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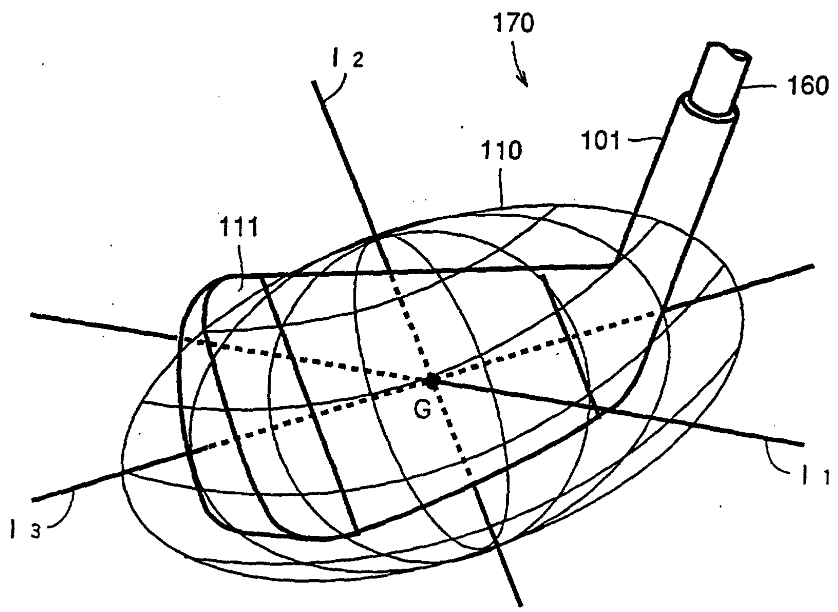
(54) GOLF CLUB HEAD, GOLF CLUB, AND GOLF CLUB SET

(57) A golf club head (1, 101) has a momental ellipsoid (10, 110). Assuming that three principal axes of the momental ellipsoid (10, 110) orthogonal to each other at the origin are an axis I_1, an axis I_2 and an axis Is in order of larger moments of inertia about the principal axes, the ratio (A/B) of a sectional area A at the time of cutting the momental ellipsoid (10, 110) along a plane passing through the origin and parallel to a face plane (11, 111) and a sectional area B at the time of cutting the momental ellipsoid along a plane including the axis I_1 and the axis I_2 is at least 1 and not more than 1.4.

FIG.12



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Description

Technical Field

[0001] The present invention relates to a golf club head, a golf club and a golf club set. In particular, it relates to a golf club head, a golf club and a golf club set efficiently reducing dispersion of carries resulting from dispersion of hitting positions.

Background Art

[0002] In general, a technique of designing a golf club head in consideration of a momental ellipsoid is described in Japanese Patent Laying-Open No. 5-57034. In this gazette, a technique of adding weight to a principal axis direction of a momental ellipsoid originally possessed by a golf club head for enlarging the momental ellipsoid while suppressing weight increase of the head to the minimum.

[0003] In Japanese Patent Laying-Open No. 9-149954 or Japanese Patent Laying-Open No. 10-248969, there is disclosed a technique of setting an angle at the time of projecting a principal axis of inertia on a plane perpendicular to a plane including a carrying line and a horizontal plane in the vicinity of a dispersion direction of hitting positions of a golfer thereby suppressing dispersion of carries.

[0004] However, the technique disclosed in Japanese Patent Laying-Open No. 5-57034 merely discloses means of enlarging the momental ellipsoid by adding the weight on the axis without changing the direction of the principal axis of inertia previously possessed by the produced head. In the aforementioned gazette, therefore, no judgment is made as to whether or not the direction of the principal axis of inertia is desirable in the first place when taking the performance of the golf club into consideration.

[0005] While the angle of inclination of the principal axis of inertia desirable for the golf club head is disclosed in Japanese Patent Laying-Open No. 9-149954 or Japanese Patent Laying-Open No. 10-248969, this merely discloses a desirable angle when projecting the golf club head on one plane as viewed from the face side. In this gazette, therefore, how to devise arrangement of a three-dimensionally existing momental ellipsoid is desirable is not mentioned.

[0006] When a golfer hits a ball, the position where the ball strikes a golf club head fluctuates due to various factors. As one of characters required to a golf club, it can be mentioned that fluctuation of a carry and a flying direction of a ball following fluctuation of a hitting position is small.

[0007] When the direction and the carry of the ball are unstabilized due to fluctuation of the hitting position, the golfer cannot carry the ball to a desired position, unpreferably for making a score.

[0008] While a certain degree of improvement has been made also in the prior art, it could not necessarily be said sufficient.

[0009] Accordingly, the present invention has been proposed in order to solve the aforementioned problem, and aims at providing a golf club head, a golf club and a golf club set in which fluctuation of a carry and a flying direction of a ball is small also when a hitting position fluctuates.

Disclosure of Invention

[0010] The inventors have made various studies as to fluctuation of a hitting position as well as a carry and a flying direction of a ball, to consequently recognize that more efficient improvement is possible not by projecting a momental ellipsoid of a golf club head on a plane but by three-dimensionally grasping the same. In other words, the present invention is to provide a golf club head more efficiently suppressing dispersion of a carry and a ball hitting direction with respect to dispersion of a hitting position by three-dimensionally designing arrangement of a principal axis of inertia desirable for a golf club, which is not disclosed in the prior art.

[0011] In a body, a momental ellipsoid 10 three-dimensionally exists as shown in Fig. 1A and Fig. 1B. Referring to Fig. 1A and Fig. 1B, a wood golf club 70 has a golf club head 1 for a wood and a shaft 60 whose one end is connected to the golf club head 11. The golf club head 1 has a face plane 11. The momental ellipsoid 10 of the golf club head 1 has principal axes I_1, I_2 and I_3 of inertia. These principal axes of inertia intersect at the center G of gravity as the origin.

[0012] Referring to Fig. 12, an iron golf club 170 has a golf club head 101 for an iron and a shaft 160 whose one end is connected to the golf club head 101. The golf club head 101 has a face plane 111. A momental ellipsoid 110 of the golf club head 101 has principal axes I_1, I_2 and I_3 of inertia. These principal axes of inertia intersect at the center G of gravity as the origin.

[0013] In a momental ellipsoid, the length of a principal axis is generally expressed by the inverse of the square root of the magnitude of the moment of inertia about the axis. When cutting the momental ellipsoid along an arbitrary plane, inertial resistance against a load perpendicularly acting on the plane enlarges as the area of the section is small.

[0014] Here, a load generated when hitting a ball with a golf club is shown by a vector F in Fig. 2. This vector F can be decomposed into a vector FP perpendicular to a face plane 11 and a small vector FH parallel to the face plane 11. Dispersion of a carry and a flying direction results from unnecessary rotary motion of a golf club head 1 shown by arrow 12. It is understood that, in most of the moment generating this rotary motion, the vector FP perpendicular to the face plane 11 is the main component from its magnitude, and the vector FH parallel to the face plane 11 is a small component and is at an ignorable degree.

[0015] In other words, it is understood that a load going to rotate the golf club head 1 is applied from the direction perpendicular to the face plane 11, and the face plane 11 may be designed to cut the momental ellipsoid along a plane parallel to the face plane 11 and passing through the center of the momental ellipsoid so that the sectional area (hereinafter referred to as an effective sectional area) is as small as possible in order to enlarge inertial resistance of the golf club head 1 against this load.

[0016] While golf club heads include such a one that a face plane 11 is convexed as a general wood golf club head, a plane located in the vicinity of the center (centroid) of the face plane is defined as the face plane in this case. In this case, a plane in contact with the face centroid, a sweet spot or a point on the face plane most having distance with respect to a plane including the outer periphery of the face plane is the face plane. Each point is located in the vicinity of the centroid, and hence there is no large difference with whichever one the reference plane is in contact.

[0017] In order to attain the aforementioned object, a momental ellipsoid and its cutting plane have been obtained in the present invention with a method consisting of the following structure.

[0018] Referring to Fig. 3, it is assumed that an axis perpendicular to the ground and passing through the center G of gravity is a Z axis, and an axis parallel to an intersection line between a contact surface at the centroid (center of the face plane 11) of the face plane 11 and the ground, perpendicular to the Z axis and passing through the center G of gravity is an X axis. An axis perpendicular to both of the X axis and the Z axis and passing through the center G of gravity is a Y axis.

[0019] First, it is assumed that a direction vector of the plane parallel to the intersection line between the contact surface (face plane) at the centroid of the face plane and the ground and passing through the center of gravity is $f(l, m,n)^T$ as shown in Fig. 4, for calculating the respective vectors of the following equations:

$$f_1(l_1, m_1, n_1)^T = f \times Z(0, 0, 1)^T$$

$$f_2(l_2, m_2, n_2)^T = f_1 \times f$$

$$f_3(l_3, m_3, n_3)^T = f_1 \times f_2 \qquad (1)$$

where × denotes cross products.

[0020] Then, assuming that an axis parallel to an intersection line 22 of a contact surface 21 at a centroid 21a of a face plane 11 and the ground 23 and passing through the center G of gravity is an α axis, an axis parallel to the contact surface 21 and perpendicular to the α axis is a β axis and an axis perpendicular to the α axis and the β axis is a γ axis, transformation from α, β, γ coordinate systems to X, Y, Z coordinate systems is expressed by the following equations:

$$X = l_1 \cdot \alpha + l_2 \cdot \beta + l_3 \cdot \gamma$$

$$Y = m_1 \cdot \alpha + m_2 \cdot \beta + m_3 \cdot \gamma$$

$$Z = n_1 \cdot \alpha + n_2 \cdot \beta + n_3 \cdot \gamma \qquad (2)$$

[0021] It follows that the magnitude of this cutting plane expresses the magnitude of inertial resistance indicating easiness of rotation on this plane, and the cutting plane expresses inertial resistance of the plane in the perpendicular direction. Further, it is obvious that the shape of this cutting plane becomes a plane ellipse since it is a cutting plane of a momental ellipsoid and a plane of a solid, as shown in Figs. 6, 7 and 8.

[0022] Assuming here that I_1, I_2 and I_3 are moments of inertia in relation to the X, Y and Z axes, I_{12} is a product of inertia in relation to the YZ plane and the XZ plane and I_{23} is a product of inertia in relation to the XZ plane and the XY plane, the following relation is obtained:

$$I_1 \cdot X^2 + I_2 \cdot Y^2 + I_3 \cdot Z^2 + 2 \cdot I_{12} \cdot X \cdot Y \cdot + 2 \cdot I_{13} \cdot X \cdot Z + 2 \cdot I_{23} \cdot Y \cdot Z = 1 \qquad (3)$$

[0023] The ellipse expressed by the equation (3) is referred to as a momental ellipsoid. This indicates the magnitude of inertial resistance in each direction. When substituting the equations (2) in the equation (3) and setting the term of γ to zero, an equation (4) of a cutting elliptic plane is obtained:

$$\begin{aligned}&(I_1 l_1{}^2 + I_2 m_1{}^2 + I_3 n_1{}^2 + I_{12} l_1 m_1 + I_{13} l_1 n_1 + I_{23} m_1 n_1)\alpha^2 \\ &+ (I_1 l_2{}^2 + I_3 m_2{}^2 + I_3 n_2{}^2 + I_{12} l_2 m_2 + I_{13} l_2 n_2 + I_{23} m_2 n_2)\beta^2 \\ &+ (I_1 l_1 l_2 + I_2 m_1 m_2 + I_3 n_1 n_2 + I_{12} l_1 m_2 + I_{12} l_2 m_1 + I_{13} l_1 n_2 \\ &+ I_{13} l_2 n_1 + I_{23} m_1 n_2 + I_{23} m_2 n_1)\alpha\beta = 1 \qquad (4)\end{aligned}$$

[0024] Assuming that the length of the major axis is a and the length of the minor axis is b as shown in Fig. 7, an area S at the time of cutting the momental ellipsoid along a plane including this major axis and the minor axis is expressed by the following equation:

$$S = \pi ab$$

[0025] The current area is the effective sectional area.

[0026] On the other hand, the effective sectional area of the momental ellipsoid cut along the plane parallel to the face plane 11 and passing through the center of the momental ellipsoid expresses the magnitude of inertial resistance of the body against the load perpendicularly acting on the plane, as described above. The inertial resistance enlarges as this effective sectional area is small. Therefore, it is possible to provide a head whose carry and direction are stable by designing it to reduce the effective sectional area to the utmost.

[0027] A golf club head according to the present invention has a momental ellipsoid. Assuming that three principal axes of the momental ellipsoid orthogonal to each other at the origin are an axis I_1, an axis I_2 and an axis I_3 in order of larger moments of inertia about those principal axes, the ratio (A/B) of a sectional area A (effective sectional area) at the time of cutting the momental ellipsoid along a plane passing through the origin and parallel to a face plane and a sectional area B (minimum sectional area) at the time of cutting the momental ellipsoid along a plane including the axis I_1 and the axis I_2 is at least 1 and not more than 1.4.

[0028] Preferably, the sectional area A (effective sectional area) is at least 0.0005 ($1/g \cdot cm^2$) and not more than 0.0025 ($1/g \cdot cm^2$).

[0029] Preferably, the sectional area A (effective sectional area) is at least 0.0005 ($1/g \cdot cm^2$) and not more than 0.00125 ($1/g \cdot cm^2$).

[0030] Preferably, a value obtained by dividing the sectional area A (effective sectional area) by the area of the face plane is not more than 1.00×10^{-4} ($1/g \cdot cm^4$).

[0031] Further, preferably, a value obtained by dividing the sectional area A (effective sectional area) by the volume of the golf club head is not more than 1.50×10^{-5} ($1/g \cdot cm^5$).

[0032] Preferably, a value obtained by dividing the sectional area A (effective sectional area) by the mass of the golf club head is not more than 1.00×10^{-5} ($1/g^2 \cdot cm^2$).

[0033] Preferably, the golf club head is a golf club head for a wood, and the sectional area A (effective sectional area) is at least 0.0005 ($1/g \cdot cm^2$) and not more than 0.0020 ($1/g \cdot cm^2$).

[0034] Preferably, the golf club head is a golf club head for an iron, and the sectional area A (effective sectional area) is at least 0.001 ($1/g \cdot cm^2$) and not more than 0.0025 ($1/g \cdot cm^2$).

[0035] Preferably, the golf club head is a golf club head for an iron, and a value obtained by dividing the sectional area A (effective sectional area) by the volume of the golf club head is not more than 7.80×10^{-5} ($1/g \cdot cm^5$).

[0036] Preferably, the golf club head is a golf club head for an iron, and a value obtained by dividing the sectional area A (effective sectional area) by the mass of the golf club head is not more than 1.10×10^{-5} ($1/g^2 \cdot cm^2$).

[0037] A golf club according to the present invention comprises the aforementioned golf club head and a shaft whose one end is connected to the golf club head.

[0038] In the golf club, a loft angle is preferably not more than 16°.

[0039] A golf club set according to one aspect of the present invention comprises an iron golf club and a wood golf club.

[0040] The iron golf club has a golf club head for an iron and a shaft whose one end is connected to the golf club head for an iron, the wood golf club has a golf club head for a wood and a shaft whose one end is connected to the golf club head for a wood, and the golf club head for an iron and the golf club head for a wood have momental ellipsoids. Face planes of the golf club head for an iron and the golf club head for a wood are so formed that, assuming that triple principal axes of the momental ellipsoids orthogonal to each other at the origins are axes I_1, axes I_2 and axes I_3 in order of larger moments of inertia about the principal axes in the golf club head for an iron and the golf club head for a wood, the ratios A/B of sectional areas A at the time of cutting the momental ellipsoids along planes passing through the origins and parallel to the face planes and sectional areas B at the time of cutting the momental ellipsoids along planes including the axes I_1 and the axes I_2 are at least 1 and not more than 1.4. The sectional area A of the golf club head for an iron is at least 0.001 $1/g \cdot cm^2$ and not more than 0.0025 $1/g \cdot cm^2$, and the sectional area A of the golf club head for a wood is at least 0.0005 $1/g \cdot cm^2$ and not more than 0.0020 $1/g \cdot cm^2$.

[0041] A golf club set according to another aspect of the present invention comprises a plurality of golf clubs. The plurality of golf clubs have golf club heads and shafts whose single ends are connected to the golf club heads, and the golf club heads have momental ellipsoids. Assuming that triple principal axes of the momental ellipsoids orthogonal to each other at the origins are axes I_1, axes I_2 and axes I_3 in order of larger moments of inertia about said principal axes, the ratios = A/B of sectional areas A at the time of cutting the momental ellipsoids along planes passing through the origins and parallel to face planes and sectional areas B at the time of cutting the momental ellipsoids along planes including the axes I_1 and the axes I_2 are at least 1 and not more than 1.4. As to the plurality of golf club heads, the values of the ratios of the sectional areas A and the sectional areas B are not more than C + 0.1 at the maximum and at least C - 0.1 at the minimum with respect to a prescribed value C.

[0042] This golf club set is applied to any of that formed by wood golf clubs, that formed by iron golf clubs and that formed by wood and iron golf clubs.

[0043] A golf club set according to the present invention comprises a wood golf club and an iron golf club. The iron golf club has a golf club head for an iron and a shaft whose one end is connected to the golf club head for an iron, the wood golf club has a golf club head for a wood and a shaft whose one end is connected to the golf club head for a wood, and the golf club head for an iron and the golf club head for a wood have momental ellipsoids. Face planes of the golf club head for an iron and the golf club head for a wood are so formed that, assuming that triple principal axes of the momental ellipsoids orthogonal to each other at the origins are axes I_1, axes I_2 and axes I_3 in order of larger moments of inertia about the principal axes in the golf club head for an iron and the golf club head for a wood, the ratios A/B of sectional areas A at the time of cutting the momental ellipsoids along planes passing through the origins and parallel to the face planes and sectional areas B at the time of cutting the momental ellipsoids along planes including the axes I_1 and the axes I_2 are at least 1 and not more than 1.4. As to a plurality of golf club heads for woods, the values of the ratios of the sectional areas A and the sectional areas B are not more than D + 0.1 at the maximum and at least D - 0.1 at the minimum with respect to a prescribed value D. As to a plurality of golf club heads for irons, the values of the ratios of the sectional areas A and the sectional areas B are not more than E + 0.1 at the maximum and at least E - 0.1 at the minimum with respect to a prescribed value E different from the prescribed value D.

Brief Description of Drawings

[0044] Fig. 1A and Fig. 1B are diagrams typically showing principal axes of inertia of a wood golf club head.

[0045] Fig. 2 is a diagram decomposing force and a moment generated when hitting a ball into a component of force horizontal to a face and a vertical component of force.

[0046] Fig. 3 is a conceptual diagram showing basic axes of the coordinates of momental ellipsoid systems.

[0047] Fig. 4 is a model diagram for illustrating a cutting elliptic plane and coordinate transformation.

[0048] Fig. 5 is a model diagram showing an axis parallel to an intersection line of a contact surface at the centroid of a face plane and the ground and passing through the center of gravity as an α axis, an axis parallel to the plane and perpendicular to the α axis as a β axis and an axis perpendicular to the α axis and the β axis as a γ axis.

[0049] Fig. 6 is a diagram showing a surface cut along a plane passing through the center of gravity of a momental ellipsoid and parallel to a face plane.

[0050] Fig. 7 is a diagram showing the surface cut along the plane passing through the center of gravity of the momental ellipsoid and parallel to the face plane.

[0051] Fig. 8 is a diagram showing the surface cut along the plane passing through the center of gravity of the momental ellipsoid and parallel to the face plane.

[0052] Fig. 9 is a graph showing results of simulation of change of an effective sectional area/minimum area ratio in a driver head and a carry at the time of hitting a ball on a position displaced by 10 mm from a sweet spot in a toe direction.

[0053] Fig. 10 is a diagram showing an effective sectional area in a driver head and a carry at the time of hitting a ball on a position displaced by 10 mm from a sweet spot toward a toe side.

[0054] Fig. 11 is a model diagram of a golf club head employed when carrying out the test shown in Fig. 10.

[0055] Fig. 12 is a diagram typically showing principal axes of inertia of an iron golf club head.

Best Mode for Carrying Out the Invention

[0056] An embodiment of the present invention is hereinafter described in detail.

[0057] First, in the present invention, it is a momental ellipsoid of a golf club head, and assuming that three principal axes of the momental ellipsoid orthogonal to each other at the origin are an axis I_1, an axis I_2 and an axis I_3 in order of larger moments of inertia about those principal axes, the ratio (A/B) of a sectional area A (effective sectional area) at the time of cutting the momental ellipsoid along a plane passing through the origin and parallel to a face plane and a sectional area B (minimum sectional area) at the time of cutting the momental ellipsoid along a plane including the axis I_1 and the axis I_2 is at least 1 and not more than 1.4.

[0058] As hereinabove described, a main load rotating the golf club head perpendicularly acts on the face plane. The magnitude of inertial resistance against the load perpendicularly acting on the face plane can be expressed by the effective sectional area A.

[0059] In other words, the resistance most enlarges against the load applied to the face plane when the effective sectional area of the momental ellipsoid is the minimum. A carry is stabilized by suppressing the effective sectional area to not more than 1.4 times the minimum sectional area B.

[0060] Fig. 9 simulates the relation between change of an effective sectional area/minimum area ratio of a momental ellipsoid and a carry at the time of continuously changing the axis I_3 in a toe-heel direction and hitting a ball on a position displaced by 10 mm from a sweet spot toward the toe side.

[0061] Thus, no remarkable reduction of the carry takes place unless the effective sectional area/minimum area ratio exceeds 1.4. In other words, it is understood that the effective sectional area/minimum area ratio may be set to not more than 1.4.

[0062] A golf club set can be structured employing the aforementioned golf club heads. In the conventional golf club head, the effective sectional area/minimum area ratio varies with the head, and the difference in a golf club head for a wood and a golf club head for an iron is particularly large. It is said that the wood is a club of a carry and the iron is a club of directivity for this reason.

[0063] When making all golf clubs forming a set satisfy the aforementioned range, the ratio of the maximum inertial resistance possessed by the golf club heads and actually possessed inertial resistance becomes constant and hence it is possible to make it a golf club set whose carries are stable.

[0064] At this time, it is needless to say that a feeling for carry stability in the golf club set more coincides by setting the value of the effective sectional area/minimum area ratio constant or within the range of ± 0.1 at the maximum in the golf club set.

[0065] The golf club head according to the present invention is such a golf club head that the effective sectional area A is at least 0.0005 ($1/g \cdot cm^2$) and not more than 0.0025 ($1/g \cdot cm^2$). The value of the effective sectional area varies with inclination of the principal axes of the momental ellipsoid or the shape of the momental ellipsoid. If this value is large, inertial resistance reduces regardless of the ratio to the minimum sectional area and it becomes a head having no carry stability. Therefore, the effective sectional area A is preferably set to at least 0.0005 ($1/g \cdot cm^2$) and not more than 0.0025 ($1/g \cdot cm^2$).

[0066] In a golf club head for a wood, further, the effective sectional area A is preferably set to at least 0.0005 ($1/g \cdot cm^2$) and not more than 0.002 ($1/g \cdot cm^2$).

[0067] The golf club head is such a golf club head that the effective sectional area A becomes at least 0.0005 ($1/g \cdot cm^2$) and not more than 0.00125 ($1/g \cdot cm^2$).

[0068] Fig. 10 shows carry change at the time of making a hit with displacement by 10 mm from a sweet spot toward a toe side when changing the effective sectional area of a driver head. This test was adjusted by preparing heads lighter than prescribed mass as shown in Fig. 11 and arranging equal weights on positions symmetrical about the center G of gravity thereof so that the center of gravity positions and the weights of the golf club heads remain unchanged while only inclination of principal axes of inertia change. A solid line 50 shows a principal axis I_3 of inertia of a general club head. A dotted line 51 shows a principal axis I_3 of inertia of a first golf club head. A dotted line 52 shows a principal axis I_3 of inertia of a second golf club head. The first golf club head has weight members 53 and 54. The second golf club head has weight members 55 and 56. As to the first golf club head, test hitting was made with a robot at a head speed of 40 ms. Also as to the others, the head speed was set to 40 m/s. Referring to Fig. 10, a broken line approximates actually measured data with a polynominal and couples the same with virtual lines. It is understood from this data that there is a plateau-shaped peak in the vicinity of the effective sectional area A of 0.00125. Further, it is understood that the carry abruptly lowers from a portion where the effective sectional area A exceeds 0.0025. Thus, it is understood that the effective sectional area A is preferably set to not more than 0.002 ($1/g \cdot cm^2$), desirably not more than 0.00125 ($1/g \cdot cm^2$).

[0069] The golf club head according to the present invention is such a golf club head that a value obtained by dividing the effective sectional area A by the area of the face plane is not more than 1.00×10^{-4} ($1/g \cdot cm^4$).

[0070] In order to reduce the effective sectional area of the momental ellipsoid, it can be attained also by enlarging the golf club head. In this case, the area of the face plane is also necessarily enlarged when enlarging the golf club head. However, dispersion of hitting point positions of a golfer of a general level is constant at 65 to 70 % of the face area. Therefore, dispersion of hitting points also enlarges when enlarging the head.

[0071] Performance as a club does not improve when dispersion of hitting points enlarges also when reducing the momental ellipsoid, and hence some limitation must be provided. Therefore, it is possible to balance both by rendering the range of the ratio of the area of the face correlated with the dispersion of hitting points and the effective sectional area not more than 1.00×10^{-4} ($1/g \cdot cm^4$).

[0072] As hereinabove described, a golfer has such a regular hitting area that the quantity of dispersion of hitting points varies with the magnitude of the face area. In a golf club set, the face area reduces as the count enlarges in a golf club head for a wood, while it is possible to provide a club easy to handle in which a feeling with the regular hitting area possessed by the golfer is coincident by rendering the ratio of the face area and the effective sectional area constant.

[0073] In the golf club head, a value obtained by dividing the effective sectional area A by the volume of the golf club head is not more than 1.50×10^{-5} ($1/g \cdot cm^5$).

[0074] In a technique of enlarging a golf club, particularly a golf club head for a wood, it can be enlarged in the height, length and width directions of the head. The shape of the momental ellipsoid varies with the enlarging direction, and the value of the effective sectional area also changes. Here, it is possible to make it a head having smaller dispersion of carries as the ratio of contribution to the momental ellipsoid per unit volume is small. The value obtained by dividing the effective sectional area A by the volume of the head is desirably set to not more than 1.50×10^{-5} ($1/g \cdot cm^5$).

[0075] A golfer empirically feels that a head having a large volume has large inertial resistance and that having a small head volume has small inertial resistance. Therefore, it is needless to say that a club set matching with the golfer's feeling can be provided when regularizing the ratio of the head volume and the effective sectional area constant.

[0076] In the golf club head, a value obtained by dividing the effective sectional area A by the mass of the golf club head is not more than 1.00×10^{-5} ($1/g^2 \cdot cm^2$).

[0077] The mass of the golf club head is subjected to restriction in design of the golf club, and hence it is possible to make it a head having small dispersion of carries as the ratio of contribution to the effective sectional area per unit mass is high whether to increase the volume or to change mass distribution. As this value, it is desirable to render the same not more than 1.00×10^{-5} ($1/g^2 \cdot cm^2$).

[0078] When making it a golf club for a wood, it is desirable to set the effective sectional area to at least 0.0005 ($1/g \cdot cm^2$) and not more than 0.0020 ($1/g \cdot cm^2$). In this case, it is possible to bring out the characteristics of the golf club for a wood and make it a head having small dispersion of carries resulting from dispersion of hitting positions.

[0079] By applying the golf club head according to the present invention to all clubs in a golf club set for woods, it is possible to homogenize the characteristics of the clubs in the set and structure a golf club set for woods whose hit feelings are unified.

[0080] In the golf clubs for woods, loft angles are preferably not more than 16°.

[0081] While it is desirable to unify hit feelings of all clubs in the set, they become insensitive to hit feelings for a ball if the loft angles enlarge. When demanding a carry, further, the golfer generally employs a loft angle of not more than 16°. As to a golf head for a wood whose loft angle is not more than 16° at the minimum, a club whose carry stability is high may be provided. While the golf club head for a wood has heretofore been mainly described, numerical values in individual characteristics vary with various factors including shapes in a wood and an iron. While the description hereinafter shows optimum values in a golf club head for an iron, effects thereof follow those in the golf club head for a wood.

[0082] The golf club head for an iron according to the present invention is such that the effective sectional area A is at least 0.001 ($1/g \cdot cm^2$) and not more than 0.0025 ($1/g \cdot cm^2$).

[0083] In the golf club head for an iron, a value obtained by dividing the effective sectional area A by the volume of the golf club head is not more than 7.80×10^{-5} ($1/g \cdot cm^5$).

[0084] In the golf club head for an iron, further, a value obtained by dividing the effective sectional area A by the mass of the golf club head is not more than 1.10×10^{-5} ($1/g^2 \cdot cm^2$).

[0085] When it is a golf club comprising the aforementioned golf club head for an iron and a shaft whose one end is connected to the golf club head, this is preferable since it can exhibit the aforementioned characteristics.

[0086] In this case, the loft angle of the golf club is 16°.

[0087] As hereinabove described, the golf club head according to the present invention is designed to reduce the area of a plane ellipse at the time of expressing the moment of inertia important as a characteristic of the club head by a momental ellipsoid about the center of gravity and cutting the momental ellipsoid along a virtual plane parallel to the face plane and passing through the center of gravity of the golf club head. Thus, it is possible to enlarge inertial resistance of the golf club head with respect to the hitting direction and efficiently reduce dispersion of carries resulting from dispersion of hitting positions. More specifically, it is possible to make it a club suppressing dispersion of carries by suppressing the effective sectional area of the momental ellipsoid possessed by the golf club head to at least 1.0

time and not more than 1.4 times with respect to the minimum sectional area. It clearly shows the value of the best mode of the current effective sectional area and makes it the design guideline of a head whose carry is stabilized, while disclosing the best mode of the effective sectional area per unit face area, unit head volume and unit head mass and having an effect of becoming a head more effectively attaining carry stabilization. Further, it has an effect of making it a golf club set whose hit feelings are unified by developing the aforementioned characteristics to clubs forming club heads.

Industrial Applicability

[0088] The present invention can be utilized for a golf club head, a golf club and a golf club set.

Claims

1. A golf club head (1, 101) having a momental ellipsoid (10, 110), wherein
   assuming that three principal axes of said momental ellipsoid (10, 110) orthogonal to each other at the origin are an axis I_1, an axis I_2 and an axis Is in order of larger moments of inertia about said principal axes, the ratio (A/B) of a sectional area A at the time of cutting said momental ellipsoid (10, 110) along a plane passing through said origin and parallel to a face plane (11, 111) and a sectional area B at the time of cutting said momental ellipsoid along a plane including said axis I_1 and said axis I_2 is at least 1 and not more than 1.4.

2. The golf club head according to claim 1, wherein said sectional area A is at least 0.0005 ($1/g\cdot cm^2$) and not more than 0.0025 ($1/g\cdot cm^2$).

3. The golf club head according to claim 1, wherein said sectional area A is at least 0.0005 ($1/g\cdot cm^2$) and not more than 0.00125 ($1/g\cdot cm^2$).

4. The golf club head according to claim 1, wherein a value obtained by dividing said sectional area A by the area of said face plane (11, 111) is not more than 1.00×10^{-4} ($1/g\cdot cm^4$).

5. The golf club head according to claim 1, wherein a value obtained by dividing said sectional area A by the volume of said golf club head (1,101) is not more than 1.50×10^{-5} ($1/g\cdot cm^5$).

6. The golf club head according to claim 1, wherein a value obtained by dividing said sectional area A by the mass of said golf club head (1,101) is not more than 1.00×10^{-5} ($1/g^2\cdot cm^2$).

7. The golf club head according to claim 1, being a golf club head (1) for a wood, wherein said sectional area A is at least 0.0005 ($1/g\cdot cm^2$) and not more than 0.0020 ($1/g\cdot cm^2$).

8. The golf club head according to claim 1, being a golf club head (101) for an iron, wherein said sectional area A is at least 0.001 ($1/g\cdot cm^2$) and not more than 0.0025 ($1/g\cdot cm^2$).

9. The golf club head according to claim 1, being a golf club head (101) for an iron, wherein a value obtained by dividing said sectional area A by the volume of said golf club head (101) is not more than 7.80×10^{-5} ($1/g\cdot cm^5$).

10. The golf club head according to claim 1, being a golf club head (101) for an iron, wherein a value obtained by dividing said sectional area A by the mass of said golf club head (101) is not more than 1.10×10^{-5} ($1/g^2\cdot cm^2$).

11. A golf club comprising the golf club head (1, 101) according to claim 1 and a shaft (60, 160) whose one end is connected to said golf club head (1, 101).

12. The golf club according to claim 11, wherein a loft angle is not more than 16°.

13. A golf club set comprising a wood golf club (70) and an iron golf club (170), wherein

    said iron golf club (170) has a golf club head (101) for an iron and a shaft (160) whose one end is connected to said golf club head (101) for an iron,
    said wood golf club (70) has a golf club head (1) for a wood and a shaft (60) whose one end is connected to

said golf club head (1) for a wood,
said golf club head (101) for an iron and said golf club head (1) for a wood have momental ellipsoids (10, 110),
face planes (11, 111) of said golf club head (101) for an iron and said golf club head (1) for a wood are so formed that, assuming that triple principal axes of said momental ellipsoids (10, 110) orthogonal to each other at the origins are axes I_1, axes I_2 and axes I_3 in order of larger moments of inertia about said principal axes in said golf club head (101) for an iron and said golf club head (1) for a wood, the ratios (A/B) of sectional areas A at the time of cutting said momental ellipsoids (10, 110) along planes passing through said origins and parallel to said face planes (11, 111) and sectional areas B at the time of cutting said momental ellipsoids along planes including said axes I_1 and said axes I_2 are at least 1 and not more than 1.4,
said sectional area A of said golf club head (101) for an iron is at least 0.001 ($1/g \cdot cm^2$) and not more than 0.0025 ($1/g \cdot cm^2$), and
said sectional area A of said golf club head (1) for a wood is at least 0.0005 ($1/g \cdot cm^2$) and not more than 0.0020 ($1/g \cdot cm^2$).

14. A golf club set comprising a plurality of golf clubs (70, 170), wherein

the plurality of said golf clubs (70, 170) have golf club heads (1, 101) and shafts (60, 160) whose single ends are connected to said golf club heads (1, 101),
said golf club heads (1, 101) have momental ellipsoids,
assuming that triple principal axes of said momental ellipsoids (10, 110) orthogonal to each other at the origins are axes I_1, axes I_2 and axes I_3 in order of larger moments of inertia about said principal axes, the ratios (A/B) of sectional areas A at the time of cutting said momental ellipsoids (10, 110) along planes passing through said origins and parallel to face planes (11, 111) and sectional areas B at the time of cutting said momental ellipsoids along planes including said axes I_1 and said axes I_2 are at least 1 and not more than 1.4, and
the values of the ratios of said sectional areas A and said sectional areas B are not more than C + 0.1 at the maximum and at least C - 0.1 at the minimum with respect to a prescribed value C as to the plurality of golf club heads (1, 101).

15. A golf club head comprising a wood golf club (70) and an iron golf club (170), wherein

said iron golf club (170) has a golf club head (101) for an iron and a shaft (160) whose one end is connected to said golf club head (101) for an iron,
said wood golf club (70) has a golf club head (170) for a wood and a shaft (60) whose one end is connected to said golf club head (1) for a wood,
said golf club head (101) for an iron and said golf club head (1) for a wood have momental ellipsoids (10, 110),
face planes (11, 111) of said golf club head (101) for an iron and said golf club head (1) for a wood are so formed that, assuming that triple principal axes of said momental ellipsoids (10, 110) orthogonal to each other at the origins are axes I_1, axes I_2 and axes I_3 in order of larger moments of inertia about said principal axes in said golf club head (101) for an iron and said golf club head (1) for a wood, the ratios (A/B) of sectional areas A at the time of cutting said momental ellipsoids (10, 110) along planes passing through said origins and parallel to said face planes (11, 111) and sectional areas B at the time of cutting said momental ellipsoids along planes including said axes I_1 and said axes I_2 are at least 1 and not more than 1.4,
the values of the ratios of said sectional areas A and said sectional areas B are not more than D + 0.1 at the maximum and at least D - 0.1 at the minimum with respect to a prescribed value D as to said plurality of golf club heads (1) for woods, and
the values of the ratios of said sectional areas A and said sectional areas B are not more than E + 0.1 at the maximum and at least E - 0.1 at the minimum with respect to a prescribed value E different from said prescribed value D as to said plurality of golf club heads (101) for irons.

FIG.1A

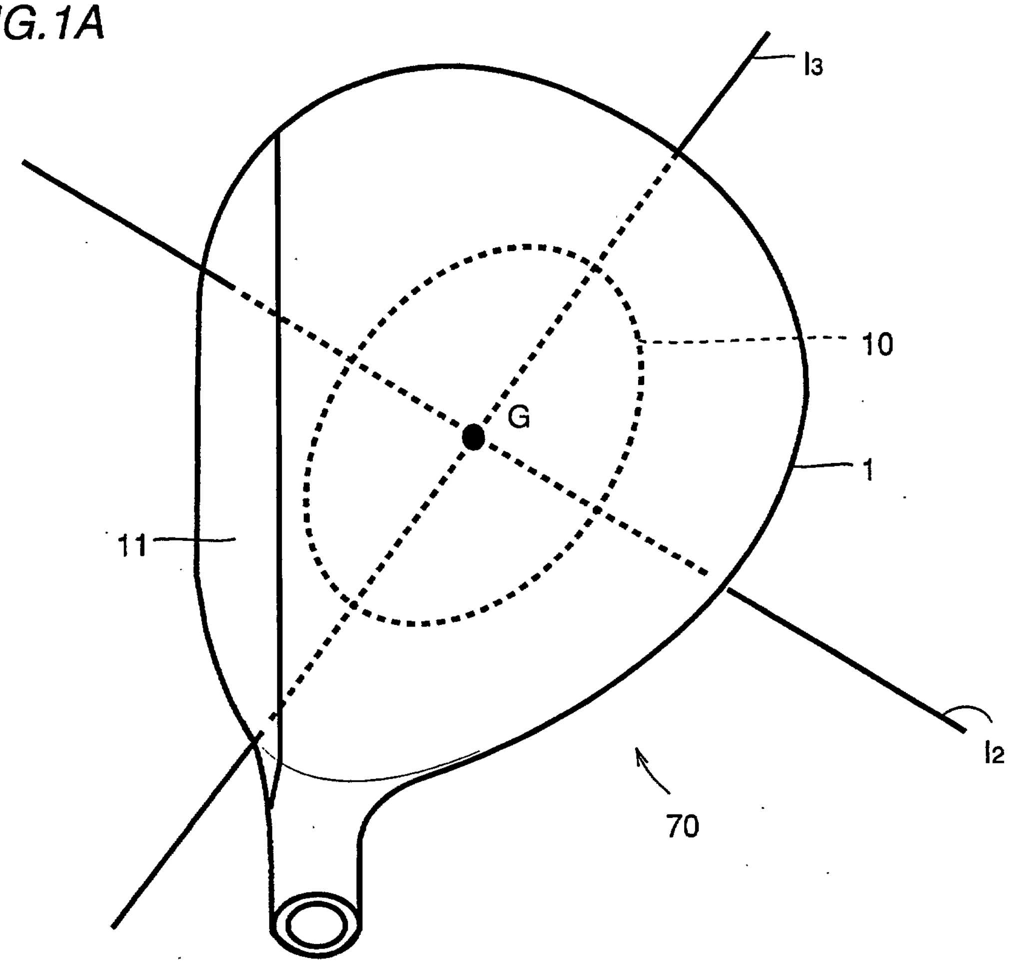


FIG.1B

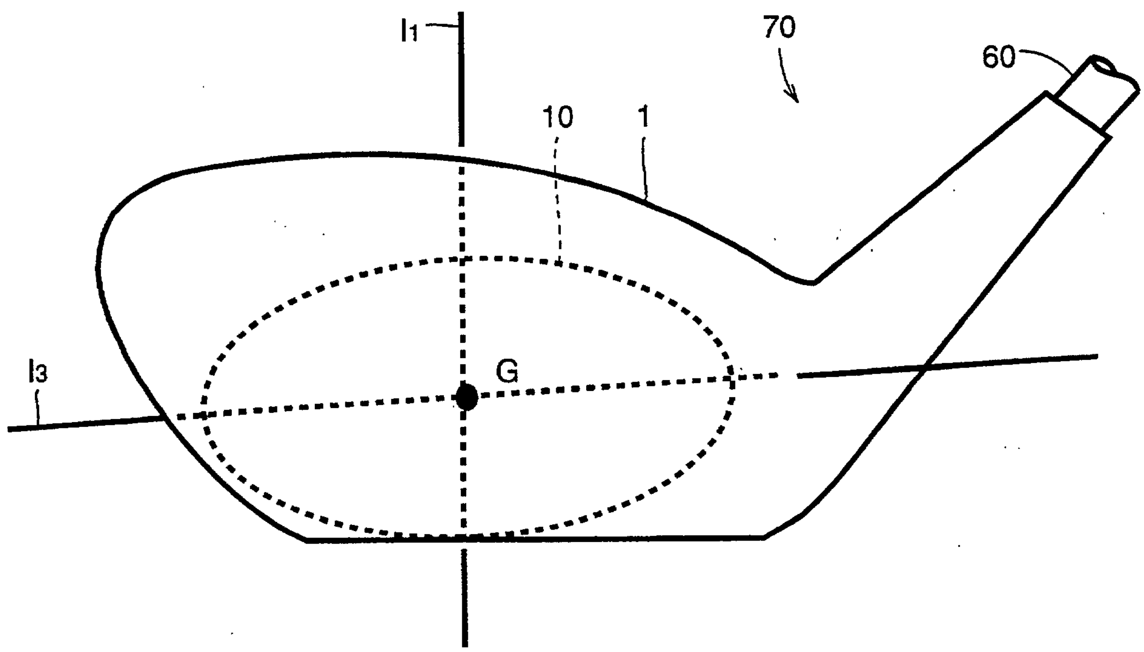


FIG.2

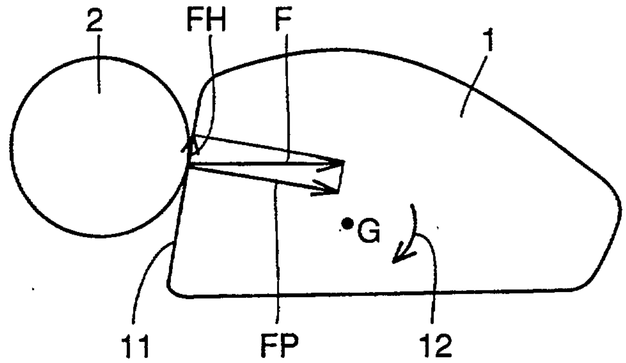


FIG.3

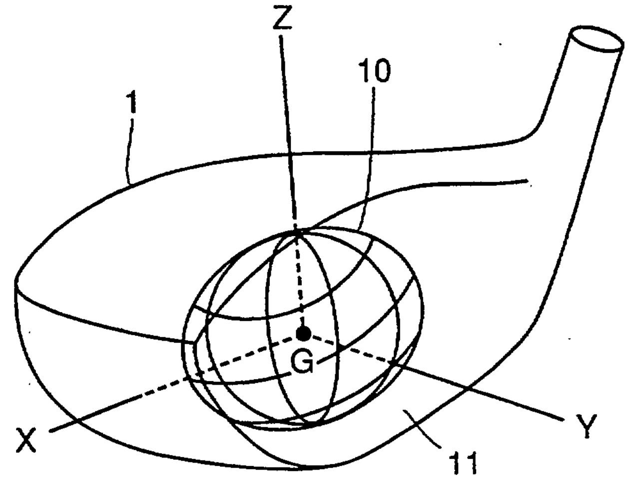


FIG.4

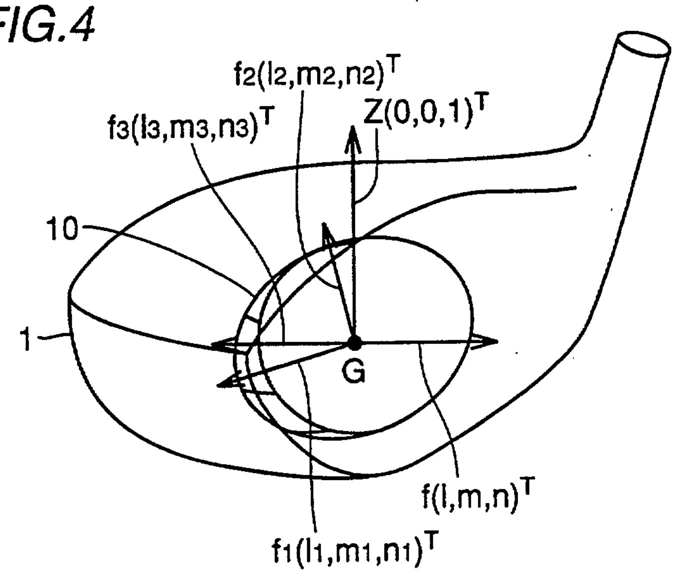

f2(l2,m2,n2)T
f3(l3,m3,n3)T
Z(0,0,1)T
10
1
G
f(l,m,n)T
f1(l1,m1,n1)T

FIG.5

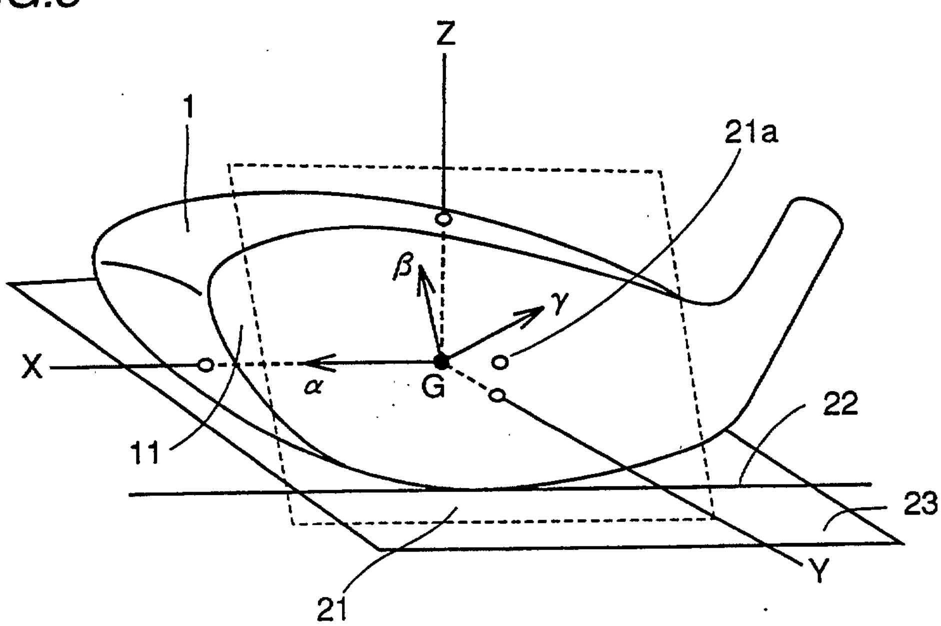

Z
1
21a
β
γ
X
α
G
11
22
23
Y
21

FIG.6

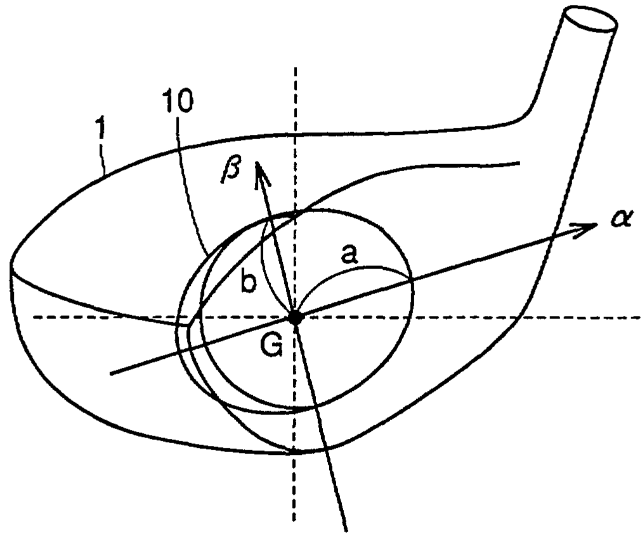


FIG.7

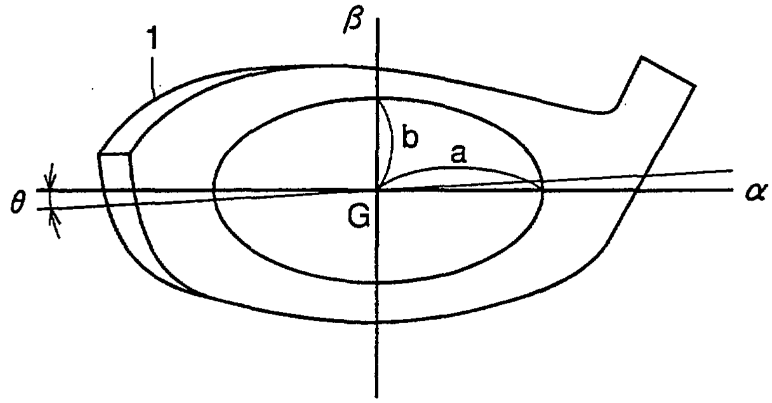


FIG.8

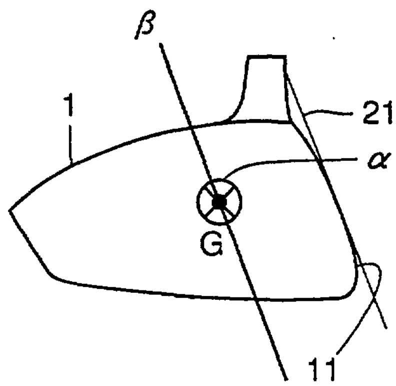
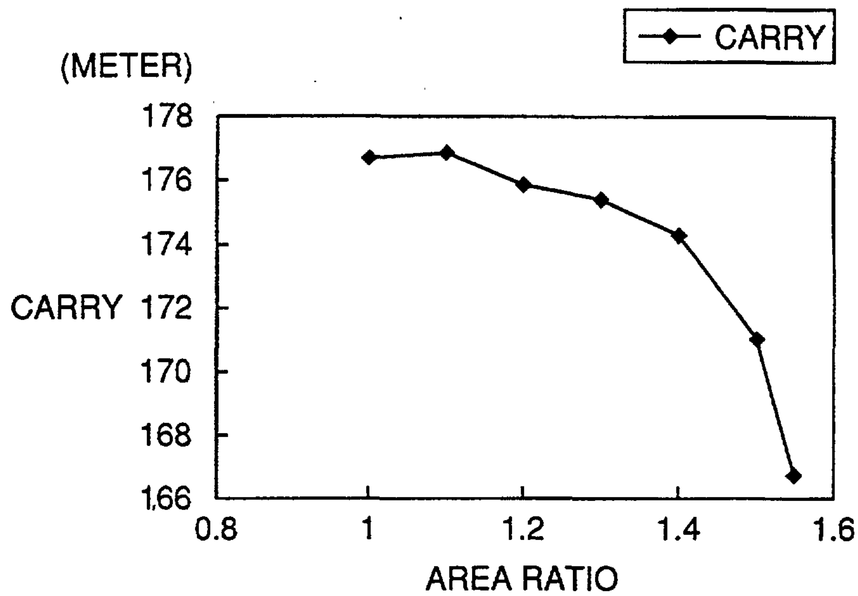


FIG.9


CARRY
(METER)
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176
174
CARRY 172
170
168
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0.8
1
1.2
1.4
1.6
AREA RATIO

FIG.10

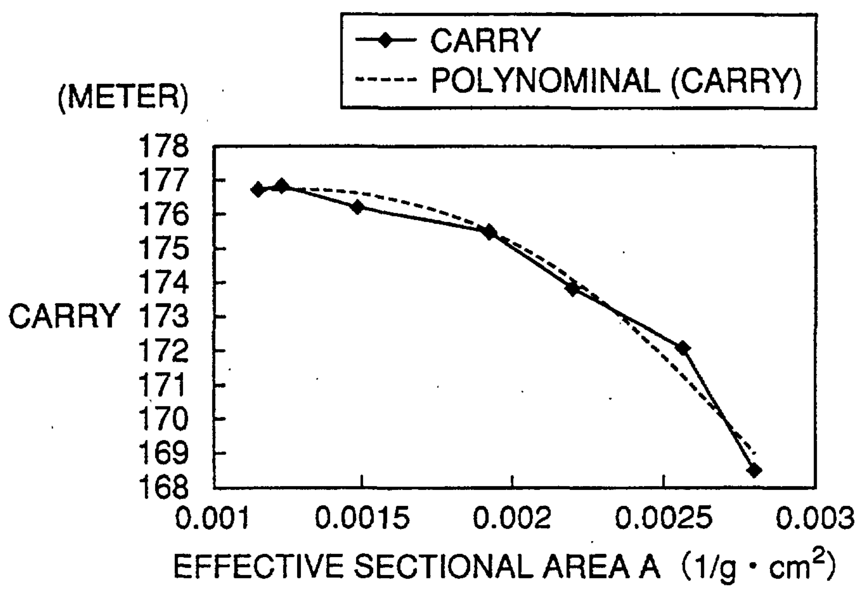

CARRY
POLYNOMINAL (CARRY)
(METER)
178
177
176
175
174
CARRY 173
172
171
170
169
168
0.001
0.0015
0.002
0.0025
0.003
EFFECTIVE SECTIONAL AREA A (1/g · cm2)

FIG.11

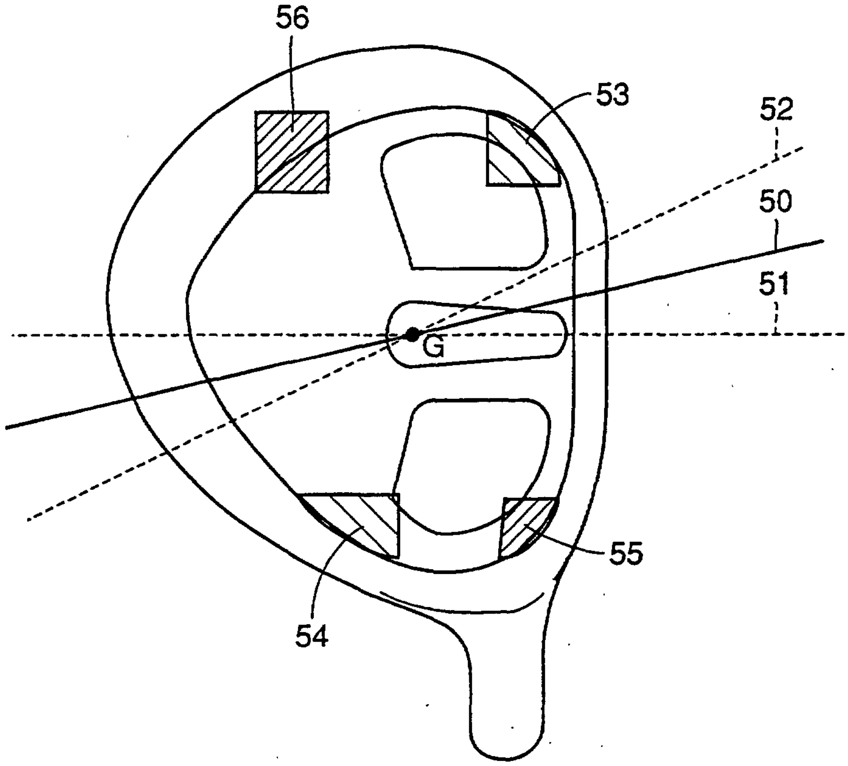
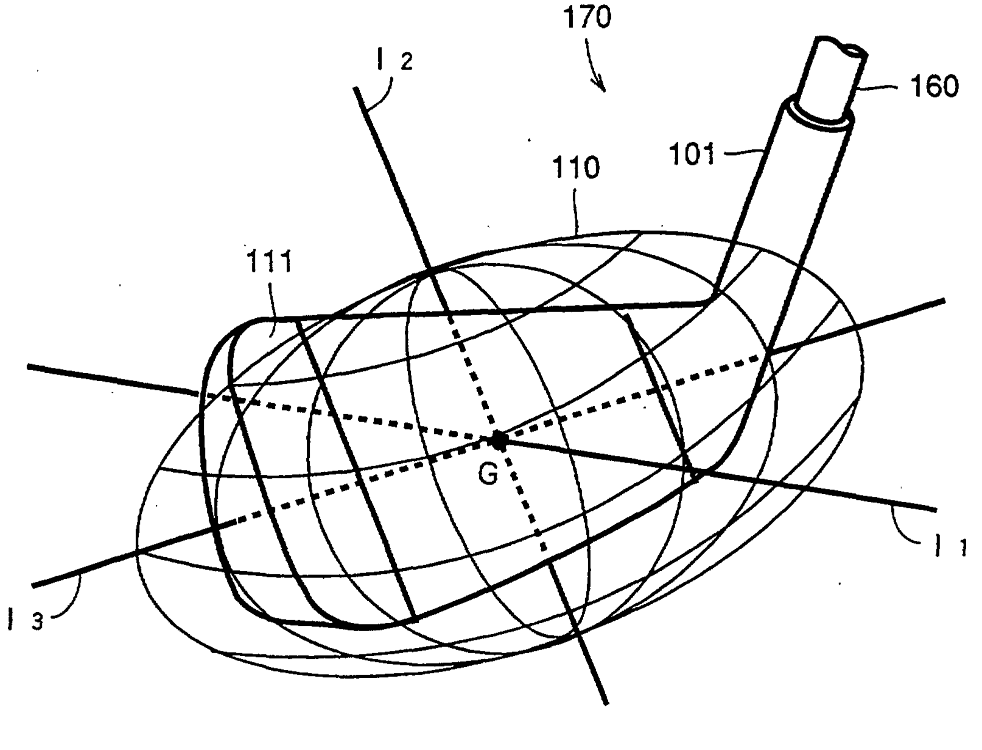


FIG.12



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP00/03335

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] A63B53/04, 53/00

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)
Int.Cl[7] A63B53/00-53/16

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

Jitsuyo Shinan Koho	1922-1996	Toroku Jitsuyo Shinan Koho	1994-2000
Kokai Jitsuyo Shinan Koho	1971-2000	Jitsuyo Shinan Toroku Koho	1996-2000

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.
A	US, 5836830, A (Sumitomo Rubber Industries,Ltd.), 17 November, 1998 (17.11.98), Full text; Figs. 1 to 16 & JP, 9-149954, A	1-15
A	JP, 5-57035, A (Maruman Golf Corporaion), 09 March, 1993 (09.03.93), Full text; Figs. 1 to 4 (Family: none)	1-15
A	US, 5366223, A (Frank D.Werner), 22 November, 1994 (22.11.94), Full text; Figs. 1 to 10 & JP, 7-124275, A	1-15
A	JP, 2542523, B2 (Yamaha Corporation), 09 October, 1996 (09.10.96), Full text; Figs. 1 to 5 (Family: none)	1-15

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

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 August, 2000 (17.08.00)	05 September, 2000 (05.09.00)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)