

Title

A GOLF BALL WITH MULTIPLE SETS OF DIMPLES

5

Technical Field

The present invention relates to a golf ball. More specifically, the present invention relates to a dimple pattern for a golf ball in which the dimple pattern has
10 different sizes of dimples.

Background Art

Golfers realized perhaps as early as the 1800's that golf balls with indented surfaces flew better than those with smooth surfaces. Hand-hammered gutta-percha golf balls could be purchased at least by the 1860's, and golf balls with
15 brambles (bumps rather than dents) were in style from the late 1800's to 1908. In 1908, an Englishman, William Taylor, received a patent for a golf ball with indentations (dimples) that flew better and more accurately than golf balls with brambles. A.G. Spalding & Bros., purchased the U.S. rights to the patent and introduced the GLORY ball featuring the TAYLOR dimples. Until the 1970s, the
20 GLORY ball, and most other golf balls with dimples had 336 dimples of the same size using the same pattern, the ATTI pattern. The ATTI pattern was an octahedron pattern, split into eight concentric straight line rows, which was named after the main producer of molds for golf balls.

The only innovation related to the surface of a golf ball during this sixty
25 year period came from Albert Penfold who invented a mesh-pattern golf ball for Dunlop. This pattern was invented in 1912 and was accepted until the 1930's.

In the 1970's, dimple pattern innovations appeared from the major golf ball manufacturers. In 1973, Titleist introduced an icosahedron pattern which divides the golf ball into twenty triangular regions. An icosahedron pattern was disclosed in British Patent Number 377,354 to John Vernon Pugh, however, this pattern had
5 dimples lying on the equator of the golf ball which is typically the parting line of the mold for the golf ball. Nevertheless, the icosahedron pattern has become the dominant pattern on golf balls today.

In the late 1970s and the 1980's the mathematicians of the major golf ball manufacturers focused their intention on increasing the dimpled surface area (the
10 area covered by dimples) of a golf ball. The dimpled surface for the ATTI pattern golf balls was approximately 50%. In the 1970's, the dimpled surface area increased to greater than 60% of the surface of a golf ball. Further breakthroughs increased the dimpled surface area to over 70%. U.S. Patent Number 4,949,976 to William Gobush discloses a golf ball with 78% dimple coverage with up to 422
15 dimples. The 1990's have seen the dimple surface area break into the 80% coverage.

The number of different dimples on a golf ball surface has also increased with the surface area coverage. The ATTI pattern disclosed a dimple pattern with only one size of dimple. The number of different types of dimples increased, with
20 three different types of dimples becoming the preferred number of different types of dimples. U.S. Patent Number 4,813,677, to Oka et al., discloses a dimple pattern with four different types of dimples on surface where the non-dimpled

surface cannot contain an additional dimple. United Kingdom patent application number 2157959, to Steven Aoyama, discloses dimples with five different diameters. Further, William Gobush invented a cuboctahedron pattern that has dimples with eleven different diameters. See *500 Year of Golf Balls*, Antique Trade Books, page 189. However, inventing dimple patterns with multiple dimples for a golf ball only has value if such a golf ball is commercialized and available for the typical golfer to play.

Additionally, dimple patterns have been based on the sectional shapes, such as octahedron, dodecahedron and icosahedron patterns. U.S. Patent 5,201,522 discloses a golf ball dimple pattern having pentagonal formations with equally number of dimples therein. U.S. Patent Number 4,880,241 discloses a golf ball dimple pattern having a modified icosahedron pattern wherein small triangular sections lie along the equator to provide a dimple-free equator. Although there are hundreds of published patents related to golf ball dimple patterns, there still remains a need to improve upon current dimple patterns. This need is driven by new materials used to manufacture golf balls, and the ever increasing innovations in golf clubs.

Disclosure of the Invention

The present invention provides a novel dimple pattern that reduces high speed drag on a golf ball while increasing its low speed lift thereby providing a golf ball that travels greater distances. The present invention is able to accomplish this by providing multiples sets of dimples arranged in a pattern that covers as

much as eighty-six percent of the surface of the golf ball.

One aspect of the present invention is a dimple pattern on a golf ball in which the dimple pattern has at least five different sets of dimples. The golf ball includes first, second, third, fourth and fifth pluralities of dimples disposed on the surface. Each of the first plurality of dimples has a first diameter. Each of the second plurality of dimples has a second diameter that is greater than the first diameter. Each of the third plurality of dimples has a third diameter that is greater than the second diameter. Each of the fourth plurality of dimples has a fourth diameter that is greater than the third diameter. Each of the fifth plurality of dimples has a fifth diameter that is greater than the fourth diameter. The first, second, third, fourth and fifth pluralities of dimples cover at least eighty percent of the surface of the golf ball.

The golf ball may also include a sixth plurality of dimples disposed on the surface with each of the sixth plurality of dimples having a sixth diameter that is greater than the fifth diameter. The first, second, third, fourth, fifth and sixth pluralities of dimples cover at least eighty-three percent of the surface of the golf ball.

The golf ball may further include at least one seventh dimple disposed on the surface. The at least one seventh dimple has a seventh diameter that is less than the first diameter. The first, second, third, fourth, fifth and sixth pluralities of dimples and the at least one seventh dimple cover at least eighty-six percent of the surface of the golf ball. The golf ball has an equator that divides the golf ball into

a first hemisphere and a second hemisphere, and the first hemisphere may be unsymmetrical with the second hemisphere.

Another aspect of the present invention is a dimple pattern on a golf ball that provides greater low speed lift and lower high speed drag. The golf ball

5 includes a plurality of different sets of dimples disposed on the surface. Each of the different sets of dimples having a different diameter than any other set of dimples. The plurality of different sets of dimples cover at least eighty-three percent of the surface of the golf ball. The golf ball has a lift coefficient greater than 0.20 at a Reynolds number of 70,000 and 2000 rpm, and a drag coefficient

10 less than 0.232 at a Reynolds number of 180,000 and 3000 rpm.

Brief Description of the Drawings

FIG. 1 is an equatorial view of a preferred embodiment of a golf ball of the present invention.

FIG. 1A is the view of FIG. 1 illustrating the rows of dimples.

5 FIG. 1B is the view of FIG. 1 illustrating the transition region of dimples.

FIG. 2 is a polar view of the golf ball of FIG. 1.

FIG. 2A is the view of FIG. 2 illustrating the cascading pentagons of dimples.

10 FIG. 2B is the view of FIG. 2 illustrating the single encompassing pentagon of dimples.

FIG. 3 is a polar view of the golf ball of FIG. 1 illustrating the star configuration.

FIG. 4 is an enlarged cross-sectional view of a dimple of a first set of dimples of the golf ball of the present invention.

15 FIG. 4A is an isolated cross-sectional view to illustrate the definition of the entry radius.

FIG. 5 is an enlarged cross-sectional view of a dimple of a second set of dimples of the golf ball of the present invention.

20 FIG. 6 is an enlarged cross-sectional view of a dimple of a third set of dimples of the golf ball of the present invention.

FIG. 7 is an enlarged cross-sectional view of a dimple of a fourth set of dimples of the golf ball of the present invention.

FIG. 8 is an enlarged cross-sectional view of a dimple of a fifth set of dimples of the golf ball of the present invention.

FIG. 9 is an enlarged cross-sectional view of a dimple of a sixth set of dimples of the golf ball of the present invention.

5 FIG. 10 is an enlarged cross-sectional view of a dimple of a seventh set of dimples of the golf ball of the present invention.

FIG. 11 is a polar view of an alternative embodiment of the golf ball of the present invention.

FIG. 12 is an equatorial view of yet another alternative embodiment of a
10 golf ball of the present invention.

FIG. 13 is a graph of the lift coefficient versus Reynolds number.

FIG. 14 is a graph of the drag coefficient versus Reynolds number.

FIG. 15 is a graph of the average drag coefficient versus the average lift coefficient.

15

Best Mode(s) For Carrying Out the Invention

As shown in FIGS. 1-3, a golf ball is generally designated 20. The golf ball may be a one-piece, two-piece, a three piece, or the like golf ball. Further, the three-piece golf ball may have a wound layer, or a solid boundary layer. The cover
20 of the golf ball 20 may be any suitable material. A preferred cover for a three-piece golf ball is a cover composed of a thermoset polyurethane material. A preferred cover for a two-piece golf ball is a blend of ionomers. The thickness of

the cover for a two piece is preferably 0.070 inch, while the thickness of the cover for a three-piece golf ball is preferably 0.030 inch. However, those skilled in the pertinent art will recognize that other cover materials may be utilized without departing from the scope and spirit of the present invention. The golf ball 20 may
5 have a finish of a basecoat and/or top coat.

The PGA compression of the golf ball is preferably between 70 to 110.

The golf ball 20 has a surface 22. The golf ball 20 also has an equator 24 dividing the golf ball 20 into a first hemisphere 26 and a second hemisphere 28. A first pole 30 is located ninety degrees along a longitudinal arc from the equator 24
10 in the first hemisphere 26. A second pole 32 is located ninety degrees along a longitudinal arc from the equator 24 in the second hemisphere 28.

On the surface 22, in both hemispheres 26 and 28, are 382 dimples partitioned into seven different sets of dimples. A first set of dimples 34 are the most numerous dimples consisting of two-hundred twenty dimples in the preferred
15 embodiment. A second set of dimples 36 are the next most numerous dimples consisting of one-hundred dimples. A third set of dimples 38 and a fourth set of dimples 40 are the next most numerous with each set 38 and 40 consisting of twenty dimples in the preferred embodiment. A fifth set of dimples 42 and a sixth set of dimples 44 are the next most numerous with each set 42 and 44 consisting of
20 ten dimples in the preferred embodiment. The seventh set of dimples 46 consist of only two dimples. In a preferred embodiment, the 382 dimples account for 86% of the surface 22 of the golf ball.

The two dimples of the seventh set of dimples 46 are each disposed on respective poles 30 and 32. Each of the fifth set of dimples 42 is adjacent one of the seventh set of dimples 46. The five dimples of the fifth set of dimples 42 that are disposed within the first hemisphere 26 are each an equal distance from the equator 24 and the first pole 30. The five dimples of the fifth set of dimples 42 that are disposed within the second hemisphere 28 are each an equal distance from the equator 24 and the second pole 32. These polar dimples 42 and 46 account for approximately 2% of the surface 22 of the golf ball 20.

A cross-section of a dimple of the fifth set of dimples 42 is shown in FIG. 8. The radius R_5 of the dimple 42 is approximately 0.0720 inches, the chord depth C_5 is approximately 0.0054 inches, the entry angle θ_5 is approximately 15.7 degrees, and the edge radius ER_5 is approximately 0.0336 inches. A cross-section of a dimple of the seventh set of dimples 46 is shown in FIG.10. The radius R_7 of the dimple 46 is approximately 0.0510 inches, the chord depth C_7 is approximately 0.0049 inches, the entry angle θ_7 is approximately 13.4 degrees, and the edge radius ER_7 is approximately 0.0336 inches.

The ten dimples of the sixth set of dimples 44 account for approximately 3% of the surface 22 of the golf ball 20. The five dimples of the sixth set of dimples 44 that are disposed within the first hemisphere 26 are each an equal distance from the equator 24 and the first pole 30. The five dimples of the sixth set of dimples 44 that are disposed within the second hemisphere 28 are each an equal distance from the equator 24 and the second pole 32. Also, each of the sixth set of dimples 44 is

adjacent to three different sets of dimples 34, 36 and 40.

A cross-section of a dimple of the sixth set of dimples 44 is shown in FIG.9.

The radius R_6 of the dimple 44 is approximately 0.0930 inches, the chord depth C_6 is approximately 0.0051 inches, the entry angle θ_6 is approximately 15.2 degrees,
5 and the edge radius ER_6 is approximately 0.0333 inches. The extraordinarily large diameter of each of the sixth set of dimples 44 allows for the extraordinary surface coverage of the dimple pattern of the present invention. This is contrary to conventional thinking that teaches that dimples with smaller diameters would provide for greater surface coverage.

10 All of the fourth set of dimples 40 are adjacent to at least one of the sixth set of dimples 44. The twenty dimples of the fourth set of dimples 40 cover approximately 2.7% of the surface 22 of the golf ball 20. The ten dimples of the fourth set of dimples 40 that are disposed within the first hemisphere 26 are each an equal distance from the equator 24 and the first pole 30. The ten dimples of the
15 fourth set of dimples 40 that are disposed within the second hemisphere 28 are each an equal distance from the equator 24 and the second pole 32. Also, each of the fourth set of dimples 40 is adjacent to three different sets of dimples 36, 38 and 44.

A cross-section of a dimple of the fourth set of dimples 40 is shown in FIG.

20 7. The radius R_4 of the dimple 40 is approximately 0.062 inches, the chord depth C_4 is approximately 0.0052 inches, the entry angle θ_4 is approximately 15.2 degrees, and the edge radius ER_4 is approximately 0.0358 inches.

All of the third set of dimples 38 are adjacent to at least one of the sixth set of dimples 44. The twenty dimples of the third set of dimples 38 cover approximately 3.8% of the surface 22 of the golf ball 20. The ten dimples of the third set of dimples 38 that are disposed within the first hemisphere 26 are each an equal distance from the equator 24 and the first pole 30. The ten dimples of the third set of dimples 38 that are disposed within the second hemisphere 28 are each an equal distance from the equator 24 and the second pole 32. Also, each of the fourth set of dimples 38 is adjacent to three different sets of dimples 34, 36 and 40.

A cross-section of a dimple of the third set of dimples 38 is shown in FIG. 6.

10 The radius R_3 of the dimple 38 is approximately 0.074 inches, the chord depth C_3 is approximately 0.0053 inches, the entry angle θ_3 is approximately 15.3 degrees, and the edge radius ER_3 is approximately 0.0344 inches.

The two-hundred twenty dimples of the first set of dimples 34 are the most influential of the different sets of dimples 34-46 due to their number, size and placement on the surface 22 of the golf ball 20. The two-hundred twenty dimples of the first set of dimples 34 cover approximately 53% of the surface 22 of the golf ball 20. The one-hundred ten dimples of the first set of dimples 34 that are disposed within the first hemisphere 26 are disposed in either a first row 80 and a second row 82 above the equator 24, or a pseudo-star configuration 84 about the first pole 30 that is best illustrated in FIG. 3. Similarly, the one-hundred ten dimples of the first set of dimples 34 that are disposed within the second hemisphere 28 are disposed in either a first row 90 and a second row 92 below the

equator 24, or a pseudo-star configuration 94, not shown, about the second pole 32, not shown.

A cross-section of a dimple of the first set of dimples 34 is shown in FIG. 4. The radius R_1 of the dimple 34 is approximately 0.0834 inches, the chord depth C_1 is approximately 0.0053 inches, the entry angle θ_1 is approximately 15.3 degrees, and the edge radius ER_1 is approximately 0.0344 inches. Unlike the use of the term “entry radius” or “edge radius” in the prior art, the edge radius as defined herein is a value utilized in conjunction with the entry angle to delimit the concave and convex segments of the dimple contour. The first and second derivatives of the two Bézier curves are forced to be equal at this point defined by the edge radius and the entry angle, as shown in FIG. 4A. A more detailed description of the contour of the dimples is set forth in co-pending U.S. Patent Application Number 09/398,918, filed on September 16, 1999, entitled Golf Ball Dimples With Curvature Continuity, which is hereby incorporated by reference in its entirety.

The one-hundred dimples of the second set of dimples 36 are the next most influential of the different sets of dimples 34-46 due to their number, size and placement on the surface 22 of the golf ball 20. The one-hundred dimples of the second set of dimples 36 cover approximately 22% of the surface 22 of the golf ball 20. Thus, together the first set of dimples 34 and the second set of dimples 36 cover over approximately 75% of the surface 22 of the golf ball 20. The fifty dimples of the second set of dimples 36 that are disposed within the first hemisphere 26 are disposed in either a third row 86 above the equator, a second

pentagon 102 about the first pole 30, or along a transition latitudinal region 70.

Similarly, the fifty dimples of the second set of dimples 36 that are disposed within the second hemisphere 28 are disposed in either a third row 96 below the equator 24, a second pentagon 102a, not shown, about the second pole 32, or along a

5 transition latitudinal region 72.

A cross-section of a dimple of the second set of dimples 36 is shown in FIG.

5. The radius R_2 of the dimple 36 is approximately 0.079 inches, the chord depth C_2 is approximately 0.0053 inches, the entry angle θ_2 is approximately 15.1 degrees, and the edge radius ER_2 is approximately 0.0315 inches.

10 As best illustrated in FIG. 1A, each hemisphere 26 and 28 begins with three rows from the equator 24. The first and second rows 80 and 82 of the first hemisphere 26 and the first and second rows 90 and 92 of the second hemisphere 28 are composed of the first set of dimples 34. The third row 86 of the first hemisphere 26 and the third row 96 of the second hemisphere 28 are composed of

15 the second set of dimples 36. This pattern of rows is utilized to achieve greater surface area coverage of the dimples on the golf ball 20. However, as mentioned previously, conventional teaching would dictate that additional rows of smaller diameter dimples should be utilized to achieve greater surface area coverage.

However, the dimple pattern of the present invention transitions from rows of equal

20 dimples into a pentagonal region 98. The pentagonal region 98 is best seen in FIG. 2A. A similar pentagonal region 98a, not shown, is disposed about the second pole 32. The pentagonal region 98 has five pentagons 100, 102, 104, 106 and 108

expanding from the first pole 30. Similar pentagons 100a, 102a, 104a, 106a and 108a expand from the second pole 32. The first pentagon 100 consists of the fifth set of dimples 42. The second pentagon 102 consists of the second set of dimples 36. The third pentagon 104 consists of the first set of dimples 34. The fourth
5 pentagon 106 also consists of the first set of dimples 34. The fifth pentagon 108 consists of the first set of dimples 34 and the sixth set of dimples 44. However, the greater fifth pentagon 108' would include the fifth pentagon 108 and all dimples disposed between the third row 86 and the fifth pentagon 108. The pentagonal region 98 allows for the greater surface area of the dimple pattern of the present
10 invention.

FIG. 2B illustrates five triangles 130-138 that compose the pentagonal region 98. Dashed line 140 illustrates the extent of the greater pentagonal region 98' which overlaps with the transition latitudinal region 70.

As best illustrated in FIG. 1B, all of the dimples of the third set of dimples
15 38, the fourth set of dimples 40 and the sixth set of dimples 44 are disposed within the transition latitudinal regions 70 and 72. The transition latitudinal regions 70 and 72 transition the dimple pattern of the present invention from the rows 80, 82, 86, 90, 92 and 96 to the pentagonal regions 98 and 98a. Each of the transition latitudinal regions 70 and 72 cover a circumferencial area between 40 to 60
20 longitudinal degrees from the equator 24 in their respective hemispheres 26 and 28. The first transition latitudinal region 70 has a polar boundary 120 at approximately 60 longitudinal degrees from the equator 24, and an equatorial boundary 122 at

approximately 40 longitudinal degrees from the equator 24. Similarly, the second transition latitudinal region 72 has a polar boundary 120a at approximately 60 longitudinal degrees from the equator 24, and an equatorial boundary 122a at approximately 40 longitudinal degrees from the equator 24.

5 Alternative embodiments of the dimple pattern of the present invention are illustrated in FIGS. 11 and 12. The dimple pattern on the golf ball 20a of FIG. 11 only has five different sets of dimples 34, 36, 40, 42 and 44. The dimple pattern on the golf ball 20b of FIG. 12 only has six different sets of dimples 34, 36, 38, 40, 42 and 44. Both of the dimple patterns of the golf balls 20a and 20b have had the
10 seventh set of dimples 46 that are disposed at the poles 30 and 32 removed, and the dimple patter of the golf ball 20a has had all of the dimples of the third set of dimples 38 substituted with dimples from the fifth set of dimples 42.

The force acting on a golf ball in flight is calculated by the following trajectory equation:

$$15 \qquad F = F_L + F_D + G \qquad (A)$$

wherein F is the force acting on the golf ball; F_L is the lift; F_D is the drag; and G is gravity. The lift and the drag in equation A are calculated by the following equations:

$$F_L = 0.5 C_L A \rho v^2 \qquad (B)$$

$$20 \qquad F_D = 0.5 C_D A \rho v^2 \qquad (C)$$

wherein C_L is the lift coefficient; C_D is the drag coefficient; A is the maximum cross-sectional area of the golf ball; ρ is the density of the air; and v is the golf ball

airspeed.

The drag coefficient, C_D , and the lift coefficient, C_L , may be calculated using the following equations:

$$C_D = 2F_D / A\rho v^2 \quad (D)$$

$$5 \quad C_L = 2F_L / A\rho v^2 \quad (E)$$

The Reynolds number R is a dimensionless parameter that quantifies the ratio of inertial to viscous forces acting on an object moving in a fluid. Turbulent flow for a dimpled golf ball occurs when R is greater than 40000. If R is less than 40000, the flow may be laminar. The turbulent flow of air about a dimpled golf ball in flight allows it to travel farther than a smooth golf ball.

The Reynolds number R is calculated from the following equation:

$$R = vD\rho/\mu \quad (F)$$

wherein v is the average velocity of the golf ball; D is the diameter of the golf ball (usually 1.68 inches); ρ is the density of air (0.00238 slugs/ft³ at standard atmospheric conditions); and μ is the absolute viscosity of air (3.74 x 10⁻⁷ lb*sec/ft² at standard atmospheric conditions). A Reynolds number, R , of 180,000 for a golf ball having a USGA approved diameter of 1.68 inches, at standard atmospheric conditions, approximately corresponds to a golf ball hit from the tee at 200 ft/s or 136 mph, which is the point in time during the flight of a golf ball when the golf ball attains its highest speed. A Reynolds number, R , of 70,000 for a golf ball having a USGA approved diameter of 1.68 inches, at standard atmospheric conditions, approximately corresponds to a golf ball at its apex in its flight, 78 ft/s

or 53 mph, which is the point in time during the flight of the golf ball when the travels at its slowest speed. Gravity will increase the speed of a golf ball after its reaches its apex.

FIG. 13 illustrates the lift coefficient of a golf ball 20 with the dimple pattern of the present invention thereon as compared to the Titleist PROFESSIONAL, the Titleist TOUR PRESTIGE, the Maxfli REVOLUTION and the Maxfli HT URETHANE. FIG. 14 illustrates the drag coefficient of a golf ball 20 with the dimple pattern of the present invention thereon as compared to the Titleist PROFESSIONAL, the Titleist TOUR PRESTIGE, the Maxfli REVOLUTION and the Maxfli HT URETHANE. FIG. 15 illustrates the average drag coefficient versus the average lift coefficient of a golf ball 20 with the dimple pattern of the present invention thereon as compared to Titleist PROFESSIONAL, the Titleist TOUR PRESTIGE, the Maxfli REVOLUTION the Titleist HP DISTANCE 202, the Titleist HP ECLIPSE 204, the SRI Maxfli HI-BRD (from Japan) 206, the Wilson CYBERCORE PRO DISTANCE 208, the Titleist PRO V1 210, the Bridgestone TOUR STAGE MC392 (from Japan) 212, the Precept MC LADY 214, the Nike TOUR ACCURACY 216, and the Titleist DT DISTANCE 218, the Maxfli HT URETHANE, and others. The average lift coefficient is the average of the four lift coefficient values consisting of the lift coefficient of the golf ball at a Reynolds number of 70,000 and 2000 rpm, the lift coefficient of the golf ball at a Reynolds number of 70,000 and 3000 rpm, the lift coefficient of the golf ball at a Reynolds number of 80,000 and 2000 rpm, and the lift coefficient of the golf ball

at a Reynolds number of 80,000 and 3000 rpm. The average drag coefficient is the average of the six drag coefficient values consisting of the drag coefficient of the golf ball at a Reynolds number of 120,000 and 2000 rpm, the drag coefficient of the golf ball at a Reynolds number of 120,000 and 3000 rpm, the drag
5 coefficient of the golf ball at a Reynolds number of 150,000 and 2000 rpm, the drag coefficient of the golf ball at a Reynolds number of 150,000 and 3000 rpm, the drag coefficient of the golf ball at a Reynolds number of 180,000 and 2000 rpm, and the drag coefficient of the golf ball at a Reynolds number of 180,000 and 3000 rpm.

10 All of the golf balls for the comparison test, including the golf ball 20 with the dimple pattern of the present invention, have a thermoset polyurethane cover. The golf balls 20 with the dimple pattern of the present invention were constructed as set forth in U.S. Patent Number 6,190,268 filed on July 27, 1999, for a Golf Ball With A Polyurethane Cover which pertinent parts are hereby incorporated by
15 reference. The aerodynamics of the dimple pattern of the present invention provides a greater lift with a reduced drag thereby translating into a golf ball 20 that travels a greater distance than golf balls of similar constructions.

As compared to other golf balls having polyurethane covers, the golf ball 20 of the present invention is the only one that combines a lower drag coefficient at
20 high speeds, and a greater lift coefficient at low speeds. Specifically, as shown in FIGS. 13 and 14, none of the other golf balls have a lift coefficient, C_L , greater than 0.18 at a Reynolds number of 70,000, and a drag coefficient C_D less than 0.23

at a Reynolds number of 180,000. For example, while the Titliest PROFESSIONAL has a C_L greater than 0.18 at a Reynolds number of 70,000, its C_D is greater than 0.23 at a Reynolds number of 180,000. Also, while the Maxfli REVOLUTION has a drag coefficient C_D greater than 0.23 at a Reynolds number
5 of 180,000, its C_L is less than 0.18 at a Reynolds number of 70,000.

In this regard, the Rules of Golf, approved by the United States Golf Association (“USGA”) and The Royal and Ancient Golf Club of Saint Andrews, limits the initial velocity of a golf ball to 250 feet (76.2m) per second (a two percent maximum tolerance allows for an initial velocity of 255 per second) and
10 the overall distance to 280 yards (256m) plus a six percent tolerance for a total distance of 296.8 yards (the six percent tolerance may be lowered to four percent).

A complete description of the Rules of Golf are available on the USGA web page at www.usga.org. Thus, the initial velocity and overall distance of a golf ball must not exceed these limits in order to conform to the Rules of Golf. Therefore, the
15 golf ball 20 has a dimple pattern that enables the golf ball 20 to meet, yet not exceed, these limits.

Claims

I claim as my invention:

1. A golf ball having a surface, the golf ball comprising multiple sets of dimples wherein the golf ball has an average lift coefficient greater than 0.23 and
5 an average drag coefficient less than 0.229;

wherein the average lift coefficient is the average of the four lift coefficient values consisting of the lift coefficient of the golf ball at a Reynolds number of 70,000 and 2000 rpm, the lift coefficient of the golf ball at a Reynolds number of 70,000 and 3000 rpm, the lift coefficient of the golf ball at a Reynolds number of
10 80,000 and 2000 rpm, and the lift coefficient of the golf ball at a Reynolds number of 80,000 and 3000 rpm;

wherein the average drag coefficient is the average of the six drag coefficient values consisting of the drag coefficient of the golf ball at a Reynolds number of 120,000 and 2000 rpm, the drag coefficient of the golf ball at a
15 Reynolds number of 120,000 and 3000 rpm, the drag coefficient of the golf ball at a Reynolds number of 150,000 and 2000 rpm, the drag coefficient of the golf ball at a Reynolds number of 150,000 and 3000 rpm, the drag coefficient of the golf ball at a Reynolds number of 180,000 and 2000 rpm, and the drag coefficient of the golf ball at a Reynolds number of 180,000 and 3000 rpm.

20

2. The golf ball according to claim 1 wherein the golf ball comprises:
a first plurality of dimples disposed on the surface, each of the first plurality

of dimples having a first diameter;

a second plurality of dimples disposed on the surface, each of the second plurality of dimples having a second diameter, the second diameter greater than the first diameter;

5 a third plurality of dimples disposed on the surface, each of the third plurality of dimples having a third diameter, the third diameter greater than the second diameter;

a fourth plurality of dimples disposed on the surface, each of the fourth plurality of dimples having a fourth diameter, the fourth diameter greater than the
10 third diameter; and

a fifth plurality of dimples disposed on the surface, each of the fifth plurality of dimples having a fifth diameter, the fifth diameter greater than the fourth diameter;

wherein the first, second, third, fourth and fifth pluralities of dimples cover
15 at least eighty percent of the surface of the golf ball.

3. The golf ball according to claim 2 further comprising a sixth plurality of dimples disposed on the surface, each of the sixth plurality of dimples having a sixth diameter, the sixth diameter greater than the fifth diameter, wherein the first,
20 second, third, fourth, fifth and sixth pluralities of dimples cover at least eighty-three percent of the surface of the golf ball.

4. The golf ball according to claim 3 further comprising at least one seventh dimple disposed on the surface, the at least one seventh dimple having a seventh diameter, the seventh diameter less than the first diameter, wherein the first, second, third, fourth, fifth and sixth pluralities of dimples and the at least one
5 seventh dimple cover at least eighty-six percent of the surface of the golf ball.

5. A golf ball comprising:
a core; and
a cover composed of a urethane material and having multiple sets of
10 dimples wherein the golf ball has an average lift coefficient greater than 0.24 and an average drag coefficient less than 0.236;

wherein the average lift coefficient is the average of the four lift coefficient values consisting of the lift coefficient of the golf ball at a Reynolds number of 70,000 and 2000 rpm, the lift coefficient of the golf ball at a Reynolds number of
15 70,000 and 3000 rpm, the lift coefficient of the golf ball at a Reynolds number of 80,000 and 2000 rpm, and the lift coefficient of the golf ball at a Reynolds number of 80,000 and 3000 rpm;

wherein the average drag coefficient is the average of the six drag coefficient values consisting of the drag coefficient of the golf ball at a Reynolds
20 number of 120,000 and 2000 rpm, the drag coefficient of the golf ball at a Reynolds number of 120,000 and 3000 rpm, the drag coefficient of the golf ball at a Reynolds number of 150,000 and 2000 rpm, the drag coefficient of the golf ball

at a Reynolds number of 150,000 and 3000 rpm, the drag coefficient of the golf ball at a Reynolds number of 180,000 and 2000 rpm, and the drag coefficient of the golf ball at a Reynolds number of 180,000 and 3000 rpm.

5 6. The golf ball according to claim 5 further comprising an intermediate layer between the core and cover.

7. The golf ball according to claim 5 wherein the golf ball comprises:
a first plurality of dimples disposed on the surface, each of the first plurality
10 of dimples having a first diameter;
a second plurality of dimples disposed on the surface, each of the second plurality of dimples having a second diameter, the second diameter greater than the first diameter;
a third plurality of dimples disposed on the surface, each of the third
15 plurality of dimples having a third diameter, the third diameter greater than the second diameter;
a fourth plurality of dimples disposed on the surface, each of the fourth plurality of dimples having a fourth diameter, the fourth diameter greater than the third diameter; and
20 a fifth plurality of dimples disposed on the surface, each of the fifth plurality of dimples having a fifth diameter, the fifth diameter greater than the fourth diameter;

wherein the first, second, third, fourth and fifth pluralities of dimples cover at least eighty percent of the surface of the golf ball.

6. A golf ball comprising:

5 a core; and

a cover composed of a thermoset urethane material and having multiple sets of dimples wherein the golf ball has an average lift coefficient greater than 0.233 and an average drag coefficient less than 0.241;

10 wherein the average lift coefficient is the average of the four lift coefficient values consisting of the lift coefficient of the golf ball at a Reynolds number of 70,000 and 2000 rpm, the lift coefficient of the golf ball at a Reynolds number of 70,000 and 3000 rpm, the lift coefficient of the golf ball at a Reynolds number of 80,000 and 2000 rpm, and the lift coefficient of the golf ball at a Reynolds number of 80,000 and 3000 rpm;

15 wherein the average drag coefficient is the average of the six drag coefficient values consisting of the drag coefficient of the golf ball at a Reynolds number of 120,000 and 2000 rpm, the drag coefficient of the golf ball at a Reynolds number of 120,000 and 3000 rpm, the drag coefficient of the golf ball at a Reynolds number of 150,000 and 2000 rpm, the drag coefficient of the golf ball at a Reynolds number of 150,000 and 3000 rpm, the drag coefficient of the golf ball at a Reynolds number of 180,000 and 2000 rpm, and the drag coefficient of the golf ball at a Reynolds number of 180,000 and 3000 rpm.

20

9. The golf ball according to claim 8 further comprising an intermediate layer between the core and cover.

10. The golf ball according to claim 8 wherein the golf ball comprises:

5 a first plurality of dimples disposed on the surface, each of the first plurality of dimples having a first diameter;

a second plurality of dimples disposed on the surface, each of the second plurality of dimples having a second diameter, the second diameter greater than the first diameter;

10 a third plurality of dimples disposed on the surface, each of the third plurality of dimples having a third diameter, the third diameter greater than the second diameter;

a fourth plurality of dimples disposed on the surface, each of the fourth plurality of dimples having a fourth diameter, the fourth diameter greater than the third diameter; and

15 a fifth plurality of dimples disposed on the surface, each of the fifth plurality of dimples having a fifth diameter, the fifth diameter greater than the fourth diameter;

wherein the first, second, third, fourth and fifth pluralities of dimples cover
20 at least eighty percent of the surface of the golf ball.

11. A golf ball comprising:
- a core; and
- a cover having multiple sets of dimples wherein the golf ball has an average lift coefficient greater than 0.245 and an average drag coefficient less than 0.234;
- 5 wherein the average lift coefficient is the average of the four lift coefficient values consisting of the lift coefficient of the golf ball at a Reynolds number of 70,000 and 2000 rpm, the lift coefficient of the golf ball at a Reynolds number of 70,000 and 3000 rpm, the lift coefficient of the golf ball at a Reynolds number of 80,000 and 2000 rpm, and the lift coefficient of the golf ball at a Reynolds number
- 10 of 80,000 and 3000 rpm;
- wherein the average drag coefficient is the average of the six drag coefficient values consisting of the drag coefficient of the golf ball at a Reynolds number of 120,000 and 2000 rpm, the drag coefficient of the golf ball at a Reynolds number of 120,000 and 3000 rpm, the drag coefficient of the golf ball at
- 15 a Reynolds number of 150,000 and 2000 rpm, the drag coefficient of the golf ball at a Reynolds number of 150,000 and 3000 rpm, the drag coefficient of the golf ball at a Reynolds number of 180,000 and 2000 rpm, and the drag coefficient of the golf ball at a Reynolds number of 180,000 and 3000 rpm.
- 20 12. The golf ball according to claim 11 further comprising an intermediate layer between the core and cover.

13. The golf ball according to claim 11 wherein the golf ball comprises:

a first plurality of dimples disposed on the surface, each of the first plurality of dimples having a first diameter;

5 a second plurality of dimples disposed on the surface, each of the second plurality of dimples having a second diameter, the second diameter greater than the first diameter;

a third plurality of dimples disposed on the surface, each of the third plurality of dimples having a third diameter, the third diameter greater than the second diameter;

10 a fourth plurality of dimples disposed on the surface, each of the fourth plurality of dimples having a fourth diameter, the fourth diameter greater than the third diameter; and

a fifth plurality of dimples disposed on the surface, each of the fifth plurality of dimples having a fifth diameter, the fifth diameter greater than the
15 fourth diameter;

wherein the first, second , third, fourth and fifth pluralities of dimples cover at least eighty percent of the surface of the golf ball.

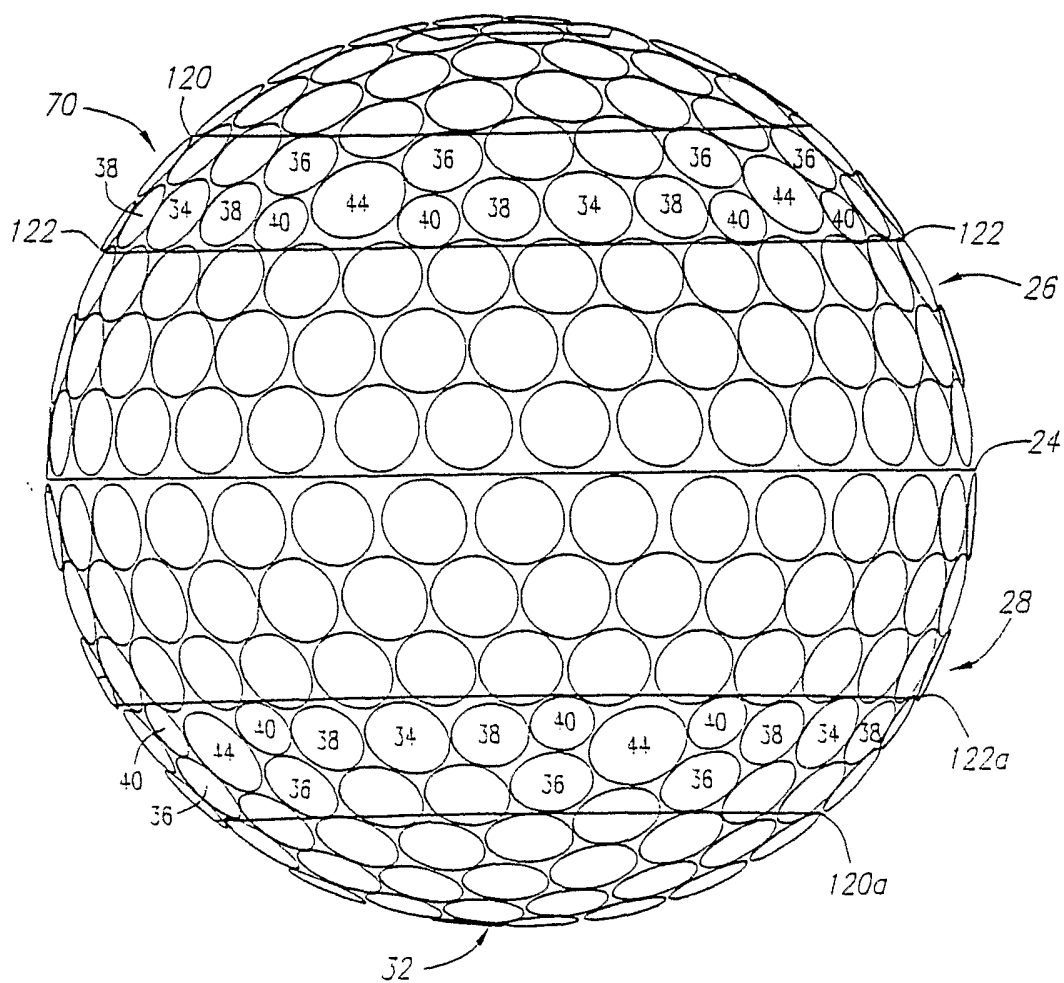
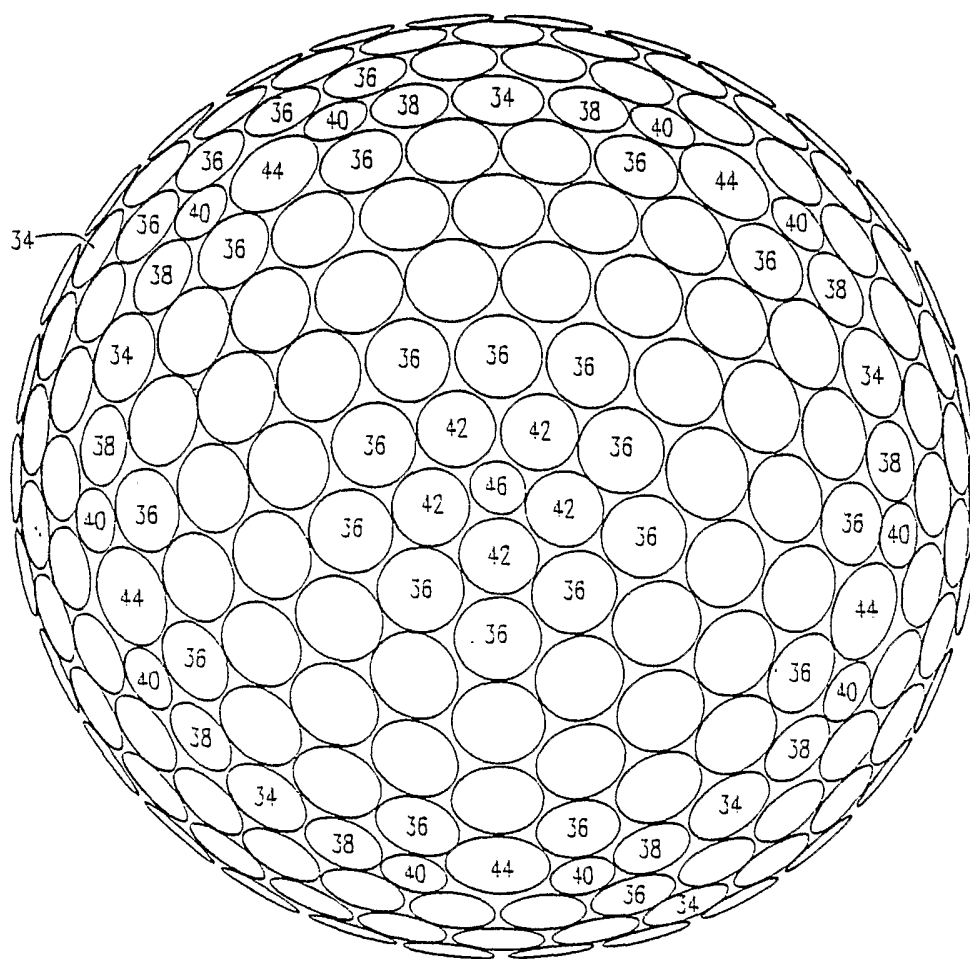


FIG. 1.

*FIG. 2*

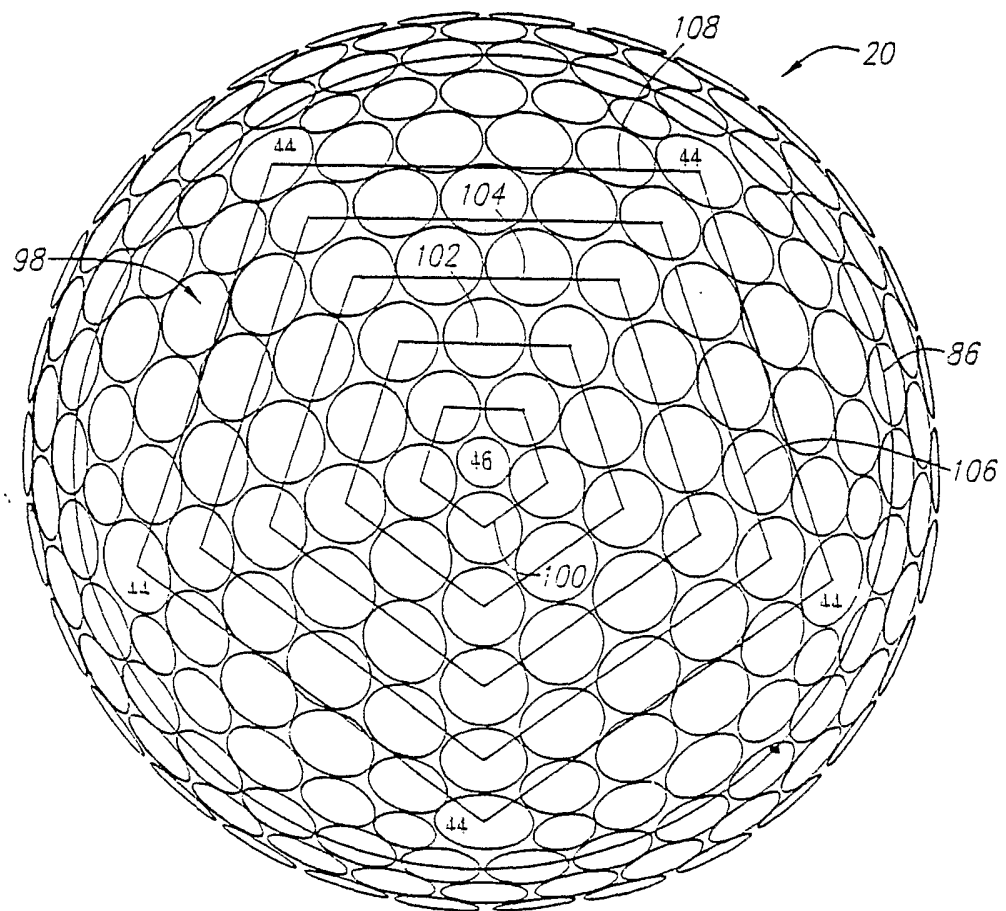


FIG. 2A

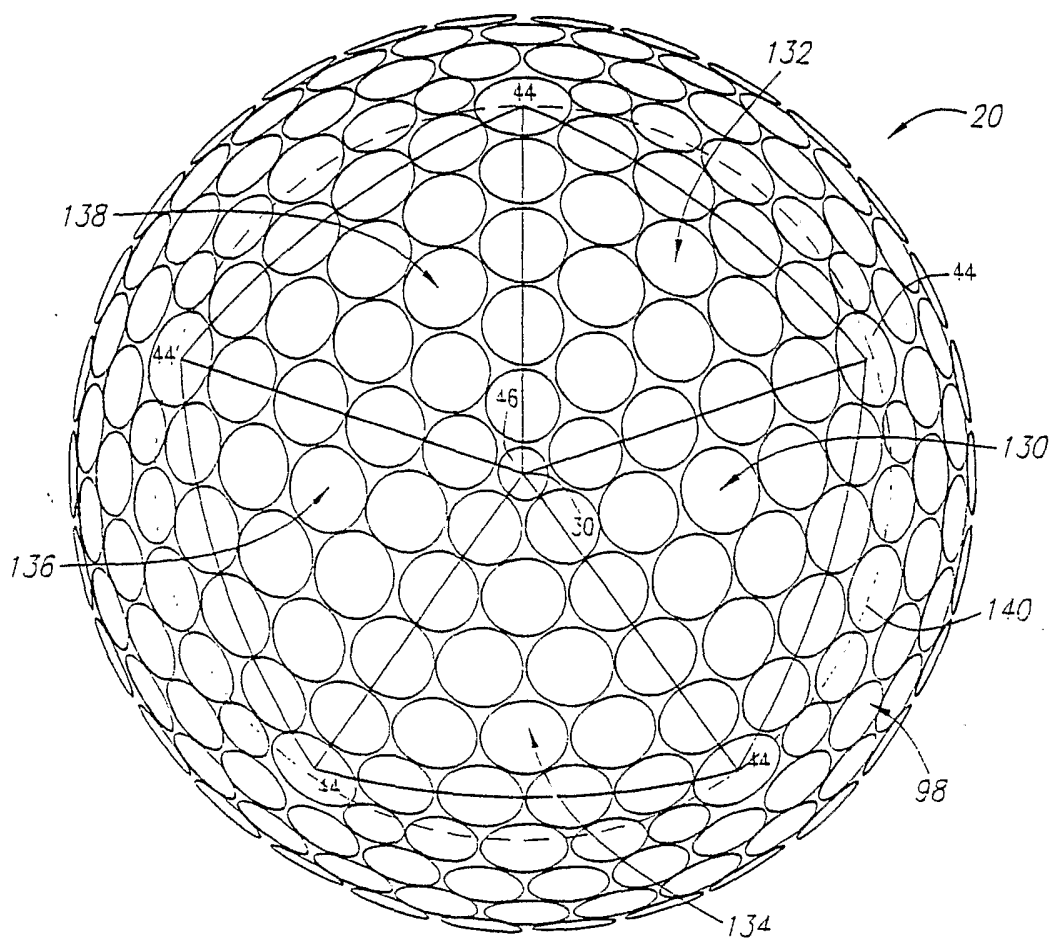


FIG. 2B

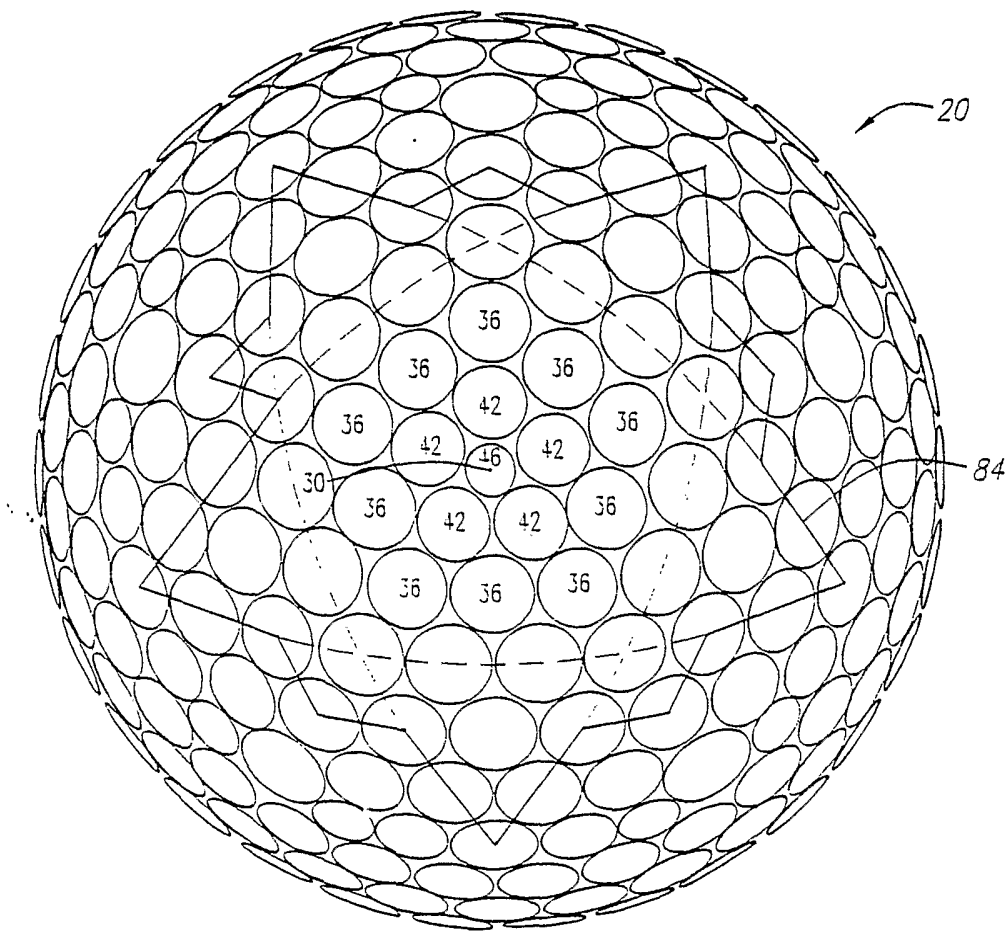
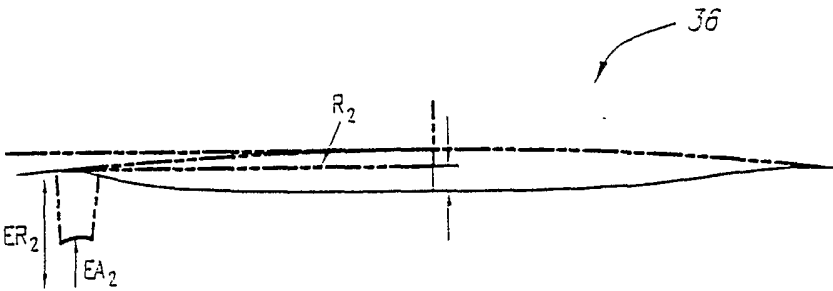
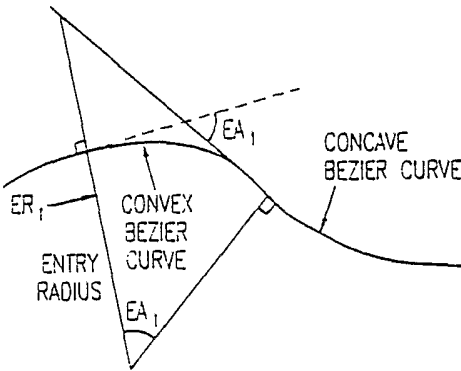
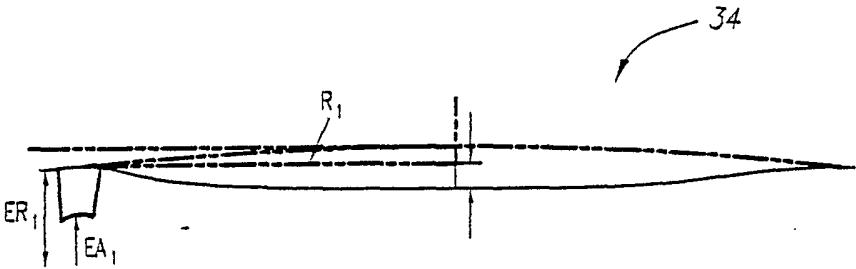


FIG. 3



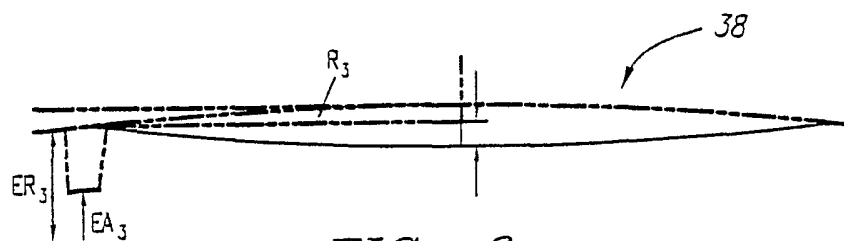


FIG. 6

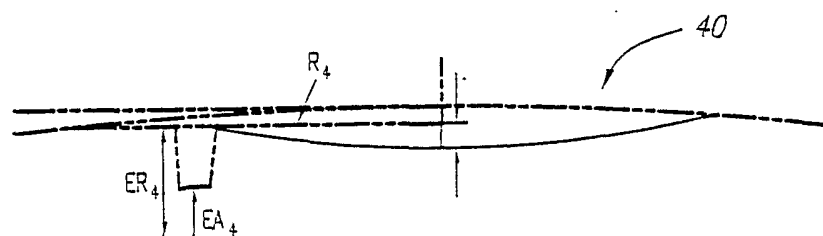


FIG. 7

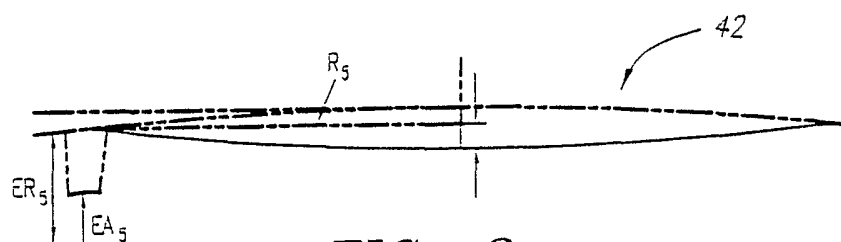


FIG. 8

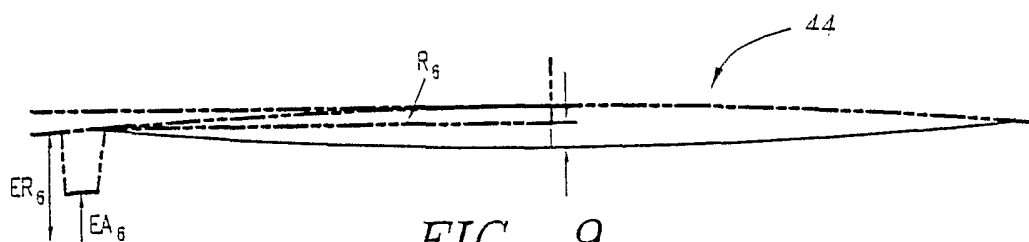


FIG. 9

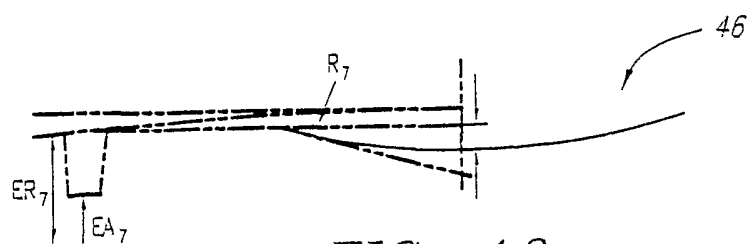
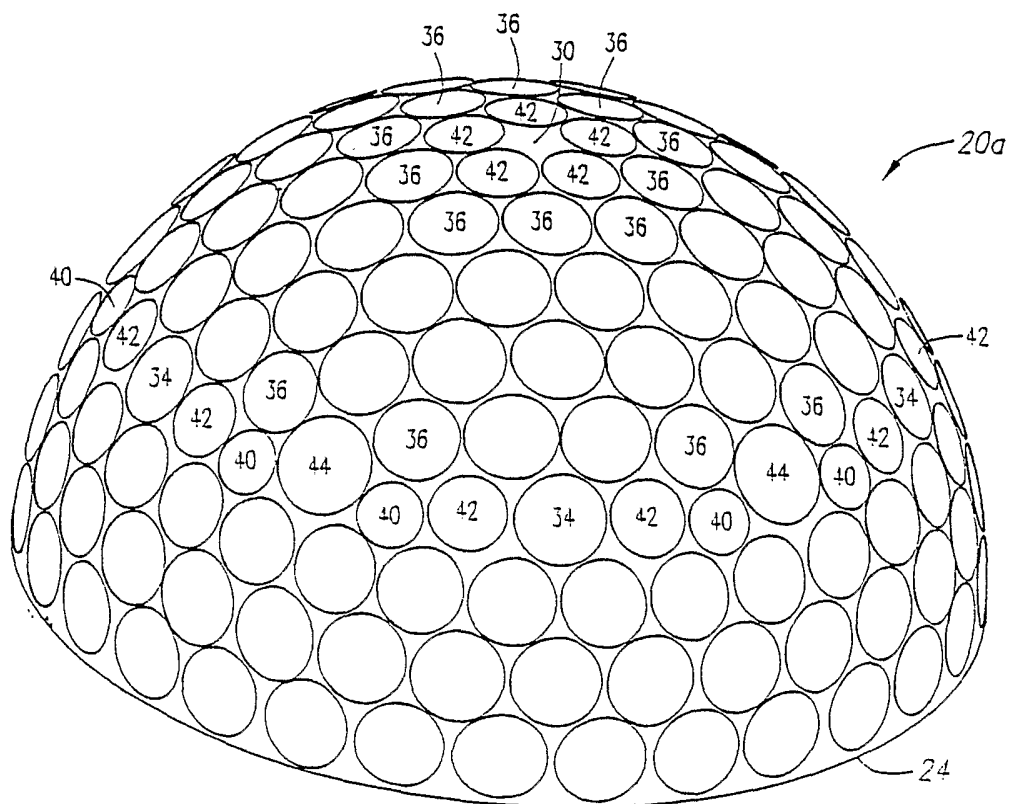
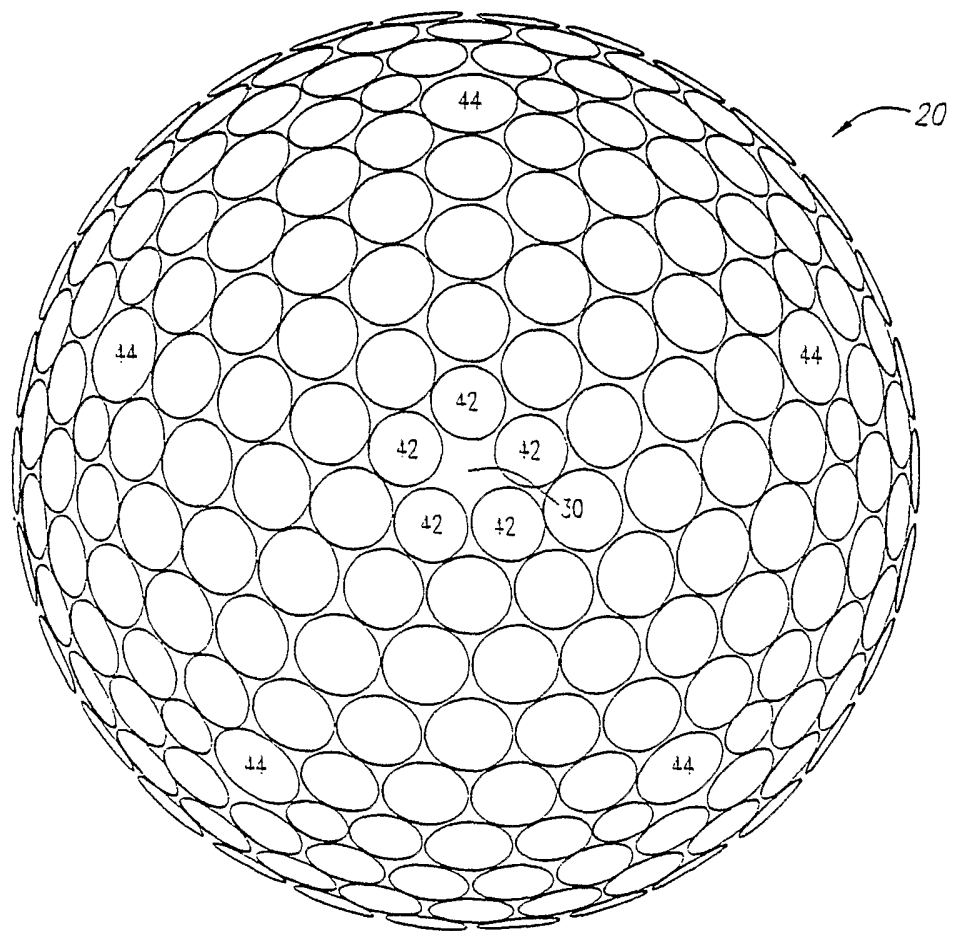


FIG. 10

*FIG. 11*

*FIG. 12*

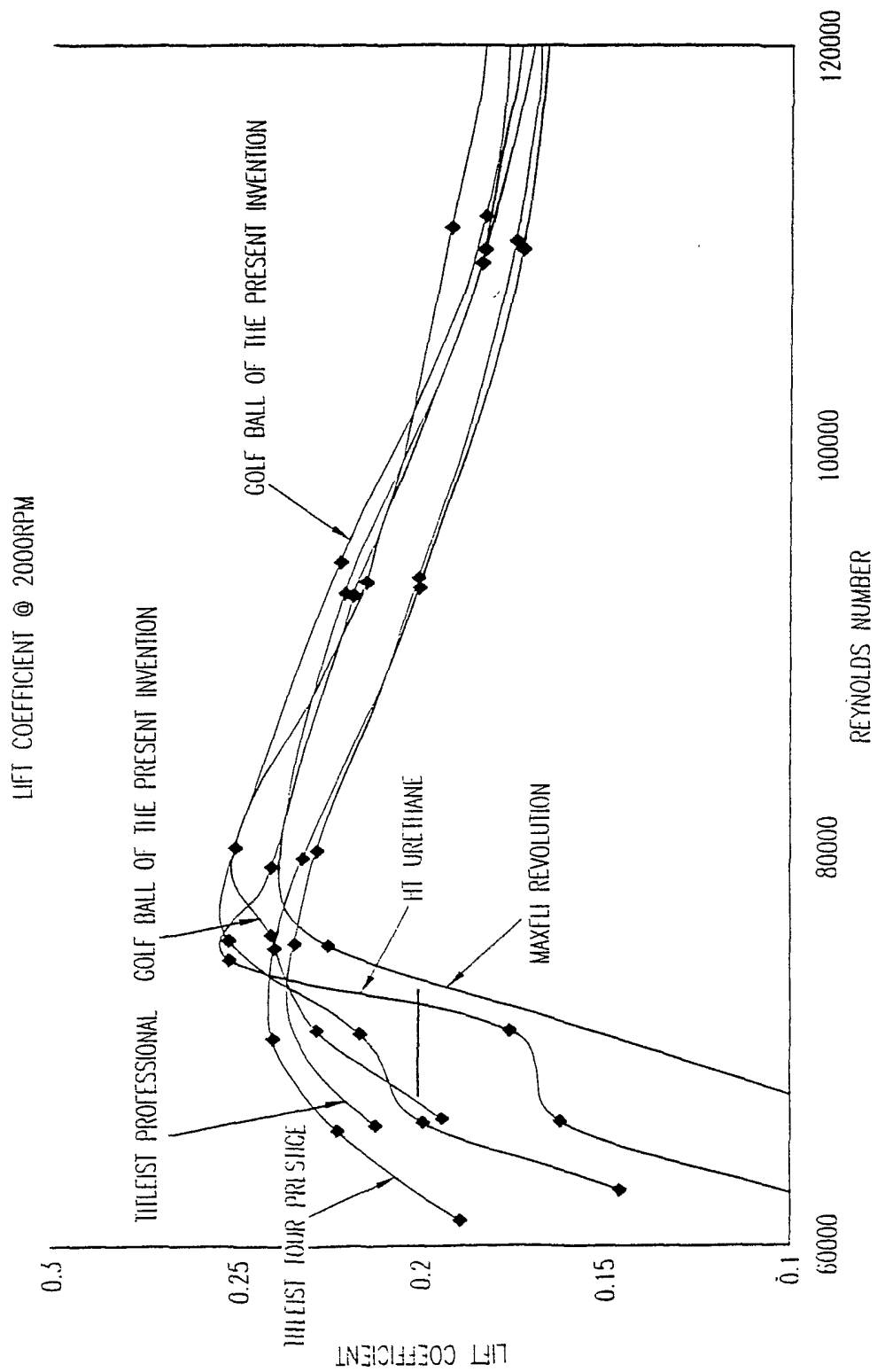


FIG. 13

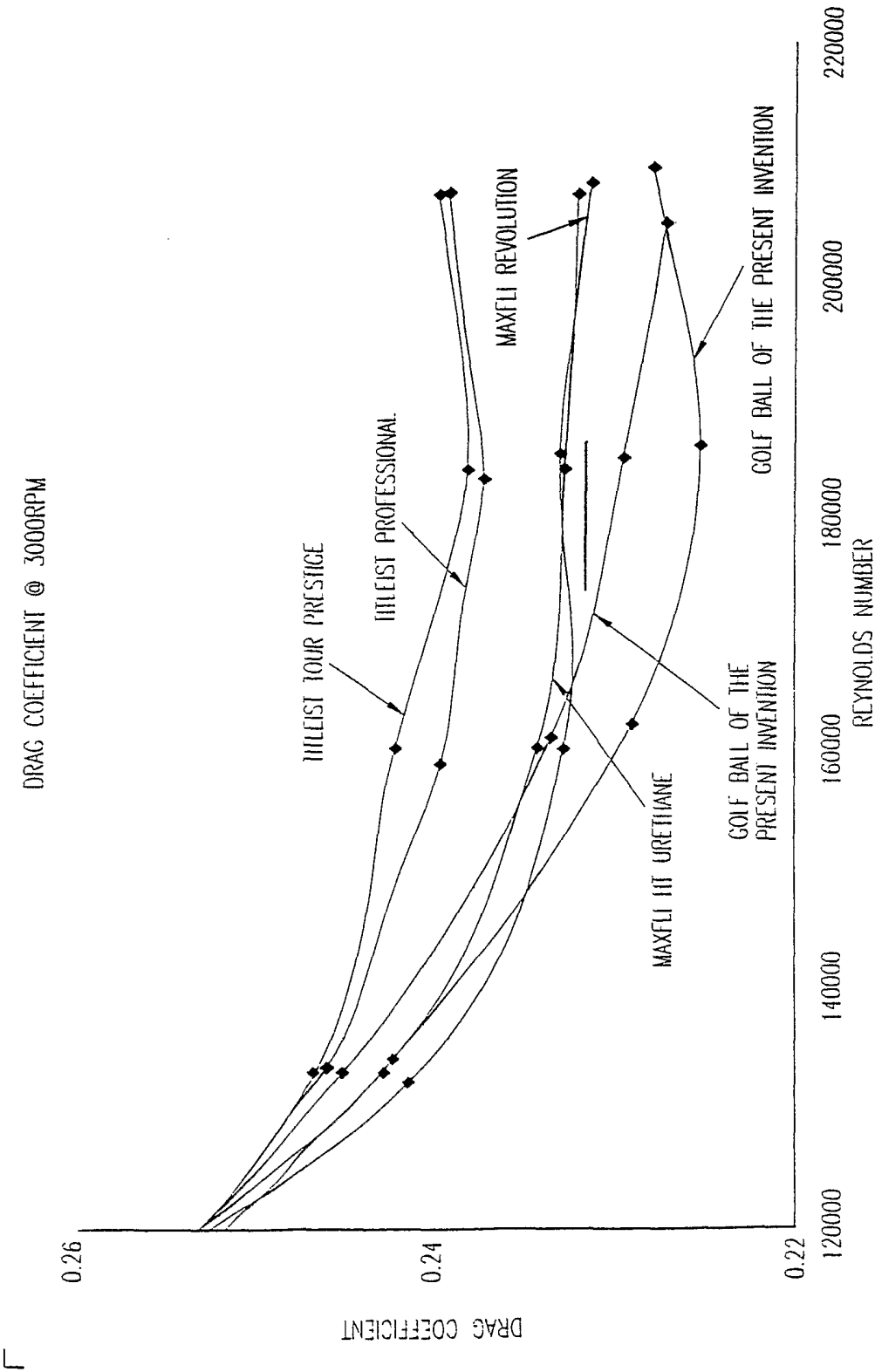


FIG. 14

Aerodynamic Performance of Golf Balls

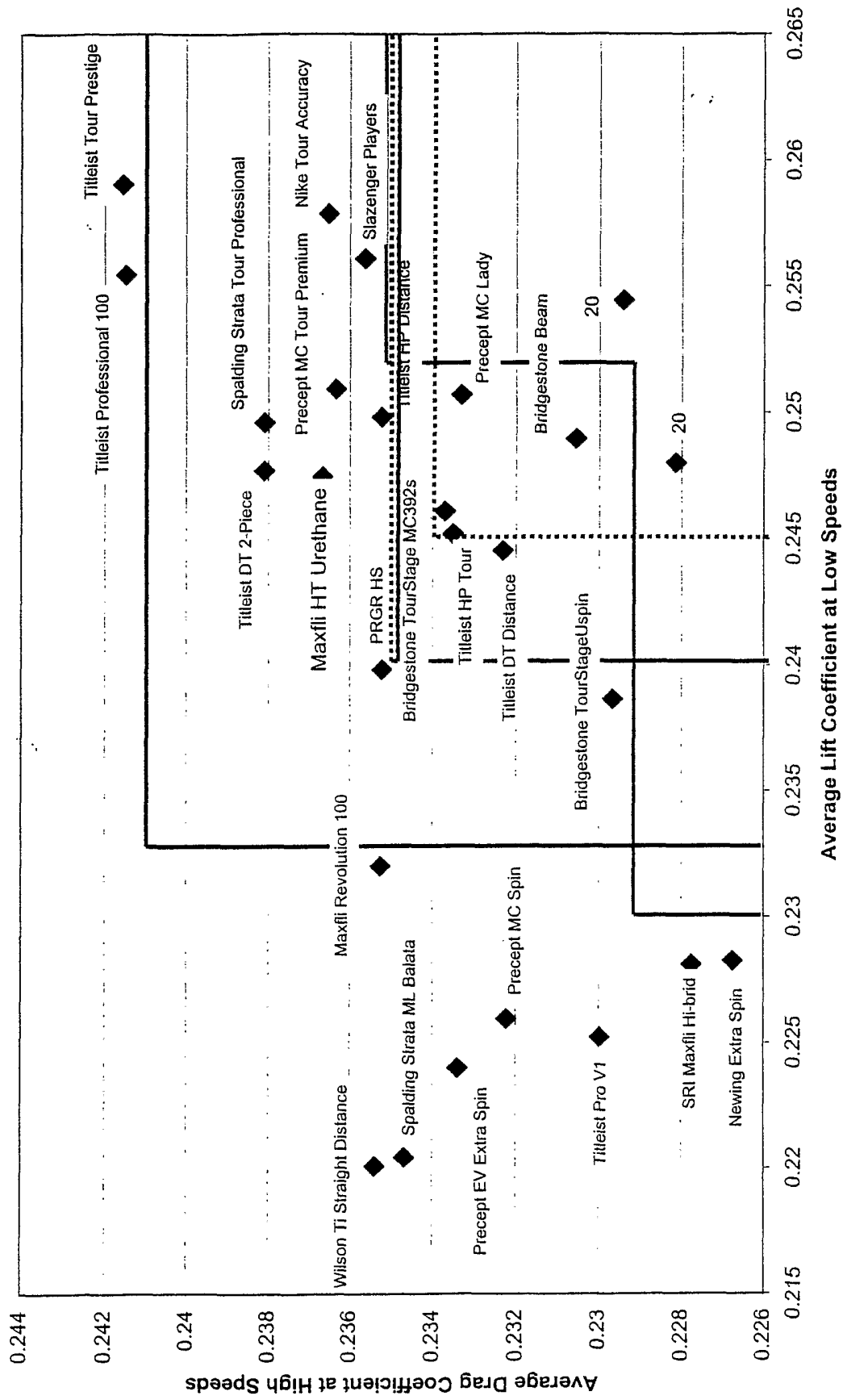


FIG. 15

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US02/12344

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : A63B 37/14

US CL : 473/383

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 473/383, 378-382, 384

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X, P	US 6,299,552 B1 (MORGAN et al) 09 October 2001 (09.10.2001), see the entire document.	1, 5, 6, 8, 9, 11, 12
X	US 6,213,898 B1 (OGG) 10 April 2001 (10.04.2001), see the entire document.	1-13
A	US 5,846,141 A (MORGAN et al) 08 December 1998 (08.12.1998).	

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

10 July 2002 (10.07.2002)

Date of mailing of the international search report

31 JUL 2002

Name and mailing address of the ISA/US

Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703)305-3230

Authorized officer

Mark Graham

Telephone No. 703-308-1148

Shelia Veney
Paralegal Specialist
Group 3700