T-BLADE DRAG REDUCTION DEVICE FOR USE WITH SPORTING EQUIPMENT SHAFTS

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Abstract
An improved sporting equipment shaft is provided. The present invention relates to aerodynamic drag-reducing structures. In particular, the present invention relates to a vortex splitter plate element that may be formed integrally or attached to the shaft of a sporting equipment shaft preferably a golf club shaft. The T-Blade Drag Reduction Device operates to substantially reduce turbulence produced when the sporting equipment shaft is swung through a fluid, such as air. The reduction in turbulence is reflected operationally in a faster, more powerful swing due to the lessened amount of induced aerodynamic drag. There is also a lessening of shaft vibration, which should increase swing accuracy.
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CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] Not Applicable.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not Applicable.

REFERENCE TO A MICROFICHE APPENDIX


BACKGROUND OF THE INVENTION

[0004] The present invention relates to aerodynamic drag-reducing structures. In particular, the present invention relates to a T-Blade drag reduction device, an embodiment of a flexible splitter plate element, which is attached to the shaft of a golf club, tennis club shaft, or the like. The T-Blade operates to reduce or eliminate turbulence produced when the shaft is swung through a fluid, such as air. The reduction in turbulence is reflected in lessened induced aerodynamic drag, which in turn permits a faster swing. The reduction in turbulence also reduces or eliminates vibration of the shaft, which should increase player accuracy. In the following description, we will refer in major part to a golf club shaft application. However, it should be noted that the present invention may be incorporated in other types of sports equipment where a shaft is swung rapidly.

[0005] Golf clubs are comprised of several elements: the grip, the shaft, the hosel, and the head. The present invention involves an improved shaft.

[0006] Golf club shafts work in harmony with the other elements of the golf club to bring the striking head into contact with the golf-ball. Similarly, related sports equipment shafts function to apply a striking surface to manipulate a component of the game; for example, a tennis club's woven face is swung by a shorter shaft so as to effect a controlled collision with the tennis ball, thereby influencing the ball's trajectory.

[0007] For the most part, those who practice the ancient and honorable sport of golf strive to improve their performance by utilizing novel equipment, strategy, practice, and luck. Many factors interact during the course of a golf swing. However, one of the most significant factors that determine the effectiveness of the swing is the speed that the club's head reaches just prior to impact with the ball. The greater the head speed, the more kinetic energy is imparted to the golf ball, which, all other factors remaining constant, then travels a greater distance. In general, the "longer" shot results in fewer overall strokes at the ball. This lowers (improves) the player's score.

[0008] The golf club makers' goal is to wring the greatest possible performance and accuracy out of their product. Many, many methods have been proposed and used in order to maximize head speed. So many, in fact, that the United States Golf Association, the organization that approves golf equipment for "legal" play, has placed strict limits on such things as the allowable length of the shaft, the configuration of the gripping surface, the size of the head, what materials may be used, and even the size and spacing of grooves placed in the striking surface.

[0009] Golf club swing speeds are subsonic—in the range of approximately 100 miles per hour to a maximum of about 140 miles per hour. Even so, the very same aerodynamic forces that govern the flight of an airplane apply to the golf equipment. Thrust, lift, drag, and gravity interact with the angle of approach and direction of impact to determine the rebound effects on the ball.

[0010] A golf club shaft is generally circular in cross section. Therefore, a portion of the shaft may be analyzed as if it were a cylinder, reducing the complexity of the full model. A large body of research exists on the aerodynamics of simple cylinders.¹

¹ One of the earliest examples of the vortex effect is the wind-driven Aeolian harp. The vortex generated when air passes around the string causes the string to vibrate.

[0011] In relation to a cylinder with a high aspect ratio (as a golf club shaft), vortex shedding is regular and parallel to the cylinder’s major axis. As the fluid (here, air) impinges on the leading edge of the cylinder, the fluid pressure rises. The high fluid pressure near the leading edge impels flow about the cylinder as boundary layers develop about both sides. However, the pressure is not so high as to force the flow about the backside of the cylinder. Accordingly, the boundary layers separate from each side of the cylinder surface at a point near its greatest width. This forms two shear layers that trail aft in the flow and bound in the wake. Since the innermost portion of the shear layers are in contact with the cylinder, they move much more slowly than the outermost layers that are in contact with the free flow. This causes the shear layers to roll into the near wake, where they fold upon each other and coalesce into discrete swirling vortices. A regular pattern of vortices, called a vortex street, trails aft in the wake of the cylinder.² Von Karman associated the formation of the stable street of staggered vortices in 1912, after Benard laid the groundwork in 1908.

² As early as the fifteenth century, Leonardo da Vinci observed and sketched a row of vortices visible in the wake of a piling in a stream of water.

[0012] This vortex street is precisely the effect observed when a golf club shaft is swung through the air. In fact, the vortex street is what causes the characteristic "swoosh" noise heard during a rapid swing.

[0013] It is well recognized that a decrease in drag bestows the same result as in an increase in thrust. For example, applying automobile wax to an airplane will raise its top speed by several miles per hour. The net result is the same as if the airplane's engine horsepower had been increased. Drag can be thought of as a retarding force—as if an unseen hand is pulling the object back. The point here is that human muscles are used to generate the all-important golf club head speed. The lessening of drag frees the effort that would be expended in fighting drag to be added to the accelerating vector, which results in higher golf club head speed.

[0014] The prior art discloses inventions that are intended to reduce drag in the golf scenario. The reduction in aerodynamic drag, causing an increase in clubhead speed was recognized at least as early as 1922. See, e.g., U.S. Pat. No.
1,418,038 to Tousey at 53. (Tousey added ridges to the shaft in order to eliminate the annoying "swish" during indoor practice, and noticed the improved playing characteristics of the golf club.)

[0015] Several prior art designs involve a shaft that has been formed into the shape of a streamlined wing. Notable are U.S. Pat. No. 6,027,414 to Koebeler, U.S. Pat. No. 5,921,870 to Chiasson, and U.S. Pat. No. 5,795,244 to Lu. However, the disadvantages of those systems are manifold:

[0016] There is the issue of high cost associated with their complex manufacture.

[0017] The club shaft’s bending characteristics, which are important to the dynamics of the golf club as a whole, are necessarily altered by changing the moment of inertia through the airfoil section (that is, the club is stiffer in the plane of the swing than in the off-axis).

[0018] To understand the third disadvantage, one must realize that during the course of the golf swing the club is actually rotated approximately 135 degrees about the shaft axis. If there is an airfoil fixed to the shaft, the airfoil’s angle of approach to the relative wind continuously varies during the course of the swing. The result is that the airfoil imparts a torque that interferes with what should be a smooth, even rotation. The symmetrical airfoil disclosed by Lu minimizes the torque effect, but does not overcome the other two disadvantages.

[0019] In every case cited above, the prior art shaft aerodynamic devices taught are complex, require expensive manufacturing tooling and processes, and/or are awkward to retrofit to existing equipment.

[0020] In 1967, Sluntsman and Hintz researched the effect of a splitter plate in reducing drag in aircraft applications. While the study was targeted to Mach numbers of 0.65 to 0.95, the results are easily extrapolated down to Mach 0.10 to 0.20, typical golf club head speeds. The splitter plate interferes with the rolling boundary layers, described above, such that they are prevented from folding upon each other and therefore cannot coalesce into discrete swirling vortices, and therefore no vortex street is formed. The splitter plate is a simple structure, much easier to manufacture than an airfoil or cavity.

[0021] While a vortex street may be reduced by several methods, none of the prior art shaft aerodynamic devices taught incorporate the present invention’s splitter plate, which prevents formation of a vortex street and thereby significantly reduces aerodynamic drag on the shaft. A surprising result is achieved when the splitter plate is formed of a flexible material: because a flexible material and/or attachment allows the splitter plate to trail during the shaft rotation during the swing, the splitter plate locates itself precisely where it needs to be to function most effectively throughout all portions of the swing.

BRIEF SUMMARY OF THE INVENTION

[0022] Therefore, one object of the present invention is to provide an aerodynamically efficient sporting equipment shaft.

[0023] Another object of this invention is to provide a sporting equipment shaft that inhibits the formation of a vortex street when it is swung through the air.

[0024] Another object of this invention is to provide a sporting equipment shaft that is not unduly torqued during the swing.

[0025] A further object of this invention is to provide a sporting equipment shaft that exhibits reduced shaft vibration.

[0026] A still further object of this invention is to provide a sporting equipment shaft that does not exhibit the characteristic "swoosh" noise when it is swung through the air.

[0027] Other objects and advantages of the present invention will become apparent hereinafter.

[0028] The present invention is a flexible splitter plate drag reduction device of a preferably "T" shaped configuration, used in conjunction with a sporting equipment shaft. The present invention fulfills all of the above desirable objects.

[0029] These and other aspects and advantages of the present invention are set forth in the following detailed description and claims, particularly when considered in conjunction with the accompanying drawings in which like parts bear like reference numerals.

DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

[0030] FIG. 1 is a front elevation view of an embodiment of the present T-Blade Drag Reduction Device as used with a golf club shaft, also illustrating a sectoral view thereof.

DESCRIPTION OF THE INVENTION

REFERENCE NUMERALS

[0031] 10 T-Blade Drag Reduction Device attached to a Golf Club Shaft

[0032] 20 Grip

[0033] 30 Shaft

[0034] 40 Head

[0035] 50 Splitter Plate

[0036] 60 T-Hinge Mount

[0037] 70 Slot

[0038] Referring now to the drawings, FIG. 1 illustrates a T-Blade Drag Reduction Device as used with a golf club shaft, shown generally as 10. Prior art golf club elements are Grip 20, Shaft 30, Head 40, which are assembled linearly. Shaft 30 is of generally circular cross section, and may be tapered gradually from one end to the other, or may be stepped down in diameter toward Head 40. Head 40 may be of any configuration; the present invention functions just as well with irons as with woods and drivers.

[0039] Splitter Plate 50 is preferably constructed of flexible plastic, but may be formed from any common material such as rigid plastic, metal, foil, textile, fiber, or composites.

[0040] The preferred embodiment utilizes a flexible plastic T-Hinge Mount 60 to connect Splitter Plate 50 to Shaft
using adhesive means. However, it should be noted that 

Splitter Plate 50 may be mounted directly to Shaft 30 by, for example, welding or adhesives, or it may be formed as an integral part of Shaft 30 during manufacture thereof. The attachment point is preferably located along the trailing edge of the shaft when the golf club is at the point of impact with the golf ball, i.e. perpendicular to the striking face of Head 40, but the attachment point may be varied to suit the individual user.

The amount of flex exhibited in T-Hinge Mount 60 is a function of its selected construction material and the dimension of the necked-down area. This flex, plus the flexible component contributed by Splitter Plate 50, allows Splitter Plate 50 to rotate as it trails behind Shaft 30 when the golf club is swung through the air. As the golf club is typically rotated about 135 degrees during the course of a swing, the flexibility feature is desirable so that Splitter Plate 50 may locate itself dynamically, maintaining a neutral angle of attack which optimally isolates the counter-rotating vortices generated by Shaft 30. The isolation of the counter-rotating vortices prevents the formation of the above-described vortex street.

The appropriate width w of Splitter Plate 50 plus T-Hinge Mount 60 assembly is calculated as a function of the outside diameter of Shaft 30, d. It has been demonstrated that when w equals d, aerodynamic drag induced by a simple cylinder in a fluid is reduced by 30 to 50%. Maximum drag reduction occurs when w equals approximately 4d. Accordingly, for best results, the width of the assembly should be about four (or more) times the diameter of Shaft 40. However, significant results are achieved with less width.

Slot 70 is optionally provided so as to allow the club Shaft 30 to flex without crimping and deforming Splitter Plate 50. Slot 70 may be incorporated in Splitter Plate 50 by physically cutting or punching Splitter Plate 50, it may be formed by leaving a gap during insertion of Splitter Plate 50 pieces into continuous T-Hinge Mount 60, or it may be formed by sectioning the Splitter Plate 50 plus T-Hinge Mount 60 assembly, and leaving a gap between the pieces when they are attached to Shaft 30. Multiple instances of Slot 70 are anticipated, even to the point where Splitter Plate 50 begins to resemble a feather or a comb. However, in the preferred embodiment, Slot 70 is incorporated at about three to five points along Shaft 30.

The striking end of the golf club travels at the highest velocity, while the handgrip moves significantly slower. Therefore, good results in aerodynamic drag reduction are achieved by installing Splitter Plate 50 only along the lower approximately one-third portion of the golf club Shaft 30, nearest Head 40. However, in the preferred embodiment, Splitter Plate 50 is installed along approximately 90% of the accessible portion of Shaft 30, as depicted in FIG. 1.

The aerodynamic drag induced by the slower-moving handgrip end of the golf club Shaft 30 is minimal. In this area, setting w equal to d is sufficient because aerodynamic drag induced by the upper one-third of Shaft 30 is significantly lower compared to that contributed by the high-speed one-third. Therefore, Splitter Plate 50 may be tapered in width from top to bottom, as shown in FIG. 1, without resulting in a significant impact on performance. Accordingly, while the present invention has been described herein in detail in relation to its preferred embodiment, it is to be understood that this disclosure is only illustrative and exemplary of the present invention and is made merely for purposes of providing a full and enabling disclosure of the invention.

The foregoing disclosure is not intended to limit, nor is it to be construed to as limiting, the present invention or otherwise to exclude any such other embodiments, adaptations, variations, modifications and equivalent arrangements, the present invention being limited only by the claims appended hereto and the equivalents thereof.

What I claim as my invention is:

1. An aerodynamic drag reduction device for use with a sports equipment shaft which is intended to move through a fluid, comprising a splitter plate element joined to said shaft in a generally trailing position normal to the striking surface of said sports equipment, extending along the long axis of said shaft for substantially the entire length of said shaft, with said splitter plate exhibiting an effective width equal to at least about four times the diameter of said shaft.

2. The aerodynamic drag reduction device of claim 1, wherein said splitter plate is composed of a flexible material.

3. The aerodynamic drag reduction device of claim 1, wherein said splitter plate is attached to said shaft by flexible hinge means.

4. The aerodynamic drag reduction device of claim 1, wherein the effective width of said splitter plate is at least about equal to the diameter of said shaft.

5. The aerodynamic drag reduction device of claim 1, wherein said splitter plate extends along the long axis of said shaft for a distance of approximately about one-fourth the length of said shaft.

6. The aerodynamic drag reduction device of claim 1, wherein said splitter plate is interrupted one or more times by a slot cut through the width of said splitter plate.

7. The aerodynamic drag reduction device of claim 1, wherein said splitter plate is divided into two or more sections such that a gap is formed between said sections.