PERFORMANCE GOLF BALL

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ABSTRACT

A golf ball having improved yardage performance for slow swing speed players without the same benefit of improved yardage for fast swing speed players. The golf ball preferably has a mass not exceeding 1.62 ounces and, more preferably is in the range of about 1.198 ounces to about 1.620 ounces; a diameter of preferably no more than about 1.680 inches and more preferably in the range of about 1.519 inches to 1.680 inches; and a density not to exceed about 0.653 ounces per cubic inches. The golf ball can have a diameter within the range of about 1.570 to 1.685 inches, a total ball weight in the range of about 1.30 ounces to 1.61 ounces and a density, for all balls, of about 0.642 ounces per cubic inch.
Figure 1
Figure 2
Figure 3
PERFORMANCE GOLF BALL
RELATED APPLICATIONS


FIELD AND BACKGROUND OF THE INVENTION

This invention relates to an improved golf ball.

The Rules of Golf require that golf balls have both a maximum mass (1.62 oz) and a minimum diameter (1.68") in addition to limits on Initial Velocity, Overall Distance and Symmetry. As a consequence of the maximum mass and minimum diameter, virtually all golf balls sold worldwide are as close to the maximum mass and minimum diameter as is practical.

Briefly, the invention provides a golf ball that benefits slow swing speed golfers while complying with all of the USGA and R&A Rules on golf balls with the exception of the minimum diameter limit and the initial velocity limit. In particular, the invention provides a golf ball characterized by having a density that does not exceed 0.653 oz/in3 (ounces per cubic inch) and a mass that does not exceed 1.62 oz. (ounces)

The golf balls of the present invention also perform similarly to conventional golf balls with regard to hooks and slices and sensitivity to head, tail and cross winds.

The invention covers golf balls which provide significant distance improvement for slow swing speed players without benefiting high swing speed players. The invention achieves this by a reduction in mass (and therefore weight), coupled with an increase in initial ball speed, which is attained by an increase in the aerodynamic forces (notably lift). For slow swing speed golfers, the lower weight and higher lift force lead to an increased flight time and an increased carry distance. However, high swing speed golfers do not realize a distance increase due to the increased drag and reduced inertia (i.e., momentum) of the ball, which, at increased speeds, negates the benefits that are realized by low swing speed players.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 shows the ball speeds for low and high swing players for a prior art (current) golf ball and for different prototype balls of the invention.

FIG. 2 shows initial ball momentum for a prior art golf ball and different ball types of the invention for the same player and ball types as in FIG. 1.

FIG. 3 shows the relative increase in drag and lift forces for the golf balls of FIG. 2.

FIG. 4 shows the drive distance improvement (in yards) for three of the ball types of the invention for both low and high swing speed players.

FIG. 5 shows the drive distance loss of four ball types of the invention compared with a prior art ball for different swing speeds.

FIG. 6 shows the preferred ball mass and diameter relationship of the present invention (constant density of 0.653 oz/in3).

FIG. 7 shows a cross-section of prototype golf balls made within the scope of the present invention.

FIG. 8 shows an alternative embodiment containing three material layers.

FIG. 9 shows an alternative embodiment containing four material layers.

FIG. 10 shows an alternative embodiment containing a rigid sphere defining a hollow interior.

TABLE 1

<table>
<thead>
<tr>
<th>Configuration #</th>
<th>Diameter (in)</th>
<th>Mass (oz)</th>
<th>Density (oz/in³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.680</td>
<td>1.620</td>
<td>0.653</td>
</tr>
<tr>
<td>2</td>
<td>1.608</td>
<td>1.586</td>
<td>0.653</td>
</tr>
<tr>
<td>3</td>
<td>1.656</td>
<td>1.551</td>
<td>0.653</td>
</tr>
<tr>
<td>4</td>
<td>1.643</td>
<td>1.515</td>
<td>0.653</td>
</tr>
<tr>
<td>5</td>
<td>1.630</td>
<td>1.480</td>
<td>0.653</td>
</tr>
<tr>
<td>6</td>
<td>1.617</td>
<td>1.445</td>
<td>0.653</td>
</tr>
<tr>
<td>7</td>
<td>1.600</td>
<td>1.399</td>
<td>0.653</td>
</tr>
<tr>
<td>8</td>
<td>1.590</td>
<td>1.374</td>
<td>0.653</td>
</tr>
<tr>
<td>9</td>
<td>1.577</td>
<td>1.339</td>
<td>0.653</td>
</tr>
<tr>
<td>10</td>
<td>1.563</td>
<td>1.304</td>
<td>0.653</td>
</tr>
<tr>
<td>11</td>
<td>1.559</td>
<td>1.293</td>
<td>0.653</td>
</tr>
<tr>
<td>12</td>
<td>1.543</td>
<td>1.233</td>
<td>0.653</td>
</tr>
<tr>
<td>13</td>
<td>1.519</td>
<td>1.198</td>
<td>0.653</td>
</tr>
</tbody>
</table>

Each ball was hit with a simulated club at two different speeds, namely a 60 MPH club head speed and a 125 MPH club head speed. The initial ball speed was determined to be as illustrated in FIG. 1 with a diamond indicating the initial ball speed at a club head speed of 60 MPH and a rectangle indicating the initial ball speed at a club head speed of 125 MPH.

For example, the initial ball speed of the ball made in accordance with the prior art (current) was 40 meters per second (m/s) at a club head speed of 60 MPH and 85 m/s at a club head speed of 125 MPH. As illustrated, the initial ball speed of the ball of the prior art was lower than all of the other balls 1-13, i.e., the balls made in accordance with the invention, for each club head speed.

Referring to FIG. 2, the initial ball momentum in kilogram meters per second (kg m/s) was plotted for the 14 golf balls of FIG. 1 for the two club head speeds.

As shown, the initial ball momentum of the prior art ball (labeled "current") was about 1.9 kg m/s at a club head speed of 60 MPH and about 3.9 at a club head speed of 125 MPH. The initial ball momentum of the prior art or current ball was higher than all of the other balls 1-13 made in accordance with the invention for each club head speed.

Referring to FIG. 3, the initial lift and drag change was plotted for the 14 golf balls of FIG. 1. again for the two club head speeds. Note that the proportional increase is independent of swing speed.

As shown, the initial lift and drag of the prior art ball was 100%. The initial lift and drag change of the balls made in accordance with the present invention was lower than the prior art ball for the same club head speed.
Referring to FIG. 4, the distance change in yards for a prior art ball (current) and three ball types (corresponding to Configuration #6, 10 and 13 of Table 1) made in accordance with the invention at club head speeds of 60 MPH and 85 MPH were plotted. It can be seen from FIG. 4 that the low swing speed player gains significantly in distance change (measured in yards) compared with the high swing speed player.

As shown, the prior art ball had a 0 distance change for both swing speed players. Ball type or configuration #2 had a distance change of about 4 yards at a club head speed of 60 MPH and a distance change of 125 MPH in a club head speed of 60 MPH. Ball type or configuration #10 had a distance change of a little over 5 yards at a club head speed of 60 MPH and a distance change of 0 yards at a club head speed of 125 MPH. Ball type or configuration #13 had a distance change of about 8 yards at a club head speed of 60 MPH and a distance change of 0 yards at a club head speed of 125 MPH.

As seen from FIG. 4, the low swing speed player gains significantly in yardage compared with the high swing speed player.

Referring to FIG. 5, the performances of four ball types made in accordance with the invention subtracted by the performance of the prior art or current ball as the distance loss in yards were plotted at different club head speeds of 60 MPH, 70 MPH, 90 MPH, 105 MPH and 120 MPH.

The diameter (in.), mass (oz.) and density (oz./in3) of each of these four golf balls are set forth in Table 2 below.

<table>
<thead>
<tr>
<th>Configuration #</th>
<th>Diameter (in)</th>
<th>Mass (oz)</th>
<th>Density (oz/in3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.680</td>
<td>1.620</td>
<td>0.653</td>
</tr>
<tr>
<td>2</td>
<td>1.600</td>
<td>1.400</td>
<td>0.653</td>
</tr>
<tr>
<td>3</td>
<td>1.360</td>
<td>1.304</td>
<td>0.653</td>
</tr>
<tr>
<td>4</td>
<td>1.500</td>
<td>1.398</td>
<td>0.653</td>
</tr>
</tbody>
</table>

As illustrated, a negative distance loss is actually a distance gain.

As shown, ball type A or Configuration #1 of Table 2 had a distance loss of 27 yards at 120 MPH, 24 yards at 105 MPH, about 20 yards at 90 MPH, about 14 yards at 70 MPH and about 6 yards at 60 MPH.

Ball type B or Configuration #2 of Table 2 had a distance loss of 25 yards at 120 MPH, 21 yards at 105 MPH, about 16 yards at 90 MPH, about 9 yards at 70 MPH and about 3 yards at 60 MPH.

Ball type C or Configuration #3 of Table 2 had a distance loss of 27 yards at 120 MPH, 21 yards at 105 MPH, about 15 yards at 90 MPH, about 8 yards at 70 MPH and about 1 yard at 60 MPH.

Ball type D or Configuration #4 of Table 2 had a distance loss of 27 yards at 120 MPH, 21 yards at 105 MPH, about 13 yards at 90 MPH, about 5 yards at 70 MPH and about 2 yards at 60 MPH.

There is a significant drive distance reduction for high swing speed players but a lesser reduction (and even a small distance increase for one ball) for low swing speed players.

It should be noted that, other than an increase in initial ball speed and increasing lift and drag force, and reductions in weight and initial momentum, the golf balls of the invention are otherwise similar to conventional golf balls. That is, they are comprised of one or more layers of primarily polymeric material and have a plurality of dimples, protrusions or other surface roughening features to promote good aerodynamics. Initial spin and launch angle are also similar to conventional golf balls. In order to achieve increased initial ball speed and lift and drag forces while simultaneously decreasing initial ball momentum in a manner that improves the drive distance of low swing speed players without benefiting high swing speed players, it is required that the golf ball mass and diameter be carefully selected simultaneously. It has been found that this is most preferably achieved by selecting the mass and diameter criteria such that;

i) The density of the golf ball shall not exceed 0.653 oz/in3

ii) The golf ball shall not have a mass exceeding 1.62 oz

The preferred relationship between golf ball mass and diameter for golf balls made according to the present invention is shown in FIG. 6.

An additional benefit of the preferred relationship between golf ball mass and diameter of the present invention is that, by preserving the density of a conventional golf ball, it has been found that the slice and hook behavior and the sensitivity to head, tail and cross winds is similar to conventional golf balls, thus preserving much of the playability of a conventional golf ball.

Three golf balls were designed and manufactured within the scope of this invention. Golf ball cores were made using DuPont AD 1035, a highly neutralized ethylene acid copolymer, weighted to achieve a specific gravity of about 1.160. Covers were injection molded from DuPont Surlyn® 9950, with a specific gravity of 0.965. The component dimensions and assembled ball dimensional properties are given below in Table 3.

<table>
<thead>
<tr>
<th>Prototype</th>
<th>Diameter</th>
<th>Core Diameter</th>
<th>Cover Thickness</th>
<th>Total Ball Weight</th>
<th>Finished Prototype Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;B&quot;</td>
<td>1.685</td>
<td>1.549</td>
<td>0.0680</td>
<td>1.61</td>
<td>0.643</td>
</tr>
<tr>
<td>&quot;M&quot;</td>
<td>1.630</td>
<td>1.500</td>
<td>0.0650</td>
<td>1.46</td>
<td>0.643</td>
</tr>
<tr>
<td>&quot;F&quot;</td>
<td>1.570</td>
<td>1.449</td>
<td>0.0665</td>
<td>1.30</td>
<td>0.642</td>
</tr>
</tbody>
</table>

Referencing FIG. 7, prototypes were visibly differentiable according to size, the largest, 1.685 inches in diameter (Ball “a.” in FIG. 7 but corresponding to the “B” prototype in Table 3), followed by the 1.630 inches in diameter (Ball “b.” in FIG. 7 but corresponding to the “M” prototype of Table 3), and 1.570 inches in diameter (Ball “c.” in FIG. 7 but corresponding to the “F” prototype of Table 3).

The golf balls were molded having circular dimples in the cover. Dimple dimensions, including depth and radius, were scaled according to the diameter of the ball to ensure similar aerodynamic characteristics (see Table 4).
TABLE 4

<table>
<thead>
<tr>
<th>Prototype</th>
<th>Surface Area (in.²)</th>
<th>Dimples Coverage</th>
<th>Lift Coefficient, Re = 180,000</th>
<th>Drag Coefficient, Re = 180,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;B&quot;</td>
<td>8.92</td>
<td>392 (icosahedron)</td>
<td>75%</td>
<td>0.215</td>
</tr>
<tr>
<td>&quot;M&quot;</td>
<td>8.35</td>
<td>392 (icosahedron)</td>
<td>75%</td>
<td>0.215</td>
</tr>
<tr>
<td>&quot;F&quot;</td>
<td>7.74</td>
<td>392 (icosahedron)</td>
<td>75%</td>
<td>0.215</td>
</tr>
</tbody>
</table>

[0043] In accordance with the invention, various changes may be made in the golf ball.

[0044] For example, the ball may be comprised of multiple layers of solid material. Referring to FIG. 8, in one embodiment, three layers may be used. Referring to FIG. 9, in another embodiment, four or more layers may be used (see FIG. 9).

[0045] The core may be comprised of a solid material and may contain at least one layer of polybutadiene, for example, comprised of; from 10 to 85 parts by weight of at least one of zinc diacrylate or zinc dimethacrylate from 0.5 to 5 parts of a processing promoter selected from the group consisting of fatty acids, zinc salts of fatty acids and mixtures thereof, a co-reaction agent, or a peroxide. Alternatively, the polybutadiene may be a high-cis-polybutadiene.

[0046] The core may contain at least one layer of neutralized acid polymer or at least one layer of at least one of Butyl rubber, Rabalon, Polyurethane, Polybutadiene, or SBR.

[0047] The cover may be comprised of thermostet urethane, thermoplastic urethane or a neutralized acid copolymer neutralized with at least one of lithium ions, zinc ions and sodium ions. In the case of a neutralized acid copolymer at least 40% of the acid groups should be neutralized.

[0048] The cover may also be comprised of trans-polyisoprene.

[0049] The golf ball may have dimples comprising at least 75% of the surface area of the golf ball covered by the dimples. The dimples may be of at least two different sizes and number from 300-450.

[0050] The dimples may also cover at least 85% of the surface area of the golf ball cover with the same differing sizes and number as above.

[0051] Referring to FIG. 10; in another embodiment, the core of the ball may be a diameter of 0.50 inch to 0.90 inch with a surrounding metal wall of a thickness of about 0.100 inch to 0.25 inch defining a hollow interior.

[0052] In another embodiment, the core may be encased in at least one layer of at least one of Butyl rubber, Rabalon, Polyurethane, Polybutadiene, highly neutralized acid copolymer, or SBR.

[0053] In still another embodiment, the core may have a diameter of 0.50 inch to 0.90 inch with a surrounding wall made from a composite material having an effective Elastic modulus of at least 900 MPa and comprised of at least one of aramid, carbon fibers and H0PE in a resin matrix, e.g. an epoxide.

[0054] Further, this core may be encased in at least one layer of at least one of Butyl rubber, Rabalon, Polyurethane, Polybutadiene, highly neutralized acid copolymer, or SBR.

[0055] In all embodiments, the golf ball is characterized in that the “total distance” as defined by the USGA Overall Distance Standard is from 240 to 320.

What is claimed is:

1. A golf ball having a mass not exceeding 1.62 ounces and in the range of about 1.198 ounces to about 1.620 ounces; a diameter of no more than about 1.680 inches and in the range of about 1.519 inches to 1.680 inches; and a density not to exceed about 0.653 ounces per cubic inches.

2. A golf ball with a diameter within the range of about 1.570 to 1.685 inches, a total ball weight in the range of about 1.30 ounces to 1.61 ounces and a density of about 0.642 ounces per cubic inch.

*   *   *   *   *