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(54) **Multilayer solid golf ball**

(57) A multilayer solid golf ball maintains performance characteristics after exposure to high ambient temperatures. A core includes a thermoplastic material. The core is surrounded by an intermediate layer comprising a peroxide cross-linked polybutadiene. A single layer or double layer cover with dimples is also provided.

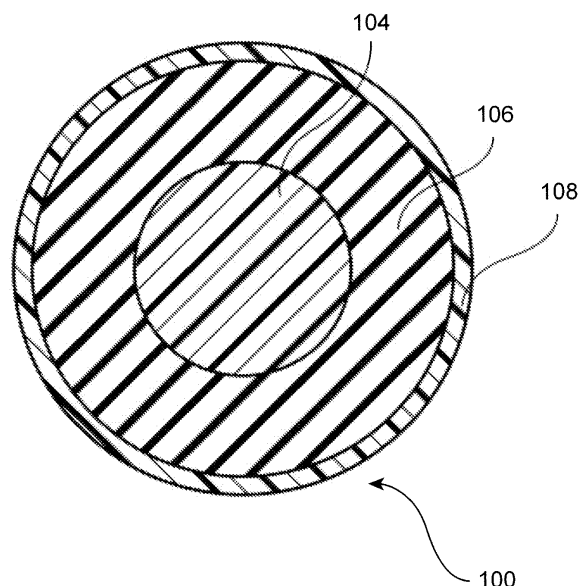


Figure 2

Description**CROSS-REFERENCE TO RELATED APPLICATION**

5 [0001] This application claims priority under 35 U.S.C. § 119(e) to U.S. Provisional Patent Application Number 61/153,952, entitled "Multilayer Solid Golf Ball", and filed on February 19, 2009, which application is hereby incorporated by reference.

BACKGROUND

10 [0002] The present invention relates generally to a golf ball and, more particularly, to a multilayer solid golf ball having a core that retains its performance characteristics after exposure to high temperature.

[0003] The history of golf ball development had gone very far from wound golf balls to solid two piece golf balls and multilayer golf balls. Rubber cores gradually replaced wound cores because of quality consistency and performance benefit such as reducing of driver spin for longer distance.

15 [0004] Multilayer golf balls with layers comprising a thermoplastic material such as ionomer materials brought golf ball technology to the next level. Typically, thin layers of different materials fused together added extra features such as lower spin off the tee but increasing spin around the green. For example, one of the layers may be a hard ionomer in a mantle layer while a soft elastomer material forms the layer for outer cover. Thin layers of ionomer layers were typically used because ionomer has relatively low resilience, particularly when compared to the rubbers typically used to form the core or the layers of the core.

20 [0005] However, highly neutralized ionomers, such as those developed by DuPont®, have resilience comparable to or even better than the resilience of rubber materials. These highly neutralized ionomers may represent the next step in innovation for golf ball cores. Golf ball cores comprising a thermoplastic material are more consistent in quality than thermoset rubber cores. One limitation on the use of thermoplastic resins, such as a highly neutralized ionomer, for a golf ball core is the effect that ambient temperature has on the shape and performance of the golf ball core.

25 [0006] Flying distance is an important index used to evaluate the performance of a golf ball. Flying distance is affected by three main factors: "initial velocity", "spin rate", and "launch angle". Initial velocity is one of the primary physical properties affecting the flying distance of the golf ball. The coefficient of restitution (COR) is an alternate parameter of initial velocity of the golf ball, and the temperature will affect the COR. The COR is generally defined as the ratio of velocity of an object before and after an impact. A COR of 1 is a perfect elastic collision where no energy is lost due to the collision, and a COR of 0 is a perfect inelastic collision, where all of the energy is dissipated during the collision. Taking 24 degrees Celsius as the standard temperature at which the United States Golf Association (USGA) sets as a standard temperature for measuring golf ball physical properties and performance characteristics for adherence to USGA rules and regulations, the physical properties, including the COR, of the golf ball will be affected when the temperature is lower or higher than 24 degrees Celsius. For example, the COR is significantly positive relative to the ambient temperature, so the golf ball usually flies shorter in a cold weather.

30 [0007] Similarly, performance is affected by long-term exposure to high temperatures. Due to the habits of many golfers, golf balls may be routinely subjected to long-term exposure to high temperatures. For example, many golfers tend to leave their golf balls in their golf bags and in their car trunks. Golfers may live in areas where daytime, or even nighttime temperatures regularly exceed 30 degrees Celsius, particularly during daylight hours during the summer. Inside a car trunk, the temperature may reach 50 degrees Celsius for extended periods of time.

35 [0008] When exposed to relatively high ambient temperatures for extended periods, golf balls tend to lose their original performance characteristics. The material of the core or the cover layers may distort or lose their shape, particularly when the temperature cycles between relatively high ambient temperatures and relatively low ambient temperatures, such as the ambient temperature changes over the course of a day. This results in loss of distance and feel.

40 [0009] Therefore, there exists a need in the art for a golf ball that maintains its performance characteristics even after exposure to relatively high ambient temperatures.

SUMMARY

45 [0010] In one aspect, the invention provides a golf ball comprising a core, said core comprising a thermoplastic material; an intermediate layer enclosing said core to form an inner ball, said intermediate layer comprising a thermoset material; and a cover enclosing said inner ball, wherein said golf ball satisfies the following requirements: (1) said inner ball has a first deflection amount of 2.2 to 3.2 millimeters under a load of 10 to 130 kilograms when said inner ball is kept in an environment of 24 degrees Celsius for at least about eight hours, (2) said inner ball has a second deflection amount under a load of 10 to 130 kilograms when said inner ball is kept in an environment of about 50 degrees Celsius for at least about 8 hours, and wherein the ratio of the second deflection amount to the first deflection amount is between

about 1.05 and about 1.15, and (3) said core has a coefficient of restitution at 40 meters per second falling between approximately 0.79 and 0.89 and higher than that of said golf ball.

[0011] In another aspect the invention provides a golf ball comprising a core, said core comprising a thermoplastic material; an intermediate layer enclosing said core to form an inner ball, said intermediate layer comprising a thermoset material; and a cover enclosing said inner ball and having a plurality of dimples on its outer surface, wherein said golf ball satisfies the following requirements: (1) said inner ball has a first deflection amount of 2.2 to 3.2 millimeters under a load of 10 to 130 kilograms when said inner ball is kept in an environment of 24 degrees Celsius for at least about 8 hours, (2) said inner ball has a second deflection amount under a load of 10 to 130 kilograms when said inner ball is kept in an environment of 50 degrees Celsius for at least about 8 hours, and the ratio of the second deflection amount to the first deflection amount is between about 1.05 and about 1.15, (3) said core has a coefficient of restitution at forty (40) meters per second falling between approximately 0.79 and 0.89 and higher than that of said golf ball, and (4) said dimples have a total volume of 550 cubic millimeters to 800 cubic millimeters.

[0012] Other systems, methods, features and advantages of the invention will be, or will become, apparent to one of ordinary skill in the art upon examination of the following figures and detailed description. It is intended that all such additional systems, methods, features and advantages be included within this description and this summary, be within the scope of the invention, and be protected by the following claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The invention can be better understood with reference to the following drawings and description. The components in the figures are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention. Moreover, in the figures, like reference numerals designate corresponding parts throughout the different views.

[0014] FIG. 1 is a perspective view of a golf ball;

[0015] FIG. 2 is a cross-sectional view of a first embodiment of the golf ball shown in FIG. 1; and

[0016] FIG. 3 is a cross-sectional view of a second embodiment of the golf ball shown in FIG. 1.

DETAILED DESCRIPTION

[0017] FIG. 1 shows a perspective view of a solid golf ball 100 according to the invention. Golf ball 100 is generally spherical in shape with a plurality of dimples 102 disposed on the surface of golf ball 100. Any number of dimples 102 may be provided on the surface of golf ball 100. In some embodiments, the number of dimples 102 may range from about 250 to about 500. In some embodiments, the number of dimples 102 may range from about 300 to about 400. Dimples 102 may be arranged on the surface of golf ball 100 in any pattern.

[0018] Though shown as substantially hemispherical, dimples 102 may have any shape known in the art, such as elliptical, polygonal, or the like. While in some embodiments dimples 102 may be protrusions extending away from the surface of golf ball 100, dimples 102 are typically indentations in the surface of golf ball 100. Each indentation defines a volume. For example, if a dimple is a hemispherical indentation in the surface, the space carved out by the dimple and bounded by an imaginary line representing where the surface of golf ball 100 would be if no dimple were present has a volume of a hemisphere, or $\frac{2}{3}\pi r^3$, where r is the radius of the hemisphere. In some embodiments, all dimples 102 may have the same diameter or radius. In other embodiments, dimples 102 may be provided with different diameters or radii. In some embodiments, each dimple may have a diameter or radius selected from a preselected group of diameters/radii. In some embodiments, the number of different diameters/radii in the preselected group of diameters/radii ranges from three (3) to six (6). In some embodiments, the number of dimples 102 with the greatest diameter/radius is greater than the number of dimples with any other diameter/radius. In other words, in such an embodiment, there are more of the largest dimples than dimples of any other size.

[0019] The aggregate of the volumes of all of dimples 102 on the surface of golf ball 100 is a total dimple volume. In one embodiment, the total dimple volume is about 550 cubic millimeters to about 800 cubic millimeters. In some embodiments, the total dimple volume may range from about 600 cubic millimeters to about 800 cubic millimeters.

[0020] Internally, golf ball 100 is generally constructed as a multilayer solid golf ball. In other words, multiple layers of material are fused or compressed together to form the ball. As shown in FIG. 2, one embodiment of golf ball 100 includes a core 104, a cover 108, and an intermediate layer 106 sandwiched between core 104 and intermediate layer 106. Together, core 104 and intermediate layer 106 may be considered to be an "inner ball".

[0021] Core 104 may include any number of materials. In some embodiments, core 104 may include a thermoplastic material or a thermoset material. The thermoplastic material of core 104 may be an ionomer resin, a highly neutralized acid polymer composition, a polyamide resin, a polyester resin, a polyurethane resin, and combinations thereof. In one embodiment, core 104 comprises an ionomer resin. For example, core 104 may include HPF and Surlyn®, both commercially available from E. I. DuPont de Nemours and Company, and IOTEK®, commercially available from Exxon Corporation. To increase COR, one composition of core 104 includes HPF as the main composition with Surlyn® and/or

IOTEK® as optional sub-compositions. Any sub-composition of core 104 may be in an amount of 0 to 40 parts by weight, or in some embodiments, 0 to 10 parts by weight, based on 100 parts by weight of the main composition of core 104.

[0022] Core 104 may be made using any method known in the art, such as hot-press molding or injection molding. Core 104 of the present invention may be single layer or multilayer construction, and except for the aforementioned materials, any other materials may be also used to make core 104. In some embodiments, the material of core 104 is selected to provide core 104 with a COR greater than 0.750. In some embodiments, core 104 has a COR at 40 meters per second ranging between about 0.79 and 0.89. In some embodiments, core 104 has a higher COR than that of golf ball 100 taken as a whole.

[0023] In some embodiments, a diameter of core 104 may be in a range between about 19.0 millimeters and about 37.0 millimeters. In some embodiments, the diameter of core 104 may range from about 19.0 millimeters and about 32 millimeters. In some embodiments, the diameter of core 104 may range between about 21.0 millimeters and about 35.0 millimeters. In some embodiments, the diameter of core 104 may range between about 23.0 millimeters and 32.0 millimeters.

[0024] In the embodiment shown in FIG. 2, intermediate layer 106 covers and substantially encloses core 104. Intermediate layer 106 has an interior surface facing an exterior surface of core 104. In the embodiment shown in FIG. 2, the exterior surface of intermediate layer 106 faces an interior surface of cover 108. Intermediate layer 106 may have any thickness. In one embodiment, the thickness of intermediate layer 106 may range from about 3 millimeters to about 11 millimeters. In one embodiment, the thickness of intermediate layer 106 may range from about 4 millimeters to about 10 millimeters.

[0025] Intermediate layer 106 may include a thermoset material. In some embodiments, the thermoset material may be a rubber composition. In some embodiments, the base rubber of the rubber composition may include 1,4-cis-polybutadiene, polyisoprene, styrene-butadiene copolymers, natural rubber, and combinations thereof. To increase the resiliency of the inner ball, 1,4-cis-polybutadiene may be used as the base rubber of the rubber composition. Alternatively, 1,4-cis-polybutadiene can be used as the base material for intermediate layer 106, with additional materials added to the base material. In some embodiments, the amount of 1,4-cis-polybutadiene is at least 50 parts by weight, based on 100 parts by weight of the rubber composition.

[0026] Additives, such as a crosslinking agent and a filler with a greater specific gravity may be added to the rubber composition. The suitable crosslinking agent can be selected from the group consisting of peroxide, zinc diacrylate, magnesium acrylate, zinc methacrylate, and magnesium methacrylate. To increase the resiliency of the rubber composition, zinc acrylate may be used. However, to increase the resistance to long-term exposure to relatively high ambient temperatures, peroxide may be used as the cross-linking agent. In particular, when core 104 is formed from a high resilient thermoplastic material, the performance of golf ball 100 is maintained in spite of long-term exposure to relatively high ambient temperatures when intermediate layer 106 is formed from a peroxide cross-linked polybutadiene material.

[0027] For example, when intermediate layer 106 is formed from a peroxide cross-linked polybutadiene material and core 104 may include a high resilient thermoplastic material, golf ball 100 may be stored at 24 degrees Celsius for at least about 8 hours. The inner ball (core 104 and intermediate layer 106) may have a first deflection amount of 2.2 millimeters to about 3.2 millimeters under a load of about 10 kilograms to about 130 kilograms when golf ball 100 is stored in an environment of about 24 degrees Celsius for at least about 8 hours. When the same ball is stored in an environment of about 50 degrees Celsius for at least about 8 hours, golf ball 100 may have a different deflection, the second deflection amount. The ratio of the second deflection amount to the first deflection amount is between about 1.5 and about 1.15.

[0028] In Table 1, various COR and deflection measurements are provided for various golf balls. An Example ball is made according to the invention. In the Example, core 104 includes HPF2000, a DuPont ionomer resin in which the MAA acid groups have been fully neutralized with magnesium ions. Intermediate layer 106 includes BR compound, a peroxide cross-linked polybutadiene material, the specific composition of which is shown in Table 2. The performance of the Example is compared with two conventional balls: Comparative 1, where the entire inner ball includes HPF2000 and Comparative 2, where the entire inner ball comprises Surlyn8940, a Dupont ionomer resin - Ethylene/methacrylic acid (E/MAA) copolymer, in which the MAA acid groups have been partially neutralized with sodium ions.

Table 1: Comparison of Example Ball Performance with Conventional Balls

	Example	Comparative 1	Comparative 2
Core	HPF2000	HPF2000	Surlyn8940
Intermediate layer	BR		
Core diameter(mm)	28.0		
Inner ball diameter (mm)	39.3	39.3	39.3

(continued)

Compression Test (10-130kg)			
Second Deflection Amount after storage at 50 degrees C for 8hrs (mm)	3.13	3.27	2.21
First Deflection Amount after storage at 24 degrees C for 8hrs (mm)	2.84	2.66	1.54
Ratio of Second Deflection Amount to First Deflection Amount	1.10	1.23	1.44
COR			
	0.838	0.825	0.726

Table 2: BR Compound Composition

TAIPOL™ BR0150	100
Zinc diacrylate	28
Zinc oxide	6
Barium sulfate	39.5
Peroxide	1

[0029] As shown in Table 1, the deflection performance of the Example ball is greater than that of Comparative 1 and Comparative 2 after exposure to high ambient temperatures. The ratio of the second deflection amount to the first deflection amount of the Example ball is about 1.1, while the other balls have a ratio of 1.23 and 1.44, respectively. This means that the Comparative balls are less capable of holding their shape and resisting compression after long exposure to high temperatures than the Example ball. Further the COR of the Example ball is greater than either of the Comparative balls.

[0030] To increase the specific gravity of intermediate layer 106, a suitable filler may be added in the rubber composition, such as zinc oxide, barium sulfate, calcium carbonate, and magnesium carbonate, and in the present invention, zinc oxide is preferred. In addition, a metal powder with a greater specific gravity may also be used as the filler, such as tungsten. By means of adjusting the added amount of the filler, the specific gravity of intermediate layer 106 can reach the desired level.

[0031] In the embodiment shown in FIG. 2, an exterior surface of intermediate layer 106 faces an interior surface of cover 108. The exterior surface of cover 108 is the exterior surface of golf ball 100, which is shown in FIG. 1. Cover 108 may include any material known in the art. In some embodiments, cover 108 may include an ionomer resin, a highly neutralized ionomer resin, a polyamide resin, a polyester resin, a thermoplastic polyurethane resin, a thermoset polyurethane resin, or combinations of these compounds.

[0032] In the embodiment shown in FIG. 3, an additional cover layer is provided: inner cover layer 110. In such an embodiment cover 108 may be considered to be an outer cover layer. Inner cover layer 110 may comprise the same material as that of outer cover layer 108.

[0033] The thickness of inner cover layer 110 may range between about 0.5 millimeters and 11.0 millimeters. In some embodiments, the thickness of inner cover layer 110 may range between about 0.5 millimeters and about 8.5 millimeters. In some embodiments, the thickness of inner cover layer 110 may range between about 0.5 millimeters and about 3.0 millimeters.

[0034] Inner cover layer 110 has an interior surface that faces an exterior surface of intermediate layer 106. Inner cover layer 110 covers and encloses intermediate layer 106. Inner cover layer 110 has an exterior surface that faces an interior surface of outer cover layer 108.

[0035] In some embodiments, the exterior surface of inner cover layer 110 has a higher hardness than the exterior surface of cover 108. In some embodiments, an exterior surface of inner cover layer 110 may have a Shore D hardness of 45 to 65, while the exterior surface of outer cover layer 108 may have a Shore D hardness of 40 to 60. In some embodiments, the entirety of inner cover layer 110 has a higher hardness than the entirety of cover 108.

[0036] While the balls described herein have compositions and layers selected to improve the performance of balls after exposure to high ambient temperatures, balls may also be designed to improve or maintain performance in other types of environments. For example, some types of golf balls may have reduced performance when cold. This problem is addressed in U.S. Patent Number _____, currently U.S. Patent Application Serial Number 12/230,272,

entitled "Multilayer Solid Golf Ball", and filed on August 27, 2008, the entirety of which is incorporated herein by reference.
[0037] Further alternatives of the present invention are as follows:

1. A golf ball comprising:

a core, said core comprising a thermoplastic material;
 an intermediate layer enclosing said core to form an inner ball, said intermediate layer comprising a thermoset material; and
 a cover enclosing said inner ball, wherein said golf ball satisfies the following requirements:

- (1) said inner ball has a first deflection amount of 2.2 to 3.2 millimeters under a load of 10 to 130 kilograms when said inner ball is kept in an environment of 24 degrees Celsius for at least about eight hours,
- (2) said inner ball has a second deflection amount under a load of 10 to 130 kilograms when said inner ball is kept in an environment of about 50 degrees Celsius for at least about 8 hours, and wherein the ratio of the second deflection amount to the first deflection amount is between about 1.05 and about 1.15, and
- (3) said core has a coefficient of restitution at 40 meters per second falling between approximately 0.79 and 0.89 and higher than that of said golf ball.

2. The golf ball of alternative 1, wherein said core has a diameter of 19 millimeters to 32 millimeters.

3. The golf ball of alternative 1, wherein said intermediate layer has a thickness of 3 millimeters to 11 millimeters.

4. The golf ball of alternative 1, wherein said intermediate layer has a thickness of 4 millimeters to 10 millimeters.

5. The golf ball of alternative 1, wherein said thermoplastic material is selected from the group consisting of ionomer resin, highly neutralized acid polymer composition, polyamide resin, polyester resin, polyurethane resin, and any combinations thereof.

6. The golf ball of alternative 1, wherein said cover comprises an inner cover layer enclosing said inner ball and an outer cover layer enclosing said inner cover layer; said outer cover layer having a Shore D hardness lower than that of the inner cover layer.

7. The golf ball of alternative 6, wherein said inner cover layer comprises an external surface having a Shore D hardness of 45 to 65; said outer cover layer comprises an external surface having a Shore D hardness of 40 to 60.

8. A golf ball comprising:

a core, said core comprising a thermoplastic material;
 an intermediate layer enclosing said core to form an inner ball, said intermediate layer comprising a thermoset material; and
 a cover enclosing said inner ball and having a plurality of dimples on its outer surface, wherein said golf ball satisfies the following requirements:

- (1) said inner ball has a first deflection amount of 2.2 to 3.2 millimeters under a load of 10 to 130 kilograms when said inner ball is kept in an environment of 24 degrees Celsius for at least about 8 hours,
- (2) said inner ball has a second deflection amount under a load of 10 to 130 kilograms when said inner ball is kept in an environment of 50 degrees Celsius for at least about 8 hours, and the ratio of the second deflection amount to the first deflection amount is between about 1.05 and about 1.15, and
- (3) said core has a coefficient of restitution at forty (40) meters per second falling between approximately 0.79 and 0.89 and higher than that of said golf ball, and
- (4) said dimples have a total volume of 550 cubic millimeters to 800 cubic millimeters.

9. The golf ball of alternative 8, wherein said dimples have a total number of 250 to 500.

10. The golf ball of alternative 8, wherein said dimples have a total number of 300 to 450.

11. The golf ball of alternative 8, wherein said dimples have a total volume of 600 cubic millimeters to 800 cubic millimeters.

12. The golf ball of alternative 8, wherein said dimples are provided with 3 to 6 kinds of different diameters.

13. The golf ball of alternative 12, wherein the number of dimples with the largest diameter is greater than the respective number of any other dimples with smaller diameters.

14. The golf ball of alternative 8, wherein said core has a diameter of 19 millimeters to 32 millimeters.

15. The golf ball of alternative 8, wherein said intermediate layer has a thickness of 3 millimeters to 11 millimeters.

16. The golf ball of alternative 8, wherein said intermediate layer has a thickness of 4 millimeters to 10 millimeters.

17. The golf ball of alternative 8, wherein said thermoplastic material is selected from the group consisting of ionomer resin, highly neutralized acid polymer composition, polyamide resin, polyester resin, polyurethane resin, and any

combinations thereof.

18. The golf ball of alternative 8, wherein said cover comprises an inner cover layer enclosing said inner ball and an outer cover layer enclosing said inner cover layer; said outer cover layer having a Shore D hardness lower than that of the inner cover layer.

19. The golf ball of alternative 18, wherein said inner cover layer or outer cover layer comprises a material selected from the group consisting of ionomer resin, highly neutralized acid polymer composition, polyamide resin, polyester resin, thermoplastic polyurethane resin, thermoset polyurethane resin, and any combinations thereof.

20. The golf ball of alternative 18, wherein said inner cover layer comprises an external surface having a Shore D hardness of 45 to 65; said outer cover layer comprises an external surface having a Shore D hardness of 40 to 60.

[0038] While various embodiments of the invention have been described, the description is intended to be exemplary, rather than limiting and it will be apparent to those of ordinary skill in the art that many more embodiments and implementations are possible that are within the scope of the invention. Accordingly, the invention is not to be restricted except in light of the attached claims and their equivalents. Also, various modifications and changes may be made within the scope of the attached claims.

Claims

1. A golf ball comprising:

a core, said core comprising a thermoplastic material;

an intermediate layer enclosing said core to form an inner ball, said intermediate layer comprising a thermoset material; and

a cover enclosing said inner ball, wherein said golf ball satisfies the following requirements:

(1) said inner ball has a first deflection amount of 2.2 to 3.2 millimeters under a load of 10 to 130 kilograms when said inner ball is kept in an environment of 24 degrees Celsius for at least about eight hours,

(2) said inner ball has a second deflection amount under a load of 10 to 130 kilograms when said inner ball is kept in an environment of about 50 degrees Celsius for at least about 8 hours, and wherein the ratio of the second deflection amount to the first deflection amount is between about 1.05 and about 1.15, and

(3) said core has a coefficient of restitution at 40 meters per second falling between approximately 0.79 and 0.89 and higher than that of said golf ball.

2. The golf ball of claim 1, wherein said cover has a plurality of dimples on its surface, and wherein the plurality of dimples have a total volume of 550 cubic millimeters to 800 cubic millimeters.

3. The golf ball of claim 2, wherein said dimples have a total number of 250 to 500, and wherein said dimples are provided with 3 to 6 kinds of different diameters.

4. The golf ball of claim 3, wherein the number of dimples with the largest diameter is greater than the respective number of any other dimples with smaller diameters.

5. The golf ball of claim 1, 2, or 3 wherein said core has a diameter of 19 millimeters to 32 millimeters.

6. The golf ball of claim 1, 2, or 3, wherein said intermediate layer has a thickness of 3 millimeters to 11 millimeters.

7. The golf ball of claim 1, 2, or 3, wherein said thermoplastic material is selected from the group consisting of ionomer resin, highly neutralized acid polymer composition, polyamide resin, polyester resin, polyurethane resin, and any combinations thereof.

8. The golf ball of claim 1, 2, or 3, wherein said cover comprises an inner cover layer enclosing said inner ball and an outer cover layer enclosing said inner cover layer, wherein said outer cover layer having a Shore D hardness lower than that of said inner cover layer.

9. The golf ball of claim 7, wherein said inner cover layer comprises an external surface having a Shore D hardness of 45 to 65, and wherein said outer cover layer comprises an external surface having a Shore D hardness of 40 to 60.

- 10.** The golf ball of claim 1, 2, 3, 8, or 9 wherein said cover layer comprises a material selected from the group consisting of ionomer resin, highly neutralized acid polymer composition, polyamide resin, polyester resin, thermoplastic polyurethane resin, thermoset polyurethane resin, and any combinations thereof.

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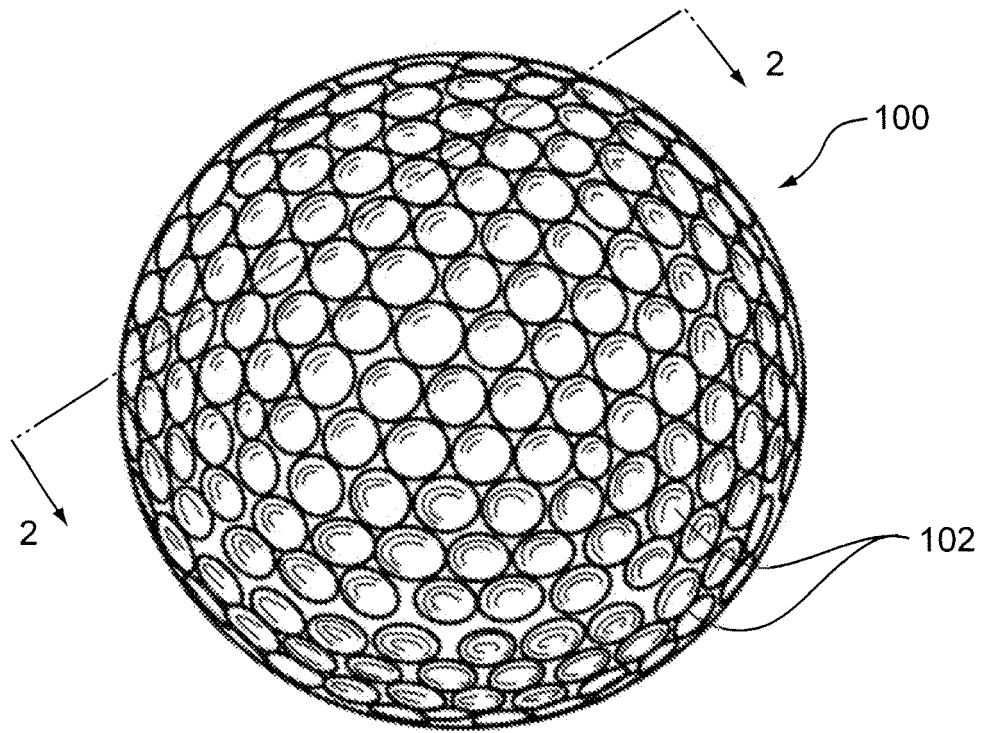


Figure 1

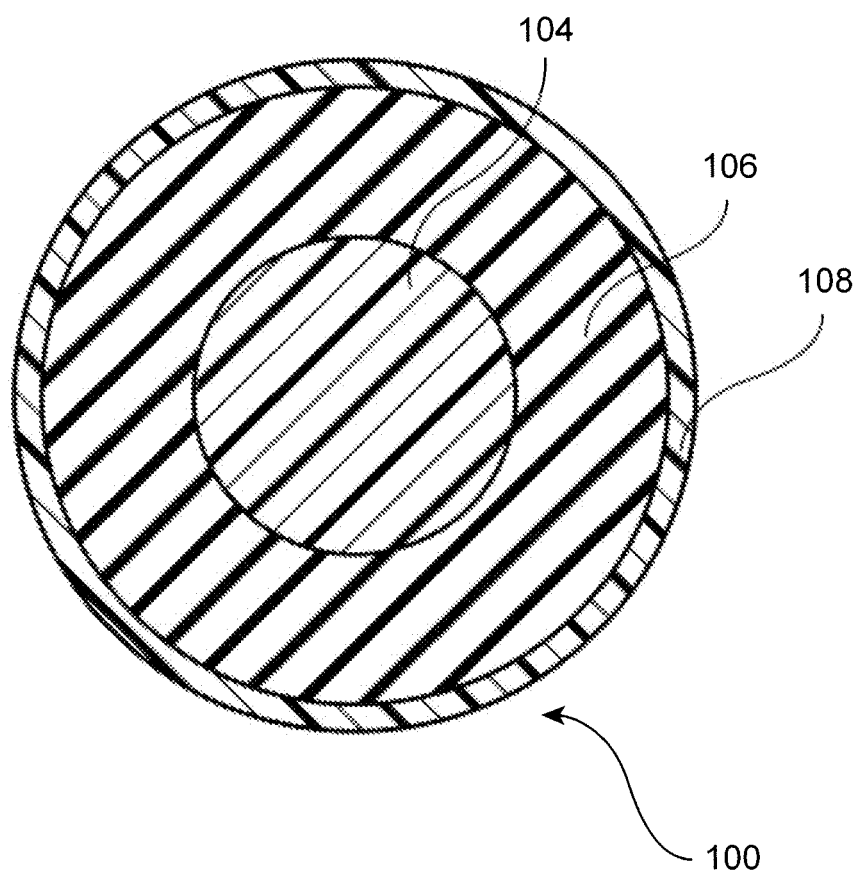


Figure 2

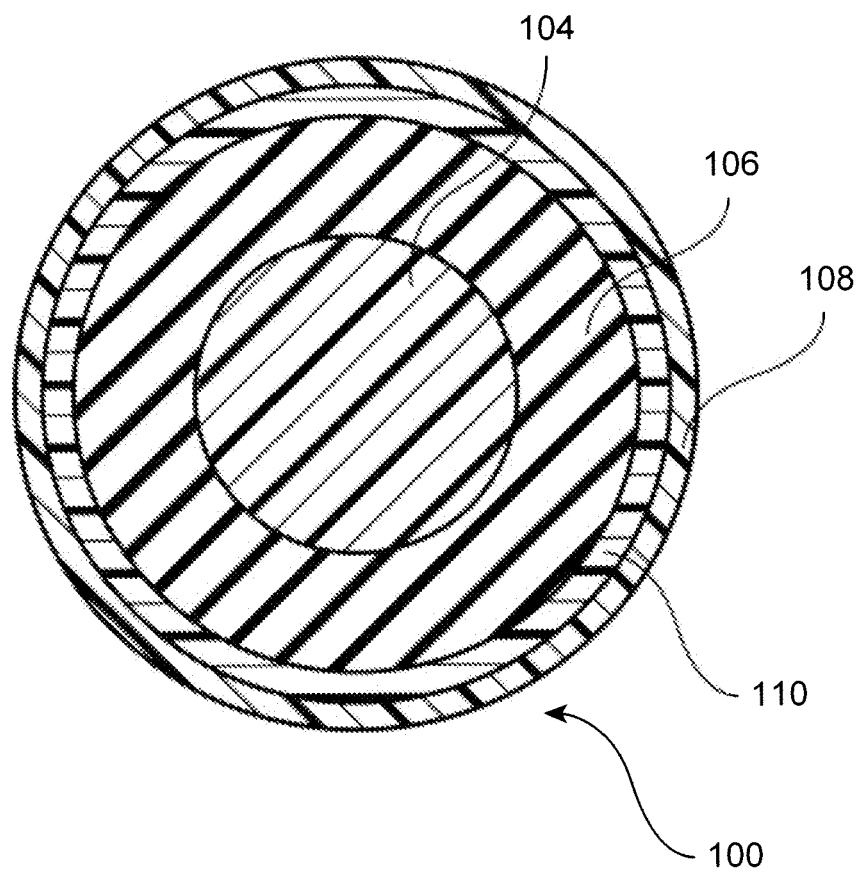


Figure 3



EUROPEAN SEARCH REPORT

Application Number
EP 11 15 4682

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2009/280928 A1 (COMEAU BRIAN [US] ET AL) 12 November 2009 (2009-11-12) * paragraphs [0026], [0027] * * paragraph [0047] * -----	1,7,10	INV. A63B37/00
A	US 2007/129172 A1 (CAVALLARO CHRISTOPHER [US]) 7 June 2007 (2007-06-07) * paragraph [0005] * -----	1	
L	US 2011/053707 A1 (ISHII HIDEYUKI [US] ET AL) 3 March 2011 (2011-03-03) -----		
A	US 2008/312008 A1 (HIGUCHI HIROSHI [JP] ET AL) 18 December 2008 (2008-12-18) * table 5 * -----	1	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
			A63B
Place of search		Date of completion of the search	Examiner
The Hague		20 May 2011	Jones, Mark
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 15 4682

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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20-05-2011

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REFERENCES CITED IN THE DESCRIPTION

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