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S. J. CROOKER

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GOLF CLUB

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Fig. 4.

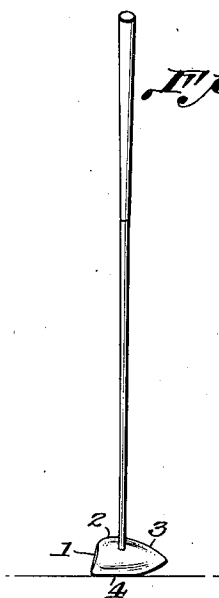


Fig. 1.

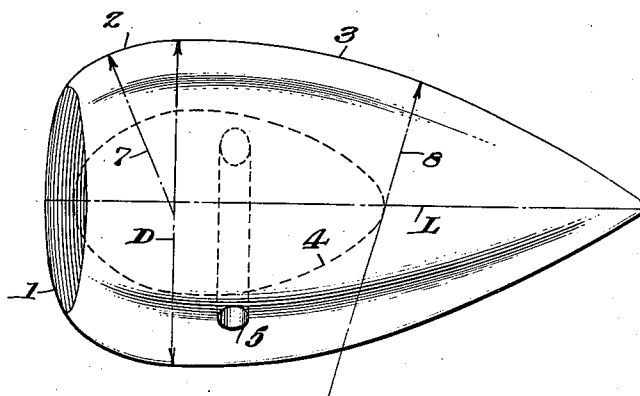


Fig. 3.

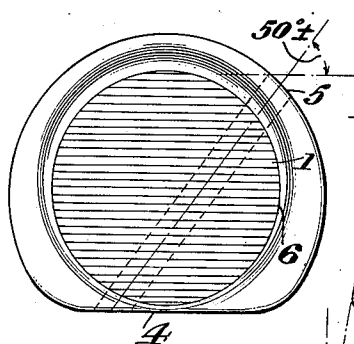
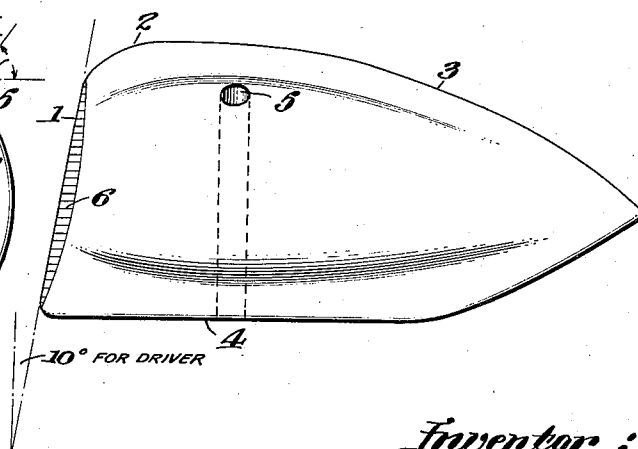


Fig. 2.



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GOLF CLUB

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3 Claims. (Cl. 273—77)

My present invention relates to golf clubs, and more particularly to an improved shape of the golf club head which has the least possible air resistance, concentrates the weight behind the striking point, provides greater playing accuracy, and is simple to manufacture.

This invention is applicable to the so-called "woods", but may also be applied to golf club heads made from metals, or materials other than wood.

Heretofore, golf club heads of wood have been made with an off-set shank to which the shaft is attached, and have been made in various irregular shapes requiring expensive hand work in their manufacture. The off-set shank of the head results in an unbalanced mass at the end of the shaft, and the customary head shapes have considerable air resistance even though the rear portions may be tapered in partial streamline contour.

When a player swings a golf club at high speed to strike the ball, the total force exerted consists essentially of two parts; (a) the force required to accelerate the mass of the club head, and (b) the force required to overcome the resistance of the air, which increases as the square of the velocity of the club head.

Experiments indicate that any individual player is capable of putting only his own quota of energy into the swing of the club. If, therefore, the force (b) required to overcome the resistance of the air can be reduced to a minimum, the player can utilize the difference to attain a higher club head speed, which will result in a greater ball velocity and a longer drive.

Experiments have shown that an expert golfer can swing a driver having a 7 ounce, or 0.437 lb., head to attain a head speed of 170 ft. per sec.

As an example, if the distance over which the club head travels from the position of rest back of the shoulder down to the point of contact with the ball is assumed as 17 feet, the force (a) required to accelerate this club head up to the stated velocity may be calculated by using the formula:

$$F_1 = \frac{1w_c v_c^2}{2gS}, \text{ lb.}$$

where w_c represents the weight of the club head, lb.,

v_c represents the velocity of the club head, ft. per sec.

g is the gravity factor=32.2 ft. per sec. per sec.,

S is the distance of travel=17 ft.

The calculated force of acceleration (a) is therefore:

$$F_1 = \frac{0.437(170)^2}{2(32.2)17} = 11.5 \text{ lb.}$$

If the air resistance of the common type of off-set golf club head may be expressed by the approximate formula:

$$R_1 = 0.000005 A_1 v_c^2, \text{ lb.}$$

where, A_1 is the exposed cross-sectional area of the club head at right angles to its line of motion, taken as 8 sq. in. from a well known driver; the force (b) required to overcome the air resistance is found to be:

$$R_1 = 0.000005(8)(170)^2 = 1.16 \text{ lb.}$$

Or the total force required to swing the club up to the velocity of 170 ft. per sec. is the sum of,

$$F_1 + R_1 = 12.66 \text{ lb.}$$

While the force required to overcome the air resistance of the fast moving club head may be only 10 to 15 per cent of that required to accelerate the mass of the club head, it can be shown that a reduction of the air resistance force to about 3 per cent of the total, will result in increasing the driving range of the club at least 10 yards.

Given in Report No. 291 of the National Advisory Committee for Aeronautics, the results of experiments made on model airship hulls of different relative lengths indicate that the minimum air resistance is offered by the airship hull model which has a length twice its maximum diameter, or the fineness ratio of length to diameter, $L/D=2$.

Selecting this minimum resistance spindle shape for the body of the golf club head, such modifications have been made as are essential to making it a practical tool for golfers, and yet retaining the characteristics of least possible air resistance.

Since it is customary to use persimmon wood for such golf club heads, the diameter of the head will be determined by the required finished weight, by the density of the wood, and by the practical modifications necessary.

If a 7 ounce head is required, in my invention the maximum diameter will be about 2 5/8 in. giving an exposed cross-sectional area at the maximum diameter of about 5 sq. in.

This golf club head may of course be weighted with suitable pieces of lead or other metal, and it may also be provided with a metal sole plate,

inset face plate, or other embellishment without altering the intent of the invention.

If the true streamline airship spindle shape results in a lower resistance coefficient, the resistance offered by the air may be expressed moderately by the equation:

$$R_2 = 0.0000025 A_2 v_c^2, \text{ lb.}$$

And if it be assumed that the least attainable air resistance will now permit the player to increase the speed of the club head to 176 ft. per sec., then the air resistance of the streamlined golf club spindle head will be found to be about,

$$R_2 = 0.0000025 (5) (176)^2 = 0.388 \text{ lb.}$$

or only about 3 per cent of the total; and the player will have a force of 12.27 lb. available for accelerating the mass of the club head.

If the first given force equation is rearranged to solve for the club head velocity, the conditions of the example will give:

$$v_c^2 = \frac{2gSF}{w_c} = \frac{64.4(17)12.27}{0.437}$$

or

$$v_c = 176 \text{ ft. per sec.}$$

which checks with the above assumed increased speed of the bi-curvature spindle streamlined head and shows that the assumption was correct.

It is possible further to calculate the projection velocity of any given golf ball of weight, w_b , when struck by a club head of effective weight, w_c , which is moving at the velocity, v_c , provided the elastic coefficient of restitution of the ball, e , is known. The equation is:

$$v_b = \frac{w_c v_c}{w_c + w_b} (1 + e)$$

Experiments indicate that the elastic coefficient of the average golf ball changes with the velocity of impact, being less at greater velocities, approximately in accordance with the empirical equation:

$$e = 0.85 - 0.0025 v_c$$

If the standard golf ball has a weight of 1.62 ounces, and is struck by a 7 ounce club head, which is moving at 170 ft. per sec.; the coefficient of restitution, e , will be about 0.425; and the ball will leave the club head at a velocity of 197 ft. per sec.

Therefore, if the same player can swing the spindle streamlined club at an increased speed of 176 ft. per sec., the corresponding elastic coefficient of the ball will then be 0.412; and the ball will be projected at a higher velocity of 201 ft. per sec.

This increased ball velocity of 4 ft. per sec. may not seem large, but it can be shown by proper ballistic calculations, assuming the balls leave at an angle of departure of 15 degrees, and with the back-spin rate of 7200 R. P. M., that the driving club of the customary style will give the ball a horizontal free flight range of only 230 yards, while the improved spindle body streamlined driver will increase the free flight range to 240 yards.

By the use of the spindle type streamlined driver, it happens to work out that this same relative increased distance will be added to the drives of the amateur as well as to those of the expert golfer.

In my development in this art, I have discovered from aerodynamic, dynamic, geometric, and practical considerations, that the usual off-set

shank for attaching the shaft to the head of the golf club is detrimental and should properly be eliminated; and that the shaft may be inserted into or secured directly to the main body of the spindle type streamlined golf club head, thus improving its useful characteristics, and at the same time greatly simplifying the manufacturing procedure.

Any suitable type of shaft may be used with this golf club, but the modern steel shaft having reasonable lateral flexibility and torsional rigidity is preferred.

An object of my invention, therefore, is an improved golf club.

In the accompanying drawing illustrating a preferred embodiment of my invention which may be employed in the manufacture thereof:

Figure 1 is a plan view of the golf club embodying my invention;

Figure 2 is a side elevation view, and Figure 3 is a front elevation view which may be used in manufacturing a golf club according to my invention.

Figure 4 shows the complete club.

Referring to the drawing, 1 designates the front striking face of the club head, 2 and 3 represent respectively the forward and rearward streamline body curves, 4 represents the sole of the club head, 5 the hole or point of attachment for the shaft, 6 the grooves in the striking face 1, 7 the radius of curvature of body curve 2, and 8 the radius of curvature of body curve 3.

The basic shape of the improved golf club head may be called a spindle, being a solid of revolution generated by a plane area the bounding curve of which is revolved 360 degrees about a chord perpendicular to the axis of the curve.

While the generating curve of a spindle may be a segment of a circle, an ellipse, a parabola, or other curve, for the purpose of describing my invention the circular spindle will be considered suitable.

The basic streamline contour of the generating plane may be approximately described by two radii defining the two revolving arcs or body curves 2 and 3.

The forward arc 2 lying between the frontal point and the end of the maximum body diameter D may have a radius slightly larger than one-half the maximum diameter and will be centered on that transverse diameter.

The rearward arc 3 lying between the end of the maximum diameter D and the stern point of the longitudinal axis L will be described by a long radius 8 centered on the maximum diameter extended and passing through the end of the transverse diameter D and the stern point of L about two diameters, 2D, from the frontal point.

This streamlined plane when revolved about the longitudinal axis L will describe a solid of revolution having approximately the required airship streamline bi-curvature spindle shape. This contour may however be altered or modified in any practical manner without voiding the true intent of my invention.

In effect the improved golf club head is formed by joining two half spindles of different shapes defined by the rotation of two adjoining portions of circular, elliptic, or other suitable plane segments about the common chord axis.

Because it is necessary to slope the striking face of the club head backward for the purpose of projecting the ball at an upward angle of several degrees, the face of the driver usually has a slope of about 10 degrees, the brassie about 15 degrees,

and the spoon about 18 degrees. The nose of the streamlined body must necessarily be cut off at the proper angle and at a suitable distance back of the frontal point to provide a circular striking face having approximately the same diameter as the golf ball.

Also for practical purposes the striking face must be low enough to hit under the side of the ball and lift it out of the grass, therefore, it is necessary to cut off the lower portion of the body of the club head to provide a relatively flat horizontal sole 4.

To preserve aerodynamic qualities which means the least possible air resistance, the junctures between the surfaces 1 and 2, and between 4 and the body of the club, are rounded off to smooth curves with ample radii of curvature.

In order that a slight misalignment of the axis of the club head in the horizontal plane at the instant of contact may not project the ball in an undesired direction, the striking face is slightly rounded or shaped into cylindrical form with a radius of about 10 inches, the axis of the cylinder being parallel to the slope of the face and intersecting the longitudinal axis of the club head.

Because the back-spin of the ball results in a long soaring flight it is desirable to have the striking face furrowed with horizontal grooves 6, which gear to the ball surface and naturally give it back-spin. Vertical or cross-wise grooves are undesirable because if the club happens to have a slight sidewise pull or push at the instant of contact, such grooves will tend to give the ball a partial side-wise spin resulting in a "hook" or a "slice", whereas the horizontal grooves alone will permit side-wise slippage of the ball and minimize the slicing effects of a faulty stroke.

The shaft is preferably inserted or attached at an angle of about 50 degrees from the horizontal plane and at a point slightly forward of and slightly below the normal center of gravity of the club head, in order to preserve the proper hanging balance and "feel" in the swinging club.

This location of the shaft places its axis nearly in line behind the point of impact; the geometric shape of the head effectively concentrates its weight behind the point of impact; and the streamline shape of the head operates to steer its direction more accurately when approaching contact with the ball. All factors taken together result to form a golf club which has been shown by test to be more accurate than the customary style of club, and with which the golfer is likely to obtain more consistent and satisfactory results.

This spindle type of golf club head in addition

to being an improvement as a driver for the high speed strokes required in long driving, is ideal for shooting from grass lies, or for playing out of the rough. While the usual brassie or spoon has a sharp leading edge extending 1½ inches or more across the base of the striking face, and usually cuts a swath of this width through the grass on approaching the ball; the airship spindle type streamline head as described has a partially rounded nose which effectively parts the grass on approach to the ball and thus the grass offers much less resistance to the motion of the club. This rounded nose club head will not be twisted and diverted by the work of cutting the grass, and will reach the ball with a higher speed, which will result in a longer and more accurate shot than might be possible with the customary style of club head.

It is understood that the invention described is not limited to the specific details shown, and the invention is therefore claimed in any of the forms or modifications within the scope of the appended claims.

Having thus described my invention what I claim and desire to protect by Letters Patent is:

1. A golf club, a club head having a striking face from which the head flares to the maximum diameter and then tapers rearwardly, said head having substantially streamline contours in all planes passing through the longitudinal axis, the basic ratio of height to width being unity in all sections perpendicular to the longitudinal axis through the fore and aft tapered contours of the club head, said head having its bottom side cut horizontally to provide a flat sole.

2. A golf club consisting of an elongated club head of substantially circular cross-section throughout made with its length extending in the intended direction of its stroke, and tapering off to its stern end, the bottom side cut horizontally to provide a flat sole, and bored angularly forward of its center of gravity in a plane at right angles to its longitudinal axis, and of a shaft attached thereto.

3. A golf club consisting of an elongated club head of substantially circular cross-section throughout made with its length extending in the intended direction of its stroke and slightly narrowing from its maximum cross-section toward its striking face, and tapering off to its stern end, the bottom side cut horizontally to provide a flat sole, and bored angularly forward of its center of gravity in a plane at right angles to its longitudinal axis, and of a shaft attached thereto.

SYLVAN JAY CROOKER.