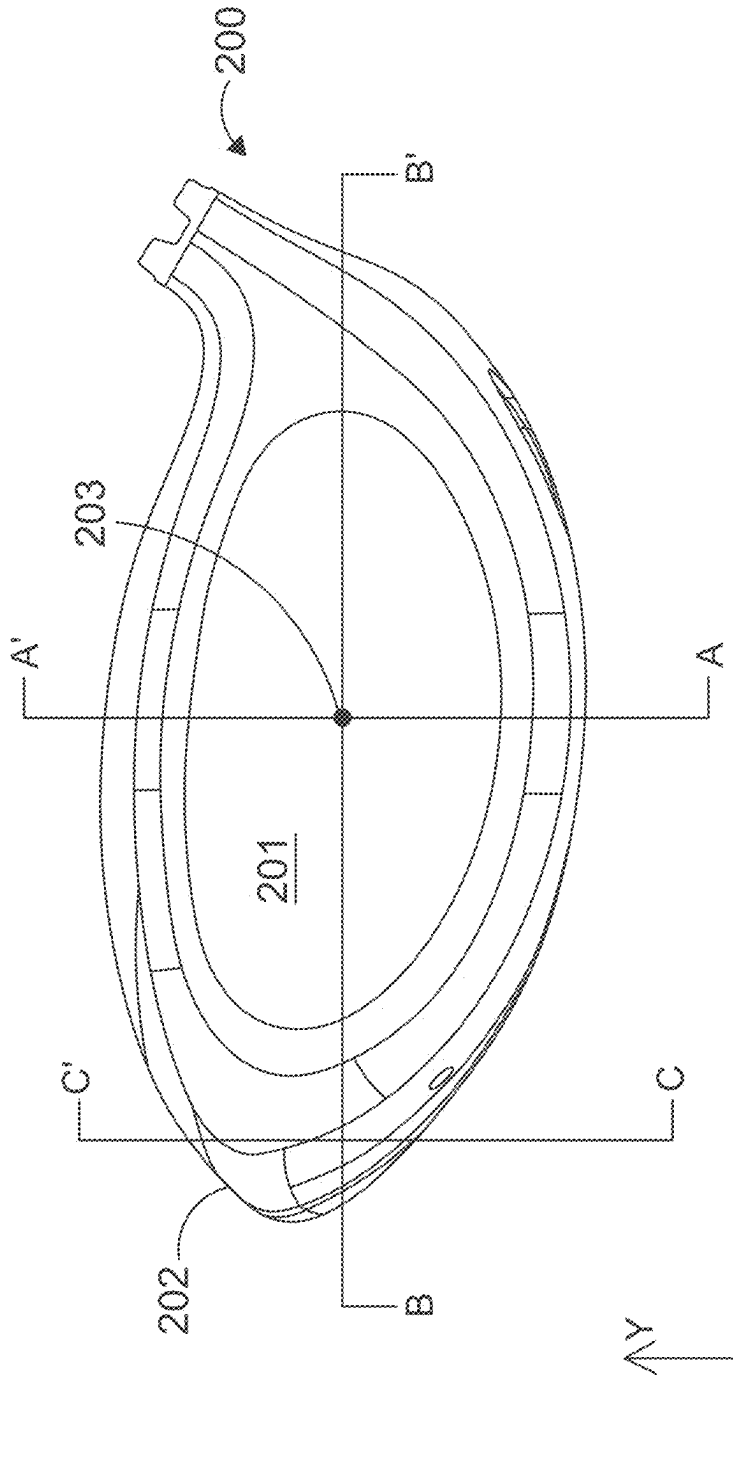


FIG. 2

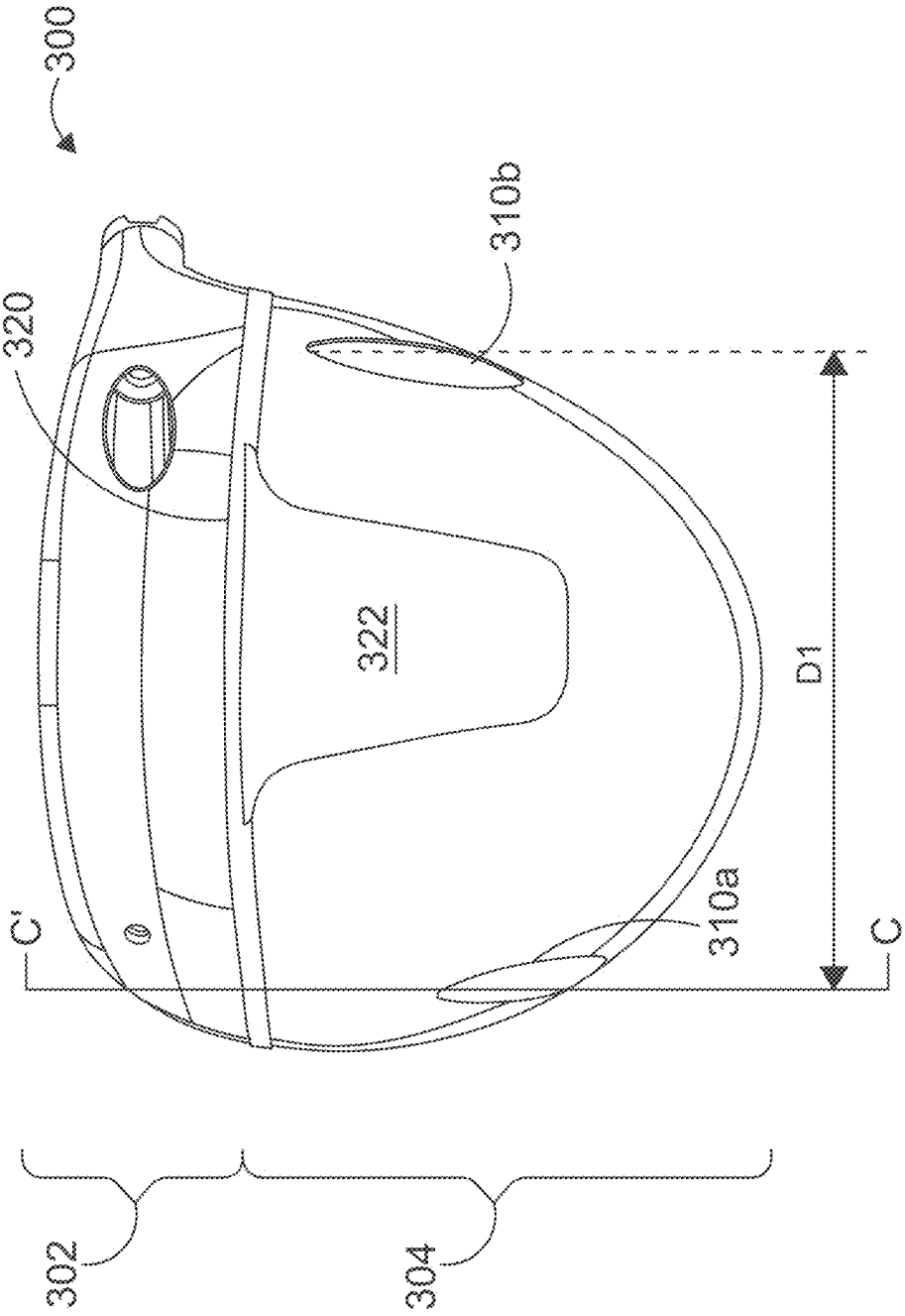
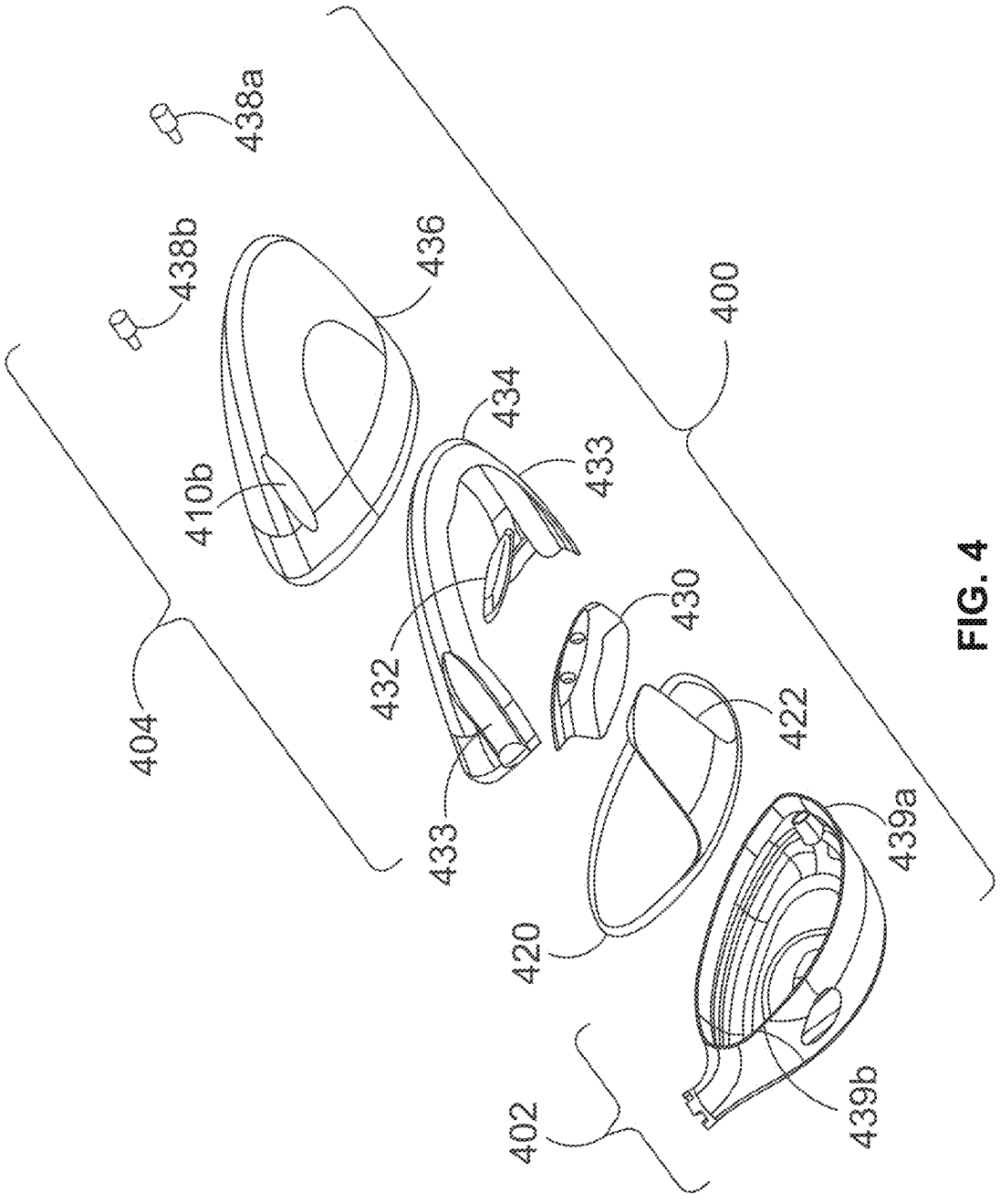


FIG. 3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439a
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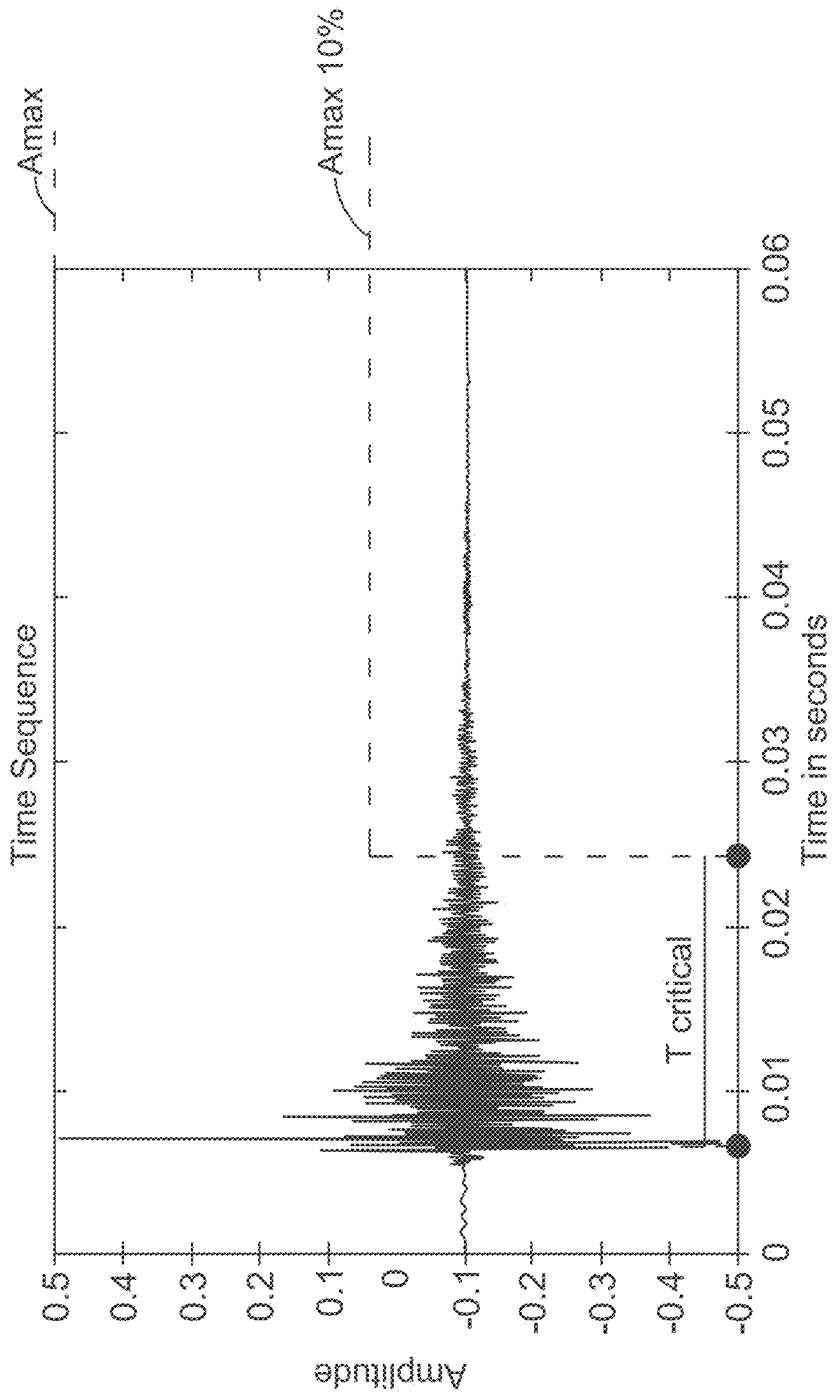
439b

FIG. 4


Amax
Amax 10%
Time Sequence
T critical
Amplitude
Time in seconds
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0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
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0.05
0.06

FIG. 5

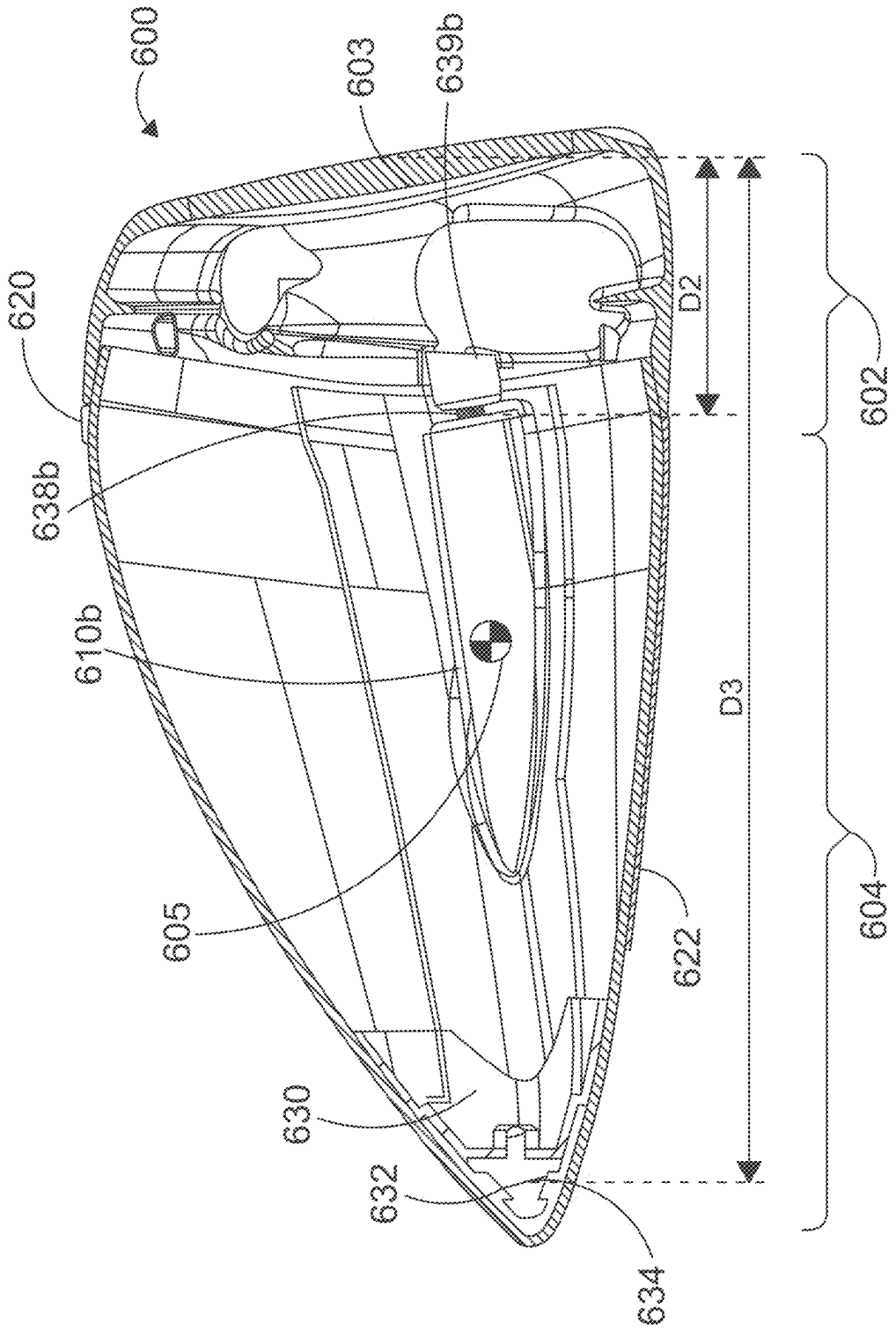


FIG. 6

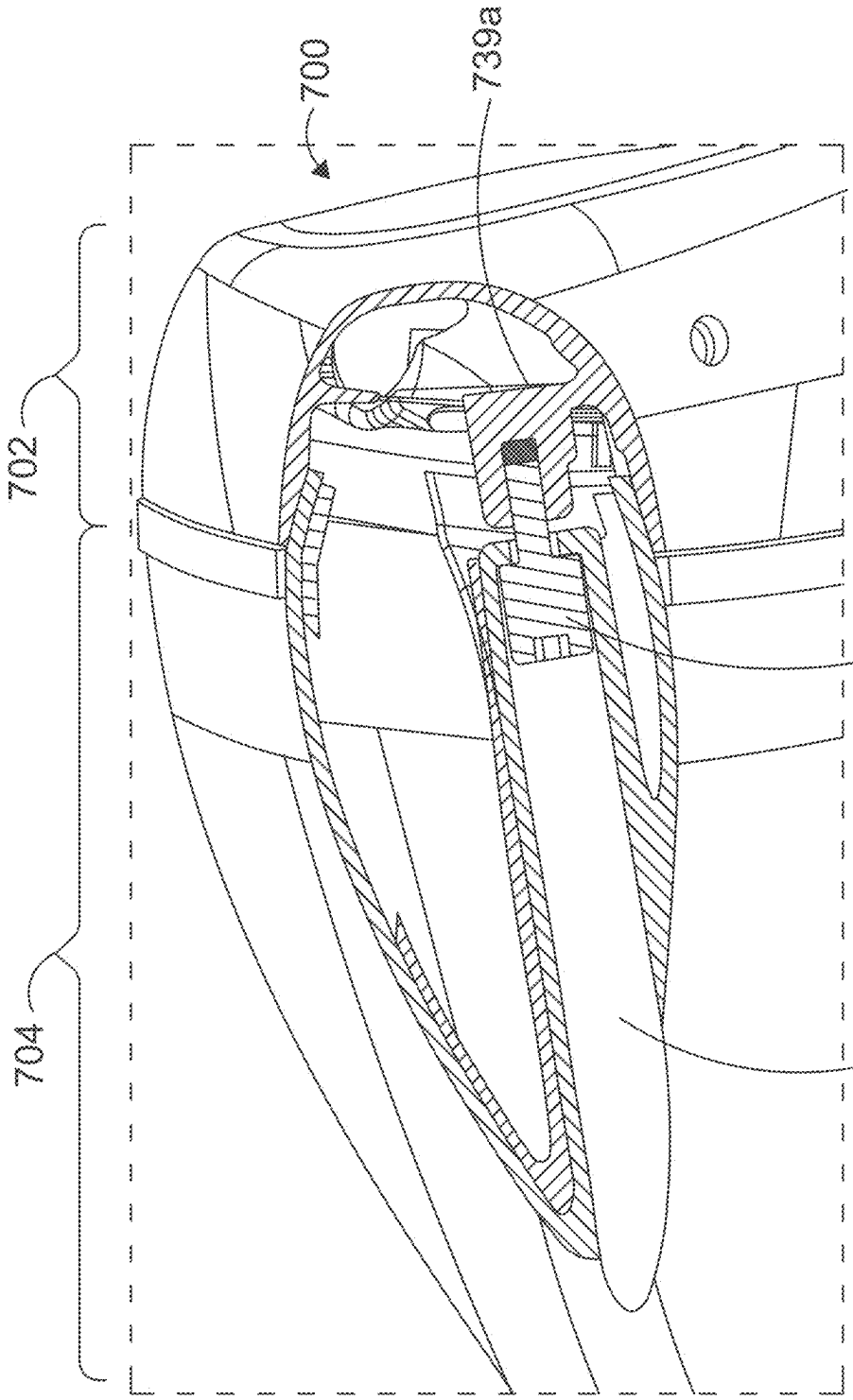


FIG. 7

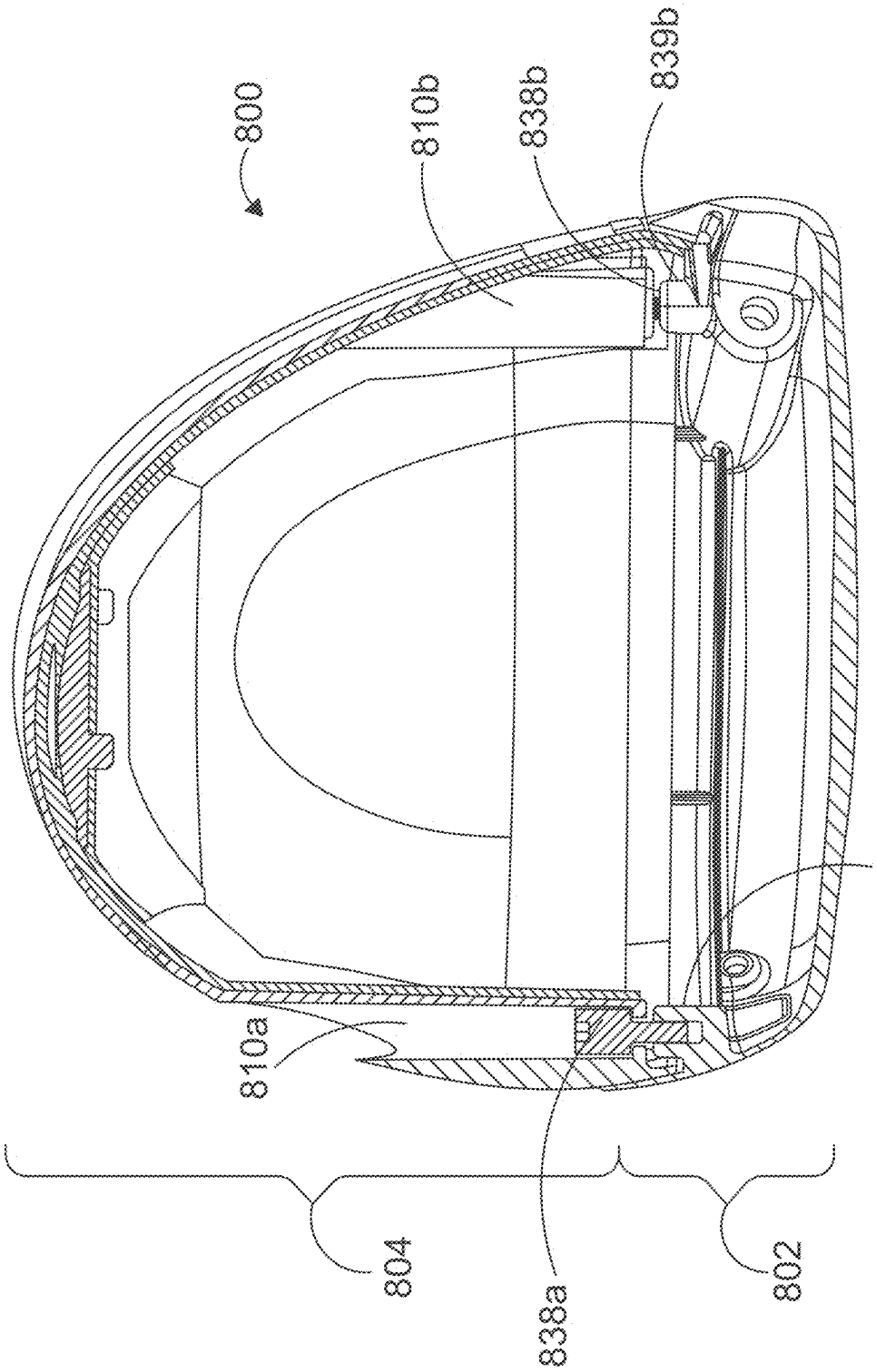
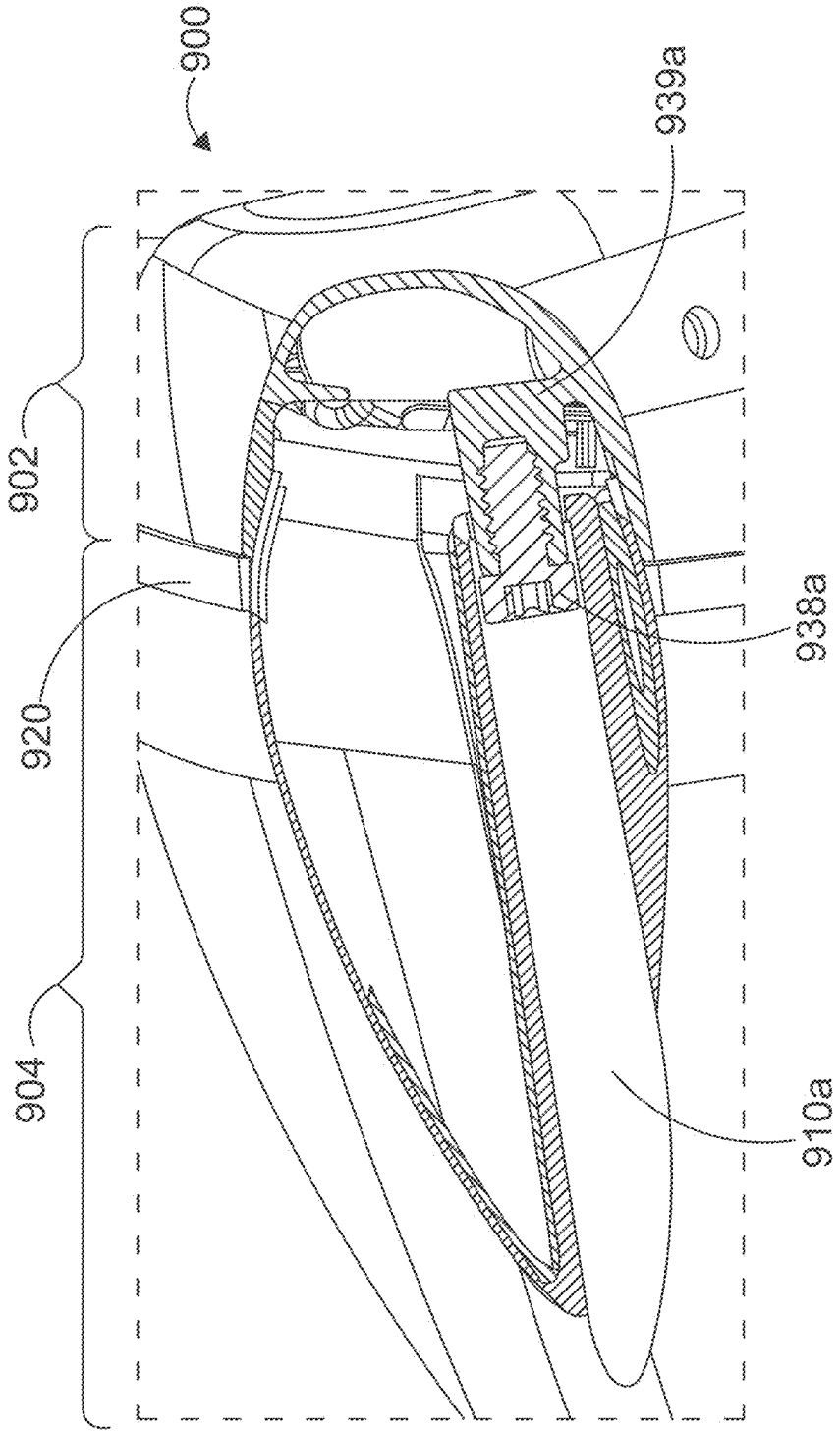


FIG. 8



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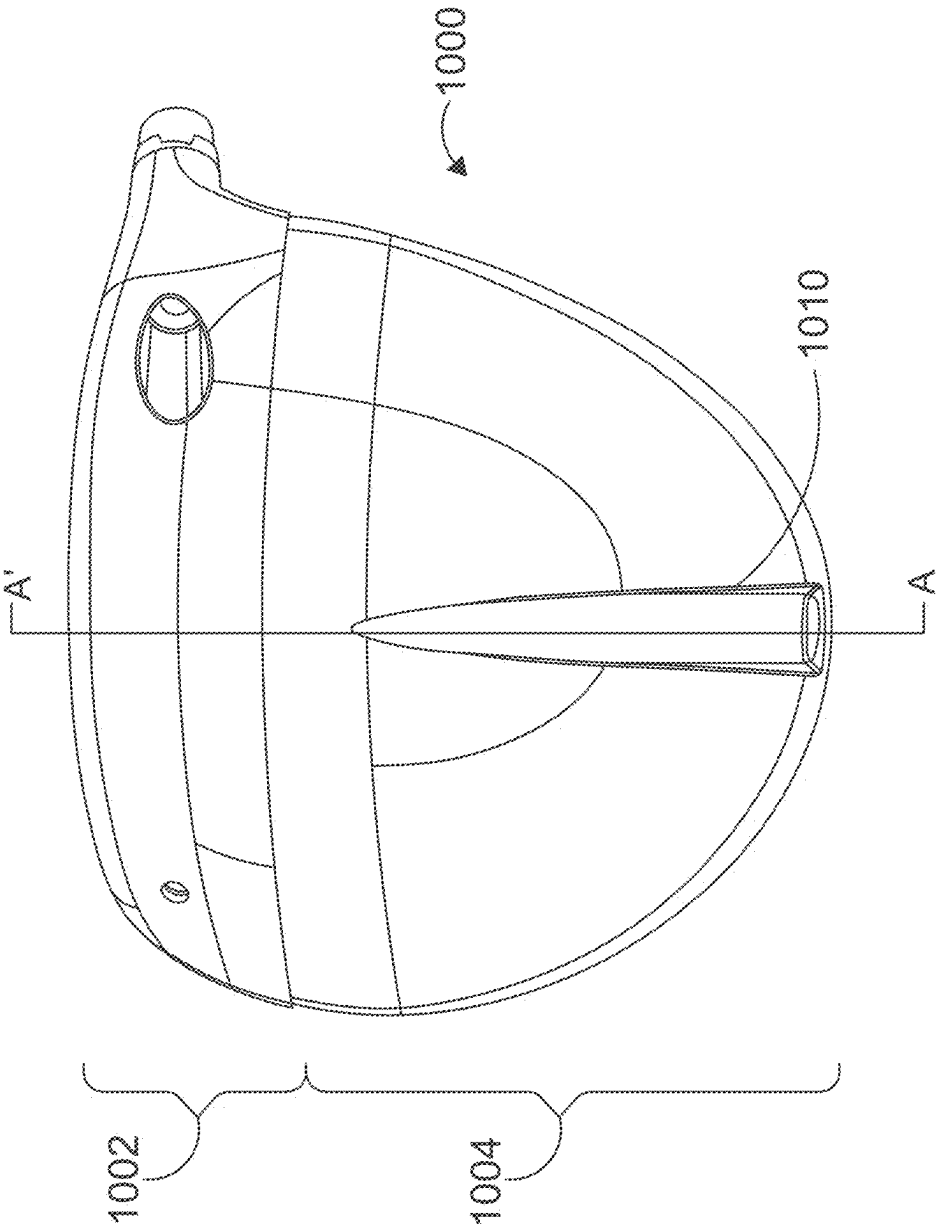
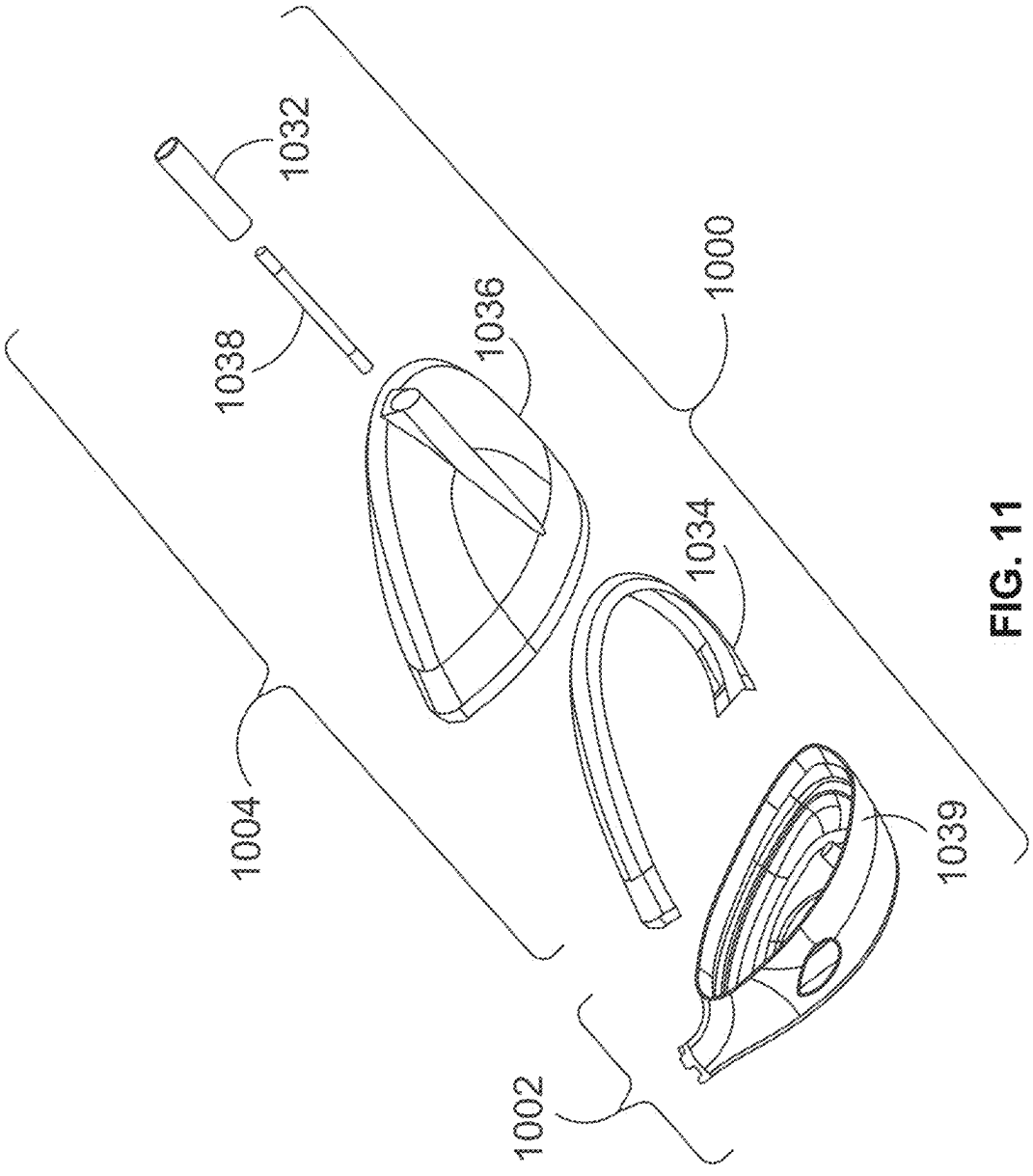


FIG. 10



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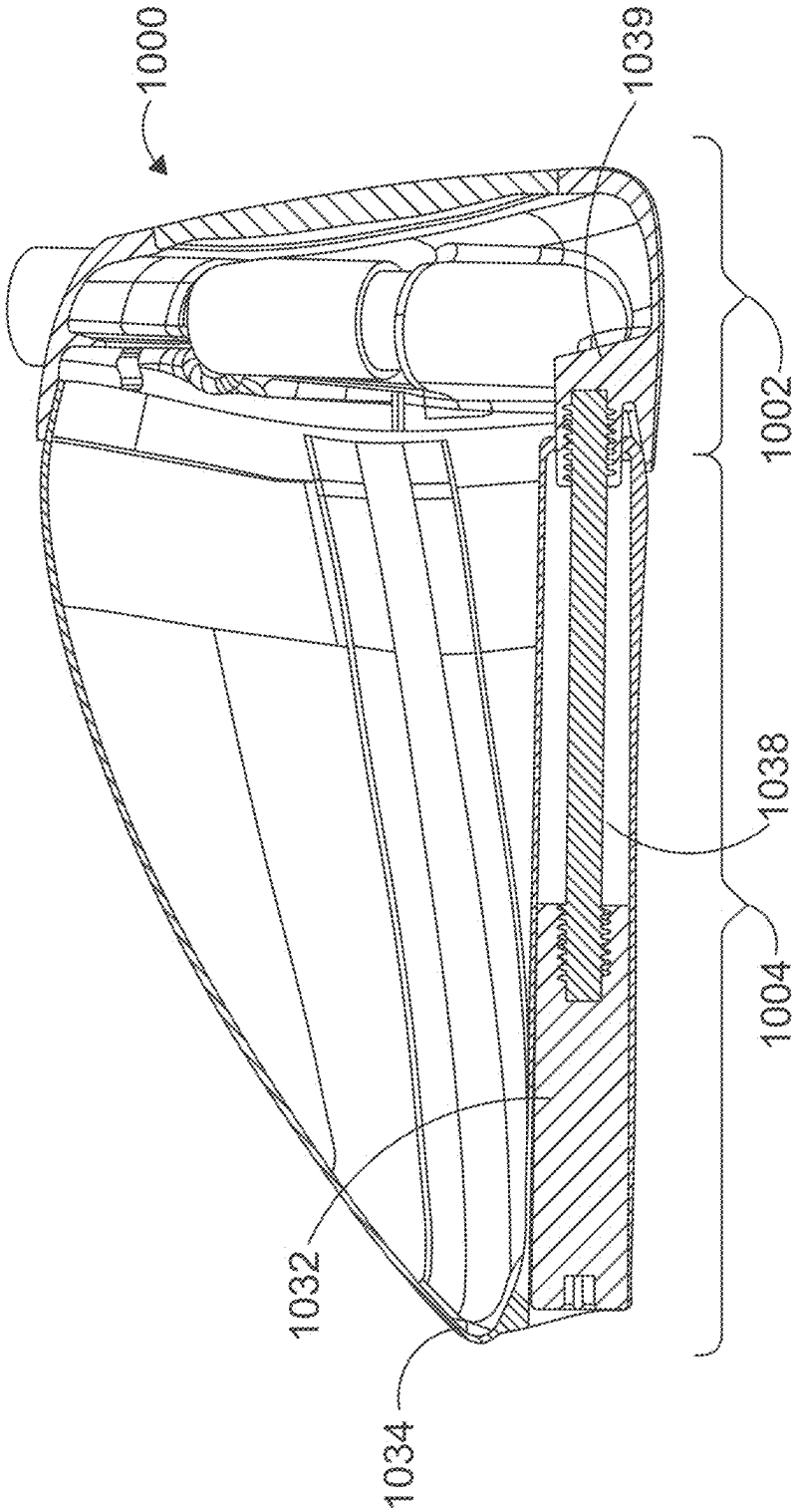


FIG. 12

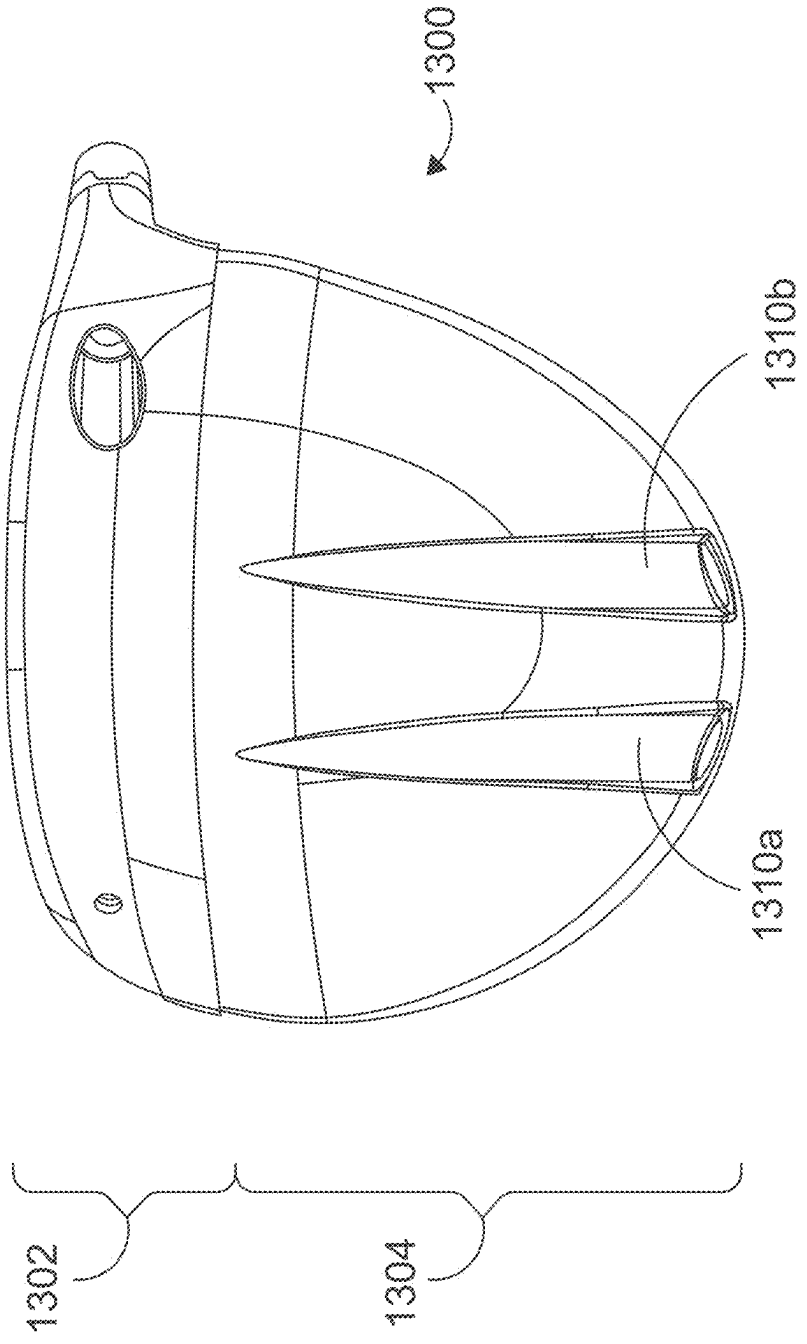


FIG. 13

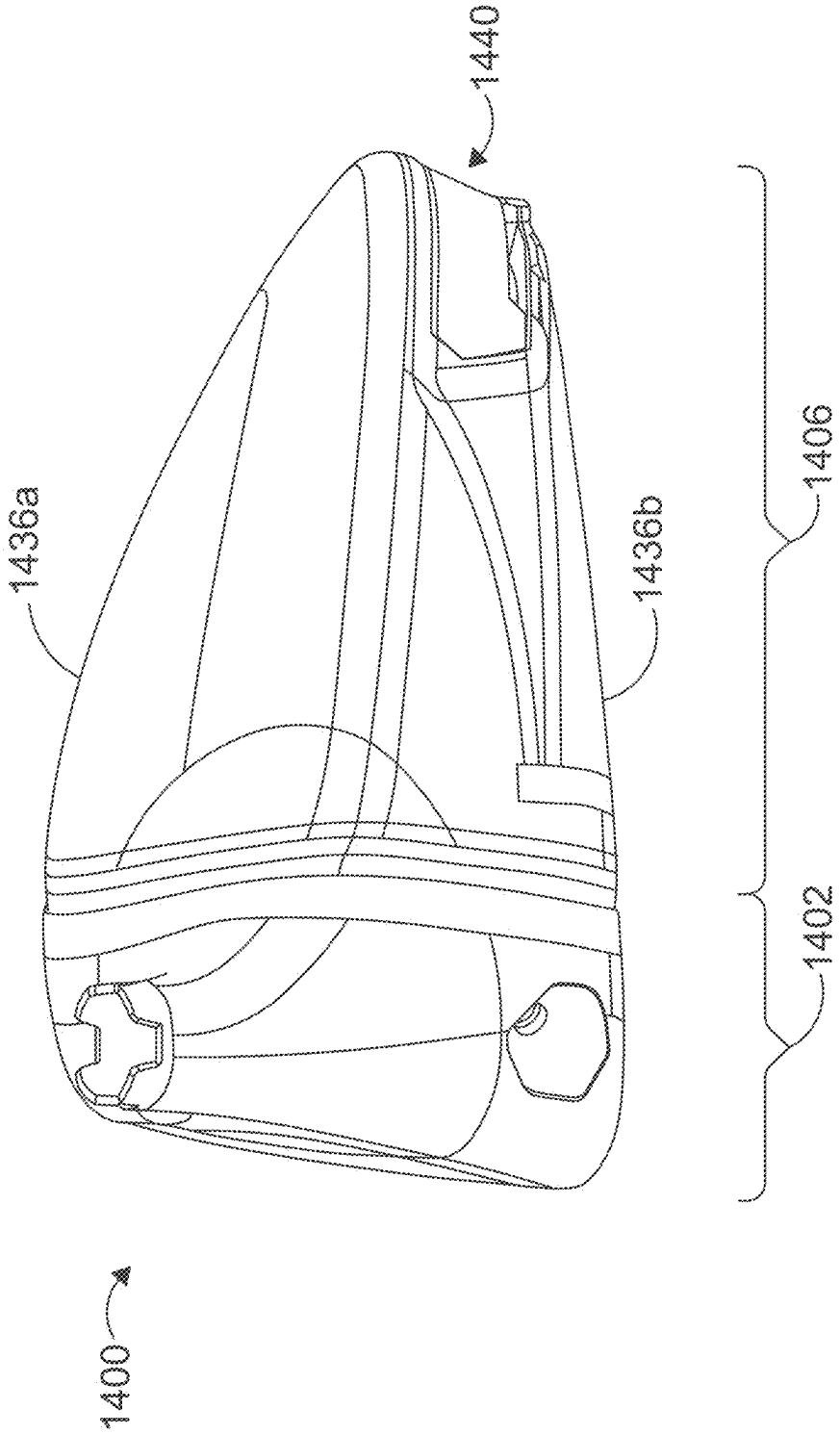


FIG. 14

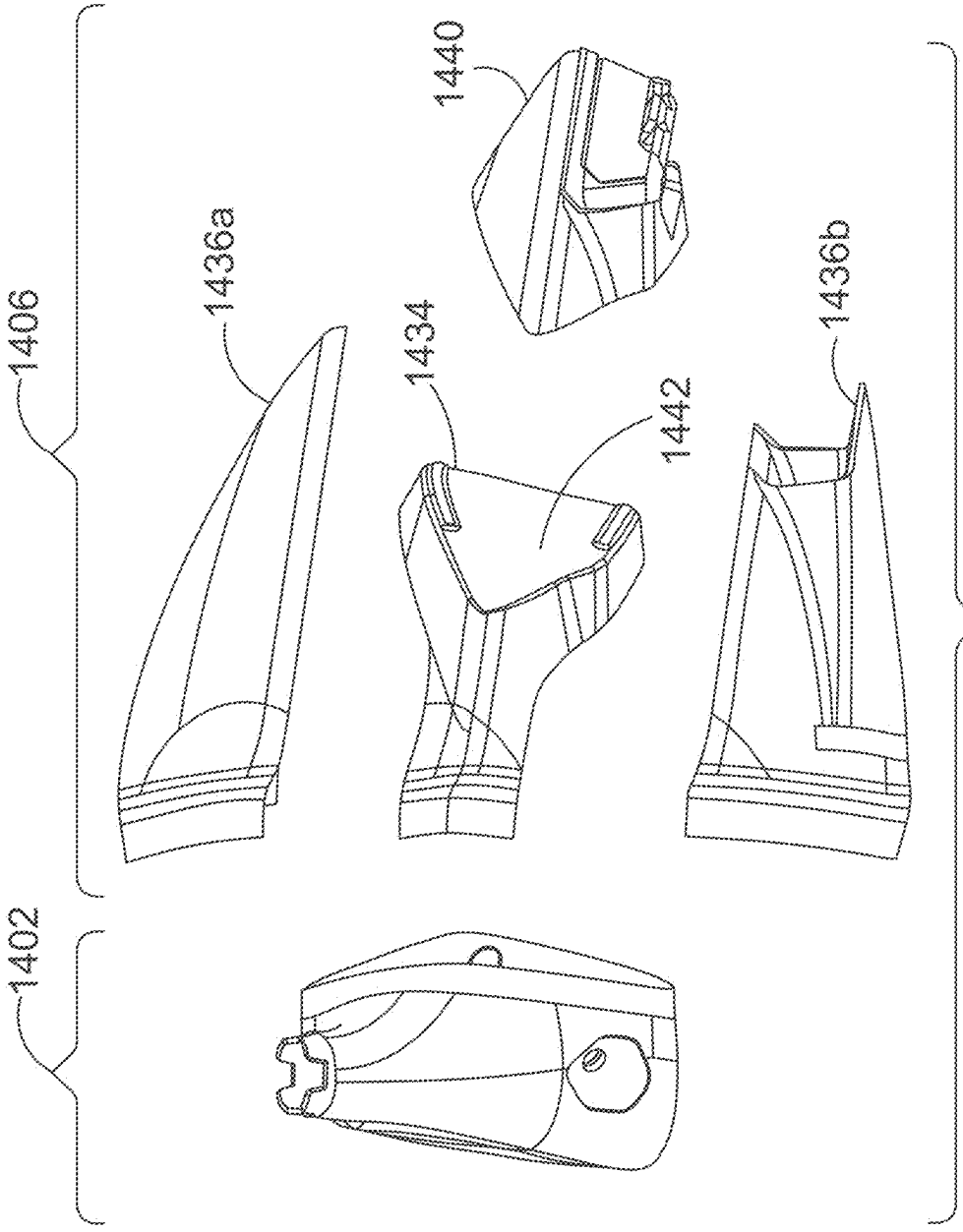
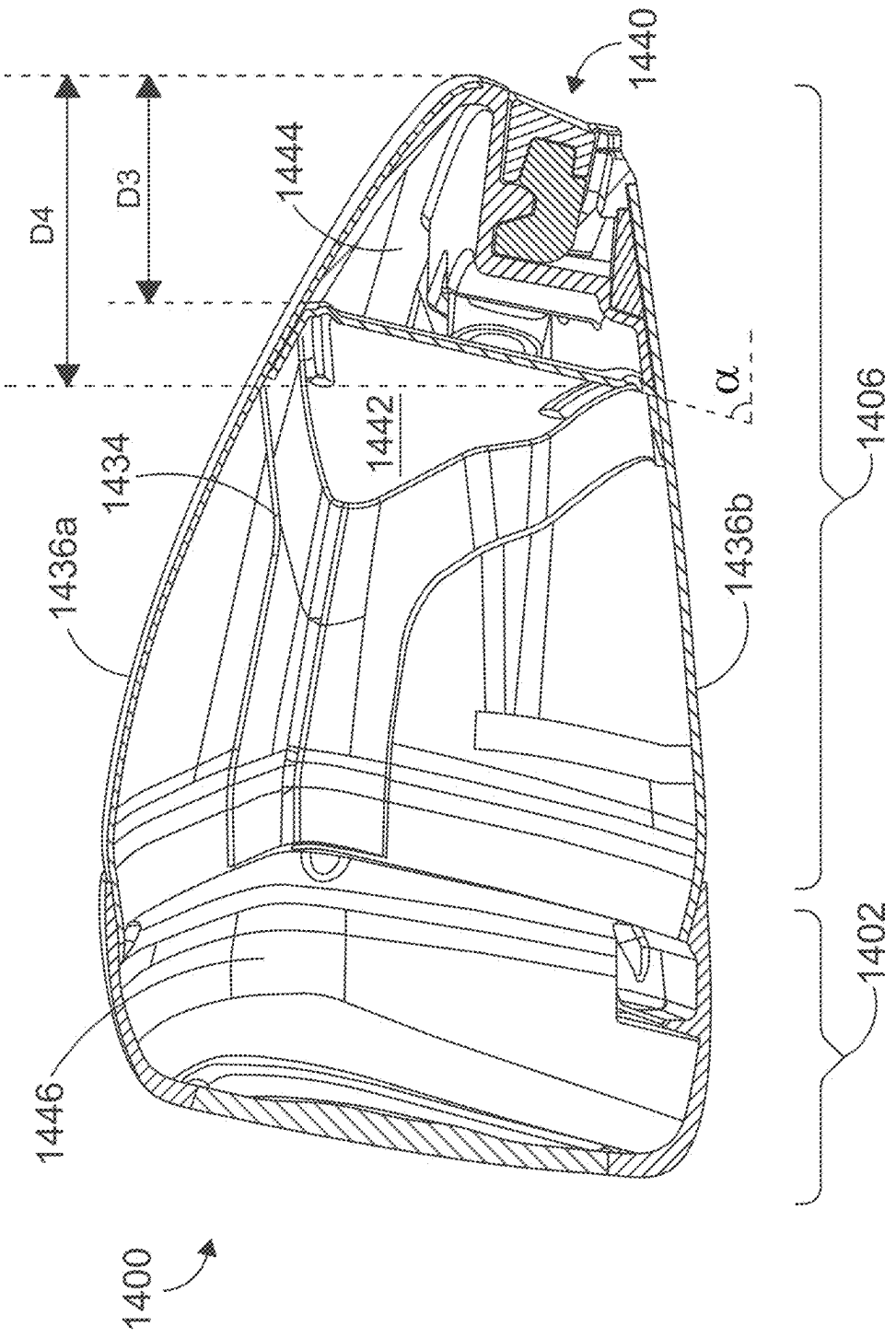


FIG. 15



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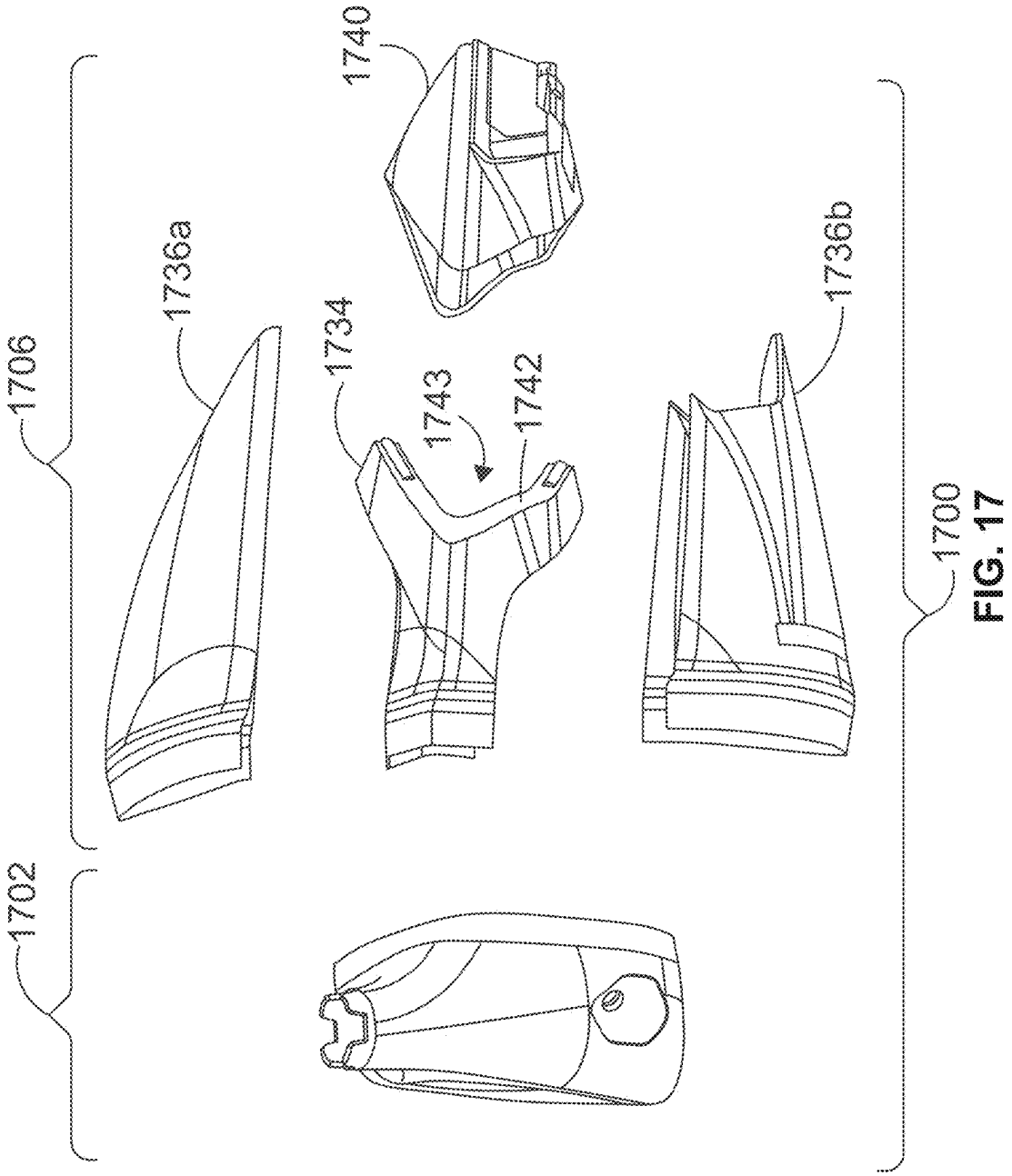

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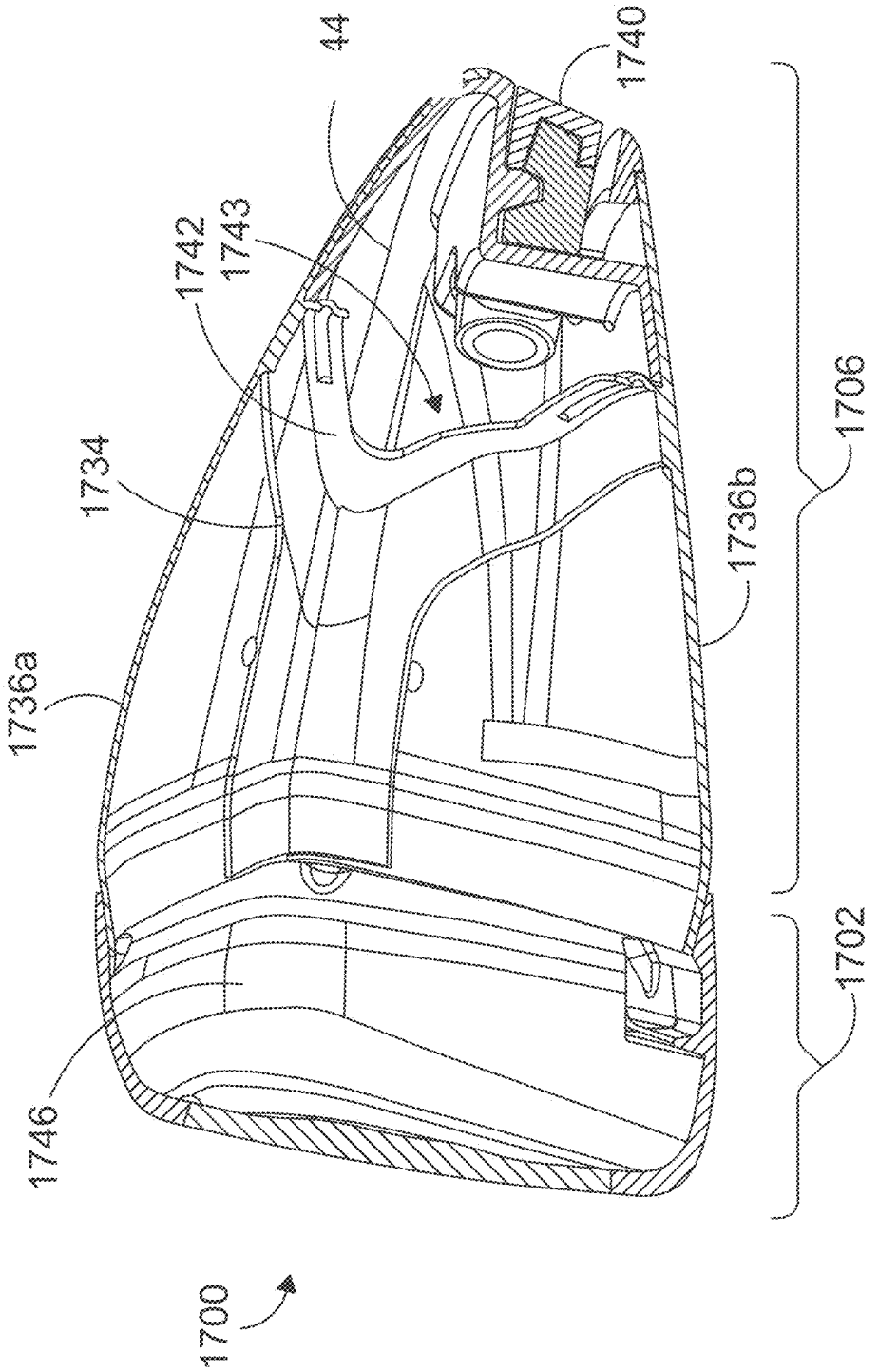

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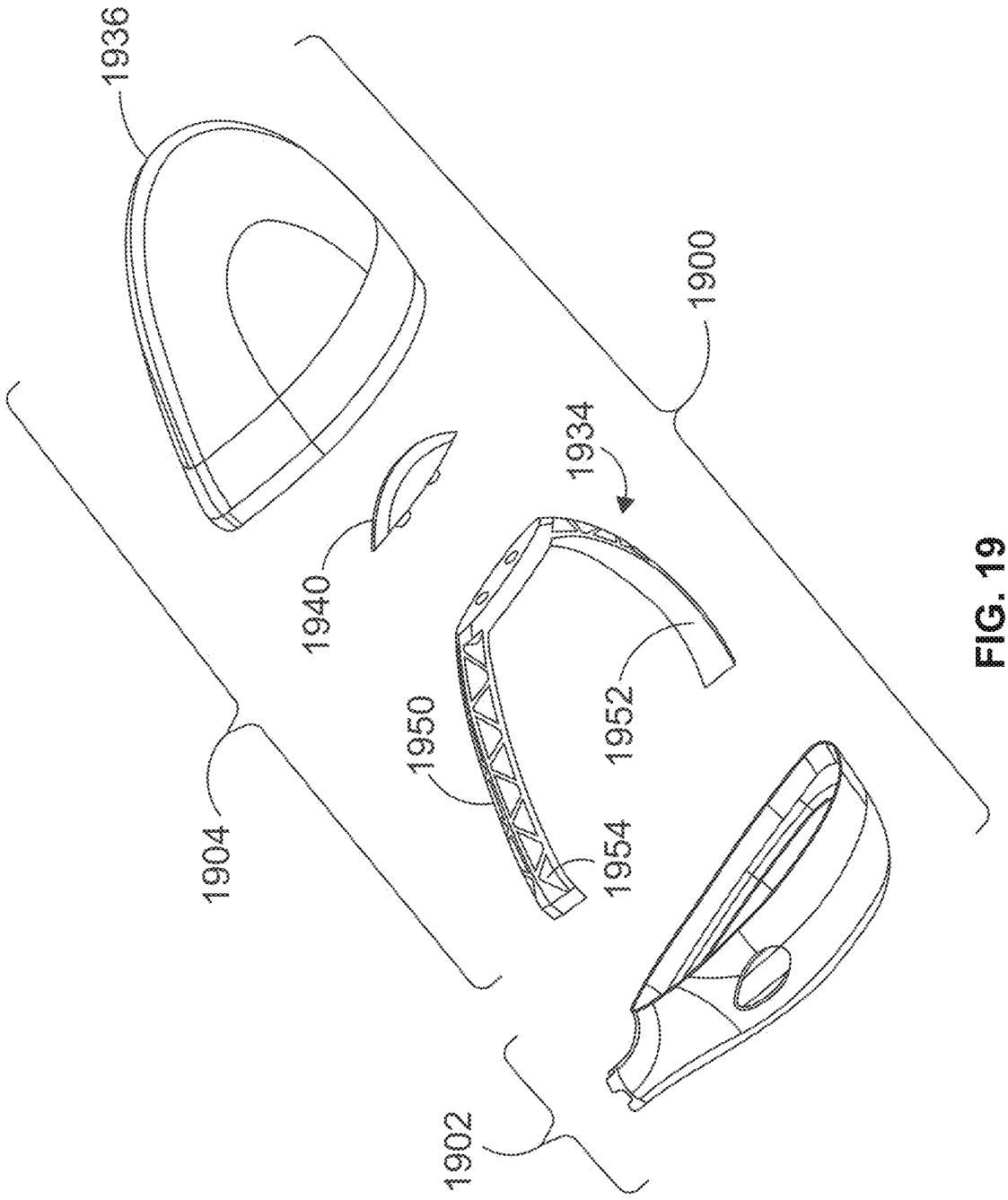

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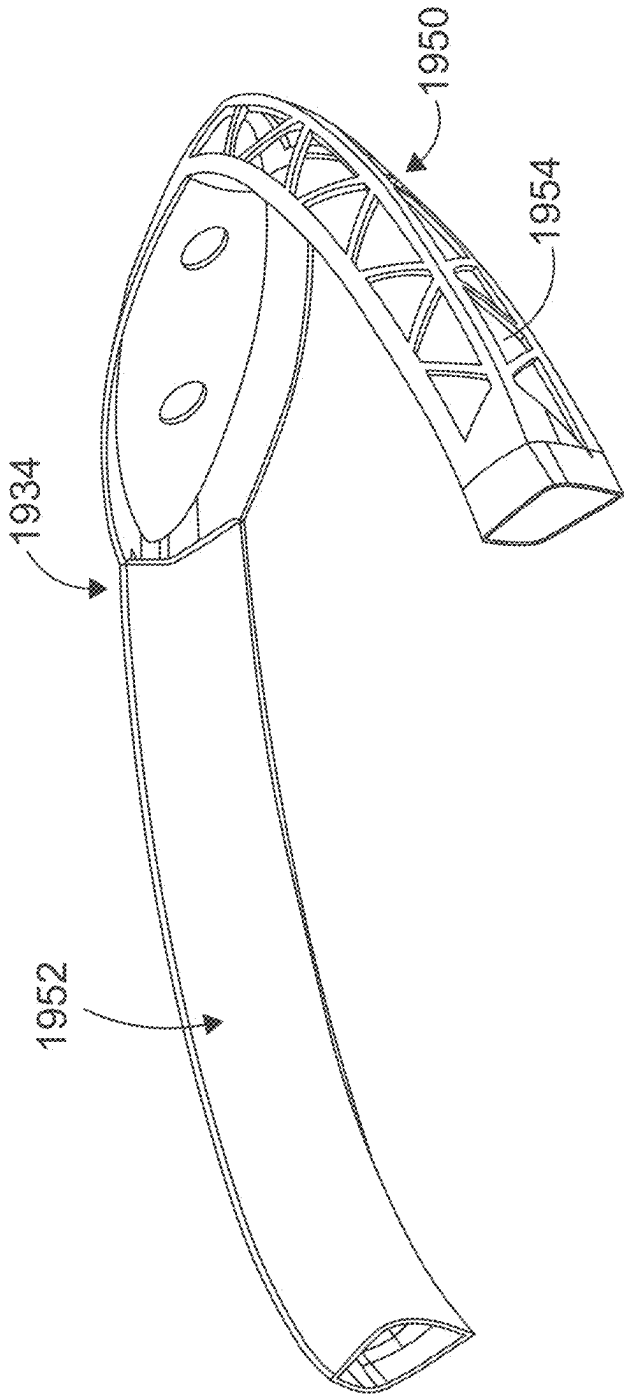

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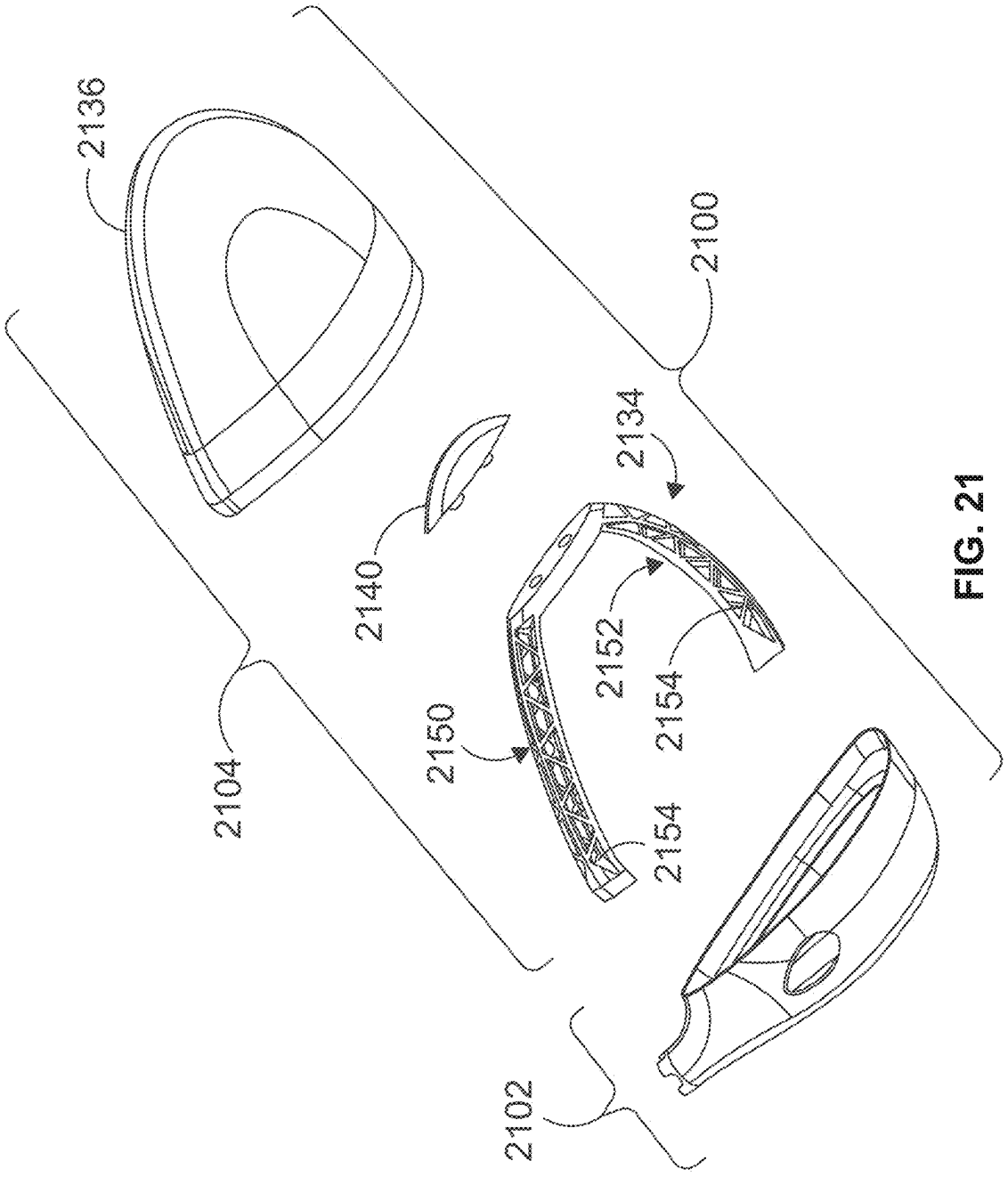

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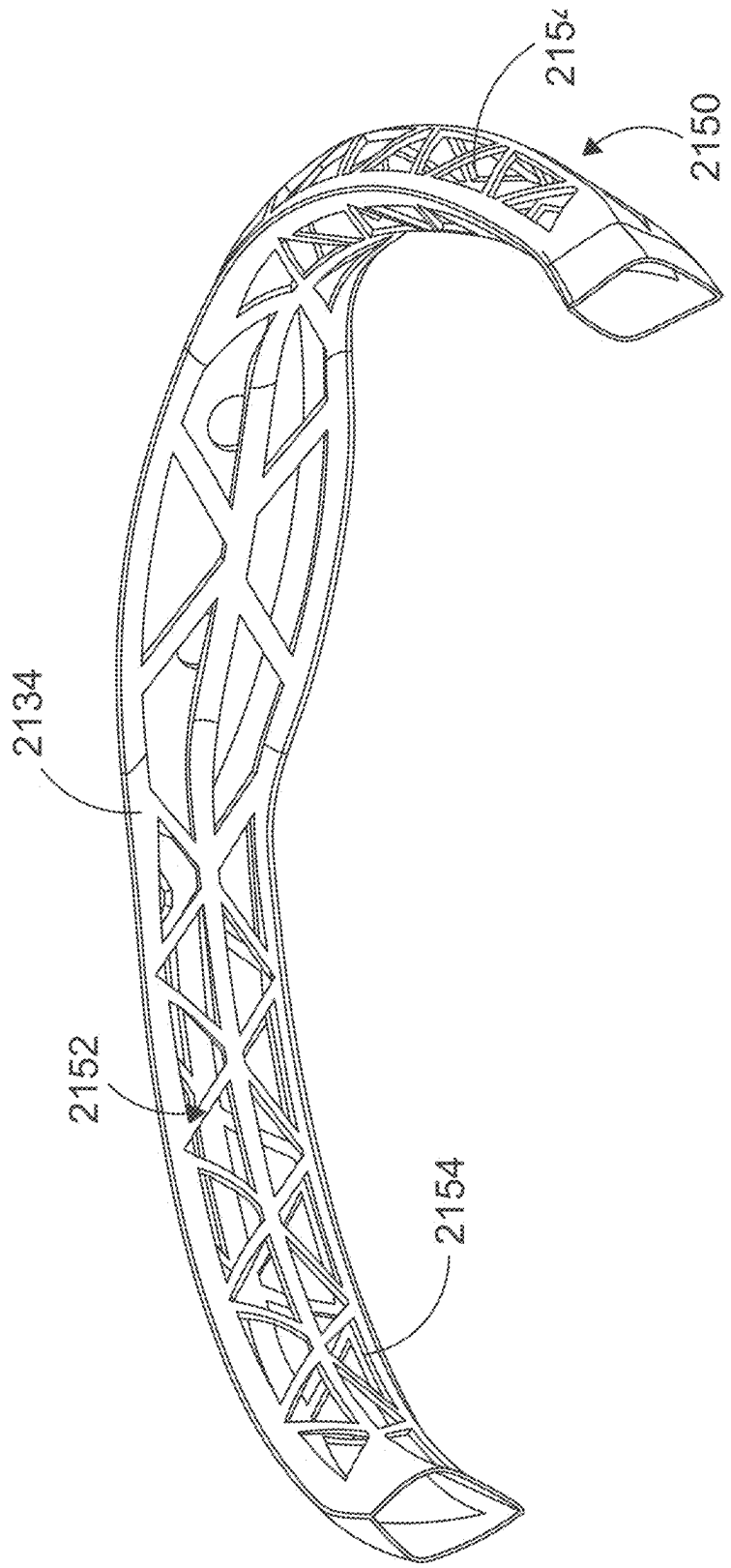

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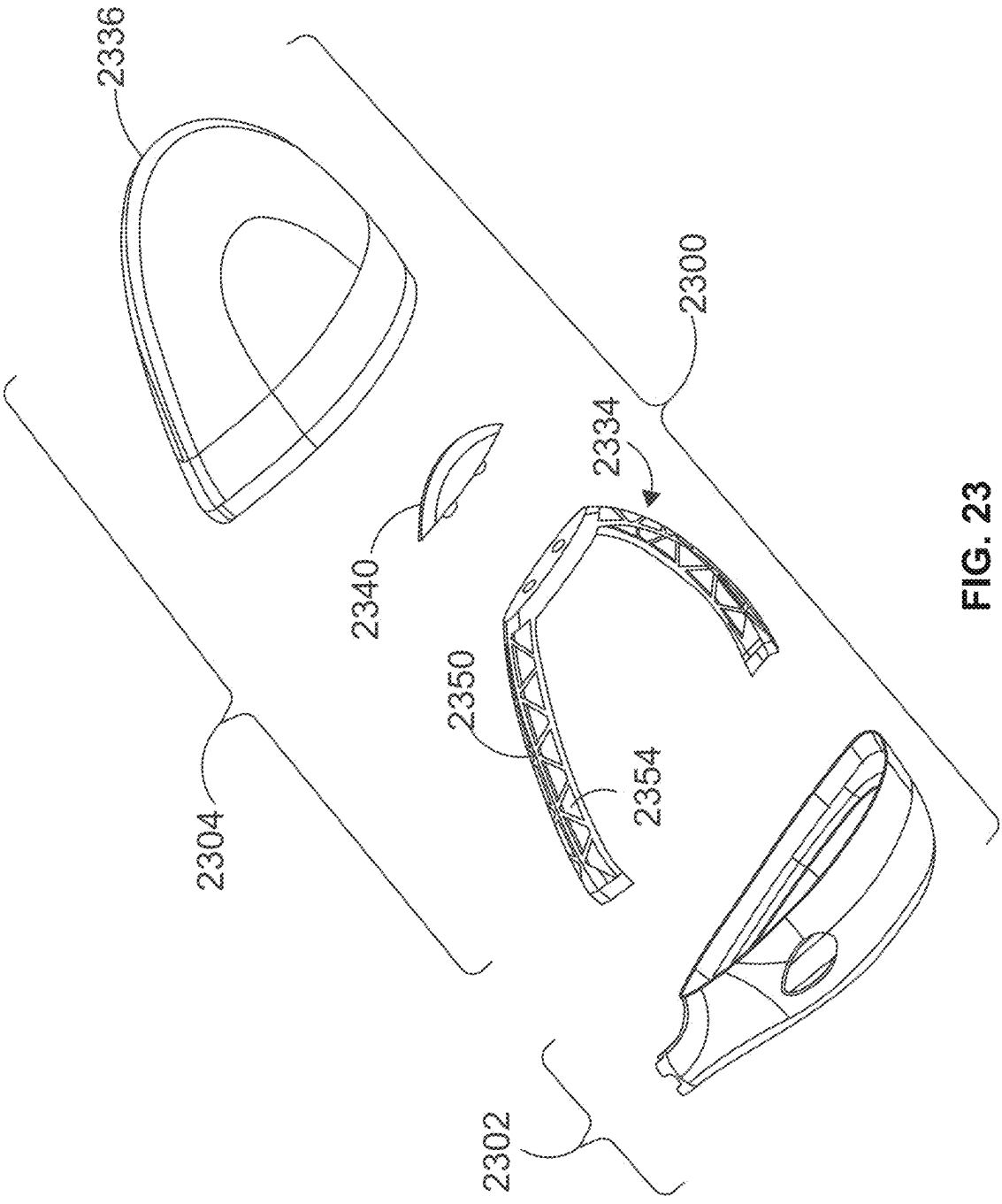


FIG. 23

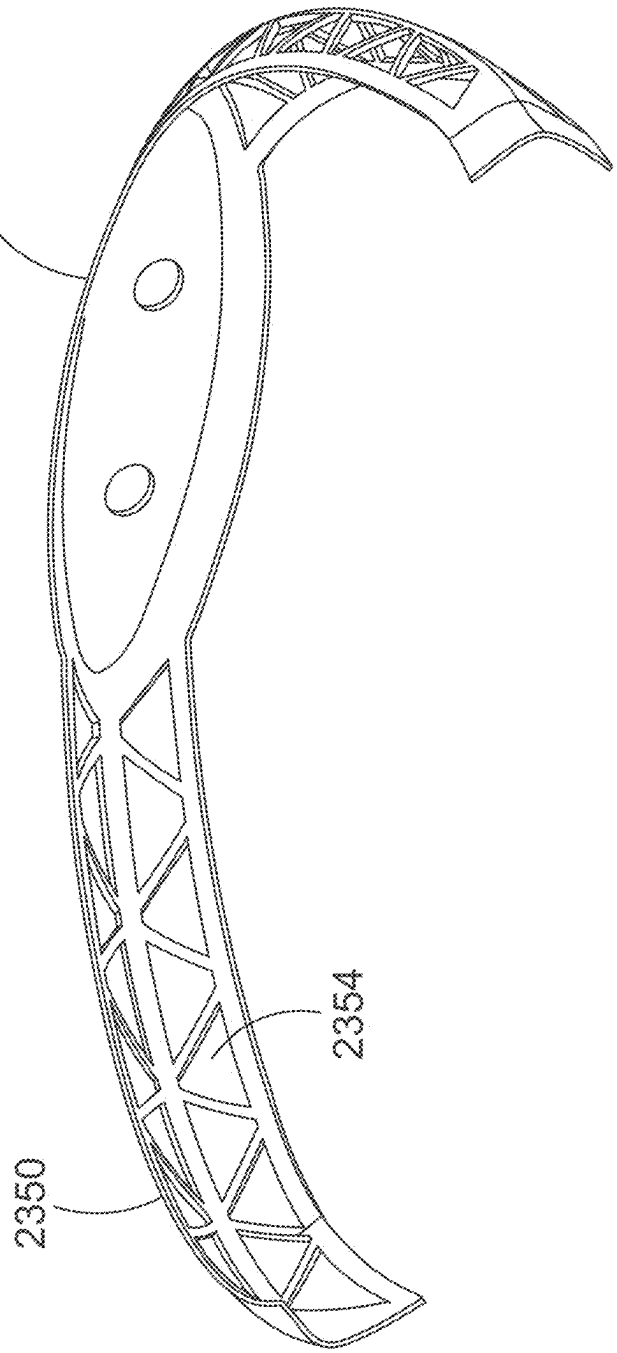


FIG. 24

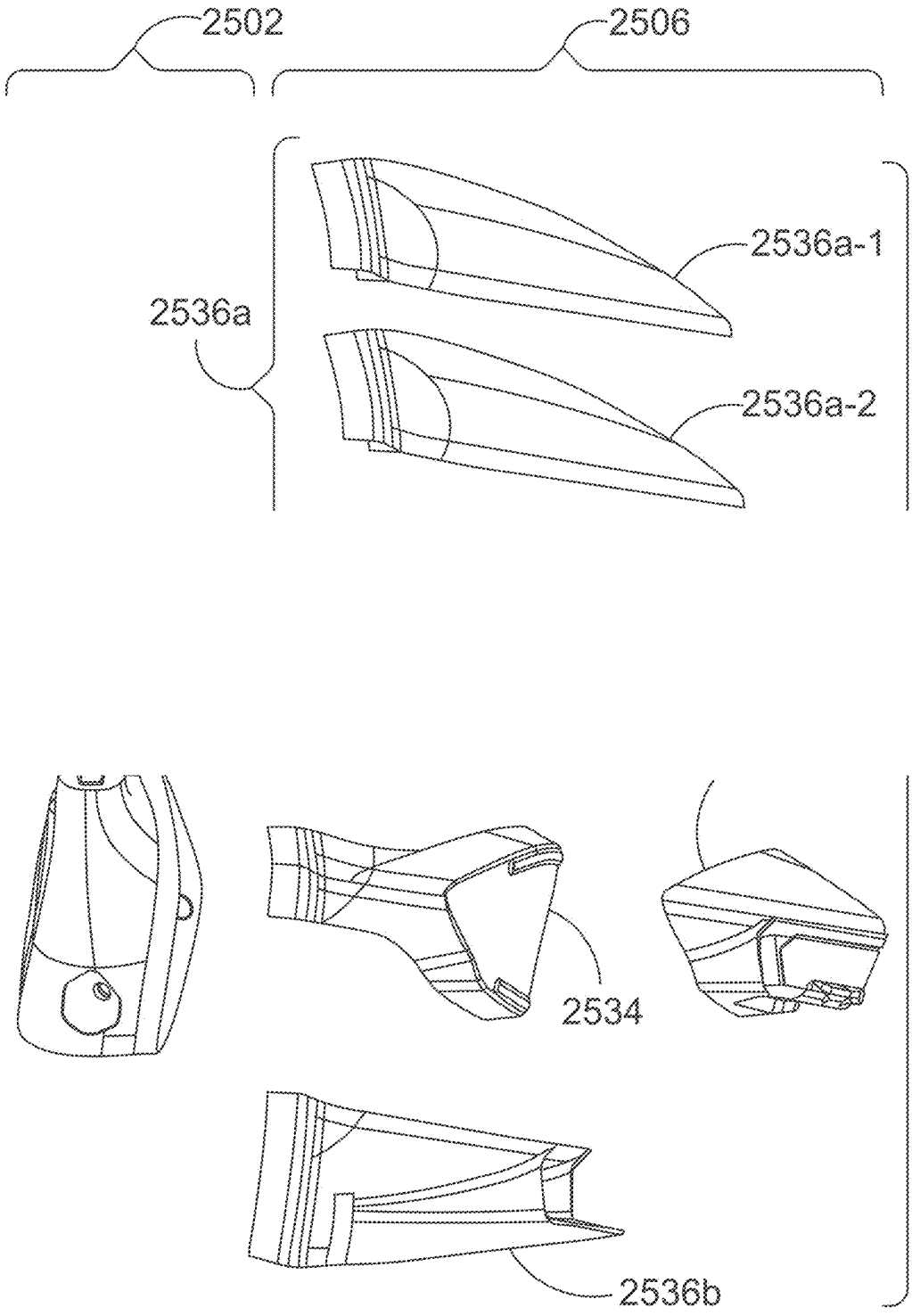


FIG. 25

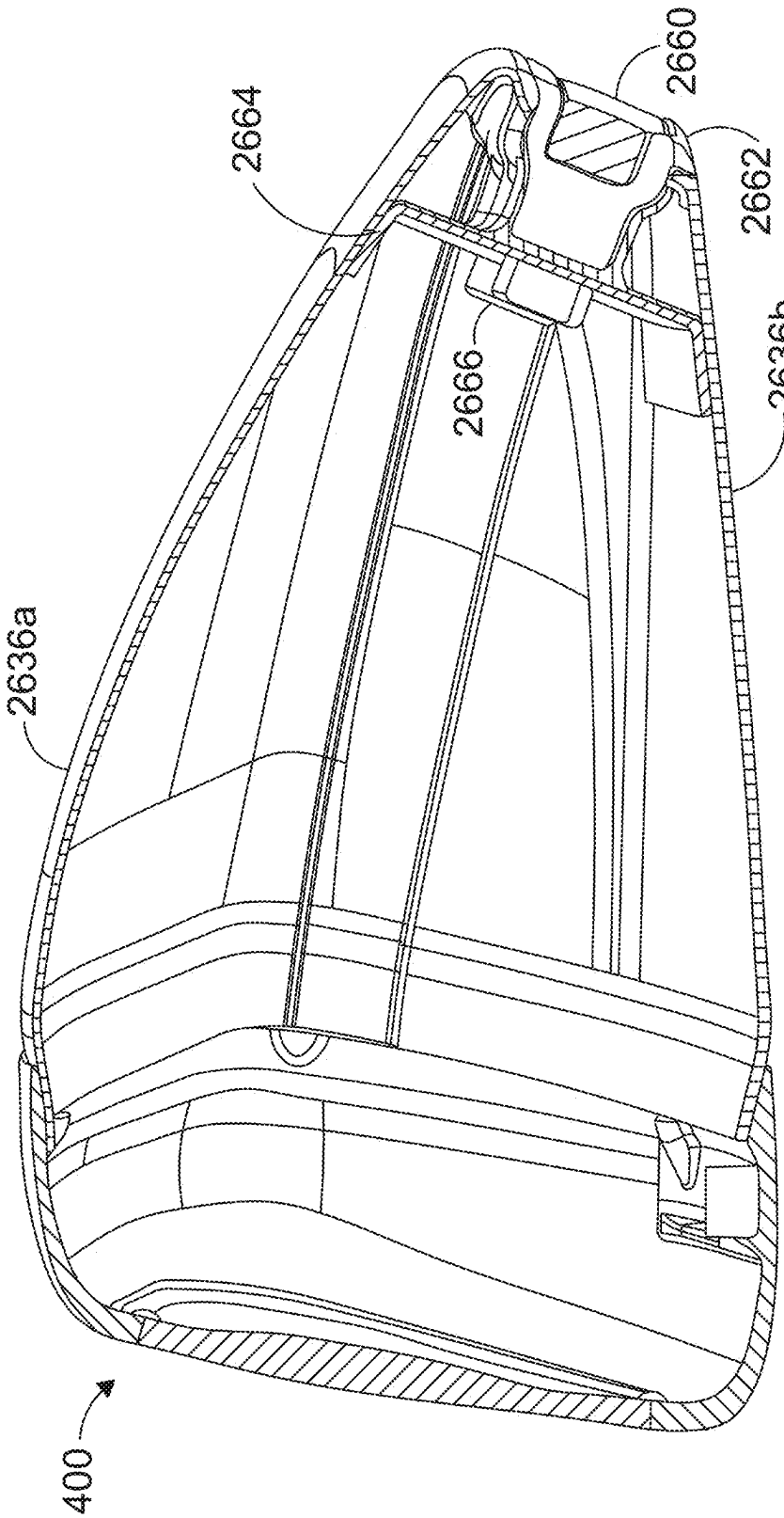
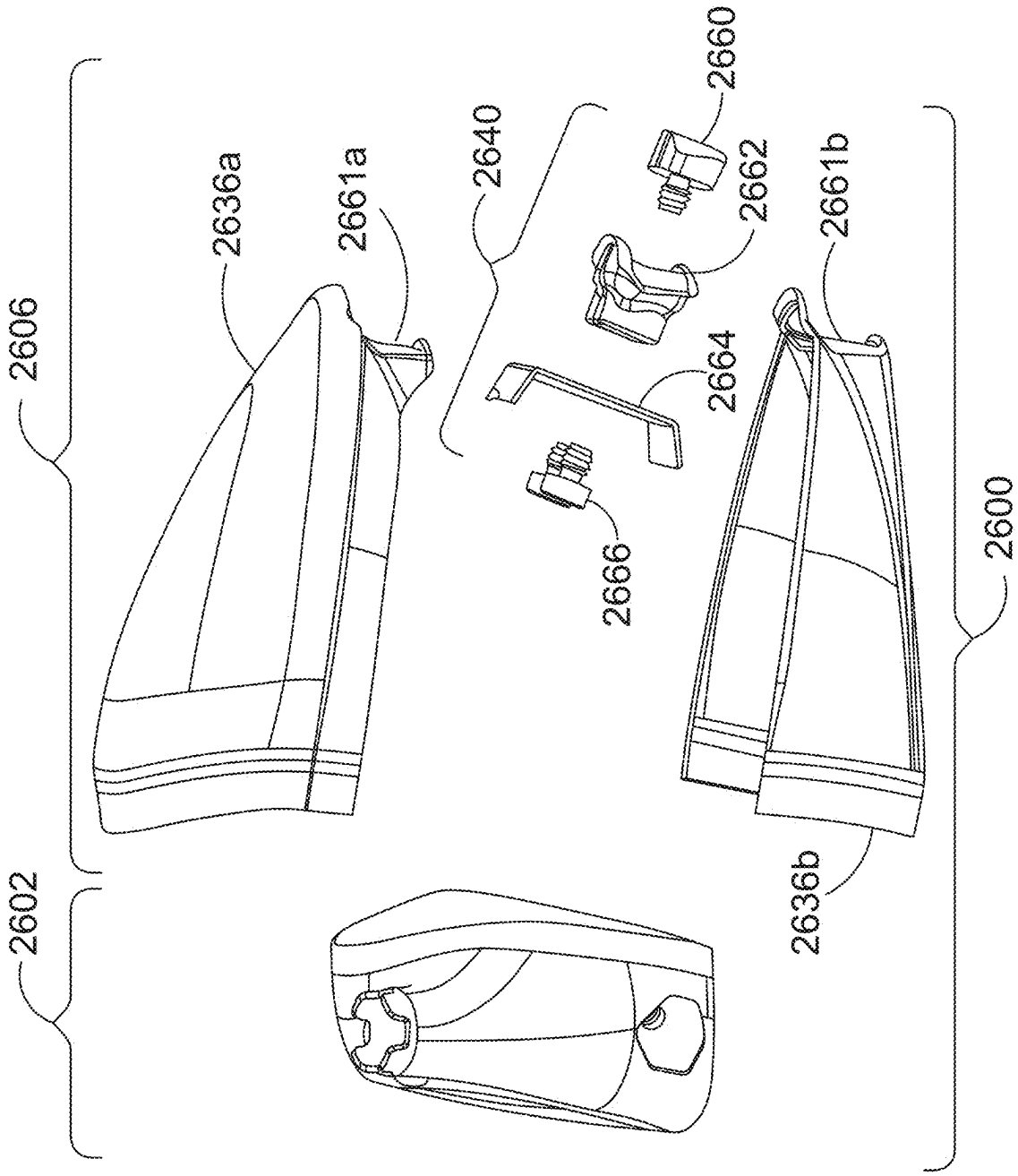


FIG. 26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2636b

FIG. 27

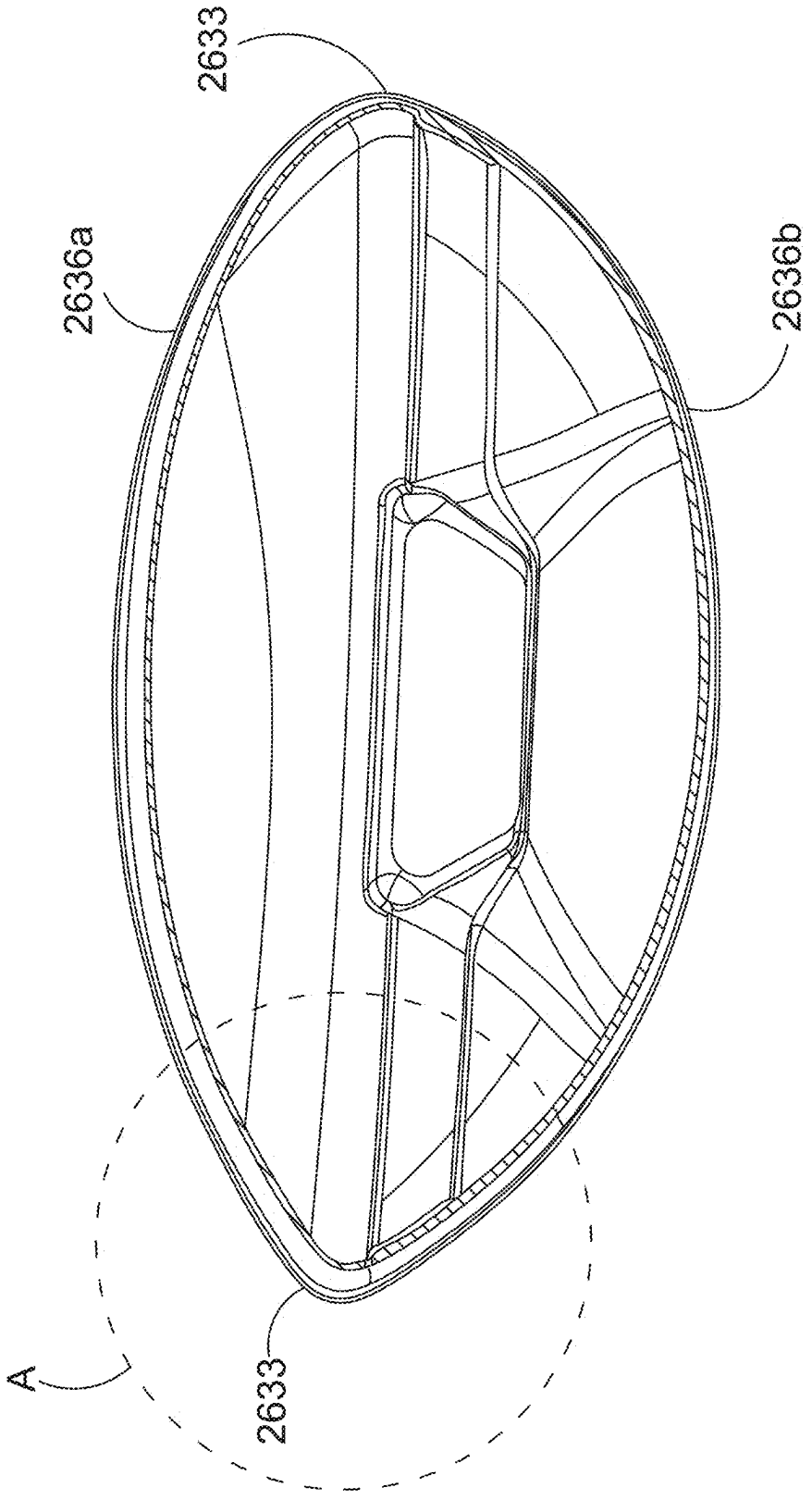

FIG. 28

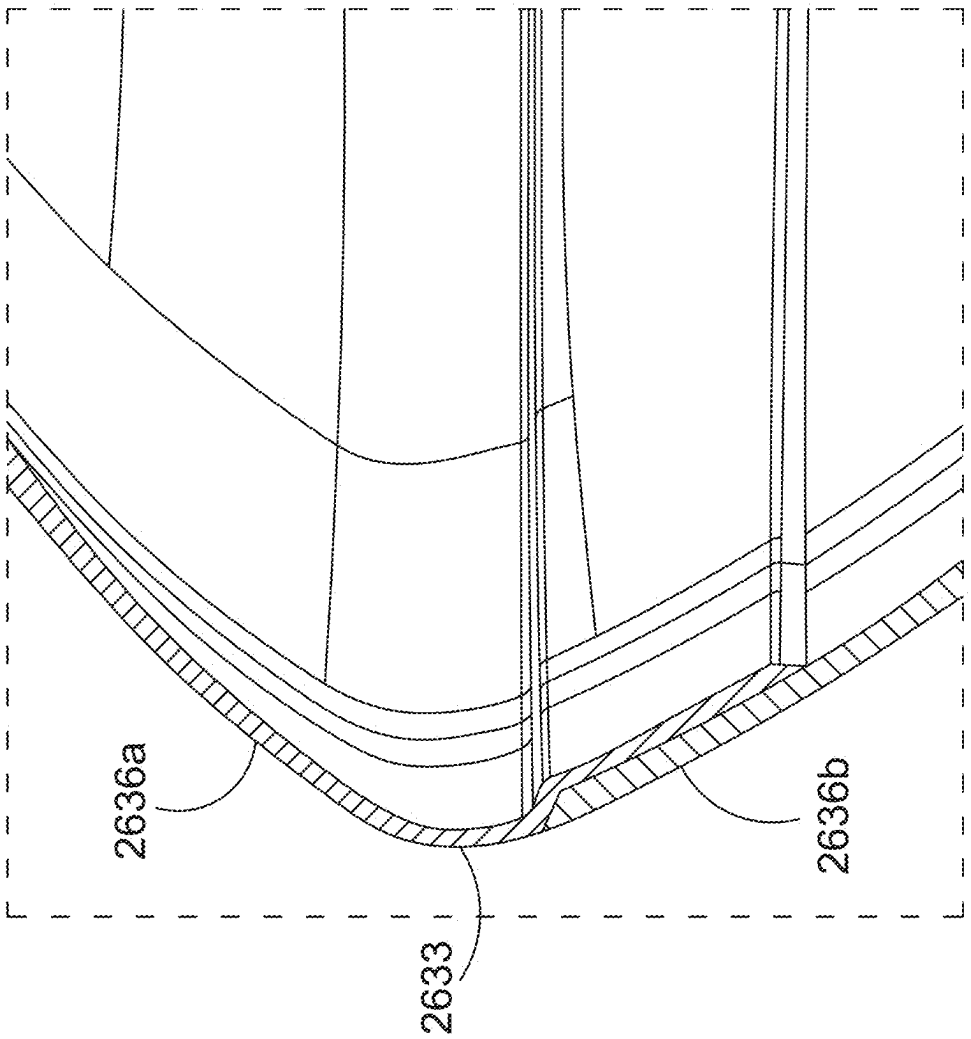

FIG. 29

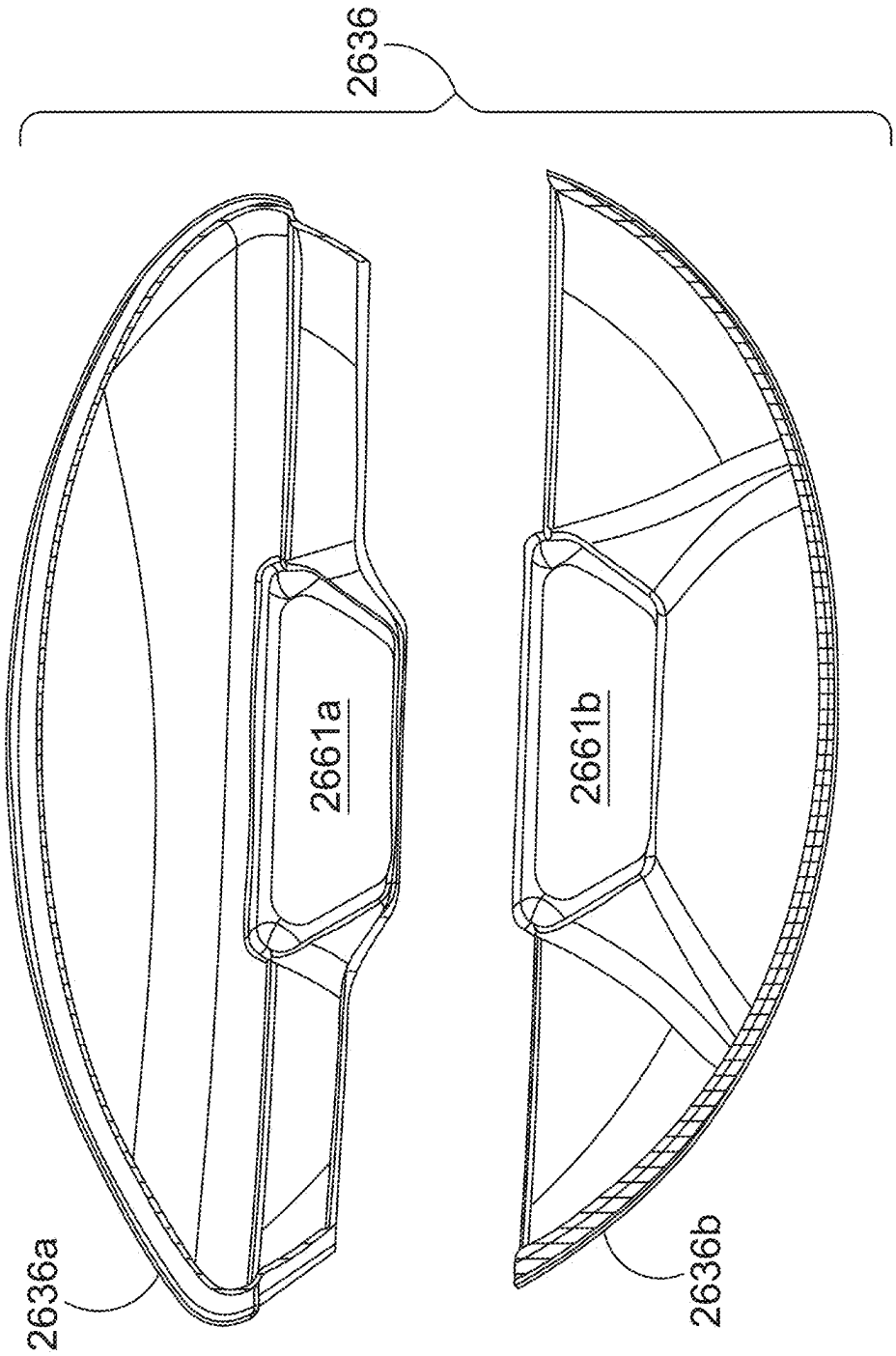

FIG. 30

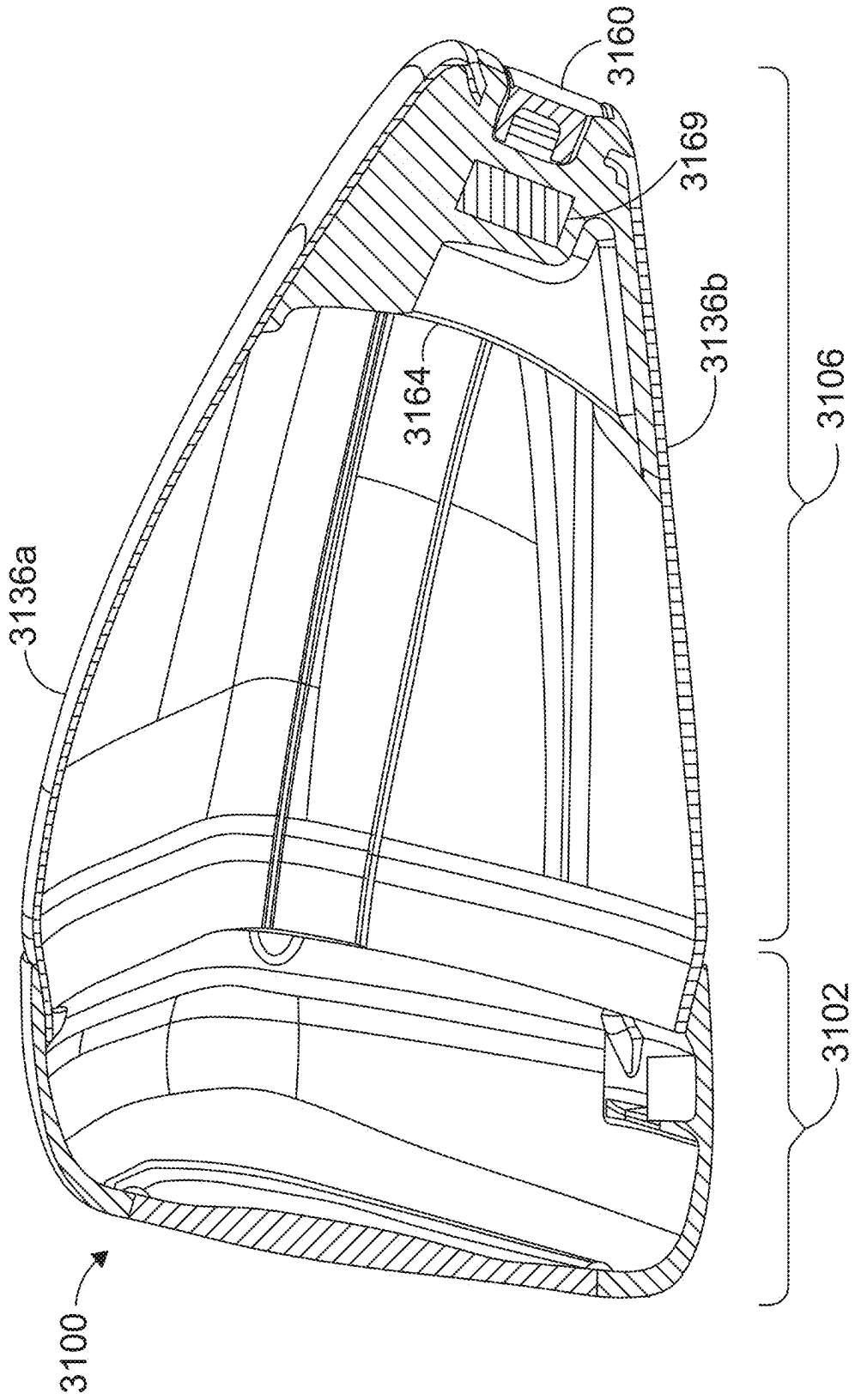

FIG. 31

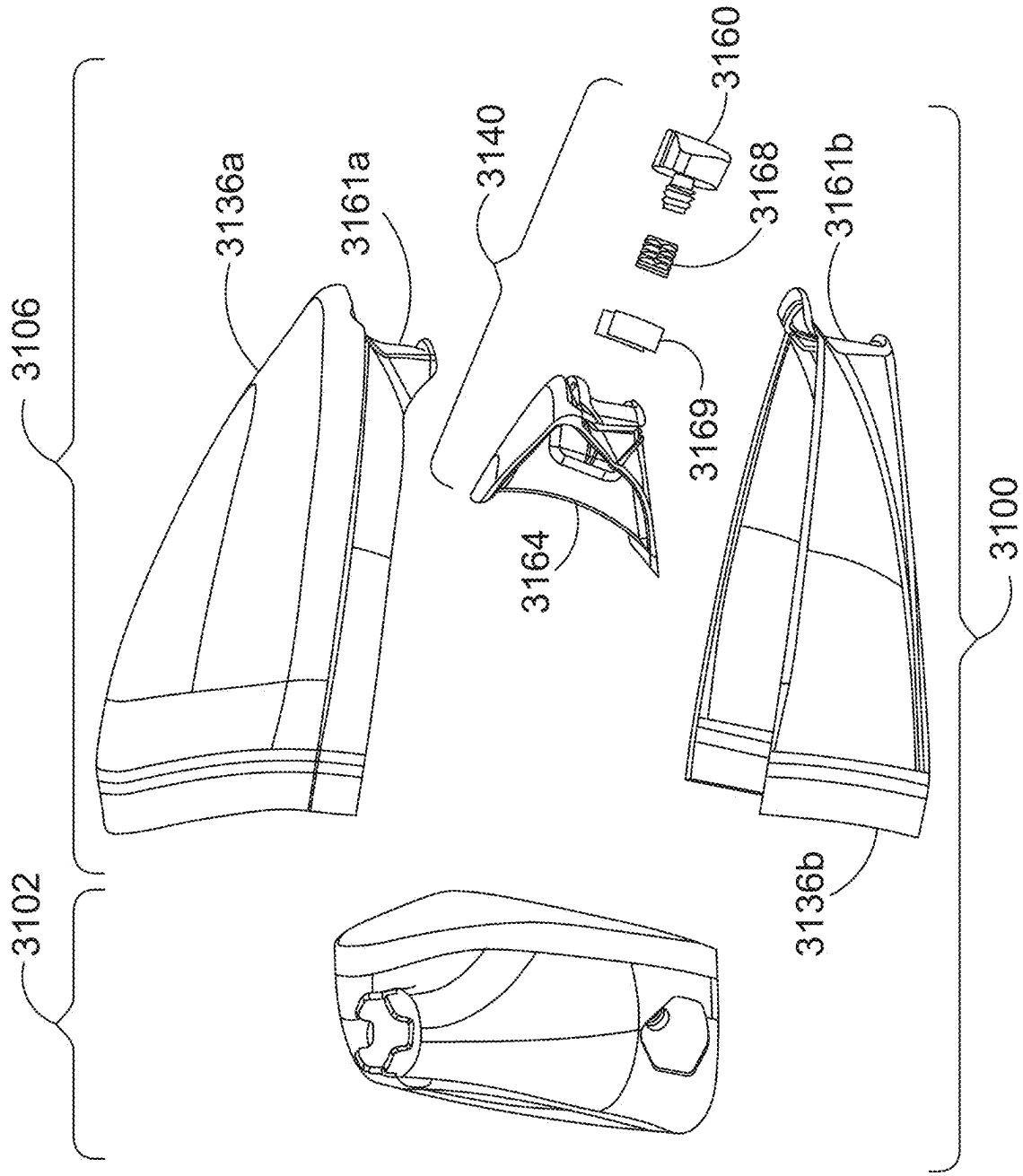
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FIG. 32

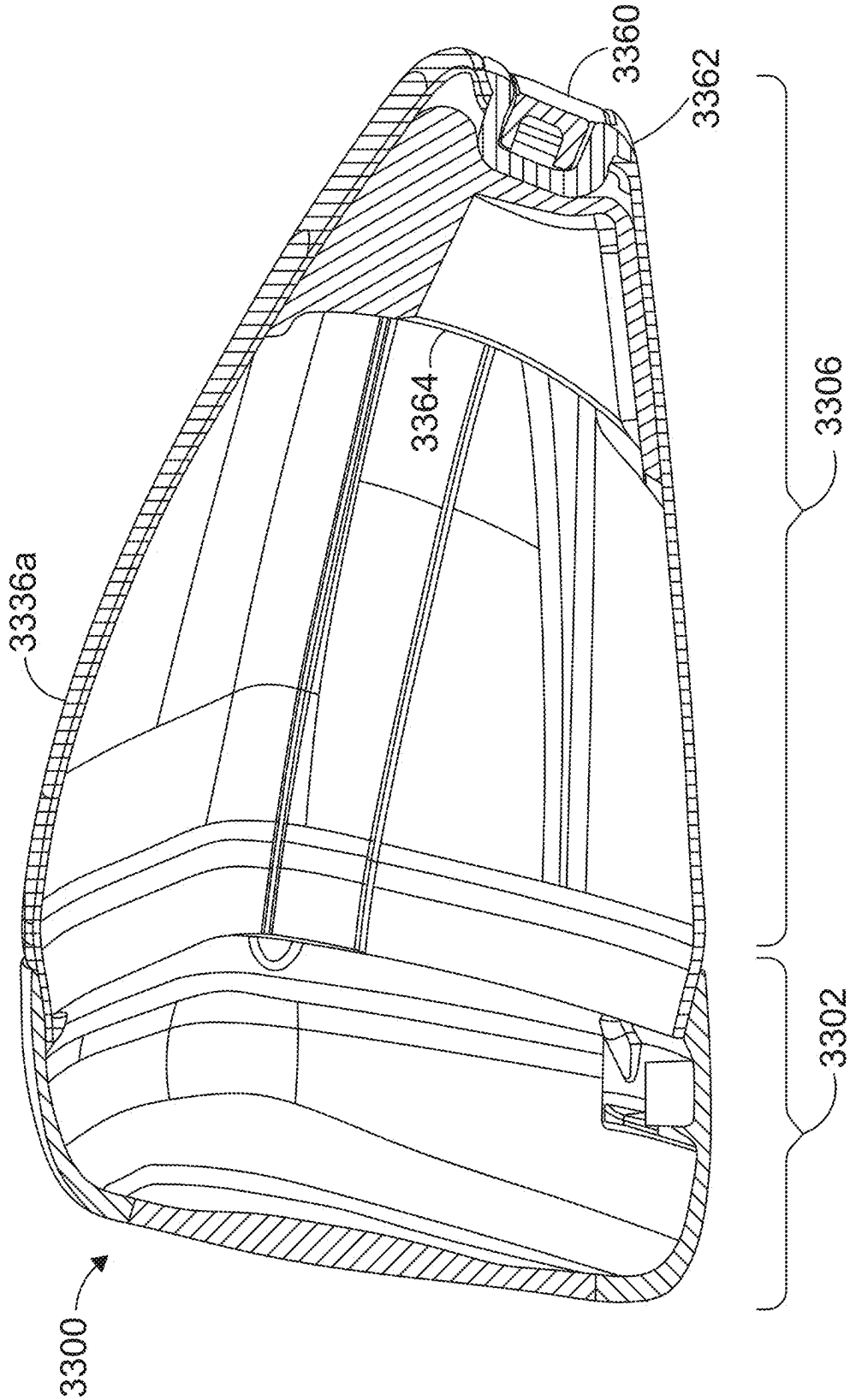


FIG. 33

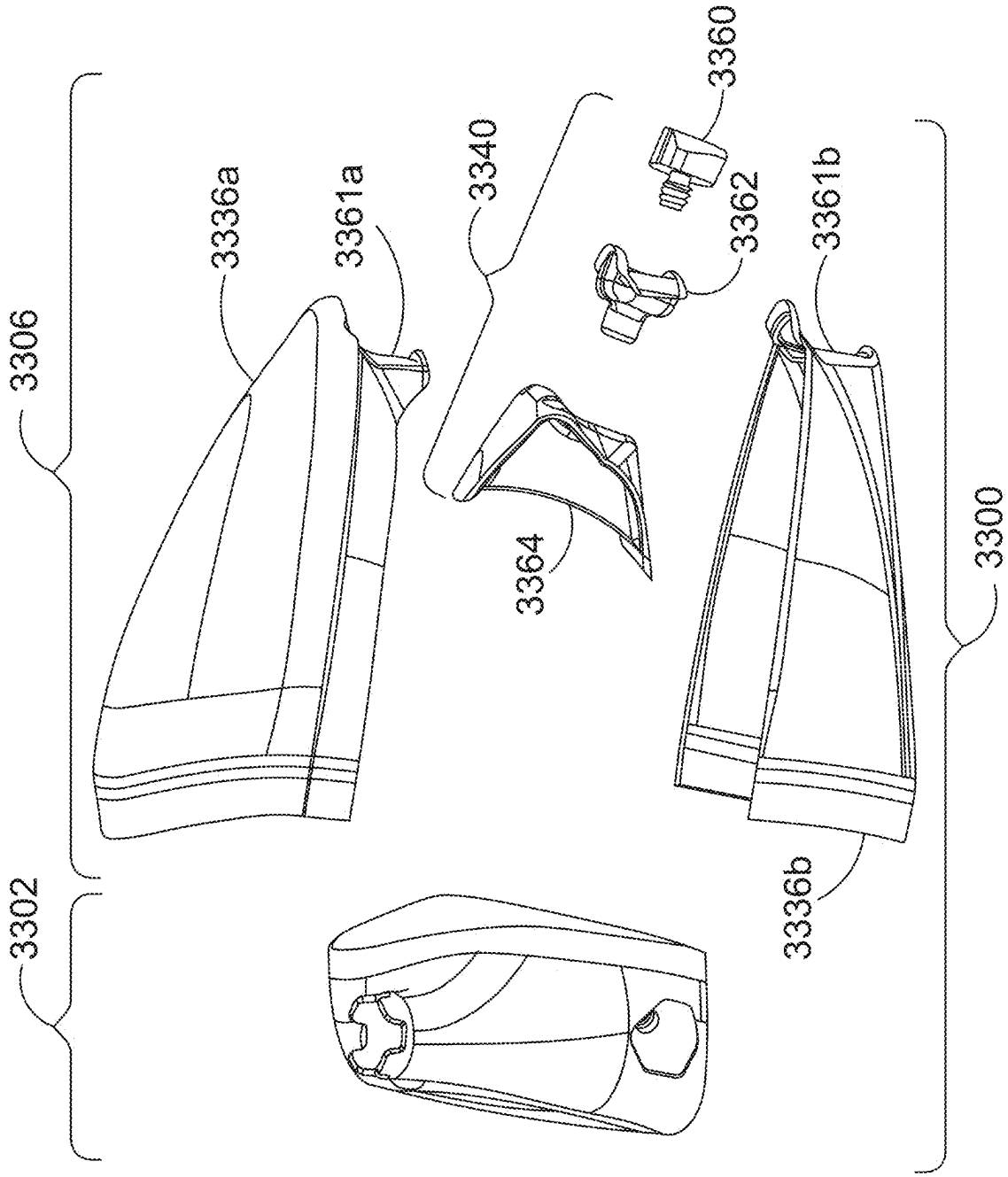


FIG. 34

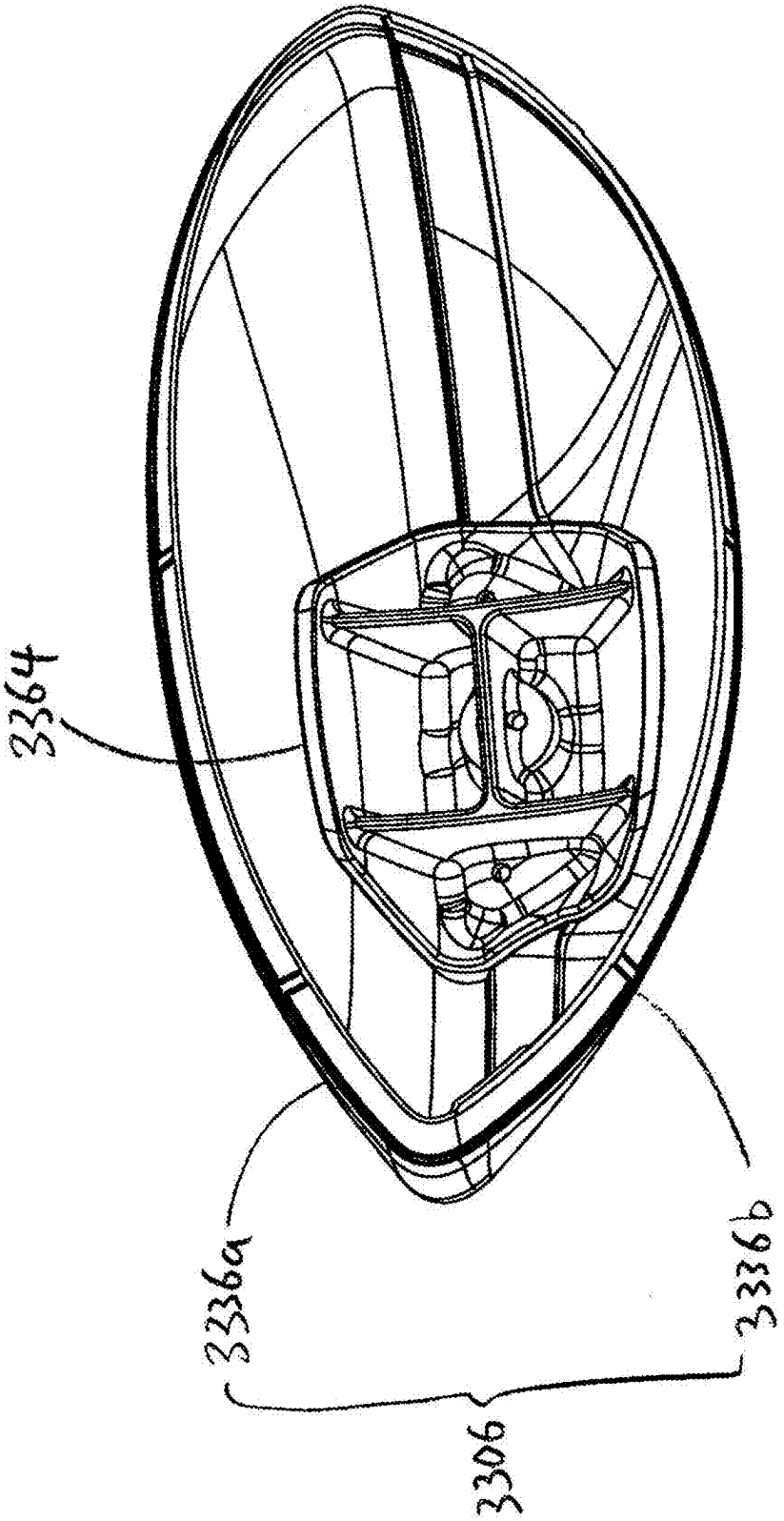


FIG. 35

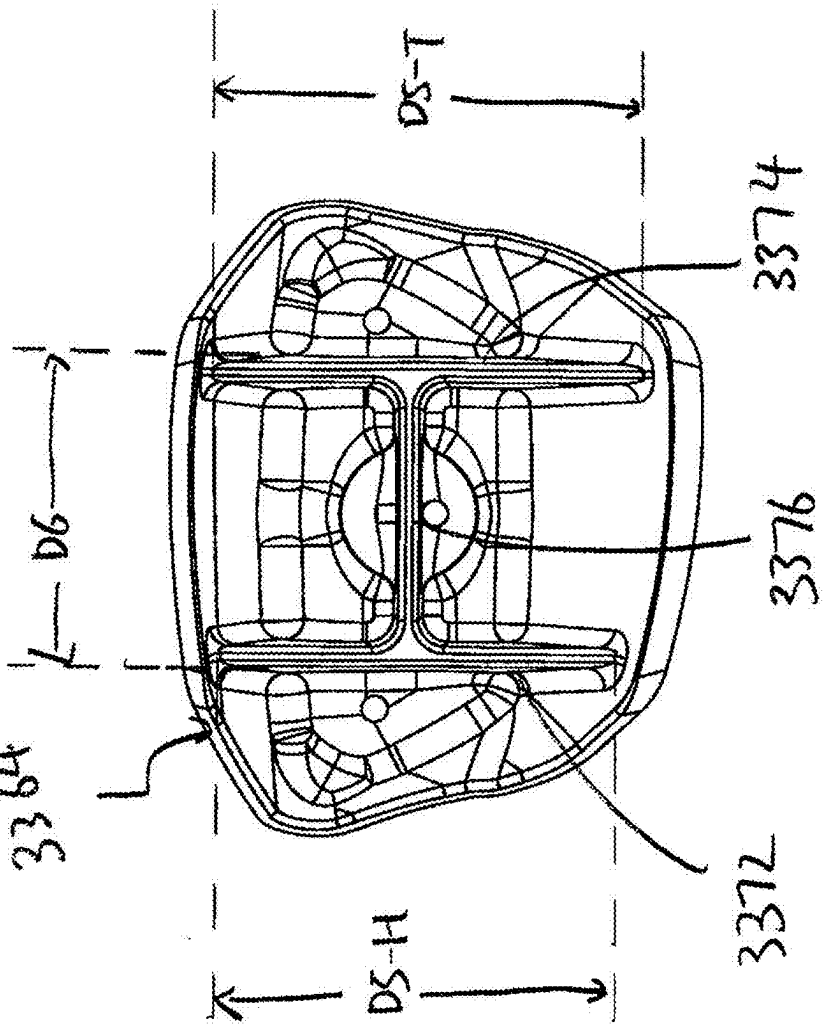


FIG. 36

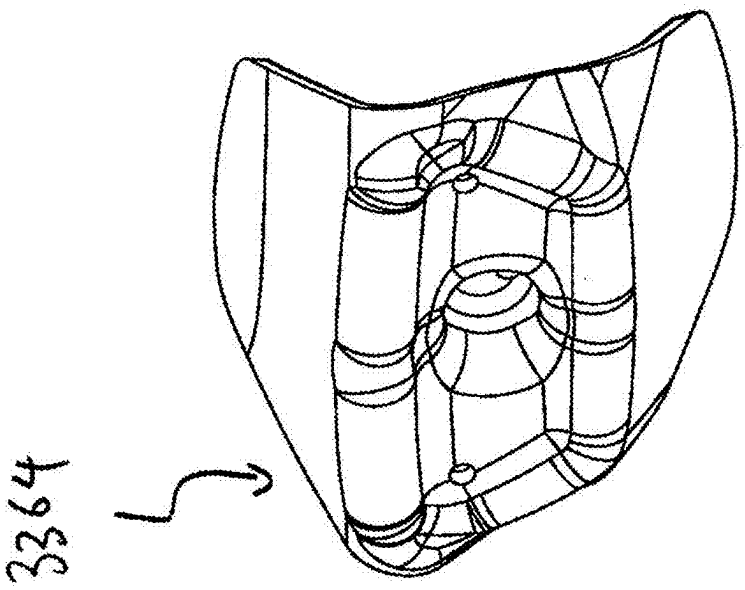
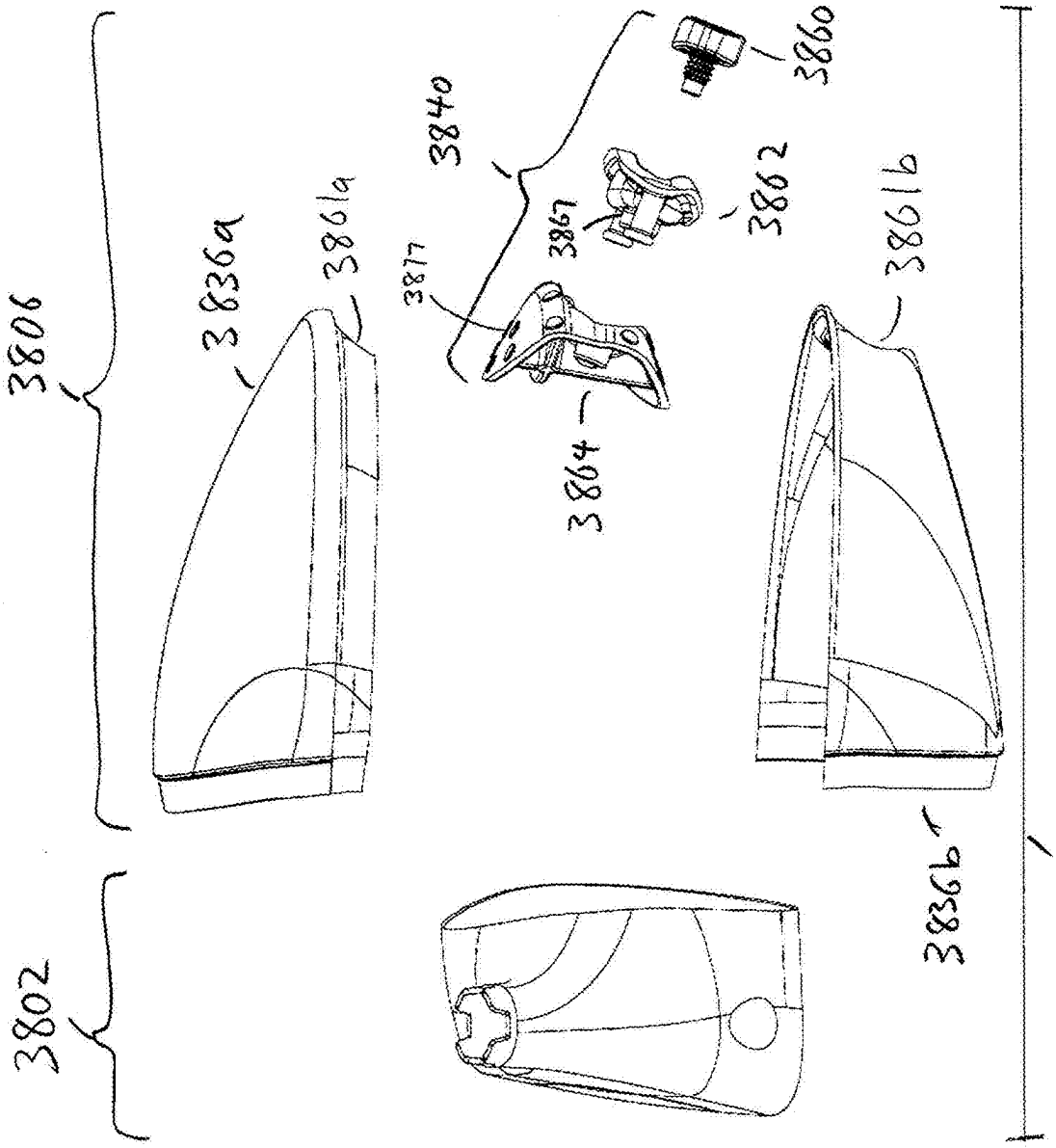


FIG. 37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3836b
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FIG. 38

MULTI-MATERIAL GOLF CLUB HEAD

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application is a Continuation-In-Part (CIP) of U.S. patent application Ser. No. 18/491,185, filed Oct. 20, 2023, which is a CIP of U.S. patent application Ser. No. 17/675,554, filed on Feb. 18, 2022, which is a CIP of U.S. patent application Ser. No. 17/255,862, filed on Apr. 8, 2021, which is a CIP of U.S. patent application Ser. No. 17/205,678, filed Mar. 18, 2021, which is a CIP of U.S. patent application Ser. No. 17/205,376, filed Mar. 18, 2021, now U.S. Pat. No. 11,766,592, which claims the benefit of U.S. Provisional Application Ser. No. 63/106,248 filed on Oct. 27, 2020, U.S. Provisional Application Ser. No. 63/112,551, filed Nov. 11, 2020, and U.S. Provisional Application Ser. No. 63/119,121, filed Nov. 30, 2020, the disclosure of which are all incorporated by reference in their entirety.

FIELD OF THE INVEN.3TION

[0002] The present invention relates generally to a multi-material golf club head with improved performance. More specifically, the present invention relates to a multi-material golf club head having a metallic frontal portion and a lightweight aft portion with an addition of an internal ribbon support member. The internal ribbon support member helps significantly improve the structural rigidity of the lightweight aft portion and improve the acoustic performance of the golf club head itself. The present invention may also further be comprised of a weighting mechanism that is accessible via an opening within the lightweight aft portion, but connects directly to the metallic frontal portion to mitigate any of the structural integrity issues associated with installing weights in lightweight portions of a golf club head.

BACKGROUND OF THE INVENTION

[0003] The utilization of weighting elements to improve the performance of a golf club head has been known in the industry. U.S. Pat. No. 3,692,306 to Glover filed in 1971 shows one of the earliest golf club with a weighting mechanism. Using different material with inherently different density and weighting properties allows the performance of the golf club head to be improved.

[0004] Modern day golf club heads, especially metalwood type golf club heads have continuously improved upon the ability to utilize weighting to improve the performance of a golf club head. U.S. Pat. No. 8,951,143 to Morales et al. illustrated one of the more modern ideas that taught a weight attachment mechanism wherein a weight member is coupled with a bracket.

[0005] The issues of adding weights to a golf club head becomes even more complicated when a lightweight composite material is used to form a portion of a golf club head. Lightweight composite materials, although very strong in an orientation that is perpendicular to their fibers, can often be weak when subjected to forces in alternate orientations. Hence, adding weighting to a lightweight composite golf club head can often be difficult. U.S. Pat. No. 8,979,671 to DeMille et al. illustrates one of the solutions to address this issue, by strengthening the material around the weight and adding additional support members.

[0006] Hence it can be seen there is a need in the industry to create a golf club that utilizes a lightweight composite aft body that is capable of sufficient structural rigidity, good sounds, and good performance.

[0007] Additionally, the addition of the thickness of the material to strengthen the material around the weight and the addition of support members can create the undesirable effect of adding in weight at locations that is not desirable. Hence, based on the above, there exists a need to help improve upon the weight attachment mechanism of a golf club head that has a lightweight second material to form a portion of the golf club head itself, without any of the negative side effects associated with traditional methods.

BRIEF SUMMARY OF THE INVENTION

[0008] One aspect of the present invention is a golf club head comprising of a frontal striking face portion having one or more threaded receptacles and an aft body attached to the rear of the frontal striking face portion. The aft body portion further comprises of a lightweight shell having one or more weight openings, and internal ribbon support member that attaches to an internal surface of the lightweight shell around a skirt of the lightweight shell, wherein the internal ribbon support member further comprises a secondary wall, separating an internal overall volume of the golf club head into a frontal volumetric chamber and a rear volumetric chamber, wherein the golf club head has a Volumetric Ratio of between about 12.6 to about 19.1. The Volumetric Ratio is defined as:

$$\text{Volumetric Ratio} = \frac{\text{Frontal Volumetric Chamber Volume}}{\text{Rear Volumetric Chamber Volume}}.$$

[0009] In another aspect of the present invention is a golf club head comprising of a frontal striking face portion having one or more threaded receptacles and an aft body attached to the rear of the frontal striking face portion. The aft body portion further comprises of a lightweight shell having one or more weight openings, and internal ribbon support member that attaches to an internal surface of the lightweight shell around a skirt of the lightweight shell, wherein the internal ribbon support member further comprises a secondary wall, separating an internal overall volume of the golf club head into a frontal volumetric chamber and a rear volumetric chamber wherein the golf club head has a frontal volumetric chamber that comprises of between about 82% to about 91% of the internal overall volume of the golf club head.

[0010] In another aspect of the present invention is a golf club head comprising of a frontal striking face portion having one or more threaded receptacles and an aft body attached to the rear of the frontal striking face portion. The aft body portion further comprises of a lightweight shell having one or more weight openings, and internal ribbon support member that attaches to an internal surface of the lightweight shell around a skirt of the lightweight shell, wherein the internal ribbon support member further comprises a secondary wall, separating an internal overall volume of the golf club head into a frontal volumetric chamber and a rear volumetric chamber wherein the golf club head has a frontal volumetric chamber that comprises of between about 82% to about 91% of the internal overall volume of the golf club head and wherein greater than about 15 percent of an overall mass of the golf club head is located rearward of and behind the secondary wall.

[0011] In another aspect of the present invention is a golf club head comprising of a frontal striking face portion having one or more threaded receptacles and an aft body attached to the rear of the frontal striking face portion. The aft body portion further comprises of a lightweight shell having one or more weight openings, and internal ribbon support member that attaches to an internal surface of the lightweight shell around a skirt of the lightweight shell, wherein the internal ribbon support member further comprises of a plurality of cutouts, and wherein the internal ribbon support member has a mass of less than about 5.0 grams.

[0012] In another aspect of the present invention the internal ribbon support member further comprises of an internal component and an external component.

[0013] In another aspect of the present invention, the internal component and the external component combine to form a diamond shaped internal ribbon support member.

[0014] In another aspect of the present invention is a golf club head that produces a sound that has a Critical Time $T_{critical}$ of greater than about 0.01 seconds and less than about 0.02 seconds; said Critical Time $T_{critical}$ is defined as the amount of time it take said sound to oscillate from a peak amplitude A_{max} to a point of 10% of said peak amplitude A_{max}.

[0015] In another aspect of the present invention is a golf club head comprising of a frontal striking face portion having one or more threaded receptacles and an aft body attached to the rear of the frontal striking face portion. The aft body portion further comprises of a lightweight shell having one or more weight openings, and internal ribbon support member that attaches to an internal surface of the lightweight shell around a skirt of the lightweight shell, and one or more screw weights inserted through the one or more weight opening to engage the one or more threaded receptacle, wherein the lightweight shell and the internal ribbon support member are both made from a fiber reinforced polymer.

[0016] In another aspect of the present invention is a golf club head comprising of a frontal striking face portion having two or more threaded receptacles, and an aft body portion attached to the rear of the frontal striking face portion. The aft body portion further comprises of a lightweight shell having two or more weigh openings, an internal ribbon support member that attaches to an internal surface of the lightweight shell around a skirt of the lightweight shell, and two or more screw weights inserted through the one or more weight openings to engage the two or more threaded receptacle, wherein the two or more screw weights are separated by a distance of between about 80 mm to about 120 mm.

[0017] In another aspect of the present invention the lightweight shell further comprises of a lightweight crown sub-shell that is further comprised of an outer layer, a central layer, and an internal layer, wherein the central layer is made from a polyphenylene sulfide (PPS) material that is a semi-crystalline resin material. And wherein the outer layer and the internal layer are both made from a polyetherimide (PEI) film.

[0018] In another aspect of the present invention, at least one of a lightweight crown sub-shell, a lightweight sole sub-shell, and a internal ribbon support member further comprises of an outer layer, a central layer, and an internal layer, wherein the central layer further comprises of between about 5 individual layers and about 13 individual layers.

[0019] In another aspect of the present invention, the aft body portion of the golf club head is further comprised of a sole plate.

[0020] In another aspect of the present invention wherein the lightweight shell further comprises a lightweight crown sub-shell and a lightweight sole sub-shell that are joined to one another via a lap joint, and wherein the lap joint is located away from a skirt portion of the golf club head.

[0021] In another aspect of the present invention the golf club head further comprises a weighting system attached to a recessed skirt portion of the golf club head, wherein the lightweight crown sub-shell forms a crown recessed skirt and the lightweight sole sub-shell forms a sole recessed skirt.

[0022] In another aspect of the preset invention, the weighting system further comprises of an internal weight housing, an outer weight housing, and a high density weight, wherein an external surface of the internal weight housing mates with an internal surface of the recessed skirt, and an internal surface of the outer weight housing mates with the external surface of the recessed skirt.

[0023] In another aspect of the present invention, the internal weight housing further comprises an H shaped internal ribbing structure.

[0024] In another aspect of the present invention, the internal weight housing has a body contact area of greater than about 1800 mm^2.

[0025] 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

[0026] 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.

[0027] FIG. **1** of the accompanying drawings shows a perspective view of a golf club head in accordance with the present invention;

[0028] FIG. **2** of the accompanying drawings shows a frontal view of a golf club head in accordance with an embodiment of the present invention;

[0029] FIG. **3** of the accompanying drawings shows a bottom sole view of a golf club head in accordance with an embodiment of the present invention;

[0030] FIG. **4** of the accompanying drawings shows an exploded sole perspective view of a golf club head in accordance with an embodiment of the present invention;

[0031] FIG. **5** of the accompanying drawings shows a time sequence diagram representing the amplitude of the sound of a golf club head in accordance with an embodiment of the present invention;

[0032] FIG. **6** of the accompanying drawing shows a cross-sectional view of a golf club head in accordance with an embodiment of the present invention taken along cross-sectional line A-A' shown in FIG. **2**;

[0033] FIG. **7** of the accompanying drawings shows an enlarged cross-sectional view of a golf club head in accor-

dance with an exemplary embodiment of the present invention taken along cross-sectional line C-C' shown in FIG. **2**;

[0034] FIG. **8** 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 B-B' shown in FIG. **2**;

[0035] FIG. **9** of the accompanying drawings shows an enlarged cross-sectional view of a golf club head in accordance with an exemplary embodiment of the present invention taken along cross-sectional line C-C' shown in FIG. **2**;

[0036] FIG. **10** of the accompanying drawings shows a bottom sole view of a golf club head in accordance with an embodiment of the present invention;

[0037] FIG. **11** of the accompanying drawings shows an exploded sole perspective view of a golf club head in accordance with an embodiment of the present invention;

[0038] FIG. **12** of the accompanying drawings shows a cross-sectional view of a golf club head in accordance with an embodiment of the present invention taken along cross-sectional line A-A' as shown in FIGS. **2** and **11**;

[0039] FIG. **13** of the accompanying drawings shows a bottom sole view of a golf club head in accordance with an embodiment of the present invention;

[0040] FIG. **14** of the accompanying drawings shows a toe side view of a golf club head in accordance with a further alternative embodiment of the present invention;

[0041] FIG. **15** of the accompanying drawings shows an exploded toe side view of a golf club head in accordance with a further alternative embodiment of the present invention;

[0042] FIG. **16** 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' as shown in FIGS. **2** and **11**;

[0043] FIG. **17** of the accompanying drawings shows an exploded toe side view of a golf club head in accordance with an even further alternative embodiment of the present invention;

[0044] FIG. **18** of the accompanying drawings shows a cross-sectional view of a golf club head in accordance with an even further alternative embodiment of the present invention taken along cross-sectional line A-A' as shown in FIGS. **2** and **11**;

[0045] FIG. **19** of the accompanying drawings shows an exploded perspective view of a golf club head in accordance with an even further alternative embodiment of the present invention;

[0046] FIG. **20** of the accompanying drawings shows an enlarged view of a internal ribbon support member in accordance with the alternative embodiment of the present invention shown in FIG. **19**;

[0047] FIG. **21** of the accompanying drawings shows an exploded perspective view of a golf club head in accordance with an even further alternative embodiment of the present invention;

[0048] FIG. **22** of the accompanying drawings shows an enlarged view of a internal ribbon support member in accordance with the alternative embodiment of the present invention shown in FIG. **21**;

[0049] FIG. **23** of the accompanying drawings shows an exploded perspective view of a golf club head in accordance with an even further alternative embodiment of the present invention;

[0050] FIG. **24** of the accompanying drawings shows an enlarged view of a internal ribbon support member in accordance with the alternative embodiment of the present invention shown in FIG. **23**;

[0051] FIG. **25** of the accompanying drawings shows an exploded heel side view of a golf club head in accordance with an even further alternative embodiment of the present invention;

[0052] FIG. **26** 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' as shown in FIGS. **2** and **11**;

[0053] FIG. **27** of the accompanying drawings shows a exploded toe side view of a golf club head in accordance with a further alternative embodiment of the present invention;

[0054] FIG. **28** of the accompanying drawings shows a different cross-sectional view of a golf club head in accordance with a further alternative embodiment of the present invention, taken perpendicular to cross-sectional line A-A';

[0055] FIG. **29** of the accompanying drawings shows an enlarged partial cross-sectional view of a skirt portion of a golf club head highlighted by circular region A shown in FIG. **28**;

[0056] FIG. **30** of the accompanying drawings shows an exploded of a rear aft portion of a golf club head in accordance with a further alternative embodiment of the present invention;

[0057] FIG. **31** 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' as shown in FIGS. **2** and **11**;

[0058] FIG. **32** of the accompanying drawings shows a exploded toe side view of a golf club head in accordance with a further alternative embodiment of the present invention;

[0059] FIG. **33** 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' as shown in FIGS. **2** and **11**;

[0060] FIG. **34** of the accompanying drawings shows a exploded toe side view of a golf club head in accordance with a further alternative embodiment of the present invention;

[0061] FIG. **35** of the accompanying drawings shows in ternal view an internal rear portion of a golf club head in accordance with an alternative embodiment of the present invention;

[0062] FIG. **36** of the accompanying shows an enlarged perspective view of an internal weight housing in accordance with an alternative embodiment of the present invention;

[0063] FIG. **37** of the accompanying drawings shows an enlarged rear view of an internal weight housing in accordance with an alternative embodiment of the present invention;

[0064] FIG. **38** of the accompanying drawings shows

DETAILED DESCRIPTION OF THE INVENTION

[0065] 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.

[0066] 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.

[0067] FIG. **1** of the accompanying drawings shows a perspective view of a golf club head **100** in accordance with an embodiment of the present invention. This perspective view of the present invention, although may not be immediately apparent in this view, shows the golf club head being separated into two major sub-components, a frontal striking face portion **102** having an actual striking face insert **101**, and an aft body portion **104**. These components are specifically identified because they are generally made from different materials. The frontal striking face portion **102**, may generally be made from a metallic material such as titanium, while the aft body portion **104** may generally be made from lightweight material such as a fiber reinforced polymer. More details regarding the fiber reinforced polymer material suitable for this aft body portion **104** may be found in commonly owned U.S. Patent Publication No. 2020/0023247 to Larsen et al. and U.S. Patent Publication No. 2020/0188746 to Sugimac et al., the disclosure of both are incorporated by reference in their entirety.

[0068] FIG. **2** of the accompanying drawings shows a frontal view of a golf club head **200** showing that the face insert **201** with a face center **203** being a part of the frontal striking face portion **202**. FIG. **2** of the accompanying drawings shows a coordinate system **205** that the present invention uses to help identify the axis. The x-axis is oriented in a heel to toe orientation, with the positive x direction pointing towards the heel of the golf club head **200**. The y-axis is oriented in a crown to sole direction, with the positive y-axis pointing towards the crown of the golf club head **200**. Finally, the z-axis is orientated in a front to back orientation, with the positive z direction pointing towards the front of the golf club head **200**. This frontal view provides some reference point for which subsequent figures may be cross-sectioned. Cross-sectional line A-A' provides the basis of cross-sectioning the golf club head **200** at the face center **203**, in a crown to sole direction. Cross-sectional line B-B' provided the basis for cross-sectioning the golf club head **200** at the face center **203**, in a heel to toe direction. Finally, Cross-sectional line C-C' provides the basis for cross-sectioning the golf club head **200** along one of the weighting systems unique to the present invention.

[0069] In order to provide more context to the location of cross-sectional line C-C' shown in FIG. **2**, the sole view of a golf club head **300** in accordance with an exemplary embodiment of the present invention is shown in FIG. **3**. FIG. **3** shows a sole view of a golf club head **300** in accordance with an exemplary embodiment of the present invention, allowing the weight openings **310** to be shown in more detail together with cross-sectional line C-C' passing through the middle of the weight opening **310**. More specifically, in this embodiment of the present invention, the golf club head **300** has a toc side weight opening **310***a* and a heel side weight opening **310***b* to allow for multiple weighting systems to be installed in the golf club head **300**. In this exemplary embodiment of the present invention, the location of the toe side weight opening **310***a* and heel side weight opening **310***b*, corresponding with the location of the toe side weight **438***a* and heel side weight **438***b* respectively (shown in FIG. **4**), may be separated by a distance D**1** of between about 80 mm to about 120 mm, more preferably between about 90 mm to about 110 mm, and most preferably about 100 mm. Alternatively, it can said that the location of the toe side screw weight **438***a* and the location of the heel side screw weight **438***b* is separated by a distance D**1** of between about 80 mm to about 120 mm, more preferably between about 90 mm to about 110 mm, and most preferably about 100 mm as well. In addition to the above, this sole view of the golf club head **300** also allows a clearer visualization of the separation between the frontal striking face portion **302** and an aft body portion **304**. Finally, FIG. **3** of the accompanying drawings shows a joint cover **320** covering the joint between the frontal striking face portion **302** and the aft body portion **304** and a sole plate **322** attached to the sole portion just behind the joint cover **320**, the details of both will be shown more clearly in subsequent figures.

[0070] FIG. **4** of the accompanying drawings shows an exploded view of a golf club head **400** in accordance with the present invention. This exploded view not only allows the external components to be shown but allows the internal components and their relationship to the external components to be illustrated as well. Before diving into the details of the specific components, it can be seen here that golf club head **400** is still separated into a frontal striking face portion **402** and an aft body portion **404**. The frontal striking face portion may further be comprised of a plurality of threaded receptacles **439** that can be further identified as a toe threaded receptacle **439***a* and a heel threaded receptacle **439***b*. The aft body portion **404** may further be comprised out of an internal weight cover **430**, a weighting member **432**, an internal ribbon support member **434**, a lightweight shell **436** having at least one weight opening **410** (only the heel side weight opening **410***b* is shown in FIG. **4**), and two screw weights **438** that can be further identified as a toc screw weight **438***a* and a heel screw weight **438***b*.

[0071] It should be noted here that the screw weight **438** of the present invention, although spatially appears at the rear end of the golf club head **400** by being inserted into the weight opening **410** on the lightweight shell **436** of the aft body portion **404**, actually engages a threaded receptacle **439** located on the frontal striking face portion **402**. The method of attachment here is critical to the proper functioning of the present invention, as it addresses some of the major drawbacks of conventional weight attachment mechanisms. Traditionally, due to the utilization of lightweight materials to form the lightweight shell **436**, it is difficult to attach high density weighting mechanisms directly onto those materials, as those materials are not strong enough to endure the vibration of high density weights when impacting a golf ball. Alternatively, one can attach weights directly onto the generally metallic frontal striking face portion **402**, but it may not always be desirable to have the weight located

so close to the front of the face. The present invention addresses both of those issues by creating a weight opening **410** in the lightweight shell **436** to which the screw weights **438** can be directly attached to the threaded receptacles **439** in the metallic frontal striking face portion **402**.

[0072] In addition to the above, the exploded view of the golf club head **400** shown in FIG. **4** also shows the joint cover **420** as well as the sole plate **422** to be spatially orientated between the frontal striking face portion **402** and the aft body portion **404** of the golf club head **400** to not only improve the bond between the two components, but also to help protect the aft body portion **404** that tends to be more susceptible to damage when impacting the ground during a golf swing.

[0073] Finally, the internal weight cover **430**, the weighting member **432**, and the internal ribbon support member **434** are also critical to the proper function of the present invention unrelated to the weighting mechanism. Although invisible from the outside, the internal ribbon support member **434** is a critical and one of the most important components to achieve the improved performance of the golf club head **400** in accordance with the present invention. The internal ribbon support member **434** attaches to the internal surface of the lightweight shell **436** around a skirt portion of said lightweight shell **436**. The skirt or ribbon of a golf club head **400** is a term of art in the industry that refers to the junction between the crown of the golf club head **400** and the sole of the golf club head **400**. The internal ribbon support member **434**, as shown in this current embodiment of the present invention, may generally also be made from fiber reinforced polymer, which can be either glued or diffusion bonded to the lightweight shell **436**. However, it should be noted that the internal ribbon support member **434** can be made out of alternate material that is either lightweight or non-lightweight all without departing from the scope and content of the present invention, as long as it is capable of increasing the structural rigidity of the aft body portion **404**. The internal ribbon support member has at least four identifiable benefits in that it 1) allows the weighting member **432** to be secured to the rear of the lightweight shell **436**, 2) improves the bond between the frontal striking face portion **402** and the aft body portion **404**, 3) increases structural rigidity of the aft body portion to prevent failure when a fiber reinforced polymer is used to form the lightweight shell **436**, and 4) enhances the sound characteristics of the golf club head **400** when it contacts a golf ball.

[0074] First, the internal ribbon support member **434** allows the weighting member **432** to be properly secured to the lightweight shell **436** of the aft body portion **404** of the golf club head **400**. The weighting member **432** in this embodiment is located at the rearmost portion of the golf club head **400** to help improve the moment of inertia of the golf club head **400**. This weighting member **432**, generally made out of a high density metallic material such as tungsten, may generally need to be bonded to the lightweight shell **436** via glue, especially if the lightweight shell **436** is made out of fiber reinforced polymer as these types of golf club heads **400** generally are. In order to address the bonding issue generally occurring when a heavy weighting member **432** is attached to a fiber reinforced polymer, an internal weight cover **430** may be used to help secure the weighting member **432** is secured to the lightweight shell **436**. Finally, due to the fact that the thickness of the lightweight shell **436** being extremely thin to save weight, combined with the geometry of the lightweight shell **436** at the rear of the golf club head **400** converging into a small edge, the structural rigidity of the lightweight shell **436** at the rear of the golf club head **400** may generally not be strong enough to support the vibration and movement of a high density weighting member **432** experiences when a golf club head **400** impacts a golf ball. In order to address this issue, the present invention includes an internal ribbon support member **434**, generally made to be slightly thicker, to further help the structural rigidity of the golf club head **400** around the portion of the weighting member **432**. The present invention does this by installing the internal ribbon support member **434** around the internal ribbon portion of the lightweight shell **436**, thus providing a more robust are for which the high density weighting member **432** and the weight cover **430** to be attached to.

[0075] Secondly, in addition to providing additional structural rigidity to the lightweight shell **436** relating to weight retention as mentioned above, the internal ribbon support member **434** provides even more benefit in helping the entire golf club head **400** stay together by providing support to the entirety of the aft body portion **404**. Increasing the structural rigidity of the entirety of the aft body portion **404** is just as important, if not more important, than the weight retention feature of the internal ribbon support member **434**. Lightweight shells **436**, as previously stated, is generally made from fiber reinforced polymer. Fiber reinforced polymer materials, for starters, can't be directly bonded to a metallic material without the need of an adhesive. Adhesively bonded materials can generally come lose when either of the bonded materials vibrate and move too much, which fiber reinforced polymers tend to do when subject to high impact forces. This movement of the material can often make it difficult to bond to solid metallic structures such as the titanium frontal striking face portion **402** to a fiber reinforced polymer aft body portion **404**, thus creating a significant design challenge. In order to address this issue, the internal ribbon support member **434** provides a solid surface around which the lightweight shell **436** may bond to, thus reducing vibration of the parts, hence increasing the bond between the frontal striking face portion **402** and the aft body portion **404** that's often achieved via glue.

[0076] As a side note, the previously mentioned joint cover **420** also helps with the bond between the frontal striking face portion **402** and the aft body portion **404** by increasing the structural rigidity of the bond area. The joint cover **420**, although made out of the same fiber reinforced polymer in this embodiment, may be made out of any alternate material that can be glued to the external surface of the bond region to improve structural rigidity all without departing from the scope and content of the present invention.

[0077] Thirdly, as a corollary to the ability of the structural rigidity of the aft body portion's **404** ability to bond to a metallic frontal striking face portion **402**; the same type of undesirable movement that prohibits proper bonding between the frontal striking face portion **402** and the aft body portion **404** could cause the lightweight shell **436** to fail when subjected to high impact forces. The present invention's utilization of the internal ribbon support member **434** also helps address the issue of the ability of the lightweight shell **436**, that is made out of a thin fiber reinforced polymer material, to withstand the impact forces of a golf club head **400** with a golf ball. The internal ribbon

support member **434** achieves this by strengthening the weak areas of the lightweight shell **436** that can often vibrate more than normal upon impact with a golf ball, thus preventing the lightweight shell **436** that is made from a fiber reinforced polymer from cracking or delaminating.

[0078] Fourthly, and finally, the addition of the internal ribbon support member **434** improves the acoustic of the golf club head **400**, as golf clubs that have a significant portion made purely out of thin fiber reinforced polymer may result in an undesirable sound. For a more detailed discussion regarding the sound in a golf club head, including the methodology to test for sounds, please refer to commonly owned U.S. Pat. No. 10,653,927 to Murphy et al., the disclosure of which is incorporated by reference in its entirety. In summary, it can be said that the internal ribbon support member **434** allows the present golf club head **400** to achieve similar desirable sound characteristics as the golf club in U.S. Pat. No. 10,653,927 described. Referring to FIG. **5** of the accompanying drawings, it can be said that the current golf club head exhibits a time it takes for the sound amplitude to oscillate from the peak amplitude A_{max} to an amplitude that is 10% of peak amplitude A_{max} is defined as the Critical Time $T_{critical}$, and is generally greater than about 0.01 seconds and less than about 0.02 seconds, more preferably greater than about 0.015 seconds and less than about 0.02 seconds, and most preferably greater than about 0.0175 seconds and less than about 0.02 seconds. In addition to the above, the current inventive golf club head **400** may, due in major part to the addition of the internal ribbon support member **434**, generally have its own resonate frequency of greater than 3300 kHz, more preferably greater than 3400 kHz, and most preferably greater than 3500 kHz, all without departing from the scope and content of the present invention.

[0079] It should also be noted here that the internal ribbon support member **434** may also further comprise out of two recesses **433**, to which they engage the two or more weight openings **410** to create a space that allows the screw weights **438** to engage the threaded receptacles **439**.

[0080] Finally, the internal ribbon support member **434**, in its current embodiment as shown, may generally have a total mass of between about 3.7 grams and about 4.1 grams, more preferably between about 3.8 grams and about 4.0 grams, and most preferably about 3.9 grams. However, it should be noted that the mass of the internal ribbon support member **434** is also critical to the proper functionality of the present golf club head **400**, as an internal ribbon support member **434** that is too robust and heavy may place weight at undesirable locations of the golf club head **400**, while the mistake of making that same internal ribbon support member **434** too flimsy and lightweight may not offer sufficient structural support to the golf club head **400** itself to achieve the desired result.

[0081] FIG. **6** of the accompanying drawings shows a cross-sectional view of a golf club head **600** in accordance with an embodiment of the present invention, taken along cross-sectional line A-A' shown in FIG. **2**. This cross-sectional view of the golf club head **600** allows the relationship between the various components to be shown more clearly in an assembled state, which sheds more lights on the inner workings of the current inventive golf club head **600**. Similar to previous discussions, FIG. **6** consists mainly of a frontal striking face portion **602** and an aft body portion **604**. The frontal striking face portion **602** has a threaded receptacle **639**, more specifically, only the heel threaded receptacle **639***b* is shown due to the cross-section only showing the heel side of the golf club head **600**. Attached to the rear of the frontal striking face portion **602** is the aft body portion **604** that's mainly made from a lightweight material generally unsuitable for direct weight attachment.

[0082] Relating to the weighting mechanism, FIG. **6** of the accompanying drawings shows the aft body portion **604** having a heel weight opening **610***b* that allows the heel screw weight **638***b* to mechanically secure the aft body portion **604** to the frontal striking face portion **602**. The location of the heel screw weight **638***b*, and the non-illustrated toe screw weight **638***a* may be located at a distance D**2** of between about 25 mm and about 35 mm rearward of the face center **603**, more preferably between about 27 mm and about 33 mm rearward of the face center **603**, and most preferably between about 28 mm and about 32 mm rearward of the face center **603**. This cross-sectional view of the golf club head **600** shown here also shows the weighting member **632** being sandwiched between the internal weight cover **630** and the internal ribbon support member **634** to help retain it. The location of the weighting member **632** may be located at a distance D**3** of greater than about 100 mm rearward of face center **603**, more preferably greater than about 105 mm rearward of face center **603**, and most preferably about 110 mm rearward of face center.

[0083] The location and existence of the screw weights **638** weighting members **632** allows the current inventive golf club head **600** to have improved center of gravity and moment of inertia properties. More specifically, the golf club head **600** may have a CG depth, in the z-direction as shown in FIG. **2** of greater than about 32 mm, more preferably greater than about 33 mm, and most preferably greater than about 34 mm. Additionally, the current inventive golf club head **600** may have a moment of inertia about a y-axis as shown in FIG. **2** of greater than about 5,200 g-cm^2, more preferably greater than about 5,300 g-cm^2, and most preferably greater than about 5,400 g-cm^2.

[0084] Finally, this cross-sectional view of the golf club head **600** shows how the joint cover **620** wraps around the entire junction between the frontal striking face portion **602** and the aft body portion **604** to eliminate any step in the transition between the two pieces, and the joint cover **620** further includes a sole plate **622** to protect the underside of the golf club head **600** as that portion of the golf club head **600** is more easily prone to being scuffed up when swinging the golf club head **600**.

[0085] Generally speaking, when applying cosmetic paint to the golf club head, the cosmetic paint may have a harder time adhering to the surface of a composite type material, especially when compared to its adhesion properties to a metallic material such as titanium. Moreover, in addition to the strength of the adhesion, the cosmetic paint, when applied to composite type material containing resin, may generally be less resistant to scratches even after it's been applied. Hence, to address this deficiency, sole plate **622** is added to the present invention to provide a protective barrier.

[0086] Sole plate **622**, and sole plate **322** (shown in FIG. **3**) in accordance with the present invention, in this exemplary embodiment of the present invention may generally be constructed out of a high abrasion resistant thermoplastic material with polyether ether ketone (PEEK), polyphenylene sulfide (PPS), or polyetherimide (PEI). However, in alternative embodiments of the present invention, the sole plate

622 could also be constructed out of a metallic material that is subsequently adhesively bonded to the bottom sole of the body portion **604** of the golf club head **600** without departing from the scope and content of the present invention. The sole plate **622** in accordance with the present invention may have a thickness of between about 0.2 mm and about 1.0 mm, more preferably between about 0.4 mm and about 0.8 mm, and most preferably about 0.5 mm without departing from the scope and content of the present invention.

[0087] FIG. **7** of the accompanying drawings shows an enlarged cross-sectional view of a golf club head **700** taken along cross-sectional line C-C' as shown in FIG. **3**. This enlarged cross-sectional view of the golf club head **700** allows the relationship between the weight opening **710**, the screw weight **738**, and the threaded receptacle **739** to be shown more clearly. Although this cross-sectional view of the golf club head **700** is taken along the toe weight opening **710***a*, the relationship between the various components is the same with respect to the heel side weighting components (not shown in FIG. **7**). Although it has been previous foreshadowed that the toe screw weight **738***a* can help mechanically connect the aft body portion **704** to the frontal striking face portion **702**, that specific relationship is not specifically illustrated until this FIG. **7**. In FIG. **7**, the toe weight opening **710***a* has an opening within its terminal end of the recess, which the male threaded portion of the toe screw weight **738***a* protrudes out of to engage a female portion of a threaded toe threaded receptacle **739***a*. Alternatively, it can be said that the diameter of the terminal opening of the toe weight opening **710***a* is smaller than a head diameter of the toe screw weight **738***a*, thus creating the mechanical retention. It should be noted here that although the toe screw weight **738***a* can be used to help further secure the attachment of the aft body portion **704** to the frontal striking face portion **702**, the screw need not provide such a mechanical engagement, as will be illustrated in subsequent figures.

[0088] FIG. **8** of the accompanying drawings shows a cross-sectional view of a golf club head **800** taken across cross-sectional line B-B' shown in FIG. **2**. This cross-sectional view of the golf club head allows both sets of the screw weights **838***a* and **838***b* to be shown more clearly. The basic components of the screw weight **838***a* and **838***b*, the threaded receptacle **839***a* and **839***b*, and weight openings **810***a* and **810***b* have all been previously discussed and remains the same in the current embodiment shown in FIG. **8**. It should be noted that although the current embodiments of the present invention shows two sets of weighting members, three or more weighting members, or maybe even 1 set of weighting member, may be used without departing from the scope and content of the present invention. Additionally, as the cross-sectional view of the golf club head **800** shows, the height of the toe side weighting members **810***a*, **838***a*, and **839***a* are higher along the y-axis (as previously discussed in FIG. **2**) then the than the heel side weighting members **810***b*, **839***b*, and **839***b*. This type of arrangement not only allows for adjustment of the center of gravity of the golf club head **800** in a heel to toe orientation by installing screw weights **838** with mass properties, but this variation in height allows for an adjustment of the center of gravity in a crown to sole direction as well. In this particular embodiment of the present invention, the toe side screw weight **838***a* is located greater than about 8 mm higher than the heel side screw weight **838***b*, more preferably greater than about 9 mm higher than the heel side screw weight **838***b*, and most preferably greater than about 10 mm higher than the heel side screw weight **838***b*. However, it should be noted that in alternative embodiment of the present invention, the toe weighting members **810***a*, **838***a*, and **839***a* may be lower than the heel weighting members **810***b*, **883***b*, and **839***b*, or even be the same height all without departing from the scope and content of the present invention.

[0089] FIG. **9** of the accompanying drawings shows an enlarged cross-sectional view of a golf club head **900** in accordance with an alternative embodiment of the present invention. In this alternative embodiment of the present invention, a different screw weighting mechanism is used, and this screw weighting mechanism does not provide any mechanical lock between the frontal striking face portion **902** and the aft body portion **904**. The enlarged cross-sectional view of the golf club head **900** illustrates the lack of the overlap between the head of the screw weight **938***a* and the inner wall of the weight opening **910***a*, as the screw weight **938***a* is threaded into the threaded receptacle **939***a*. Alternatively, it can be said that the terminal opening of the weight opening **910***a* may have a diameter that is greater than a head diameter of the screw weight **938***a*. This lack of an overlap means that the screw weight **938***a* is only attached to the frontal striking face portion **902** of the golf club head **900** for the purpose of attaching weight to the golf club head **900**, and the bond between the frontal striking face portion **902** and the aft body portion **904** is purely achieved via the joint around the external perimeter joint, in the regions that's covered by the joint cover **920**.

[0090] FIGS. **10**, **11**, and **12** shows a golf club head **1000** in accordance with an alternative embodiment of the present invention, More specifically, FIG. **10** shows a sole view of the golf club head **1000**, FIG. **11** shows an exploded perspective view of the golf club head **1000**, and FIG. **12** shows a cross-sectional view of the golf club head **1000**. Discussing all three of these figures together, we can see that in this embodiment of the present invention, the location of the weight opening **1010** is located near the rear central portion of the aft body portion **1004** of the golf club head **1000** adapted to receive the weighting system previously discussed. This embodiment of the present invention may be preferred when the need for heel to toe weighting adjustment is not needed, and a heavier emphasis is placed on moving the center of gravity rearward in the golf club head **1000**. The exploded view of the golf club head **1000** shown in FIG. **11** once again further illustrates the internal ribbon support member **1034** being located in the aft body portion **1004** of the golf club head **1000**, which the previous discussion has already shown to provide significant benefits to the present invention. In addition to the above, FIG. **11** also shows the internal components of the screw weight **1038** engaging the threaded receptacle **1039**, however, in this embodiment, the weighting member **1032** may be retained via the screw weight **1038** as shown in FIG. **11** instead of being held in place by internal ribbon support member **1034** as shown in previous embodiments.

[0091] FIG. **12** showing a cross-sectional view of a golf club head **1000** along cross-sectional line A-A' as shown in FIGS. **2** and **10** allows the newly introduced weighting mechanism to be explained more clearly. In FIG. **12**, we can see that the screw weight **1038** helps retain a weighting member **1032** near a rear portion of the golf club head **1000** without actually attaching to the aft body portion **1004**. The

extra-long screw weight **1038** retains the weighting member **1032** near the rear of the weight opening **1010**, and threadedly engages the threaded receptacle **1039** that is located at the metallic frontal striking face portion **1002**. Finally, it is worth noting that in this embodiment of the present invention, due to the fact that the head of the screw weight **1038** is located towards the rear of the golf club head **1000**, the screw weight **1038** does not help with mechanically securing the aft body portion **1004** to the frontal striking face portion **1002** as some of the earlier embodiments may show.

[0092] It should be noted here that although FIGS. **10**, **11**, and **12** shows a golf club head having one weighting systems with one weight opening **1010** located on the rear of the golf club head **1000**, two or more weighting systems could be placed at the rear of the golf club head without departing from the scope and content of the present invention as shown in FIG. **13** of the accompanying drawings. FIG. **13** of the accompanying drawings shows a sole view of a golf club head **1300** having a heel weight opening **1310***a* and a toe weight opening **1310***b* capable of incorporating two weighting systems, as these weighting configurations may be desirable in certain situations.

[0093] FIGS. **14** through **16** shows a golf club head **1400** in accordance with a further alternative embodiment of the present invention utilizing a different weighting mechanism that does not directly connect to the frontal striking face portion.

[0094] FIG. **14** of the accompanying drawings shows a heel side view of a golf club head **1400** in accordance with this alternative embodiment of the present invention. The golf club head **1400**, similar to previous embodiments, all have a frontal striking face portion **1402** and an aft body portion **1406**. The aft body portion **1406** in this embodiment may very slightly from the previous embodiments in that it uses multiple pieces to form the lightweight shell **1436**, and it has a slightly different weighting system **1440**. The details of the weighting system will be discussed later.

[0095] The lightweight shell **1436** in this embodiment may be formed out of two different pieces, a lightweight crown sub-shell **1436***a* and a lightweight sole sub-shell **1436***b*, both of which combine to form the lightweight shell **1436**. These sub-components may generally be formed independently of one another and joined as separate and individual pieces after they have been formed. It should be noted that since the entirety of the lightweight shell is generally made from a fiber reinforced polymer, the lightweight crown sub-shell **1436***a* and the lightweight sole sub-shell **1436***b* may generally also be formed out of the same fiber reinforced polymer. However, in an alternative embodiment of the present invention, the lightweight crown sub-shell **1436***a* and the lightweight sole shell **1436***b* could each be made out of different fiber reinforced polymer, have only one of the components be made out of a fiber reinforced polymer, or even have both be made out of alternate lightweight materials that's not a fiber reinforced polymer all without departing from the scope and content of the present invention. Combining a lightweight crown sub-shell **1436***a* and a lightweight sole sub-shell **1436***b* to form the lightweight shell **1436** itself may be preferred as these substantially flat sub-components are easier to manufacture. However, when joining multiple sub-component pieces together to form the lightweight shell **1436**, the structural integrity of the aft body portion **1406** may suffer, thus making the internal ribbon support member (not shown in FIG. **14**) even more critical to the present invention. In order to show the relationship between the various component in accordance with this further alternative embodiment of the present invention, FIG. **15** is provided below.

[0096] FIG. **15** of the accompanying drawings shows an exploded toc side view of a golf club head **1400** in accordance with a further alternative embodiment of the present invention. As previously discussed, in this further alternative embodiment of the present invention, the lightweight shell **1436** is split into two sub-components, a lightweight crown sub-shell **1436***a* and a lightweight sole sub-shell **1436***b*, that attaches to one another to form the rear aft body portion **1406**. The weighting system **1440** attaches to the rear of the rear aft body portion **1406** by engaging an opening in the lightweight sole sub-shell **1436***b*. Finally, the critical component in the present invention is the internal ribbon support member **1434** shown in the exploded view of the golf club head **1400** in FIG. **15**.

[0097] The internal ribbon support member **1434** shown in FIG. **15** differs slightly from previous ribbon support member **1434** shown previously in FIG. **4** in that it does not support the entirety of the skirt portion across the entire lightweight shell **1436** because of the existence of the weighting system **1440** located at the rear of the aft body portion **1406**. This internal ribbon support member **1434** provides makes up for that lack of connection at the rear of the aft body portion **1406** by creating a secondary wall **1442** that connects the lightweight crown sub-shell **1436***a* with the lightweight sole sub-shell **1436***b* in a y-shaped structure as illustrated in FIG. **15**. The secondary wall **1442**, despite not contacting the rear skirt portion of the lightweight shell **1436**, makes up for that by providing structural rigidity to the lightweight shell **1436** via the connection between the lightweight crown sub-shell **1436***a* and the lightweight sole sub-shell **1436***b*. The secondary wall **1442**, as shown in this embodiment of the present invention may generally have a thickness of between about 0.5 mm to about 1.0 mm, more preferably between about 0.6 mm to about 0.9 mm, and most preferably between about 0.7 mm to about 0.8 mm. Although it won't be visible until the cross-sectional view of the golf club head **1400** is provided in FIG. **16**, the secondary wall creates two separate volumetric chambers within the golf club head **1400**.

[0098] Finally, the weighting system **1440** may generally be a weighting system that has a high density weight member made from a metallic material attached to a chassis that is made from a lightweight material. The utilization of the lightweight material may generally be the same type of material as the lightweight shell **1436**, however alternative materials may be used for the chassis of the weighting system so long as it is capable of being bonded to the remainder of the rear aft body **1406** all without departing from the scope and content of the present invention.

[0099] It should be noted here that a significant portion of the weighting system here in this embodiment is placed behind the secondary wall **1442**, and it makes up a significant portion of the overall mass of the golf club head **1400**. In this current exemplary embodiment, the mass rearward of and behind the secondary wall **1442** may generally be greater than about 30 grams, more preferably greater than about 35 grams, and most preferably greater than about 40 grams. Alternatively speaking, assuming that the overall golf club head **1400** has a mass of about 200 grams, it can be said that greater than about 15 percent of the overall mass of the

golf club head **1400** is located rearward of and behind the secondary wall **1442**, more preferably greater than about 17.5 percent of the overall mass of the golf club head **1400** is located rearward of and behind the secondary wall **1442**, and most preferably greater than about 20 percent of the overall mass of the golf club head **1400** is located rearward of and behind the secondary wall **1442**.

[0100] In order to better see the two separate volumetric chambers created by the secondary wall **1442** and the internal workings of the weighting system **1440**, a cross-sectional view of this golf club head **1400** in accordance with this further alternative embodiment is provided in FIG. **16**. FIG. **16** of the accompanying drawings shows a cross-sectional view of a golf club head **1400** take along a cross-sectional line A-A' show in FIG. **2**. In the cross-sectional view of the golf club head **1400** shown in FIG. **16**, it can be seen that the secondary wall **1442** separates the golf club head **1400** into two separate volumetric chambers, a frontal volumetric chamber **1446** and a rear volumetric chamber **1444**. Because the secondary wall **1442** is located near the rear portion of the golf club head **1400**, the frontal volumetric chamber may generally have a volume of between about 380 cc and about 420 cc, more preferably between about 390 cc and about 410 cc, and most preferably about 400 cc. Given that the overall size of a driver type golf club head is has an internal overall volume of about 460 cc, it can also be said that the frontal volumetric chamber comprises of between about 82% to about 91% of the internal overall volume, more preferably between about 84% to about 89% of the internal overall volume, and most preferably about 87% of the internal overall volume. Conversely, the rear volumetric chamber **1444** is created on the other side of the secondary wall **1442**. In this embodiment shown, due to the existence of a track based weighting system **1440**, the rear volumetric chamber has a volume of between about 22 cc to about 30 cc, more preferably between about 24 cc to about 28 cc, and most preferably about 26 cc. In this embodiment, the rear volumetric chamber comprises of between about 4.7% to about 6.5% of the internal overall volume, more preferably between about 5.2% to about 6.0% of the internal overall volume, and most preferably about 5.6% of the internal overall volume. However, it should be noted that in alternative embodiments of the present invention, the rear volumetric chamber **1444** may have a simple screw weight system, or no weighting system at all, all without departing from the scope and content of the present invention. In those alternative embodiments, the rear volumetric chamber **1444** may have a complimentary volume of about 40 cc to about 80 cc, more preferably between about 50 cc to about 70 cc, and most preferably about 60 cc, resulting in a percentage of between about 9% to about 18%, more preferably between about 11% to about 16%, and most preferably about 13 percent of the internal overall volume respectively all without departing from the scope and content of the present invention.

[0101] Based on the numbers and percentages outlined above, it can be said that the golf club head **1400** may have a Volumetric Ratio of between about 12.6 to about 19.1, more preferably between about 13.9 to about 17.1, and most preferably about 15.4 all without departing from the scope and content of the present invention, with the Volumetric Ratio defined by Equation (1) below:

$$\text{Volumetric Ratio} = \frac{\text{Frontal Volumetric Chamber Volume}}{\text{Rear Volumetric Chamber Volume}} \quad \text{Eq. (1)}$$

[0102] As a corollary to the volume measurements articulated above, the location of the secondary wall **1442** may also be defined as a measurement from the rearmost point of the golf club head **1400**. In the current exemplary embodiment of the present invention, the second wall is angled at an angle α of between about 8° to about 12°, more preferably between about 9° to about 11°, and most preferably about 10° measured from a horizontal ground plane. Resultingly, the upper end of the secondary wall **1442** is located at a distance **D3** of between about 20 mm to about 26 mm from the rearmost portion of the golf club head **1400**, more preferably between about 21 mm to about 25 mm from the rearmost portion of the golf club head **1400**, and most preferably about 23 mm from the rearmost portion of the golf club head **1400**. The lower end of the secondary wall **1442** is located at a distance **D4** of between about 28 mm to about 34 mm from the rearmost portion of the golf club head **1400**, more preferably between about 29 mm to about 33 mm from the rearmost portion of the golf club head **1400**, and most preferably about 31 mm from the rearmost portion of the golf club head **1400**. Due to the positive angle α, the upper end of the secondary wall **1442** is always located closer to the rearmost point of the golf club head **1400**. It should be noted that in an alternative embodiment, the angle α could be a negative number, wherein the lower end of the secondary wall **1442** is located closer to the rearmost point of the golf club head **1400** as well, also without departing from the scope and content of the present invention. Thus, regardless of whether the angle α is positive or negative, it can be said that no portion of the secondary wall **1442** is located within 26 mm from the rearmost portion of the golf club head **1400**, more preferably no portion of the secondary wall **1442** is located within 25 mm from the rearmost portion of the golf club head **1400**, and most preferably no portion of the secondary wall **1442** is located within 23 mm from the rearmost portion of the golf club head **1400**.

[0103] Finally, the cross-sectional view of golf club head **1400** shown in FIG. **16** illustrates a track type weighting system **1440**. More details regarding this type of track type weighting system **1440** may be found in commonly owned U.S. Pat. No. 10,695,628 to Yi et al., the disclosure of which is incorporated by reference in its entirety.

[0104] FIGS. **17** and **18** of the accompanying drawings shows an exploded and cross-sectional view of a golf club head **1700** in accordance with a further alternative embodiment of the present invention. In this further alternative embodiment of the present invention, all of the elements are similar to previous embodiment shown, but the secondary wall **1643** of the internal ribbon support member **1734** may have an opening **1743** to allow for an adjustment of the acoustic properties of the golf club head **1700**. The opening **1743** may help control the acoustic property of the golf club head **1700** by allowing the vibrational energy to travel between the frontal volumetric chamber **1746** and the rear volumetric chamber **1744** to relieve any undesirable vibrations that cause bad sound.

[0105] Other than the opening **1743** in the secondary wall **1643** of the internal ribbon support member **1734**, the remaining components of the golf club head **1700** are essentially identical. The golf club head **1700** is still com-

prised out of a frontal striking face portion **1702** and an aft body portion **1706**. The lightweight shell **1736** in this embodiment could be further split up into the lightweight crown sub-shell **1736***a* and a lightweight sole sub-shell **1736***b*, and the weighting system **1740** is still attached to the rear portion of the aft body portion **1702**.

[0106] FIG. **19** of the accompanying drawings shows an exploded perspective view of a golf club head **1900** in accordance with a further alternative embodiment of the present invention, wherein the internal ribbon support member **1934** has additional features to help improve the performance of the golf club head **1900** itself. More specifically, only the outer surface **1950**, and not the internal component **1952** of the internal ribbon support member **1934** includes the additional features of a plurality of cutouts **1954** to create a lattice structure. The lattice structure, in this current exemplary embodiment of the present invention, may further increase the structural rigidity of the internal ribbon support member **1934**, thus further allowing the lightweight shell **1936** to be made even thinner and lighter. In this alternative embodiment of the present invention, the internal ribbon support member may have a mass that is less than between about 7.0 grams, more less than about 6.0 grams, and most preferably less than about 5.0 grams. Other than the internal ribbon support member **1934** being different, all other components of the golf club head **1900** such as the frontal striking face portion **1902**, the aft body portion **1904**, the lightweight shell **1936**, and the weighting system **1940** essentially remain the same.

[0107] In order to show more details regarding the plurality of cutouts **1954** on the external component **1950** of the internal ribbon support member **1934**, an enlarged perspective view of the internal ribbon support member **1934** is shown in FIG. **20**. In this enlarged perspective view of the internal ribbon support member **1934** shown in FIG. **20** from a different perspective view allows the difference between the external component **1950** and the internal component **1952** to be shown more clearly. In this FIG. **20**, it can be seen that the plurality of cutouts **1954** is only on the external component **1950** and takes on a substantially triangular shape. The pattern of the plurality of cutouts alternate in director lengthwise along the internal ribbon support member **1934** and are mirror images of one another above and below the hemispheric midpoint to create the lattice structure previously mentioned. It should be noted that in alternative embodiments of the present invention, different cutout shapes may be used to form the plurality of cutouts **1954** such as squares, rectangles, ovals, circles, or any other shapes all without departing from the scope and content of the present invention.

[0108] In addition to illustrating the plurality of cutouts **1954** along the external component **1954** of the internal ribbon support member **1934**, FIG. **20** of the accompanying drawings also illustrates how the external component **1950** and the internal component **1952** of the internal ribbon support member **1934** combine together to create a diamond shaped support member. These types of shapes may generally be preferred in engineering design, as it tends to further increase the structural rigidity of the internal ribbon support member **1934**, maximizing the strength to weight ratio of the internal ribbon support member **1934**.

[0109] FIGS. **21** and **22** of the accompanying drawings shows an exploded view of a golf club head **2100** and an enlarged perspective view of an internal ribbon support member **2134** respectively to illustrate a different alternative embodiment of the present invention. In this alternative embodiment of the present invention, the golf club head **2100** will still have a striking face portion **2102** and an aft body portion **2104**. The aft boy portion **2104** will be further comprised of a lightweight shell **2136**, an internal ribbon support member **2134**, a weighting system **2140**. However, a closer examination of the internal component **2152** of the internal ribbon support member **2134** will highlight the unique feature of this embodiment wherein the internal component **2152** of the internal ribbon support member **2134** will also have a plurality of cutouts **2154** to help further reduce the mass of the internal ribbon support member. Alternatively, it can be said that both the internal component **2152** and the external component **2150** of the internal ribbon support member **2134** both further comprises of a plurality of cutouts **2154**. With the additional mass removed from the internal component **2152** of the internal ribbon support member **2134**, the internal ribbon support member **2134** in accordance with this embodiment of the present invention may have a total mass of less than about 4.0 grams, more preferably less than about 3.9 grams, and most preferably less than about 3.8 grams.

[0110] FIGS. **23** and **24** of the accompanying drawings shows an exploded view of a golf club head **2300** and a perspective view of an internal ribbon support member **2334** respectively to illustrate a different alternative embodiment of the present invention. In this alternative embodiment of the present invention, the golf club head **2300** will still have a striking face portion **2302** and an aft body portion **2304**. The aft boy portion **2304** will be further comprised of a lightweight shell **2336**, an internal ribbon support member **2334**, a weighting system **2340**. However, in this embodiment, the internal ribbon support member **2334** only has an external component **2350**, removing the internal component shown in previous embodiments completely. This embodiment may be desired when a dramatic weight reduction is desired, however, it does come at the expense of reduced structural stiffness support. In this embodiment of the present invention, the internal ribbon support member **2334** may have a total mass less than about 2.8 grams, more preferably less than about 2.7 grams, and most preferably less than about 2.6 grams.

[0111] FIG. **25** of the accompanying drawings shows an exploded heel side view of a golf club head **2500** in accordance with an even further alternative embodiment of the present invention. In this further alternative embodiment of the present invention, the lightweight crown sub-shell **2536***a* may be further comprised out of three layers to further improve the performance of the golf club head **2500**. The golf club head **2500**, is very similar to the previous embodiments of the present invention, having a frontal striking face portion **2502** and an aft body portion **2506**, wherein the aft body portion **2506** is further comprised of a lightweight crown sub-shell **2536***a*, a lightweight sole sub-shell **2536***b*, an internal ribbon support member **2534**, and a weighting system **2540**. As previously discussed, the lightweight crown sub-shell **2536***a* in this embodiment of the present invention is further comprised out of three or more layers, having an outer layer **2536***a*-**1**, a central layer **2536***a*-**2**, and an internal layer **2536***a*-**3**. The utilization of the multi-layered construction helps improve the performance of the golf club head **2500** because of the different materials

selected to form this lightweight crown sub-shell **2536***a* can take advantage of each material's inherent properties.

[0112] Starting with the most critical layer in the lightweight crown sub-shell **2536***a*, the central layer **2536***a*-**2** in accordance with this embodiment of the present invention is generally made out of a semi-crystalline thermoplastic part for its ability to achieve desirable acoustic properties with desirable sound when the golf club head **2500** itself comes into contact with a golf ball. Such semi-crystalline materials may be polyether ether ketone (PEEK), polyphenylene sulfide (PPS), and polyacryletherketone (PEAK), and as previously discussed in U.S. Patent Publication No. 2020/0023247 to Larsen et al. and U.S. Patent Publication No. 2020/0188746 to Sugimae et al., both of which have been previously incorporated by reference in their entirety. Alternatively, the material of the central layer **2536**-*a*-**2** could also be made out of amorphous materials such as polyetherimide (PEI) polysulfone (PSU), or polyvinyl chloride (PVC) also without departing from the scope and content of the present invention. In this alternative embodiment of the present invention, the central layer **2536***a*-**2** comprises of at least one layer of PPS resin having about 80 grams/m^2 Fiber Areal Weight (FAW) with about 40% resin content, having a thickness of about 0.10 mm. In a preferred embodiment, the central layer **2536***a*-**2** could have two or more layers of between about 5 layers to about 13 layers of PPS resin materials for a total thickness of between about 0.50 mm and 1.30 mm, all without departing from the scope and content of the present invention. In a more preferred embodiment of the present invention, the central layer **2536***a*-**2** could have between about 7 layers to about 11 layers of PPS semi-crystalline resin materials having a total thickness of between about 0.70 mm to about 1.10 mm. However, it should be noted that other types of polymer material may be used to form the central layer **2536***a*-**2** without departing from the scope and content of the present invention as long as it is capable of producing the desired acoustics frequencies of the golf club previously described.

[0113] In addition to the number of layers used to form the central layer **2536***a*-**2**, the fiber orientation of each of the specific layers to form the central layer **2536***a*-**2** may also be critical to the performance of the golf club head.

[0114] In a 5 layered embodiment, the fiber orientation and layup in accordance with exemplary embodiments of the present invention may be as follows, with the 1st layer being closest to the inside of the central layer **2536***a*-**2** resulting in that 1st layer being closest to the inside of the golf club head **2500** itself.

1st Layer	2nd Layer	3rd Layer	4th Layer	5th Layer
0°	45°	−90°	−45°	0°
0°	90°	0°	90°	0°
0°	90°	−45°	45°	0°

[0115] In a 7 layer embodiment, the fiber orientation and layer in accordance with exemplary embodiments of the present invention may be as follows, with the 1st layer being closes to the inside of the central layer **2536***a*-**2** resulting in that 1st layer being closest to the inside of the golf club head **2500** itself.

1st Layer	2nd Layer	3rd Layer	4th Layer	5th Layer	6th Layer	7th Layer
0°	45°	90°	−45°	45°	90°	0°
0°	90°	0°	90°	0°	90°	0°
0°	90°	45°	−45°	0°	90°	0°
0°	90°	45°	−45°	45°	90°	0°
90°	0°	45°	−45°	45°	0°	90°
90°	0°	45°	−45°	90°	0°	90°

[0116] In an 8 layer embodiment, the fiber orientation and layer in accordance with exemplary embodiments of the present invention may be as follows, with the 1st layer being closes to the inside of the central layer **2536***a*-**2** resulting in that 1st layer being closest to the inside of the golf club head **2500** itself.

1st Layer	2nd Layer	3rd Layer	4th Layer	5th Layer	6th Layer	7th Layer	8th Layer
0°	45°	90°	−45°	45°	90°	−45°	0°
0°	90°	0°	90°	0°	90°	0°	90°
0°	90°	45°	0°	−45°	90°	0°	90°
90°	45°	0°	−45°	0°	45°	−45°	90°
90°	45°	−45°	0°	0°	−45°	45°	90°

[0117] In an 11 layer embodiment, the fiber orientation and layer in accordance with exemplary embodiments of the present invention may be as follows, with the 1st layer being closest to the inside of the central layer **2536***a*-**2** resulting in that 1st layer being closest to the inside of the golf club head **2500** itself.

1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th
90°	0°	45°	−45°	90°	0°	90°	−45°	45°	0°	90°

[0118] In a 12 layer embodiment, the fiber orientation and layer in accordance with exemplary embodiments of the present invention may be as follows, with the 1st layer being closes to the inside of the central layer **2536***a*-**2** resulting in that 1st layer being closest to the inside of the golf club head **2500** itself.

1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
0°	45°	90°	−45°	0°	45°	90°	−45°	0°	45°	90°	−45°
0°	−45°	90°	45°	0°	−45°	90°	45°	0°	−45°	90°	45°
0°	90°	45°	0°	−45°	90°	45°	0°	−45°	90°	45°	0°
90°	45°	0°	−45°	90°	45°	−45°	90°	−45°	0°	45°	90°

[0119] The PPS material in accordance with the present invention may be a filled PPS or unfilled PPS material that is a semi-crystalline resin material. The filler material, if used, may incorporate continuous or chopped reinforcing fiber. Alternatively, the central layer may be filled or unfilled with the base material in the polysulfides family such as PSU, PES, or PPSU all without departing from the scope and content of the present invention.

[0120] Despite the tremendous acoustic benefit associated with semi-crystalline thermoplastic type materials described above, the problem with these types of material is it's inability to bond well to non-resin based materials such as a titanium chassis of a golf club head **2500**. The inability to create a strong bond is at least partially due to the fact that the resin of semi-crystalline thermoplastic type material is generally chemically resistant to solvents. Another downside of semi-crystalline thermoplastic type material is that the resin is generally clear, thus allowing the underlying fiber to be shown; and it tends to create a relatively dull finish. In order to address these drawbacks, the present invention utilizes a three layered construction, wherein the outer layer **2536***a*-**1** is made out of a material capable of addressing the cosmetic deficiencies of the semi-crystalline thermoplastic type material, and the internal layer **2536***a*-**3** is made out of material capable of addressing the bonding deficiencies of the semi-crystalline thermoplastic type material.

[0121] Moving onto the outer layer **2536***a*-**1** of the lightweight crown sub-shell **2536***a*, it should be noted that the outer layer **2536***a*-**1** shown here is generally made out of a polyetherimide (PEI) polymer resin film having a thickness of less than about 0.10 mm, more preferably less than about 0.08 mm, and most preferably less than about 0.06 mm. This utilization of the PEI polymer resin film to form the outer layer **2536***a*-**1** can provide a finished product that is cosmetically appealing, without the need to paint the lightweight crown sub-shell **2536***a* in a secondary post processing step.

[0122] Finally, the inner layer **2536***a*-**3** of the lightweight crown sub-shell **2536***a* in accordance with the current embodiment of the present invention may also be made out of a PEI polymer resin film material having a thickness of less than about 0.10 mm, more preferably less than about 0.08 mm, and most preferably less than about 0.06 mm. This utilization of the PEI polymer resin film to form the inner layer **2536***a*-**3** can provide a nice intermediary bonding layer between the multiple layers of PPS resin and other non-resin based material used to form the chassis of the golf club head **2500**. In one exemplary embodiment of the present invention, a DP420 NS type epoxy may be used to bond the entirety of the lightweight crown sub-shell **2536** formed of the three layered sandwiched material to the chassis without departing from the scope and content of the present invention.

[0123] It should be noted that although FIG. **25** of the accompanying drawings shows the lightweight crown sub-shell **2536***a* being a three layered composition, the central layer **2536***a*-**2** could be formed out of multiple layers of PPS resin material with different fiber orientations without departing from the scope and content of the present invention. In addition to the above, this multi-layered formation of the lightweight crown sub-shell **2536***a* could also be used to form the lightweight sole sub-shell **2536***b*, or even the internal ribbon support member **2534** also without departing from the scope and content of the present invention.

[0124] FIGS. **26** through **30** show various cross-sectional views and exploded views of a golf club head **2600** in accordance with a further alternative embodiment of the present invention. FIG. **26** of the accompanying drawings shows a cross-sectional view of a golf club head **2600** take along a cross-sectional line A-A' show in FIG. **2**. In the cross-sectional view of the golf club head **2600** shown in FIG. **26**, the striking face portion **2602**, similar to previous embodiments, attaches to an aft body portion **2606**. It should be noted here that although it has been previously shown in numerous other embodiments, the joint between the striking face portion **2602** and the aft body portion **2606** is worth highlighting here, as this type of lap joint is important to the proper functionality of the present invention. In this embodiment of the present invention, it is important to have the aft body portion **2606** taper inward at the joint section to allow it to fit beneath the striking face portion **2602**, as this type of relationship allows the relatively stiff striking face portion **2602** to constrain any potential movement of the aft body portion **2606**. In an alternative embodiment of the present invention, the joint between the frontal striking face portion **2602** may be designed in a way to reduce the gap as shown in FIG. **33** without departing from the scope and content of the present invention. In the embodiment of the joint shown in FIG. **33**, excess material is added to the aft body portion **3606** around the bonding ledge, creating a seamless fit without departing from the scope and content of the present invention.

[0125] The cross-sectional view of golf club head **2600** shown in FIG. **26**, combined with the exploded view of the golf club head **2600** shown in FIG. **27** illustrates a striking face portion **2602** formed out of a metallic material and may or may not have an additional face insert attached to the frontal surface of the striking face portion **2602**. The striking face portion **2602** may also have a return portion that extends rearward from the striking face plane, wherein the return portion is adopted to engage the aft body portion **2606**. The aft body portion **2606** may generally be formed out of a lightweight crown sub-shell **2636***a* and a lightweight sole sub-shell **2636***b* both of which combine to create the aft body portion **2606** all while helping capture a weighting system **2640**.

[0126] The weighting system **2640** shown in FIGS. **26** and **27** further comprises of a high density mass **2660**, an outer weight housing **2662**, an inner weight housing **2664**, and an inner threaded screw **2666**, all combining to create a mass member at the rear of the golf club head **2600**. In this exemplary embodiment of the present invention, the high density mass **2660** is threaded and attaches to the outer weight housing **2662** via the threads. The high density weight **2600** may generally be formed out of a tungsten type material with a density of greater than about 17 g/cc, however other types of lower density tungsten or steel type material may also be used without departing from the scope and content of the present invention so long as the material has a density greater than that of the lightweight shell **2636**. The outer weight housing **2662** in this embodiment may be made out of a steel type material to allow the threads of the high density weight **2600** to engage itself, however, in alternative embodiments of the present invention, numerous other types of material such as tungsten, aluminum, or even some polymeric material can all be used without departing from the scope and content of the present invention so long as it is capable of creating durable threads to engage the high

density weight **2600** also all without departing from the scope and content of the present invention. Both the high density weight **2600** and the outer weight housing **2662** are located on the external surface of a crown recessed skirt **2661***a* of the lightweight crown sub-shell **2636***a* and a sole recessed skirt **2661***b* of the lightweight sole sub-shell **2636***b*. On the internal surface of the recessed skirt **2661** of the lightweight crown sub-shell **2636***a* is the inner weight housing **2664** as well as the inner threaded screw **2666**. The inner weight housing **2664** provides some support to the internal portion of the recessed skirt **2661***a* and **2661***b*, and has openings that allows the one or more inner threaded screws **2666** to engage the outer weight housing **2662** to secure the entirety of the weighting system **2640** to the aft portion of the golf club head **2600**. It should be noted that the outward facing geometry of the combination of the recessed skirt **2661***a* and **2661***b* generally match the inward facing geometry of the outer weight housing **2662** to facilitate this bond without departing from the scope and content of the present invention. It is important to note here that in this embodiment of the present invention with the screws, the entirety of the weighting system does not require any glue.

[0127] It is worth noting here that the current aft body portion **2606** no longer requires the utilization of a ribbon support member, and the elimination of a ribbon support member is accomplished through a unique overlap joint between the lightweight crown sub-shell **2636***a* and the lightweight sole sub-shell **2636***b*, the relationship is shown more clearly in a different cross-sectional view of the golf club head **2600** taken in a heel to toc direction shown in FIG. **28**. In the cross-sectional view shown in FIG. **28**, it can be seen that the joint between the lightweight crown sub-shell **2636***a* and the lightweight sole sub-shell **2636***b* is once again a lap joint located towards the lower portion of the golf club head below the geometric pinch point **2633** around the skirt of the golf club head **2600**, having the lightweight crown sub-shell **2636***a* bending inward of the lightweight sole sub-shell **2636***b*. In order to provide a better illustration of the bond, an enlarged view of circular region A shown in FIG. **28** is provided as FIG. **29**.

[0128] FIG. **29** of the accompanying drawings shows an enlarged cross-sectional view of a golf club head **2600** shown as circular region A in FIG. **28**. In this enlarged cross-sectional view of the golf club head **2600**, it can be seen that the joint between the lightweight crown sub-shell **2636***a* and the lightweight sole sub-shell **2636***b* is moved away from the geometric pinch point **2633**. The geometric pinch point **2633** is generally a location that does not lend itself well to joints, thus moving the joint between the lightweight crown sub-shell **2636***a* and the lightweight sole sub-shell **2636***b* away from the geometric pinch point **2633** significantly increases the bonding strength between the lightweight crown sub-shell **2636***a* and the lightweight sole sub-shell **2636***b*; thus eliminating the need of an internal ribbon support member completely. Shifting the joint between the lightweight crown sub-shell **2636***a* and the lightweight sole sub-shell **2636***b* is critical to the structural rigidity of the rear aft portion **2606**, but it does come with some manufacturing challenges.

[0129] The manufacturing challenge in shifting this joint stems mainly from the need to form complex shapes via a generally flat composite sheet material that is used to create the lightweight crown sub-shell **2636***a* and the lightweight sole sub-shell **2636***b* and how these pieces cannot be easily shaped using traditional curing methods with a male and female cavity. In this embodiment of the present invention, the complex shape of the lightweight crown sub-shell **2636***a* can no longer be formed using traditional methods is because now the shape creates multiple undercuts in multiple orientations. In order to address these manufacturing challenges, the present invention manufacturers the lightweight crown sub-shell **2636***a* using multiple male inserts to form the male portion of the mold, allowing the male portion of the mold to be disassembled after the mold opens. In an alternative embodiment of the present invention, the lightweight crown sub-shell **2636***a* could be formed using a bladder molded process to achieve the same geometry without departing from the scope and content of the present invention. In one example, the bladder could be made out of a silicone type material that can withstand high temperatures without departing from the scope and content of the present invention as well.

[0130] In addition to the shifting of the joint between the lightweight crown sub-shell **2636***a* and the lightweight sole sub-shell **2636***b* away from the geometric pinch point **2633**, the enlarged cross-sectional view of the circular region A shown in FIG. **29** also illustrates the relative placement of the two components. More specifically, it can be seen in FIG. **29** that the thicker lightweight sole sub-shell **2636***b* may generally form the outer ledge of the butt joint, while the thinner crown sub-shell **2636***a* may generally form the inner ledge of the butt joint. This type of relationship is generally preferred in this embodiment of the present invention, as having the thicker of the two components constrain the thinner of the two components in helping minimizing the movement of the entire aft body portion **2606** and keeping the lightweight crown sub-shell **2636***a* and the lightweight sole sub-shell **2636***b* together.

[0131] FIG. **30** of the accompanying drawings shows an exploded view of the lightweight shell **2636** separated into the lightweight crown sub-shell **2636***a* and the lightweight sole sub-shell **2636***b*. This frontal exploded view of the lightweight shell **2636** shown in FIG. **30**, not only shows the shape of the lightweight crown sub-shell **2636***a* and the lightweight sole sub-shell **2636***b* in their unassembled state, it also allows the crown recessed skirt **2661***a* and the sole recessed skirt **2661***b* to be shown with more clarity as well.

[0132] FIGS. **31** and **32** of the accompanying drawings shows a cross-sectional view and an exploded view of a golf club head **3100** in accordance with a further alternative embodiment of the present invention wherein the weighting system **3140** is mainly secured using an adhesive rather than a threaded attachment mechanism. In this embodiment of the present invention, the golf club head **3100** may also be formed out of a striking face portion **3102** and an aft body portion **3106**. The aft body portion has a lightweight crown sub-shell **3136***a* and a lightweight sole sub-shell **3136***b*, both of which combine to help capture and retain a weighting system **3140** at the rear portion of the golf club head **3100**. The weighting system **3140** here is formed out of a high density weight **3160** that contains a male threaded member, a female threaded receiver **3168**, an internal over-molded weight **3169**, and an internal weight housing **3164**. In this embodiment of the present invention, the internal weight housing **3164** is made out of lightweight composite type material and is formed with the internal over-molded weight **3169** as well as the female threaded receiver **3168** to help

capture these components within the formation of the internal weight housing **3164**. Once the internal weight housing **3164** is formed, it is then glued to the internal surface of the combination of the crown recessed skirt **3161***a* and the sole recessed skirt **3161***b*, exposing the threads of the female threaded receiver **3168** to accommodate the high density weight **3160**.

[0133] FIGS. **33** and **34** of the accompanying drawings shows a cross-sectional view and an exploded view of a golf club head **3300** in accordance with a further alternative embodiment of the present invention wherein the weighting system **3340** is mainly secured using an adhesive rather than a threaded attachment mechanism. However, this embodiment of the present invention differs from a previous embodiment by simplifying and combining the various component. In this embodiment of the present invention, the golf club head **3300** still has a striking face portion **3302** and an aft body **3306**, wherein the aft body **3306** is formed mainly out of a lightweight crown sub-shell **3336***a* and a lightweight sole sub-shell **3336***b*. The main difference in this embodiment of the golf club head **3300** shown in FIGS. **33** and **34** is in the weighting system **3340**. The weighting system **3340** shown in this embodiment of the present invention is has a high density weight **3360**, an outer weight housing **3362** and an inner weight housing **3364**. The female end of the threads that engages the male end of the threads of the high density weight **3360** is generally built directly into the outer weight housing **3362** itself.

[0134] The outer weight housing **3362** and the inner weight housing **3364** are adapted to fit along the external and internal contours of the recessed skirt **3361** (formed by the combination of crown recessed skirt **3361***a* and sole recessed skirt **3361***b*) respectively. In this embodiment of the present invention, the outer weight housing **3362** is generally adhesively glued to the external contours of the recessed skirt **3361** while the inner weight housing **3364** is glued to the internal contours of the recessed skirt **3361**, and the combination of the both of these components being attached to the recessed skirt **3361** will not only provide a method to attach a weighting mechanism to the rear of the golf club head **3300**, it also structural rigidity to the overall golf club head **3300** itself as well. Alternatively speaking, it can be said that an external surface of the internal weight housing **3364** mates with an internal surface of the recessed skirt **3361** and the internal surface of the outer weight housing **3362** mates with an external surface of the recessed skirt **3361**. In addition to engaging the recessed skirt **3361**, at least a portion of said outer weight housing **3362** is directly engaged with the internal weight housing **3364** to further enhance the bond. More specifically, in this embodiment of the present invention, the outer weight housing **3362** may have a protrusion **3367** that, even after assembled in the recessed skirt **3361**, protrudes beyond the recessed skirt **3361** itself via an opening to engage a recess in the internal weight housing **3364**. This engagement between the external weight housing **3362** and the internal weight housing **3364** may generally be bonded to one another via an adhesive, thus further enhancing the bond of the weighting system **3340** to the actual golf club head **3200** itself.

[0135] FIG. **35** of the accompanying drawings shows an internal view of the aft body **3306** wherein the shape and geometry of the internal weight housing **3364** can be shown more clearly. The aft body **3306** shown here in FIG. **35** further comprises of a lightweight crown sub-shell **3336***a* and a lightweight sole sub-shell **3336***b*. This internal view of the internal weight housing **3364** illustrates the unique shape and geometry of the internal weight housing **3364** not shown in any of the previous views. The internal weight housing **3364**, in order to provide structural support for the high density weight **3360** (shown in FIG. **34**), must be firmly attached to the aft body **3306** and have enough structural integrity not to deform when the high density weight **3360** moves when the golf club head impacts a golf ball. In order to achieve this, the internal weight housing **3364** may have an "H" shaped ribbing structure to provide the structural integrity previously discussed.

[0136] FIG. **36** of the accompanying drawings shows an enlarged perspective view of the internal weight housing **3364** in accordance with the present invention to allow the "H" shaped ribbing structure to be shown more clearly. The "H" shaped ribbing structure of the internal weight housing **3364** is comprised of a toc biased vertical rib **3372**, a heel biased vertical rib **3374** that are connected via a horizontal rib **3376** that connects the toe biased vertical rib **3372** and the toe biased vertical rib **3374**. The height D**5**-T of the toc biased vertical rib **3372** may generally be between about 29.0 mm to about 33.0 mm, more preferably between about 30.0 mm to about 32.0 mm, and most preferably about 31.5 mm. The height DT-H of the heel biased vertical rib **3374** may generally be between about 32.0 mm to about 36.0 mm, more preferably between about 33.0 mm to about 35.0 mm, and most preferably about 34.0 mm. The height of both the toe biased vertical rib **3372** and the heel biased vertical rib **3374** is critical to achieving the structural integrity of the internal weight housing **3364** because it not only supports the mainly unsupported portion of the C shaped structure, but it determines the depth of the internal weight housing **3364** into the cavity of the golf club head. Because the external profile of the internal weight housing **3364** must be congruent to the internal profile of the golf club head **3300** (shown in FIG. **34**) itself at this rear location, the size and dimension of the toc biased vertical rib **3372** and the heel biased vertical rib **3374** indirectly determines the depth of this internal weight housing **3364**. It should be noted that in this current embodiment of the present invention, the height of the toe biased vertical rib **3372** and the heel biased vertical rib **3374** are the different in order to conform to the symmetrical shape at the rear portion of the golf club head, however, in an alternative embodiment of the present invention, the height of the toe biased vertical rib **3372** may be the same as the heel biased vertical rib **3374** without departing from the scope and content of the present invention.

[0137] The final rib in the "H" shaped ribbing structure to complete the shape is the horizontal rib **3376**. The horizontal rib **3376**, as previously discussed, connect the toe biased vertical rib **3372** and the heel biased vertical rib **3374** to increase the structural integrity to the internal weight housing **3364** which prevents movement of the high density weight **3360** (shown in FIG. **34**). Similar to the dimension of the vertical ribs, the dimensions of the horizontal rib **3376** is related to the actual shape of the rear portion of the golf club head **3300** (shown in FIG. **34**). In this exemplary embodiment of the present invention, the horizontal rib **3376** may have a length D**6** of between about 21.0 mm and 25.0 mm, more preferably between about 22.0 mm and about 24.0 mm, and most preferably about 23.5 mm. It should be noted that the "H" shaped ribs that provide structural integrity,

both in its shape and dimension, are critical to the proper functionality of the present invention.

[0138] In order for the internal weight housing **3364** to provide the structural integrity to the rear portion of the golf club head **3300** (shown in FIG. **34**) and to provide a solid base for the high density weight **3360** (shown in FIG. **34**) to attach to, the internal weight housing **3364** has a high amount of surface area that come in contact with the aft body **3306** (shown in FIG. **35**). This high amount of surface area is shown more clearly in FIG. **37** of the accompanying drawings.

[0139] FIG. **37** of the accompanying drawings shows a rear perspective view of the internal weight housing **3364** in accordance with an exemplary embodiment of the present invention. This reverse perspective view of the internal weight housing **3364** shown in FIG. **37** allows the high amount of rear contact surface area to be shown more clearly, which is critical to the proper functionality of the present invention. Additionally, it should be noted that despite the high amount of rear surface area of the internal weight housing **3364** that comes in contact with the aft body **3306** (shown in FIG. **35**), a significant amount of surface area must also be preserved to come into contact with the outer weight housing **3362** and the high density weight **3360**; and the fine balance between these two opposing forces is once again critical to the present invention.

[0140] In this exemplary embodiment of the present invention, the rear surface area of the internal weight housing **3364** that comes into contact with the aft body **3306** (shown in FIG. **35**), defined here as a body contact area, of greater than about 1800 mm^2, more preferably greater than about 1820 mm^2, and most preferably greater than about 1840 mm^2. Conversely, the amount of surface area of the internal weight housing **3364** that comes into contact with either the outer weight housing **3362** (shown in FIG. **34**), defined here as the weighting contact area, may also be greater than about 500 mm^2, more preferably greater than about 510 mm^2, and most preferably greater than about 530 mm^2. The internal contact area and the weighting contact area are critical to the proper functionality of the present invention, as the proper synergistic balance of the two contact areas will dictate the amount of weight that can be supported via this weighting system. In fact, this proper balance can be quantified as a ratio of the internal body contact area over the weighting contact area, which is greater than about 3.25, more preferably greater than about 3.5, and most preferably greater than about 3.60.

[0141] FIGS. **38** and **39** of the accompanying drawings shows an exploded view of a golf club head **3800** in accordance with the same alternative embodiment of the present invention, wherein the weight system **3840** is improved to provide better structural integrity. This golf club head **3800**, similar to previous embodiments of the present invention, may generally have a striking face portion **3802** located at a frontal portion of the golf club head **3800**, while an aft body **3806** is attached to the rear of the striking face portion **3802**. The aft body **3806** is still formed from a lightweight crown sub-shell **3836***a* and a lightweight sole sub-shell **3836***b*. Once again, as indicated previously, this embodiment of the present invention has an improved weighting system **3840**. The weighting system **3840** has a high-density weight **3860**, an outer weight housing **3862** and an inner weight housing **3864**. The high-density weight **3860** may generally have a male thread that passes through an internally threaded and internally facing protrusion **3867** in the outer weight housing **3862**. The internally facing protrusion **3867** of the outer weight housing **3862** and its internal female threads are adapted to engage a through bore recess within the inner weight housing **3864** via an adhesive.

[0142] A closer examination of the cross-sectional view of the golf club head **3800** shown in FIG. **39** illustrates the relationship between the high-density weight **3860**, the outer weight housing **3862**, and the internal weight housing **3864** more clearly. First off, the high-density weight **3860** may generally have a male threaded fastener protruding inward towards the internal cavity of the golf club head **3800**. The external weight housing **3862** may generally have an internally facing threaded protrusion **3867** that is adapted to receive the male threads of the high-density weight **3840**. Finally, the inner weight housing **3864** may have a through bore that is adapted to receive the protrusion **3867** of the outer weight housing **3862**, and these two components are bonded to one another via an adhesive that also bonds these two components to the lightweight shell **3836**. Alternatively speaking, it can be said that no portion of the inner weight housing **3864** is threaded because its bond to the outer weight housing **3862** is via an adhesive, similar to its bond to the lightweight shell **3836**.

[0143] It should be noted that in this embodiment of the present invention, the inner weight housing **3864** may have a plurality of glue bumps **3877** on the outer surface of the inner weight housing **3864** to help create a gap with the lightweight shell **3836** to increase the amount of adhesive between the two components, thus improving the bond.

[0144] The cross-sectional view of the golf club head **3800** shown in FIG. **39** shows that the lightweight crown sub-shell **3836***a* and the lightweight sole sub-shell **3836***b* combine to create an aft body portion **3806** with a recessed skirt **3861** (formed by the combination of crown recessed skirt **3861***a* and sole recessed skirt **3861***b*). The recessed skirt **3861**, similar to previous embodiments, is sandwiched between the inner weight housing **3864** and the outer weight housing **3862** to help provide a structure that can help retain the high density weight **3860**.

[0145] FIGS. **40** and **41** are both exploded views of the weight system **4040** in accordance with the same alternative embodiment of the present invention, shown from two different angles to illustrate the various components without departing from the scope and content of the present invention. The weight system **4040**, similar to previous embodiments shown, may generally be comprised of three major components, the internal weight housing **4064**, the external weight housing **4062**, and the high density weight **4060**. However, unlike previous embodiments, both the internal weight housing **4064** and the external weight housing **4062** contain additional features to help with the structural integrity of the overall weight system **4040**.

[0146] More specifically, the exploded view shown here that is enlarged allows it to illustrate the plurality of glue bumps **4077** around the external outer surface of the inner weight housing **4064**. Because the external outer surface of the inner weight housing **4064** is the one that will only be glued to the lightweight shell **3836** (shown in FIG. **38**), this bond needs to be as strong as possible. The addition of glue bumps **4077** will allow s thin gap to be created between the external outer surface of the inner weight housing **4064** and the complimentary lightweight shell **3836** (shown in FIG.

38) for which the bonding adhesive to be retained, hence increasing the bond strength between these two components.

[0147] In addition to the glue bumps **4077** shown above, the exploded views of the weight system **4040** also allows the stabilizing rods **4078** on the external weight housing **4062** to be shown more clearly. The stabilizing rods **4078** on the external weight housing **4062** are adapted to engage receptacles **4079** in the internal weight housing **6064** to further help improve the overall structural rigidity of the overall weight system **4040**. The stabilizing rods **4078** shown in this embodiment of the present invention may be further separated into a heel stabilizing rod **4078***a* and a toe stabilizing rod **4078***b*, both of which are adapted to engage a heel receptacle **4079***a* and a toe receptacle **4079***b* respectively. The engagement of the stabilizing rods **4078** with the receptacles **4079** limit the rotational movement of the inner weight housing **4064** with the external weight housing **4062**, hence increasing the structural integrity of the entire weight system **4040**.

[0148] 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.

[0149] 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.

[0150] 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.

What is claimed is:

1. A golf club head comprising:

a frontal striking face portion located at a frontal portion of said golf club head, and

an aft body portion, attached to a rear of said striking face portion;

wherein the aft body portion further comprises a lightweight shell,

wherein said golf club head further comprises a weighting system sandwiching a rear portion of said lightweight shell, said weighting system further comprises;

an inner weight housing having a through bore,

an outer weight housing having an internally facing protrusion adapted to engage said through bore, and

a high-density weight adapted to engage said internally facing protrusion of said outer weight housing,

wherein at least a portion of an external surface of said internal weight housing mates with at least a portion of an internal surface of said lightweight shell,

wherein at least a portion of an internal surface of said external weight housing mates with at least a portion of an external surface of said lightweight shell, and

wherein no portion of said high-density weight engages said inner weight housing.

2. The golf club head of claim **1**, wherein said high-density weight further comprises a male threaded fastener, and

wherein said internally facing protrusion further comprises an internal female threaded bore, and

wherein said male threaded fastener of said high-density weight only engages said internal female threaded bore of said internally facing protrusion.

3. The golf club head of claim **2**, wherein said protrusion of said outer weight housing is bonded to said through bore of said inner weight housing via an adhesive.

4. The golf club head of claim **1**, wherein said outer weight housing further comprises a plurality of two or more stabilizing rods adapted to engage a plurality of two or more receptacles.

5. The golf club head of claim **4**, wherein said plurality of two or more stabilizing rods work with said plurality of two or more receptacle to prohibit a rotation of said inner weight housing from said outer weight housing.

6. The golf club head of claim **1**, wherein said internal weight housing further comprises an H shaped internal ribbing structure.

7. The golf club head of claim **6**, wherein said H shaped internal ribbing structure further comprises;

a toe side vertical rib,

a heel side vertical rib, and

a horizontal rib connecting said toe side vertical rib to said heel side vertical rib.

8. The golf club head of claim **7**, wherein both said toe side vertical rib and said heel side vertical rib have the same height.

9. The golf club head of claim **7**, wherein said toe side vertical rib and said heel side vertical rib have different heights.

10. The golf club head of claim **7**, wherein said toe side vertical rib has a height of between about 29.0 mm and about 33.0 mm.

11. The golf club head of claim **10**, wherein said horizontal rib has a distance of between about 21.0 mm and about 25.0 mm.

12. A golf club head comprising:

a frontal striking face portion located at a frontal portion of said golf club head, and

an aft body portion, attached to a rear of said striking face portion;

wherein the aft body portion further comprises a lightweight shell,

wherein said golf club head further comprises a weighting system sandwiching a rear portion of said lightweight shell, said weighting system further comprises;

an inner weight housing having a through bore,

an outer weight housing having an internally facing protrusion adapted to engage said through bore, and

a high-density weight adapted to engage said internally facing protrusion of said outer weight housing,

wherein no portion of said high-density weight engages said inner weight housing, and

wherein said inner weight housing further comprises an H shaped internal ribbing structure.

13. The golf club head of claim **12**, wherein said H shaped internal ribbing structure further comprises;

a toe side vertical rib,

a heel side vertical rib, and

a horizontal rib connecting said toe side vertical rib to said heel side vertical rib.

14. The golf club head of claim **13**, wherein both said toe side vertical rib and said heel side vertical rib have the same height.

15. The golf club head of claim **13**, wherein said toe side vertical rib and said heel side vertical rib have different heights.

16. The golf club head of claim **13**, wherein said toe side vertical rib has a height of between about 29.0 mm and about 33.0 mm.

17. The golf club head of claim **16**, wherein said horizontal rib has a distance of between about 21.0 mm and about 25.0 mm.

18. The golf club head of claim **12**, wherein said protrusion of said outer weight housing is bonded to said through bore of said inner weight housing via an adhesive.

19. The golf club head of claim **18**, wherein no portion of said inner weight housing is threaded.

20. The golf club head of claim **19**, wherein said outer weight housing further comprises a plurality of two or more stabilizing rods adapted to engage a plurality of two or more receptacles.

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