

PATENT SPECIFICATION (11)

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- (21) Application No. 29831/72 (22) Filed 26 June 1972 (19)
 (31) Convention Application No. 156 855 (32) Filed 25 June 1971 in
 (33) United States of America (US)
 (44) Complete Specification published 6 Aug. 1975
 (51) INT. CL.³ A63B 37/14
 (52) Index at acceptance
 A6D 1C11



(54) GOLF BALL

(71) We, UNIROYAL, INC., a corporation organised and existing under the laws of the State of New Jersey, one of the United States of America, of 1230 Avenue of the Americas, New York, New York 10020, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention pertains to golf balls.

Current practice in the art is to make balls having about 336 dimples arranged on the ball surface with octahedral symmetry, each dimple being substantially bowl-shaped and opening into the surface of the ball along a circular line when inspected in an undistorted planar front view.

According to the present invention a golf ball has a substantially spherical surface formed with a plurality of depressions, substantially all of said depressions having substantially the shape of inverted pyramids with hexagonal bases, said ball being divisible about its equatorial plane into two hemispheres and the depressions on each hemisphere being arranged so that notional spatial demarcation lines can be drawn through a number of adjacent depressions to form spherical triangles and parts of spherical triangles which substantially conform to the radial projection of a concentric regular half-icosahedron inscribed on the hemispherical surface.

Preferably some of the depressions have substantially the shape of inverted pyramids with pentagonal bases, and a particularly preferred ball has 240 hexagonal pyramidal depressions and 12 pentagonal pyramidal depressions.

For a better understanding of the present invention, reference is made to the following description, taken in connection with the accompanying drawings, in which:—

Fig. 1 is a top plan view of a golf ball constructed in accordance with the invention and having spatial pattern lines traced about the surface of the ball;

Fig. 1a is a cross-sectional view of the internal structure of the golf ball of Fig. 1;

Fig. 2 is a front elevational view of the Fig. 1 golf ball with spatial pattern lines traced about the surface of the ball;

Fig. 3 is a view, to an enlarged scale, of a typical triangular surface section of the Fig. 1 golf ball as developed on a plane surface;

Fig. 4 is a view, to an enlarged scale, of a depression having a hexagonal base;

Fig. 5 is a sectional view to an enlarged scale, taken along line 5—5 of Fig. 4, through the cover of the ball and a portion of the interior of the ball to represent a depression having a hexagonal base;

Fig. 6 is a view, to an enlarged scale, of a depression having a pentagonal base;

Fig. 7 is a sectional view, to an enlarged scale, taken along line 7—7 of Fig. 6, through the cover of the ball and a portion of the interior of the ball to represent a depression having a pentagonal base;

Fig. 8 is a top plan view of a golf ball constructed in accordance with the invention, similar to Fig. 1 depicting the several circumferential path lines circumscribed about the top surface of the ball; and

Fig. 9 is a front elevational view of the Fig. 8 golf ball depicting several circumferential path lines circumscribed about the side surface of the ball.

As is well known in the art, the surface of the ball is formed in the final molding operation in a negative mold which is adapted to mold the desired imprint on the surface of the ball. In specifying the surface desired in the ball, it is accepted practice in the art to specify mold dimensions rather than ball dimensions because of the variability inherent in the production of molds and balls. Furthermore, after the ball is molded it is customary to paint the surface of the ball and, therefore, its surface will depart somewhat from the surface imparted in the mold because of the coating of paint applied to the ball. However, any discrepancies which may occur in the ultimate surface of the ball from that provided on the mold are small, and the exigencies of ball

[Price 33p]

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production make it acceptable and desirable to specify the ball surface in terms of the mold dimensions. Accordingly, it should be understood that throughout this specification and claims the ball surface is to be achieved by providing a mold having the stated dimensions, and that a ball produced in such a mold will have substantially the desired dimensions, a painted ball further differing slightly from these dimensions. The exact mold dimensions will depend on the type of ball being made and the molding conditions. Those skilled in the art know how to select mold dimensions suitable for the materials being used and the type of ball being made.

Referring now more particularly to Fig. 1 of the drawings, a golf ball comprises a spherical surface 10 having a plurality of depressions 11 therein. The majority of the depressions have substantially the shape of inverted pyramids with hexagonal bases. The ball has two poles 12 (only one of which appears in Fig. 1) and an equator 13 and each polar region is divisible into five similar equilateral spherical triangles indicated by broken lines 14 with a common vertex at a given pole 12. Lines 14 do not appear on the ball, but are spatial demarcation lines which are illustrative only. These lines may be inscribed to show how the depressions 11 are arranged on the surface of the ball. It will be realized that these depressions are distributed about the face of the ball to define an icosahedral lattice of equilateral spherical triangles. The apex of each pyramid may be slightly rounded as will be described more fully hereinafter. It will be understood that the hexagonal base of the pyramid is substantially hexagonal being on a spherical surface. If the ball is rotated 180° in the direction of the arrow 15, the bottom plan view appears identical with the top plan view. The depressions cover approximately 50% of the surface area of the golf ball.

Referring now more particularly to Figs. 1 and 2 of the drawings, each vertex 16 of equilateral triangles 14, 14, 14 other than the polar vertex 12 serves as a vertex for a similar spherical equilateral triangle 14, 17, 17 having at least one vertex 16 across the equator 13 from another vertex 16 of the triangle 14, 17, 17. Referring to Fig. 2 rotation of the ball by 72° increments in the direction of the arrow 18 (running along the equator of the ball) would present four additional elevational views which appear identical with Fig. 2 as shown.

As mentioned previously, the other polar region of the ball is divisible into five additional equilateral triangles 14, 14, 14 similar to the previously described triangles 14, 14, 14 and having a common vertex at the other pole 12 and having common vertices 16 with the triangles 14, 17, 17 crossing the equator.

The arcs 14 and 17 bounding all the equilateral triangles pass through the apices of a plurality of the depressions 11 and each equilateral triangle includes within its arcs the same number of depressions and each vertex of the equilateral triangles is in a depression.

All of the depressions 11 except the vertices 12 and 16 of the spherical triangles have substantially the shape of inverted pyramids with hexagonal bases and are of substantially the same size. The depressions 12 and 16 which are the vertices of the equilateral triangles may have substantially the shape of inverted pyramids with pentagonal bases and are of substantially the same size. The pentagonal bases of such pyramids are substantially pentagonal being on a spherical surface. The pentagonal shape of the depressions 12 and 16 is preferred, but the depressions 12 and 16 could conceivably take the shape of conventional part-spherical depressions if so desired.

Referring now more particularly to Fig. 3 of the drawings, there is represented a typical triangular surface portion 14, 14, 14 having its vertex at pole 12 developed as if on a planar surface. Pentagons 16 are located at the other vertices. This triangular surface may be formed by utilizing a hemispherical mold (not shown) in which the bottom of the cavity is a pole. The equator of the mold may then be divided into ten equal parts and five great circles drawn through the pole and the ten divisions. A plane passing through the center of the sphere forms a great circle on the surface of that sphere. With a suitable (depending on the diameter of the ball) chordal length and the pole as center, ten intersections may be marked, two on each of the great circles. Alternate intersections may be connected by respective great circles to form five spherical triangles corresponding to triangles 14, 14, 14 of the ball.

The ten divisions along the equator may then be bisected and respective great circles drawn from the vertices corresponding to vertices 16 of the five spherical triangles to the adjacent bisecting points just referred to, forming portions corresponding to parts of the triangles 14, 17, 17. A pentagonal projection may then be located at each vertex of the mold corresponding to the vertices 12 and 16 shown in Fig. 3. The spherical triangles may be provided with hexagonal projections corresponding to the uniformly spaced hexagonal regions shown in Fig. 3. All lines interconnecting hexagonal regions shown in Fig. 3 are arcs of great circles. The centers of the hexagonal regions included with the triangle 14, 14, 14 may be located at the vertices of the small triangles formed by the arcs of those great circles as shown in Fig. 3.

The other half of the mold is identical with the half just described but is rotated 36° along the equator with respect thereto. The location of the hexagonal and pentagonal regions of all the spherical triangles of the mold may be determined in accordance with the typical portion just described. If, however, the bottom mold is rotated less or greater than 36°, or odd multiples thereof, the two mold halves, while being identical, will not form a true icosahedral pattern.

Each hemisphere of the ball will now form only one-half of an icosahedron of equilateral spherical triangles. Although it is preferable to develop the whole icosahedron by phasing the two molds exactly 36° apart, it is nonetheless possible to achieve suitable aerodynamic results if the halves are not exactly aligned. As required by the limitations imposed by mold making equipment, the positions of the hexagonal and/or pentagonal depressions, or regions thereof, may deviate slightly from the aforementioned preferred locations.

Referring now more particularly to Figs. 4 and 5, the hexagonal depression 11 is shown in plan and in section to an enlarged scale. Referring to Figs. 6 and 7, the pentagonal base preferably has vertices on a circle of the same diameter as the hexagonal base and the pentagonal depression preferably has the same depth as the hexagonal depression. The sides of both the hexagonal and the pentagonal pyramids may be curved, and the apices of the pyramids may be slightly rounded. Portions of the interior of the ball appears in Figs. 5 and 7.

Figs. 1a, 5 and 7 show the internal cross-section of the golf ball. The core (Fig. 1a) of the ball may comprise a center 26 of cis-polybutadiene or cis-polybutadiene/rubber mixture and a rubber thread winding 25

wound thereabout. For a ball conforming to the USGA specification requirement that the diameter be from 1.68 to 1.69 inches the diameter of the core is approximately between 1.57 and 1.59 inches. A cover 27 is molded about the core and is approximately between 0.045 and 0.055 inch thick (depending on the core diameter).

Figs. 8 and 9 correspond to the ball surfaces of Figs. 1 and 2, respectively. Arrow lines 20 are inscribed about the face of the ball to demonstrate that any chosen circumferential path line will eventually intersect several depressions. The air stream rushing over the surface of the ball in any flight path will thus intersect the depressions causing the ball to exhibit enhanced aerodynamic characteristics.

However, due to the limitation imposed by mould-making equipment the equatorial mold line 21 and adjacent lines 22 and 23, respectively, may trace a continuous uninterrupted path about the surface of the ball. Lines 21, 22 and 23, however, are extremely narrow being about or less than .005 inch in width, and do not therefore, present a significant path line to the air stream. Thus, there are no closed circumferential pathways of substantial width that may be circumscribed about the face of the golf ball without intersecting depressions.

The following are the mold specifications for a golf ball of approximately 1.680 to 1.690 inches diameter constructed in accordance with a preferred form of the invention which was found to have longer carry in the air, that is, could be driven further in the air than similar conventional balls. The nominal parameters of the mold for a standard USGA approved ball in accordance with this invention, having the required diameter of not less than 1.680 inches are as follows:

Number of depression-forming regions	252
Number of depression-forming regions with hexagonal bases	240
Number of depression-forming regions with pentagonal bases	12
Diameter of ball-forming regions	1.68 — 1.69 inches
Arc length of equilateral triangle	.93 — .94 inch
Chordal length from vertex to vertex	.883 — .896 inch
Size of hexagonal and pentagonal bases of depression-forming regions	Vertices on circle of .165 ± .015 inch diameter
Maximum depth of hexagonal and pentagonal depression-forming regions from spherical surface	.015 ± .003 inch

While the ball has been described above as having a diameter of between 1.680 and 1.690 inches, it is also contemplated that other balls of different diameters can be manufactured. For example, the standard diameter of the golf ball normally used in Great Britain is 1.620—1.630 inches. Other intermediate diameters, such as 1.660—1.670 inches can also be made. The normal parameters of these balls can readily be modified to lie within or otherwise conform to the invention. By this it is meant to say, that suitable performance will be achieved for balls with these differing diameters and having the depressions designed and arranged according to the invention.

While a plurality of the depressions must be of hexagonal pyramidal form, some of the depressions may be all or in part arcuate in shape rather than polygonal as shown, i.e. they may be curvilinear either in circumference or on depth (when viewed in cross-section) or in both. In particular, some of either the disclosed hexagonal or pentagonal depressions may be spherically curved such as to have a generally hemispherical shape with an opening at the surface of the ball which is circular when inspected in an undistorted planar front view. Any arcuate shape depressions may also have an elliptical curvature in either the circumference or the depth or both.

EXAMPLE

An example of how a ball according to the invention may be fabricated is as follows:

A solid center $1\frac{1}{16}$ " indiameter was prepared by mixing the composition shown below on a two-roll rubber mill and then molding it in a conventional center mold for 20 minutes at 320°F. in a hydraulic press.

	Parts by Weight
cis-polybutadiene (a)	45
natural rubber (b)	55
barytes (filler)	151
"DiCup" (trademark) (c)	7.5

- (a) BRO1 sold commercially by Mitsui
- (b) 50 Mooney smoked sheets
- (c) "DiCup" is active dicumyl peroxide supported on precipitated calcium carbonate. It is marketed as a rubber curing agent by Hercules, Incorporated.

The center described was frozen in dry ice and while still frozen was wound with natural rubber golf ball thread in a conventional golf ball winding machine to produce a core 1.580 inches in diameter.

The thread used had the following properties:

width	0.070 inch
thickness	0.020 inch

tensile strength 2400 psi
 breaking elongation 1000%
 modulus at 500% stretch 325 psi
 The wound core showed a compression (deformation under a 300 lb. load) of 0.115 inch.

An ionomer resin cover made of 5 parts of titanium dioxide pigment blended with 100 parts of Surlyn A type 1559 resin was applied as described below. Surlyn A, manufactured and sold by du Pont, is an ionic copolymer of approximately 96.5 mole-percent of ethylene and 3.5 mole-percent of methacrylic acid, sodium or zinc ions being distributed throughout the copolymer to an extent representing about 50% of the methacrylic acid. The material is described in U.S. Patent No. 3,264,272. "Surlyn" is a Registered Trade Mark.

To make the cover, the pigmented resin was formed into crude slugs weighing 90 grains each. Half shells were molded in place in the ball molding cavity by placing one of these slugs in each half of a pre-heated golf ball mold (300°F.) fitted with a removable mating center piece which on closing forms a half shell in each half of the ball mold. The mold is held closed hot, with the center piece in place for 2 minutes to completely form the half shells and to bring the half shells to mold temperature. After 2 minutes, the mold was opened to remove the center piece and replace it with the above-mentioned wound core. With the core in position in the bottom half of the mold, the mold was closed quickly with slower closing at the final stage of closing (last $\frac{1}{4}$ ") to allow the excess cover stock to flow out around the mold parting line. After complete closure, the mold was held under high pressure (about 1500 psi) for 30 seconds, at which time cold (35°F.) water was circulated around the mold for 10 minutes to cool the ball.

After cooling in the mold, the mold was opened to remove the ball. The ball was then buffed to remove the excess cover at the mold parting line. Subsequent to buffing, the ball was finished by the usual painting operation. The final ball had a diameter of 1.68 inches and had the following properties:

PGA hardness — 88

Rebound from 100" drop — 73 inches

The final ball had unusually good playing qualities (click, feel, distance and durability).

The exterior surface patterns disclosed herein may, of course, be applied to various golf ball constructions. Thus, the ball may have a fluid, liquid or a solid center or core, and the solid core may be made of metal or of synthetic plastics or of elastomeric material. If desired the center or core may be surrounded by windings of elastomeric

yarns or filaments or by an elastomeric composition, having a sufficient radial dimension to ensure that the golf ball will have the desired outer diameter. The cover need not be made from Surlyn, and in particular may be of the conventionally used balata, or of other polymeric material. If a cover is provided in any of the foregoing described golf ball constructions, the depression pattern will be provided in the cover itself.

The pattern may also be applied to solid golf balls, i.e. ball molded from a single compound. By way of example, a solid golf ball may be an elastomer cured in the presence of a relatively large amount of a monomer which is capable of acting as a cross-linking agent for the elastomer and under conditions which will additionally result in polymerization of the monomer. In this elastomer a structure is formed which consists of the elastomer cross-linked into a three dimensional network with a high density of long flexible cross-links. A solid ball of this type is described in U.S. Patent 3,313,545. In a further example a solid golf ball is made from a composition comprised of a polybutadiene elastomer; an ionomer (such as described in the aforementioned U.S. Patent 3,264,272 to Rees); a thermoplastic resinous material other than an ionomer; a filler; a polyfunctional co-curing monomer ester having at least two non-conjugated ethylenic double bonds and a source of free radicals. A solid golf ball of this composition is described in U.S. Patent 3,421,766. A further example of a solid golf ball composition comprises a cured elastomer in conjunction with resin micro-balloons. A golf ball of this composition is described in U.S. Patent 3,238,156.

The disclosed golf ball may also be made from a composition comprising a polybutadiene elastomer, a gum plastic, a filler, a polyunsaturated co-curing monomer ester and a source of free radical or more fully described in U.S.A. Patent 3,666,272.

Although the present invention is operative with any thermoplastic material as noted above, it should be emphasized that certain thermoplastic materials such as polystyrene will not have the properties needed in a top quality golf ball to be used in competition, however, such materials can be used to form range balls, novelty golf balls or display golf balls etc.

Our co-pending Applications Nos. 41046/74 and 41047/74 (Serial Nos. 1,402,272 and 1,402,273) describe and claim, respectively, details of the depression in the ball surface and details of the cover thickness and material.

WHAT WE CLAIM IS:—

1. A golf ball having a substantially spherical surface formed with a plurality of depressions, substantially all of said depressions having substantially the shape of inverted pyramids with hexagonal bases; said ball being divisible about its equatorial plane into two hemispheres and the depressions on each hemisphere being arranged so that notional spatial demarcation lines can be drawn through a number of adjacent depressions to form spherical triangles and parts of spherical triangles which substantially conform to the radial projection of a concentric regular half-icosahedron inscribed on the hemispherical surface.
2. A golf ball according to claim 1 in which the two hemispheres are angularly aligned so that the spherical triangles conform substantially to the radial projection of a concentric regular icosahedron inscribed on the spherical surface.
3. A golf ball according to claim 1 or claim 2 in which some of the depressions have substantially the shape of inverted pyramids with pentagonal bases.
4. A golf ball according to any of the preceding claims in which there are 240 hexagonal pyramidal depressions on the surface of said ball.
5. A golf ball according to any one of the preceding claims in which there are 12 pentagonal pyramidal depressions on the surface of the ball.
6. A golf ball according to any one of the preceding claims in which there are 252 depressions on the surface of the ball.
7. A golf ball according to any one of the preceding claims in which an axis through the centre of the ball perpendicular to the equatorial plane defines a pair of poles on the spherical surface, and the depression pattern includes a plurality of equilateral spherical triangles, five such triangles having a common vertex at one pole, and five other such triangles having a common vertex at the other pole.
8. A golf ball according to claim 7 in which each vertex of said five such triangles other than said polar vertex serves as a vertex for a similar spherical equilateral triangle crossing the equator and having at least one vertex across the equator therefrom, and said five other such triangles have common vertices with said triangles crossing the equator.
9. A golf ball according to claim 7 or claim 8 in which the depressions at the vertices of the spherical triangles are of pentagonal pyramidal form and all other depressions are of hexagonal pyramidal form.
10. A golf ball according to any one of

yarns or filaments or by an elastomeric composition, having a sufficient radial dimension to ensure that the golf ball will have the desired outer diameter. The cover need not be made from Surlyn, and in particular may be of the conventionally used balata, or of other polymeric material. If a cover is provided in any of the foregoing described golf ball constructions, the depression pattern will be provided in the cover itself.

The pattern may also be applied to solid golf balls, i.e. ball molded from a single compound. By way of example, a solid golf ball may be an elastomer cured in the presence of a relatively large amount of a monomer which is capable of acting as a cross-linking agent for the elastomer and under conditions which will additionally result in polymerization of the monomer. In this elastomer a structure is formed which consists of the elastomer cross-linked into a three dimensional network with a high density of long flexible cross-links. A solid ball of this type is described in U.S. Patent 3,313,545. In a further example a solid golf ball is made from a composition comprised of a polybutadiene elastomer; an ionomer (such as described in the aforementioned U.S. Patent 3,264,272 to Rees); a thermoplastic resinous material other than an ionomer; a filler; a polyfunctional co-curing monomer ester having at least two non-conjugated ethylenic double bonds and a source of free radicals. A solid golf ball of this composition is described in U.S. Patent 3,421,766. A further example of a solid golf ball composition comprises a cured elastomer in conjunction with resin microballoons. A golf ball of this composition is described in U.S. Patent 3,238,156.

The disclosed golf ball may also be made from a composition comprising a polybutadiene elastomer, a gum plastic, a filler, a polyunsaturated co-curing monomer ester and a source of free radical or more fully described in U.S.A. Patent 3,666,272.

Although the present invention is operative with any thermoplastic material as noted above, it should be emphasized that certain thermoplastic materials such as polystyrene will not have the properties needed in a top quality golf ball to be used in competition, however, such materials can be used to form range balls, novelty golf balls or display golf balls etc.

Our co-pending Applications Nos. 41046/74 and 41047/74 (Serial Nos. 1,402,272 and 1,402,273) describe and claim, respectively, details of the depression in the ball surface and details of the cover thickness and material.

WHAT WE CLAIM IS:—

1. A golf ball having a substantially spherical surface formed with a plurality of depressions, substantially all of said depressions having substantially the shape of inverted pyramids with hexagonal bases; said ball being divisible about its equatorial plane into two hemispheres and the depressions on each hemisphere being arranged so that notional spatial demarcation lines can be drawn through a number of adjacent depressions to form spherical triangles and parts of spherical triangles which substantially conform to the radial projection of a concentric regular half-icosahedron inscribed on the hemispherical surface.

2. A golf ball according to claim 1 in which the two hemispheres are angularly aligned so that the spherical triangles conform substantially to the radial projection of a concentric regular icosahedron inscribed on the spherical surface.

3. A golf ball according to claim 1 or claim 2 in which some of the depressions have substantially the shape of inverted pyramids with pentagonal bases.

4. A golf ball according to any of the preceding claims in which there are 240 hexagonal pyramidal depressions on the surface of said ball.

5. A golf ball according to any one of the preceding claims in which there are 12 pentagonal pyramidal depressions on the surface of the ball.

6. A golf ball according to any one of the preceding claims in which there are 252 depressions on the surface of the ball.

7. A golf ball according to any one of the preceding claims in which an axis through the centre of the ball perpendicular to the equatorial plane defines a pair of poles on the spherical surface, and the depression pattern includes a plurality of equilateral spherical triangles, five such triangles having a common vertex at one pole, and five other such triangles having a common vertex at the other pole.

8. A golf ball according to claim 7 in which each vertex of said five such triangles other than said polar vertex serves as a vertex for a similar spherical equilateral triangle crossing the equator and having at least one vertex across the equator therefrom, and said five other such triangles have common vertices with said triangles crossing the equator.

9. A golf ball according to claim 7 or claim 8 in which the depressions at the vertices of the spherical triangles are of pentagonal pyramidal form and all other depressions are of hexagonal pyramidal form.

10. A golf ball according to any one of



the preceding claims wherein any closed circumferential pathway having a width of 0.005 inch or greater that may be inscribed in the surface of the ball will intersect at least one depression.

5 11. A golf ball according to any one of the preceding claims in which each depression has a maximum depth of 0.015 ± 0.003 inch.

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Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1975.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.

