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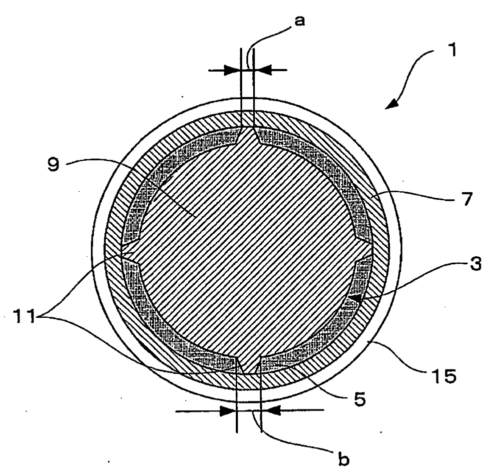
(54) **GOLF BALL**

(57) The present invention provides a golf ball that achieves a satisfactorily long carry distance when hit with a driver and that accurately generates a desirable amount of backspin in an approach shot. The golf ball of the present invention has a spherical main part, a plurality of ribs formed on the surface of the main part, an interlayer that is placed in depressions surrounded by the ribs and has a hardness greater than that of the ribs, an inner cover that covers the interlayer, and an outer cover that covers the inner cover and has a hardness lower than the inner cover.

Fig. 1



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Description

Technical Field

[0001] The present invention relates to a multi-layered golf ball.

Background Art

[0002] Recently, several kinds of golf balls exhibiting both high rebound resilience and a soft feel when hit have been proposed. One example of such a golf ball is a multi-layered golf ball in which the ball is composed of a plurality of layers. For example, Patent Document 1 discloses a golf ball having ribs provided on the surface of a spherical main part, and an interlayer formed in the depressions surrounded by the ribs. By setting the hardness of the interlayer higher than that of the ribs, the golf ball described above achieves the following effects. When a golf club comes into contact with a golf ball, usually the ball is deformed in the circumferential direction due to friction generated between the ball and the clubface. When the deformed ball returns to its original condition due to elastic resistance, a force in the direction opposite to the direction of backspin is applied to the ball. At this moment, the greater the deformation of the deformed ball, the more the backspin is suppressed, and the longer the carry distance becomes.

[0003] In the golf ball of Patent Document 1, the ribs enhance the elastic resistance, which is the force applied when the ball is returning to its original condition, and therefore the backspin can be effectively reduced. More specifically, in this golf ball, because the hardness of the ribs is lower than that of the interlayer, the ribs deform to a greater degree than the interlayer. The ribs are not mere protrusions but are structured so as to form walls surrounding the interlayer, and therefore when the ribs are returning to their original condition, the force of the entire wall strongly acts on the interlayer from the perimeter of the interlayer, and this increases the force opposing the backspin. As a result, a significantly longer carry distance can be achieved. This effect is particularly remarkable when the ball is hit by a driver, etc., which is designed to attain a long carry distance.

Citation List

Patent Document

[0004]

Patent Document 1: WO2005/089883 (Patent Document 1: Domestic re-publication of PCT international application)

Summary of Invention

Technical Problem

[0005] The golf ball described above is desirable for hitting with a driver. However, it has a drawback when it is hit with an iron in an approach shot. In an approach shot, it is important to stop the ball by using backspin; however, the ball cannot be accurately stopped when the force opposing the backspin is increased as described above.

[0006] An object of the present invention is to provide a golf ball with which a long carry distance can be achieved when hit by a driver, while also enabling backspin to be accurately generated for an approach shot.

Solution to Problem

[0007] The golf ball of the present invention comprises a spherical main part, a plurality of ribs formed on the surface of the main part, an interlayer that is harder than the ribs and placed in depressions surrounded by the ribs, an inner cover that covers the interlayer, and an outer cover that is softer than the inner cover and that covers the inner cover.

[0008] In this structure, because the hardness of the ribs is lower than that of the interlayer, the ribs deform to a greater degree than the interlayer when hit. The ribs are not mere protrusions but are structured so as to form walls surrounding the interlayer, and therefore when the ribs are returning to their original condition, the force of the entire wall strongly acts on the interlayer from the perimeter of the interlayer, and this increases the force opposing the backspin. As a result, a significantly longer carry distance can be achieved. This effect is particularly remarkable when the ball is hit by a driver, etc., which is designed to attain a long carry distance.

[0009] Because the inner cover is provided between the interlayer and the outer cover, direct transmission of the striking force to the interlayer and the ribs can be prevented in an approach shot, such as one performed using an iron, in which the deformation of the ball is small. As a result, the increase of the force opposing the backspin can be prevented.

Therefore, the golf ball of the present invention achieves a long carry distance by reducing the amount of backspin when hit by a driver. Furthermore, the golf ball of the present invention can be accurately stopped by the application of backspin when it is hit by an iron.

[0010] Because the hardness of the outer cover is lower than that of the inner cover, a soft feeling can be obtained when hit. Furthermore, because this structure can increase the deformation of the outer cover, the backspin effect can be increased when hit by an iron. Because the hardness of the inner cover is greater than that of the outer cover in this embodiment, even though the outer cover has a soft feeling when hit, a high rebound resilience can be attained by the inner cover. This achieves a longer carry distance. The rebound resilience can be increased by setting the Shore D hardness of the inner cover, for example, to 55 to 70. A soft feeling when hit can be obtained by setting the Shore D hardness of the outer cover to 54 to 60.

[0011] In the golf ball described above, the inner cover can be made harder than the interlayer. This makes the hardness of the inner portion in the radical direction lower than that of the inner cover, reducing the hitting hardness attributable to the inner cover.

[0012] In the golf ball described above, the total thickness of the inner cover and the outer cover can be 1.9 mm or more. The deformation of the ball in an approach shot using a wedge may sometimes reach about 2.0 mm. Having the total thickness of the inner cover and the outer cover 1.9 mm or more makes it difficult for the hitting impact to be transmitted to the interlayer and ribs when making an approach shot using a wedge. This makes it possible to effectively reduce the backspin-canceling effect of the ribs. Therefore, the ball can be accurately stopped in an approach shot using a wedge. Furthermore, having such a total thickness can also improve the durability of the ball.

[0013] In the golf ball described above, the hardness of the main part can be made the same as that of the ribs by forming the main part and the ribs as a unit. In this structure, the hardness of the interlayer is not only greater than that of the ribs but is also greater than that of the main part, so the amount of spin can be reduced to obtain a longer carry distance.

Brief Description of Drawings

[0014]

Fig. 1 is a cross-sectional view showing a golf ball according to a first embodiment of the present invention.
Fig. 2 is a perspective view of the core of the golf ball of Fig. 1.
Fig. 3 is a cross-sectional view showing the condition of the golf ball of Fig. 1 when hit.
Fig. 4 is a perspective view of another example of the core of the golf ball of Fig. 1.
Fig. 5 is a cross-sectional view of another example of the core of Fig. 1.
Fig. 6 is a cross-sectional view of another example of the core of Fig. 1.
Fig. 7 is a cross-sectional view of another example of the core of Fig. 1.
Fig. 8 is a cross-sectional view of another example of the core of Fig. 1.
Fig. 9 is a cross-sectional view of another example of the core of Fig. 1.
Fig. 10 illustrates an example of a process for forming the golf ball of Fig. 1.
Fig. 11 illustrates an example of a process for forming the golf ball of Fig. 1.

Description of Embodiments

[0015] One embodiment of the multi-piece golf ball of the present invention is explained below with reference to the drawings. Fig. 1 is a cross-sectional view of the golf ball according to the present embodiment.

[0016] As shown in Fig. 1, the golf ball 1 of the present embodiment is a multi-piece golf ball comprising a core 3 covered with an interlayer 5, an inner cover and an outer cover 15. According to the rules (see R&A and USGA), the diameter of a golf ball must be not less than 42.67 mm. However, taking aerodynamic characteristics and the like into consideration, it is preferable that the diameter of the ball be as small as possible. Therefore, it can be, for example, 42.7 mm to 42. 9 mm. The core 3 is composed of a rubber composition, and, as shown in Fig. 2, comprises a spherical main part 9 and three ribs (protrusions) 11 molded as a unit on the surface of the spherical main part 9. Each rib 11 extends along one of the great circles drawn around the main part 9 so as to intersect each other at right angles. These ribs form eight depressions 13 on the surface of the main part 9.

[0017] It is preferable that the diameter of the main part 9 be 29.5 to 36.7 mm, and more preferably 29.9 to 35.1 mm. The height of the ribs 11 is preferably 1.0 to 4.0 mm, and more preferably 1.2 to 2.0 mm. The Shore D hardness of the surface of the core 3 is preferably 50 to 60, and more preferably 53 to 57. When the Shore D hardness thereof is lower than 50, the rebound resilience becomes unduly low, resulting in a coreless feel. In contrast, when the Shore D hardness exceeds 60, the ball becomes too hard, resulting in a poor impact feel.

[0018] As shown in Figs. 1 and 2, each rib 11 is structured so as to have a trapezoidal profile in its sideways crosssection in such a manner that its width increases as it approaches the main part 9. It is preferable that the width of the top portion a of each rib in the outward radial direction be 1.5 to 2.5 mm and that the width of the bottom portion b in the inward radial direction be 3.0 to 6.0 mm. The widths of the end portions of the rib 11 may be set outside this range; however, by setting a lower limit for the width of each end portion of the rib 11, it is possible to prevent the rib 11 from being deformed by the pressure of filling the interlayer 5 that results from tightly closing the mold when filling the material for the interlayer 5 during the manufacturing process. As a result, it is possible to accurately hold the core 9 in the center of the mold.

[0019] The interlayer 5 is made of a rubber composition or an elastomer, covers the surface of the core 3, and has a substantially spherical outside shape. As shown in Fig. 1, the interlayer 5 has almost the same thickness as the height of the ribs 11, and fills in each of the eight depressions 13 surrounded by the ribs 11. The top portions of the ribs 11 are exposed through the surface of the interlayer 5. To control backspin, as described later, it is necessary to make the hardness of the interlayer 5 greater than that of the core 3. The Shore D hardness of the interlayer 5 is preferably 53 to 62, and more preferably 56 to 60. In this structure, the Shore D hardness of the interlayer 5 is greater than that of the core 3 preferably by 1 to 5.

[0020] The inner cover 7 is composed of an elastomer, and covers the top portions of the ribs 11 and the interlayer 5. It is preferable that the thickness of the inner cover 7 be 0.9 to 1.7 mm, and more preferably 0.9 to 1.5 mm. The thickness of the inner cover 7 may be set outside this range; however, if the thickness of the inner cover 7 is less than 0.9 mm, the ball becomes too soft, reducing the rebound resilience and the durability of the ball. On the other hand, if it exceeds 1.7 mm, the impact feel becomes too hard. The Shore D hardness on the surface of the inner cover 7 is preferably 55 to 70, more preferably 58 to 68, and still more preferably 64 to 68.

[0021] The outer cover 15 is composed of an elastomer, and covers the inner cover 7. Predetermined dimples (not shown) are formed on the outer surface of the outer cover. The thickness of the outer cover 15 is preferably 0.8 to 1.3 mm, and more preferably 0.9 to 1.2 mm. The thickness of the outer cover 15 may be set outside this range; however, if the thickness of the outer cover 15 is less than 0.8 mm, the durability of the outer cover 15 decreases remarkably and molding becomes difficult. On the other hand, if it exceeds 1.3 mm, the rebound resilience is excessively reduced and a satisfactory carry distance cannot be obtained. The outer cover 15 has a Shore D hardness on the golf ball surface of preferably 54 to 60, and more preferably 56 to 60. The thickness of the outer cover 15 is defined as the distance from an arbitrary point on the outermost part in the outward radial direction where no dimple is formed to an arbitrary point that comes into contact with the interlayer that is measured along the normal line. The total thickness of the inner cover 7 and the outer cover 15 is preferably 1.9 to 3.0 mm, more preferably 2.0 to 2.8 mm, and still more preferably 2.0 to 2.6 mm. Setting the total thickness within this range enables a preferable rebound resilience and durability to be attained.

[0022] The dimples formed in the outer cover 15 are explained below. The dimples can be circular, polygonal, oval or a like shape, and one type or a combination of two or more types can be used. For example, circular dimples having a diameter of 2.5 to 4.5 mm may be provided. The number of dimples is 350 to 450, and preferably 360 to 410. If too many dimples are provided, the trajectory of the ball lowers, and this may reduce the carry distance. On the other hand, if the number of dimples is too small, the trajectory of the ball rises, and this may also reduce the carry distance. The proportion of the area of the dimples relative to the total area of the spherical surface of the golf ball is preferably 73% or more, and more preferably 75% or more.

[0023] The component materials of the above-described golf ball are explained in detail. The core 3 can be manufactured using a known rubber composition comprising a base rubber, a cross-linking agent, an unsaturated carboxylic acid metal salt, a filler, etc. Specific examples of the base rubber include natural rubber, polyisobutylene rubber, styrenebutadiene rubber, EPDM, etc. Among these, it is preferable to use high-cis polybutadiene that contains 80% or more cis-1,4 bonds.

[0024] Specific examples of cross-linking agents include dicumyl peroxide, t-butylperoxide, and like organic peroxides; however, it is particularly preferable to use dicumyl peroxide. The compounding ratio of the cross-linking agent is generally 0.3 to 5 parts by weight, and preferably 0.5 to 2 parts by weight per 100 parts by weight of the base rubber.

[0025] As metal salts of unsaturated carboxylic acids, it is preferable to use monovalent or bivalent metal salts of acrylic acid, methacrylic acid, and like C_3 to C_8 unsaturated carboxylic acids. Among these, the use of zinc acrylate can improve the rebound resilience of the ball and is particularly preferable. The compounding ratio of the unsaturated carboxylic acid metal salt is preferably 10 to 40 parts by weight per 100 parts by weight of base rubber.

[0026] Examples of the fillers include those generally added to cores. Specific examples thereof include zinc oxide, barium sulfate, calcium carbonate, etc. The preferable compounding ratio of the filler is 2 to 50 parts by weight per 100 parts by weight of base rubber. If necessary, it is also possible to add an antioxidant, a peptizer, and the like.

[0027] The interlayer 5 is composed of a rubber composition or elastomer as described above. When a rubber composition is used, the same materials as used for the core 3 described above can be used. However, it is preferable that the compounding ratio of unsaturated carboxylic acids be increased to make the interlayer harder than the core 3.

[0028] When the interlayer 5 is composed of an elastomer, it is possible to use, for example, a styrene/butadiene/styrene block copolymer (SBS), a styrene/isoprene/styrene block copolymer (SIS), a styrene/ethylene/butylene/styrene block copolymer (SEBS), a styrene/ethylene/propylene/styrene block copolymer (SEPS), or like styrene-based thermoplastic elastomer; an olefin-based thermoplastic elastomer having polyethylene or polypropylene as a hard segment and butadiene rubber, acrylonitrile butadiene rubber or ethylene/propylene rubber as a soft segment; a vinyl chloride-based plastic elastomer having crystallized poly(vinyl chloride) as a hard segment and amorphous poly (vinyl chloride) or an acrylonitrile butadiene rubber as a soft segment; a urethane-based plastic elastomer having polyurethane as a hard segment and polyether or polyester urethane as a soft segment; a polyester based plastic elastomer having polyester as a hard segment and polyether or polyester as a soft segment; an polyamide based plastic elastomer having polyamide as a hard segment and polyether or polyester as a soft segment; an ionomer resin, etc.

[0029] Each of the inner cover 7 and the outer cover 15 is composed of a known elastomer. Examples of usable elastomers are the same as those used in forming the interlayer described above. Among these, ionomer resin is preferable in obtaining desirable rebound resilience, durability, moldability and the like. Examples of usable ionomer resins include Himilan 1706, Himilan 1605 (manufactured by Mitsui-DuPont Polychemicals Co., Ltd.), Surlyn 9910, Surlyn 8940, Surlyn 8150, Surlyn 8120, and Surlyn 8320 (manufactured by DuPont). For example, HPF1000 and HPF2000 (ionomers manufactured by DuPont) are preferably used as the material for the inner cover 7 from the viewpoint of a soft feel and rebound resilience. For example, HPC AD1043 (an ionomer manufactured by DuPont) is preferably used as the material for the outer cover 15 from the viewpoint of rebound resilience, scratch resistance and the like.

[0030] These materials may be used singly or in combination to improve their performance.

[0031] As described above, the present embodiment achieves the following effect. Usually, when a golf club comes into contact with a golf ball, the ball is deformed in the circumferential direction due to friction generated between the ball and the clubface. As the deformed ball proceeds to resume its original condition due to elastic resistance, a force in the direction opposite to the backspin direction is applied to the ball. At this time, the greater the ball deformation, the stronger the backspin suppression, and the longer the carry distance.

[0032] In the golf ball of the present embodiment, the ribs 11 enhance the elastic resistance that acts to return the ball to its original condition, so the backspin can be effectively reduced. More specifically, as shown in Fig. 3(a), in this golf ball, because the hardness of the ribs 11 is lower than that of the interlayer 5, when the ball is hit by a club C, the ribs 11 deform more severely than the interlayer 5. Due to the impact, a force causing backspin B is applied to the ball. When the ball separates from the club C, as shown in Fig. 3(b), the low-hardness rib 11 returns to its original condition from the deformed condition, and this restoration applies a force F to the ball in the direction that cancels the backspin B. As a result, the spin amount is reduced and a longer carry distance is attained. In particular, in the present embodiment, the ribs 11 are not simple protrusions but are structured so as to form walls surrounding the interlayer 5, and therefore when the ribs 11 are returning to their original condition, the force of the entire wall greatly acts on the interlayer 5 from the perimeter of the interlayer 5, and this increases the force F opposite to the backspin B. As a result, the amount of backspin is reduced and a significantly longer carry distance is achieved. This effect is particularly remarkable when the ball is hit by a driver, etc., which is designed to obtain a long carry distance. In Fig. 3, the current condition is shown by the solid lines and the condition immediately before the current condition is shown by the dashed lines.

[0033] However, because an inner cover 7 is provided between the interlayer 5 and the outer cover 15, transmission of the striking force to the interlayer 5 and the ribs 11 can be controlled in an approach shot, such as one performed using an iron, in which the ball deformation is small. As a result, the increase of the above-described force canceling the backspin can be prevented. Therefore, the golf ball of the present invention achieves a long carry distance by reducing the amount of backspin when hit by a driver. Furthermore, the golf ball of the present invention can be accurately stopped by the application of backspin when hit by an iron.

[0034] Because the hardness of the outer cover 15 is lower than that of the inner cover 7, a soft feeling can be obtained when hit. Furthermore, because the hardness of the outer cover 15 is low, the outer cover 15 is easily deformed. In other words, because the outer cover 15, which is the outermost cover of the ball, is easily deformed, the backspin effect can be increased when hit by an iron.

[0035] Also, because the hardness of the inner cover 7 is high, even though the outer cover 15 causes a soft feeling when hit, the rebound resilience can be improved by the inner cover 7. This makes it possible to achieve a high rebound resilience even when the club head speed is slow, which enables a longer carry distance.

[0036] As described above, by providing the ribs 11 on the core 3 and setting the hardness of the interlayer 5 greater than that of the ribs 11, the golf ball of the present embodiment achieves a backspin reduction effect. The extent of this backspin reduction effect can be controlled by adjusting the height of the ribs 11, and the difference in the hardness between the interlayer 5 and the ribs 11. This makes it possible to desirably control the carry distance. The carry distance is also controllable by adjusting the lift force applied to the ball by suitably selecting the shape of the dimples and the like. The adjustment of the ball performance is conducted according to the user’s level and desired performance. For example, among professional and other top-class golfers, there is a demand for a ball in which, when the golfer wishes to stop the ball in an approach shot, the backspin reduction effect due to the ribs is suppressed so that a certain amount of backspin can be generated. However, if too much focus is placed on approach shots, the ball tends to rise excessively when hit by a driver, which shortens the carry distance. This drawback can be overcome by selecting a design for the dimples and the like that prevents the ball from rising excessively by reducing the lift force applied to the ball, so that a longer carry distance can be achieved when hit by a driver.

[0037] In response to this demand, the lift force may be set as shown below. For example, immediately after being hit by a driver, a ball has a velocity of 62 m/s, a spin rate of 2,400 rpm, and a spin parameter of 0.09. In this case, the lift coefficient is preferably 0.13 to 0.17. Immediately after being hit by an iron, a ball has, for example, a velocity of 46 m/s, a spin rate of 4, 700 rpm, and a spin parameter of 0.23. However, when hit from the rough, a ball has a spin rate of about 2,500 rpm, which is remarkably lower than when the ball is hit from the fairway. Here, the spin parameter becomes 0.12. When the spin parameter is 0.12, the lift coefficient is preferably 0.16 to 0.20. As described above, having an unduly high lift coefficient results in an unexpected carry distance caused by excessive rising and the like. In contrast, if the lift coefficient is too small, the ball trajectory and launch angle become too low when hit from the rough, and the ball does not stop as desired. Based on the structure of the ball described above, it is preferable to design the dimples and the like so as to obtain the lift force described above.

[0038] The force applied to a ball, such as the aforementioned lift force, can be expressed by the trajectory equation shown below.

$$F = FL + FD + Mg$$

F: Force applied to the golf ball
FL: Lift force (N)
FD: Drag force (N)
M: Mass of the golf ball (kg)
g: Gravitational acceleration (m/s^2)

[0039] The lift force (FL) and drag force (FD) can be expressed by the equations shown below.

$$FL=0.5\times CL\times \rho\times A\times V^2$$

$$FD=0.5\times CD\times \rho\times A\times V^2$$

CL: Lift coefficient
CD: Drag coefficient
p: Air density (kg/m^3)
A: Cross-sectional area of the golf ball (m^2)
V: Velocity of the golf ball (m/s)

[0040] The spin parameter (Sp) can be expressed by the equation shown below.

$$Sp=\pi\times d\times N/V$$

d: Diameter of the golf ball (m)
N: Rate of rotation of the golf ball (rps)

[0041] The spin parameter, lift force and the like can be measured by tracking a ball shot by a golf robot using TrackMan (manufactured by Interactive Sports Games Co., Ltd.). TrackMan is a system designed for tracking and measuring ball flight using Doppler radar technology.

[0042] The above-described ribs may be formed into various shapes; however, from the viewpoint of effectively molding the interlayer, it is preferable to provide a notch in the rib having a structure as described below. Fig. 4 is a perspective view of a core provided with notches. Fig. 5 is a cross-sectional view of the core of Fig. 4. As shown in Figs. 4 and 5, the notch 24 is structured so as to have a bottom surface 24a extending along a tangent plane H that passes through the intersection P of the great circles. In other words, the notch 24 is formed by excising the rib 11 at the tangent plane H. By forming notches 24 in this manner, four depressions 13 that are arranged so as to have a common center at an intersection P of the great circles are made to communicate with each other, and the material for the interlayer can readily spread between the depressions 13 via the notches 24. In this case, as shown in Fig. 6, it is also possible to form the bottom surface 24a of the notch 24 along a plane H_1 that extends away from the tangent plane H by being slanted toward the center of the rib 11 by 1 to 3°, i.e., a plane having an angle made between the normal line n of the main part 9 passing through the intersection P is 91 to 93° as viewed from the front. This arrangement enables the angle to serve as a draft angle, and, for example, when a core is molded using two molds, such as an upper mold and a lower mold, the core 3 can be easily removed from the mold.

[0043] When the notch 24 is formed as described above, it is preferable that the length of the notchless top portion of each arc section S of the ribs in the arc direction, divided at the intersection P, as shown in Fig. 5, be no smaller than 10 mm.

[0044] As shown in Fig. 7, it is also possible to form a notch 24 so as to have a bottom surface 24a extending along a plane H_2 that is perpendicular to the normal line n that passes through the mid point in the height direction of the rib 11. In this case, in order to smoothly spread the interlayer material throughout the depressions 13, it is preferable that the distance D from the top portion of the virtual rib 11 without a notch 24 to the bottom surface 24a be no less than 1.2 mm. The length L should preferably be no less than 10 mm, as in the above-described case. Furthermore, it is possible to form a draft angle by forming the bottom surface 24a of the notch 24 along a plane that has an angle of 91 to 93° relative to the normal line n in the same manner as shown in Fig. 6.

[0045] It is also possible to provide a notch in the middle of the arc section S of the rib 11 in the arc direction. As shown in Fig. 8(a), it is possible to form the notch 25 so as to have two bottom surfaces 25a each extending toward the intersection P from a point on the normal line m of the main body 9 that passes through the mid point Q of each arc section in the circumferential direction. In this case, it is preferable that the angle made between the bottom surfaces 25a and the normal line m be 45 to 48° as viewed from the front. This arrangement makes it possible to easily remove the core 3 from the mold. However, if this angle exceeds 48°, the above-described length L of the rib in the circumferential direction becomes unduly short. It is preferable that the depth D of the notch 25 be no less than 1.2 mm. The depth D may be set outside of this range; however, by setting the depth D in this range, it is possible to smoothly spread the interlayer material throughout the depressions 13. Note that the depth D of the notch 25 is defined as the length from the top of the virtual rib 11 without a notch 25 to the deepest portion of the notch 25.

[0046] Alternatively, as shown in Fig. 8(b), it is possible to structure the notch 25 so as to have two side surfaces 25b each extending in the direction of the intersection P from a point Q on a normal line m of the main part 9 that passes through the mid point of each arc section S in the arc direction, and a bottom surface 25c of an arc shape along the main part 9 connecting the two side surfaces 25b. In this case, as in the case shown in Fig. 8(a), taking the draft angle into consideration, it is preferable that the angle between the side surface 25b and the normal line m be 45 to 48° as viewed from the front. Note that it is also possible to form the bottom surface 25c so as to pass through the mid point in the height direction of the rib 11. Also in this case, it is preferable that the depth D of the notch be no less than 1.2 mm. As long as the smooth removal of the core is ensured, two or more notches 25 may be provided in the middle of the arc section S.

[0047] As shown in Fig. 9, the arc section S may have a notch 24 as shown in Fig. 5, Fig. 6, or Fig. 7, and a notch 25 as shown in Fig. 8. As shown in Figs. 8 and 9, it is preferable that the length L (= L_1 + L_2) of the arc section S without a notch be no less than 10 mm.

[0048] In the above-described embodiment, the thickness of the interlayer 5 and the height of the rib 11 are the same; however, they do not necessarily have to be the same. For example, it is possible to make the thickness of the interlayer 5 greater than the height of the rib 11. However, it is preferable that the thickness of the interlayer 5 be slightly greater than the height of the rib 11, for example, by 0.3 mm or less.

[0049] One example of a method for manufacturing a golf ball having the above-described structure is explained next with reference to drawings. This manufacturing method, wherein an interlayer is formed from a rubber composition, is explained below. Figs. 10 and 11 show the method for manufacturing a four-piece golf ball comprising the core of Fig. 5.

[0050] First, a core is molded. Here, a predetermined amount of non-vulcanized rubber composition is placed in a mold. As described above, this rubber composition comprises a base rubber, a cross-linking agent, a metal salt of unsaturated carboxylic acid, a filler and the like, mixed by a Banbury mixer, rolls, or like mixing equipment. Then, this rubber composition is press molded at 130 to 180°C and a core 3, as shown in Fig. 4, is obtained.

[0051] Then, as shown in Fig. 10, an interlayer 5 is formed by press molding. As shown in Fig. 10(a), the mold for the interlayer comprises an upper mold 43 and a lower mold 45, each having a hemispherical depression 41. The depressions 41 of the upper mold 43 and lower mold 45 have the same kind of roughly finished surfaces as those of the molds for the core. Around each depression 41, a plurality of depressions 49 for holding excess flow are formed.

[0052] As shown in Fig. 10(a), a non-vulcanized rubber composition 61 is inserted into the depression 41 of the lower mold 45, a rubber composition 61 is placed on the above-obtained core 3, and the core 3 is positioned between the upper mold 43 and the lower mold 45. Consequently, as shown in Fig. 10(b), the upper mold 43 and the lower mold 45 are brought into contact. The rubber composition 61 is subjected to full vulcanization at 130 to 180°C for 5 to 25 minutes, and press molding, to obtain an interlayer 5.

[0053] At this time, the rubber compositions 61 placed on the core 3 and in the depression 41 of the lower mold 45 fill the depressions 13 while being pressed against the surface of the core 3. As described above, the two adjacent depressions 13 communicate with each other through notches 24, and therefore the rubber composition spreads throughout each depression and uniformly fills the space therein. The interlayer 5 may also be molded by injection molding using, for example, a mold such as that shown in Fig. 11. In this case, if no notch is provided, it is impossible to uniformly place the rubber composition in each depression 13 without providing a gate for each depression 13. However, by providing notches 24 to the ribs 11, it is possible to uniformly insert the rubber composition into the depressions 13 via the notches 24 as described above by inserting the rubber composition even from a single gate 50 after placing the core 3 into the molds 47 and 48.

[0054] When the molding of the interlayer 5 is completed, the core 3 covered with the interlayer 5 is removed from the mold. Thereafter, a cover 7 is applied to the surface of the interlayer 5 by press molding or injection molding. Thereafter, an outer cover is applied to the surface of the inner cover by press molding or injection molding in such a manner that the cover has predetermined dimples, thus obtaining a golf ball of the present embodiment.

[0055] As described above, notches 24 are provided in the ribs 11, and the two adjacent depressions 13 communicate with each other through the notches 24. Therefore, the rubber composition 61 spreads throughout the depressions 13 and uniformly fills the space therein when pressed from any position on the surface of the core 3. It is thus possible to cover the core 3 with the interlayer in a single press molding step. As a result, the manufacturing time can be significantly reduced.

[0056] A method for manufacturing a golf ball comprising an interlayer with notches is explained above. However, a golf ball without notches can also be manufactured by almost the same method. However, when notches are not provided, it is necessary to conduct press molding by arranging the interlayer material so that it spreads throughout the depressions, or, for injection molding, to provide a plurality of gates corresponding to the depressions.

[0057] One embodiment of the golf ball of the present invention is explained above. However, the golf ball of the present invention is not limited to this embodiment, and various modifications can be made as long as they do not depart from the scope of the invention. For example, three ribs are formed along the great circle drawn around the main part in the present embodiment. However, the embodiment of the rib is not limited to this and the shape, number and location thereof may be appropriately modified as long as depressions, to which an interlayer is inserted, can be formed by the ribs.

Examples

[0058] Examples of the present invention and Comparative Examples are explained below. Here, seven types of golf balls according to the present invention are compared with nine types of golf balls according to Comparative Examples. The Examples correspond to the embodiment described above. Table 1 below shows the shape of each golf ball, and Table 2 shows the hardness of each component of the golf balls. These golf balls had a diameter of 42.7 mm and a weight of 45.5 g.

[0059]

[Table 1]

	Shape (mm)				
	Diameter of Main Part	Height of Rib	Outside Diameter of Interlayer	Thickness of Inner Cover	Thickness of Outer Cover
Example 1	33.9	1.8	37.5	1.5	1.1
Example 2	29.9	3.8	37.5	1.5	1.1
Example 3	35.1	1.2	37.5	1.5	1.1
Example 4	33.1	2.2	37.5	1.5	1.1
Example 5	33.9	1.8	37.5	1.5	1.1
Example 6	33.9	1.8	37.5	1.5	1.1
Example 7	34.7	1.8	38.3	1.1	0.9
Comp. Ex. 1	35.9	0.8	37.5	1.5	1.1
Comp. Ex. 2	29.1	4.2	37.5	1.5	1.1
Comp. Ex. 3	34.3	1.6	37.5	1.5	1.1
Comp. Ex. 4	33.1	2.2	37.5	1.5	1.1

(continued)

	Shape (mm)				
	Diameter of Main Part	Height of Rib	Outside Diameter of Interlayer	Thickness of Inner Cover	Thickness of Outer Cover
Comp. Ex. 5	33.9	1.8	37.5	1.5	1.1
Comp. Ex. 6	33.9	1.8	37.5	1.1	1.5
Comp. Ex. 7	33.9	1.8	37.5	1.5	1.1
Comp. Ex. 8	35.3	1.8	38.9	0.9	0.9
Comp. Ex. 9	33.9	1.8	37.5	-	2.6

[0060]

[Table 2]

	Surface Hardness: D			
	Core	Interlayer	Inner Cover D	Outer Cover D
Example 1	56	59	68	57
Example 2	56	58	68	57
Example 3	56	60	68	57
Example 4	54	56	58	56
Example 5	56	59	68	57
Example 6	56	59	64	60
Example 7	56	59	68	57
Comp. Ex. 1	56	60	68	57
Comp. Ex. 2	56	59	68	57
Comp. Ex. 3	56	62	68	57
Comp. Ex. 4	56	60	58	62
Comp. Ex. 5	56	59	68	52
Comp. Ex. 6	56	59	58	60
Comp. Ex. 7	56	60	53	51
Comp. Ex. 8	56	60	68	57
Comp. Ex. 9	56	60	-	62

[0061] Tables 3 and 4 show the compounding ratio (unit: parts by weight) of the materials for the cores and the interlayers.

[0062]

[Table 3]

	Cores of Examples 1, 2, 3, 5 and 6, and Comparative Examples 1-7 and 9; and Interlayer of Example 4	Core of Example 4	Core of Example 7	Core of Comparative Example 8	Interlayer of Example 2
Cis-1,4-polybutadiene	100.00	100.00	100.00	100.00	100.00
Zinc oxide	3.00	3.00	3.00	3.00	3.00
Barium sulfate	26.10	26.90	22.4	21.8	25.40
Antioxidant	0.10	0.10	0.10	0.10	0.10
Zinc acrylate	25.20	23.20	25.20	25.20	27.40
Dicumyl peroxide	1.50	1.50	1.50	1.50	1.50

[0063]

[Table 4]

	Inter-layers of Examples 1, 5 and 6, and Comparative Examples 2, 5 and 6	Inter-layers of Example 3, and Comparative Examples 1, 4, 7 and 9	Inter-layer of Comparative Example 7	Inter-layer of Comparative Example 3	Inter-layer of Comparative Example 8
Cis-1,4-polybutadiene	100.00	100.00	100.00	100.00	100.00
Zinc oxide	3.00	3.00	3.00	3.00	3.00
Barium sulfate	24.90	24.50	21.00	23.50	20.00
Antioxidant	0.10	0.10	0.10	0.10	0.10
Zinc acrylate	28.60	29.80	28.60	32.40	29.80
Dicumyl peroxide	1.50	1.50	1.50	1.50	1.50

[0064] The materials for the inner covers and outer covers are shown below. Table 5 shows the compounding ratio of the materials.

[0065]

[Table 5]

	Inner Cover	Outer Cover
Example 1	1706:1601 = 1:1	HPC:8150 = 4:1
Example 2	1706:1601 = 1:1	HPC:8150 = 4:1
Example 3	1706:1601 = 1:1	HPC:8150 = 4:1
Example 4	HPF1000	HPC:8150 = 4:1
Example 5	1706:1601 = 1:1	8320:8150 = 3:2

(continued)

	Inner Cover	Outer Cover
Example 6	1706:1601:8320 = 1:1:1	HPC:8150 = 2:1
Example 7	1706:1601 = 1:1	HPC:8150 = 4:1
Comp. Ex. 1	1706:1601 = 1:1	HPC:8150 = 4:1
Comp. Ex. 2	1706:1601 = 1:1	HPC:8150 = 4:1
Comp. Ex. 3	1706:1601 = 1:1	HPC:8150 = 4:1
Comp. Ex. 4	HPF1000	HPC:8150 = 4:3
Comp. Ex. 5	1706:1601 = 1:1	HPC:8150 = 9:1
Comp. Ex. 6	HPF1000	HPC:8150 = 2:1
Comp. Ex. 7	1706:8320 = 1:5	HPC:8150 = 9:1
Comp. Ex. 8	1706:1601 = 1:1	HPC:8150 = 4:1
Comp. Ex. 9	-	HPC:8150 = 4:3

[0066] In Table 5, 1706 stands for Himilan 1706 manufactured by Du Pont-Mitsui Polychemicals Co., Ltd., and 1601 stands for Himilan 1601 manufactured by Du Pont-Mitsui Polychemicals Co., Ltd; HPC stands for HPC AD 1043 (an ionomer manufactured by DuPont, HPF stands for HPF 1000 (an ionomer manufactured by DuPont) ; and 8150 stands for Surlyn 8150 (an ionomer manufactured by DuPont).

[0067] Using the golf balls obtained in the Examples and Comparative Examples, which have the above-described structures, hitting tests were conducted using a hitting robot (manufactured by Miyamae Co., Ltd.: product name "SHOT ROBO V") with a number 1-wood (1W: manufactured by Mizuno Corporation: MP Craft 425, loft angle: 9.5°, shaft: QUAD 6 Butt Standard (shaft length: 45 inches, shaft flex: S))and sand wedge (SW: manufactured by Mizuno Corporation: MP T Series, loft angle: 56°, Chrome plated, shaft: Dynamic Gold Wedge Flex, shaft length: 35.25 inches), and the carry distances were measured. Here, the head speed of the 1-wood was set at 45 m/s, and the head speed of the sand wedge was set at 35 m/s. Tests of the feeling when hit were conducted by five amateurs using a 1-wood. The five amateurs were asked to select either 1: very soft, 2: soft, 3: hard, or 4: very hard, to evaluate the feeling when the ball was hit and the average value of all values selected was defined as the feeling value for each Example and Comparative Example. Durability tests were also conducted. In the durability tests, balls were shot from an air gun at 40 m/s, and repeatedly allowed to impact against an iron plate to determine the number of strikes until the balls cracked. A durability test was conducted using the ball of Example 1, and the number of impacts until the ball cracked was set to 100. The relative value of each ball was then calculated as a durability index. Table 6 below shows the results.

[0068]

[Table 6]

	1-Wood: 45 m/s		Feel When Actually Hit with a 1-Wood	Wedge	
	Carry (y)	Spin (rpm)	feeling	Spin (rpm)	Durability index
Example 1	230	2490	2.2	5810	100
Example 2	229	2460	2.0	5790	97
Example 3	230	2530	2.2	5810	102
Example 4	227	2520	1.2	5230	97
Example 5	227	2420	2.6	5310	97
Example 6	231	2420	2.6	5030	98
Example 7	231	2280	2.0	5750	94
Comp. Ex. 1	226	2630	2.2	5850	101
Comp. Ex. 2	226	2330	2.4	5760	94
Comp. Ex. 3	226	2320	2.2	5770	95

(continued)

	1-Wood: 45 m/s		Feel When Actually Hit with a 1-Wood	Wedge	
	Carry (y)	Spin (rpm)	feeling	Spin (rpm)	Durability index
Comp. Ex. 4	231	2350	2.0	4480	102
Comp. Ex. 5	225	2660	1.8	6080	95
Comp. Ex. 6	226	2360	2.4	5890	102
Comp. Ex. 7	221	2690	1.2	6110	101
Comp. Ex. 8	223	2490	1.8	5790	88
Comp. Ex. 9	230	2410	2.9	4810	99

[0069] As is clear from the results shown in Table 6, Examples 1 to 7 exhibited excellent results. However, Comparative Example 1 showed an unsatisfactory backspin reduction effect due to the ribs being too short. In contrast, Comparative Examples 2 and 3 showed undesirably large reductions in the backspin amount, because the ribs in Comparative Example 2 were too high and Comparative Example 3 had an undesirably large difference in height between the core and the interlayer. This reduced the carry distance. One of the reasons for the unsatisfactory carry distance may be a reduction in the lift force applied to the ball.

[0070] The outer cover in Comparative Example 4 was too hard and therefore had a small deformation therein. This caused a small backspin amount when a sand wedge was used; therefore, the ball in Comparative Example 4 is not suited for use in an approach shot. In contrast, the outer cover in Comparative Example 5 was too soft. This caused excessive backspin even when a driver was used, resulting in an unsatisfactory carry distance. The outer cover in Comparative Example 6 was unduly thick. This reduced the rebound resilience and resulted in an unexpectedly short carry distance. In Comparative Example 7, both the outer cover and the inner cover were soft. This reduced the rebound resilience and resulted in an unexpectedly short carry distance. In Comparative Example 8, the total thickness of the inner cover and the outer cover was too thin, resulting in poor durability. The ball of Comparative Example 9 was hard because it had a single-layer cover. This adversely affected the impact feel, and resulted in a small amount of backspin when a sand wedge was used.

[0071] As is clear from the results described above, the golf ball of the present invention remarkably increases the carry distance and generates an adequate amount of backspin in an approach shot.

Reference Signs List

[0072]

1 golf ball

3 core

5 interlayer

7 inner cover

9 main part

11 rib

13 depressions

15 outer cover

Claims

1. A golf ball comprising:

a spherical main part;
a plurality of ribs formed on the surface of the main part;
an interlayer placed in depressions surrounded by the ribs, the interlayer having a hardness greater than that of the ribs;
an inner cover covering the interlayer; and
an outer cover covering the inner cover, the outer cover having a hardness lower than that of the inner cover.

2. The golf ball according to claim 1, wherein the inner cover has a hardness greater than that of the interlayer.

3. The golf ball according to claim 1 or 2, wherein the total thickness of the inner cover and the outer cover is not less than 1.9 mm or more.

4. The golf ball according to any one of claims 1 to 3, wherein the inner cover has a Shore D hardness of 55 to 70.

5. The golf ball according to any one of claims 1 to 4, wherein the outer cover has a Shore D hardness of 54 to 60.

Fig. 1

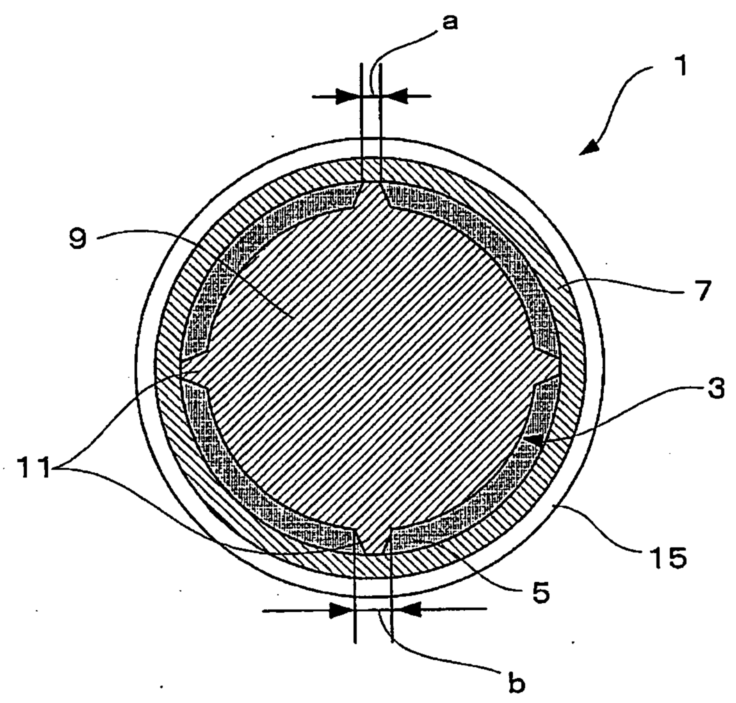


Fig. 2

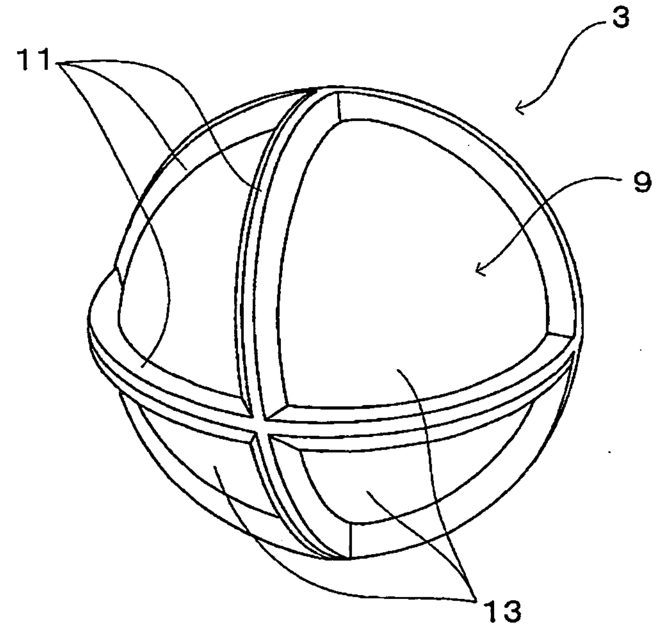
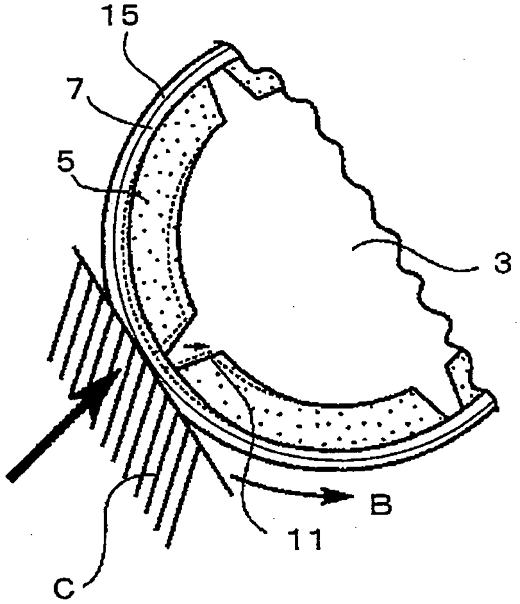


Fig. 3

(a)



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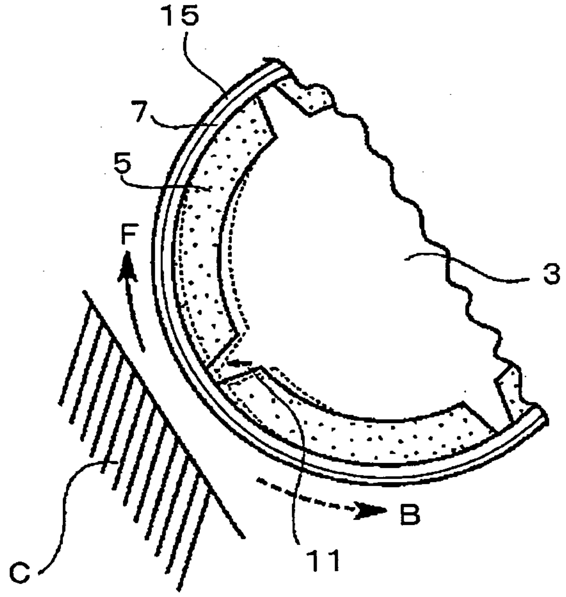


Fig. 4

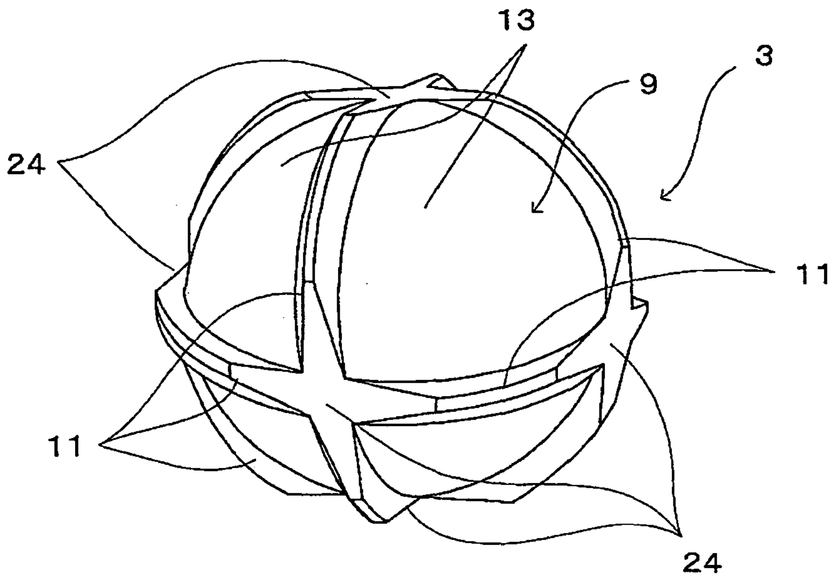


Fig. 5

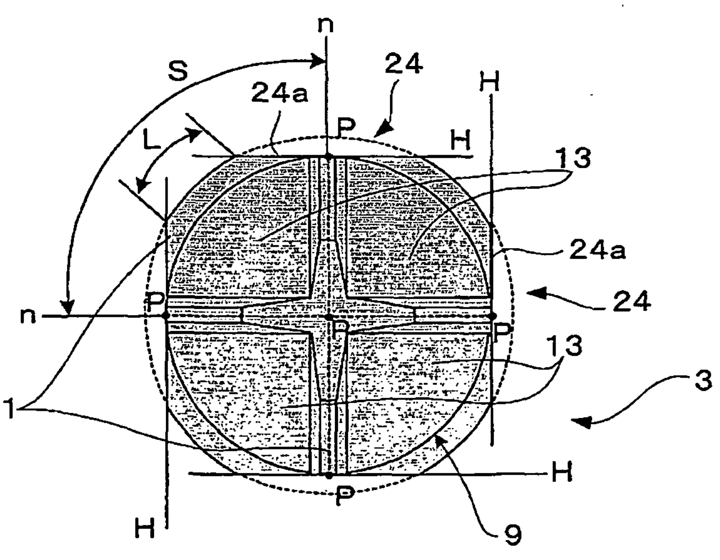
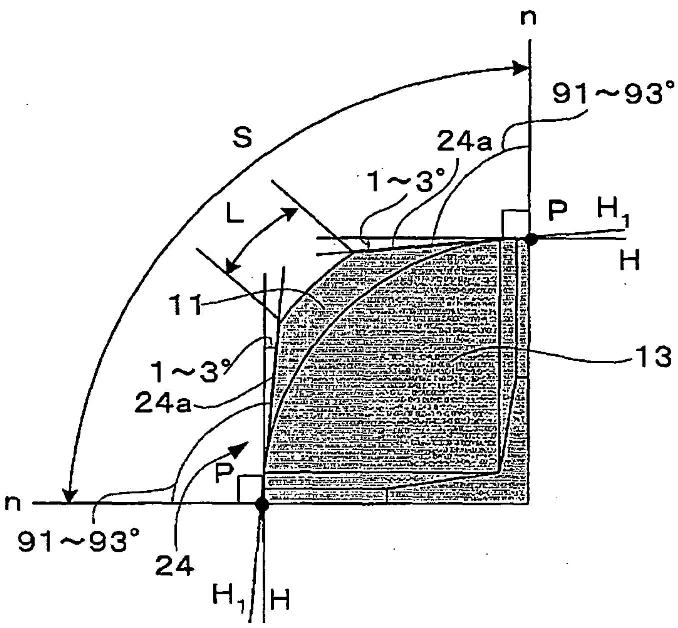


Fig. 6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P
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H_1
H

Fig. 7

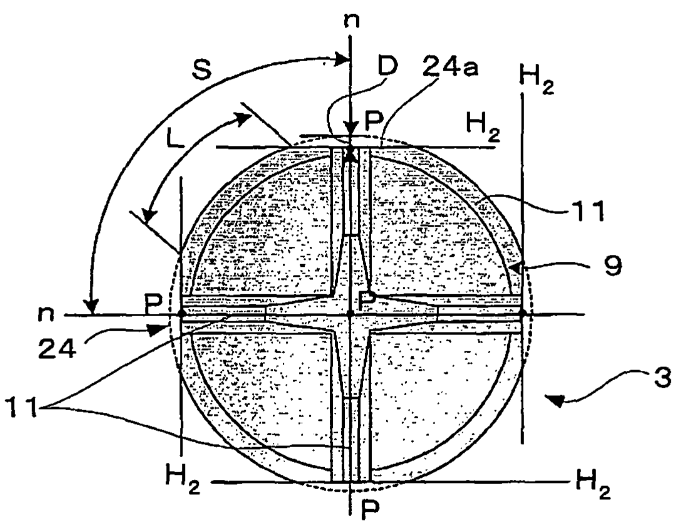
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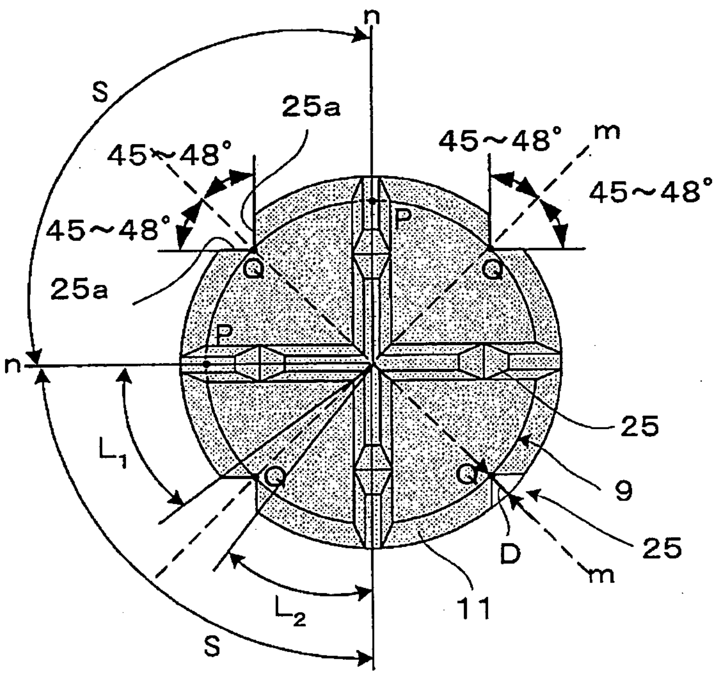
Fig. 8

(a)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(b)

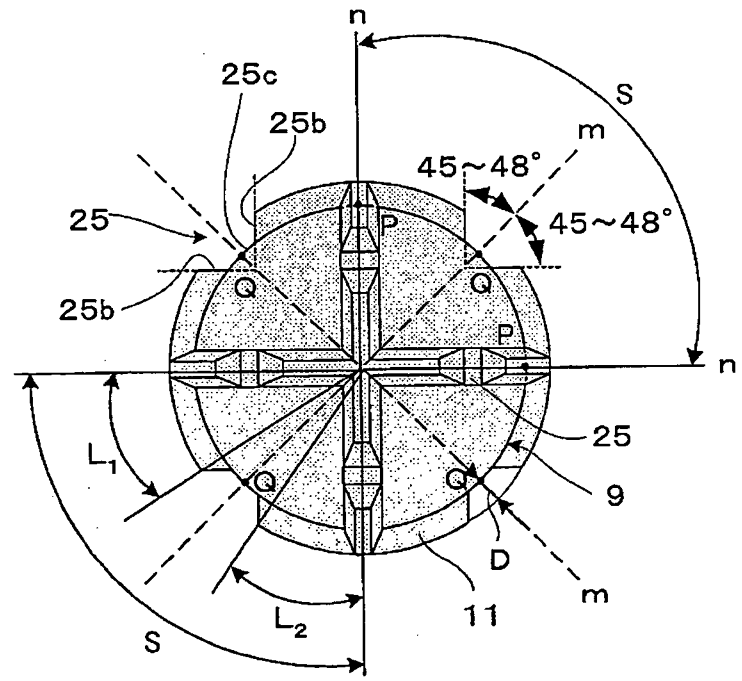
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Fig. 9

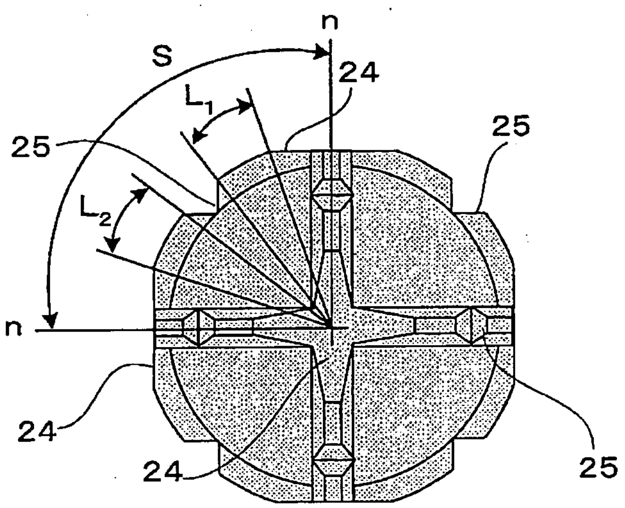
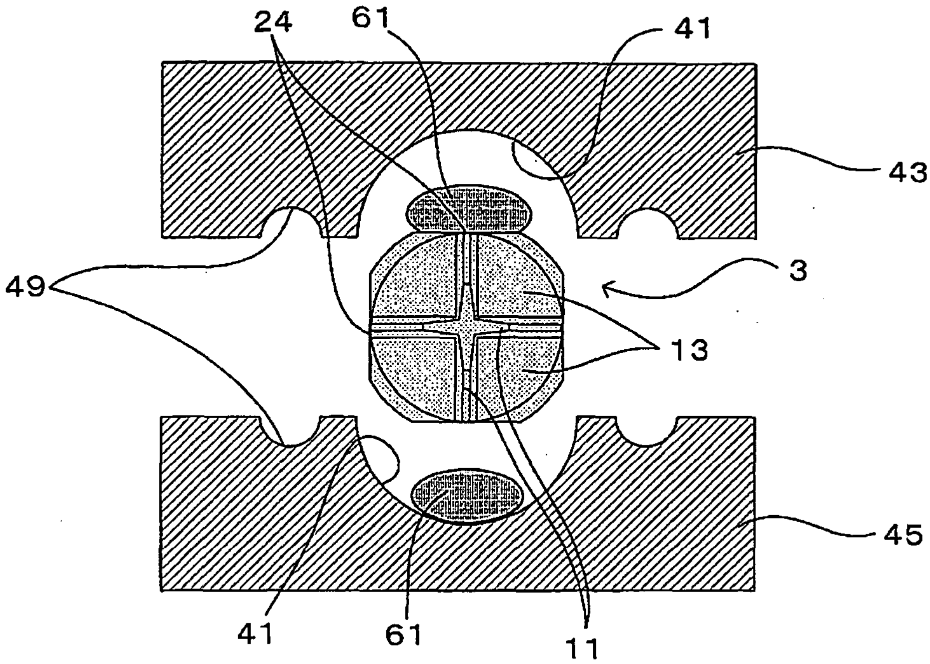


Fig. 10

(a)



(b)

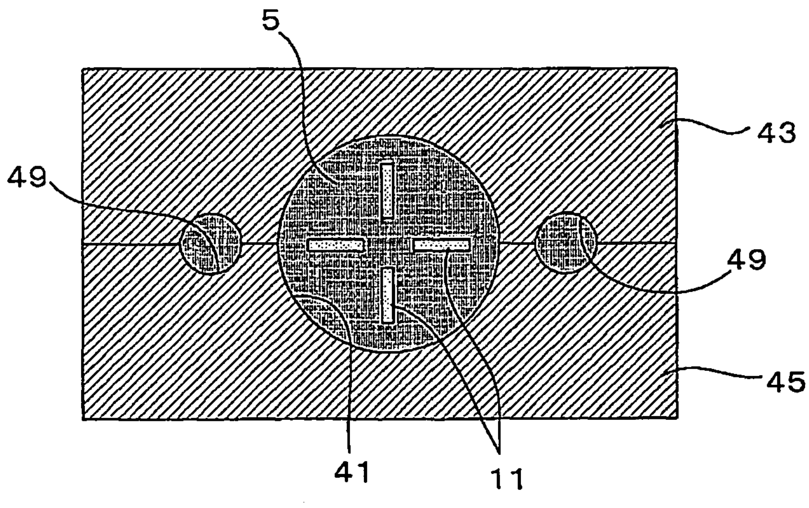
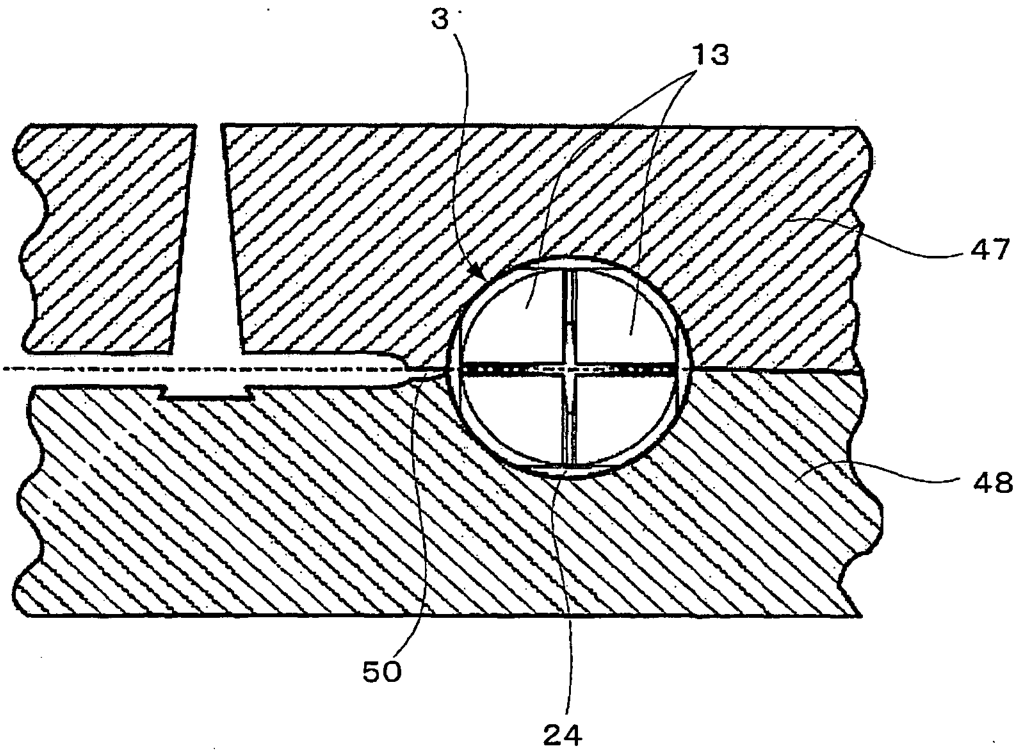


Fig. 11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/064385

A. CLASSIFICATION OF SUBJECT MATTER
A63B37/00(2006.01)i, *A63B37/02*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A63B37/00, A63B37/02

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2010
Kokai Jitsuyo Shinan Koho	1971-2010	Toroku Jitsuyo Shinan Koho	1994-2010

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2005/089883 A1 (MIZUNO INC.), 29 September 2005 (29.09.2005), claim 1; paragraph [0036]; fig. 1 to 2 & US 2005/0255944 A1 & CN 1950130 A	1-5
Y	JP 2009-34509 A (Bridgestone Sports Co., Ltd.), 19 February 2009 (19.02.2009), paragraphs [0159] to [0165]; fig. 1 & US 7425182 B1 & US 2009/0036233 A1	1-5

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search
10 November, 2010 (10.11.10)

Date of mailing of the international search report
22 November, 2010 (22.11.10)

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REFERENCES CITED IN THE DESCRIPTION

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- WO 2005089883 A **[0004]**