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(54) **SOLID CENTER TYPE THREAD WOUND GOLF BALL**

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(57) **ABSTRACT**

The present invention provides a solid center type thread wound golf ball, of which flight distance is largely improved. The present invention related to a solid center type thread wound golf ball comprising a solid center, a thread rubber layer formed on the solid center, and a cover layer covering the thread rubber layer, wherein

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assuming that a deformation amount when applying from an initial load of 9.8 N to a final load of 29.4 N is represented as A (mm), and a diameter of the solid center is represented as B (mm), the golf ball satisfies the following formulae:

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$$13.0 - 0.33B \leq A \leq 13.8 - 0.33B$$

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$$27 \leq B \leq 34.$$

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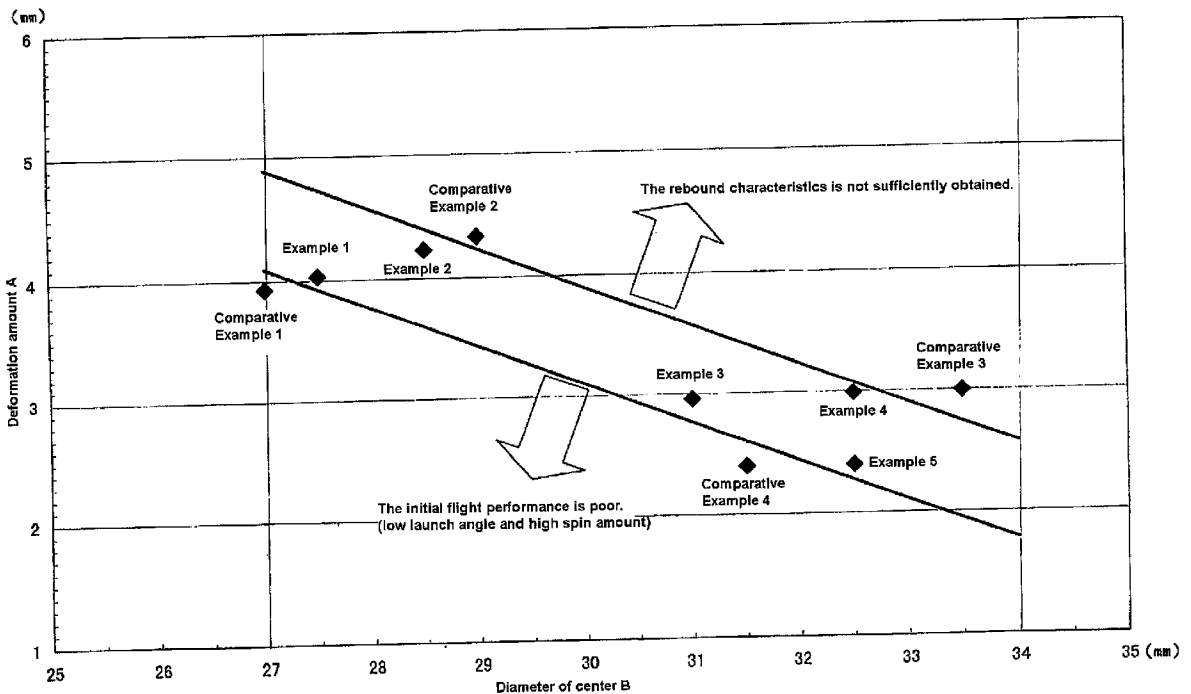
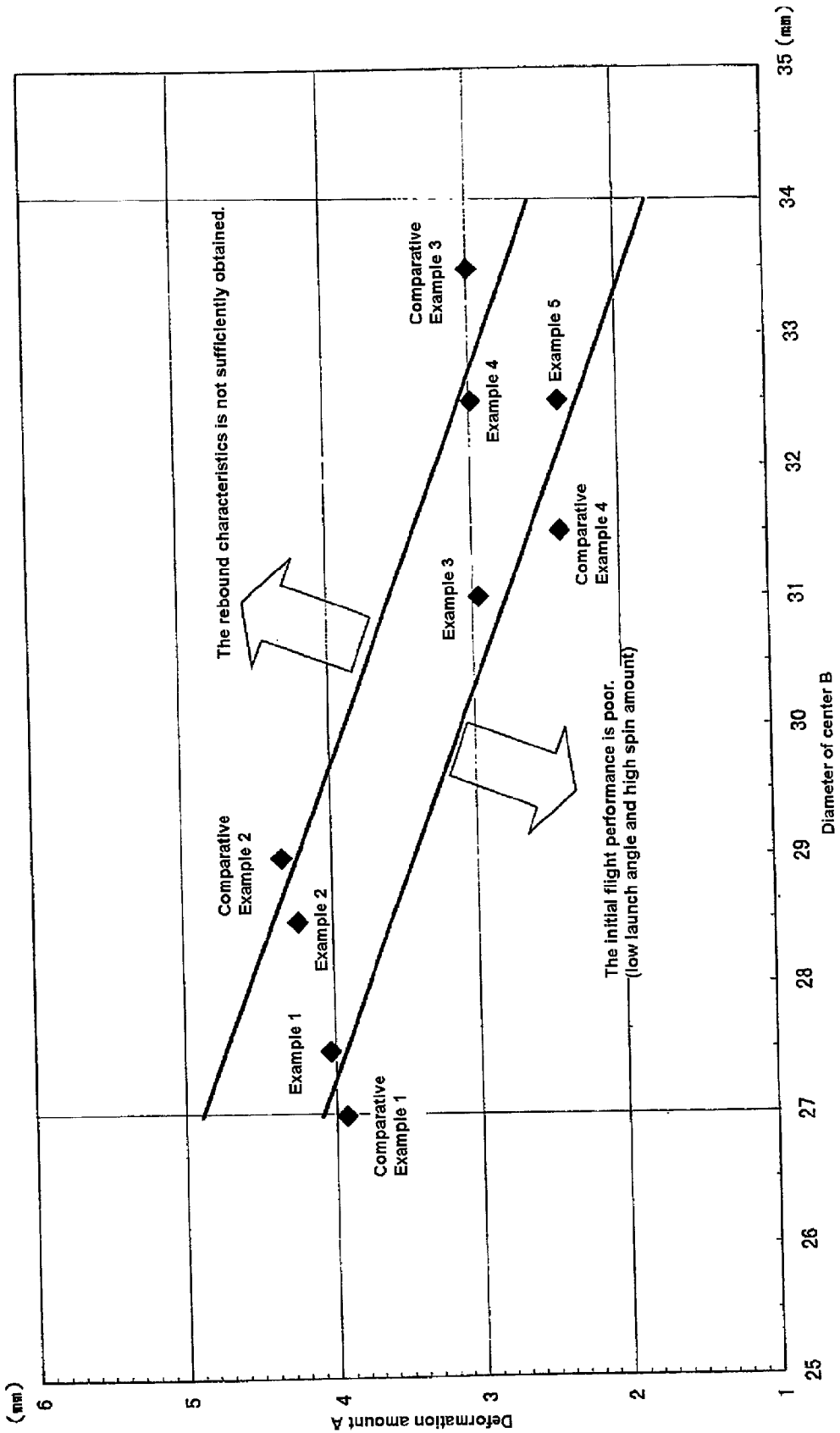


Fig. 1



SOLID CENTER TYPE THREAD WOUND GOLF BALL

FIELD OF THE INVENTION

[0001] The present invention relates to a thread wound golf ball comprising a solid center (a solid center type thread wound golf ball). More particularly, it relates to a solid center type thread wound golf ball, of which flight distance is largely improved.

BACKGROUND OF THE INVENTION

[0002] Many golf balls are commercially selling, but they are typically classified into solid golf balls such as two-piece golf ball and three-piece golf ball, and thread wound golf balls. The thread wound golf ball consists of a thread wound core comprising a thread wound layer and a cover covering on the thread wound core. The thread wound golf ball, when compared with the solid golf ball, has better shot feel at the time of hitting and better spin performance. The thread wound golf ball is generally approved of or employed by high level golfers, especially professional golfers, who regard the characteristics as most important. On the other hand, the thread wound golf ball is inferior in flight distance to the solid golf ball.

[0003] In the thread wound golf balls, there are two types depending on the type of center, on which thread rubber is wound to form thread wound core, such as a solid center type and liquid center type. The liquid center is composed of a hollow rubber sphere and liquid encapsulated in the sphere. The solid center is formed from unvulcanized rubber material. In the solid center type thread wound golf ball, the rebound characteristics of the solid center have effect on those of the golf ball. Therefore the solid center type thread wound golf ball, when compared with the liquid center type thread wound golf ball, is superior in flight distance. However, since the thread wound golf ball is generally inferior in flight distance as described above, it is required to increase the flight distance of the thread wound golf ball, while maintaining the characteristics thereof, such as good shot feel and good spin performance.

[0004] It has been proposed to improve the flight distance of the solid center type thread wound golf ball by various means. For example, in Japanese Patent Kokai Publication No. 54930/1994, a solid center type thread wound golf ball obtained by adjusting the surface hardness and deformation amount when applying a load of 500 kg of the solid center to a specified range is described. In Japanese Patent Kokoku Publication No. 25029/1992, a solid center type thread wound golf ball obtained by adjusting the diameter, hardness and weight of the solid center, and the hardness, softening point and thickness of the cover to a specified range is described. In Japanese Patent No. 2751022, a solid center type thread wound golf ball obtained by adjusting the diameter and deformation amount when applying from an initial load of 10 kg to a final load of 30 kg of the solid center to a specified range is described.

[0005] In Japanese Patent No. 2886804, a solid center type thread wound golf ball obtained by adjusting the diameter and deformation amount when applying a load of 30 kg of the solid center, the hardness of the cover and the shape of the dimple to a specified range is described.

[0006] The conventional solid center type thread wound golf balls as proposed above, is improved by adjusting the diameter, hardness, deformation amount or rebound characteristics of the solid center, and optionally the properties of the cover to a specified range. However, it is fact that they are yet inferior in flight distance to solid golf balls.

OBJECTS OF THE INVENTION

[0007] A main object of the present invention is to provide a solid center type thread wound golf ball having long flight distance by optimizing a balance of the diameter and deformation amount of the solid center to adjust the launch angle and spin performance to a proper range.

[0008] According to the present invention, the object described above has been accomplished by providing a solid center type thread wound golf ball comprising a solid center, a thread rubber layer formed on the solid center, and a cover layer covering the thread rubber layer and by adjusting A and B to the range of the following formulae (1) and (2):

$$13.0-0.33B \leq A \leq 13.8-0.33B \quad (1)$$

$$27 \leq B \leq 34 \quad (2)$$

[0009] when assuming that a deformation amount when applying from an initial load of 9.8 N to a final load of 29.4 N is represented as A (mm), and a diameter of the solid center is represented as B (mm).

[0010] It is confirmed that the solid center type thread golf ball has also good spin performance at approach shot peculiar to thread golf balls by designing so that the Shore D hardness of the cover layer is within the range of 45 to 60 and the thickness of the cover is within the range of 1 to 2 mm.

[0011] When the diameter of the solid center is larger, the thickness of the thread rubber layer is smaller because the diameter of the golf ball is limited to a certain extent. Therefore it assimilates to the structure of solid golf ball to increase the flight distance, but the performances of the thread wound golf ball such as shot feel are degraded. It is attempted to soften the center, that is, to increase the deformation amount in order to maintain the performance of the thread wound golf ball, but the softening of the center adversely degrades the rebound characteristics, which reduces the flight distance. In the present invention, it is possible to increase the flight distance of the golf ball by making a correlation between the performances clear in order to keep a balance between the performances contradictory to each other. According to the present invention, there has the advantage of becoming easy to design the solid center type thread wound golf ball.

BRIEF EXPLANATION OF DRAWINGS

[0012] FIG. 1 is a graph illustrating the correlation of the deformation amount A (mm) with the diameter of the solid center B (mm) described in Claim of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] A base rubber used for preparing the solid center of the present invention is not particularly limited, but includes, for example, polybutadiene rubber (BR), natural rubber (NR), ethylene-propylene-diene monomer terpolymer rubber (EPDM), polynorborene rubber, silicone rubber and the

like. Preferred are polynorbornene rubber and silicone rubber. Polynorbornene rubber can contain an oily substance in high amount to obtain a soft rubber, which imparts suitable rebound characteristics to the resulting solid center by selecting the oily substance.

[0014] It is required to freeze and harden the solid center in order to prevent the center from deforming when winding a thread rubber around the solid center. Therefore the rubber which can harden at low temperature, preferably at -30 to -50° C. is suitable. Polynorbornene rubber can harden within the above temperature range even in case of containing the oily substance, and it is also suitable from this viewpoint.

[0015] The oily substance, which is used for lowering hardness and imparting suitable rebound characteristics to the resulting solid center, is not limited, but includes alkylbenzene oil; naphthenic oil; paraffinic oil; aromatic oil; ester plasticizer such as dioctyl adipate (DOA), dioctyl sebacate (DOS) and the like. Preferred are naphthenic oil and alkylbenzene oil, because it is difficult to occur bleeding in case of containing in high amount and they impart high rebound characteristics to the resulting solid center.

[0016] The solid center is generally obtained by mixing 100 to 500 parts by weight of the oily substance, 0.5 to 5 parts by weight of sulfur, 3 to 10 parts by weight of vulcanization aid, 1 to 5 parts by weight of vulcanization accelerator and a desired amount of weight adjuster, based on 100 parts by weight of the base rubber using a Banbury mixer or a mixing roll and by press molding and vulcanizing at 150 to 170° C. for 10 to 20 minutes. The silicone rubber may be room temperature vulcanizing type or heat vulcanizing type, which is not limited, but preferred is heat vulcanizing type silicone rubber which is copolymer of dimethyl siloxane as a main component and methyl vinyl siloxane as small component.

[0017] A method for vulcanizing the silicone rubber includes a method of using organic peroxide, fatty azo compound, radiation and the like, but organic peroxide is generally used. The solid center is generally obtained by mixing 0.5 to 5 parts by weight of vulcanizing agent and a desired amount of weight adjuster, based on 100 parts by weight of the silicone rubber using a Banbury mixer or a mixing roll and by press molding and vulcanizing at 150 to 170° C. for 10 to 20 minutes.

[0018] The vulcanization aid, vulcanization accelerator and weight adjuster may be one which has been conventionally used for solid center. However, as the weight adjuster, high specific gravity filler is used in order to accomplish high weight ratio of the rubber component in the solid center and low hardness of the solid center. Example of the weight adjuster includes barium sulfate, calcium carbonate, clay, silica and the like

[0019] In the present invention, when assuming that a deformation amount when applying from an initial load of 9.8 N to a final load of 29.4 N is represented as A (mm), and a diameter of the solid center is represented as B (mm), it is required that the A and B satisfy a correlation of the following formulae (1) and (2):

$$13.0-0.33B \leq A \leq 13.8-0.33B \quad (1)$$

$$27 \leq B \leq 34 \quad (2)$$

[0020] It is desired for the deformation amount A to be within the range of 1.5 to 5.0 mm, preferably 2.0 to 4.5 mm. When the deformation amount A is smaller than 1.5 mm, the shot feel is hard and poor, and the spin amount is large. On the other hand, when the deformation amount A is larger than 5.0 mm, it is difficult to obtain a desired hardness of the golf ball, and the rebound characteristics are degraded. When the formula (1) is transformed, the following formula (3):

$$13.0 \leq A + 0.33B \leq 13.8 \quad (3)$$

[0021] is obtained. A graph illustrating the correlation of the value of A with the value of B from the formula is FIG. 1. As shown in FIG. 1, when the value of A of the golf ball is smaller than the lower limit of the formula (3), which is the line represented by the formula: $A = -0.33B + 13.0$, the initial flight performance is poor, that is, the launch angle is low and the spin performance is poor. On the other hand, when the value of A of the golf ball is larger than the upper limit of the formula (3), which is the line represented by the formula: $A = -0.33B + 13.8$, the rebound characteristics is not sufficiently obtained.

[0022] It is required for the diameter of the solid center B to be within the range of 27 to 34 mm, preferably 27.5 to 33.5 mm. When the diameter of the solid center B is smaller than 27 mm, the spin amount is large, and the launch angle is small. On the other hand, when the diameter of the solid center is larger than 34 mm, the thread rubber layer is too thin and the suitable hardness of the resulting golf ball is not obtained.

[0023] A thread rubber layer is formed by winding a thread rubber in an elongated state around the solid center. The thread rubber may be of the same kind which is conventionally used in thread wound layers in thread wound golf balls, and is not limited.

[0024] As the thread rubber of the present invention, for example, the thread rubber obtained by vulcanizing a rubber composition in which natural rubber or a blend of natural rubber and synthetic polyisoprene rubber have been compounded and the like may be used. A thread-wound core can be produced by drawing the thread rubber 500 to 1500%, preferably 800 to 1200% over the center and winding it there. The thickness of the thread rubber layer is within the range of 3.0 to 7.0 mm, preferably 4.0 to 6.5 mm. When the thickness of the thread rubber layer is smaller than 3.0 mm, the performance of the thread rubber layer is sufficiently obtained, and the suitable hardness of the resulting golf ball is not obtained. On the other hand, when the thickness of the thread rubber layer is larger than 7.0 mm, the spin amount is too large, which reduces the flight distance.

[0025] The cover is covered on the resulting thread wound core to form the thread wound golf ball. A method of covering on the thread wound core with the cover is not specifically limited, but may be a conventional method. For example, there can be used a method comprising molding the cover composition into a hemispherical half-shell in advance, covering the thread wound core with the two half-shells, followed by press molding, or a method comprising injection molding the cover composition directly on the thread wound core to cover it.

[0026] The cover of the present invention, which is not specifically limited, may be the cover which has been conventionally used for the cover of the thread wound golf

balls, and is generally formed from ionomer resin, thermoplastic elastomer, or mixtures thereof, as the base resin in the cover. It is desired for the cover layer to have a Shore D hardness of 45 to 60, preferably 48 to 55. When the hardness is smaller than 45, the rebound characteristics are degraded. On the other hand, when the hardness is larger than 60, the spin performance at approach shot is poor, and the controllability is degraded. It is desired for the cover to have a thickness of 1 to 2 mm, preferably 1.4 to 1.8 mm. When the thickness of the cover is smaller than 1 mm, the durability is not sufficiently obtained. On the other hand, when the thickness is larger than 2 mm, the rebound characteristics are much degraded.

[0027] The ionomer resin used for the cover may be, for example, a copolymer of α -olefin and α,β -unsaturated carboxylic acid having 3 to 8 carbon atoms, of which at least a portion of carboxylic acid groups is neutralized with metal ion; or a terpolymer of α -olefin, α,β -unsaturated carboxylic acid having 3 to 8 carbon atoms and α,β -unsaturated carboxylic acid ester having 2 to 22 carbon atoms, of which at least a portion of carboxylic acid groups is neutralized with metal ion. As a composition ratio in the ionomer resin, when the base polymer of the ionomer resin is the copolymer, it is preferable for the ionomer resin to comprise 80 to 90% by weight of the α -olefin and 10 to 20% by weight of the α,β -unsaturated carboxylic acid. When the base polymer is the terpolymer, it is preferable for the ionomer resin to comprise 70 to 85% by weight of the α -olefin, 5 to 20% by weight of the α,β -unsaturated carboxylic acid and 10 to 25% by weight of α,β -unsaturated carboxylic acid ester. It is desired for the ionomer resin to have a melt index of 0.1 to 20, preferably 0.5 to 15.

[0028] Examples of the α -olefins in the ionomer, for example, include ethylene, propylene, 1-butene, 1-pentene and the like. Preferred is ethylene. Examples of the α,β -unsaturated carboxylic acid in the ionomer, for example, include acrylic acid, methacrylic acid, fumaric acid, maleic acid, crotonic acid and the like. Preferred are acrylic acid and methacrylic acid. Examples of the α,β -unsaturated carboxylic acid ester in the ionomer, for example, include methyl ester, ethyl ester, propyl ester, n-butyl ester and isobutyl ester of acrylic acid, methacrylic acid, fumaric acid, maleic acid and the like. Preferred are acrylic acid esters and methacrylic acid esters. The metal ion which neutralizes a portion of carboxylic acid groups of the copolymer or terpolymer includes a sodium ion, a lithium ion, a zinc ion, a magnesium ion, a potassium ion and the like. When the ionomer is a copolymer of ethylene and acrylic acid or methacrylic acid, of which at least a portion of carboxylic acid groups is neutralized with metal ion, it is preferable for the ionomer resin to have a melt index of 3 to 7 and a flexural modulus of 200 to 400 MPa, which is high stiffness and high flow type ionomer resin.

[0029] Examples of the ionomer resin will be shown by a trade name thereof. Examples of the ionomer resin, which is commercially available from Mitsui Du Pont Polychemical Co., Ltd. include Hi-milan 1555 (Na), Hi-milan 1557 (Zn), Hi-milan 1605 (Na), Hi-milan 1707 (Na), Hi-milan AM7318 (Na), Hi-milan 1706 (Zn), Hi-milan AM7315 (Zn), Hi-milan AM7317 (Zn), Hi-milan AM7311 (Mg) and Hi-milan MK7320 (K); and Hi-milan 1856 (Na), Hi-milan 1855 (Zn), Hi-milan AM7316 (Zn) and the like as the terpolymer ionomer resin. Examples of the ionomer resin, which is

commercially available from Du Pont U.S.A., include Surlyn 8945 (Na), Surlyn 8940 (Na), Surlyn AD8512 (Na), Surlyn 9910 (Zn), Surlyn 9945 (Zn), Surlyn 7930 (Li) and Surlyn 7940 (Li); and Surlyn AD8265 (Na), Surlyn AD8269 (Na) and the like as the terpolymer ionomer resin.

[0030] Examples of the ionomer resin, which is commercially available from Exxon Chemical Co., include Iotek 7010 (Zn), Iotek 8000 (Na) and the like. Incidentally, Na, Zn, K, Li and Mg, which are described in parentheses after the trade name of the above ionomer resin, indicate their neutralizing metal ion species. These ionomer resins may be used alone or in combination of two or more thereof, or a mixture of one or more of the ionomer resin obtained by neutralizing with monovalent metal ion and the ionomer resin obtained by neutralizing with divalent metal ion, as the base resin of the cover in the present invention.

[0031] The thermoplastic elastomer used in the present invention, which comprises soft segment and hard segment, includes polystyrene-based elastomer, polyester-based elastomer, polyurethane-based elastomer, or block copolymers having conjugated diene compound such as polybutadiene block or polyisoprene block. Examples of the conjugated diene compounds include butadiene, isoprene, 1,3-pentadiene, 2,3-dimethyl-1,3-butadiene and the like, or mixtures thereof. Preferred are butadiene, isoprene and combinations thereof. Examples of components comprising the other block copolymer include styrene, α -methylstyrene, vinyltoluene, p-t-butylstyrene, 1,1-diphenylethylene and the like, or mixtures thereof. Preferred are styrene.

[0032] Examples of the block copolymer include, for example, styrene-isoprene-butadiene-styrene copolymer (SIBS structure); styrene-butadiene-styrene copolymer (SBS structure); styrene-ethylene-butylene-styrene block copolymer (SEBS structure), of which the double bond in the butadiene portion is hydrogenated; styrene-isoprene-styrene copolymer (SIS structure); styrene-ethylene-propylene-styrene block copolymer (SEPS structure), of which the double bond in the isoprene portion is hydrogenated; styrene-ethylene-ethylene-propylene-styrene block copolymer (SEEPS structure); and modification thereof.

[0033] A styrene content in the SIBS structure, the SBS structure, the SEBS structure, the SIS structure, the SEPS structure and the SEEPS structure is within the range of 10 to 50% by weight, preferably 15 to 45% by weight, based on the weight of the copolymer. When the styrene content is smaller than 10% by weight, the cover is too soft, and the cut resistance is degraded. On the other hand, when the styrene content is larger than 50% by weight, the technical effect of softening the ionomer resin is not sufficiently accomplished. Therefore, the shot feel and controllability are degraded.

[0034] In the present invention, the block copolymers having the SBS structure, the SEBS structure, the SIS structure, the SEPS structure and the SEEPS structure may have epoxy groups in a portion of the copolymer.

[0035] The wording "styrene-butadiene-styrene block copolymer (SBS structure) comprising polybutadiene block containing epoxy groups" as used herein means block copolymer in which polybutadiene block containing epoxy groups is sandwiched by two polystyrene blocks, and may be the block copolymer, of which a portion or all of the double bonds in the polybutadiene portion is hydrogenated. The wording "styrene-isoprene-styrene block copolymer

(SIS structure) comprising polyisoprene block containing epoxy groups” as used herein means block copolymer in which polyisoprene block containing epoxy groups is sandwiched by two polystyrene blocks, and may be the block copolymer, of which a portion or all of the double bonds in the polyisoprene portion is hydrogenated.

[0036] An epoxy group content in the block copolymer having epoxidized SBS structure or epoxidized SIS structure is within the range of 0.05 to 10% by weight, preferably 0.2 to 5% by weight, based on the weight of the copolymer. When the epoxy group content is smaller than 0.05% by weight, the reaction of the epoxy group with a free carboxyl group in the ionomer resin decreases, and the dispersibility of the block copolymer having epoxidized SBS structure or epoxidized SIS structure in the ionomer resin is degraded. Therefore the durability of the resulting golf ball is degraded. On the other hand, when the epoxy group content is larger than 10% by weight, the reaction of the epoxy group with a free carboxyl group in the ionomer resin increases, and the flowability is poor, which degrades the moldability of the golf ball.

[0037] Examples of the epoxidized SBS structure or epoxidized SIS structure block copolymer include styrene-butadiene-styrene block copolymer (SBS structure) comprising polybutadiene block containing epoxy groups commercially available from Daicel Chemical Industries, Ltd. under the trade name of “Epofriend A1010”, “ESBS” and the like; styrene-butadiene-styrene block copolymer comprising polybutadiene block containing epoxy groups, of which a portion of the polybutadiene block is hydrogenated, commercially available from Daicel Chemical Industries, Ltd. under the trade name of “ESBS AT018”, “ESBS AT019” and the like, which can be suitably used in the present invention.

[0038] The SEBS structure or SEPS structure block copolymer having terminal OH groups is commercially available from Kuraray Co., Ltd. under the trade name of “Septon HG-252”.

[0039] The polyester-based thermoplastic elastomer used in the present invention may be “Hytrel (trade name)” such as “Hytrel 4047”, which is commercially available from Toray-Do Pont Co., Ltd. The polyamide-based thermoplastic elastomer used in the present invention may be “Pebax (trade name)” such as “Pebax 2533SNOO”, which is commercially available from Toray Industries, Inc.

[0040] As the materials used in the cover of the present invention, the ionomer resin is suitably used in combination with the thermoplastic elastomer in order to accomplish good shot feel, high rebound characteristics and good spin performance (controllability). It is desired for a weight ratio of the ionomer resin/thermoplastic elastomer to be within

the range of 20/80 to 80/20, preferably 30/70 to 70/30. The amount of the ionomer resin is smaller than 20% by weight, the rebound characteristics are degraded. On the other hand, when the thermoplastic elastomer is smaller than 20% by weight, the shot feel is poor (the impact force at the time of hitting is large), or the spin performance is degraded. As the thermoplastic elastomer used in the present invention, the block copolymer type thermoplastic elastomer is suitably used. If used, the amount of the block copolymer type thermoplastic elastomer, is 10 to 80% by weight, preferably 20 to 70 by weight, based on the base resin of the cover (that is, the total amount of the ionomer resin and thermoplastic elastomer). When the amount of the thermoplastic elastomer is within the range of not less than 10% by weight, it is possible to improve the shot feel and spin performance while maintaining good rebound characteristics. However, when the amount is larger than 80% by weight, the rebound characteristics are easily degraded. It is possible to accomplish a golf ball having excellent spin performance and excellent flight distance by selecting the cover material to adjust the deformation amount to the scope of the present invention. In the golf ball of the present invention, the cover composition may optionally contain fillers (such as barium sulfate, etc.), pigments (such as titanium dioxide, etc.), and other additives (such as a dispersant, an antioxidant, a UV absorber, a photostabilizer and a fluorescent agent or a fluorescent brightener, etc.), in addition to the resin component, as long as the addition of the additive does not deteriorate the desired performance of the golf ball cover. The weight ratio of the base resin to all cover material pigment is preferably not less than 0.8, more preferably not less than 0.9.

[0041] The multi-piece solid golf ball of the present invention is formed to a diameter of at least 42.67 mm and a weight of no more than 45.92 g, in accordance with the regulations for golf balls.

EXAMPLES

[0042] The following Examples and Comparative Examples further illustrate the present invention in detail but are not to be construed to limit the scope of the present invention.

Examples 1 to 5 and Comparative Examples 1 to 4

[0043] The rubber composition for the solid core having the formulation shown in Table 1 was mixed, and the mixture was then vulcanized by press-molding in a mold at the vulcanization condition shown in the same Table to obtain a spherical solid core having a diameter, weight, hardness (JIS-A hardness) and deformation amount shown in Table 2 and Table 3. The value of (A+0.33B) was calculated and the result is also shown in the same Table.

TABLE 1

Center composition	Example No.					(parts by weight) Comparative Example No.			
	1	2	3	4	5	1	2	3	4
Norsorex *1	100	100	—	—	—	100	100	—	—
Alkyl benzene oil	300	300	—	—	—	300	300	—	—

TABLE 1-continued

Center	Example No.					(parts by weight) Comparative Example No.			
	1	2	3	4	5	1	2	3	4
composition									
Barium sulfate	381	339	362	36.5	116	403	319	16.9	142
Zinc oxide	5	5	—	—	5	5	5	—	5
Stearic acid	1	1	—	—	1	1	1	—	1
Sulfur	2.5	2.5	—	—	1	2.5	2.5	—	1
Nocceler ZTC *2	3	3	—	—	—	3	3	—	—
Nocceler DM *3	2	2	—	—	—	2	2	—	—
X30-2812U *4	—	—	100	100	—	—	—	100	—
C-17 *5	—	—	0.6	0.6	—	—	—	0.6	—
Esprene 532 *6	—	—	—	—	100	—	—	—	100
Carbon black PX-90 *7	—	—	—	—	40	—	—	—	40
Nocceler M *8	—	—	—	—	1	—	—	—	1
Nocceler TET *9	—	—	—	—	0.5	—	—	—	0.5
Nocceler BZ *10	—	—	—	—	0.5	—	—	—	0.5
Nocceler TTTE *11	—	—	—	—	0.5	—	—	—	0.5
Vulcanization condition									
Temp. (° C.)	155	155	150	150	170	155	155	150	170
Time (min)	15	15	10	10	22	15	15	10	22

*1: Polynorbornene rubber (trade name "Norsorex") from Nippon Zeon Co., Ltd.

*2: Vulcanization accelerator (trade name "Nocceler ZTC") zinc dibenzylthiocarbamate from Ouchi Shinko Chemical Industrial Co., Ltd.

*3: Vulcanization accelerator (trade name "Nocceler DM") N-cyclohexyl-2-benzothiazyl sulfenamide from Ouchi Shinko Chemical Industrial Co., Ltd.

*4: Silicone compound (trade name "X30-2812U") available from Shin-Etsu Chemical Co., Ltd.

*5: Peroxide (trade name "C-17") available from Shin-Etsu Chemical Co., Ltd.

*6: "Esprene 532 (trade name)" available from Sumitomo Chemical Co., Ltd.

*7: Paraffin oil (trade name "PX-90") available from Idemitsu Kosan Co., Ltd.

*8: Vulcanization accelerator (trade name "Nocceler N") 2-mercaptobenzothiazole from Ouchi Shinko Chemical Industrial Co., Ltd.

*9: Vulcanization accelerator (trade name "Nocceler TET") tetraethyl thiuram disulfide from Ouchi Shinko Chemical Industrial Co., Ltd.

*10: Vulcanization accelerator (trade name "Nocceler PZ") zinc dibutylthiocarbamate from Ouchi Shinko Chemical Industrial Co., Ltd.

*11: Vulcanization accelerator (trade name "Nocceler TTTE") tellurium diethyldithiocarbamate from Ouchi Shinko Chemical Industrial Co., Ltd.

[0044]

TABLE 2

	Example No.				
	1	2	3	4	5
Diameter B (mm)	27.5	28.5	31	32.5	32.5
Weight (g)	17.3	18.6	21.8	23.8	23.8
Hardness (JIS-A)	18	18	24	24	32
Deformation amount A (mm)	4.03	4.23	2.96	2.99	2.40
(A + 0.33B)	13.105	13.635	13.19	13.715	13.125

[0045]

TABLE 3

	Comparative Example No.			
	1	2	3	4
Diameter B (mm)	27	29	33.5	31.5
Weight (g)	16.6	19.2	25.1	22.5
Hardness (JIS-A)	18	18	24	32
Deformation amount A (mm)	3.93	4.32	3.00	2.40
(A + 0.33B)	12.84	13.90	14.055	12.795

[0046] Each thread wound core was obtained by winding a thread rubber around the resulting solid center. The thread rubber, of which a base rubber is a blend of natural rubber and a low cis-isoprene rubber=40/60 (weight ratio), has a width of 1.5 mm and a thickness of 0.5 mm. A diameter of the thread wound core was about 39.7 mm.

[0047] Each cover was covered on the resulting thread wound core by using a given cover composition. The cover composition comprises

- [0048] 25 parts by weight of "Surlyn 9945",
- [0049] 25 parts by weight of "Surlyn 8945",
- [0050] 15 parts by weight of "Epofriend A1010",
- [0051] 35 parts by weight of "Septon HG-252",
- [0052] 2 parts by weight of titanium dioxide, and
- [0053] 2 parts by weight of barium sulfate.

[0054] The cover has a Shore D hardness of 52. The Shore D hardness of the cover was measured with a Shore D hardness meter according to ASTM D-2240-68, using a sample of a stack of three or more heat and press molded sheet having a thickness of about 2 mm from each cover composition, which had been stored at 23° C. for 2 weeks.

[0055] Surlyn 9945 (trade name), ethylene-methacrylic acid copolymer ionomer resin obtained by neutralizing with zinc ion, manufactured by Du Pont Co. (neutralization number=50, Shore D hardness=59, melt index=5.2, flexural modulus=2255 kgf/cm²=221 MPa).

[0056] Surlyn 8945 (trade name), ethylene-methacrylic acid copolymer ionomer resin obtained by neutralizing with sodium ion, manufactured by Du Pont Co. (neutralization number=50, Shore D hardness=61, melt index=4.8, flexural modulus=2775 kgf/cm²=272 MPa)

[0057] Epofriend A1010 (trade name), epoxy group modified styrene-butadiene-styrene structure block copolymer having a polybutadiene block with epoxy groups, manufactured by Daicel Chemical Industries, Ltd.

[0058] Septon HG-252 (trade name), hydrogenated polystyrene block-isoprene/butadiene random polymer block-polystyrene block copolymer having a terminal OH group, manufactured by Kuraray Co. Ltd. (JIS-A hardness=80)

[0059] The covered thread wound core together with the cover composition was heat-pressed in a mold for golf ball having dimples, followed by coating with a paint to obtain a thread wound golf ball having an outer diameter of 42.7 mm. The thickness of the cover was 1.5 mm. With respect to the resulting golf ball, flight test was conducted, and the result is shown in Table 4 and Table 5. The test methods are described later.

[0060] Test Results

TABLE 4

Test item	Example No.				
	1	2	3	4	5
<u>Flight test 1 (W #1, 49 m/sec)</u>					
Launch angle (°)	9.7	9.7	9.7	9.8	9.7
Spin amount (rpm)	3010	2990	2960	2900	2980
Flight distance (total) (m)	242.1	240.9	243.5	240.3	242.8

TABLE 4-continued

Test item	Example No.				
	1	2	3	4	5
<u>Flight test 2 (I #5, 41 m/sec)</u>					
Launch angle (°)	13.6	13.7	13.7	13.9	13.6
Spin amount (rpm)	5470	5480	5430	5200	5460
Flight distance (carry) (m)	180.6	180.9	181.5	180.1	181.1

[0061]

TABLE 5

Test item	Comparative Example No.			
	1	2	3	4
<u>Flight test (W #1, 49 m/sec)</u>				
Launch angle (°)	9.7	9.7	10	9.7
Spin amount (rpm)	2890	3060	2810	3090
Flight distance (total) (m)	237.4	238.6	238.9	236.6
<u>Flight test (I #5, 41 m/sec)</u>				
Launch angle (°)	13.7	13.9	14	13.1
Spin amount (rpm)	6010	5140	4840	6110
Flight distance (carry) (in)	177.7	179.8	177.4	179.0

[0062] Test Method

[0063] (1) Flight Test 1

[0064] After a No. 1 wood club (a driver, W#1; "Newbreed Tour Forged" loft angle=8.5 degrees, X shaft, manufactured by Sumitomo Rubber Industries, Ltd.) was mounted to a swing robot manufactured by True Temper Co. and a golf ball was hit at head speed of 49 m/sec, the launch angle, spin amount (backspin) and flight distance were measured. As the flight distance, total that is a distance to the stop point of the hit golf ball were measured. The measurement was conducted 12 times for each golf ball (n=12), and the average is shown as the result of the golf ball.

[0065] (2) Flight Test 2

[0066] After a No. 5 iron club (I#5; "Newbreed Tour Forged" S shaft, manufactured by Sumitomo Rubber Industries, Ltd.) was mounted to a swing robot manufactured by True Temper Co. and a golf ball was hit at head speed of 41 m/sec, the launch angle, spin amount (backspin) and flight distance were measured. As the flight distance, carry that is a distance to the drop point of the hit golf ball was measured. The measurement was conducted 12 times for each golf ball (n=12), and the average is shown as the result of the golf ball.

[0067] As a unit of each measurement, the launch angle is represented in degree, the spin amount is represented in rpm, and the flight distance (total and carry) is represented in meter.

[0068] With respect to the golf balls of Examples 1 to 5 and Comparative Examples 1 to 4, the results of Tables 2 and 3 (deformation amount A and diameter of solid center B) is plotted in the graph shown in FIG. 1. As is apparent from

FIG. 1, all plots of the golf balls of the present invention of Examples 1 to 5 are on the line or within the area having higher A value than the line represented by the formula: $A = -0.33B + 13.0$, and are on the line or within the area having lower A value than the line represented by the formula: $A = -0.33B + 13.8$. That is, in the golf balls of the present invention of Examples 1 to 5, the values of

[0069] The golf balls of Comparative Examples 1 and 4 are within the area having lower A value than the line represented by the formula: $A = -0.33B + 13.0$, and the initial flight performance is poor, that is, the launch angle and the spin amount is low. In addition, the flight distance is short.

[0070] The golf balls of Comparative Examples 2 and 3 are within the area having higher A value than the line represented by the formula: $A = -0.33B + 13.8$, and the rebound characteristics is not sufficiently obtained. In addition the flight distance is short.

What is claimed is:

1. A solid center type thread wound golf ball comprising a solid center, a thread rubber layer formed on the solid center, and a cover layer covering the thread rubber layer, wherein

assuming that a deformation amount when applying from an initial load of 9.8 N to a final load of 29.4 N is represented as A (mm), and a diameter of the solid center is represented as B (mm), the golf ball satisfies the following formulae:

$$13.0 - 0.33B \leq A \leq 13.8 - 0.33B$$

$$27 \leq B \leq 34.$$

2. The solid center type thread wound golf ball according to claim 1, wherein the cover layer has a Shore D hardness of 45 to 60 and a thickness of 1 to 2 mm.

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