US 20140342847A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2014/0342847 A1**

(43) **Pub. Date: Nov. 20, 2014**

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(54) **GOLF CLUB HEAD WITH CHANNEL AND STABILIZING STRUCTURE**

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(21) Appl. No.: **14/254,246**

(22) Filed: **Apr. 16, 2014**

Related U.S. Application Data

(60) Provisional application No. 61/824,092, filed on May 16, 2013.

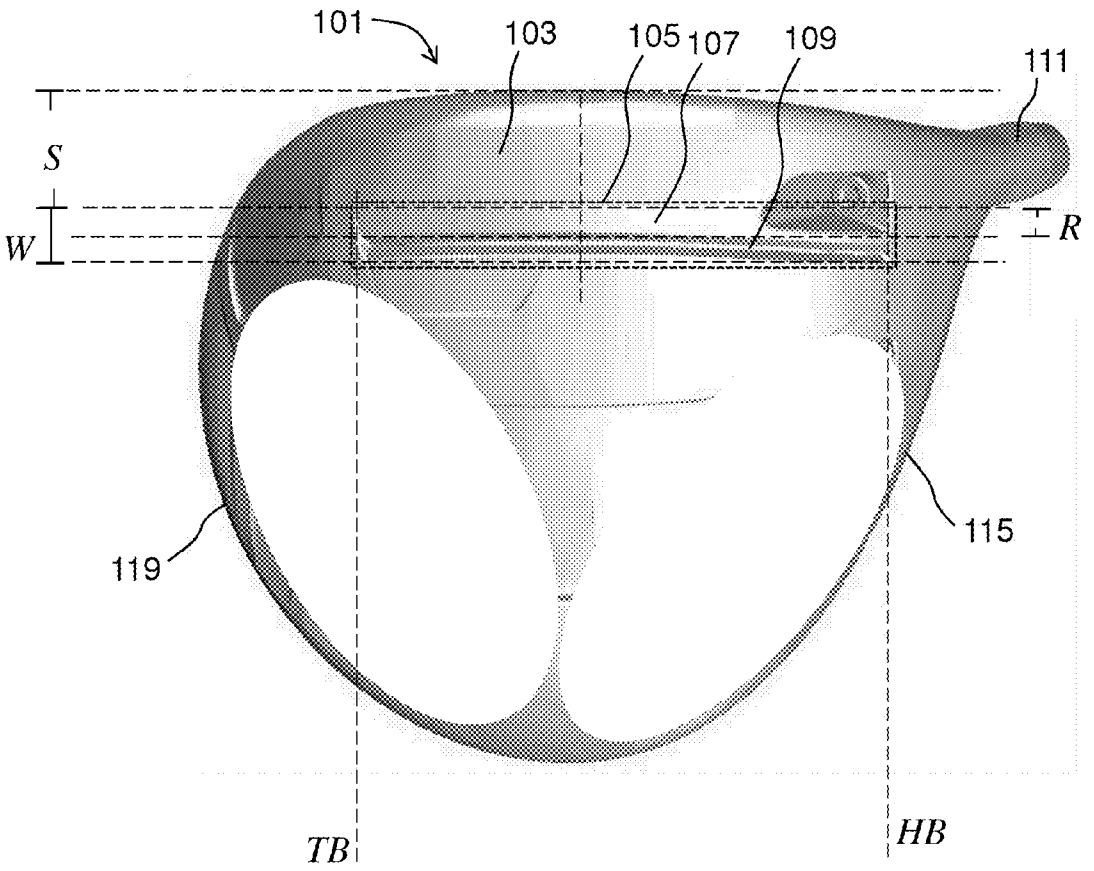
Publication Classification

(51) **Int. Cl.**
A63B 53/04 (2006.01)

(52) **U.S. Cl.**
CPC ***A63B 53/0466*** (2013.01); ***A63B 53/04*** (2013.01); *A63B 2053/0408* (2013.01); *A63B 2053/0433* (2013.01)
USPC **473/345**; 473/324

(57) **ABSTRACT**

The invention generally relates to a golf club with a channel area. The channel area includes a groove disposed alongside a ramp having a shallow slope with respect to the horizontal when the club head is at address. The channel area may extend across a portion of the club head such as the crown or the sole. The ramp is oriented such that, during a high speed drive, the ramped portion of the sole may distribute and neutralize torsional stresses, dampening unwanted and unpredictable twisting, preventing the ball from flying in unpredictable directions while the deeper groove contributes to a high coefficient of restitution of a ball-striking face, a large sweet spot area, or both, thus causing the ball to fly a long distance.



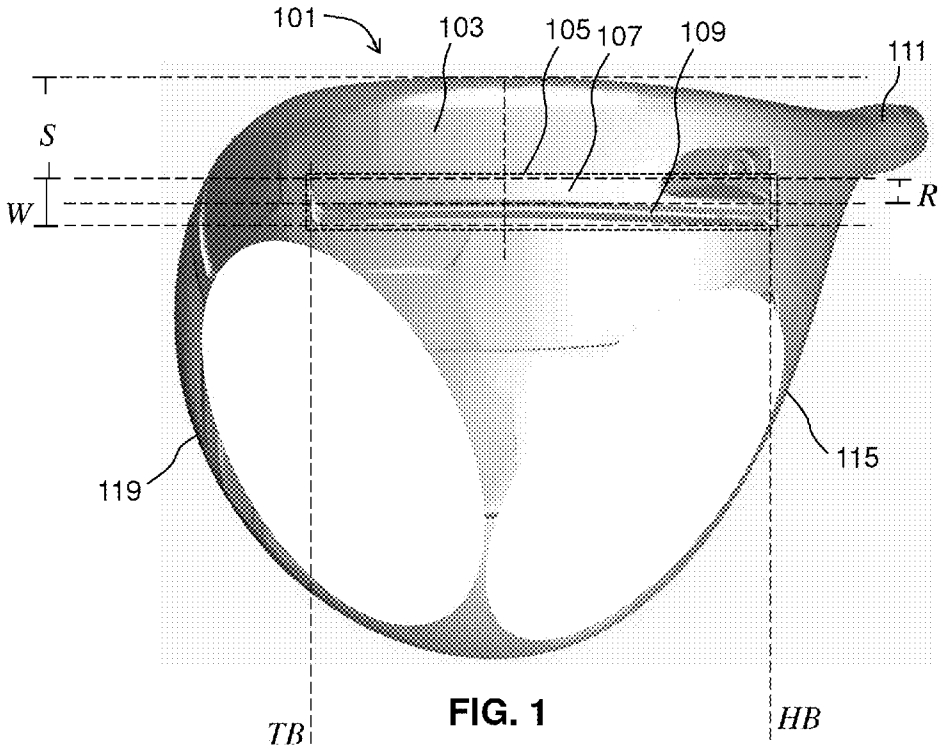


FIG. 1

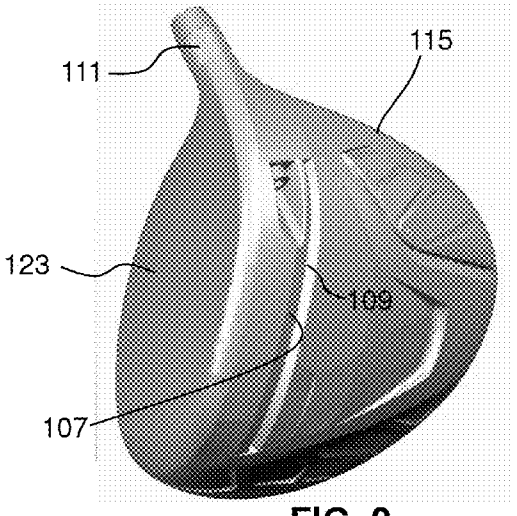


FIG. 2

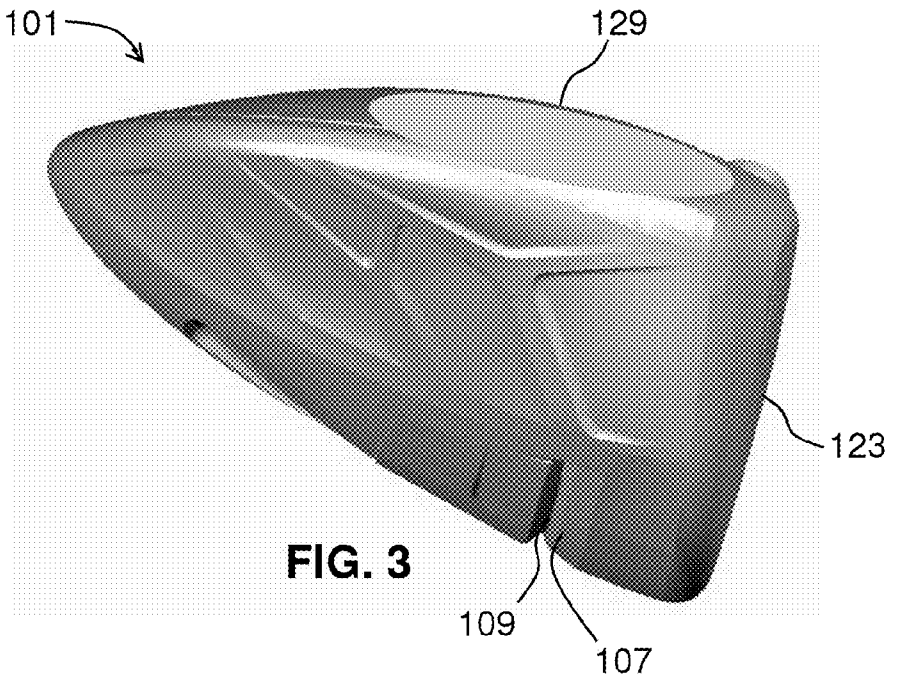


FIG. 3

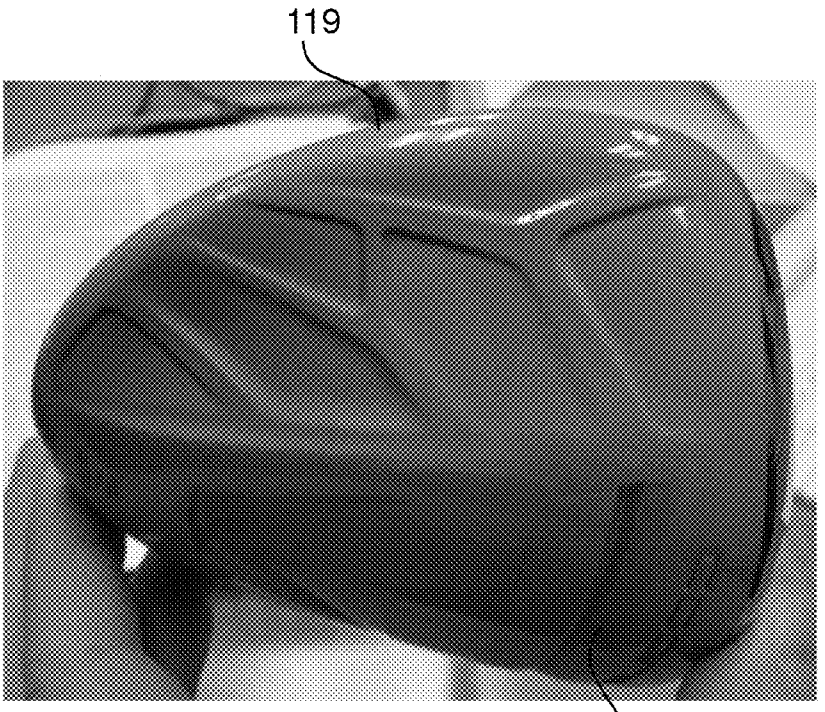


FIG. 4

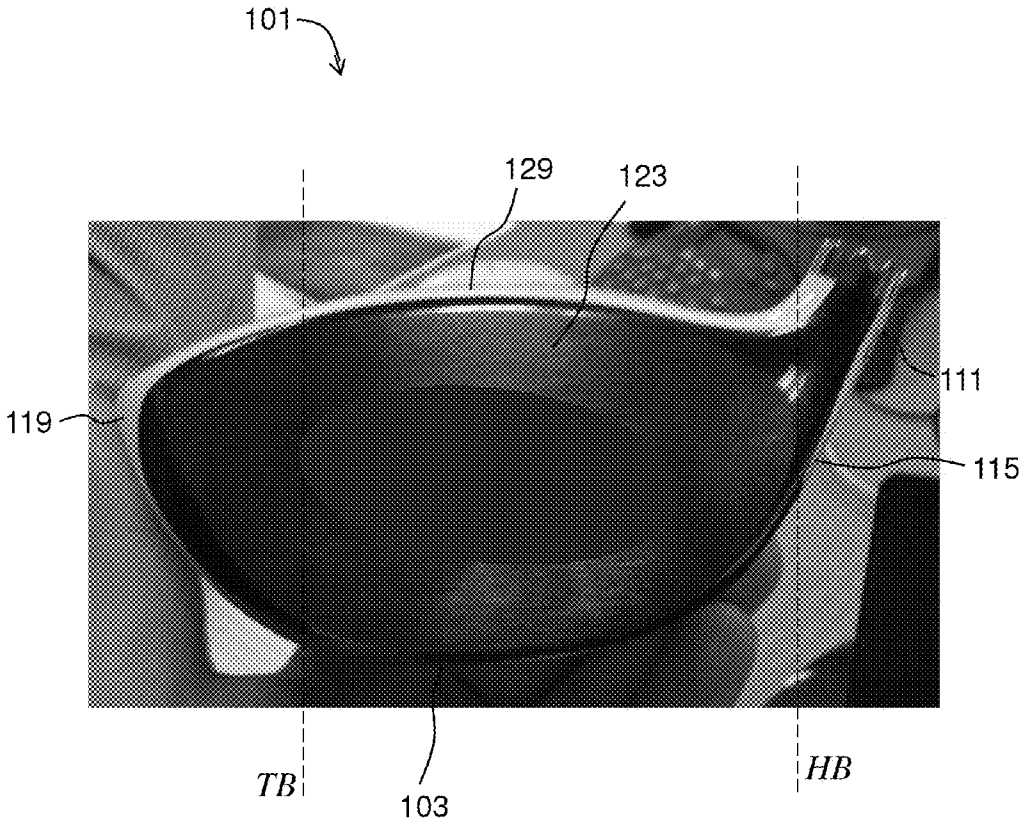


FIG. 5

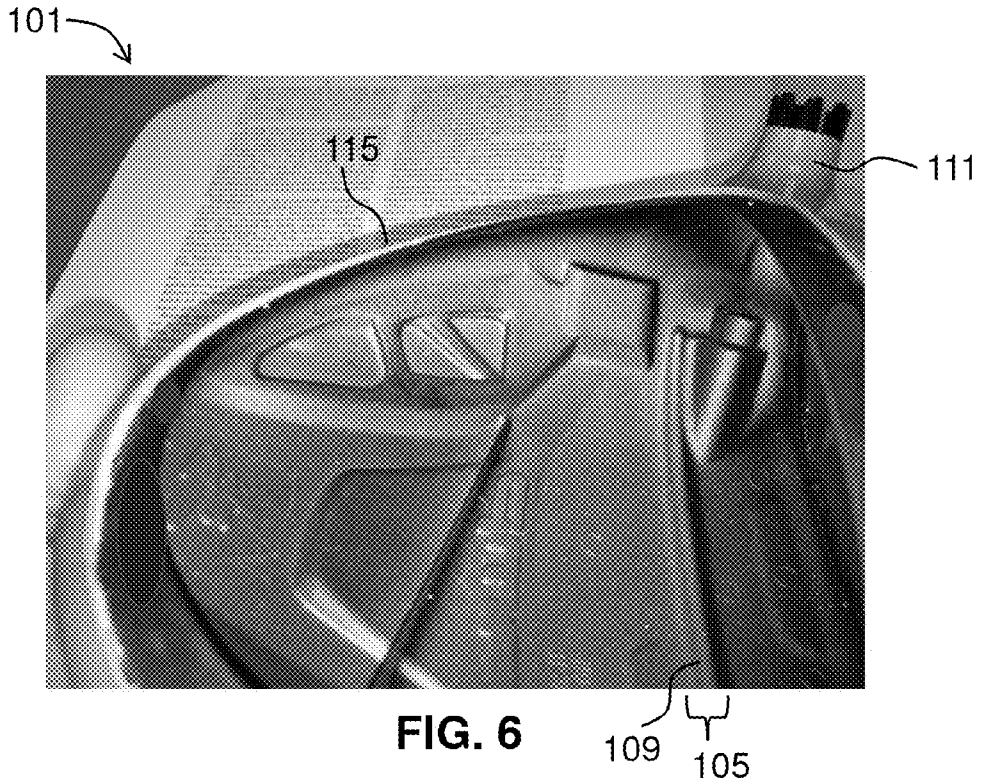


FIG. 6

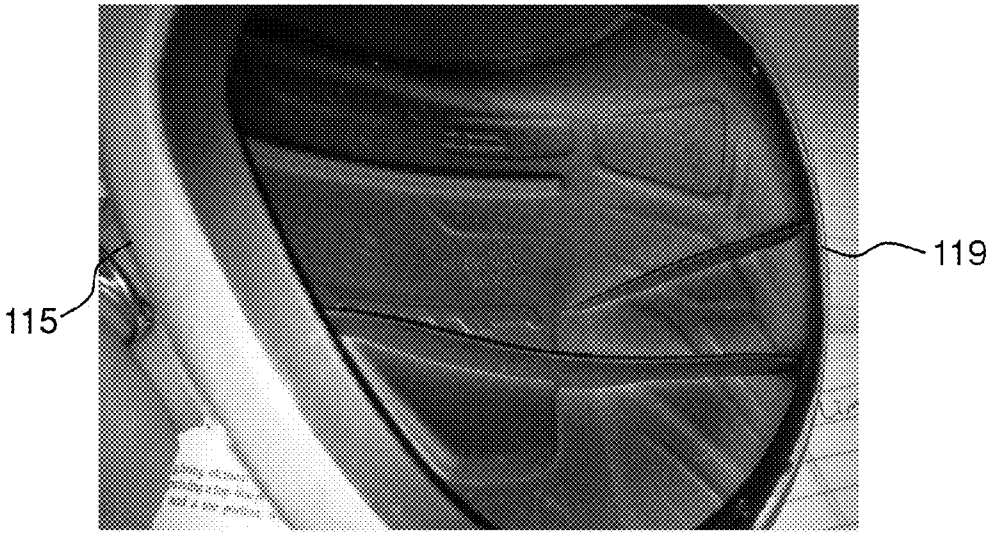


FIG. 7

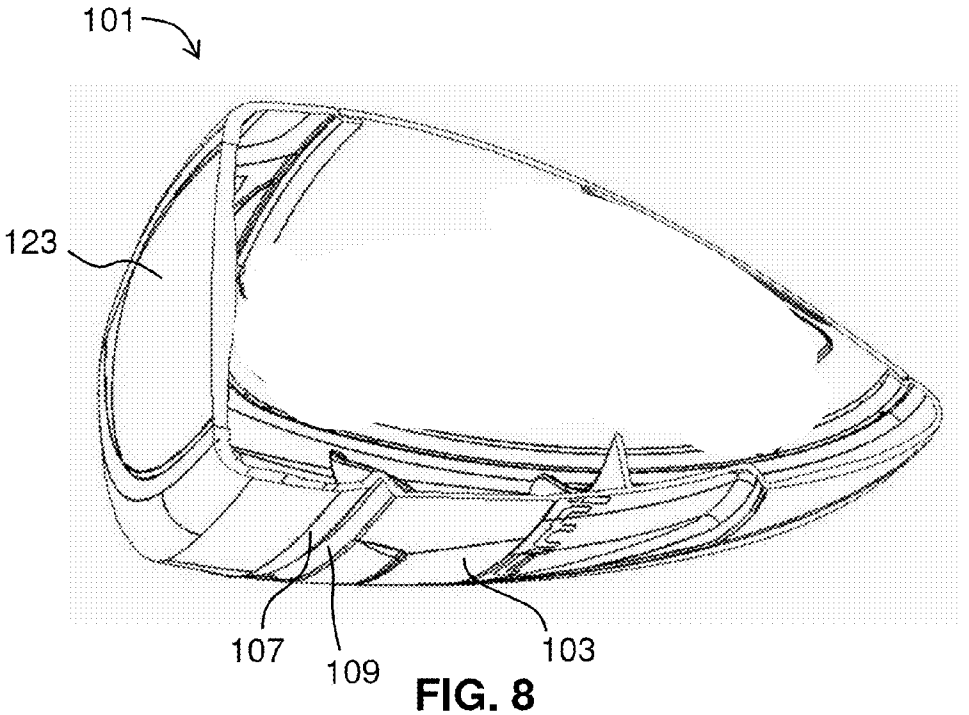


FIG. 8

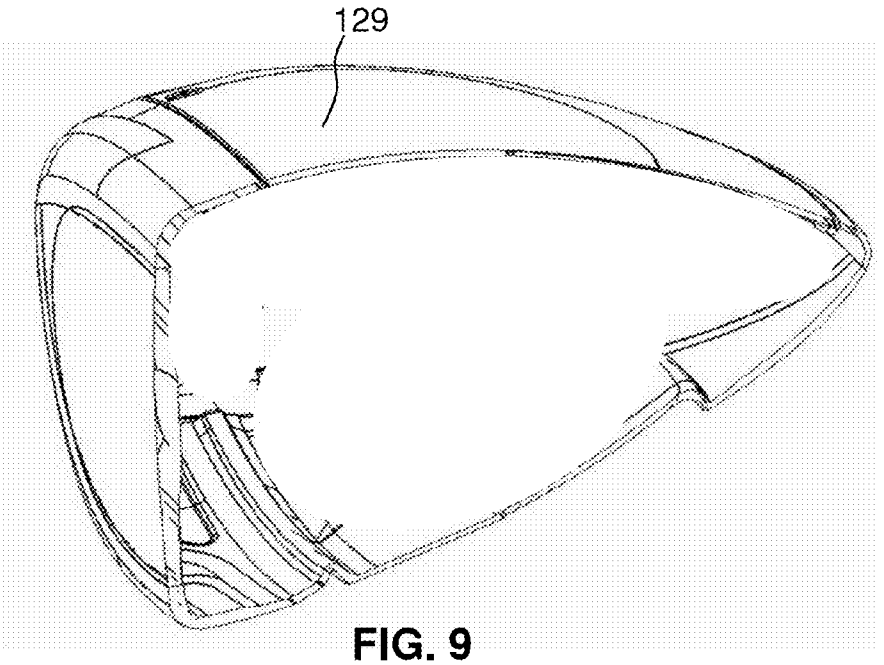


FIG. 9

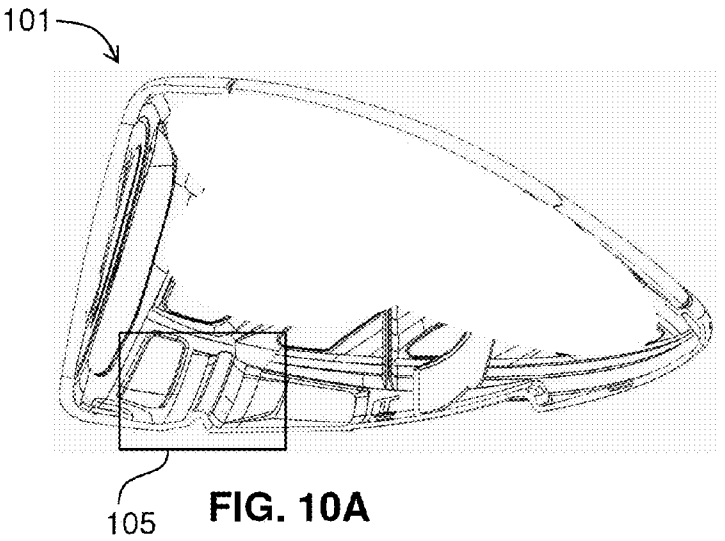


FIG. 10A

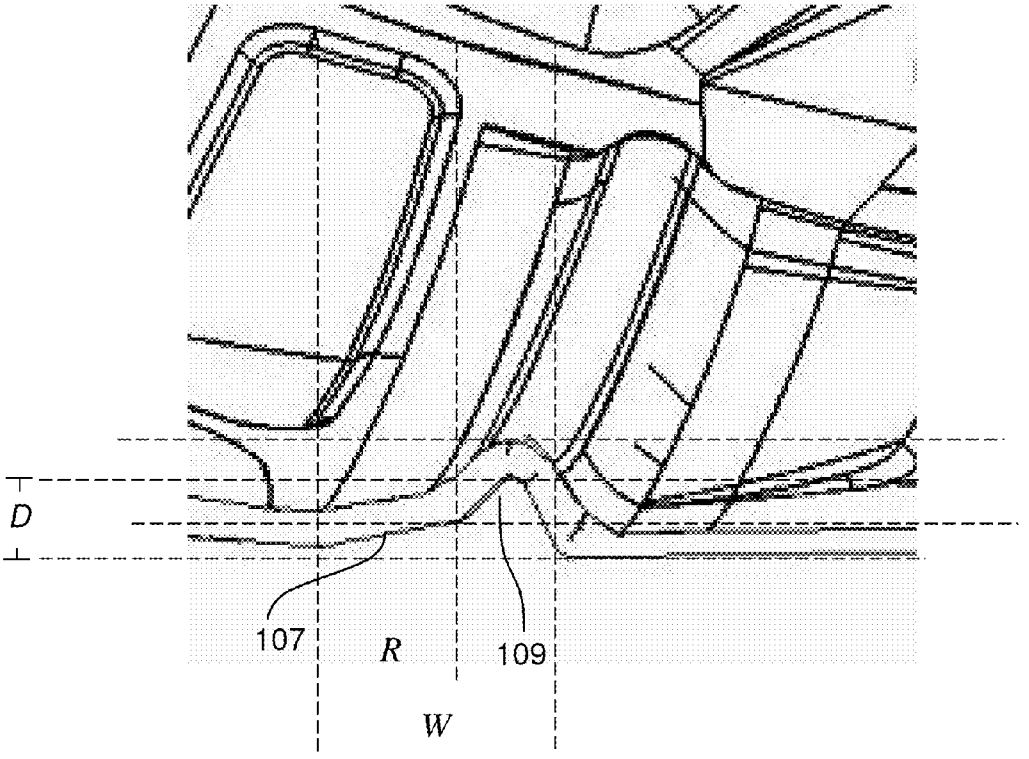


FIG. 10B

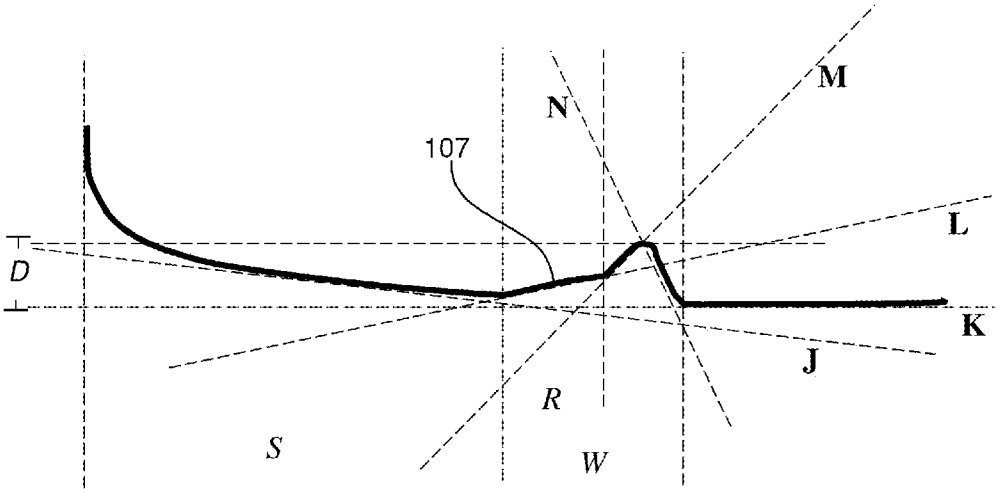


FIG. 10C

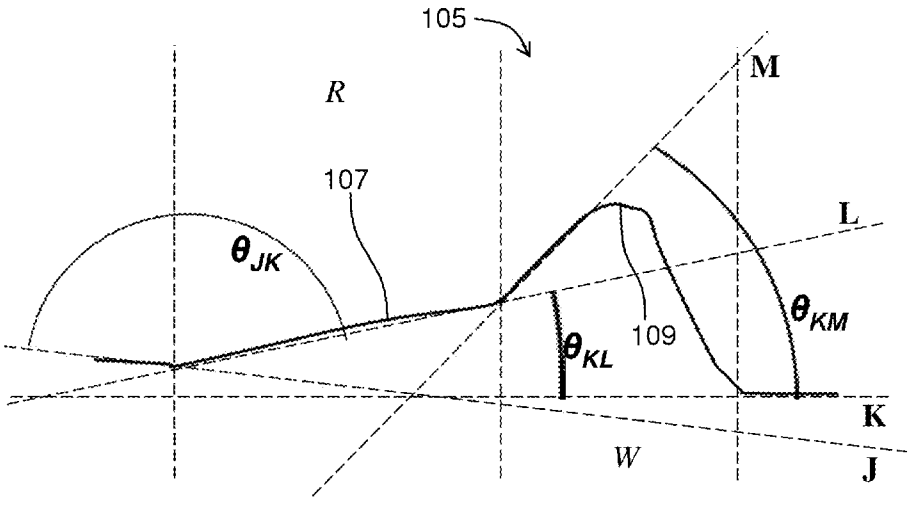


FIG. 10D

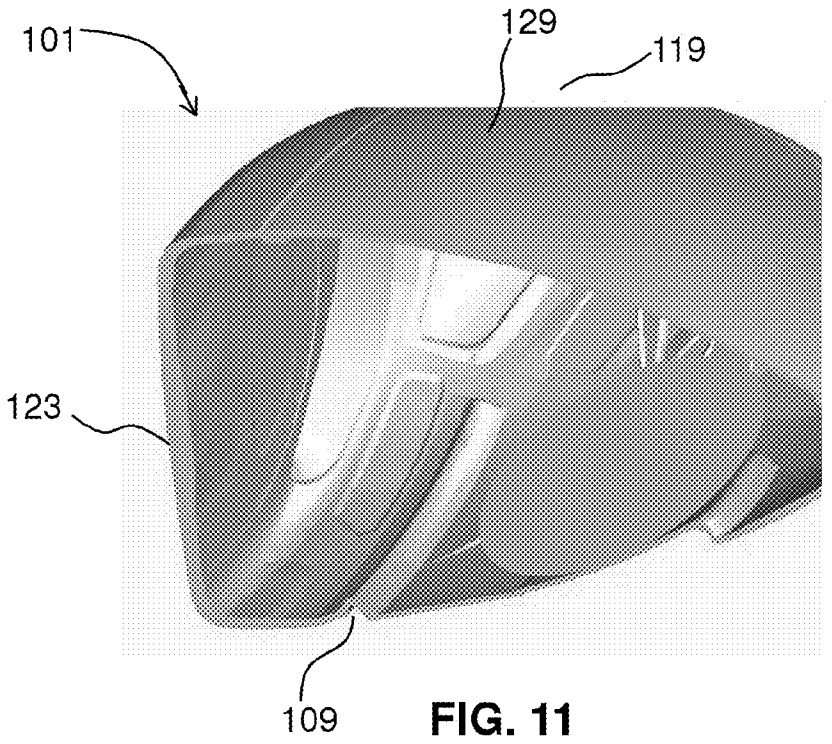


FIG. 11

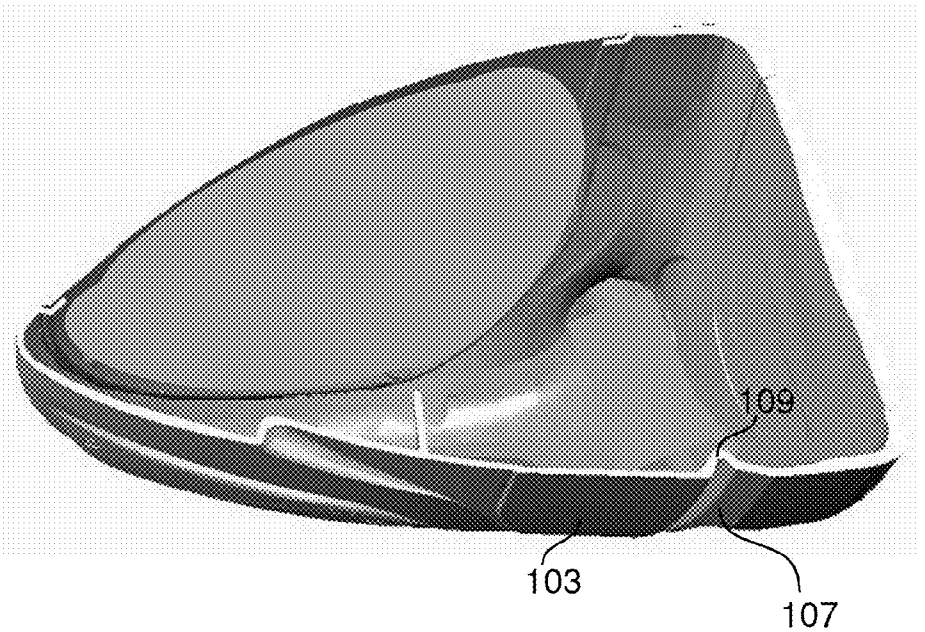


FIG. 12

GOLF CLUB HEAD WITH CHANNEL AND STABILIZING STRUCTURE

[0001] This application claims the benefit of, and priority to, U.S. Provisional Application 61/824,092, filed May 16, 2013, the contents of which are incorporated by reference.

FIELD OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention generally relates to a golf club head with a channel area in the sole to contribute to straight, long-distance drives.

[0004] 2. Background

[0005] When people play golf, they would like to be able to hit a golf ball a long distance in the right direction. Driver-style golf clubs are designed to a have a large face with a sweet spot that hits the ball far. Club designers have tried different structures in attempts to improve the sweet spot and hitting distance of drivers. For example, U.S. Pat. No. 7,294,064 to Tsurumaki shows an elastically deformable groove or recess to increase coefficient of restitution and move sweet spot downwards. Other clubs with some such feature are shown in U.S. Pat. No. 8,529,368 to Rice; U.S. Pat. No. 7,582,024 to Shear; U.S. Pat. No. 7,572,193 to Yokota; U.S. Pat. No. 7,500,924 to Yokota; U.S. Pat. No. 7,396,293 to Soracco; U.S. Pat. No. 6,887,165 U.S. Pat. No. 5,735,754 to Antonious; U.S. Pat. No. 5,603,668 to Antonious; U.S. Pat. No. 1,835,718 to Morton; U.S. Pub. 2013/0029779 to Stites; U.S. Pub. 2012/0143452 to Burnet; U.S. Pub. 2012/0142447 to Boyd; U.S. Pub. 2012/0196703 to Sander; U.S. Pub. 2012/0244960 to Tang; U.S. Pub. 2012/0220387 to Beach; U.S. Pub. 2007/0117648 to Yokota; U.S. Pub. 2007/0026961 to Hou; U.S. Pub. 2004/0192463 to Ando; and U.S. Pub. 2002/0183134 to Allen.

[0006] Unfortunately, introducing a structure to accomplish one goal can compromise another. Some golfers find that, despite the distance of their drives, the balls tend to hook or slice unpredictably. In fact, it may be found that prior art club heads with a channel in the sole are notoriously hard to hit, sending the ball in all directions, and thus negating the intended improvement of the channel.

SUMMARY

[0007] The invention provides a golf club with a channel that includes a recess set apart from an adjacent sole surface by at least one curved surface defining a ramp disposed at an angle intermediate the orientation of the channel wall and the sole surface. The ramp is oriented such that, during a high speed drive, the ramped portion of the sole may distribute and neutralize torsional stresses, dampening unwanted and unpredictable twisting that can be introduced or amplified by prior art channel structures. One insight of the invention is that adding an elastically deformable channel to a driver head can destabilize the structure, allowing the club head to twist, shear, or compress non-uniformly and transfer momentum non-uniformly to the strike face during the down stroke of a high-speed drive or at impact. A club head may twist or shear because the down stroke stresses the club along certain vectors and the prior art structure is compressible along that vector. An inclined surface, such as a ramp with a shallow slope, can introduce a plane of material extending in parallel to a component of such a vector and that material can resist compression or deformation. Preferably, that first ramp is adjacent another second ramped portion that is sloped in the same direction but at a steeper angle, with an opposed third ramped surface facing the first and second ramped surfaces. Thus a club head that includes a channel area with a groove that is buttressed by a shallow ramp will resist non-uniform deformation and non-uniform momentum transfer to the face with the result that shots will fly straight, and the club head will provide the full and intended benefit of a channel in the sole—a high coefficient of restitution and a large sweet spot in a club head that hits true. The channel area or groove preferably runs in a heel-to-toe direction substantially parallel to the face and close (e.g., within a few centimeters) to the face.

[0008] In certain aspects, the invention provides a golf club head having a crown, sole, heel portion, toe portion, and face cooperating to define a club head body. A hosel extends upwards from the body. The club head includes a channel area extending along an outer surface of the sole from the heel portion towards the toe portion. The channel area includes a groove disposed alongside a ramp with a shallow slope with respect to the horizontal when the club head is at address.

[0009] The groove may include two opposed, inward-facing walls such as a fore facing inward wall and an aft-facing inward wall. The aft-facing inward wall can have a steep slope with respect to the horizontal when the club head is at address. The shallow slope may be between 5° and 20° and the steep slope is between 20° and 80°. In some embodiments, the shallow slope is between 10° and 20° and the steep slope is between 30° and 60°. A heel-toe length of the channel may be between about 5 cm and about 15 cm. A face-aft width of the channel may be between about 0.2 cm and about 3 cm. A face-aft width of the ramp may between about 0.1 cm and about 1.5 cm.

[0010] In some embodiments, the club head is a hollow club head such as a driver, fairway wood, or hybrid.

[0011] In certain aspects, the invention provides a golf club head with a crown, sole, heel portion, toe portion, and face cooperating to define a club head body as well as a hosel extending upwards from the body and an inclined surface transitioning from a downward-facing portion of the sole surface to a narrow furrow in the sole. The furrow preferably extends from the heel portion to the toe portion. The inclined surface may extend along substantially an entirety, or only a part, of the furrow. A portion of the inclined surface may contain a portion of an idealized conical surface. The idealized conical surface defines an axis of a cone that is parallel to an axis of percussion of the club head or to a horizontal axis passing in a face-aft direction through a geometric center of face when the club head is at address.

[0012] In certain aspects, the invention provides a golf club head with a crown, sole, heel portion, toe portion, and face cooperating to define a club head body as well as a hosel extending upwards from the body and an inclined surface transitioning from a portion of a surface of the club head to a narrow furrow in the club head.

[0013] In certain aspects, the invention provides a golf club head that has a crown, sole, heel portion, toe portion, and face cooperating to define a club head body and a hosel extending upwards from the body. A channel extends across a surface of the club head. A cross-sectional profile of a portion of the channel has, when the club head is at address, a gently inclined portion forming a first angle with the horizontal and a steeply inclined portion forming a second angle with the horizontal. Preferably, the channel extends across the sole. In some embodiments, the first angle is between 5° and 20° and the second angle is between 20° and 80°. Preferably, the

gently inclined portion and the steeply inclined portion extend for a distance across the sole substantially in a heel-toe direction. That distance may be greater than about 4 cm.

[0014] In certain embodiments, the steeply inclined portion provides part of a wall of a groove in the sole. The groove can be substantially parallel to the face and spaced away from the face by at least a setback distance over a majority of a length of the groove. That setback distance may be between about 1 cm and about 5 cm. Preferably, the gently inclined portion is disposed between the face and the groove. In certain embodiments, the groove comprises a depth, with respect to a predominant surface of the sole, between about 1 mm and about 10 mm.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. **1** is a view from below of a club head of the invention at address.

[0016] FIG. **2** is a lower perspective view of a club head of the invention.

[0017] FIG. **3** is a toe-side view of a club head of the invention.

[0018] FIG. **4** gives an alternative view of a club head of the invention.

[0019] FIG. **5** shows a face of a club head of the invention.

[0020] FIG. **6** is a cutaway view down into a heel-side of a club head of the invention.

[0021] FIG. **7** is provides a cutaway view down into a toe-side of a club head of the invention.

[0022] FIG. **8** shows a cutaway view from a heel side.

[0023] FIG. **9** gives another cutaway view.

[0024] FIG. **10**A gives a side cutaway view.

[0025] FIG. **10**B gives a detailed view of a portion of FIG. **10**A.

[0026] FIG. **10**C shows a portion of a section of a sole surface from the view of FIG. **10**A.

[0027] FIG. **10**D gives a close-up view of the surface section shown in FIG. **10**C.

[0028] FIGS. **11** and **12** give additional cutaway views.

DETAILED DESCRIPTION

[0029] The invention provides a golf club head with a structure designed to improve a coefficient of restitution or increase the size of a sweet spot without introducing structural instability into the club head that leads to unpredictable twists and uncontrollable hooking or slicing. Without being bound by any mechanism of action, it is theorized that an elastically deformable groove in a club head can compress non-uniformly during a swing due to torsional stresses introduced during a down-swing (i.e., the club head can squeeze more on one side than the other in a manner similar to the compression of a corridor connection between cars of a passenger train as it rounds a curve). It is possible that the predominantly upright nature of the internal walls of a deformable groove and the narrow connection between them does little to resist non-uniform connection. Accordingly, the invention provides an area of material that is sloped, with respect to the surrounding area of the club head, less than the internal walls of a deformable groove. Specifically, a preferred embodiment includes a groove or slot on the sole that is substantially parallel to the face and that defines at least three surface: two that are opposed, steeply sloped surfaces facing one another, and a third that is gently sloped, providing a transition from the deeper groove to the sole surface. The gently sloped portion allows the deeper groove to still provide its beneficial contribution to sweet spot and coefficient of restitution, but may strongly resist the non-uniform compression and non-uniform momentum transfer to the strike face resulting from torsional stresses of a hard downward swing. A channel area with a gently sloped portion adjacent a deeper groove may be located anywhere on a club head. For example, a channel area may be substantially parallel to a face and extend across a crown or sole (either centered or off-center). In a preferred embodiment, the channel area extends across the sole.

[0030] FIG. **1** shows a club head **101** of the invention. Club head **101** has a sole **103** extending between a heel side portion **115** and a toe side portion **119**. Extending upward form club head **101** is hosel **111**. Club head **101** further includes a channel area **105** extending along an outer surface of sole **103** from the heel portion towards the toe portion. Channel area **105** includes a ramp, or sloped area **107**, defining a shallow slope (when club head **101** is at address) disposed alongside a groove **109**.

[0031] Channel area **105** may be described according to dimension. A length of channel area **105** may be taken to be the distance between heel boundary HB and toe boundary TB. A width W of channel area **105** can be taken to be a distance between a foremost and aft-most part of sloped area **107** and channel **109**. The foremost part of channel area **105** can be described as being spaced away from face **123** by a setback distance S. Sloped area **107** has a ramp width R measured within a horizontal plane when the club is at address and preferably between about 0.1 cm and about 5 cm. Groove **109** can be taken to have a width equal to W−R.

[0032] FIG. **2** is a lower perspective view of club head **101** showing heel side portion **115** and face **123**. As can be seen, sloped area **107** provides a ramp between a foremost portion of sole **103** and deeper groove **109**.

[0033] FIG. **3** give a toe-side view of club head **101** in profile, showing crown **129** and sole **103** extending back from face **123**. Channel area **105** seen in this perspective reveals that sloped area **107** provides a gentle ramp upwards toward groove **109**.

[0034] FIG. **4** shows channel area **105** from an angle, revealing that sloped area **107**, groove **109**, or both may curve around sole **103** from heel side **115** to toe side **119**. Due to the fact that sloped area **107** curves around sole **103** and also slopes upwards at address, a surface of sloped area **107** may contain a portion of an idealized conical surface. The idealized conical surface defines an axis of a cone. The orientation of this axis relates to an ability of sloped area **107** to resist torsional stresses during a stroke. This axis may be substantially parallel to an axis of percussion of the club head. Alternatively, the axis may be parallel to a horizontal axis passing through a geometric center of face when the club head is at address. In fact, the axis may be located near but not precisely on a horizontal axis or an axis of percussion (e.g., anywhere intermediate to those axes). Orienting the curved plane of material provided by sloped area **107** in such a way disposes that material to resist non-uniform compression of club head due to the fact that vectors of torsional stress may lie substantially within or close to that curved plane. Other portions of sole **103** also provide planar areas of material that contain vectors of torsional stress. However, during the down stroke of a golf swing (FIG. **3** is useful for visualizing club head **101** in motion shortly before it reaches a ball), predominating vectors of torsional stresses on club head **101** may be oblique

to planes of material provided by sole **103**. In some embodiments, the invention provides a club head with a channel and any area of material disposed substantially along a flat or curved plane and adjacent the channel in which the area of material is inclined with respect to a predominant portion of the sole at an angle <180°. Preferably, this ramp is disposed between the sole and the channel and forms an angle with the sole (or with the horizontal when the club head is at address) that is between about 1° and about 80°. In fact, it may be found that the angle should most preferably be between about 5° and about 25°. Additionally, it may be preferable that the channel include at least one interior wall that is disposed more steeply than the ramp (e.g., between about 30° and about 60° with respect to the sole or the horizontal when the club head is at address). Preferably, channel area **105** extends substantially parallel to face area **123** and behind a sweet spot of the striking face.

[0035] FIG. **5** shows face of 123 of club head **101** with hosel **111** extending upwards at heel side portion **115** opposite from toe side portion **119**. Channel area **105** (not visible in FIG. **5**) extends along sole **103** from heel boundary HB to toe boundary TB. Boundaries HB and TB may be symmetrically disposed around a geometric center of face, disposed symmetrically around a club head center of gravity, or disposed asymmetrically.

[0036] In certain embodiments, including a channel area **105** on an outer surface of sole **103** will create a rib-like structure on an inside surface of sole **103**. In particular, groove **109** having the form of a narrow furrow adjacent the inclined surface **107** may protrude upwards on an inside of sole **103**.

[0037] FIG. **6** is a cutaway view showing an inside of heel portion **115** of club head **101**. The narrow furrow of groove **109** is visible inside of the sole **103** as a ridge along the inside of the club head.

[0038] FIG. **7** is provides a cutaway view down into toe portion **119** showing a toe-side terminus of the ridge corresponding to narrow furrow **109**. Extending along the face-most side of the ridge is a gently sloped portion (not visible in FIGS. **6** and **7**).

[0039] FIG. **8** gives a cutaway side view of club head **101** making visible the gently sloped portion that provides an inclined surface **107** transitioning from a downward-facing portion of the sole surface **103** to a narrow furrow **109** in the sole.

[0040] FIG. **9** gives another cutaway view. As can be seen in FIGS. **8** and **9**, club head **101** also includes crown **129** and face **123**, which cooperate with sole **103**, heel portion **115** and toe portion **119** to define a club head body. Channel area **105** may be included in any style of club head including one or more of a putter, a wedge, an iron, a hybrid, a fairway wood, a driver (either hollow or solid wood type). Due to the high speed drives or other fairway strokes and the nature of material compression, it may be preferable to include a channel area **105** in a hollow club head **101** such as a driver, fairway wood, or hybrid. In certain embodiments, crown **129**, sole **103**, heel portion **115**, toe portion **119**, and face **123** cooperate to define a hollow, enclosed club head body having hosel **111** extending upwards therefrom. Sole **103** includes channel area **105**, which may be described as having an inclined surface **107** transitioning from a downward-facing portion of a surface of sole **103** to a narrow furrow or groove **109** into sole **103**. It may be most preferable to include channel area **105** in a hollow, enclosed club head such as a driver to dampen and inhibit the adverse torsional strains that would otherwise result from torsional stresses in high-speed swings such as drives.

[0041] Channel area **105** may be described with respect to a section (i.e., a drawing of club head **101**, sole **103**, or channel area **105** as it would appear if cut straight through in a given plane).

[0042] FIG. **10**A is a section of club head **101** where the sectional plane is a plane that is vertical when club head **101** is at address and passes substantially through a center of club head **101**. Club head **101** includes channel area **105** shown in a box drawn on FIG. **10**A.

[0043] FIG. **10**B is a section through the area of channel area **105** that is enclosed by the box drawn on FIG. **10**A. Channel area **105** includes a gently inclined portion **107** forming a first angle with the horizontal alongside a channel **109** that has a steeply inclined portion forming a second angle with the horizontal. If club head **101** were held at address resting on flat, planar ground, the highest point within the open space of channel area **105** defines a depth D of a channel in sole **103**. The gently inclined portion **107** has a ramp width R extending from the face-most point of the inclined portion **107** to the transition from the inclined portion **107** to the channel **109**. The gently inclined portion **107** and the channel **109** may provide surfaces that can be described with reference to the horizontal when the club head is at address.

[0044] FIG. **10**C is a detail view of a section of a surface of sole **103**. Gently inclined portion **107** substantially extends along a line L that lies within the section (i.e., lies within the plane of the page of FIG. **10**C). The horizontal defines a line K within the section. Channel **109** preferably contains at least two oppose and inward-facing walls. An aft-facing wall substantially meets a line M that lies within the section. A fore-facing wall substantially meets a line N that lies within the section. A predominant portion of sole **103** just forward of channel area **105** lies along line J that lies within the section. Lines J, K, L, M, and N as well as depth D, ramp distance R, channel area width W and setback S provide references for describing aspects of channel area **105**.

[0045] FIG. **10**D gives a close-up view of the surface section shown in FIG. **10**C. Gently inclined portion **107** may form an angle θ_{JK} with a predominant portion of sole **103** just forward of channel area **105**. It may be preferable that θ_{JK} is between about 10° and about 25° to optimize bounce angle. Gently inclined portion **107** may form an angle θ_{KL} with the horizontal. It may be preferable that θ_{KL} is between about 5° and about 20° to optimize torsional rigidity. An aft-facing wall of channel **109** may form an angle θ_{KM} with the horizontal. It may be preferable that θ_{KM} is between about 30° and about 60° to optimize the contribution of the steeply inclined portion of channel **109** to a coefficient of restitution of face **123**.

[0046] One significant improvement over prior art structures may be provided by a channel that has two adjacent wall portions, a first with a shallow slope angle θ_{KL} and a second with a steeper slope angle θ_{KM}. Particularly in cooperation with sole **103**, these areas lying substantially within a plane or a curved plane may add planar material that resists stress in a plurality of different vectors. It may be found that the shallow slope angle θ_{KL} should be between about 1° and about 20° and that the steep slope angle θ_{KM} should be between about 20° and about 70°. Additionally, those portions are described here as defining angles, but they need not be surfaces that extend strictly within planes. Gently curved or rolled surfaces are

included within the scope of the invention as are areas in which the gently inclined portion **107** curves continually into the steeply inclined portion. In certain aspects, the invention provides a club head in which a cross-sectional profile of a portion of a channel area **105** has, when the club head is at address, a gently inclined portion **107** disposed at an angle to the horizontal and a steeply inclined portion disposed at a second angle to the horizontal and in which the gently and steeply inclined portions are each and all substantially curved forming a continually curving cross sectional profile.

[0047] Golf club heads of the invention can be made by methods and materials known in the art.

[0048] FIGS. **11** and **12** show club head **101** having a body that provides a hollow, enclosed shell. Club head **101** can include metals, plastics, other materials, or a combination thereof. Materials can include titanium, aluminum, other metals, alloys thereof, any plastic or thermoplastic, laminate, or prepreg, carbon fiber, extruded materials, or combinations thereof. Panels of the walls can have layered or sandwiched constructions. Components can be formed by casting, stamping, forging, molding, co-molding, machining, milling, CNC manufacturing, hand-forming, other methods, or combinations thereof. Club head **101** may include other useful features such as weight members, inserts, structural ribs, construction seams, connection hardware, etc. Components may be assembled by adhesives, welding, mechanical fasteners, co-molding, other methods, or combinations thereof.

[0049] Construction of club head **101** may be via known methods. U.S. Pat. No. 7,294,064; U.S. Pat. No. 8,529,368 to Rice; U.S. Pat. No. 7,582,024 to Shear; U.S. Pat. No. 7,572,193 to Yokota; U.S. Pat. No. 7,500,924 to Yokota; U.S. Pat. No. 7,396,293 to Soracco; U.S. Pat. No. 6,887,165 U.S. Pat. No. 5,735,754 to Antonious; U.S. Pat. No. 5,603,668 to Antonious; U.S. Pat. No. 1,835,718 to Morton; U.S. Pub. 2013/0029779 to Stites; U.S. Pub. 2012/0143452 to Burnet; U.S. Pub. 2012/0142447 to Boyd; U.S. Pub. 2012/0196703 to Sander; U.S. Pub. 2012/0244960 to Tang; U.S. Pub. 2012/0220387 to Beach; U.S. Pub. 2007/0117648 to Yokota; U.S. Pub. 2007/0026961 to Hou; U.S. Pub. 2004/0192463 to Ando; and U.S. Pub. 2002/0183134 to Allen show features and constructions that may be modified for incorporation in a club head of the invention and the content of each of those references is incorporated by reference for all purposes.

[0050] As used herein, the word "or" means "and or or", sometimes seen or referred to as "and/or", unless indicated otherwise.

INCORPORATION BY REFERENCE

[0051] References and citations to other documents, such as patents, patent applications, patent publications, journals, books, papers, web contents, have been made throughout this disclosure. All such documents are hereby incorporated herein by reference in their entirety for all purposes.

EQUIVALENTS

[0052] Various modifications of the invention and many further embodiments thereof, in addition to those shown and described herein, will become apparent to those skilled in the art from the full contents of this document, including references to the scientific and patent literature cited herein. The subject matter herein contains important information, exemplification and guidance that can be adapted to the practice of this invention in its various embodiments and equivalents thereof.

What is claimed is:

1. A golf club head comprising:
- a crown, sole, heel portion, toe portion, and face cooperating to define a club head body;
- a hosel extending upwards from the body; and
- a channel extending along an outer surface of the sole from the heel portion towards the toe portion, the channel comprising a groove disposed alongside a ramp with a surface that is sloped with respect to the horizontal when the club head is at address.

2. The club head of claim **1**, wherein the club head is a hollow club head.

3. The club head of claim **1**, wherein the club head is a driver-style club head.

4. The club head of claim **1**, wherein the groove comprises a fore facing inward wall and an aft-facing inward wall.

5. The golf club of claim **4**, wherein the aft-facing inward wall is sloped more steeply than the surface of the ramp with respect to the horizontal when the club head is at address.

6. The golf club of claim **5**, wherein the surface of the ramp is sloped at an angle between 5° and 20° and the aft-facing inward wall is sloped at an angle between 20° and 80°, with respect to the horizontal when the club head is at address.

7. The golf club of claim **5**, wherein the surface of the ramp is sloped at an angle between 10° and 20° and the aft-facing inward wall is sloped at an angle between 30° and 60°, with respect to the horizontal when the club head is at address.

8. The golf club of claim **7**, wherein a heel-toe length of the channel is between about 5 cm and about 15 cm and a face-aft width of the channel is between about 0.2 cm and about 3 cm.

9. The golf club of claim **8**, wherein a face-aft width of the ramp is between about 0.1 cm and about 1.5 cm.

10. A golf club head comprising:
- a crown, sole, heel portion, toe portion, and face cooperating to define a club head body;
- a hosel extending upwards from the body; and
- an inclined surface transitioning from a downward-facing portion of the sole surface to a narrow furrow in the sole.

11. The club head of claim **10**, wherein the inclined surface extends along substantially an entirety of the furrow.

12. The club head of claim **10**, wherein a portion of the inclined surface defines an idealized conical surface comprising a conical axis extending parallel to an axis of percussion of the club head.

13. The club head of claim **10**, wherein a portion of the inclined surface defines an idealized conical surface comprising a conical axis extending parallel to a horizontal axis passing through a geometric center of the face when the club head is at address.

14. A golf club head comprising:
- a crown, sole, heel portion, toe portion, and face cooperating to define a club head body;
- a hosel extending upwards from the body; and
- a channel extending across the sole defining a cross-sectional profile with, when the club head is at address, a gently inclined portion forming a first angle with the horizontal and a steeply inclined portion forming a second angle with the horizontal.

15. The club head of claim **14**, wherein the first angle is between 5° and 20° and the second angle is between 20° and 80°.

16. The club head of claim **14**, wherein the gently inclined portion and the steeply inclined portion extend for a distance across the sole substantially in a heel-toe direction.

17. The club head of claim **16**, wherein the channel is substantially parallel to the face and spaced away from the face by at least a setback distance over a majority of a length of the channel, wherein the setback distance is between about 1 cm and about 5 cm.

18. The club head of claim **17**, wherein the gently inclined portion is disposed between the face and the groove.

19. The club head of claim **18**, wherein the channel comprises a depth, with respect to a predominant surface of the sole, between about 5 mm and about 10 mm.

20. The club head of claim **19**, wherein the club head is a hollow driver-type club head.

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