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(54) **GOLF CLUB WITH VERTICALLY
ADJUSTABLE CENTER OF GRAVITY**

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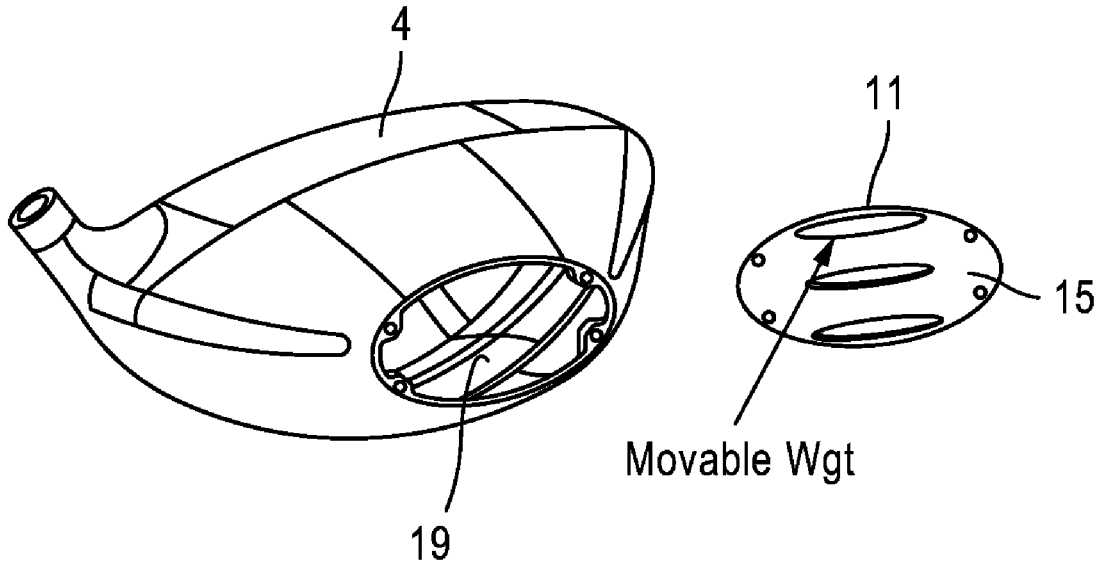
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(57) **ABSTRACT**

The invention generally relates to golf clubs with adjustable mass properties. In certain aspects, the invention provides methods and mechanisms for adjusting a club head center of gravity in a vertical direction. Changing a center of gravity in the vertical direction can be done without substantially changing the center of a gravity in other directions.

(22) Filed: **Jun. 3, 2013**



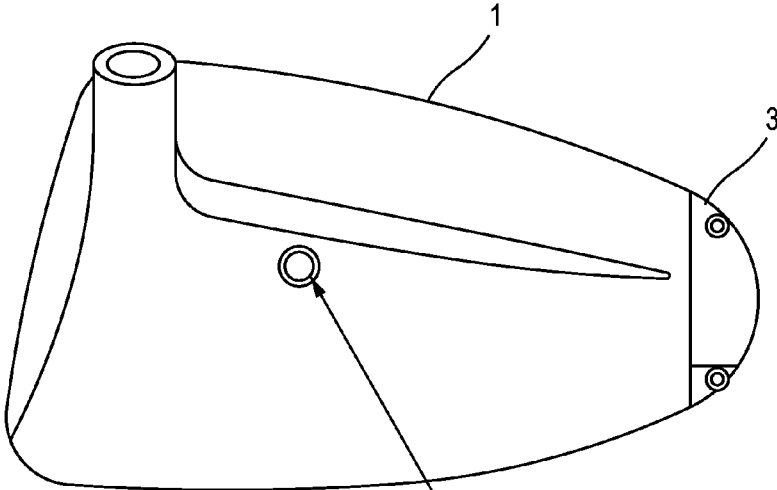


FIG. 1

Approx. CG of Baseline

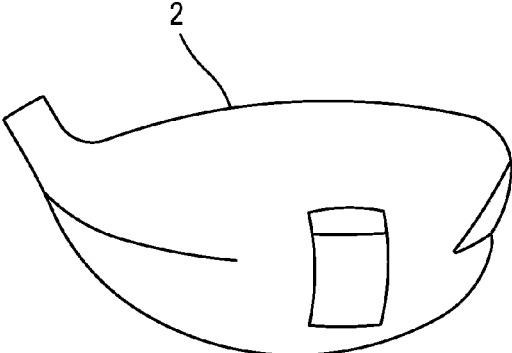


FIG. 2A

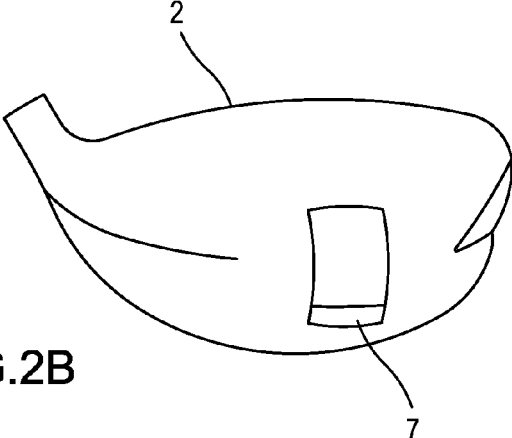


FIG. 2B

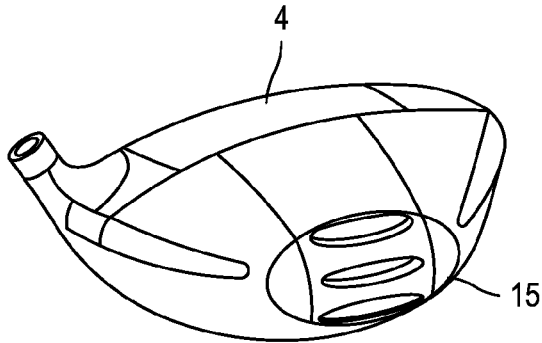


FIG. 3

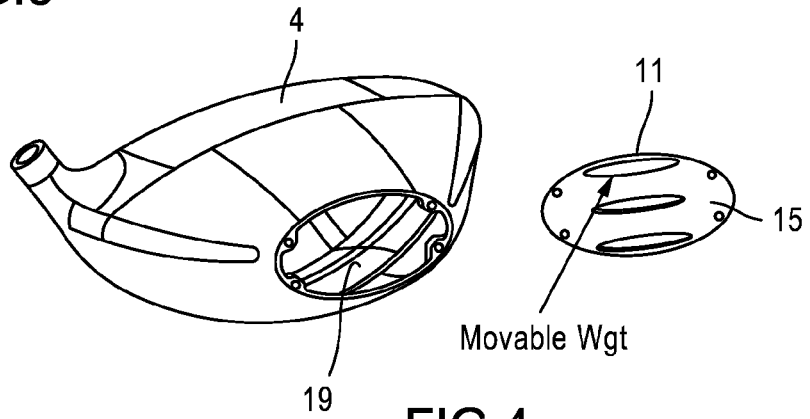


FIG. 4

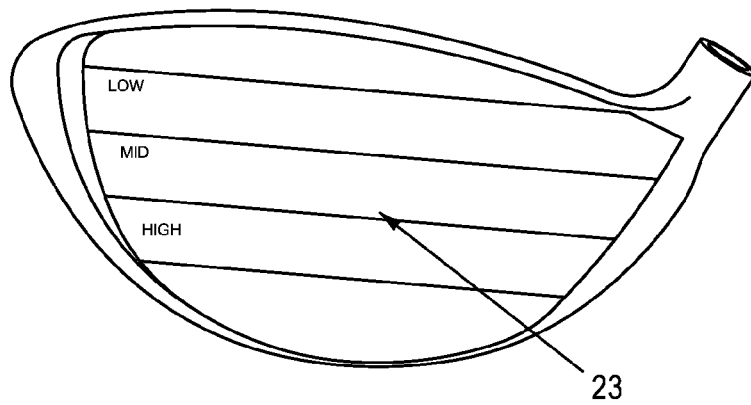


FIG. 5

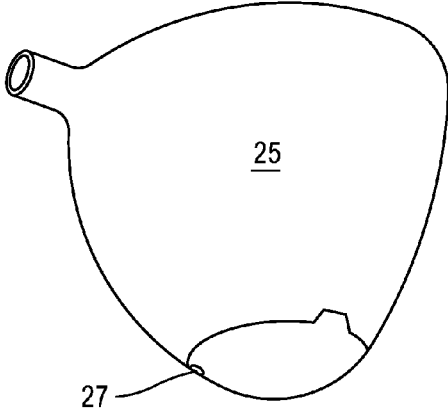


FIG. 6A

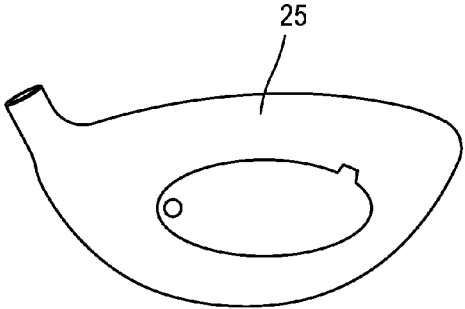


FIG. 6B

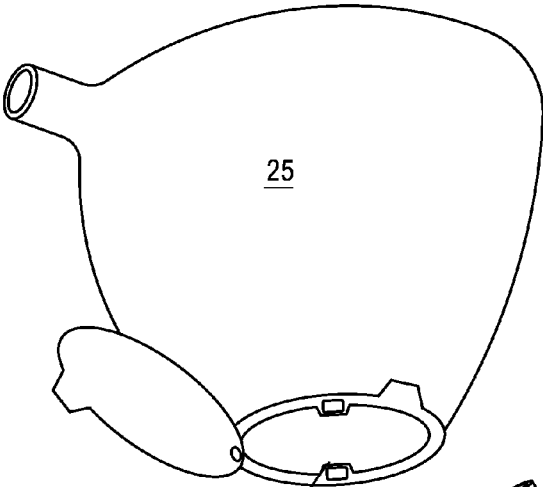


FIG. 7A

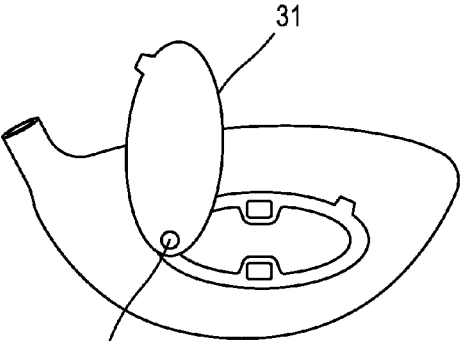


FIG. 7B

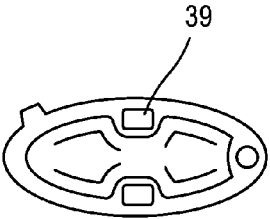
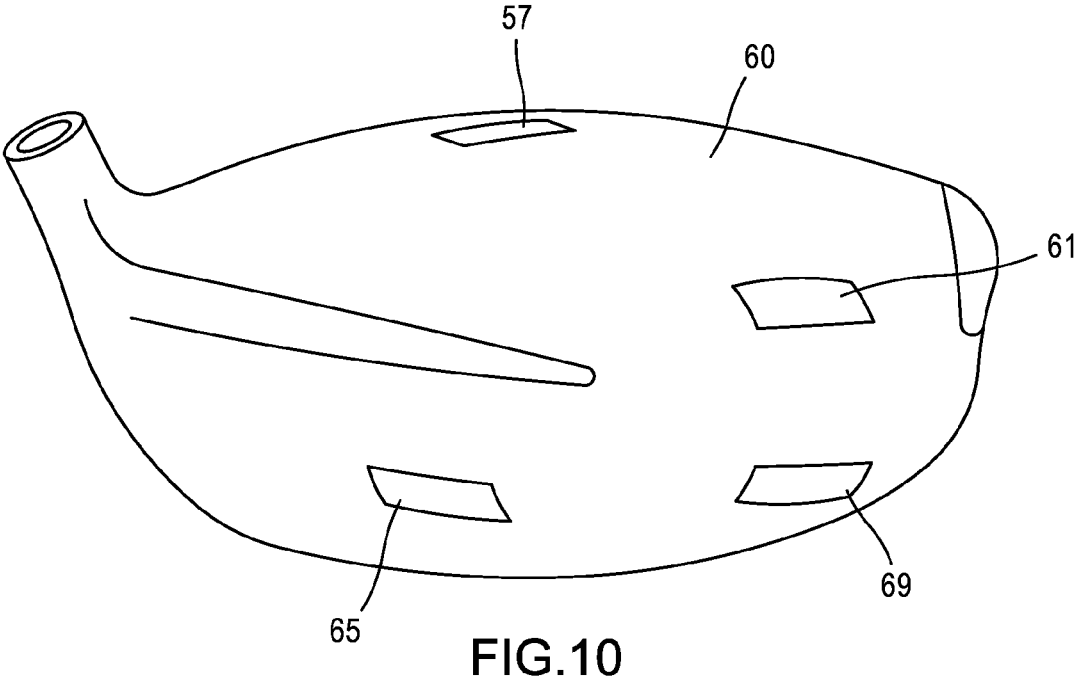
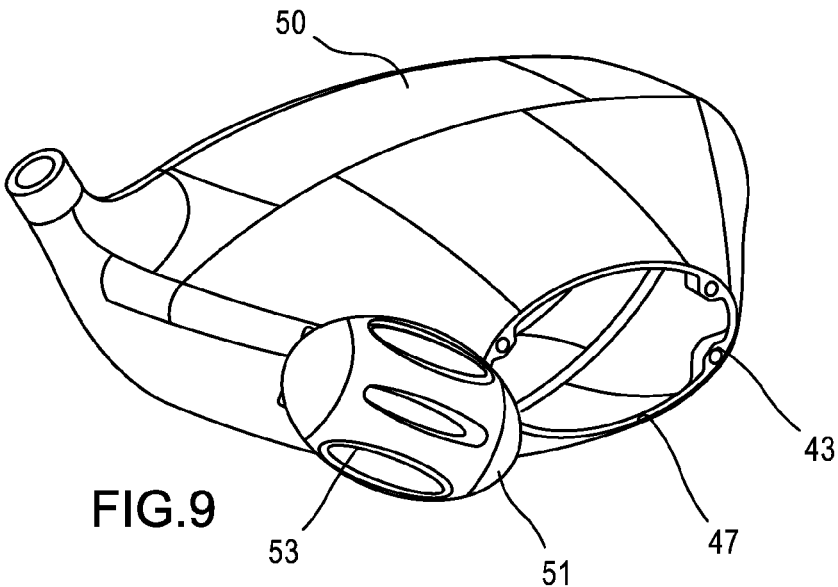


FIG. 8



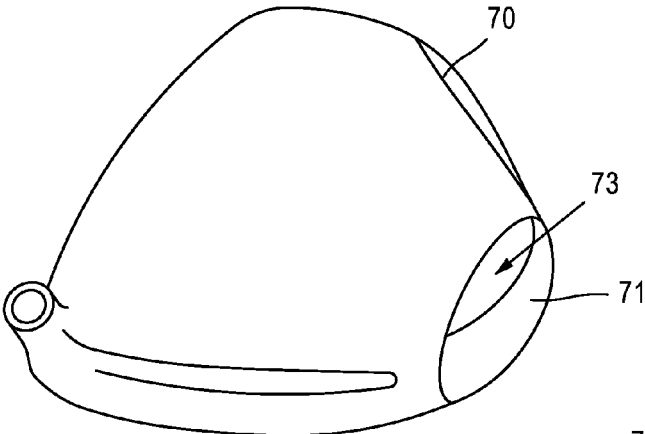


FIG. 11A

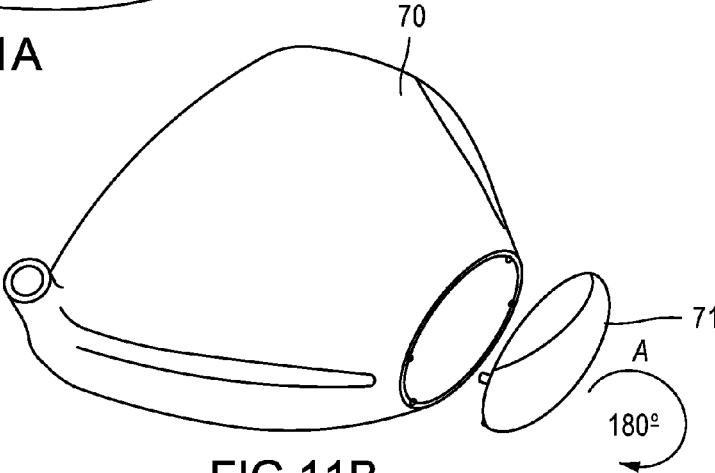


FIG. 11B

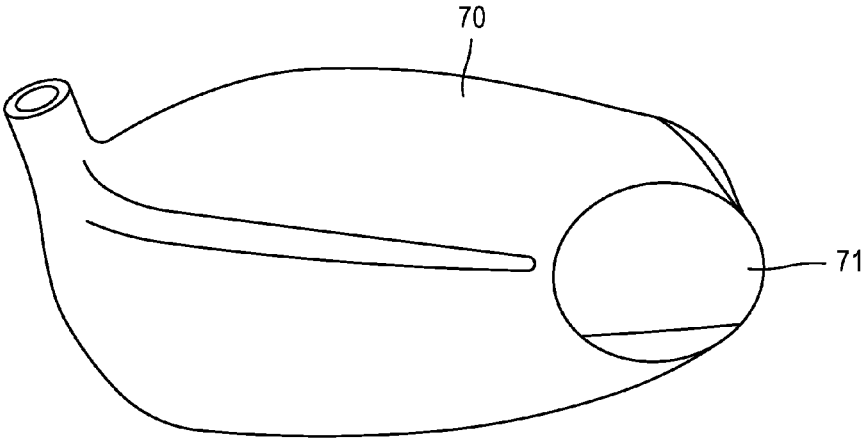
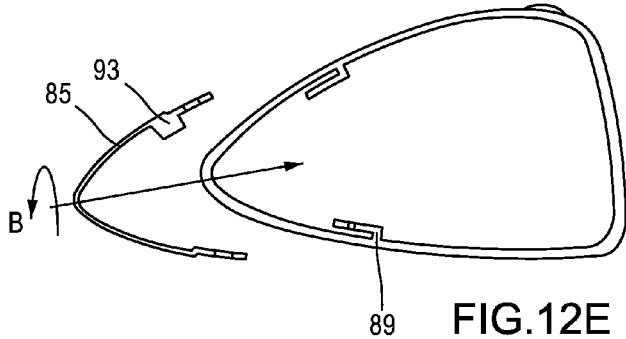
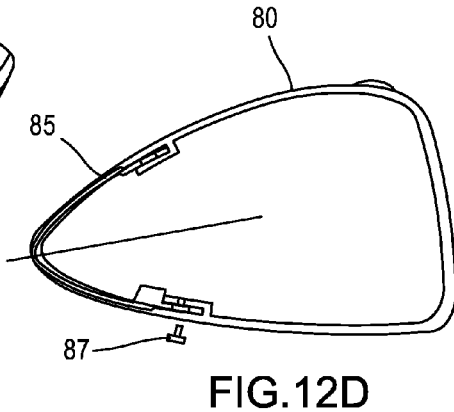
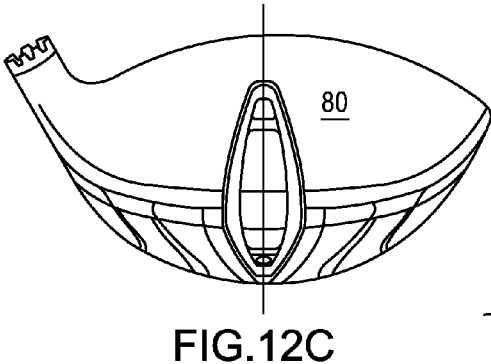
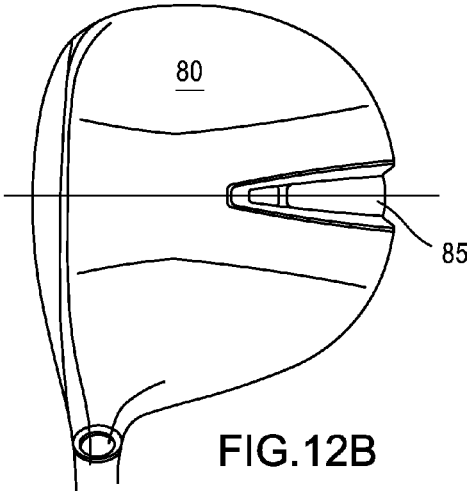
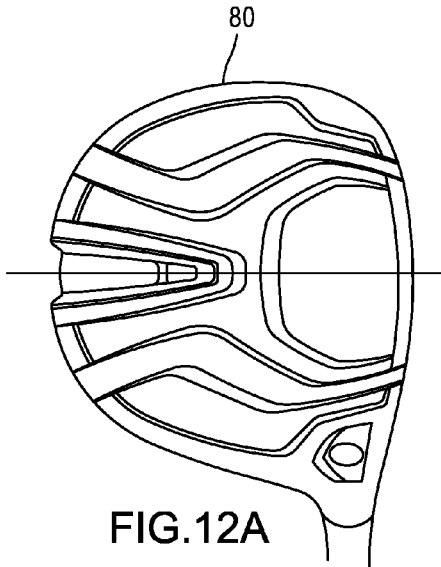


FIG. 11C



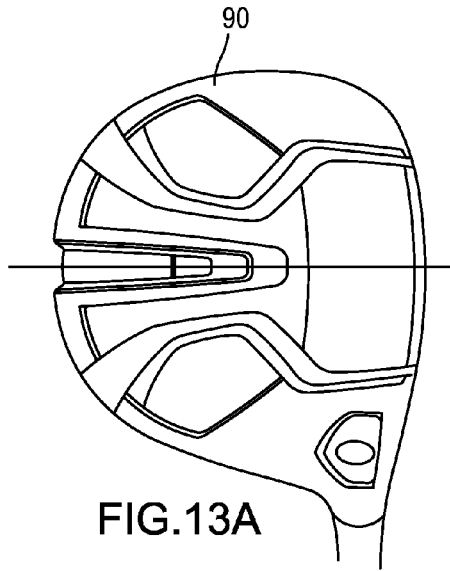


FIG. 13A

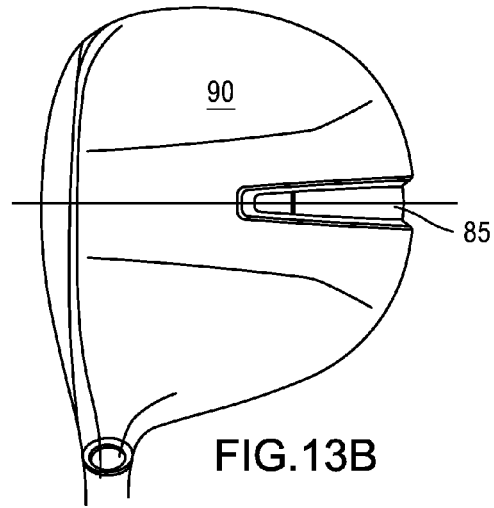


FIG. 13B

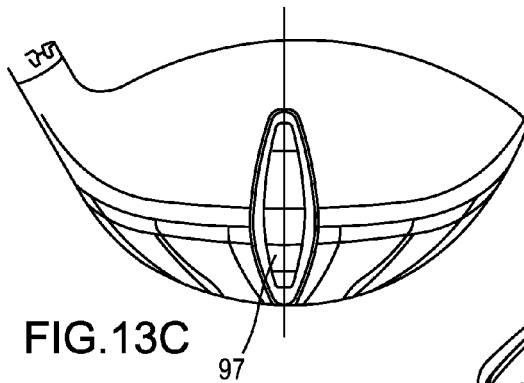


FIG. 13C

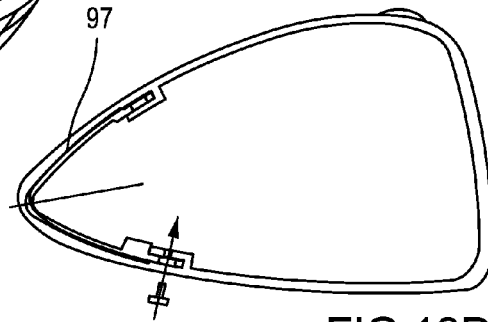


FIG. 13D

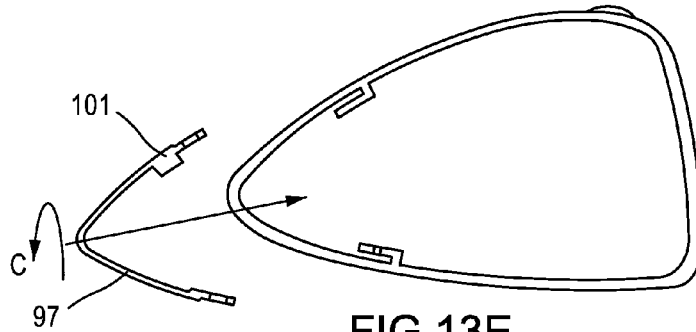
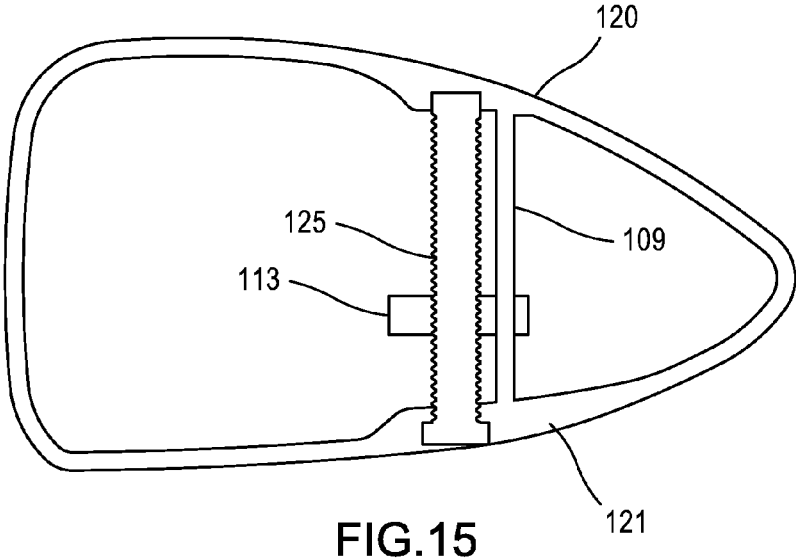
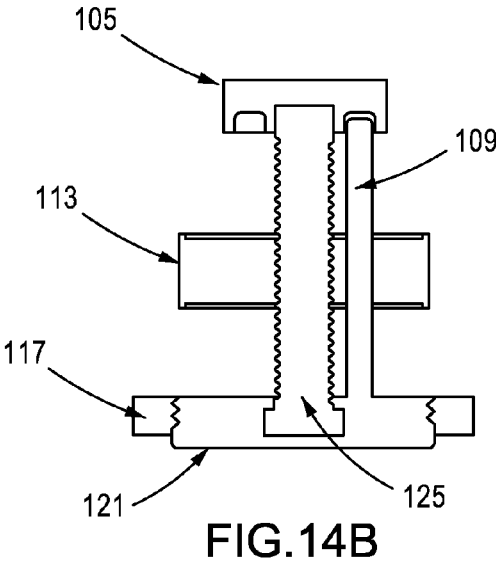
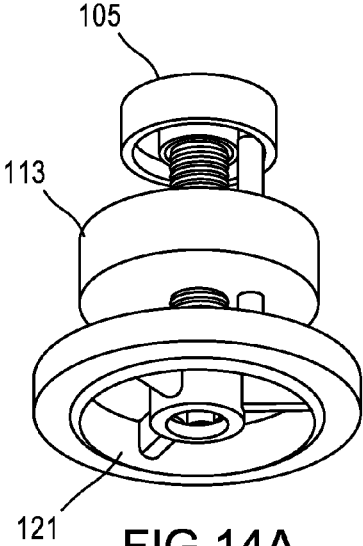


FIG. 13E



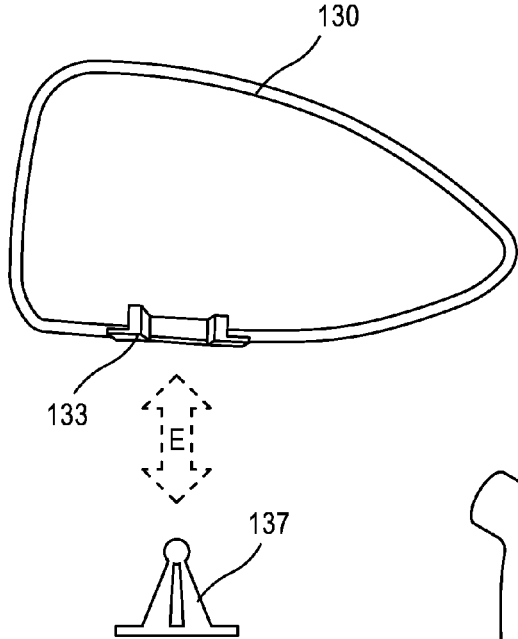


FIG. 16

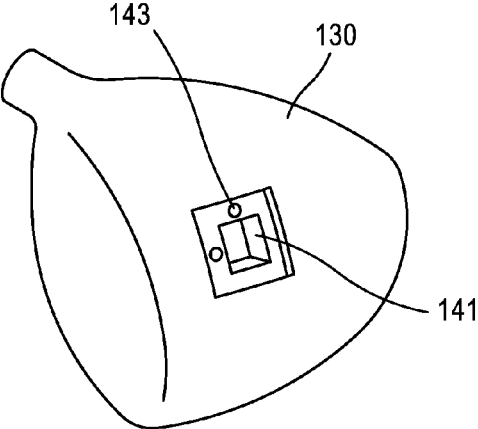


FIG. 17

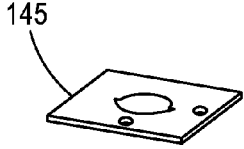


FIG. 18

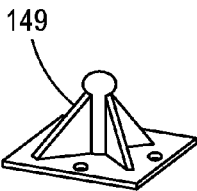


FIG. 19

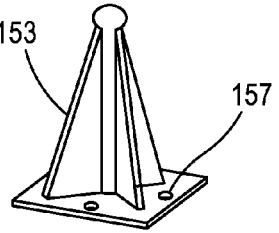


FIG. 20

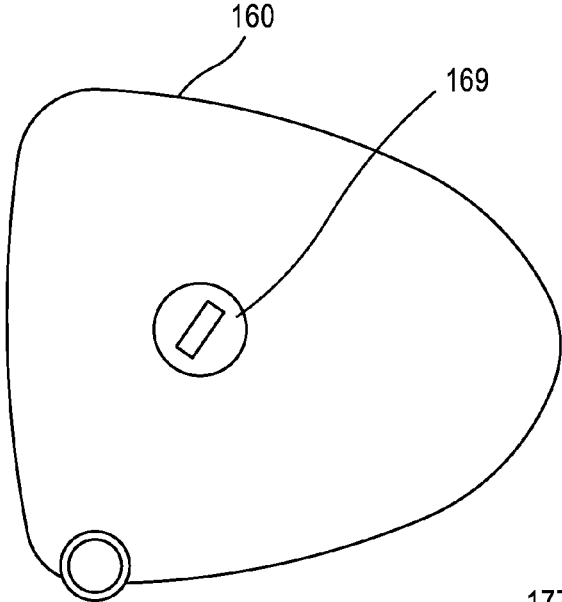


FIG. 21

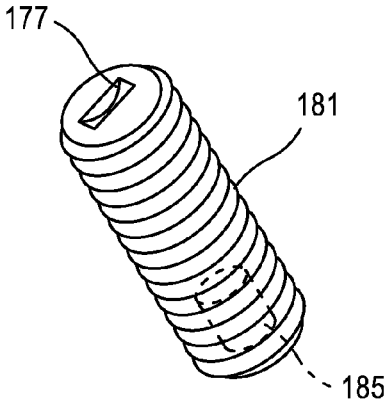


FIG. 22

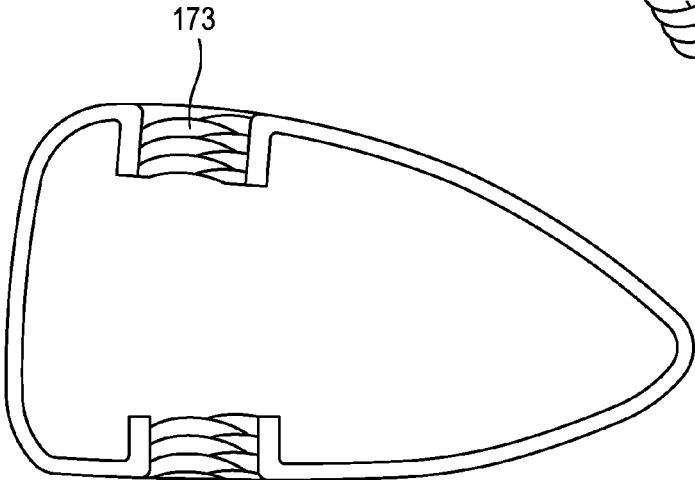


FIG. 23

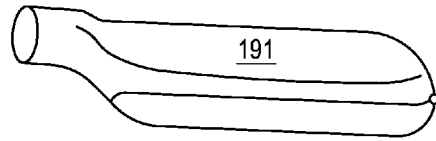


FIG. 24B

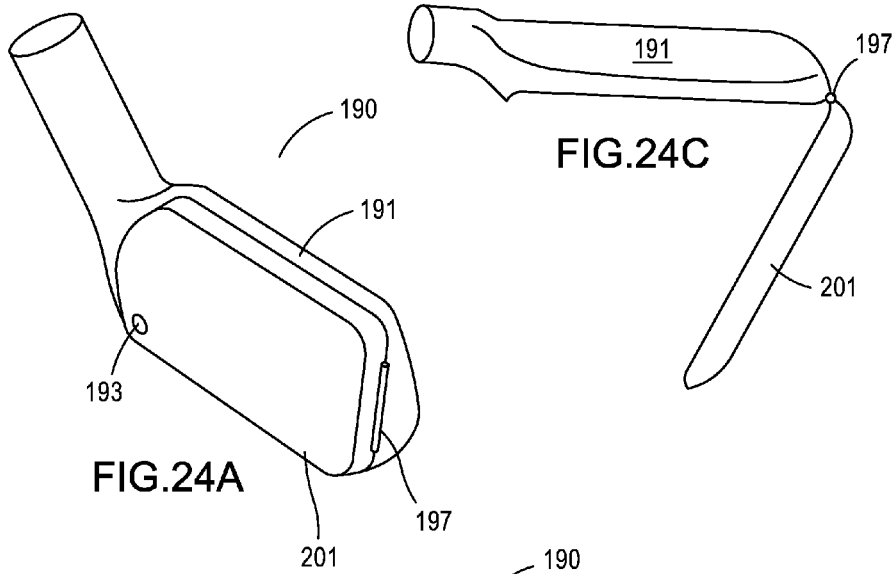


FIG. 24A

FIG. 24C

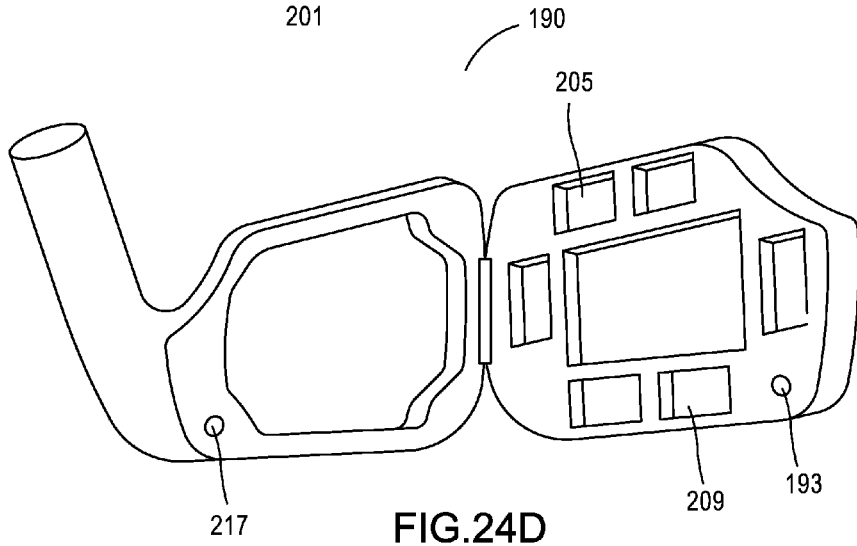


FIG. 24D

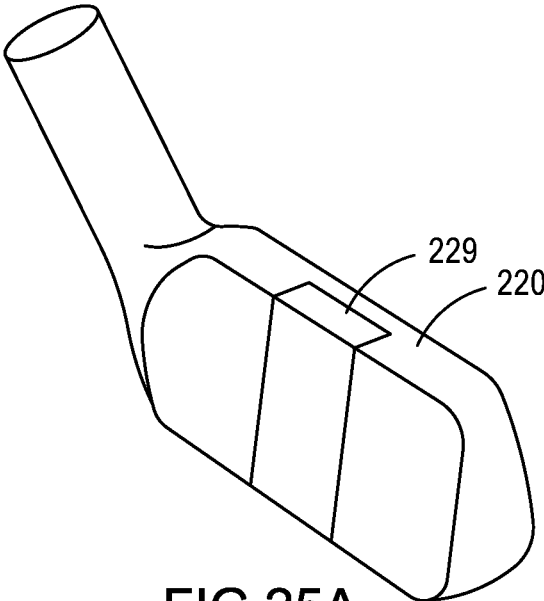


FIG. 25A

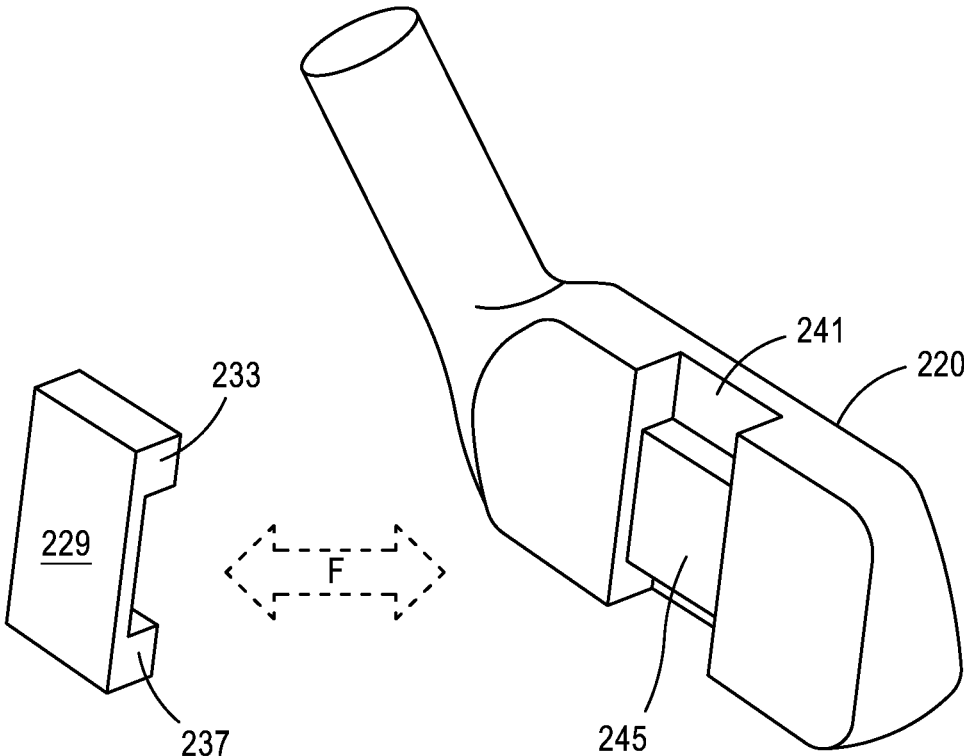


FIG. 25B

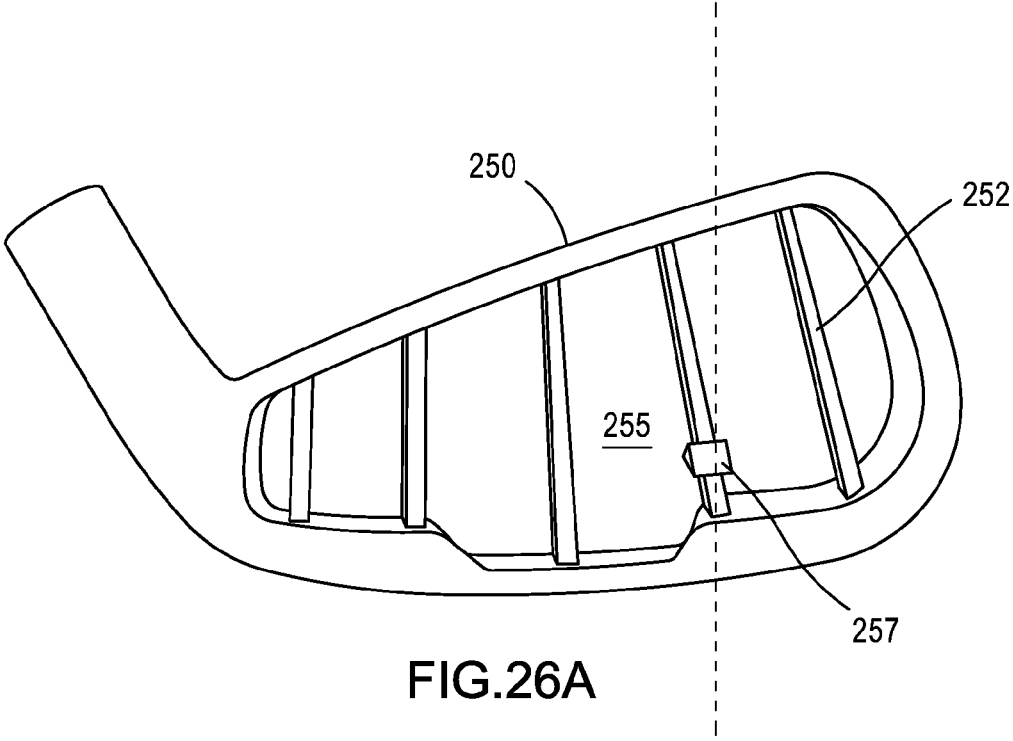


FIG. 26A

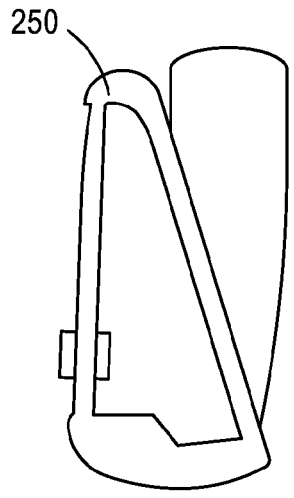


FIG. 26B

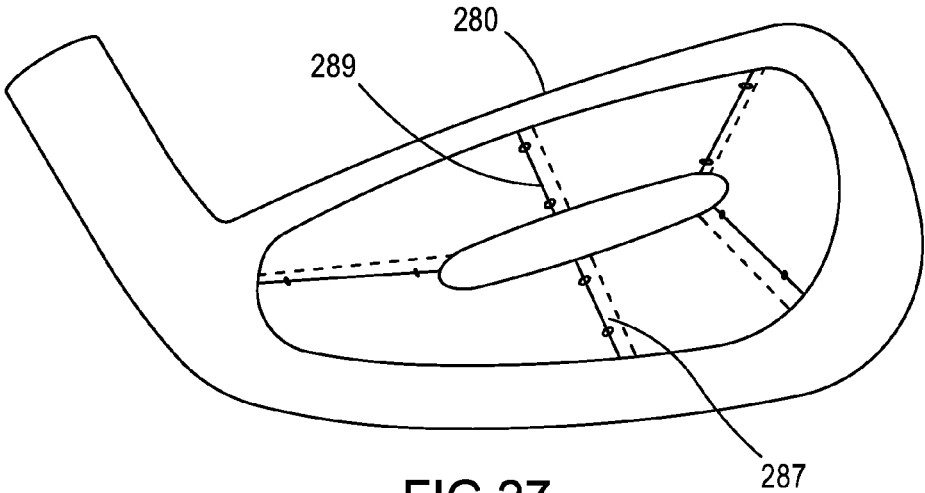


FIG.27

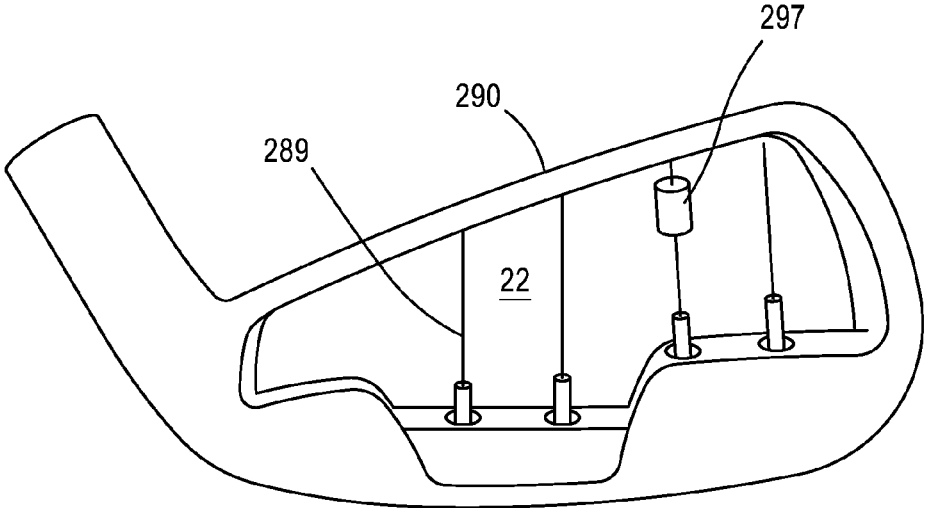


FIG.28

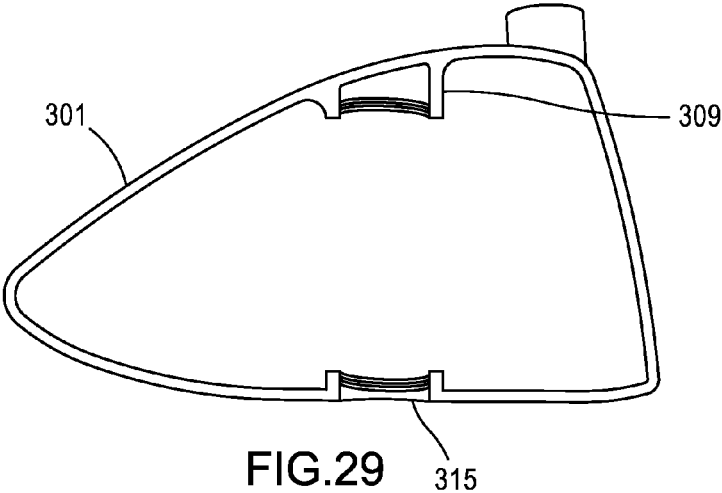


FIG.29

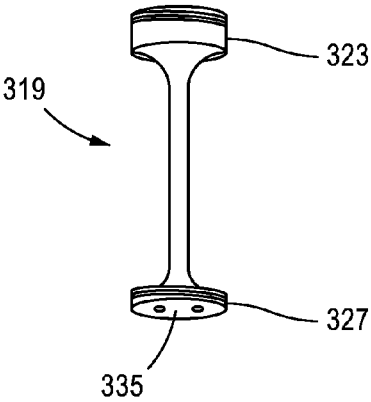


FIG.30

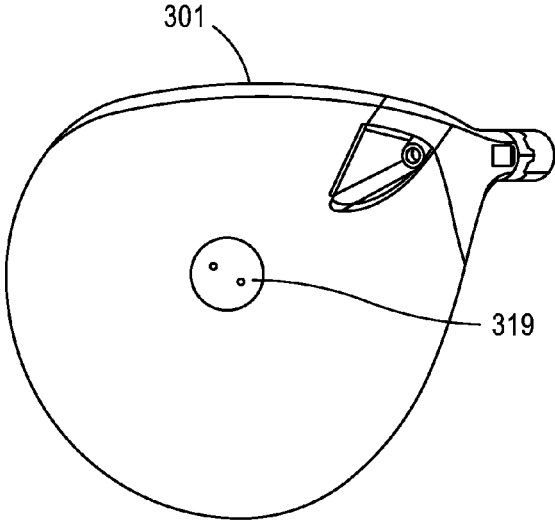


FIG.31

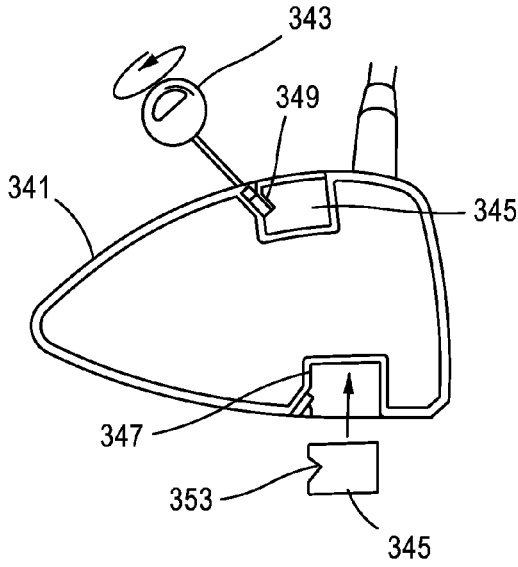


FIG.32

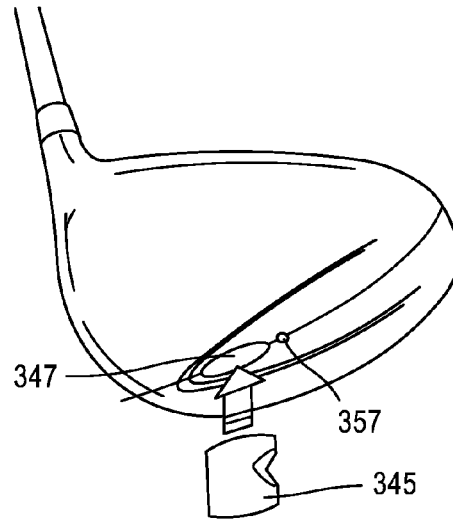


FIG.33

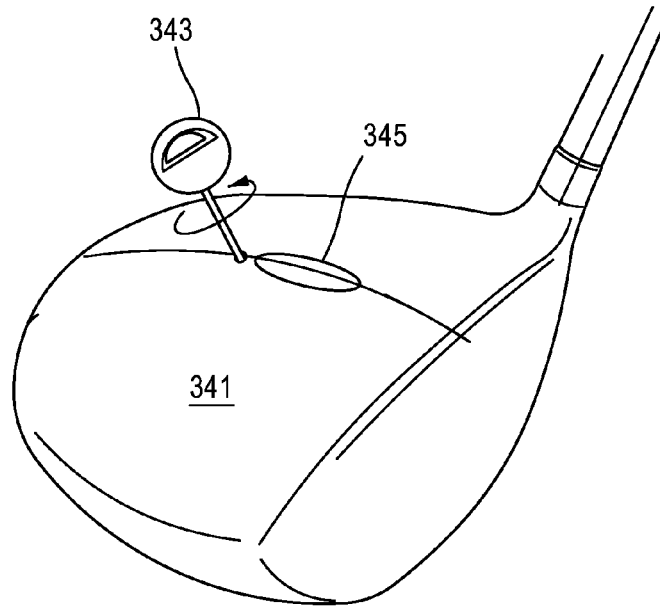


FIG.34

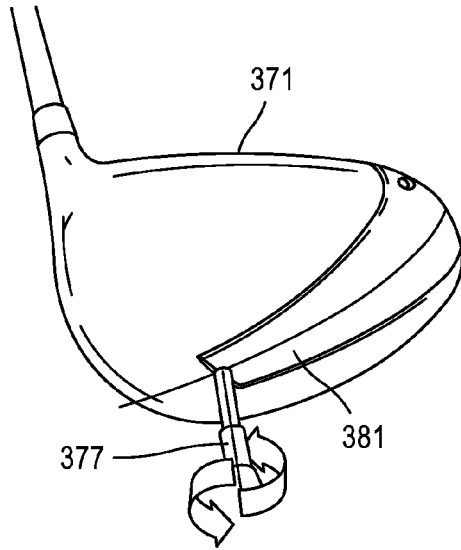


FIG. 35

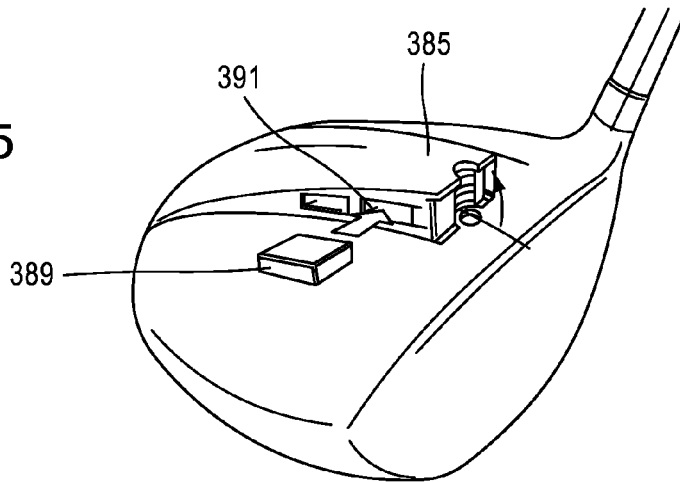


FIG. 36

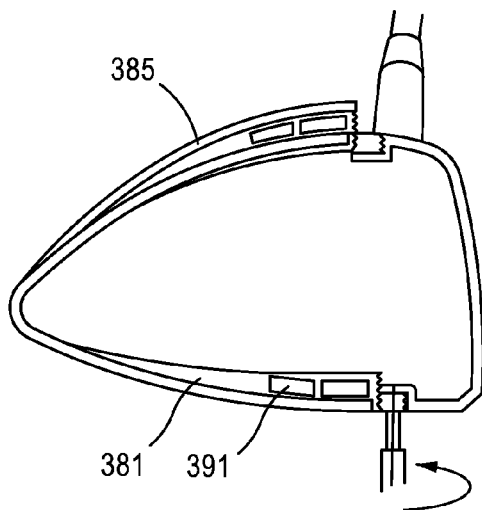


FIG. 37

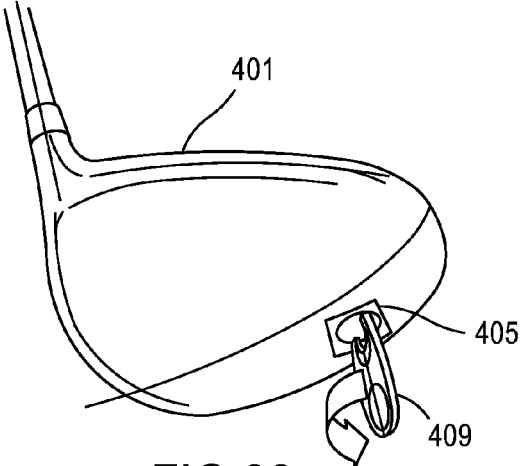


FIG.38

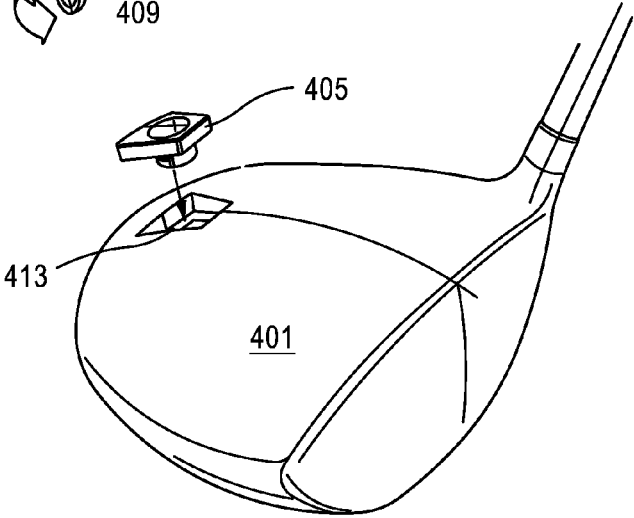


FIG.39

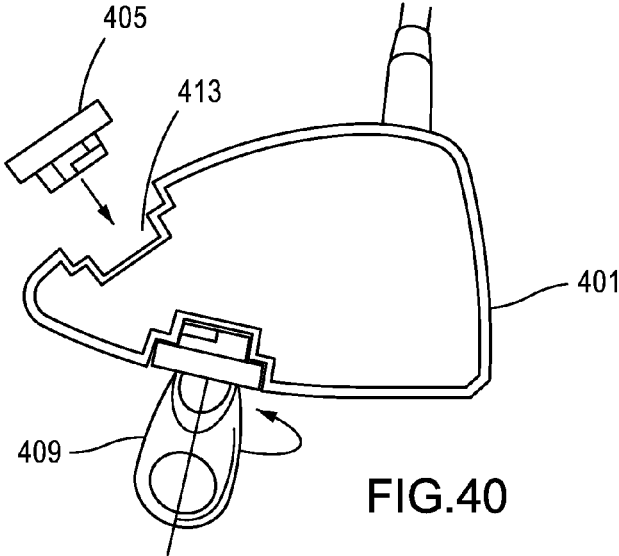
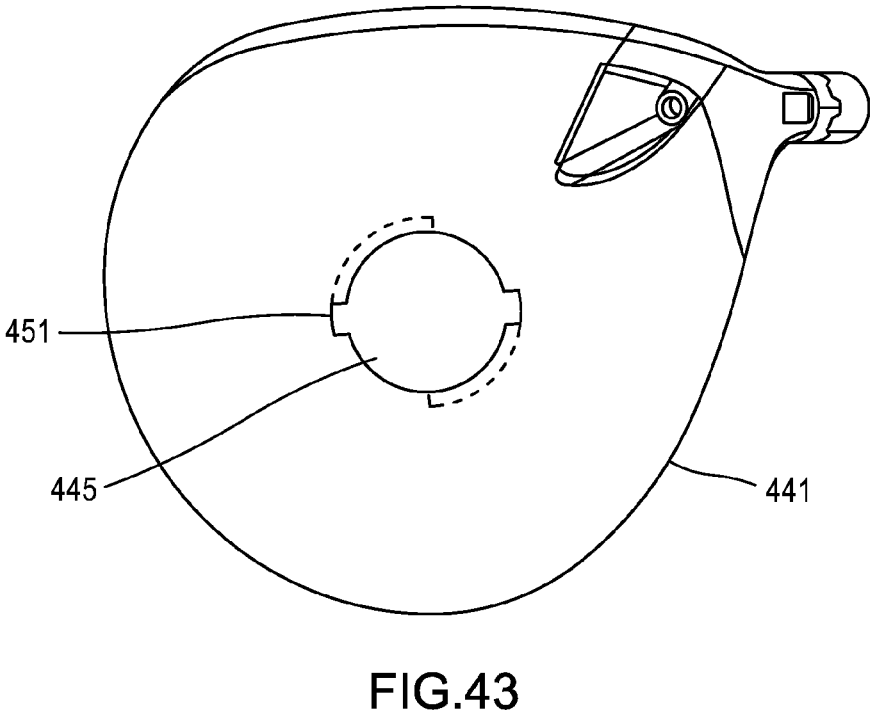
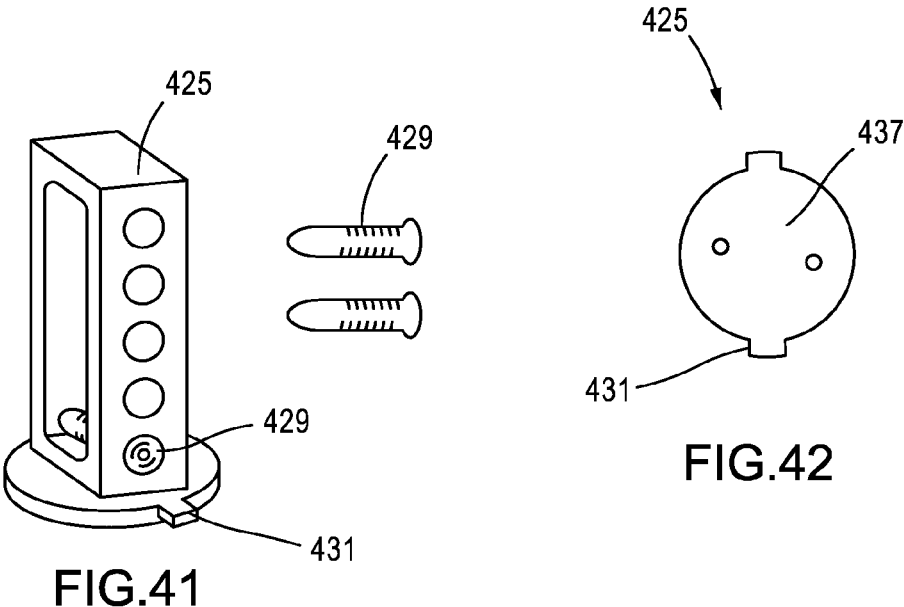


FIG.40



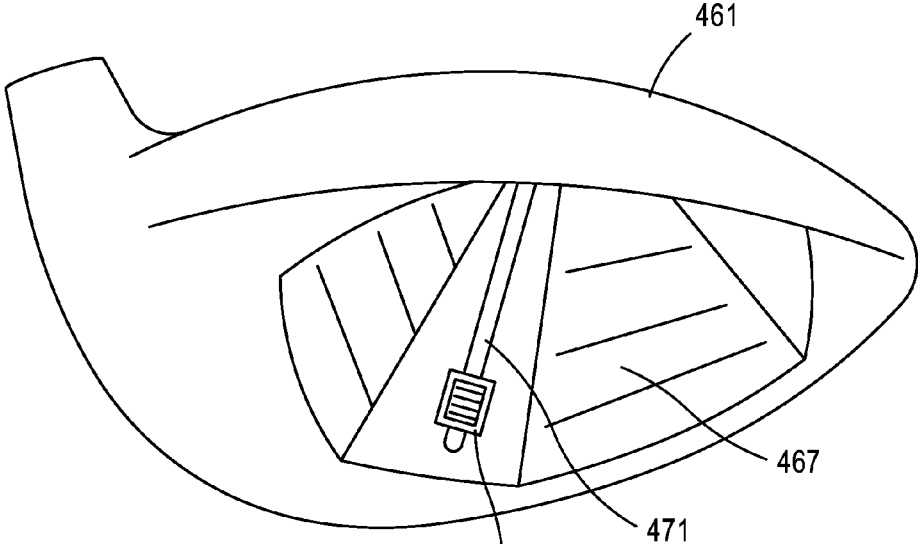


FIG. 44

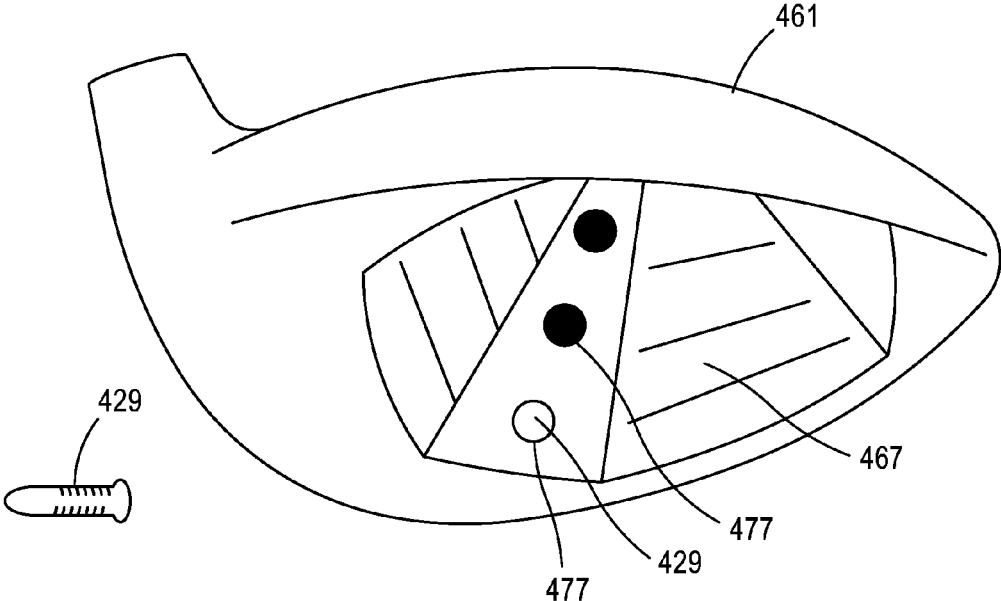


FIG. 45

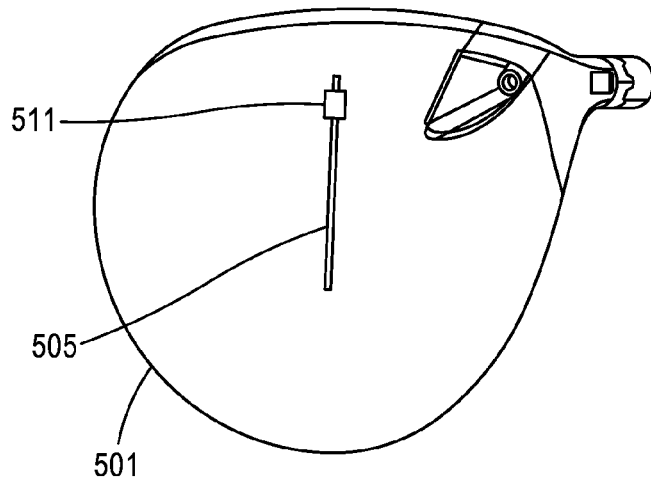


FIG.46

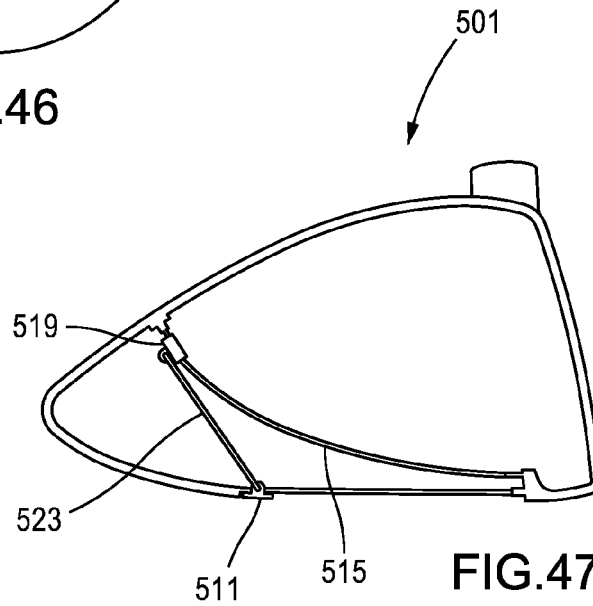


FIG.47

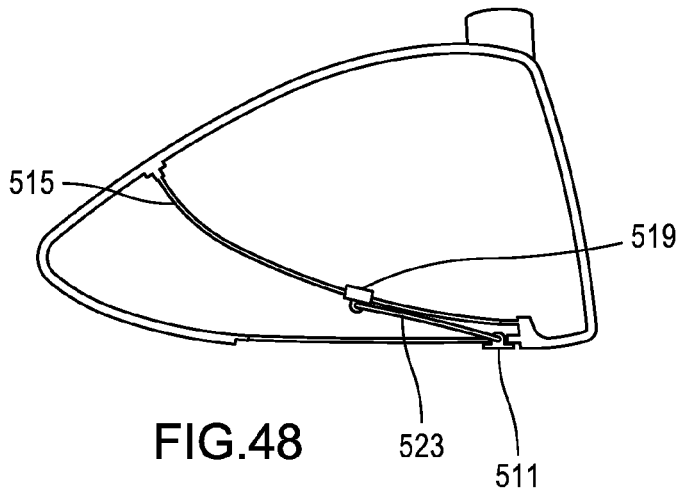


FIG.48

GOLF CLUB WITH VERTICALLY ADJUSTABLE CENTER OF GRAVITY

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a non-provisional of 61/655,669 filed Jun. 5, 2012, the contents of which are incorporated by reference.

FIELD OF THE INVENTION

[0002] The invention generally relates to golf clubs with adjustable mass properties.

BACKGROUND

[0003] When a golfer hits a golf ball, he would like for the ball to go a great distance. The total distance the ball travels is influenced by initial conditions such as ball speed, launch angle, and spin. Every golfer hits uniquely, and to get the best distance, each golfer must strive for that combination of launch angle, ball speed, and spin that produces the greatest carry distance. A golfer can influence those initial conditions by changing their club head speed, their stroke, or their golf club. For example, all other things being equal, using a golf club with a higher loft will produce a higher launch angle.

[0004] Unfortunately, changing a golf club to optimize one of those initial conditions can compromise others. For example, a golfer who starts using a driver with a certain loft to obtain just the right launch angle may find that their ball launches with too much spin. Changing the loft angle to control the spin then compromises the launch angle. As such, the golfer may have to settle for a loft angle that reflects a least-objectionable compromise in which neither the launch angle nor the spin is wrong, but neither is just right.

SUMMARY

[0005] The invention provides a golf club head with a mechanism that can be operated to adjust a height of a club head center of gravity, allowing initial conditions such as spin and launch angle to be adjusted independently of one another. A golfer can have a club head with a loft angle that optimizes spin and then can raise or lower the center of gravity of the club head to decrease or increase, respectively, the launch angle. A club head in which the location of the center of gravity can be adjusted in a direction with a component that is vertical when the club head is at address may uncouple spin and launch angle. Since a golfer may control initial conditions of ball flight independently of one another due to the fact that they are uncoupled, the golfer may optimize those initial conditions to get the combination that produces the greatest carry distance. Thus using a club head of the invention, when the golfer hits a ball, the ball will go a great distance.

[0006] The invention includes the insights that adjusting physical parameters of a club head can influence initial ball flight conditions in various ways. While different golfers may get their own unique results from a club head, it may be found for some golfers that lowering the center of gravity can increase launch angle, increasing loft may increase spin, distance is highest at a certain medium-high spin rate, or a combination thereof.

[0007] Adjusting the center of gravity in the vertical direction solves problems presented by one-size-fits-all clubs. A golfer who needs a more forgiving club can lower the center of gravity while a golfer who desires greater distance can

raise the center of gravity. One insight of the invention is that, in one club, all other things being equal, a high center of gravity aids in making a shot that bores forward. A low center of gravity tends to impart high loft to a ball. Some players find that golf club head with a low center of gravity is more forgiving to off-center hits. While some very skilled players prefer a high center of gravity because they find they can make shots with great distance. The application of this insight is in the provision of golf clubs that include a mechanism by which to adjust a center of gravity in a vertical direction when a club is at address.

[0008] An unexpected benefit of the invention is that by providing a mechanism that allows for the adjustment of center of gravity in the vertical direction, a golf club can include a mechanism that can accommodate unwanted changes that result from adjusting some other property of the club head, such as moment of inertia, loft angle, face angle, heel-toe center of gravity, or face-back center of gravity.

[0009] Further, mechanisms are provided that allow a club to have a varied center of gravity without requiring separate manufacturing of manufacturing tools. Since a single club head form factor can be manufactured that provides varied centers of gravity, production costs and times are reduced even where club makers want to provide a variety of clubs with different vertical centers of gravity.

[0010] In certain aspects, the invention provides a golf club head having a face, a hosel, and an aft body, and further includes a mechanism operable to change a position of a center of gravity of the club head in a direction that has a substantial component that is vertical when the club head is at address. The mechanism may include an openable cap (e.g., to provide access to weight ports, or a non-uniformly weighted cap that can be opened and closed back in different orientation); a reversible member (e.g., such as a strap, dowel, or screw that has a non-uniform density along its length); or a separable cartridge member (e.g., non-uniformly weighted and loadable in different orientations, with ports for weights, interchangeable with other such cartridges, or a combination thereof). The mechanism may operate by including repositionable weights, a non-uniformly weighted member, a track for weight travel, or other features. In some embodiments, the mechanism comprises weights accessible at an exterior surface of a club head. In certain embodiments, the mechanism is substantially concealed within the club head. Alternatively, the mechanism could be both accessible at an exterior surface and substantially contained within the club head.

[0011] In related aspects, the invention provides a golf club head that includes a mechanism for adjusting a center of gravity in a vertical direction without substantially changing the center of a gravity in a direction orthogonal to the vertical direction. The mechanism may use a separable member that can be attached to the club head in at least two different orientations. In some embodiments, the club head includes a separable bent strap that can be attached in a corresponding recess in an aft portion of the club head. The mechanism may include numerous ports that each receive and retain a weight (e.g., accessible from an outer surface or by opening a single hatch on the club head). Alternatively or additionally, the mechanism can use an aft portion of the club head that is moveable relative to the rest of the club head.

[0012] In certain embodiments, the invention provides an internal elevator that includes a threaded shaft, rotation of which changes a height of the center of gravity substantially only in the vertical direction.

[0013] In some embodiments, a hole in a surface of the club head is configured to receive a weight pylon (e.g., one of a set) that attaches to the surface and positions a weight member within the club head spaced away from the surface.

[0014] Aspects of the invention provide a method for changing a vertical center of gravity of a golf club head by adjusting a center of gravity in a golf club head in a vertical direction without substantially changing the center of gravity in a direction orthogonal to the vertical direction.

[0015] The method may include repositioning a separable member (a separable member that can be attached to the club head in at least two different orientations; a separable member with a non-uniform mass distribution; a separable member that can be attached to the club head in a corresponding recess in an aft portion of the club head; a separable member with a tab on one end dimensioned to be received by a slot on the club head; a separable member that can be attached to the club head in two orientations related by a 180° rotation of the separable member, or a threaded member).

[0016] In certain aspects, the invention provides a golf club head with a mechanism for adjusting a center of gravity in a vertical direction. Changing a center of gravity in the vertical direction can be done without substantially changing the center of a gravity in other directions. Clubs included in the invention include all types (e.g., putters, irons, woods, hybrids, drivers, and wedges). The mechanism can operate according to a variety of principles and can include a mechanistic device such as a hinge, truss, spoke, door, port, pylon, separable member, or repositionable weight.

[0017] In certain embodiments, a club head is provided with a separable member that can be mounted on the club head in more than one position (e.g., rotated 180°) or that can be replaced with another member having a similar shape but different mass properties. If the separable member has a non-uniform weight distribution, mounting it in a different orientation can change a center of gravity in a vertical direction. In some embodiments, a separable member can be attached to the club head in a corresponding recess in an aft portion of the club head.

[0018] In certain embodiments, a mechanism involves a threaded member (e.g., a removable rod with a non-uniform weight distribution or an elevator mechanism). Elevator mechanisms may include a threaded member configured to rotate to cause the weight member to change position in a vertical direction within the club head. In certain embodiments, an elevator mechanism comprises a threaded member and a post member that extend through a weight member.

[0019] In some embodiments, a club head includes a door that can be opened or closed and/or a port adapted to receive a weight (e.g., one or more ports dimensioned to receive weights can be provided within or behind the door). The door can be provided, for example, as an aft portion of a club head.

[0020] In certain aspects, the invention provides a kit for adjusting a center of gravity that includes two members, each of which is adapted to be attached to a club head. In some embodiments, each of the two members has a non-uniform mass distribution, each of the two members has a mass distribution different from the other, or both. Other features provided by the members in various embodiments include threaded surfaces, truss-mountable weights, and interchangeable pylons.

[0021] A kit can further include printed matter such as, for example, information about center of gravity in golf clubs, tools for interchanging the members, or both.

[0022] In certain aspects, the invention provides a method for changing a vertical center of gravity of a golf club head. Methods may include adjusting a center of gravity in a golf club head in a vertical direction without substantially changing the center of gravity in a direction orthogonal to the vertical direction. Methods may further include use of any of the embodiments described herein.

[0023] In certain aspects, the invention provides a method of providing golf clubs by obtaining two or more golf clubs that are substantially the same and that are configured so a center of gravity of each golf club can be independently adjusted in a vertical direction optionally without substantially changing the center of gravity in a direction orthogonal to the vertical. The golf clubs can be provided, for example, to a retail store or to an end-user (e.g., customer golfer). Methods of the invention allow a greater variety of clubs to be provided through commercial distribution channels without requiring a dedicated manufacturing process for each club with a unique center of gravity.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] FIG. 1A shows a club head with a non-uniformly weighted member.

[0025] FIGS. 2A and 2B show a club head with a repositionable member.

[0026] FIG. 3 shows a club head with a weight member with ports.

[0027] FIG. 4 shows a club head and a weight member with ports.

[0028] FIG. 5 illustrates areas of a face of a club.

[0029] FIGS. 6A and 6B give a top and rear view of a club head with an opening member.

[0030] FIGS. 7A and 7B give a top and rear view of a club head with an open member.

[0031] FIG. 8 shows an inside view of a weight member.

[0032] FIG. 9 shows a club head with an open weight member.

[0033] FIG. 10 shows a club head with repositionable, interchangeable weights.

[0034] FIGS. 11A-11C show a club head with a rotatable member.

[0035] FIG. 12A-12E show a club head with a repositionable, interchangeable member.

[0036] FIG. 13A-13E show a club head with a repositionable, interchangeable member.

[0037] FIGS. 14A and 14B illustrate an elevator.

[0038] FIG. 15 is a cross sectional view of a club head including an elevator.

[0039] FIG. 16 shows a club head and a pylon.

[0040] FIG. 17 shows a club head with a mount for a pylon.

[0041] FIGS. 18-20 show interchangeable pylons.

[0042] FIG. 21 shows a top view of a club including a threaded member.

[0043] FIG. 22 shows a threaded member.

[0044] FIG. 23 shows a cross-sectional view of a club with mounts for a threaded member.

[0045] FIGS. 24A-24D show a club head with an openable member.

[0046] FIGS. 25A and 25B show a club head with a repositionable, interchangeable member.

[0047] FIGS. 26A and 26B show a club head with a moveable weight.

[0048] FIG. 27 shows a club head with moveable weights.

[0049] FIG. 28 shows a club head with a moveable barrel weight.

[0050] FIG. 29 shows a club head configured to receive a weight member.

[0051] FIG. 30 shows weight member for insertion into club head.

[0052] FIG. 31 shows club head having weight member installed therein.

[0053] FIGS. 32-34 depict an embodiment in which a club head includes interchangeable weight members.

[0054] FIGS. 35-37 show an embodiment in which a club head has interchangeable weight members.

[0055] FIGS. 38-40 reveal an embodiment in which a club head has recesses to receive interchangeable weights.

[0056] FIGS. 41-43 illustrate a club head with a cartridge with multiple weight ports.

[0057] FIG. 44 shows a cavity-backed wood-type club head that includes a cavity.

[0058] FIG. 45 illustrates a club head with a cavity with a surface that includes a component that is substantially vertical when club head is at address.

[0059] FIGS. 46-48 show a club head that includes a slider to adjust a height of a center of gravity.

DETAILED DESCRIPTION

[0060] The invention provides methods and mechanisms for adjusting a center of gravity of a golf club head. As used herein throughout, reference to a direction or orientation of a center of gravity, such as vertical, is made with reference to a club head at address. The invention further provides golf club heads with a center of gravity that is adjustable in a vertical direction. In certain embodiments, a golf club head of the invention has a center of gravity that can be adjusted in a vertical direction without simultaneously substantially changing the center of gravity in a direction orthogonal to the vertical direction.

[0061] FIG. 1 shows a club head 1 with a non-uniformly weighted member. The club shown in FIG. 1 can be described with respect to a baseline center of gravity. Club head 1 includes a repositionable member 3 coupled to the back of the club head. Member 3 has a non-uniform mass distribution and a mass. The point shown on club head 1 in FIG. 1A represents what would be the center of gravity of club head 1 if member 3 had the a uniform distribution of mass.

[0062] As shown in FIG. 1, the lower edge of member 3 has a greater mass concentration than the rest of member 3. Further, member 3 can be removed from club head 1 and re-connected to it in an inverted configuration (relative to how it is shown in FIG. 1), with the dense mass portion nearer to the crown of the club head. The repositionable nature of member 3 and its non-uniform mass distribution provides a range of distance in a vertical direction over which mass can be repositioned, thereby changing the center of gravity of club head 1 in a vertical direction.

[0063] The body of club head 1, member 3, or any other club head or member disclosed herein, can include any suitable materials known in the art such as a metal (e.g., titanium, aluminum, stainless steel) or a plastic, a polymer, or a composite (e.g., carbon fiber, various hard plastics, etc.). Member 3 can couple to club head 1 in any suitable way such as, for example, a screw, a snap-together construction, or an adhesive. In some embodiments, member 3 includes one or more pins protruding from a forward-facing (when club at address) surface and club head 1 includes corresponding holes. The

arrangement of pins and holes is symmetrical in the vertical direction (i.e., across a horizontal line). Member 3 is mated to and fixed on club head 1 by pushing the pins into the holes.

[0064] FIGS. 2A and 2B show a club head 2 with a repositionable member. Operating under a principle substantially similar to that illustrated in FIG. 1, here, weight member 7 mounts in a slot in the back of club head 2. Weight member 7 includes a mass, denser than the rest of member 7, at a position off of a vertical center of member 7. Member 7 can be mated to and coupled to club head 2 in either of two different configurations, thereby adjusting a vertical center of gravity.

[0065] Member 3 in FIG. 1 and member 7 in FIGS. 2A and 2B, as well as any other suitable removable member shown herein, can be provided as one of a set of interchangeable members. For example, in some embodiments, club head 2 can be provided with a non-uniform member 7 as well as a one or more other members that fit in the same slot, each having different mass characteristics. In some embodiments, a club head of the invention comes with a “neutral” or “baseline” member having a uniform mass distribution as well as a member having non-uniform mass distribution. Use of the baseline member provides a club head that has a substantially baseline center of gravity.

[0066] FIG. 3 shows a club head 4 with openable cap 15 that includes ports 11 for receiving weights. In some embodiments, cap 15 is removable and re-connectable to club head 4. Cap 15 includes one or more of port 11 (here, shown with three of port 11). Insertable weights are provided that can be mounted in port 11.

[0067] In some embodiments, a port 11 is only visible and only accessible from an inside surface of cap 15. In certain embodiments, port 11 are open to, and accessible from, an inside surface of cap 15, but further include a viewing window so that a golfer may see which of port 11 are occupied. A viewing window can include an open void space dimensioned so that weight members do not fall out or can include a clear material (such as a plastic or other polymer like poly(methyl methacrylate), polyvinyl chloride, PDMS, etc.).

[0068] In some embodiments, one or more of port 11 are open to, and accessible from, an outside surface of cap 15.

[0069] A golfer can remove cap 15 from club head 4, as shown in FIG. 4, and insert one or any number of weight members into desired positions of port 11 and mount cap 15 on the back of club head 4, resulting in a club substantially as shown in FIG. 3. By positioning different weights in different arrangements in port 11, a vertical center of gravity is adjusted.

[0070] FIG. 5 illustrates areas of a face of a club. Without being bound by any particular mechanism of action, it may be theorized that lowering a vertical center of gravity tends to shift which region of a face (low, med, or high) transfers momentum to or makes contact with a ball during a shot. Hits from a lower part of the club head face may go high and be more forgiving. Hits from a top portion of the club face (here labeled low) may tend to drive the ball forward, favoring long-distance shots.

[0071] FIGS. 6A and 6B give a top and rear view of a club head 25 with an openable cap while FIGS. 7A and 7B give a top and rear view of a club head with an open cap. As shown in FIGS. 6A-7B, club head 24 includes opening cap 31. Opening cap 31 may open by any suitable mechanism such as, for example, pivot 27 (shown here), a hinge (see, e.g., FIGS. 24A-24D), pins and holes (see, e.g., FIG. 9 or FIG. 11B).

[0072] FIG. 8 shows an inside view of cap 31. In certain embodiments, cap 31 includes one or more of port 39 disposed therein. In some embodiments, club head 26 includes one or more of ports 35 disposed therein. A weight member (e.g., lead, tungsten, other material) can be pushed into, and retained by, a port.

[0073] A cap may be taken to refer to a cover or panel that cooperates with a remainder of a club head to provide an overall shape of the club head. For example, FIGS. 9 and 11A-11C depict a cap on an aft end of a club head; FIGS. 16-20 illustrate pylons that can act as a cap in a base of a club head; FIGS. 24A-24D show a club head with a hinged cap; and FIG. 43 shows a removable cap that carries with it a removable cartridge.

[0074] FIG. 9 shows a club head 50 with an open weight member 51. Weight member 51 includes one or more of port 53 (similar to cap 15 described above in reference to FIG. 3). As shown in FIG. 9, member 51 pivots about a pin-hinge. One or more of weight insert 53 can be positioned in one or more of port 53.

[0075] In some embodiments, the invention provides a club head with a center of gravity that is adjustable in a vertical direction based on one or more repositionable weight inserts fixably connectable to the club head. FIG. 10 shows a club head 60 with repositionable, interchangeable weights. Each of crown weight 57, aft crown weight 61, aft sole weight 69, a sole weight (not shown, substantially beneath crown weight 57), heel-side weight 65 and a similarly situated toe-side weight can be provided to fit into a corresponding recess in the club head. In some embodiments, the weight inserts are provided as a firm but soft material, such as a urethane compound, optionally impregnated with a high-density material such as lead or tungsten (e.g., in filings, ingots, cubes, etc.) that can be, for example, embedded in the material. The weight inserts are pushed into the recess to weight the club head. In some embodiments, the weight members are removed through the use of a tool, such as by digging a small knife or screwdriver into the recess and prying the weight out. In some embodiments, the weight members snap-fit into the recesses.

[0076] Club head 60 can further be provided with “blanks”—cosmetic cover pieces that take the place of a weight insert to give club head 60 a finished appearance without substantially affecting a mass distribution.

[0077] FIGS. 11A-11C show a club head 70 with a rotatable cap 71. As shown here, cap 71 includes a mass-dense portion 73. Member 71 mates to club head 70 to create a smooth, finished appearance. In the illustrated embodiment, cap 71 mounts on head 70 through the use of a matching pin-and-hole sets. In some embodiments, cap 71 mounts to head 70 through the use of a screw, or high-powered magnets (e.g., rare-earth magnets). In some embodiments, cap 71 is cemented to club head 70. Club head 70 (or a golf club including club head 70) can be provided with one or a plurality of cap 71. By mounting cap 71 in a different orientation, or by mounting a different cap 71 from a set, a vertical center of gravity of club head 70 can be adjusted. Noting that mass-dense portion 73 is called out in the illustrations here, FIGS. 11A and 11C show a high and a low, respectively, positioning of a center of gravity of club head 70 in a vertical direction.

[0078] FIG. 12A-12E show a club head 80 with a repositionable, interchangeable bent strap 85. Member 85 includes a weight mass 93 at one end. A channel is formed on the back of club head 80 and bent strap 85 can be inserted therein so

that ends of bent strap 85 slide into slots under the outermost surface (e.g., the crown and sole) of club head 80. The slots may be dimensioned to exert pressure on the ends of bent strap 85, thereby retaining it in place. Additionally or alternatively, one or more of set screw 87 can be used to fix bent strap 85 in place. As shown by arrow B, bent strap 85 can be inserted in multiple orientations so that weight mass 93 is high, or low, on club head 80. Further, club head 80 may be provided with multiples of bent strap 85, each exhibiting different mass properties.

[0079] FIG. 13A-13E show a club head 90 with a repositionable, interchangeable bent strap 97 having weight mass 101. Similar to that shown in FIGS. 12A-12E, bent strap 97 can be removably coupled to club head 90 via one or more of a press-fit slot, set screw, adhesive, Velcro, snap-fit retention mechanism, or similar, or a combination thereof. As shown by arrow C, bent strap 97 can be attached in multiple orientations to adjust a center of gravity of club head 90 in a vertical direction.

[0080] FIGS. 14A and 14B illustrate an elevator member. Central shaft 125 extends from cap member 105 to base member 121. Either of cap member 105 or base member 121 can be provided by part of a golf club head, or can be pieces that are affixed to a golf club head. As shown in FIG. 14B, base member 121 is seated within sole portion 117 of a golf club head, while cap member 105 is provided by a portion of a golf club crown. Weight 113 is mounted on central shaft 125 through a threaded interface and bar 109 extends through weight 113.

[0081] In some embodiments as pictured in FIGS. 14A and 14B, rotation of base member 121 (e.g., by manual manipulation of a spoke-like structure therein) causes bar 109 to revolve around shaft 125. An end of bar 109 distal from base 121 may be engaged with a circular groove in cap member 105 to aid smooth revolution. As bar 109 revolves around shaft 125 it rotates weight 113 around its axis. Shaft 125 is fixed in cap member 121. Due to the threaded interface between cap member 105 and shaft 125, weight 113 moves in an upward or downward direction while base member 121 is rotated.

[0082] In alternative embodiments, cap member 105, base member 121, and bar 109 are fixed together with no motion possible between or among them. Shaft 125 is rotatably mounted as shown in FIG. 14B having weight 113 threaded thereon. Shaft 125 can be rotated by engaging a tool in a mating recess on one end. Rotating shaft 125 causes weight 113 to move up or down because bar 109 prevents weight 113 from rotating with shaft 125.

[0083] Mechanisms like the one pictured in FIGS. 14A-14B can include any suitable material known in the art. In some embodiments, one or more of the included components are a polymer material such as plastic, or a metal, or a composite material. Weight 113 can be a metal or can be a plastic or composite material with a metal weight member mounted therein. In some embodiment, shaft member 125, weight member 113, another component, or any combination thereof include a low friction material such as PTFE. FIG. 15 is a cross sectional view generally showing how an elevator member as shown in FIGS. 14A and 14B may be installed within a club head.

[0084] FIG. 16 shows a club head 130 and weight pylon 137. Arrow E indicates how pylon 137 may be mated with or removed from club head 130. Viewing FIG. 17 in conjunction with FIGS. 18-20, it will be appreciated that a weighting

pylon may be mounted in mount hole **141** on a portion of club head **130** (here, hole **141** is shown in a sole). While hole **141** may be at any position on club head **130**, when it is on a sole, FIG. **18** shows a low CG pylon **145**. FIGS. **18** and **20** show an intermediate CG pylon **149** and a high CG pylon **153**, respectively. A CG pylon may be positioned in club head **130** by inserting it through hole **141**.

[0085] In some embodiments, hole **141** includes one or more of a set hole **143** configured to match to mounting mechanism **157** on a base of a pylon. Mounting mechanism **157** can include a hole and a screw that threads through the pylon into hole **143**. In certain embodiments, mounting mechanism **157** on a pylon is a barbed pointer that clips through hole **143**.

[0086] One benefit of the mechanism for adjusting vertical center of gravity as shown in FIGS. **16-20** is that the mass of club head **130** is limited to the sole, crown, face plate, etc.—the positions on a club head where the mass would be anyway. Because a pylon protrudes into the free space of club head **130**, and is not surrounded by the material of an indentation in club head **130**, a golfer is given maximum control over a vertical position of the center of gravity.

[0087] FIGS. **21-23** show a mechanism for adjusting a center of gravity of a club head in a vertical direction. Club head **160** includes one or more of threaded bore portion **173**. Threaded member **181** can be mounted in club head **160** by threading it through bore portion **173**.

[0088] In some embodiments, threaded member **181** is generally made to include a low or neutral density material such as a plastic or a composite. In certain embodiment, to facilitate insertion or removal of member **181**, it includes a low-friction material such as a polymer like PTFE. Positioning member **181** in club head **160** can adjust a center of gravity of the club head in a vertical direction. For example, member **181** can include a weight mass **185** located at an off-center position. A golfer can mount member **181** in club head **160** in either orientation to change a vertical center of gravity. Further, a club head **160** can be provided with one of or a set of member **181**. In a set, each of member **181** can include different mass distribution properties. For example, weight mass **185** can be progressively more distant from a center of member **181** within members of a set.

[0089] Member **181** can further include a mechanism to aid in insertion or removal. In certain embodiments, member **181** includes a screwing slot **177** that allows for rotating member **181** about an axis through the use of a tool. In some embodiments, slot **177** is dimensioned to receive an edge of a coin, such as a nickel or penny.

[0090] FIGS. **24A-24D** show a club head **190** with an openable door **201** (e.g., a hinged cap) that can provide functionality in a number of ways. In some embodiments, FIGS. **24A-24D** show a club head **190** with an openable door **201** that provides a mechanism for adjusting a club head center of gravity in a vertical direction. Member **201** is mounted on club head **190** via hinge **197**. Member **201** optionally includes fastening mechanism **193** to maintain club head **190** in a closed configuration (as shown in FIGS. **24A** and **24B**). FIGS. **24C** and **24D** show club head **190** in an open configuration. Body member **191** can optionally include a component **217** of fastening mechanism **193**. In some embodiments, fastening mechanism **193** includes a set screw (e.g., on openable door **201**) and a threaded receiving hole (e.g., on body member **191**). In some embodiments, fastening mechanism

193 includes a magnet such as, for example, a high powered magnet (e.g., a rare-earth element magnet).

[0091] Club head **190** includes a center of gravity that is adjustable in a vertical direction. In some embodiments, high port **205** and low port **209** are provided as recesses in door **201** (e.g., on an inside surface so that they are not visible when club head **190** is in a closed configuration). One or more weight members may be provided that mount in any of the ports. A weight member may be retained in a port by any suitable method. Suitable methods for retaining a weight member in a port include: dimensioning the weight and club head so that a back of the body member **191** holds the weight in place when club head **190** is in a closed configuration; adhesives; magnets (e.g., high powered magnets such as rare earth elements); a press-fit construction; a snap fit construction; one or more of a screw or similar fastener; spot-welding; or other similar methods.

[0092] By repositioning weight members among the ports depicted in FIG. **24D**, a golfer may adjust a center of gravity in a vertical direction. In some embodiments, a door **201** further includes ports in a center, near a heel end, near a toe end, or anywhere else within.

[0093] FIGS. **25A** and **25B** show a club head **220** with a repositionable, interchangeable member **229** for adjusting a center of gravity in a vertical direction. As can be seen in FIG. **15B**, member **229** can include a first end mass **233** and a second end mass **237**. These masses can include different masses (e.g., by including materials of different densities, by having different volumes, by including a void space in one of them, or a combination thereof). Club head **220** can be provided with one of or a set of member **229**. Where two or more are provided, they can be interchangeable and each can provide unique mass characteristics. Since each of member **229** can be positioned on club head **220** in two different configurations, a set of two members can provide four different vertical center of gravity settings for club head **220**.

[0094] In certain embodiments, member **229** is a separable cartridge with ports **209** (e.g., as shown in FIG. **24D**) therein for carrying removable weight members.

[0095] In certain embodiments, member **229** includes an indicator window (e.g., positioned off-center) in a position to correspond to indicia printed on club head **220** to indicate a presently effective mass property setting. Suitable setting indicator windows are disclosed in U.S. patent application Ser. No. 13/363,886, filed Feb. 1, 2012, and titled SETTING INDICATOR FOR GOLF CLUB, the contents of which are hereby incorporated by reference in their entirety.

[0096] Member **229** can be attached to club head **220** as shown by arrow F in FIG. **25B** and fixed in place by any suitable means. Suitable methods for retaining member **229** in club head **220** include: adhesives; magnets (e.g., high powered magnets such as rare earth elements); a press-fit construction; a snap fit construction; one or more of a screw or similar fastener; spot-welding; or other similar methods.

[0097] Club head **220** generally includes a recess for receiving member **229**. One or more of pocket **241** is separated by bridge **245**. In some embodiments, bridge **245** and member **229** include a ferromagnetic material, at least one of which is a permanent magnet (i.e., magnetized). In some embodiments, either or both use a strong magnet such as a rare earth element magnet.

[0098] FIGS. **26A** and **26B** show a club head **250** with a moveable weight **257** that allows a center of gravity of club head **250** to be adjusted in a vertical direction. As can be seen

in FIGS. 26A and 26B, club head 250 includes one or more of truss element 252 extending vertically one portion of the club to another (here, from a sole to the topline). As shown here, truss element 252 is spaced away from back surface 255 of a striking face of club head 250.

[0099] One or more of truss element 252 can include one more of weight 257 repositionably mounted thereon. In some embodiments, weight 257 slides a long a length of truss element 252. In some elements, weight 257 can be separated from, and reattached to, truss element 252. Weight 257 can be fixed into position on truss member 252 by any suitable means, such as a clamp-on mechanism, a set-screw, or other means.

[0100] FIG. 27 shows a club head 280 with moveable donut weights 287. Moveable weights as shown in FIG. 27 generally may be provided having a torus shape to fit snugly on spoke member 289. FIG. 28 shows a club head 290 with a moveable barrel weight 297 disposed on one of spoke member 289 (here, spaced away from a back surface 22 of a strike face of club head 290). As shown in either of FIG. 27 or FIG. 28, a donut weight 287 or a barrel weight 297 can be slidably positioned on a spoke member 289. A spoke may be a separate piece of metal (similar to a bicycle spoke) or maybe a piece of a body portion of club head 280 (or 290) extending in a spoke like conformation. By slidably positioning donut weight 287 or barrel weight 297, a golfer can adjust a center of gravity of a club head in a vertical direction.

[0101] FIG. 29 shows a club head 301 configured to receive a weight member 319. Club head 301 preferably includes an internal boss 309 to receive and stabilize a location of weight member 319 and a surface-exposed boss 315. Either or both of internal boss 309 and surface boss 315 may include a mechanism to mate with a portion of weight member 319. Any suitable mechanism may be included such as a snap-fit tab or tabs, a threaded interface, press-fit parts, or other.

[0102] FIG. 30 shows weight member 319 for insertion into club head 301 to provide a position of a center of gravity that is adjustable in a vertical direction. Weight member 319 preferably has a non-uniform density. For example, weight member 319 may include a heavy portion 323 and a light portion 327 (e.g., at opposed ends of weight member 319) and the heavy portion could weigh more (e.g., anywhere from 1 to 10 grams more). In certain embodiments, one end of member 319 weighs about 6 to 9 grams more than the other end (e.g., if you cut member 319 in half at the middle and weight each half separately). Weight member 319 may also include a tool interface surface 335. Club head 301 may be used with a plurality of members 319 that have different weight properties (e.g., a set or kit).

[0103] FIG. 31 shows club head 301 having weight member 319 installed therein. In some embodiments, weight member 319 may be installed and removed by using a tool on tool interface surface 335 (e.g., to unscrew member 319 at threaded ends from bosses 309 and 315). In certain embodiments, member 319 is a screw that may be inserted from the sole to connect to a boss on the interior surface of the crown. Surface boss 315 can have a smooth bore (e.g., with an internal diameter large enough for an end of screw 319 to pass through, such that screw 319 attaches to club head 301 only at internal boss 309).

[0104] FIGS. 32-34 depict an embodiment in which a club head 341 includes interchangeable weight members 345. Weight members 345 may be positioned in receiving wells 347. Club head 341 can include a retaining member 349 that

can be caused to engage weight members 345 through the use of tool 343. As shown for example in FIG. 34, tool 343 can access retaining members 349 through a dedicated tool entry port 357 (also visible in FIG. 33). Preferably, weight members 345 are available with different weights (e.g., at least two of weight members 345 differ by an amount between about 1 g and about 10 g or more).

[0105] In certain embodiments, weight members 345 slide into or out of receiving wells 347. Since this attachment is not threaded, weight members 345 and wells 347 need not be circular. Thus, the weight provided by members 345 can be concentrated into certain locations (e.g., close to a fore-aft plane) and thus using weight members 345 need not substantially influence mass distribution properties of club head 341 other than a vertical position of a center of gravity of club head 341. Club head 341 may be provided with a plurality of weight members 345, such as two, or three, or seven, or twenty, or any number—so that a golfer can personalize their golf club.

[0106] FIGS. 35-37 show an embodiment in which a club head 371 has interchangeable weight members 389 that can be held within pop-out turret 385 or 381. Tool 377 can be used to engage turrets 381 and 385. For example, club head 371 may have a threaded barrel rotatably mounted adjacent a threaded hemi-cylindrical face in an edge of turret 381 or 385. When turret 381 or 385 is brought against the threaded barrel, tool 377 can be used to rotate the barrel, causing the threads to engage, and driving turrets 381 or 385 into or out of club head 371. Turrets 381 or 385 can be provided with one or a plurality of weight ports 391 for receiving weight members 389. Through the use of weight members 389 of different weights, a vertical position of a center of gravity of club head 371 can be adjusted.

[0107] FIGS. 38-40 reveal an embodiment in which a club head 401 has recesses 413 to receive interchangeable weights 405. Here, recesses 413 include an inner coupling portion and an outer shaped area. Each weight 405 has an outer perimeter shaped to correspond to the outer shaped area of a recess 413. Each weight 405 has a rotatable coupling barrel that corresponds to the inner coupling portion of a recess 413. An outer surface of weight 405 may include a tool engagement surface. A weight 405 can be positioned in recess 413 and tool 409 may be used to attach weight 405 to club head 401. The inner coupling portion and the rotating coupling barrel may both be threaded and may screw together. In a related embodiment, recess 314 and the corresponding portion of weight 405 are not threaded but included corresponding tab and groove structures to lock together.

[0108] FIGS. 41-43 illustrate a club head 441 that embodies an adjustable center of gravity concept in which a cartridge 425 with multiple weight ports can be inserted and removed from a receiving chamber 445 in club head 441. Weight slugs 429 can be selectively inserted into the weight ports, and cartridge 425 can be inserted and locked into club head 441.

[0109] In certain embodiments, cartridge 425 includes a tool engagement surface 437. Cartridge 425 and receiving chamber 445 may interact through a combination of tabs 431 and slots 451 (which may each be on either of cartridge 425 and receiving chamber 445). Club head 441 can be caused to have a center of gravity with a different height when the club head is at address by removing and interchanging slugs 429 in cartridge 425.

[0110] In certain aspects, the invention provides a cavity-backed wood-type club head that employs a surface of the club head that has a vertical component when the club head is at address.

[0111] FIG. 44 shows a cavity-backed wood-type club head 461 that includes a cavity 467. At least one surface of cavity 467 has a component that is substantially vertical when club head 461 is at address. Preferably, a surface within cavity 467 includes two points (e.g., at least about 1 cm apart, preferably at least two cm apart) defining a surface vector s . With club head 461 held at address, x , y , and z orthogonal axes may be defined wherein z is vertical and x is normal to a center of a ball striking face. The surface vector s may be decomposed into x , y , and z components. Surface vector s of club head 461 will include a non-trivial z component (e.g., at least a cm or two long). Here, slot 471 may be taken to lie along the surface vector.

[0112] Club head 461 includes a slot 471 in cavity 467 oriented to include a component that is substantially vertical when club head 461 is at address. Club head 461 includes slider 473 that can be repositioned along slot 471 to adjust a height of a center of gravity of club head 461. Slider 473 may include a tool engagement surface that requires a tool to slide the slider (e.g., most of slider 473 is within club head 461 and only a portion of slider 473 is accessible through slot 471, that portion bearing a special feature for engagement with a special tool).

[0113] FIG. 45 illustrates a related embodiment in that club head 461 includes cavity 467 with a surface that includes a component that is substantially vertical when club head 461 is at address. Here, the vertical surface includes a plurality of weight port 477 dimensioned to receive weight slugs 429. By interchanging weight slugs (e.g., of different weight, through selective inclusion and exclusion, or both) a height of a center of gravity of club head 461 may be adjusted. Preferably, interchanging weight slugs requires use of a tool that engages a base of a slug 429 for insertion and removal.

[0114] A slot and slider (e.g., as shown in FIG. 44) need not strictly have a vertical component to adjust a vertical position of a center of gravity.

[0115] FIGS. 46-48 show a club head 501 that includes a slider 511 that travels along a crown or a sole of the club head to adjust a height of a center of gravity. Here, slider 511 can travel along slot 505. Club head 501 includes an internal track 515 that has a component that is substantially vertical when club head 501 is at address. A weight member 519 may be mounted on track 515 such that moving weight member 519 to different positions (e.g., by sliding) along track 515 adjusts a height of a center of gravity. Alternatively, member 519 may interface with track 515 by rollers, gears, etc., or track 515 may be a wire fixed to member 519 wherein track 515 itself travels through opposed pulleys mounted in club head 501.

[0116] Slider 511 may be linked to member 519 via linkage arm 523, which may preferably include a material with some stiffness and optionally stiffness with just a bit of pliability, such as a metal (like aluminum or titanium) or a plastic or other polymer (e.g., TEFLON). Track 515 may be rigid and may have a form for extra strength, such as a cross-sectional I-beam profile. Track 515 may be disposed in club head 501 with a desired positioning such as predominantly up-and-down or angled. As shown in FIGS. 47 and 48, track 515 curves down towards the face so that a position of a club head center of gravity can be adjusted to be biased lower or towards the back. It will be appreciated that the orientation could be

reversed, so that the one extreme is down and towards the back, and moving slider 511 adjusts the position forwards and upwards. Other possible orientations and combinations of any of the possible orientations are within the scope of the invention and will be appreciated.

[0117] It may be found that changing the position of the center of gravity of the golf club head for different golf clubs may compensate for the swing characteristics of certain golfers so as to optimize initial ball flight conditions. For example, increasing loft may increase launch angle, decreasing total distance. So, a golfer may want a low-loft club head. However, a golfer may find that a high spin increases distance, so the golfer may want a club head with a high center of gravity. While every different golfer is unique, some may find that the ideal driver is one in which a point on the face directly in line with a club head center of gravity is also the point on the face which has the correct loft angle to generate the golfer's optimum launch angle. Such a golfer may procure a driver of the invention with a given loft angle and strike point and adjust the center of gravity accordingly.

[0118] A mechanism for adjusting a vertical component of a position of a club head of center of gravity may have particular benefit in a club head that also includes a mechanism for adjusting or configuring another physical parameter such as a loft angle.

[0119] Adjustable or configurable golf clubs are discussed further in U.S. Pat. No. 8,262,507; U.S. Pat. No. 7,771,291; U.S. Pat. No. 7,147,573; U.S. Pat. No. 6,015,354; U.S. Pat. No. 5,947,840; U.S. Pat. No. 4,052,075; U.S. Pub. 2011/0151990; U.S. Pub. 2010/0331102; and U.S. Pub. 2010/0075773, the contents of which are hereby incorporated by reference for all purposes.

[0120] A golf club head that includes a mechanism for adjusting a position of a club head center of gravity in a direction that includes a component that is substantially vertical when the club head is at address may be characterized by one or a combination of categories of features. Categories include: reversible member; separable cartridge member; repositionable/interchangeable weights; openable hatch; non-uniformly weighted member; track for weight travel; others; and combinations thereof. Embodiments that employ a reversible member are depicted, for example, in FIGS. 1A, 2A, 2B, 11A-11C, 12E, 13E, 21, 25B, 29-31, among others. Embodiments that show use of a separable cartridge member can be found in FIGS. 3, 4, 9, 25A, 30, and 41-43, for example. The use of weights that are repositionable, interchangeable weights, or both is depicted in the embodiments shown in FIGS. 3, 4, 7A-8, 10, 16-20, 24D, 26A, 28, 32-43, and 45 among others. The use of an openable hatch or lid—i.e., a cap—is illustrated, for example, in FIGS. 3, 4, 6A-7B, 9, 11A-11C, 24A-24D, 37, and 43. Non-uniformly weighted member-based adjustment mechanisms are shown at least in FIGS. 1A-2B, 3-4, 9, 11B, 12E, 13E, 21-22, 25A-25B, 30, 41. Mechanisms that includes a track for weight travel are shown in FIGS. 14A-15, 26A-28, 44, and 46-48. A theme that may be preferred for ease of access and use is weights accessible at an exterior surface of a club head such as is shown in FIGS. 10, 12, 16, 32-34, 38-40, 44, and 45. In some embodiments, a mechanism for adjusting a center of gravity is substantially concealed within a club head which may be preferred for aerodynamics and structural soundness (e.g., keep weight mechanism parts retained in club head during high-energy use). This is depicted, for example, in FIGS. 6A-8, 14A-15, 21-23, 24A-24D, 29-31, 35-37, 41-43, 46-48, etc. A center of

gravity adjustment mechanism can be both accessible at an exterior surface and still substantially contained within a club head, as shown for example in FIGS. 6A-8, 21-23, 29-31, 35-37, 41-43, among others.

Incorporation by Reference

[0121] References and citations to other documents, such as patents and patent publications, are hereby incorporated herein by reference in their entirety for all purposes.

EQUIVALENTS

[0122] 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 face, a hosel, an aft body, and a mechanism operable to change a position of a center of gravity of the club head in a direction that has a substantial component that is vertical when the club head is at address.
2. The golf club of claim 1, wherein the mechanism comprises an openable cap.
3. The golf club head of claim 1, wherein the mechanism comprises a reversible member.
4. The golf club head of claim 1, wherein the mechanism comprises a separable cartridge member.
5. The golf club head of claim 1, wherein the mechanism comprises repositionable weights.
6. The golf club head of claim 1, wherein the mechanism comprises a non-uniformly weighted member.
7. The golf club head of claim 1, wherein the mechanism comprises a track for weight travel.
8. The golf club head of claim 1, wherein the mechanism comprises weights accessible at an exterior surface of a club head.
9. The golf club head of claim 1, wherein the mechanism is substantially concealed within the club head.
10. The golf club head of claim 1, wherein the mechanism is both accessible at an exterior surface and substantially contained within the club head.

11. A golf club head comprising:

a mechanism for adjusting a center of gravity in a vertical direction without substantially changing the center of a gravity in a direction orthogonal to the vertical direction.

12. The club head of claim 11, wherein the mechanism comprises a separable member that can be attached to the club head in at least two different orientations.

13. The club head of claim 11, wherein the mechanism comprises a separable bent strap that can be attached to the club head in a corresponding recess in an aft portion of the club head.

14. The club head of claim 11, wherein the mechanism comprises an elevator member that includes a threaded shaft, rotation of which changes a height of the center of gravity substantially only in the vertical direction.

15. The club head of claim 11, wherein the mechanism comprises a plurality of ports, each configured to receive and retain a weight.

16. The club head of claim 15, wherein the plurality of ports are accessible by opening a single hatch on the club head.

17. The club head of claim 11, wherein the mechanism comprises a hole in a surface of the club head, the hole being configured to receive a weight pylon that attaches to the surface and positions a weight member within the club head spaced away from the surface.

18. The club head of claim 11, wherein the mechanism comprises an aft portion of the club head that is moveable relative to the rest of the club head.

19. A method for changing a vertical center of gravity of a golf club head, the method comprising:

adjusting a center of gravity in a golf club head in a vertical direction without substantially changing the center of gravity in a direction orthogonal to the vertical direction.

20. The method of claim 19, further comprising repositioning a separable member, wherein the separable member is one selected from the list consisting of:

a separable member that can be attached to the club head in at least two different orientations,

a separable member with a non-uniform mass distribution, a separable member that can be attached to the club head in a corresponding recess in an aft portion of the club head,

a separable member with a tab on one end dimensioned to be received by a slot on the club head,

a separable member that can be attached to the club head in two orientations related by a 180° rotation of the separable member, and

a threaded member.

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