A golf club steel shaft in which, when a distance from a front end of the shaft to a center of gravity point of the shaft is $L_{c}$, and when a full length of the shaft is $L_{s}$, a center-of-gravity rate $Y$ (%) obtained as $L_{c}/L_{s}$ satisfies 51.0 ≤ Y ≤ 60.0, a shaft weight $X$ (g) satisfies 80 ≤ $X$ ≤ 140, and a full length of the shaft $L_{s}$ (inch) satisfies 30 ≤ $L_{s}$ ≤ 42.
GOLF CLUB STEEL SHAFT

TECHNICAL FIELD

[0001] The present invention relates to a steel shaft.

BACKGROUND ART

[0002] For golfers, flight distance of a ball is one of the important factors when selecting a golf club. Therefore, hitherto, in order to extend the flight distance of the ball, various improvements have been made with regard to shapes and materials of elements forming a golf club.

[0003] However, in recent years, in order to enhance fairness of competition by suppressing excessive flight distance, there have been regulations set in the rules regarding rebound performance of a club face, club length, and inertia moment of a head; and thereby it is becoming difficult to improve flight distance.

[0004] In such a situation, in view of the fact that initial velocity of a ball largely influences flight distance, there has been a proposal (for example, cf. Patent Literature 1) of extending the club length close to the upper limit regulated by the rule to increase head speed of a club.

SUMMARY OF THE INVENTION

Technical Problem

[0006] However, with the method of increasing head speed of a club by extending the club length, controllability of the head deteriorates as the length of the club becomes longer, and it becomes difficult to hit a ball at a sweet spot of the head. Thus, a ball smash factor deteriorates and initial velocity of a ball cannot be stably increased; and, as a result, flight distance of a ball cannot be improved.

[0007] In order to solve this, it is necessary to increase the smash factor by reducing the length of the club and increase initial velocity of the ball by increasing the head weight. However, simply increasing the head weight leads to a problem where ease of swinging the club decreases due to inertia moment of the club now becoming large.

[0008] Therefore, it is conceivable to move the center of gravity of the shaft toward the butt side (hand side) in order to prevent the increase of inertia moment of the club without further increasing the club weight.

[0009] Although it is ordinarily possible to move the center of gravity of the shaft toward the butt side by increasing the thickness of the butt side portion of the shaft; with this method, a flexural rigidity value EI (kgf·m²) of the butt side portion of the shaft also increases, and feel of hitting a ball and directivity of a hit ball deteriorate.

[0010] The present invention has been made in view of such circumstances, and an objective of the present invention is to provide a golf club steel shaft that makes it possible to extend flight distance of a ball while maintaining feel of hitting a ball and directivity of a hit ball.

Solution to the Problems

[0011] (1) In a golf club steel shaft of the present invention, when a distance from a front end of the shaft to a center of gravity point of the shaft is \( L_S \), and when a full length of the shaft is \( L_S \), a center-of-gravity rate Y (%) obtained as \( L_S / L_S \) satisfies 51.0 < Y ≤ 60.0.

[0012] a shaft weight X (g) satisfies 800 < X < 140, and

[0013] a full length of the shaft \( L_S \) (inch) satisfies 30 < \( L_S \) < 42.

[0015] In the golf club steel shaft of the present invention, since the center-of-gravity rate Y (%), the shaft weight X (g), and the full length of the shaft \( L_S \) (inch) are each set as values within the above described ranges, it is possible to increase weight of a golf club head with steel iron, and extend flight distance of a ball while maintaining feel of hitting a ball and directivity of a hit ball.

[0016] (2) In the golf club steel shaft according to (1) described above, a thickness of a portion up to 150 mm from a butt end toward a front end side of the shaft is preferably not smaller than 0.30 mm but not larger than 0.40 mm.

[0017] (3) In the golf club steel shaft according to (1) or (2) described above, an outer diameter of a portion up to 150 mm from a butt end toward a front end side of the shaft is preferably not smaller than 14.5 mm but not larger than 15.5 mm.

[0018] (4) In the golf club steel shaft according to (1) to (3) described above, the number of steps included in a portion up to 400 mm from a butt end toward a front end side of the shaft is preferably not less than 5 but not more than 8.

Advantageous Effects of the Invention

[0019] With the steel shaft according to the present invention, it is possible to extend flight distance of a ball while maintaining feel of hitting a ball and directivity of a hit ball.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] FIG. 1 is an illustrative diagram of a golf club including one embodiment of a golf club steel shaft of the present invention.

[0021] FIG. 2 is for describing a method for measuring T-point strength.

DESCRIPTION OF EMBODIMENTS

[0022] In the following, detailed embodiments of a steel shaft for a golf club of the present invention will be described with reference to the accompanying drawings.

[0023] FIG. 1 is an illustrative diagram showing the entirety of a golf club 1 including a steel shaft (hereinafter, may be simply referred to as “shaft””) for a golf club, according to one embodiment of the present invention. The golf club 1 includes an iron type golf club head 2 having a predetermined loft angle, a shaft 3, and a grip 4. The head 2 has a hosel 6 including a shaft hole 5 to which a tip end 3a on the front end side of the shaft 3 is inserted and fixed. A butt end 3b at the back end side of the shaft 3 is inserted and fixed in a grip hole 7 of the grip 4. The tip end 3a is positioned inside the head 2, and the butt end 3b is positioned inside the grip 4. It should be noted that, in FIG. 1, a reference character of "G" indicates the center of gravity (centrigravity point) of the shaft 3. The center of gravity G is located on a shaft axis inside the shaft 3.

[0024] Although the weight of the golf club 1 is not particularly limited in the present invention, it is preferably set...
within a range of not smaller than 360 g. If the weight of the golf club 1 is too small, the strengths of respective elements (parts) forming the golf club become low, and durability of the golf club may deteriorate. Therefore, the weight of the golf club 1 is preferably not smaller than 370 g, and further preferably not smaller than 380 g. On the other hand, if the weight of the golf club 1 is too large, it becomes difficult to perform a swing, and it becomes difficult to increase head speed. Therefore, the weight of the golf club 1 is further preferably not larger than 500 g, and particularly preferably not larger than 400 g.

Furthermore, the length of the golf club 1 itself is also not particularly limited in the present invention, and is ordinarily from 34.0 to 42.0 inches. If the length of the golf club 1 is too small, although a swing can be performed easily, a turning radius of the swing becomes small, and it becomes difficult to obtain a sufficient head speed. As a result, the ball speed cannot be increased, and the flight distance of the ball cannot be extended. Therefore, the length of the golf club 1 is preferably not smaller than 34.5 inches, and further preferably not smaller than 35.0 inches. On the other hand, if the length of the golf club 1 is too large, the head speed decreases since it becomes difficult to swing the club. Therefore, the ball speed cannot be increased, and the flight distance of the ball cannot be extended. Therefore, the length of the golf club 1 is preferably not larger than 41.5 inches, and further preferably not larger than 41.0 inches.

It should be noted that, in the present specification, “club length” is a length measured based on the description in “Appendix II—Design of Clubs” “1. Clubs” “1c. Length” in the Rules of Golf determined by R&A (The Royal and Ancient Golf Club of Saint Andrews).

The head 2 in the present embodiment is a solid iron head and has a large inertia moment. With a club having the head 2 with a large inertia moment, an advantageous effect of improvement in flight distance can be stably obtained.

In the present invention, there is no particular limitation in the material of the head 2, and, for example, titanium, titanium alloys, stainless steel, stainless steel, soft iron, and the like can be used. Furthermore, instead of manufacturing the head 2 using a single material, the head 2 may be manufactured by combining multiple materials as appropriate.

In the present invention, although the weight of the head 2 itself is not particularly limited, it is preferably within a range from 230 to 310 g. If the head 2 is too light, the kinetic energy of the head 2 cannot be sufficiently provided to the ball, and it becomes difficult to increase the ball speed. Therefore, the weight of the head 2 is further preferably not smaller than 235 g, and particularly preferably not smaller than 240 g. On the other hand, if the weight of the head 2 is too large, the golf club becomes heavy and difficult to swing. Therefore, the weight of the head 2 is further preferably not larger than 305 g, and particularly preferably not larger than 300 g.

Furthermore, in the golf club 1 of the present embodiment, the ratio (head weight/club weight) of the head weight and the club weight is set to be not lower than 0.55 but not higher than 0.70. If this ratio is too small, the kinetic energy of the head 2 becomes small and obtaining a sufficient ball speed becomes difficult. Therefore, the ratio is preferably not lower than 0.56, and further preferably not lower than 0.57. On the other hand, if the ratio is too large, the head 2 becomes heavy and it becomes difficult to swing the club. Therefore, the ratio is preferably not higher than 0.69, and further preferably not higher than 0.68.

In the present invention, there is no particular limitation in the material and structure of the grip 4, and those commonly used can be adopted as appropriate. For example, there can be used one that is obtained by blending and kneading natural rubber, oil, carbon black, sulfur, and zinc oxide, and molding and vulcanizing the materials into a predetermined shape.

In the present invention, although the weight of the grip 4 itself is not particularly limited, it can be ordinarily set to be not smaller than 20 g but not larger than 55 g. If the weight of the grip 4 is too small, the strength of the grip 4 becomes low, and its durability may deteriorate. Therefore, the weight of the grip 4 is preferably not smaller than 23 g, and further preferably not smaller than 26 g. On the other hand, if the weight of the grip 4 is too large, the golf club becomes heavy and difficult to swing. Therefore, the weight of the grip 4 is preferably not larger than 53 g, and further preferably not larger than 51 g.

The shaft 3 in the present embodiment is a steel shaft having a hollow structure and is manufactured with a method commonly used in the art. The full length of the shaft 3 is represented as Lc, and the distance from the tip end (front end) 3a of the shaft 3 to the center of gravity G of the shaft 3 is represented as Lp.

A weight X of the shaft 3 in the present invention is set to be not smaller than 80 g but not larger than 140 g. If the weight of the shaft 3 is too small, the possibility becomes high for strengths such as flexural strength to be insufficient due to having a small thickness. Therefore, the weight of the shaft 3 is preferably not smaller than 85 g, and further preferably not smaller than 90 g. On the other hand, if the weight of the shaft 3 is larger than 140 g, it becomes difficult to perform a swing at an increased speed due to the whole golf club being heavy. Therefore, the weight of the shaft 3 is preferably not larger than 135 g, and further preferably not larger than 130 g.

In addition, the length (full length) Lc of the shaft 3 is set to be not smaller than 30 inches but not larger than 42 inches. If the length of the shaft 3 is too small, a turning radius of the swing becomes small, and it becomes difficult to obtain a sufficient head speed. As a result, the ball speed cannot be increased, and the flight distance of the ball cannot be extended. Therefore, the length of the shaft 3 is preferably not smaller than 32 inches, and further preferably not smaller than 34 inches. On the other hand, if the length of the shaft 3 is too large, the head speed cannot be increased, and the flight distance of the ball cannot be extended. Thus, the length of the shaft 3 is preferably not larger than 41.5 inches, and further preferably not larger than 41 inches.

Furthermore, although the position of the center of gravity G of the shaft 3 is not particularly limited in the present invention, it is ordinarily within a range of, for example, for a shaft whose length is 39 inches, 595 to 550 mm from the tip end 3a (front end) of the shaft 3. If the position of the center of gravity G of the shaft 3 is located closer than 505 mm from the front end of the shaft 3, there is a high possibility of not being able to increase head speed since the ease of swinging the club is not improved due to the position of the
center of gravity not being sufficiently moved in the hand side direction. Therefore, the position of the center of gravity of the shaft 3 from the front end of the shaft 3 is preferably not closer than 510 mm, and further preferably not closer than 515 mm. On the other hand, if the position of the center of gravity G of the shaft 3 is further than 595 mm from the front end of the shaft 3, there is a high possibility of strengths such as flexural strength being insufficient due to a small thickness on the front end side of the shaft. Therefore, the position of the center of gravity of the shaft 3 from the front end of the shaft 3 is preferably not farther than 585 mm, and further preferably not farther than 575 mm.

[0040] In the present invention, when the distance from the front end of the shaft 3 to the center of gravity G of the shaft is $L_G$, and when the full length of the shaft 3 is $L_3$, a center-of-gravity rate Y (%) obtained as $L_G/L_3$ satisfies $51.0 \leq Y \leq 60.0$.

[0041] If the center-of-gravity rate Y is lower than 51.0(%), since the center of gravity of the shaft is located close to the front end side of the shaft, the weight of the head has to be reduced in order to obtain a swing balance equivalent to that obtained from a hitherto known club, and the degree of freedom in designing a head becomes small. Thus, the inertia moment of the head becomes small, and a technique for lowering the center of gravity cannot be implemented. Therefore, it becomes difficult to achieve a large ball flight distance. Hence, the center-of-gravity rate Y is preferably not lower than 52.0%, and further preferably not lower than 53.0%.

[0042] On the other hand, if the center-of-gravity rate Y is higher than 60.0%, since the center of gravity of the shaft is located too close to the back end side of the shaft, even if the weight of the head is excessively increased in order to obtain a level of ease of swinging equivalent to that obtained from a hitherto known club, it is still difficult to perform a swing since the club weight is also increased. In addition, since the weight is allocated on the back end side rather than on the front end of the shaft, the strength of the front end side of the shaft becomes small. Therefore, the center-of-gravity rate Y is preferably not higher than 58.0%, and further preferably not higher than 56.0%.

[0043] Furthermore, in the present embodiment, a thickness t of a portion up to 150 mm from the butt end $3_b$ of the shaft 3 toward the front end side of the shaft is set to be not smaller than 0.30 mm but not larger than 0.40 mm.

[0044] If the thickness t is smaller than 0.3 mm, since the center of gravity of the shaft is located close to the front end side of the shaft, the weight of the head has to be reduced in order to obtain a swing balance equivalent to that obtained from a hitherto known club, and the degree of freedom in designing a head becomes small. Thus, the inertia moment of the head becomes small, and a technique for lowering the center of gravity cannot be implemented. Therefore, it becomes difficult to achieve a large ball flight distance. Hence, the thickness t is preferably not smaller than 0.32 mm, and further preferably not smaller than 0.34 mm.

[0045] On the other hand, when the thickness t is larger than 0.4 mm, since the center of gravity of the shaft is located too close to the back end side of the shaft, even if the weight of the head is excessively increased in order to obtain a level of ease of swinging equivalent to that obtained from a hitherto known club, i.e., the same level of swing balance, it is still difficult to perform a swing since the club weight is also increased. In addition, since the weight is allocated on the back end side rather than on the front end of the shaft, the strength of the front end side of the shaft becomes small. Therefore, the thickness t is preferably not larger than 0.38 mm, and further preferably not larger than 0.36 mm.

[0046] Furthermore, in the present embodiment, an outer diameter d of a portion up to 150 mm from the butt end $3_b$ of the shaft 3 toward the front end side of the shaft is set to be not smaller than 14.5 mm but not larger than 15.3 mm.

[0047] If the outer diameter d is smaller than 14.5 mm, a flexural rigidity value EI of the butt side of the shaft becomes too low and the shaft becomes soft. In addition, since directional stability of a hit ball deteriorates, the feel obtained when hitting a ball deteriorates. Therefore, the outer diameter d is preferably not smaller than 14.7 mm, and further preferably not smaller than 14.9 mm.

[0048] On the other hand, if the outer diameter d is larger than 15.5 mm, the flexural rigidity value EI of the butt side of the shaft becomes too high, and the feel obtained when hitting a ball deteriorates since the shaft bends little and is felt as being hard. Therefore, the outer diameter d is preferably not larger than 15.4 mm, and further preferably not larger than 15.3 mm.

[0049] Furthermore, in the present embodiment, the number of steps included in a portion up to 400 mm from the butt end $3_b$ of the shaft 3 toward the front end side of the shaft is set to be not less than 5 but not more than 8.

[0050] If the number of the steps is less than 5, the flexural rigidity value EI of the butt side of the shaft becomes too high, and the feel obtained when hitting a ball deteriorates since the shaft bends little and is felt as being hard. Therefore, the number of the steps is preferably not less than 6.

[0051] On the other hand, if the number of the steps is more than 8, the flexural rigidity value EI of the butt side of the shaft becomes too low and the shaft becomes soft. In addition, since directional stability of a hit ball deteriorates, the feel obtained when hitting a ball deteriorates. Therefore, the number of the steps is preferably not more than 7.

[0052] In addition, in the present embodiment, when compared to a portion up to 600 mm from the tip end $3_a$ of the shaft toward the butt end $3_b$ side, the contained amount of retained austenite in the material of the shaft is set to be larger in a portion toward the butt end $3_b$ from this 600-mm part. That is, the contained amount of retained austenite is different in the tip end side of the shaft and in the butt end side of the shaft, with the boundary therebetween being the part 600 mm from the tip end $3_a$ of the shaft toward the butt end $3_b$ side. More specifically, the contained amount of retained austenite in the portion on the butt end side of the 600-mm boundary is set to be larger than the tip end side of the boundary.

[0053] If the “boundary” is located closer than 600 mm from the tip end $3_a$ of the shaft with respect to the butt end $3_b$ side, the flexural rigidity value EI of the butt side of the shaft becomes too low and the shaft becomes soft. In addition, since directional stability of a hit ball deteriorates, the feel obtained when hitting a ball deteriorates. Therefore, the “boundary” is located preferably not closer than 650 mm, and further preferably not closer than 700 mm.

[0054] On the other hand, if the “boundary” is located farther than 900 mm from the tip end $3_a$ of the shaft toward the butt end $3_b$, the flexural rigidity value EI of the butt side of the shaft becomes too high, and the feel obtained when hitting a ball deteriorates since the shaft bends little and is felt as being hard. Therefore, the “boundary” is located preferably not farther than 850 mm, and further preferably not farther than 800 mm.
Example

Next, the steel shaft of the present invention will be described based on Examples; however, the present invention is not limited only to those Examples.

15 golfers having an average head speed of 42 m/s were each asked to actually hit ten balls by using a 5-iron (club length: 38 inches, club weight: 400 g) having a shaft with a specification shown in Table 1, and were asked to answer a question regarding the feel obtained when hitting a ball. The golfers were asked to take into consideration ease of swinging, directivity of a hit ball, and flight distance to perform a 5-scale evaluation. An evaluation obtained from the most number of golfers was adopted.

5 points: Very good
4 points: Good
3 points: Average
2 points: Bad
1 point: Very bad

A shaft front end strength (T-point strength) was measured in accordance with a testing method defined by SG mark. SG-type three point flexural strength is a SG-type breaking strength determined by the Consumer Product Safety Association. FIG. 2 is an illustrative diagram for the method for measuring the SG-type three point flexural strength. As shown in FIG. 2, load F was applied downward from above at a load point t3 while the shaft 3 was supported from below at two support points t1 and t2. The position of the load point t3 was a position dividing, into two equal parts, the interval between the support point t1 and the support point t2. The load point t3 was matched with the point (T-point) that was to be measured, and measurement was conducted.

Results of evaluation of feel of hitting a ball, flexural strength of a shaft front end portion, and flight distance are shown in Tables 1 to 3.

TABLE 1

<table>
<thead>
<tr>
<th></th>
<th>Example 1</th>
<th>Example 2</th>
<th>Example 3</th>
<th>Example 4</th>
<th>Example 5</th>
<th>Example 6</th>
<th>Example 7</th>
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<tbody>
<tr>
<td>Shaft weight [g]</td>
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<td>95</td>
<td>95</td>
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<td>Shaft full length [inch]</td>
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<tr>
<td>Center-of-gravity rate [%]</td>
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<td>52</td>
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<td>0.38</td>
<td>0.41</td>
<td>0.28</td>
<td>0.32</td>
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<td>2</td>
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<td>Flexural strength (T-point) [kgf] of front end part</td>
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<td>230</td>
<td>220</td>
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<td>230</td>
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<td>Flight distance [yard]</td>
<td>162</td>
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<td>162</td>
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TABLE 2

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<th>Example 7</th>
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<td>Shaft full length [inch]</td>
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<td>Center-of-gravity rate [%]</td>
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<td>Feel evaluation</td>
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TABLE 3

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<td>Shaft full length [inch]</td>
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<tr>
<td>Center-of-gravity rate [%]</td>
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<tr>
<td>Thickness [mm] of a portion from butt end to 150 mm therefrom</td>
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<td>Outer diameter [mm] of a portion from butt end to 150 mm therefrom</td>
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TABLE 3-continued

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<th>Example 1</th>
<th>Example 9</th>
<th>Example 10</th>
<th>Example 11</th>
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<tr>
<td>Feel evaluation</td>
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<td>Flight distance [yard]</td>
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<td>170</td>
<td>168</td>
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</table>

REFERENCE SIGNS LISTS

- [0064] 1 iron type golf club
- [0065] 2 head
- [0066] 3 shaft
- [0067] 3a tip end
- [0068] 3b butt end
- [0069] 4 grip
- [0070] 5 shaft hole
- [0071] 6 hosel
- [0072] 7 grip hole
- [0073] G center of gravity of a shaft
- [0074] \( L_c \) distance from a tip end of a shaft to the center of gravity of the shaft
- [0075] \( L_s \) shaft full length

What is claimed is:

1. A golf club steel shaft in which, when a distance from a front end of the shaft to a center of gravity point of the shaft is \( L_c \), a center-of-gravity rate \( Y \) (%) obtained as \( L_c/L_s \) satisfies \( 5.0 \leq Y \leq 60.0 \), a shaft weight \( X \) (g) satisfies \( 80 \leq X \leq 140 \), and a full length of the shaft \( L_s \) (inch) satisfies \( 30 \leq L_s \leq 42 \).

2. The golf club steel shaft according to claim 1, wherein a thickness of a portion up to 150 mm from a butt end toward a front end side of the shaft is not smaller than 0.30 mm but not larger than 0.40 mm.

3. The golf club steel shaft according to claim 1, wherein an outer diameter of a portion up to 150 mm from a butt end toward a front end side of the shaft is not smaller than 14.5 mm but not larger than 15.3 mm.

4. The golf club steel shaft according to claim 2, wherein an outer diameter of a portion up to 150 mm from a butt end toward a front end side of the shaft is not smaller than 14.5 mm but not larger than 15.3 mm.

5. The golf club steel shaft according to claim 1, wherein the number of steps included in a portion up to 400 mm from a butt end toward a front end side of the shaft is not less than 5 but not more than 8.

6. The golf club steel shaft according to claim 2, wherein the number of steps included in a portion up to 400 mm from a butt end toward a front end side of the shaft is not less than 5 but not more than 8.

7. The golf club steel shaft according to claim 3, wherein the number of steps included in a portion up to 400 mm from a butt end toward a front end side of the shaft is not less than 5 but not more than 8.

8. The golf club steel shaft according to claim 4, wherein the number of steps included in a portion up to 400 mm from a butt end toward a front end side of the shaft is not less than 5 but not more than 8.

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