W. TAYLOR.

GOLF BALL.

APPLICATION FILED FEB. 4, 1916.

1,286,834. Patented Dec. 3, 1918.

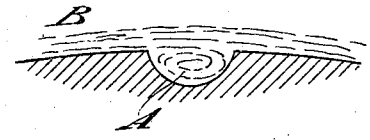


Fig. 1.



Fig. 2.

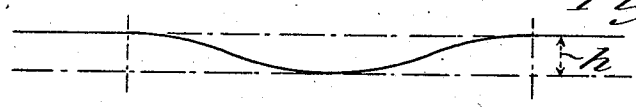


Fig. 3.

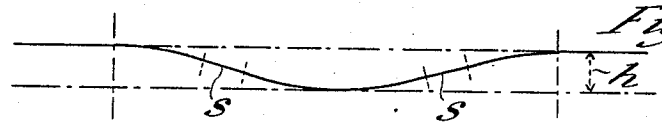


Fig. 4.

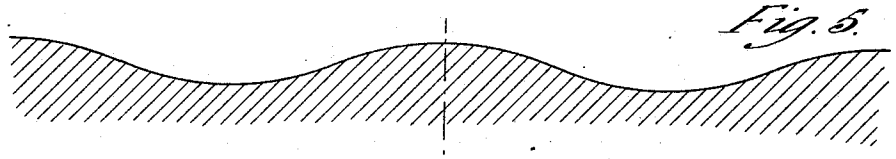


Fig. 5.

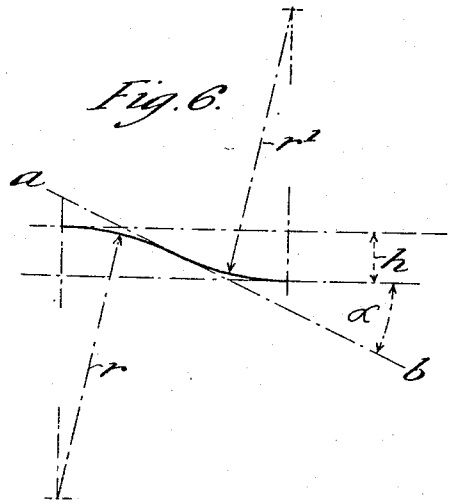


Fig. 6.

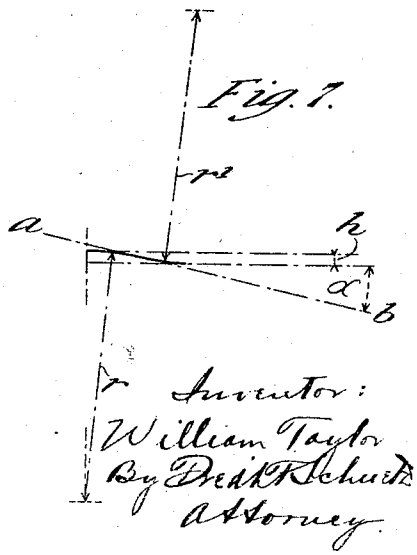


Fig. 7.

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GOLF-BALL.

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To all whom it may concern:

Be it known that I, WILLIAM TAYLOR, a subject of the King of Great Britain, residing in Leicester, England, have invented certain new and useful Improvements in Golf-Balls, of which the following is a specification.

This invention relates to balls such as are used in the game of golf, and has for its principal object to prolong the flight of the ball by avoiding waste of the ball's energy in causing useless eddies in the air and in particular eddies formed by the marking or roughening on the ball's surface. Another object is, while avoiding such eddies to provide a series of suitable inclined surfaces upon which the air shall impinge so as to give the ball the requisite tendency to rise above its initial direction and sustain it during flight against the action of gravity. It consists essentially in an improved form of the sides of the depressions or prominences which constitute the marking, and it will be described hereinafter with the help of the accompanying diagrammatic drawing, in which Figure 1 is a section through a portion of the surface of a ball having a cavity which is of the inverted bramble type of marking and part spherical in form with sharp edges. Fig. 2 is a section of a depression of shallower type. Fig. 3 is a section of a depression having a profile constituted by a true ogee-curve of two equal circular arcs; Fig. 4 is a section of a depression, the profile of which is two equal circular arcs joined by a short length of a straight line; Fig. 5 is a section of a depression containing a projection of a stream-line section or having a profile of an ogee-curve; Fig. 6 represents an ogee-curve struck with a radius five and a half times the height of the curve; Fig. 7 is an ogee-curve struck with a radius twenty times the height of the curve.

Golf balls are marked in order to modify their trajectory in flight. A smooth ball projected without spin has a trajectory approximately parabolic and attains its greatest length of flight over level ground when its initial direction is at about forty-five degrees with the horizontal. A ball with suitably roughened surface projected with back spin has a straighter trajectory than that of a smooth ball, or a trajectory curving upward at some part and attains a greater length of flight when its initial direction is practically horizontal, and this is known to be due to the backspin imparted to the ball when struck by the sloping face of the club.

I have found that in marking a golf ball it is desirable to avoid forms of marking which cause eddies in the air, particularly in air passing them tangentially, for such eddies, instead of being—as has hitherto been thought—part of a useful air entanglement, generally interfere with it and cause merely a waste of part of the ball's energy.

As a ball travels through the air and displaces continuously the air immediately in front of it, this spreads laterally over the ball's surface under some degree of compression depending on the ball's velocity, and having passed the equatorial center the flood of air continues to cling to the surface of the ball and tends to close together in its rear.

In the main therefore, and except as regards relatively small areas of the ball fore and aft in the axis of its flight, the flow of air over the ball's surface is tangential. And this is true of those parts of the surface on the top and bottom of the ball at any moment where differences of air pressure occasion the upward tendency of its trajectory. At these parts the air flood impinging on the inclined surfaces of the markings is diverted by them and compressed upon them, and this useful action being hereinafter referred to as "impingement."

I also find that eddies are formed in the air flood wherever the contour of the ball's surface changes too abruptly in any direction and they generally interfere with "impingement". Thus the aforementioned deep inverted bramble depressions, as shown in Fig. 1, become filled with whirls A which almost entirely prevent impingement and make such balls behave as smoother balls. With shallower depressions, as shown in Fig. 2, having either sharp edges C at the ball's surface, or with these edges merely blunted, the air flood B entering the depression impinges obliquely on the bottom or slope F thereof, but two eddies are formed, namely one eddy D within the depression where the air flood enters, and one eddy E outside the cavity where the air emerges, and the latter parts the air flood from the ball's surface so as to disturb its entrance to the next cavity if that be near. Such exterior eddies also appear to interfere with the clos-

ing together of the air flood in the wake of the ball.

With such cavities made still shallower and their edges less steep, both eddies are diminished in size but so also does the impingement diminish, hence this form of depression can never be made thoroughly effective.

Now according to the present invention I mark the surface of the ball with depressions or projections or both of such section that they form substantially true stream lines, their contours stream surfaces, and their sides inclined impingement surfaces, and this I do by making the side of every depression or projection to progress from its base to the surface of the ball in an ogee-curve, whereof the depth h (Fig. 3) of the ogee-curve, measured where the ogee reaches the base, is neither greater than ten fifty-fifths nor less than one-twentieth of such radius of curvature.

If the depth be greater than the above stated maximum and possibly also when somewhat less than this maximum, an eddy appears to be formed by the entering air, especially at low velocities. If it be less and possibly also when a trifle greater than the minimum, the impingement surfaces will not be sufficiently inclined.

The best results which I have hitherto obtained were with markings having a depth of about one-ninth of the radius of curvature.

For the purpose of securing sufficient impingement, however, it is not the radius of the ogee-curve which is the deciding factor, but the area and inclination of the impingement surfaces. In Fig. 6, wherein the radii r, r' of the two branches constituting the ogee-curve have one of the limiting values above referred to, that is five and a half times the depth h of the curve, the inclination α of the common tangent a, b at the center of the curve is 24°.37′ and is the maximum inclination of the curve or surface, and in Fig. 7, where the radii r, r' of the two branches have the other limiting value, that is twenty times the depth h, the maximum inclination of the curve or surface is about 13°, which is the inclination α of the tangent a, b. Impingement, however, depends not on the maximum inclination of the surface, but more nearly on the mean inclination, which with a true ogee-curve is half the maximum. Consequently the mean inclination of the impingement surfaces represented by the curves in Figs. 6 and 7 are respectively 12°.18½′ and 6½°, and I prefer to regard this latter angle as the true limit to the minimum height h and the maximum curvature of the ogee curve.

Though it appears desirable that the ogee-curve be formed by two exactly equal circular curves, this is not an essential condition. The two parts may differ somewhat in curvature and either may vary in curvature throughout its length, provided the curvature everywhere lies within the above stated limits. The two halves of the true ogee-curve may even be slightly separated and connected by a straight line as shown at s in Fig. 4, or by a curve struck with a radius greater even than twenty times the total depth of the ogee-curve. The above modifications are herein included in the expression "ogee curve".

Golf ball markings having this improved streamline section may be in other respects of various design. Fig. 5 indicates for example, the section of what may be regarded as a prominence formed within a depression in the ball's surface, both the prominence and the depression having my improved streamline contours. But I prefer to use simple depressions of substantially circular form, and for two principal reasons which are:—that they act, in all directions alike, on the air which impinges within them, and that they give to the impingement surfaces a maximum cuplike form, concave in all directions like the active side of a ship's sail or the inside of an umbrella, and thereby they condense the air which strikes them and increase the force of "impingement". Conversely, I discard markings formed exclusively like the old "bramble" marking with impingement surfaces which are convex in plan as well as in section and not cupped anywhere, for these impair "impingement", but I may secure sufficiently effective impingement by forming angular depressions in which the angles are less than two right angles, and such depressions are preferable in the form of polygonal cavities.

I shall hereafter, for brevity, refer to all such cup-like surfaces and combinations of surfaces as being "concave in plan". Markings of which the elements are neither circular nor symmetrical in plan and which do not act upon the air crossing them in all directions alike must be so arranged upon the ball that the aggregate effect of the elements is substantially equal in all directions and without common bias or orientation.

The ogee curved side of a depression may, in the case of a simple circular depression, meet at its base and flow into the base of the opposite side of the depression so that the central part of the depression will be part spherical, as in Fig. 3; but this is not essential, and there may be (and generally, if the depression be other than circular, for example, polygonal, there will be) some small area of corresponding form at the bottom of the depression between its sides, and this may be a plane or may, without bad effect, be slightly concave. I prefer to use isolated depressions between one and two-tenths of an inch in diameter, of depth about one-

tenth of the diameter, and to cover therewith about half the surface of the ball.

Having thus described the said invention and the best means I know of carrying the same into practical effect, I claim:—

1. A golf ball whose surface marking is formed with a number of inclined impingement surfaces, which are in substantial part or wholly concave in plan, which flow tangentially into the outer surface of the ball and into the bottom of the marking, whose mean inclination is not less than six-and-a-half degrees and which form substantially true stream lines and their contours stream surfaces.

2. A golf ball whose surface marking is formed with a number of inclined impingement surfaces which are in substantial part or wholly concave in plan and have an ogee-curved profile, the ogee being so curved that the radius of no part thereof is less than five and a half nor more than twenty times the height of the marking.

3. A golf ball whose surface is formed with a number of inclined impingement surfaces which are in substantial part or wholly concave in plan, have an ogee-curved profile, and a mean inclination not less than six and a half degrees, the ogee being so curved that the radius of no part thereof is less than five and a half times the height of the marking.

4. A golf ball whose surface marking is formed with a number of inclined impingement surfaces, which are in substantial part or wholly concave in plan, which flow tangentially into the outer surface of the ball and into the bottom of the marking, whose mean inclination is not less than six-and-a-half degrees and which are of ogee-curved section such that no part thereof is curved with a radius less than five and a half times the height of the marking.

5. A golf ball, the surface of which is provided with isolated depressions whose sides form inclined impingement surfaces, no normal section of which has a mean inclination of less than $6\frac{1}{2}°$, the sides being formed so as to flow tangentially into the surface of the ball and into the bottoms of the depressions and being of ogee section and such that no part thereof is curved with a radius less than five and a half times the depth of the side.

6. A golf ball, the surface of which is provided with isolated circular depressions whose sides form inclined impingement surfaces, no normal section of which has a mean inclination of less than $6\frac{1}{2}°$, the sides being formed so as to flow tangentially into the surface of the ball and into the bottoms of the depressions and being of ogee section and such that no part thereof is curved with a radius less than five and a half times the depth of the side.

7. A golf ball whose surface marking is formed with a number of inclined impingement surfaces, which are in substantial part or wholly concave in plan, which flow tangentially into the outer surface of the ball and into the bottom of the marking, whose mean inclination is not less than six-and-a-half degrees and which are of ogee section, the radius of the ogee curve being about nine times the height of the marking.

8. A golf ball whose surface marking is formed with a number of inclined impingement surfaces, which are in substantial part or wholly concave in plan, which flow tangentially into the outer surface of the ball and into the bottom of the marking, whose mean inclination is not less than six-and-a-half degrees and which are of modified ogee-curved section such that no part thereof is curved with a radius less than five and a half times the height of the marking.

9. A golf ball whose surface marking is formed with a number of inclined impingement surfaces, which are in substantial part or wholly concave in plan, which flow tangentially into the outer surface of the ball and into the bottom of the marking, whose mean inclination is not less than six-and-a-half degrees, and which are of modified ogee-curved section in which the modification of the ogee curve consists in straightening more or less its central part, the ogee being such that no part thereof is curved with a radius less than five and a half times the height of the marking.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM TAYLOR.

Witnesses:
JOSEPH WILLARD,
H. P. FITCH.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."