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(71) Applicant(s)
Sumitomo Rubber Industries, Ltd.

(72) Inventor(s)
Yoshikazu Yabuki; Akira Kato

(74) Agent/Attorney
DAVIES COLLISON CAVE,1 Little Collins Street,MELBOURNE VIC 3000

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ABSTRACT OF THE DISCLOSURE

The present invention provides a golf ball having good shot feel and durability as well as satisfactory flight performance and cut resistance. The golf ball of the present invention comprises a core and a cover covering the core, wherein the cover is formed from a heated mixture of

(A) an ionomer resin, and

(B) a block copolymer having a styrene-butadiene-styrene structure in which the polybutadiene block contains epoxy groups, or a block copolymer having a styrene-isoprene-styrene in which the polyisoprene block contains epoxy groups,

and the cover has a flexural modulus of from 50 to 300 MPa and a Shore D-scale hardness of from 40 to 60, in the form of a cover composition before forming into the cover.

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COMPLETE SPECIFICATION

NAME OF APPLICANT(S):

Sumitomo Rubber Industries, Ltd.

ADDRESS FOR SERVICE:

DAVIES COLLISON CAVE
Patent Attorneys
1 Little Collins Street, Melbourne, 3000.

INVENTION TITLE:

Golf ball

The following statement is a full description of this invention, including the best method of performing it known to me/us:-

FIELD OF THE INVENTION

The present invention relates to a golf ball. More particularly, it relates to a golf ball having good shot feel when hitting and controllability as well as good flight performance and good cut resistance.

BACKGROUND OF THE INVENTION

Recently, ionomer resin has widely been used for cover material of golf balls (e.g. Japanese Patent Publication No. 49-27093 etc.). Particularly, the ionomer resin is exclusively used as cover resin for two-piece golf balls using a solid core. This is because the ionomer resin is superior in durability, cut resistance, rebound performance, etc. and it is easily processed.

However, since the ionomer resin has high hardness and rigidity, the resulting golf ball is poor in shot feel and controllability (ease of giving spin) in comparison with balata (transpolyisoprene) which has been used as cover material of a multi-layer structure golf ball containing a thread rubber layer.

In order to improve shot feel and controllability of the ionomer-covered golf balls, softening the ionomer resin has been intensively studied.

For example, Japanese Patent Laid-Open Publication Nos. 1-308577 and 5-3931 suggest to blend or mix a hard ionomer resin with a soft ionomer resin prepared by neutralizing a terpolymer of α-olefin, an unsaturated carboxylic acid (e.g. acrylic acid, methacrylic acid, etc.) and an acrylate with sodium or zinc ion, thereby improving shot feel and controllability.

However, the blending of the soft ionomer resin as suggested by the above mentioned publications has not provided with the shot feel which is closed to the balata covered golf ball. Instead, the rebound performance and flight performance are adversely lowered by blending the soft ionomer resin and, therefore, sufficient technical effects have not been obtained.

Japanese Patent Laid-Open Publication No. 5-220240 suggests to improve shot feel and controllability by blending the ionomer resin with a polymer containing glycidyl groups. According to this method, shot feel and controllability are slightly improved but they are not sufficient and ionomer-covered gold balls having sufficient characteristics (particularly, rebound performance, flight performance, etc.) are still desired.

ADVANTAGES OF THE INVENTION

Under these circumstances, the present inventors have intensively studied the cover to satisfy excellent shot feel and controllability, which are not available with the balata-covered golf balls, and excellent flight performance and cut resistance based on the ionomer resin.

A golf ball of the present invention may have the advantages of good shot feel and controllability as well as satisfactory flight performance and cut resistance.

This advantage as well as other advantages of the present invention will become apparent to those skilled in the art from the following description with reference to the accompanying drawings.

BRIEF EXPLANATION OF DRAWINGS

Fig. 1 is a schematic cross section illustrating one embodiment of the golf ball of the present invention.

Fig. 2 is a schematic cross section illustrating another embodiment of the golf ball of the present invention.

SUMMARY OF THE INVENTION

The present invention provides a golf ball which comprises a core and a cover covering the core, wherein the cover is formed from a heated mixture of

(A) an ionomer resin, and

(B) a block copolymer having a styrene-butadiene-styrene structure in which the polybutadiene block contains epoxy groups, or a block copolymer having a styrene-isoprene-styrene structure in which the polyisoprene block contains epoxy groups,

and the cover has a flexural modulus of from 50 to 300 MPa and a Shore D-scale hardness of from 40 to 60, in the form of a cover composition before forming into the cover.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, the present invention will be explained in detail. In case of explanation, the ionomer resin is referred to as a "component (A)" and the styrene-butadiene-styrene structure block copolymer having a polybutadiene block containing epoxy groups or the styrene-isoprene-styrene structure block copolymer having a polyisoprene block containing epoxy groups is referred to as a "component (B)". Particularly, the component (B) is abbreviated to "SBS structure block copolymer" or "SIS structure block copolymer".

In the present invention, by mixing the ionomer resin of the component (A) and the SBS structure or SIS structure block copolymer of the component (B) with heating, the epoxy groups of the SBS structure or SIS structure block copolymer of the component (B) are reacted with free carboxyl groups present in the ionomer resin (A) to form graft copolymers having a soft polymer chain, and the grafted copolymers are finely dispersed in a matrix of the ionomer resin (A) by shear force when kneading. Therefore, the ionomer resin is softened and its rebound performance is improved.

As a result, by using the above heated mixture as a main component of the cover, shot feel and controllability are improved and the degradation of flight performance (rebound performance) and cut resistance are inhibited, thus obtaining a golf ball having good shot feel and controllability as well as satisfactory flight performance and cut resistance.

In the present invention, examples of the ionomer resin as the component (A) are one obtained by neutralizing at least a portion of carboxylic groups in a copolymer of an α-olefin and an α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms with metal ion; and one obtained by neutralizing at least a portion of carboxylic groups in a terpolymer of an α-olefin, an α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms and an α,β-unsaturated carboxylate having 2 to 22 carbon atoms with metal ion. Regarding the compositional ratio of the monomers, when a backbone of the ionomer resin is a copolymer of an α-olefin and an α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms, the amount of the α-olefin is preferably from 80 to 90% by weight and the amount of the α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms is preferably from 10 to 20% by weight. When the backbone is a terpolymer of an α-olefin, an α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms and an α,β-unsaturated carboxylate having 2 to 22 carbon atoms, the amount of the α-olefin is from 70 to 85% by weight, the amount of the α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms is preferably from 5 to 20% by weight and, further the amount of the α,β-unsaturated carboxylate having 2 to 22 carbon atoms is preferably from 10 to 25% by weight. It is preferred that the ionomer resin has a melt index (MI) of 0.1 to 20, particularly 0.5 to 15.

The α-olefin listed above can be ethylene, propylene, 1-butene, 1-pentene and the like. Particularly, ethylene is preferred. The α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms may be acrylic acid, methacrylic acid, fumaric acid, maleic acid, crotonic acid and the like. Particularly, acrylate and methacrylate are preferred. Examples of the unsaturated carboxylate are methyl, ethyl, propyl, n-butyl and isobutyl ester of acrylic acid, methacrylic acid, fumaric acid and maleic acid. Particularly, acrylate and methacrylate are preferred. Examples of the metal ion which neutralizes at least a portion of carboxylic groups in the copolymer of the α-olefin and α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms or in the terpolymer of the α-olefin, α,β-unsaturated carboxylic acid having 3 to 8 carbon atoms and α,β-unsaturated carboxylate having 2 to 22 carbon atoms are monovalent metal ions or divalent metal ions, such as sodium ion, lithium ion, zinc ion, magnesium ion, potassium ion and the like.

Specific examples of the above ionomer resins will be indicated by the trade name thereof. Examples of the ionomer resins which are commercially available from Mitsui Du Pont Polychemical Co., Ltd. include 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) and Hi-milan AM7316 (Zn) as the terpolymer ionomer resin. Examples of the ionomer resins which are commercially available from Du Pont U.S.A. Co. include Surlyn 8920 (Na), Surlyn 8940 (Na), Surlyn AD8512 (Na), Surlyn 9910 (Zn), Surlyn AD8511 (Zn), Surlyn 7930 (Li) and Surlyn 7940 (Li); and Surlyn AD8265 (Na) and Surlyn AD8269 (Na) as the terpolymer ionomer resin. Examples of the ionomer resins which are commercially available from Exxon Chemical Co. include Iotek 7010 (Zn) and Iotek 8000 (Na). 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. In the present invention, two or more ionomer resins described above may be used in combination. Alternatively, two or more ionomer resins neutralized with monovalent metal ion and ionomer resins neutralized with divalent metal ion may be used in combination.

In the present invention, the SBS structure block copolymer having a polybutadiene block containing epoxy groups is a block copolymer having polystyrene blocks at both terminal ends, wherein the intermediate layer is polybutadiene block containing epoxy groups and abbreviated to "SBS" and a portion or all of double bonds of the polybutadiene moiety is hydrogenated. The SIS structure block copolymer having a polyisoprene block containing epoxy groups is a block copolymer having polystyrene blocks at both terminal ends, wherein the intermediate layer is polyisoprene block containing epoxy groups and abbreviated to "SIS" and a portion or all of double bonds of the polyisoprene moiety is hydrogenated.

In order to soften the ionomer resin of the component (A), it is preferred that the SBS structure or SIS structure block copolymer of the component (B) has a JIS-A hardness of 30-90 , particularly, 40-88. When the JIS-A hardness of the SBS structure or SIS structure block copolymer as the component (B) is smaller than 30, the cover is too soft and cut resistance is lowered. On the other hand, when the JIS-A hardness is larger than 90, softening of the ionomer resin is not sufficiently accomplished and the properties of the ionomer resin appear strongly and, therefore, shot feel and controllability are poor. The JIS-A hardness is a hardness measured by a JIS-A hardness tester (JIS K 6301).

The styrene content of the SBS structure or SIS structure block copolymer of the component (B) is preferably from 10 to 50% by weight, particularly from 15 to 45% by weight. When the styrene content is less than 10% by weight, the cover is too soft and cut resistance is likely to be lowered. On the other hand, when the styrene content is larger than 50 % by weight, softening of the ionomer resin is not sufficiently accomplished and the properties of the ionomer resin appear strongly and shot feel and controllability are poor.

The epoxy content of the SBS structure or SIS structure block copolymer of the component (B) is preferably from 0.05 to 10 % by weight, particularly from 0.2 to 5 % by weight. When the epoxy content is less than 0.05 % by weight, the amount of reaction between the epoxy group and free carboxyl group in the ionomer resin as the component (A) is small and the dispersion of the SBS structure or SIS structure block copolymer of the component (B) into the ionomer resin of the component (A) is deteriorated and, therefore, durability is poor. On the other hand, when the epoxy content is larger than 10 % by weight, the amount of reaction between the epoxy group and free carboxyl group in the ionomer resin is too much and its fluidity is poor and therefore, molding of the golf ball is difficult.

Examples of the commercially available SBS structure or SIS structure block copolymers of the component (B) are SBS structure block copolymers having a polybutadiene block containing epoxy groups, which are commercially from Daicel Chemical Industries, Ltd. under the trade name of "ESBS A1005", "ESBS A1010" and "ESBS A1020"; and SBS structure block copolymers prepared by hydrogenating a portion of a polybutadiene block containing epoxy groups, which are commercially from Daicel Chemical Industries, Ltd. under the trade name of "ESBS AT018" and "ESBS AT019". Both are suitably used in the present invention.

In the present invention, it is necessary that the cover is formed from a cover composition which is composed of the ionomer resin of the component (A) and the SBS structure or SIS structure block copolymer of the component (B). The cover composition preferably has a flexural modulus of 50 to 300 MPa and a Shore D-scale hardness of 40 to 60. When the flexural modulus of the cover composition is smaller than 50 MPa, the cover is too soft and spin amount increases too much. Therefore, flight distance is lowered and cut resistance is lowered. On the other hand, when the flexural modulus is larger than 300 MPa, it is impossible to obtain a suitable backspin amount. Therefore, controllability is poor and shot feel also is poor. When the Shore D-scale hardness of the cover composition is smaller than 40, the cover is too soft and cut resistance is poor. On the other hand, when the Shore D-scale hardness is larger than 60, it is impossible to obtain a suitable backspin amount. Therefore, controllability is poor and shot feel also is poor. Regarding the cover composition, a heated mixture of the ionomer resin of the component (A) and the SBS structure or SIS structure block copolymer of the component (B) occupies a main part and, in the majority of case, a small amount of titanium dioxide and barium sulfate is merely added. Therefore, the flexural modulus and Shore D-scale hardness are substantially the same as those of the heated mixture of the ionomer resin of the component (A) and SBS structure or

SIS structure block copolymer of the component (B).

In the present invention, the weight ratio of the ionomer resin of the component (A) to the SBS structure or SIS structure block copolymer of the component (B) is preferably within the range of from 95:5 to 50:50, particularly from 90:10 to 55:45. When the amount of the ionomer resin of the component (A) is larger than the above range, softening of the ionomer resin is not sufficiently accomplished and the properties of the ionomer resin appear strongly and, therefore, the shot feel and controllability of the resulting golf balls are poor. On the other hand, when the amount of the ionomer resin of the component (A) is smaller than the above range, the cover is too soft and spin amount increases too much. Therefore, the flight distance and cut resistance of the resulting golf balls are degraded.

In the present invention, it is possible to obtain desired characteristics by mixing the ionomer resin of the component (A) and the SBS structure or SIS structure block copolymer of the component (B) with heating. The components (A) and (B) are generally mixed at a temperature of 150 to 260 ℃, using an internal mixer such as a kneading type twin-screw extruder, a Banbury mixer, a kneader, etc.

If necessary, various additives such as pigments, dispersants, antioxidants, UV absorbers, photostabilizers, etc. can be formulated in the cover composition, in addition to the heated mixture of the ionomer resin of the component (A) and the SBS structure or SIS structure block copolymer of the component (B). The other resin can also be added as long as the characteristics of the component (A) and the component (B) are not damaged. When the other resin is added to form the cover composition, the amount of the heated mixture of ionomer resin of the component (A) and the SBS structure or SIS structure block copolymer of the component (B) is preferably not less than 70 % by weight, particularly not less than 80% by weight. In the present invention, "the heated mixture of the ionomer resin of the component (A) and the SBS structure or SIS structure block copolymer of the component (B) is used as the main component of the cover" means not only one that the resin component of the cover is composed of only the heated mixture of the ionomer resin of the component (A) and SBS structure or SIS structure block copolymer of the component (B), but also one that another resin is added to the heated mixture to form the resin component of the cover. In the present invention, the heated mixture of the ionomer resin of the component (A) and the SBS structure or SIS structure block copolymer of the component (B) may be previously mixed with heating, followed by mixing with the other resin. In addition, the mixture may be mixed with the other additives when the cover composition is prepared.

The cover composition can be used for covering any kind of a solid core and a thread wound core.

The solid core may be not only a core having a single-layer structure, but also a core having a multi-layer structure composed of two or more layers. For example, the solid core for two-piece golf ball can be obtained by subjecting a rubber composition to a press vulcanization to compress with heating (e.g. at a temperature of 140 to 170℃ for 10 to 40 minutes) into a spherical vulcanized article. The rubber composition can be prepared by formulating 10 to 60 parts by weight of at least one vulcanizing agent (crosslinking agent) of α,β-ethylenically unsaturated carboxylic acids (e.g. acrylic acid, methacrylic acid, etc.) or metal salts thereof and functional monomers (e.g. trimethylolpropane trimethacrylate, etc.), 10 to 30 parts by weight of a filler (e.g. zinc oxide, barium sulfate, etc.), 0.5 to 5 parts by weight of a peroxide (e.g. dicumyl peroxide, etc.) and 0.1 to 1 parts by weight of an antioxidant, into 100 parts by weight of polybutadiene.

The thread wound core is composed of a center and a thread rubber layer formed by winding in a stretched state around the center. The center may be a solid center of a vulcanized molded article of a rubber composition, or a liquid center wherein a liquid such as water, paste, etc. is encapsulated in a center cover made of a vulcanized rubber. The solid center preferably has a diameter of from 28 to 38 mm and a deformation amount of 0.5 to 2.5 mm when applying a weight from an initial load of 10 Kg to a final load of 30 Kg. When the diameter of the solid center is smaller than 28 mm, launch angle is small and spin amount is increased. Therefore, flight distance is poor. On the other hand, when the diameter of the solid center is larger than 38 mm, winding of a thread rubber is finished before a suitable tension is applied to the thread rubber when winding the thread rubber around the solid center. Therefore, the rebound force of the thread rubber layer is not sufficiently utilized and the rebound performance of the golf ball is poor and flight distance is also poor. When the deformation amount is less than 0.5 mm, the center is too hard and the resulting golf ball has very poor shot feel. If the deformation amount is more than 2.5 mm, the center is too soft and it is difficult to control to a suitable ball hardness, thus degrading initial velocity of the resulting golf ball. In case of the liquid center, the diameter is preferably from 26 to 34 mm. When the diameter of the liquid center is smaller than 26 mm, launch angle is small and spin amount increases. Therefore, flight distance is poor. On the other hand, when the diameter of the liquid center is larger than 34 mm, not only is the desired ball hardness hardly obtained, but also is the thread rubber layer thin. Therefore, the rebound performance of the golf ball is lowered and flight distance is poor.

The thread rubber may be one which has hitherto been used. For example, it can be obtained by vulcanizing a rubber composition wherein an antioxidant, a vulcanizing accelerator and sulfur are formulated in a natural rubber or a blend rubber of a natural rubber and synthetic polyisoprene.

A method of covering the cover on the core is not specifically limited, but may be a conventional method. For example, there can be used a method comprising molding a cover composition containing a heated mixture of the ionomer resin of the component (A) and the SBS structure or SIS structure block copolymer of the component (B) into semi-spherical half-shells, covering a core with the two half-shells and then subjecting to pressure molding at 130 to 170℃ for 1 to 5 minutes, or a method comprising injection molding the cover composition directly on the core. A thickness of the cover is generally about from 1 to 4 mm. In case of cover molding, dimples may be formed on the surface of the ball, if necessary. Further, if necessary, painting or marking may be provided after cover molding.

Fig. 1 is a schematic cross-section illustrating one embodiment of the golf ball of the present invention. The golf ball shown in Fig. 1 is a two-piece solid golf ball comprising a core **1** of a vulcanized molded article, which is generally referred to as a "solid core", and a cover **2** covering the core **1**. The core **1** is not specifically limited, for example, a vulcanized molded article of a rubber composition comprising polybutadiene as a main material is used. The cover **2** for covering the core is formed from a cover composition which has a flexural modulus of 50 to 300 MPa and a Shore D-scale hardness of 40 to 60, which contains the heated mixture of the ionomer resin of the component (A) and the SBS structure or SIS structure block copolymer of the component (B). In addition, **2a** indicates dimples provided on the cover **2**. In the golf ball shown in Fig. 1, the core **1** is composed of a vulcanized molded article of a single-layer structure rubber composition, but it may also be a two-layer solid core obtained by further forming an outer core of a vulcanized molded article of a rubber composition comprising polybutadiene as a main material around an inner core of a vulcanized molded article of a rubber composition comprising polybutadiene as a main material.

Fig. 2 is a schematic cross-section illustrating another embodiment of the golf ball of the present invention. The golf ball shown in Fig. 2 is a multi-layer structure golf ball having a thread rubber layer. In Fig. 2, **1** is a core of a center **1a** and a thread rubber layer **1b**. **2** is a cover and **2a** indicates dimples.

The center **1a** may be any of a solid center and a liquid center. The thread rubber layer **1b** is formed by winding a thread rubber in a stretched state around the center **1a**, and the core **1** referred to as a "thread wound core" is formed of the center **1a** and thread rubber layer **1b**. The cover **2** is used for covering the core **1** and is formed from a cover composition having a flexural modulus of 50 to 300 MPa and a Shore D-scale hardness of 40 to 60, which contains the heated mixture of the ionomer resin of the component (A) and the SBS structure or SIS structure block copolymer of the component (B).

A suitable number/embodiment of dimples **2a** are optionally provided on the cover **2** of the golf ball so that desired characteristics may be obtained. In addition, painting or marking is optionally provided on the surface of the golf ball.

As described above, according to the present invention, there could be provided a golf ball having good shot feel and controllability as well as satisfactory flight performance and cut resistance and excellent durability.

EXAMPLES

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

<u>Examples 1 to 29 and Comparative Examples 1 to 12</u>

Golf balls of Examples 1 to 29 and Comparative Examples 1 to 12 were produced through the following processes (1) to (3).

(1) <u>Production of core</u>

(1)-a <u>Production of solid core</u>

After a rubber composition having the composition shown in Table 1 was prepared, the rubber composition was charged in a mold and subjected to vulcanization molding to obtain a spherical solid core having a diameter of 39.0 mm. The vulcanization was conducted in two steps under the condition shown in Table 1. That is, the solid core was vulcanized at 142℃ for 20 minutes, followed by vulcanization at 165℃ for 8 minutes. An amount of deformation formed by applying a load within the range from 10 to 130 kg of the solid core [i.e. amount of deformation formed by applying a load to the solid core within the range from 10 kg (initial load) to 130 kg (final load)] was 2.7 mm. An amount of the respective components formulated in Table 1 is represented by parts by weight. Polybutadiene used was BR-11 (trade name) manufactured by Nippon Synthetic Rubber Co., Ltd. An antioxidant is Yoshinox 425 (trade name) manufactured by Yoshitomi Seiyaku Co., Ltd. This solid core is used for producing golf balls of Examples 1 to 9 and Comparative Examples 1 to 4.

Table 1

Polybutadiene	100
Zinc acrylate	33
Zinc oxide	18
Antioxidant	0.5
Dicumyl peroxide	1.0
Vulcanization conditions	142℃ x 20 minutes 165℃ x 8 minutes
Amount of deformation (mm) (at the time of applying load within the range from 10 to 130 kg)	2.7

(1)-b Production of thread wound core

(1)-b-1 Production of solid center

After a rubber composition having the composition shown in Table 2 was prepared, the rubber composition was charged in a mold and subjected to vulcanization molding at 165℃ for 20 minutes to obtain a solid center. An amount of the respective components formulated in Table 2 is represented by parts by weight. Polybutadiene used was BR-11 (trade name) manufactured by Nippon Synthetic Rubber Co., Ltd. An antioxidant is Yoshinox 425 (trade name) manufactured by Yoshitomi Seiyaku Co., Ltd. The weight, diameter and deformation amount of the resulting solid center are shown in Table 2. The deformation amount was determined by applying an initial load of 10 Kg to a final load of 30 Kg and measuring the difference of a deformation of the center by mm. The solid center-a was used for the golf ball of Example 19 and the solid center-c was used for the golf ball of Example 20. The other Examples all employed the solid center-b.

Table 2

Composition of solid center:	a	b	c
Polybutadiene	100	100	100
Zinc acrylate	8	15	30
Dicumyl peroxide	1.5	1.5	1.5
Zinc oxide	15	15	15
Barium sulfate	67	41	18
Antioxidant	0.5	0.5	0.5
Physical properties of solid center:			
Weight (g)	20.7	26.9	30.2
Diameter (mm)	30.0	34.0	36.0
Deformation amount (mm)	2.3	1.5	0.7

(1)-b-2 Production of liquid center

Using a rubber composition for center cover having the composition shown in Table 3 and a paste, a liquid center was produced. An amount of the respective components formulated in Table 3 is represented by parts by weight.

In the production of the liquid center, the paste shown in Table 3 was firstly poured into a mold cooled by a refrigerant carrier and frozen to produce a spherical core having a diameter of 24.5 mm.

Then, a rubber composition for center cover having the composition shown in Table 3 was molded into a sheet and the above frozen spherical core was covered with the sheet. After punching, the resultant was put in a mold and subjected to vulcanization molding at 155℃ for 30 minutes to produce a liquid center having a diameter of 28.1 mm. The weight and diameter of the resulting liquid center are shown in Table 3.

Table 3

Composition of center cover:	
Natural rubber	100
Zinc oxide	5
Sulfur	2
Vulcanization accelerator (CZ)	2
Calcium carbonate	56
Composition of paste:	
Water	88
Glycerine	12
Clay	20
Barium sulfate	114
Physical properties of liquid center:	
Weight (g)	18.5
Diameter (mm)	28.1

Then, a thread rubber layer was formed by winding a thread rubber made of a blend rubber, wherein a base rubber was a natural rubber/low-cis isoprene rubber (weight ratio: 30:70) [Shell IR-309 (trade name), manufactured by Shell Chemical Co.] in a stretched state around the solid center of the above item (1)-b-1 and liquid center of the above item (1)-b-2, thereby producing a thread wound core having an outer diameter of about 39 mm. When using the liquid center as the center, the liquid center was frozen in case of winding the thread rubber.

The resulting thread wound core using the solid center was used for producing golf balls of Examples 10 to 20 and Comparative Examples 5 to 8, and the thread wound core using the liquid center was used for producing golf balls of Examples 21 to 29 and Comparative Examples 9 to 12.

(2) Production of cover composition

The formulation materials shown in Table 4 to Table 6 were mixed using a kneading type twin-screw extruder to obtain pelletized cover compositions A to M. The formulation amount described in Table 4 to Table 6 is represented by parts by weight. With respect to those represented by the trade name, the details will be explained at the back of Table 6.

The extrusion conditions were as follows: a screw diameter: 45 mm; a screw revolution per minute: 200 rpm; a screw L/D: 35. The formulation materials were heated to 220-260℃ at the die position of the extruder. Then, the flexural modulus and Shore D-scale hardness of the resulting cover composition were measured. The flexural modulus was measured according to ASTM D-747 after a sheet having a thickness of about 2 mm obtained by heat-press molding was preserved at 23℃ for two weeks. The Shore D-scale hardness was measured according to ASTM D-2240 after a sheet having a thickness of about 2 mm obtained by heat-press molding was preserved at 23 ℃ for two weeks. These results are shown in Table 4 to Table 6, together with the cover composition. The cover compositions A-I shown in Table 4 to Table 5 were used for the golf balls of Examples, and cover compositions J-M shown in Table 6 were used for the golf balls of Comparative Examples.

Table 4

	Cover composition				
	A	B	C	D	E
Hi-milan 1605 *1	0	35	0	0	35
Hi-milan 1706 *2	0	35	0	0	35
Hi-milan AM7317 *3	37.5	0	0	0	0
Hi-milan 1855 *4	0	0	20	0	0
Surlyn AD8512 *5	37.5	0	35	25	0
Surlyn AD8511 *6	0	0	35	35	0
ESBS A1005 *7	25	0	10	40	0
ESBS A1010 *8	0	30	0	0	0
ESBS A1020 *9	0	0	0	0	30
Titanium dioxide	2	2	2	2	2
Barium sulfate	2	2	2	2	2
Flexural modulus (MPa)	240	210	230	75	200
Shore D-scale hardness	58	57	59	48	56

Table 5

		Cover composition			
		F	G	H	I
Hi-milan 1706	*2	0	0	30	0
Hi-milan AM7317	*3	20	0	0	30
Hi-milan 1855	*4	0	0	20	25
Surlyn AD8511	*6	0	25	0	0
Hi-milan 1707	*10	0	25	0	0
Hi-milan AM7318	*11	20	0	0	0
Hi-milan 1856	*12	40	0	0	0
Hi-milan MK7320	*13	0	0	15	0
Surlyn AD8269	*14	0	10	0	0
Surlyn 7940	*15	0	0	15	0
Iotek 8000	*16	0	0	0	30
ESBS A1005	*7	0	0	0	15
ESBS A1010	*8	0	0	20	0
ESBS AT018	*17	20	0	0	0
ESBS AT019	*18	0	40	0	0
Titanium dioxide		2	2	2	2
Barium sulfate		2	2	2	2
Flexural modulus (MPa)		190	160	200	220
Shore D-scale hardness		56	53	56	58

Table 6

	Cover composition			
	J	K	L	M
Hi-milan 1605 *1	50	0	15	0
Hi-milan 1706 *2	50	0	15	0
Hi-milan AM7317 *3	0	25	0	0
Hi-milan 1855 *4	0	0	70	10
Hi-milan AM7318 *11	0	25	0	0
Surlyn AD8269 *14	0	50	0	90
Titanium dioxide	2	2	2	2
Barium sulfate	2	2	2	2
Flexural modulus (MPa)	340	200	150	40
Shore D-scale hardness	62	58	55	37

※1: Hi-milan 1605 (trade name), ethylene-methacrylic acid copolymer ionomer resin obtained by neutralizing with sodium ion, manufactured by Mitsui Du Pont Polychemical Co., Ltd., MI (melt index): 2.8, flexural modulus: 310 MPa, Shore D-scale hardness: 62

※2: Hi-milan 1706 (trade name), ethylene-methacrylic acid copolymer ionomer resin obtained by neutralizing with zinc ion, manufactured by Mitsui Du Pont Polychemical Co., Ltd., MI: 0.8, flexural modulus: 260 MPa, Shore D-scale hardness: 61

※3: Hi-milan AM7317 (trade name), ethylene-methacrylic acid copolymer ionomer resin obtained by neutralizing with zinc ion, manufactured by Mitsui Du Pont Polychemical Co., Ltd., MI: 1.2, flexural modulus: 310 MPa, Shore D-scale hardness: 64

※4: Hi-milan 1855 (trade name), ethylene-butyl acrylate-methacrylic acid terpolymer ionomer resin obtained by neutralizing with zinc ion, manufactured by Mitsui Du Pont Polychemical Co., Ltd., MI: 1.0, flexural modulus: 90 MPa, Shore D-scale hardness: 55

※5: Surlyn AD8512 (trade name), ethylene-methacrylic acid copolymer ionomer resin obtained by neutralizing with sodium ion, manufactured by Du Pont Co., Ltd., MI: 4.4, flexural modulus: 280 MPa, Shore D-scale hardness: 62

※6: Surlyn AD8511 (trade name), ethylene-methacrylic acid copolymer ionomer resin obtained by neutralizing with zinc ion, manufactured by Du Pont Co., Ltd., MI: 3.4, flexural modulus: 220 MPa, Shore D-scale hardness: 60

※7: ESBS A1005 (trade name), SBS structure block copolymer having a polybutadiene block containing epoxy groups, manufactured by Daicel Chemical Industries, Ltd., JIS-A hardness: 70, styrene/butadiene (weight ratio: 40/60), epoxy content: about 0.7-0.9% by weight

※8: ESBS A1010 (trade name), SBS structure block copolymer having a polybutadiene block containing epoxy groups, manufactured by Daicel Chemical Industries, Ltd., JIS-A hardness: 67, styrene/butadiene (weight ratio: 40/60), epoxy content: about 1.5-1.7% by weight

※9: ESBS A1020 (trade name), SBS structure block copolymer having a polybutadiene block containing an epoxy group, manufactured by Daicel Chemical Industries, Ltd., JIS-A hardness: 65, styrene/butadiene (weight ratio: 40/60), epoxy content: about 2.9-3.4% by weight

※10: Hi-milan 1707 (trade name), ethylene-methacrylic acid copolymer ionomer resin obtained by neutralizing with sodium ion, manufactured by

Mitsui Du Pont Polychemical Co., Ltd., MI: 0.9, flexural modulus: 320 MPa, Shore D-scale hardness: 63

※11: Hi-milan AM7318 (trade name), ethylene-methacrylic acid copolymer ionomer resin obtained by neutralizing with sodium ion, manufactured by Mitsui Du Pont Polychemical Co., Ltd., MI: 2.1, flexural modulus: 345 MPa, Shore D-scale hardness: 65

※12: Hi-milan 1856 (trade name), ethylene-butyl acrylate-methacrylic acid terpolymer ionomer resin obtained by neutralizing with sodium ion, manufactured by Mitsui Du Pont Polychemical Co., Ltd., MI: 1.0, flexural modulus: 85 MPa, Shore D-scale hardness: 53

※13: Hi-milan MK7320 (trade name), ethylene-methacrylic acid copolymer ionomer resin obtained by neutralizing with potassium ion, manufactured by Mitsui Du Pont Polychemical Co., Ltd., MI: 2.8, flexural modulus: 290 MPa, Shore D-scale hardness: 61

※14: Surlyn AD8269 (trade name), ethylene-butyl acrylate-methacrylic acid terpolymer ionomer resin obtained by neutralizing with zinc ion, manufactured by Du Pont Co., MI: 1.0, flexural modulus: 26 MPa, Shore D-scale hardness: 36

※15: Surlyn 7940 (trade name), ethylene-methacrylic acid copolymer ionomer resin obtained by neutralizing with lithium ion, manufactured by Du Pont Co., MI: 2.8, flexural modulus: 350 MPa, Shore D-scale hardness: 63

※16: Iotek 8000 (trade name), ethylene-acrylic acid copolymer ionomer resin obtained by neutralizing with sodium ion, manufactured by Exxon Chemical Co. MI: 0.8, flexural modulus: 370 MPa, Shore D-scale hardness:

※17: ESBS AT018 (trade name), SBS structure block copolymer prepared by hydrogenating a portion of double bonds of a polybutadiene block containing epoxy groups, manufactured by Daicel Chemical Industries, Ltd., JIS-A hardness: 70, styrene/butadiene (weight ratio: 40/60), epoxy content: about 0.7-0.9% by weight

※18: ESBS AT019 (trade name), SBS structure block copolymer prepared by hydrogenating a portion of double bonds of a polybutadiene block containing epoxy groups, manufactured by Daicel Chemical Industries, Ltd., JIS-A hardness: 67, styrene/butadiene (weight ratio: 40/60), epoxy content: about 1.5-1.7% by weight

(3) Production of golf ball

(3)-a Production of solid golf ball

The cover composition of the above item (2) was injection-molded on the solid core of the above item (1)-a to cover the solid core, thereby forming a cover. Then, golf ball having an outer diameter of 42.7 mm of Examples 1 to 9 and Comparative Examples 1 to 4 were produced by coating the surface with a paint.

(3)-b Production of multi-layer structure golf ball having thread rubber layer

Golf balls having an outer diameter of 42.8 mm of Examples 10 to 29 and Comparative Examples 5 to 12 were produced by molding a semi-spherical half-shell from the cover composition of the above item (2), covering the thread wound core of the above item (1)-b with two half-shells, press-molding the thread wound core in a mold for ball at 150℃ for 2 minutes to cover it with cover, followed by painting on the surface. The combination between the center and cover used for producing the above golf ball is shown in Table 10 to Table 15, together with ball physical properties described hereinafter.

The ball weight, ball initial velocity, flight distance (carry) and spin amount of the golf ball thus obtained were measured. The ball initial velocity was measured by a R&A initial velocity measuring method. The flight distance was measured by attaching a No. 1 wood club to a swing robot manufactured by True Temper Co. and hitting a golf ball at a head speed of 45 m/second. The spin amount was measured by attaching a No. 9 iron club to the above swing robot manufactured by True Temper Co., hitting a golf ball at a head speed of 34 m/second, and taking a photograph of a mark provided on the hit golf ball using a high-speed camera.

In order to evaluate the cut resistance of the golf balls of Examples 1 to 29 and Comparative Examples 1 to 12, a pitching wedge was attached to a swing robot manufactured by True Temper Co. and the top part of a golf ball was hit at a head speed of 30 m/second, and then it was examined whether a cut mark is formed or not. The evaluation criteria are as follows.

<u>Evaluation criteria</u>

○: Cut marks are not formed.

△: Small size cut marks are formed.

×: Large size cut marks are formed.

××: Large size cut marks which are scarcely fit for use are formed.

In order to evaluate the durability of the above golf balls, a No.

1 wood club was attached to a swing robot manufactured by True Temper Co. and a golf ball was hit at a head speed of 45 m/second, and then the number of times until breakage arises was measured. The resulting value is indicated as an index in case of an impact-resistant number (number of times until breakage arises) of Comparative Examples 1, 5 and 9 as a criterion for comparison being 100.

The shot feel and controllability of the resulting golf balls were evaluated with 10 top professional golfers according to a practical hitting test. The evaluation criteria are as follows. The results shown in the Tables below are based on the fact that not less than 8 out of 10 professional golfers evaluated with the same criterion about each test item.

<u>Evaluation criteria</u>

○:	Shot feel and controllability are similar to those of a golf ball using a balata cover, good.
△:	Controllability is similar to that of a golf ball using a balata cover, but shot feel is quite different. That is, the golf ball is too hard and, therefore, the impact force is too strong, or the golf ball is too soft, which results in heavy feeling.
×:	Both shot feel and controllability are poor.

The ball physical properties of Examples 1 to 9 and Comparative Examples 1 to 4 with respect to the solid golf ball are shown in Table 7 to Table 9, together with the kind of the cover (kind of cover composition), flexural modulus and Shore D-scale hardness.

The ball physical properties of Examples 10 to 20 and Comparative Examples 5 to 8 with respect to the multi-layer structure golf ball using a solid center are shown in Table 10 to Table 12, together with the kind of the cover (cover composition), flexural modulus and Shore D-scale hardness. Those of Examples 23 to 29 and Comparative Examples 9 to 12 with respect to the multi-layer structure golf ball using a liquid center are shown in Table 13 to Table 15.

Table 7

	Example No.				
	1	2	3	4	5
Cover:					
Kind	A	B	C	D	E
Flexural modulus (Mpa)	240	210	230	75	200
Shore D-scale hardness	58	57	59	48	56
Ball physical properties					
Weight (g)	45.3	45.3	45.3	45.4	45.3
Initial velocity (feet/second)	253.6	253.4	253.5	252.8	253.3
Flight distance (yard)	236	235	236	232	234
Spin amount (rpm)	8200	8350	8250	8600	8400
Cut resistance	○	○	○	○	○
Durability (index)	155	162	157	183	165
Shot feel and controllability	○	○	○	○	○

Table 8

	Example No.			
	6	7	8	9
Cover:				
Kind	F	G	H	I
Flexural modulus (Mpa)	190	160	200	220
Shore D-scale hardness	56	53	56	58
Ball physical properties				
Weight (g)	45.4	45.4	45.3	45.4
Initial velocity (feet/second)	253.2	253.0	253.3	253.5
Flight distance (yard)	234	233	234	235
Spin amount (rpm)	8350	8450	8350	8300
Cut resistance	○	○	○	○
Durability (index)	165	172	162	160
Shot feel and controllability	○	○	○	○

Table 9

	Comparative Example No.			
	1	2	3	4
Cover:				
Kind	J	K	L	M
Flexural modulus (Mpa)	340	200	150	40
Shore D-scale hardness	62	58	55	37
Ball physical properties				
Weight (g)	45.4	45.4	45.3	45.3
Initial velocity (feet/second)	253.3	251.5	251.3	247.0
Flight distance (yard)	233	226	225	212
Spin amount (rpm)	6800	7500	7900	10000
Cut resistance	○	○	○	×
Durability (index)	100	130	135	70
Shot feel and controllability	×	△	△	△

As is shown in Table 7 to Table 9, the golf balls of Examples 1 to 9 were solid golf balls, which showed good shot feel and controllability, suitable large spin amount and good spin performance. Besides, the golf balls attained the flight distance of 232 to 236 and showed almost the same flight distance as that of the golf ball of Comparative Example 1 using only a high-rigid ionomer resin as a base resin. The cut resistance reached a sufficiently satisfactory level. The golf balls of Examples 1 to 9 were considerably superior in durability to the golf ball of Comparative Example 1.

To the contrary, a standard two-piece solid golf ball of Comparative Example 1 using only a high-rigid ionomer resin as a base resin was superior in flight performance and cut resistance, as shown in

Table 9, but was poor in shot feel and controllability. In addition, the golf balls of Comparative Examples 2 to 3 using a high-rigid ionomer resin in combination with a terpolymer soft ionomer resin and golf ball of Comparative Example 4 using only the terpolymer soft ionomer resin were poor in shot feel, the controllability and durability to the golf balls of Examples 1 to 9, and was considerably poor in flight distance to the golf balls of Examples 1 to 9.

Next, the physical properties of the multi-layer structure golf ball having a thread rubber layer are shown in table 10 to Table 15.

Table 10

	Example No.				
	10	11	12	13	14
Center	Solid-b	Solid-b	Solid-b	Solid-b	Solid-b
Cover:					
Kind	A	B	C	D	E
Flexural modulus (Mpa)	240	210	230	75	200
Shore D-scale hardness	58	57	59	48	56
Ball physical properties					
Weight (g)	45.4	45.4	45.4	45.4	45.4
Initial velocity (feet/second)	253.4	253.2	253.3	252.5	253.1
Flight distance (yard)	235	234	235	231	233
Spin amount (rpm)	8250	8400	8340	8660	8450
Cut resistance	○	○	○	○	○
Durability (index)	155	160	155	180	165
Shot feel and controllability	○	○	○	○	○

Table 11

	Example No.					
	15	16	17	18	19	20
Center	Solid-b	Solid-b	Solid-b	Solid-b	Solid-a	Solid-c
Cover:						
Kind	F	G	H	I	B	B
Flexural modulus (Mpa)	190	160	200	220	210	210
Shore D-scale hardness	56	53	56	58	57	57
Ball physical properties						
Weight (g)	45.4	45.4	45.4	45.4	45.4	45.4
Initial velocity (feet/second)	252.9	252.7	253.0	253.2	253.3	253.4
Flight distance (yard)	233	232	233	234	233	235
Spin amount (rpm)	8410	8500	8410	8320	8460	8350
Cut resistance	○	○	○	○	○	○
Durability (index)	160	165	162	155	172	150
Shot feel and controllability	○	○	○	○	○	○

Table 12

	Comparative example No.			
	5	6	7	8
Center	Solid-b	Solid-b	Solid-b	Solid-b
Cover:				
Kind	J	K	L	M
Flexural modulus (Mpa)	340	200	150	40
Shore D-scale hardness	62	58	55	37
Ball physical properties				
Weight (g)	45.4	45.4	45.4	45.4
Initial velocity (feet/second)	253.0	251.2	251.0	246.0
Flight distance (yard)	232	225	224	211
Spin amount (rpm)	6850	7530	7960	9580
Cut resistance	○	○	○	×
Durability (index)	100	130	135	85
Shot feel and controllability	×	△	△	△

Table 13

	Example No.				
	21	22	23	24	25
Center	Liquid	Liquid	Liquid	Liquid	Liquid
Cover:					
Kind	A	B	C	D	E
Flexural modulus (Mpa)	240	210	230	75	200
Shore D-scale hardness	58	57	59	48	56
Ball physical properties					
Weight (g)	45.4	45.4	45.4	45.4	45.4
Initial velocity (feet/second)	253.3	253.1	253.2	252.5	253.0
Flight distance (yard)	234	233	234	230	232
Spin amount (rpm)	8300	8430	8360	8630	8460
Cut resistance	○	○	○	○	○
Durability (index)	160	170	165	185	175
Shot feel and controllability	○	○	○	○	○

Table 14

	Example No.			
	26	27	28	29
Center	Liquid	Liquid	Liquid	Liquid
Cover:				
Kind	F	G	H	I
Flexural modulus (Mpa)	190	160	200	220
Shore D-scale hardness	56	53	56	58
Ball physical properties				
Weight (g)	45.4	45.4	45.4	45.4
Initial velocity (feet/second)	252.9	252.7	253.0	253.2
Flight distance (yard)	232	231	232	233
Spin amount (rpm)	8440	8570	8430	8410
Cut resistance	○	○	○	○
Durability (index)	165	172	168	165
Shot feel and controllability	○	○	○	○

Table 15

	Comparative example No.			
	9	10	11	12
Center	Liquid	Liquid	Liquid	Liquid
Cover:				
Kind	J	K	L	M
Flexural modulus (Mpa)	340	200	150	40
Shore D-scale hardness	62	58	55	37
Ball physical properties				
Weight (g)	45.4	45 .4	45.4	45.4
Initial velocity (feet/second)	253.0	251.2	251.0	246.8
Flight distance (yard)	231	224	223	210
Spin amount (rpm)	6930	7550	7980	9640
Cut resistance	○	○	○	×
Durability (index)	100	132	138	83
Shot feel and controllability	×	△	△	△

As is shown in Table 10 to Table 11 and Table 13 to Table 14, the golf balls of Examples 10 to 29 showed good shot feel and controllability, suitable large spin amount and good spin performance regardless of solid center or liquid center. Besides, the golf balls attained the flight distance of 230 to 235 and showed almost the same flight distance as that of the golf ball of Comparative Example 5 or Comparative Example 9 using only a high-rigid ionomer resin as a base resin. The cut resistance reached a sufficiently satisfactory level. The golf balls of Examples 10 to 29 was considerably superior in durability to the golf balls of Comparative Example 5 and Comparative Example 9.

To the contrary, the golf balls of Comparative Example 5 and

Comparative Example 9 using only a high-rigid ionomer resin as a base resin were superior in flight performance and cut resistance, as shown in Table 12 and Table 15, but was poor in shot feel and controllability. In addition, the golf balls of Comparative Examples 6 to 7 and Comparative Examples 10 to 11 using a high-rigid ionomer resin in combination with a terpolymer soft ionomer resin and golf balls of Comparative Example 8 and Comparative Example 12 using only the terpolymer soft ionomer resin were poor in shot feel, controllability and durability to the golf balls of Examples 10 to 29, and was considerably poor in flight distance to the golf balls of Examples 10 to 29.

Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A golf ball comprising a core and a cover covering the core, wherein the cover is formed from a heated mixture of

(A) an ionomer resin, and

(B) a block copolymer having a styrene-butadiene-styrene structure in which the polybutadiene block contains epoxy groups, or a block copolymer having a styrene-isoprene-styrene in which the polyisoprene block contains epoxy groups,

and the cover has a flexural modulus of from 50 to 300 MPa and a Shore D-scale hardness of from 40 to 60, in the form of a cover composition before forming into the cover.

2. The golf ball according to claim 1, wherein the ionomer resin is obtained by neutralizing at least a portion of carboxylic groups in a copolymer of ethylene and acrylic or methacrylic acid with metal ion and/or obtained by neutralizing at least a portion of carboxylic groups in a terpolymer of ethylene, acrylic or methacrylic acid and an α,β-unsaturated carboxylate with metal ion.

3. The golf ball according to claim 1 or 2, wherein the ionomer resin is obtained by neutralizing at least a portion of carboxylic groups in a copolymer of ethylene and acrylic or methacrylic acid with metal ion, which has a melt index of 3 to 7 and a flexural modulus of 200 to 400 MPa.

4. The golf ball according to claim 2, wherein the ionomer resin has an acid content of from 10 to 20% by weight when the backbone

polymer of the ionomer resin is a copolymer of ethylene and acrylic or methacrylic acid, or a acid content of from 5 to 20% by weight when a backbone polymer of the ionomer resin is a terpolymer of ethylene, acrylic or methacrylic acid and an α,β-unsaturated carboxylate.

5. The golf ball according to claim 1, wherein the styrene-butadiene-styrene block copolymer or the styrene-isoprene-styrene block copolymer has a styrene content of from 10 to 50% by weight.

6. The golf ball according to claim 1, wherein the styrene-butadiene-styrene block copolymer or the styrene-isoprene-styrene block copolymer has a epoxy content of from 0.05 to 10% by weight.

7. The golf ball according to claim 1, wherein at least a portion of the remaining double bonds in the butadiene block of the styrene-butadiene-styrene block copolymer or in the isoprene block the styrene-butadiene-styrene block copolymer is hydrogenated.

8. The golf ball according to claim 1, wherein a weight ratio of the ionomer resin (A) to the block copolymer (B) is from 95:5 to 50:50.

9. The golf ball according to claim 1, 2, 3, 4, 5, 6, 7 or 8, wherein the core is a solid core being a vulcanized molded article formed from a rubber composition.

10. The golf ball according to claim 1, 2, 3, 4, 5, 6, 7 or 8, wherein the core is a thread wound core composed of a center and a thread rubber layer formed by winding thread rubber around the center, the center is a solid center having a diameter of from 28 to 38 mm and a deformation amount of 0.5 to 2.5 mm, the deformation amount being determined by applying a weight of from an initial load of 10 Kg to a final

load of 30 Kg on the solid center and measuring a change of the deformation of the solid conter by mm.

11. The golf ball according to claim 1, 2, 3, 4, 5, 6, 7 or 8, wherein the core is a thread wound core composed of a center and a thread rubber layer formed by winding thread rubber around the center, and the center is a liquid center having a diameter of from 26 to 34 mm.

12. A golf ball substantially as hereinbefore described with reference to the drawings and/or Examples, excluding the comparative Examples.

DATED this 26th day of APRIL 2000
Sumitomo Rubber Industries, Ltd.

By DAVIES COLLISON CAVE
Patent Attorneys for the Applicants

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Fig. 1

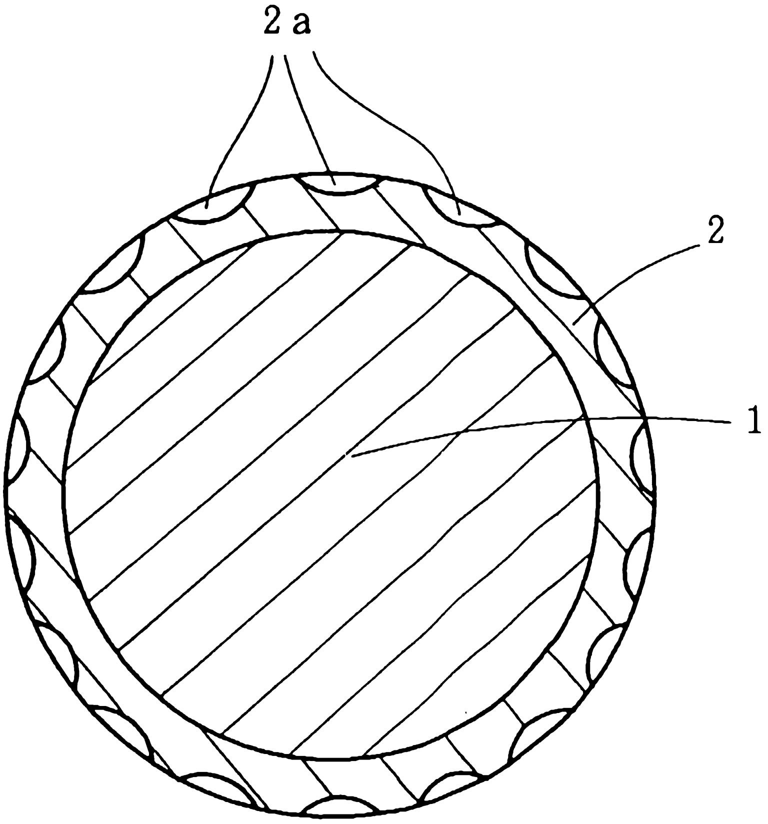

Fig. 2