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(54) GOLF CLUB

(76) Inventors: Hiroto Setokawa, Kobe-shi (JP); Masayuki Kato, Kobe-shi (JP)

Correspondence Address:
BIRCH STEWART KOLASCH & BIRCH
PO BOX 747
FALLS CHURCH, VA 22040-0747 (US)

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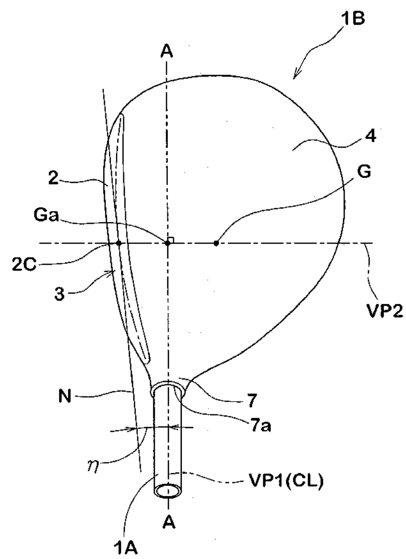
(57) ABSTRACT

A golf club comprises a club shaft and a club head attached to the end of the club shaft, the club head volume is not less than 280 cc, the club head comprises a face portion which has, at least partially, a Young's modulus E of from 30 to 110 GPa, and the club shaft has a kick point index of not less than 50, wherein kick point index={inverse flexure/(inverse flexure+normal flexure)}×100.



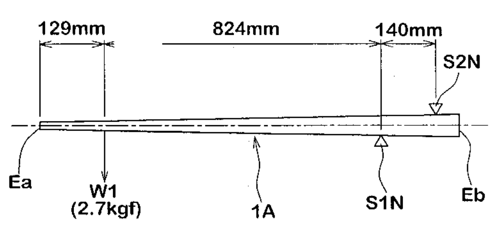


Fig.1

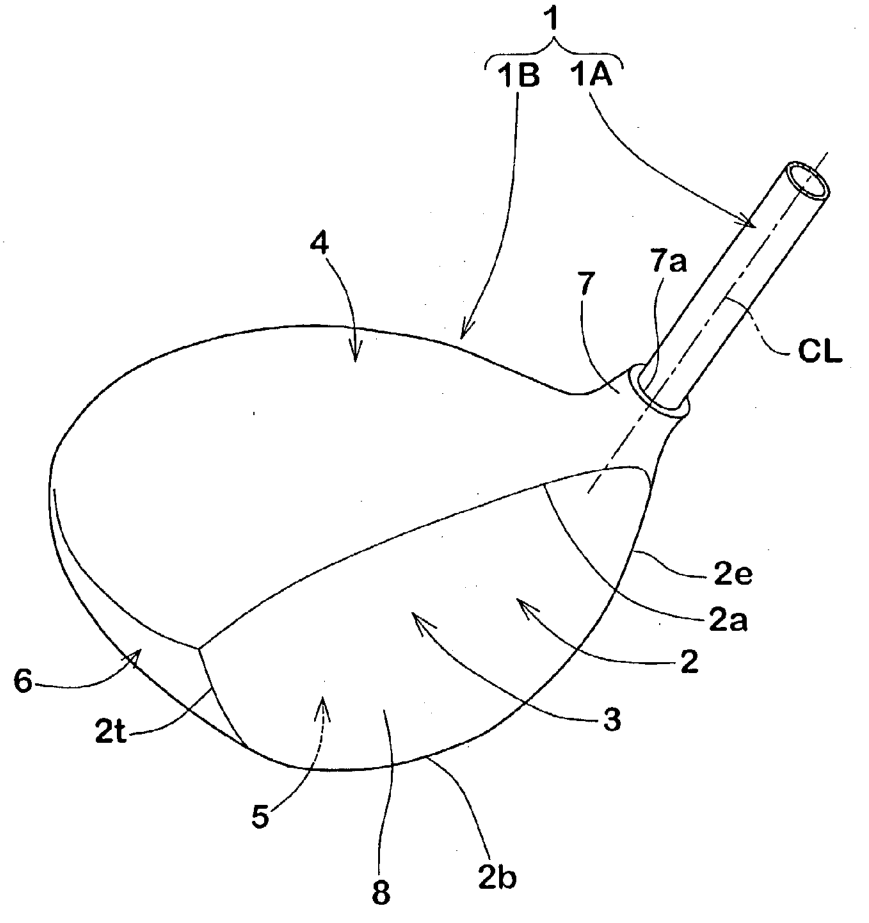


Fig.2

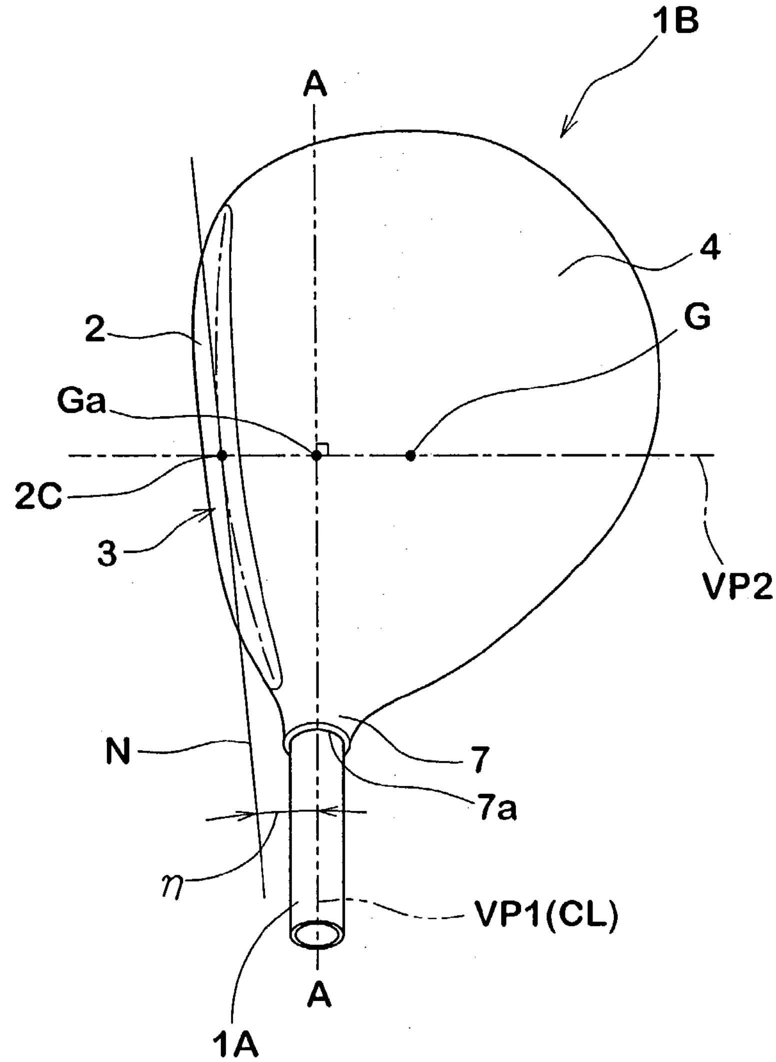


Fig.3

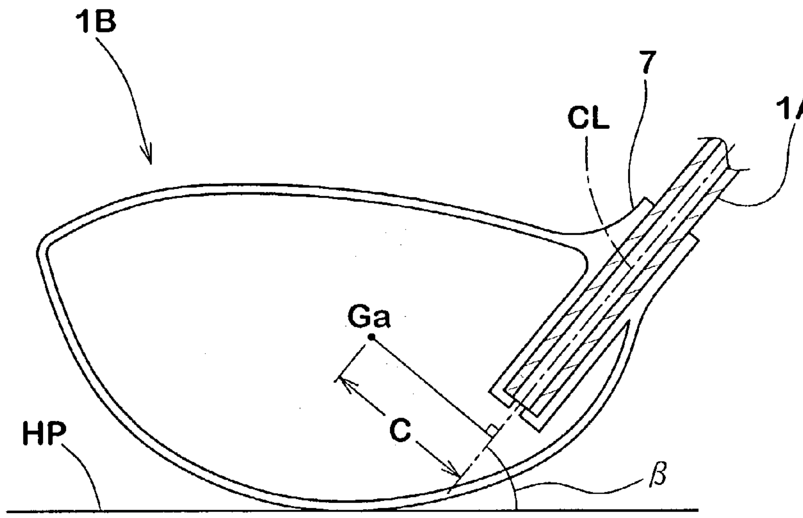


Fig.4

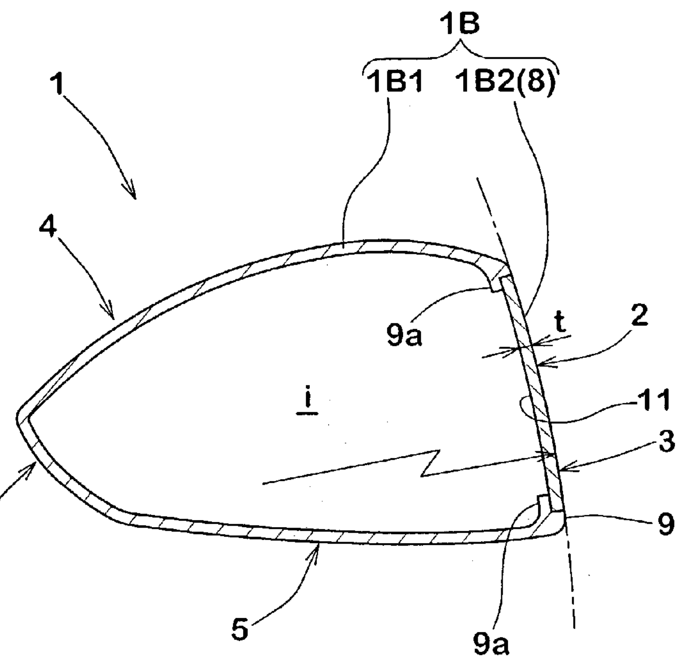


Fig.5

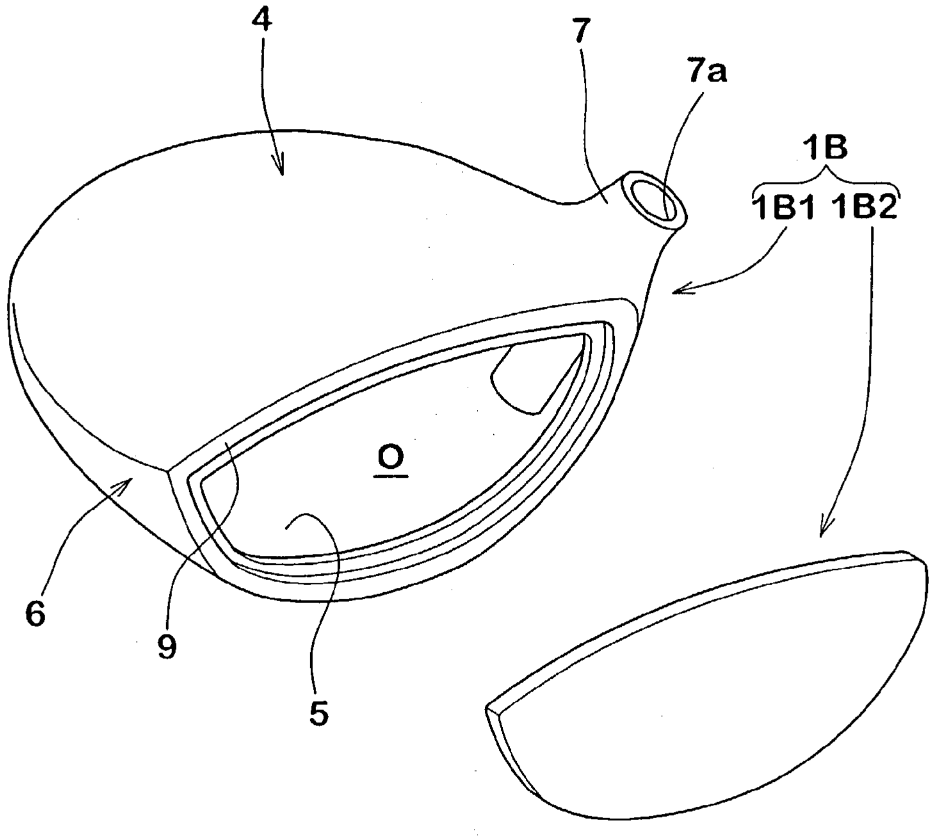


Fig.6(a)

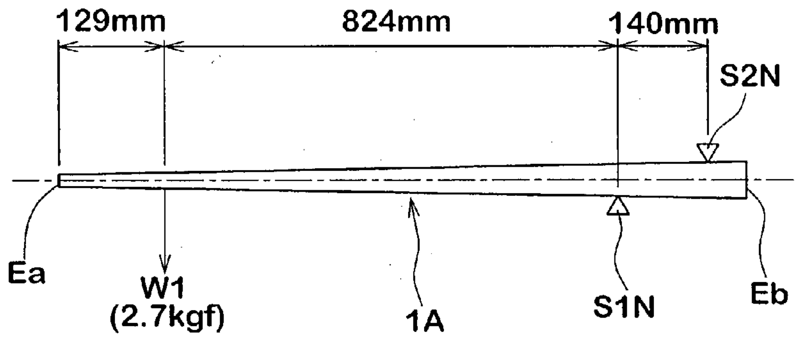

129mm
824mm
140mm
S2N
Ea
W1
(2.7kgf)
1A
S1N
Eb

Fig.6(b)

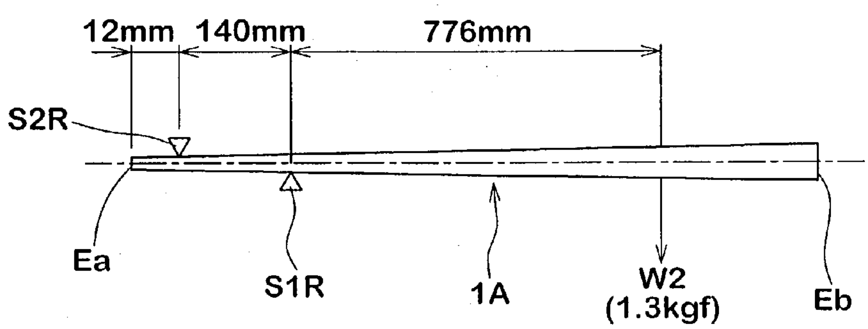

12mm
140mm
776mm
S2R
Ea
S1R
1A
W2
(1.3kgf)
Eb

Fig.7

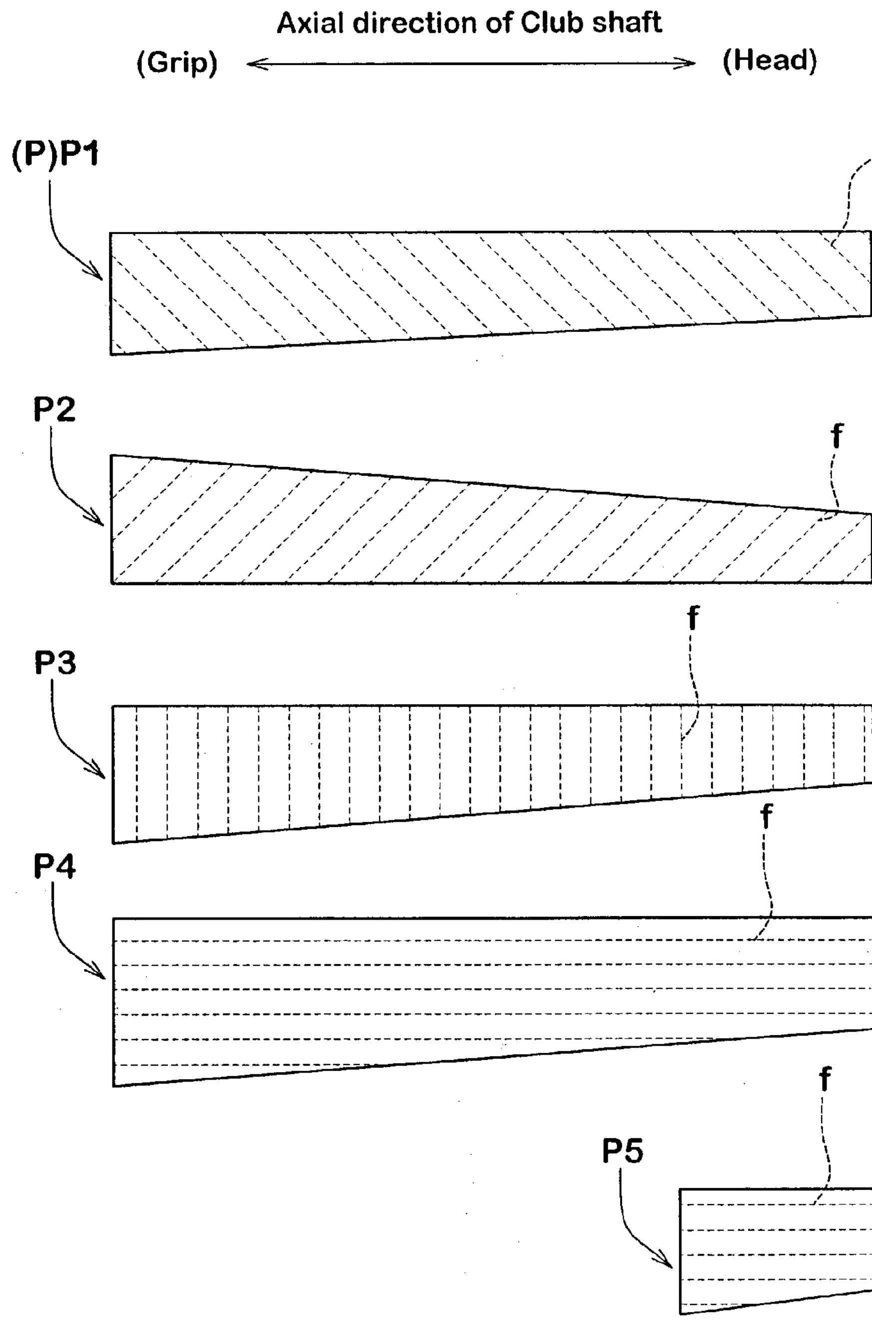


Fig.8

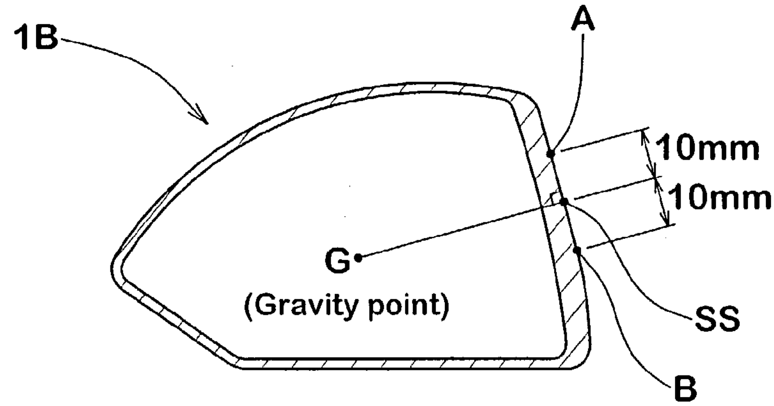


Fig.9

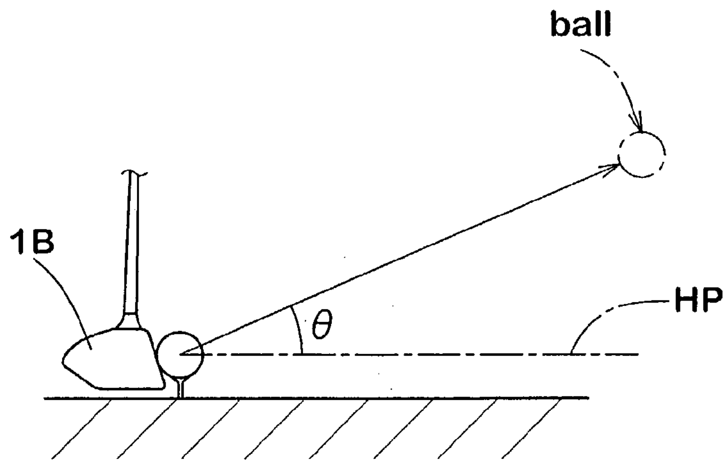


Fig.10

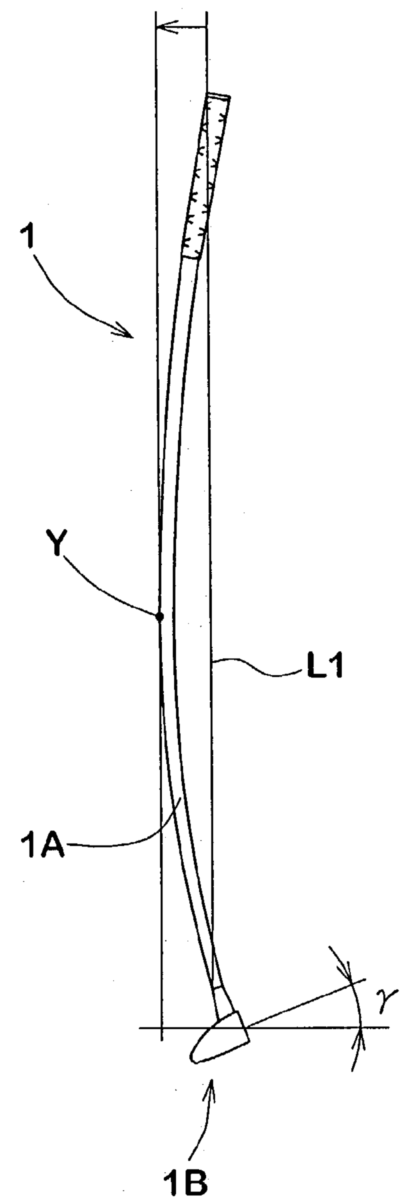
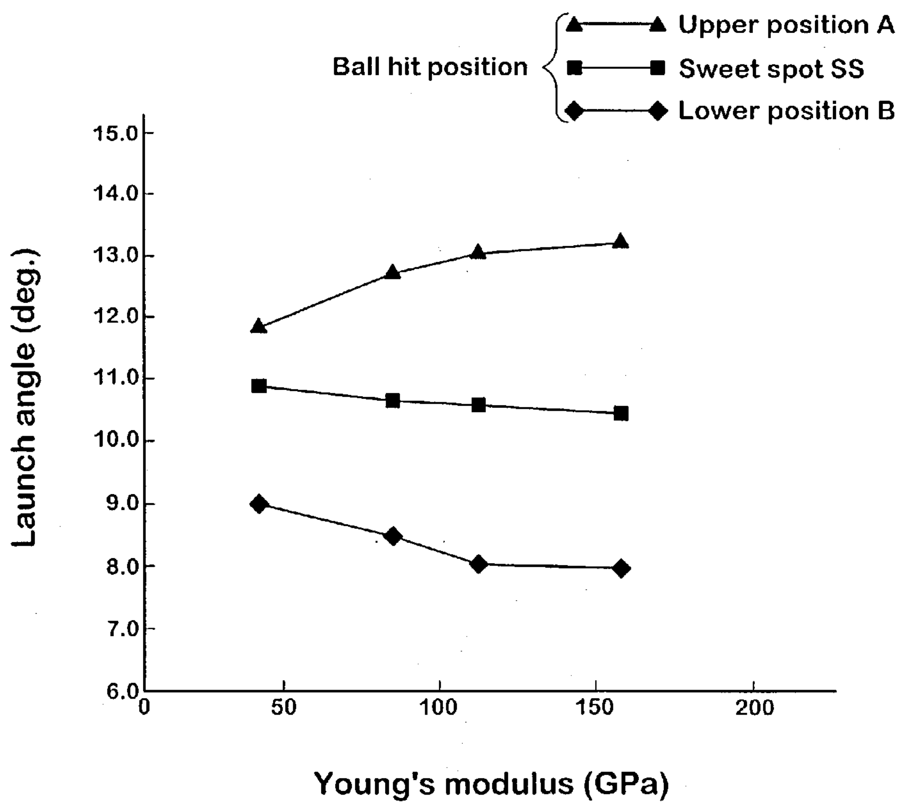


Fig.11


Ball hit position
Upper position A
Sweet spot SS
Lower position B
Launch angle (deg.)
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
0
50
100
150
200
Young's modulus (GPa)

GOLF CLUB

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a golf club whose head has a low Young's modulus face portion, more particularly to a club shaft having a specific bending property optimized for such a low modulus head to increase the traveling distance of a struck ball.

[0002] In order to increase the traveling distance (carry+run) of the struck ball, use of a metal material having a low Young's modulus in the face portion of the club head is disclosed in the published international application No.WO98/46312. This is intended that, by setting the mechanical impedance of the face portion close to or nearly equal to that of golf balls, the impact energy transferred from the club head to the struck ball is maximized, and the club head is improved in the rebound performance. This technique is nowadays widely used in wood-type club heads.

[0003] In such wood-type club heads, there is a tendency to increase the head volume in order to make the sweet spot area wider, and club heads over 280 cc are widely used in recent years.

[0004] In case of a large-sized club head whose face portion has a low Young's modulus, when the ball hitting position is above the sweet spot, there is a tendency for the ball launch angle to become smaller as the Young's modulus of the face portion becomes lower although the launch angle is almost constant or slightly increased when the ball hitting position is on or under the sweet spot. **FIG. 11** shows such typical variations of the launch angle. As shown in this graph, in case of a low Young's modulus face, even if the ball hits upper position, the launch angle is not increased and the traveling distance of the ball can not be increased.

SUMMARY OF THE INVENTION

[0005] It is therefore, an object of the present invention to provide a golf club, in which the launch angle of the ball when hit upper position is increased in spite of the club face having a low Young's modulus, and the traveling distance of the ball can be improved.

[0006] According to the present invention, a golf club comprises a club shaft and a club head attached to the end of the club shaft, the club head having a club head volume of not less than 280 cc and comprising a face portion which has a Young's modulus E of from 30 to 110 GPa at least partially, and the club shaft having a kick point index of not less than 50, wherein

> [0007] Kick point index={inverse flexure/(inverse flexure+normal flexure)}×100 wherein,
>
> [0008] the normal flexure is the flexure of the club shaft measured as the displacement of a loading point in the vertical direction when the club shaft is horizontally supported at two points S1N abd S2N which are a first point S1N at a distance of 953 mm for supporting the under side and a second point S2N at a distance of 1093 mm for supporting the upper side, each distance measured from the end of the club shaft towards the opposite end of the club shaft, and the club shaft is loaded downward with 2.7 kgf at the loading point spaced apart from the end of the club shaft towards the opposite end by 129 mm, and
>
> [0009] the inverse flexure is the flexure of the club shaft measured as the displacement of a loading point in the vertical direction when the club shaft is horizontally supported at two points S1R and S2R which are a first point S1R at a distance of 152 mm for supporting the under side and a second point S2R at a distance of 12 mm for supporting the upper side, each distance measured from the end the club shaft towards the opposite end of the club shaft, and the club shaft is loaded downward with 1.3 kgf at the loading point spaced apart from the end of the club shaft towards the opposite end by 928 mm.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] **FIG. 1** is a perspective partial view of a golf club according to the present invention showing the club head and the end of the club shaft.

[0011] **FIG. 2** is a top view of the golf club head in the undermentioned measuring state.

[0012] **FIG. 3** is a cross sectional view of the club head taken along a line A-A (vertical plane VP1) in **FIG. 2**.

[0013] **FIG. 4** is a cross sectional view of the club head taken along vertical plane VP2 in **FIG. 2**.

[0014] **FIG. 5** is an exploded perspective view of the club head showing an example of two-piece head structure.

[0015] **FIG. 6**(*a*) and **FIG. 6**(*b*) are side views of a club shaft for explaining the definition and method of measuring the "kick point index" of the club shaft, wherein **FIG. 6**(*a*) shows the supporting positions and a loading position for measuring the normal flexure of the club shaft, and **FIG. 6**(*b*) shows those for the inverse flexure.

[0016] **FIG. 7** shows an exemplary set of prepreg pieces used to make the club shaft in this embodiment.

[0017] **FIG. 8** is a schematic cross sectional view similar to **FIG. 4** for explaining an upper hitting position A and a lower hitting position B which are 10 mm above and 10 mm under the sweet spot SS, respectively.

[0018] **FIG. 9** is a diagram for explaining the launch angle θ of the golf ball.

[0019] **FIG. 10** is a view for explaining the effect of setting the "kick point index" in the specific range with exaggeration.

[0020] **FIG. 11** is a graph showing the launch angle as a function of the Young's modulus of the face portion.

DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0021] Embodiment of the present invention will now be described in detail in conjunction with the accompanying drawings.

[0022] In the drawings, golf club **1** according to the present invention is a wood-type metal club comprising a shaft **1A**, a head **1B** attached to the end Ea of the shaft **1A**, and a grip on the opposite side of the head **1B**.

[0023] In this embodiment, the club **1** is a #1 driver.

[**0024**] The club head 1B comprises a face portion **3** of which front face defining a club face **2** for hitting a ball, a crown portion **4** of which top face intersects the club face **2** at the upper edge **2***a* thereof, a sole portion **5** of which bottom face intersects the club face **2** at the lower edge **2***b* thereof, a side portion **6** between the crown portion **4** and sole portion **5**, extending from the toe-side edge **2***t* to the heel-side edge **2***e* of the club face **2** through the back face of the club head, and a hosel portion **7** having a club shaft inserting hole **7***a* and attached to the end of the club shaft 1A.

[**0025**] As shown in **FIG. 5**, the club head **1B** in this example is composed of a hollow main body **1B1** having an opening O at the front thereof, and a face plate **1B2** attached to the head main body **1B1** so as to close the opening O. Therefore, a closed cavity (i) is formed therein and the back face of the face portion **3** faces the cavity or hollow. Thus, there is no substantial support for the back face **11**.

[**0026**] The head main body **1B1** in this example is made up of the above-mentioned crown portion **4**, sole portion **5**, side portion **6**, hosel portion **7** and further a part **9** which surrounds the opening O, forming an annular narrow peripheral part of the club face **2**. The head main body **1B1** is formed by lost-wax precision casting as an integral molding of an alpha-beta-type titanium alloy Ti-6Al-4V.

[**0027**] The face plate **1B2** is accommodated to the opening O and forms major part of the face portion **2** which part includes the sweet spot SS or the centroid of the club face **2**. In this embodiment, the face plate **1B2** forms a high-resilience part **8** of the face portion **2**.

[**0028**] The high-resilience part **8** is defined as having a Young's modulus E of not more than 110 GPa, preferably not more than 100 GPa, more preferably not more than 90 GPa, still preferably not more than 80 GPa, yet still preferably not more than 70 GPa, but not less than 30 GPa, preferably not less than 40 GPa, more preferably not less than 50 GPa, still more preferably not less than 60 GPa. Such high-resilience part **8** may improve the transfer of impact energy from the head to the struck ball to increase the traveling distance of the ball. If the Young's modulus E increases over 110 GPa, the impedance difference from a golf ball is increased and it becomes difficult to improve the impact energy transfer. If the Young's modulus E decreases under 30 GPa, it is difficult to obtain necessary durability for the face plate.

[**0029**] As to the material for the face plate **1B2** having such Young's modulus E, various metal materials may be used, but amorphous alloys and titanium alloys are preferably used. In case of amorphous alloys, for example, amorphous Zr-based alloys are preferably used. In case of crystalloid metals, Ti-Zr-base alloys are preferably used.

[**0030**] If the face plate **1B2** is too thick, the rigidity of the face portion **2** excessively increases and it becomes difficult to increase the traveling distance. If too thin, it is difficult to obtain necessary strength and durability. Therefore, it is preferable that the thickness (t) of the face plate **1B2** is set in the range of not less than 1.0 mm, more preferably not less than 1.5 mm, still more preferably not less than 2.0 mm, but not more than 3.0 mm, more preferably not more than 2.8 mm, still more preferably not more than 2.5 mm.

[**0031**] In this embodiment, further, the product (t·E) of the Young's modulus E (GPa) and the thickness t (mm) of the high-resilience part **8** is set in a specific range.

[**0032**] If the product (t·E) is less than 80 GPa·mm, the durability of the high-resilience part **8** is liable to become insufficient.

[**0033**] If the product (t·E) is more than 240 GPa·mm, the face portion **3** becomes rigid and it is difficult to increase the traveling distance of the struck ball.

[**0034**] Therefore, the product (t·E) is set in a range of not less than 80 GPa·mm, more preferably not less than 90 GPa·mm, still more preferably not less than 100 GPa·mm, but not more than 240 GPa·mm, more preferably not more than 230 GPa·mm, still more preferably not more than 220 GPa·mm, yet still more preferably not more than 200 GPa·mm.

[**0035**] As to the material for the main body **1B1** of the head, on the other hand, various metal materials may be used, for example, aluminum alloys, pure titanium, titanium alloys, stainless steel and the like, but titanium alloys having a relatively large specific gravity are suitably used. But, it may be also possible to make the main body **1B1** out of a fiber reinforced resin and the like. Further, it is also possible to make the club head as a whole out of a metal material having the above-mentioned low Young's modulus.

[**0036**] As shown in **FIG. 4** and **FIG. 5**, the face portion **2** in this example is provided around the opening O with a supporting part **9***a* for a peripheral part of the backside **11** of the face plate **1B2**. The supporting part **9***a* is formed continuously along the edge of the opening O in this example, but it may be formed discontinuously. In any case, not to hinder a large deflection of the face plate **1B2** when hit by a ball, the total contacting area Sa of the supporting part **9***a* with the backside **11** of the face plate **1B2** is preferably set in a range of from 2 to 20%, more preferably 2 to 10%, still more preferably 2 to 5% of the total area S of the club face **2** (namely, not the back face. This is intended to eliminate the variation of the apparent area caused by possible irregularity of the back face.)

[**0037**] Thus, it is not always necessary to provide the supporting part **9***a* as far as the face plate can be fixed to the main body stably and durably. The face plate **1B2** and the head main body **1B1** can be fixed to each other by means of welding, adhesive agent, caulking, press fitting or the like depending on the materials used.

[**0038**] The club head **1B** in this embodiment is, as explained above, a large-sized wood-type head and the head volume thereof is in the range of not less than 280 cc, preferably not less than 300 cc, more preferably not less than 320 cc, still more preferably not less than 340 cc, yet still more preferably not less than 350 cc, but preferably not more than 450 cc, more preferably not more than 420 cc. Incidentally, the head volume is the apparent volume including the hollow (i), shaft inserting hole and the like. If the head volume is less than 280 cc, it becomes difficult to improve the rebound performance, and the handling may be deteriorated. If the head volume is more than 450 cc, it becomes difficult to prevent the weight of the club head from increasing while maintaining the necessary durability. Incidentally, it is possible to leave the above-mentioned cavity (i) void, but it is also possible to provide a filler made of a material such as foamed plastic, foamed rubber and elastomers, which substantially does not alter the rigidity of the face portion. Further, it is also possible to dispose a separate weight in the head to adjust the gravity point and the like of the head.

[0039] According to the present invention, the club shaft **1A** is formed to have a specific kick point index.

[0040] First, as shown in **FIG. 6**(*a*), a club shaft **1A** alone is horizontally supported at two points **S1N** and **S2N** which are a first point **S1N** at a distance of 953 mm(=129 mm+824 mm) for supporting the under side of the shaft and a second point **S2N** at a distance of 1093 mm(=129 mm+824 mm+140 mm) for supporting the upper side of the shaft, each distance measured from the end Ea (club head side) towards the opposite end Eb (grip side) of the club shaft. Then, the club shaft **1A** is loaded downward with 2.7 kgf (26.5 N) for example by hanging a weight **W1** of 2.7 kg, wherein the loading point is spaced apart from the end Ea towards the opposite end Eb by 129 mm. And the flexure of the club shaft **1A** (or the "normal flexure") is measured as the displacement in mm of the loading point in the vertical direction.

[0041] Next, as shown in **FIG. 6**(*b*), the club shaft **1A** alone is horizontally supported at different two points **S1R** and **S2R** which are a first point **S1R** at a distance of 152 mm (=12 mm+140 mm) for supporting the under side and a second point **S2R** at a distance of 12 mm for supporting the upper side, each distance measured from the end Ea towards the opposite end Eb of the club shaft. Then, the club shaft **1A** is loaded downward with 1.3 kgf (12.7 N) for example by hanging a weight **W2** of 1.3 kg, wherein the loading point is spaced apart from the end Ea towards the opposite end Eb by 928 mm(=12 mm+140 mm+776 mm). And the flexure of the club shaft **1A** (or the "inverse flexure") is measured as the displacement in mm of the loading point in the vertical direction.

[0042] Based on the normal flexure and inverse flexure measured, a kick point index is found by using the following equation:

[0043] Kick point index={inverse flexure/(inverse flexure+normal flexure)}×100.

[0044] If the kick point index is less than 50, it is difficult to increase the launch angle of the struck ball when hitting at upper positions of the sweet spot.

[0045] On the other hand, if the kick point index is more than 56, the loft angle of the club head becomes excessively increased at the time of impact, and even when hitting at the sweet spot SS, the launch angle is excessively increased and the carry distance is liable to be lost due to the heightened trajectory. Therefore, the kick point index is set in a range of not less than 50, preferably not less than 51, more preferably not less than 52, still more preferably not less than 53, but preferably not more than 56, more preferably not more than 55, still more preferably not more than 54. By setting the kick point index within this narrow specific range, it becomes possible to increase the launch angle of the struck ball when hitting at upper positions while preventing an excessive increase of the launch angle when hitting at the sweet spot SS.

[0046] In this embodiment, the club shaft is a tubular lamination of prepreg P. Thus, the kick point index can be set in the above-mentioned range by arranging the positions, sizes, shape, orientations of reinforcing fibers of the prepreg pieces and the like in spite of some trial and error steps.

[0047] The prepreg P used in this example is made of reinforcing fibers (f) oriented in one direction and thermosetting resin penetrating therethrough. For the reinforcing fibers (f), for example, carbon fibers, glass fibers, aramid fibers, metal fibers such as boron, titanium, tungsten, stainless steel, copper and alumina and the like can be used alone or in combination. For the thermosetting resin, epoxy resin, unsaturated polyester resin, phenol resin, vinylester resin and the like can be used alone or in combination.

[0048] A sheet of prepreg P is cut into a plurality of pieces having specific shapes associating with the fiber orient direction.

[0049] **FIG. 7** shows an exemplary set of prepreg pieces **P1**, **P2**, **P3**, **P4** and **P5** used to make the club shaft **1A** in this embodiment. The first, second, third and fourth major prepreg pieces **P1** to **P4** each extend along the entire length of the club shaft **1A**, but a small prepreg piece **P5** which is used in a specific position for example at the tip of the club shaft **1A** as the outermost layer is shorter than the shaft length. Each of the major prepreg pieces **P1** to **P4** is a rectangle or trapezoid. In this embodiment, as the shaft **1A** to be made is tapered towards the shaft end Ea, a trapezoid which tapers towards the shaft end Ea is used.

[0050] As shown in **FIG. 7**, the orient directions of the reinforcing fibers (f) in the respective prepreg pieces **P1**-**P5** are as follows: in the first prepreg piece **P1**, 40 to 50 degrees (in this example substantially 45 degrees); in the second prepreg pieces **P2**, 40 to 50 degrees, and the same as **P1** (in this example, thus substantially 45 degrees), but reverse to the first major prepreg pieces **P1**; in the third prepreg pieces **P3**, substantially 90 degrees; in the fourth prepreg pieces **P4**, substantially 0 degree; and in the fifth small prepreg **P5**, substantially 0 degree, each referred with respect to the direction of the axis of the club shaft.

[0051] The prepreg pieces **P1** to **P5** are wound around a mandrel (shaping core) from **P1** to **P5**. As to the first, second and third major prepreg pieces **P1** to **P3**, only one piece is used for each. However, as to the fourth major prepreg pieces **P4**, two or more pieces, preferably three or four pieces are used. As to the auxiliary prepreg **P5**, again one piece is used.

[0052] Then, the tubular lamination is put in a casting mold. The mandrel is pulled out of the tubular lamination, and in turn an inflatable bladder is put therein. The bladder is inflated while applying heat to the prepreg to press the outside of the tubular lamination to the inside surface of the casting mold. After the thermosetting resin is cured by the applied heat, the bladder is pull out and the lamination is took out from the mold. Thus, the kick point index of the club shaft **1A** can be adjusted by changing one or more factors such as the number, shapes, sizes of prepreg pieces, the elastic modulus of the reinforcing fibers and the like, more specifically for example, increasing the number of laminate layers in the shaft end portion, increasing the reinforcing fibers oriented in the axial direction of the shaft, increasing the elastic modulus of the reinforcing fibers, and the like.

[0053] As to the method of making the club shaft, aside from the above-described method to laminate a plurality of prepreg pieces P using a mandrel, it is also possible to employ a "tape wrapping method" to spirally winding a long prepreg tape around a mandrel, a "filament winding method" to coil a reinforcing filament around a mandrel while applying a resin, and the like.

[0054] In view of the head speed, a longer shaft is preferred. But, if the club shaft **1A** is too long, it becomes difficult for the user to set the club face **2** properly at the time of impact. Therefore, the length of the club shaft **1A** is preferably set in a range of not more than 48 inches, more preferably not more than 47 inches, but not less than 42 inches, more preferably not less than 43 inches.

[0055] In case of a combination of a club head having a large head volume and a relatively long club shaft, if the gravity point distance C is too long, deformation of the club shaft under torsion around its axis during swing increases and the directions of the struck balls are liable to be disturbed. If the gravity point distance C is too short, rebound performance is liable to decrease. Therefore, the gravity point distance C is set in a range of not less than 26 mm, preferably not less than 28 mm, more preferably not less than 30 mm, but not more than 40 mm, preferably not more than 38 mm, more preferably not more than 36 mm, still more preferably not more than 34 mm.

[0056] To give the definition of the gravity point distance C, a measuring state of the club head **1** is explained first. The measuring state is, as shown in **FIG. 2** and **FIG. 3**, such that the club head **1** is put on a horizontal plane HP such that the axis CL of the club shaft **1A** inclines at the predetermined lie angle β within a vertical plane **VP1**, and an angle between the above-mentioned vertical plane **VP1** and a horizontal tangential line N to the centroid **2C** of the club face **2** becomes the predetermined face angle η. In the measuring state, the gravity point G of the club head projected on the vertical plane **VP1** normally to the vertical plane **VP1** is called "projected gravity point Ga". The above-mentioned gravity point distance C is defined as the minimum distance of the projected gravity point Ga from the axis CL of the club shaft **1A**.

[0057] Comparison Tests

[0058] 350 cc wood-type heads and 45-inche shafts were made and number one (#1) drivers were assembled.

[0059] The club heads had the basic structure shown in **FIG. 1** to **FIG. 5**, and the gravity point was adjusted by adding weight to a suitable position such as the rear of the side portion, the hosel portion, the toe portion and the sole portion of the head main body. The club shafts were each made by laminating a plurality of prepreg pieces as explained above. The prepreg pieces used were basically the same as those shown in **FIG. 7** and the kick point index was adjusted by changing the winding position of the small prepreg pieces **P5** with respect to the axial direction of the shaft. The specifications are shown in Table 1. The following tests were conducted using those golf clubs.

[0060] Hitting test 1

[0061] Each of the golf clubs was attached to a swing robot and hit commercially available three-piece balls "HI-BRID" (Trademark of Sumitomo Rubber Industries, Ltd.) at the head speed of 40 m/sec. The launch angle θ, the initial ball speed and the traveling distance (carry+run) of the struck ball were measured. In each of the clubs, the hitting was made five times at the sweet spot SS of the club face and five times at an upper point 10 mm above the sweet spot. The average for the five time hitting is shown in table 1. Incidentally, the launch angle is, as shown in **FIG. 9**, the initial angle θ of the direction of the struck ball with respect to a horizontal plane.

[0062] Hitting test 2

[0063] Ten golfers whose handicaps ranged from 2 to 11 each hit golf balls ten times for each club, and the difference between the ground hitting point of the struck ball and the target ballistic line in the right or left direction was measured. The results are shown in Table 1 as the average for the ten golfers. Thus, the smaller the value, the better the directional stability.

TABLE 1

Club	Ref. 1	Ref. 2	Ref. 3	Ref. 4	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5
Club head									
Face plate	A	B	C	D	A	A	A	A	A
Material *1									
Young's modulus E (GPa)	69	98	118	196	69	69	69	69	69
Thickness t (mm)	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
EXt GPa · mm	193.2	274.4	330.4	548.8	193.2	193.2	193.2	193.2	193.2
Gravity point distance C (mm)	36	36	36	36	40	36	30	26	36
Club shaft									
Low kick point index	48	48	48	48	53	53	53	53	50
Test results									
Launch angle (deg.)									
Upper point	12.5	12.7	12.9	12.9	12.6	12.7	12.7	12.8	12.6
Sweet spot	11.0	10.7	10.5	10.5	11.1	11.2	11.2	11.3	11.1
Initial speed (m/s)									
Upper point	57.1	56.8	56.2	55.8	57.6	57.5	57.4	57.2	57.3
Sweet spot	58.7	58.3	57.9	57.4	59.3	59.0	58.9	57.3	58.9

TABLE 1-continued

Club	Ref. 1	Ref. 2	Ref. 3	Ref. 4	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5
Traveling distance (m) *2									
Upper point	240.3	237.8	235.8	233.1	244.5	244.3	244.1	243.9	242.3
*2	(103)	(102)	(101)	(100)	(105)	(105)	(105)	(105)	(104)
Sweet spot	236.6	234.5	228.2	224.5	236.9	236.8	236.3	236.4	236.9
*2	(105)	(104)	(102)	(100)	(106)	(105)	(105)	(105)	(106)
Difference from target (m)	11.3	10.9	10.6	10.2	9.5	7.9	4.9	3.2	7.4

*1 Face plate materials A: $Zr_{54}Al_{10}Cu_{30}Ni_5$ Hf_1, B: $Zr_{60}Al_{10}Cu_{20}Ni_{10}$, C: Ti-6Al-4V, D: SUS630 Main body material: Ti-6Al-4V
*2 The value in parenthesis is the index based on Ref. 4 being 100.

[0064] Focused attention on the test results on the sweet spot hitting, the initial speed and traveling distance were increased as the Young's modulus was decreased, which means that the rebound performance of the club head was improved. If focused attention on the test results on the upper point hitting, in case of Refs., the launch angle was decreased as the Young's modulus was decreased and as a result, the traveling distance was decreased. In Ex.1 and Ex.2, however, a decrease in the traveling distance was minimized even under the upper point hitting. In Ex.3 and Ex.4, as the gravity point distance was also optimized, the directional stability was also improved.

[0065] The reason for such improvement is considered as follows. By setting the kick point index as above, the bending of the club shaft at the time of impact is optimized. As shown in **FIG. 10** with exaggeration, the real loft angle γ is somewhat increased as compared to the design loft angle, and the increased loft angle compensates the decrease in the launch angle due to the decreased Young's modulus of the high-resilience part of the club face. Incidentally, as well known in the art, the term "kick point" refers to the highest point (Y) on a shaft which is being bent through application of force. In this instance, the direction of the applied force is the axial direction of the shaft, and the position of the application of force is the ends of the shaft. Thus, there is no direct relationship between the well known "kick point" and the "kick point index" in the present invention although both relate to bending of the shaft.

[0066] As described above, in the golf club according to the present invention, as the face portion has a low Young's modulus, the restitution coefficient thereof is improved to increase the traveling distance of the struck ball. Further, the club shaft has a specific kick point index. Therefore, even if the ball hitting position is off, especially above, the sweet spot, the launch angle is prevented from decreasing, and it becomes possible to increase the traveling distance.

[0067] The present invention is suitably applied to wood-type golf clubs, but it may be also applied to iron-type and utility-type golf clubs as far as the club face portion has a high-resilience part or low Young's modulus part facing a hollow on the backside thereof.

1. A golf club comprising

a club shaft and

a club head attached to the end of the club shaft,

the club head having a club head volume of not less than 280 cc and comprising a face portion which has, at least partially, a Young's modulus E of from 30 to 110 GPa,

the club shaft having a kick point index of not less than 50, wherein

kick point index={inverse flexure/(inverse flexure+normal flexure)}×100 wherein,

the normal flexure is the flexure of the club shaft measured as the displacement of a loading point in the vertical direction when the club shaft is horizontally supported at two points S1N abd S2N which are a first point S1N at a distance of 953 mm for supporting the under side and a second point S2N at a distance of 1093 mm for supporting the upper side, each distance measured from the end of the club shaft towards the opposite end of the club shaft, and the club shaft is loaded downward with 2.7 kgf at the loading point spaced apart from the end of the club shaft towards the opposite end by 129 mm,

the inverse flexure is the flexure of the club shaft measured as the displacement of a loading point in the vertical direction when the club shaft is horizontally supported at two points S1R and S2R which are a first point S1R at a distance of 152 mm for supporting the under side and a second point S2R at a distance of 12 mm for supporting the upper side, each distance measured from the end the club shaft towards the opposite end of the club shaft, and the club shaft is loaded downward with 1.3 kgf at the loading point spaced apart from the end of the club shaft towards the opposite end by 928 mm.

2. A golf club according to claim 1, wherein

the kick point index is in a range of from 52 to 56.

3. A golf club according to claim 1, wherein

a gravity point distance of the club head is 26 to 40 mm.

4. A method of making a golf club, the golf club comprising a club shaft and a club head having a head volume of not less than 280 cc and comprising a face portion which has, at least partially, a Young's modulus E of from 30 to 110 GPa, said method comprising

selecting a kick point index for the club shaft from a range of not less than 50,

making the club shaft having the selected kick point index, and

attaching the club head to the end of the club shaft, wherein kick point index={inverse flexure/(inverse flexure+normal flexure)}×100, wherein,

the normal flexure is the flexure of the club shaft measured as the displacement of a loading point in the vertical direction when the club shaft is horizontally supported at two points S1N and S2N which are a first point S1N at a distance of 953 mm for supporting the under side and a second point S2N at a distance of 1093 mm for supporting the upper side, each distance measured from the end of the club shaft towards the opposite end of the club shaft, and the club shaft is loaded downward with 2.7 kgf at the loading point spaced apart from the end of the club shaft towards the opposite end by 129 mm, and

the inverse flexure is the flexure of the club shaft measured as the displacement of a loading point in the vertical direction when the club shaft is horizontally supported at two points S1R and S2R which are a first point S1R at a distance of 152 mm for supporting the under side and a second point S2R at a distance of 12 mm for supporting the upper side, each distance measured from the end the club shaft towards the opposite end of the club shaft, and the club shaft is loaded downward with 1.3 kgf at the loading point spaced apart from the end of the club shaft towards the opposite end by 928 mm,

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