FULL AIRFOIL SAIL

FIG. 1.

FIG. 2.

FIG. 3.
ABSTRACT OF THE DISCLOSURE

A full airfoil sail has a plurality of rigid, horizontal, vertically spaced apart ribs, each having the shape of an airfoil cross-section, encased in the sail. The ribs slide up and down a rotatable mast. When the sail is lowered the sail and ribs may be received in a furl box for storage. Differential shaped sails may be interchanged for different tasks.

This invention relates to a new and improved full airfoil sail. The invention is characterized by the use of a plurality of horizontal, vertically spaced ribs each having the cross-section of an airfoil rib which slide up and down a mast. The sail encloses the ribs and thus has the cross-section thereof and, accordingly, comprises a thick, high lift, low drag airfoil which is considerably more efficient than conventional sails.

One of the limitations of the conventional sail is that it is a single thickness of a thin material. Accordingly, inherently such a sail cannot have the high lift characteristics of a true airfoil.

Still another inefficiency of the conventional sail is the fact that the angle of attack of the sail varies with the elevation. A conventional sail is connected to the mast along one vertical edge and its lower edge is attached to a boom. Thus at the bottom, the configuration of the sail is practically straight, i.e., the same as the boom. As the elevation above the boom increases, the chord of the curvature of the sail increases and, accordingly, the angle of attack increases. However, only one angle of attack is most efficient under any given set of sailing conditions and hence only a limited area of the sail presents such angle of attack to the wind. In accordance with the present invention, the angle of attack is constant throughout the length of the mast and the efficiency of the sail is maintained throughout its length.

Another feature of the present invention is the fact that the ribs extend slightly forwardly of the mast and hence the sail is as thick immediately before and behind the mast as at any other point. In conventional sails where a single sheet of material is used, there is an abrupt decrease in cross-section from the relatively thick mast to the thin sail. The most serious situation exists at the luff-mast union where there is excessive turbulence with resultant drag and loss of lift. In accordance with the present invention, the mast merges into the cross-section of the rib and there is no turbulence behind the mast.

Accordingly, the present invention provides a high lift of the ribs of uninterrupted contours which can be maintained at a constant angle of attack throughout its length.

A still further feature of the invention is the fact that the sail is capable of being furled or reefed. Even when the sail is only partially hoisted, the ribs and the fact that the ribs are spaced even when the sail is partially hoisted maintains the fabric around the ribs in a proper airfoil configuration.

Still another feature of the invention is the provision of tracks on the mast and rollers on the ribs which facilitate hoisting and lowering the sail.

Another feature of the invention is the provision of stretcher which are attached to the mast and to the outer edges of the lowermost rib to maintain the ribs substantially horizontal.

Another feature of the invention is the provision of a furl box which fits partially around the mast and is shaped to accommodate the ribs and furl a sail so that they can be quickly detached from the mast and a new sail attached. This feature of the invention is of particular importance when the tack of the vessel is changed. Two mirror-image sets of sails are provided, each in its individual furl box, the sails being rapidly interchangeable as the tack changes.

A further feature of the invention is the provision of a convenient arrangement interrupting the tracks on the mast to provide for insertion of the furl box, the furl box having track segments which match the mast track.

Other objects of the present invention will become apparent upon reading the following specification and referring to the accompanying drawings in which similar characters of reference represent corresponding parts in each of the several views.

In the drawings:

FIG. 1 is a schematic perspective view of a sail, mast and supporting structure partially broken away to reveal interior construction.

FIG. 2 is a fragmentary perspective view showing the sail partially furled.

FIG. 3 is a schematic view illustrating the use of two sails, one for port and one for starboard tacks.

FIG. 4 is an enlarged fragmentary view partially broken away in section.

FIGS. 5 and 6 are horizontal section views taken substantially along the lines 5--5 and 6--6, respectively, of FIG. 4.

In a preferred form of the present invention, the mast 11 is in the shape of a hollow square. The lower end of the mast is received in an externally cylindrical inner bearing member 12 which is rotatable in a cylindrical bore 13 of a pedestal 14 mounted on a subdeck 16 spaced below the top deck 17. Accordingly the mast 11 may turn relative to the vessel and it will be understood that various mechanical means for turning the mast and for retaining it in a position of adjustment may be employed as is well understood in the art of sailing vessel construction. The top 18 of the mast is connected to swivel relative to the remainder thereof about a vertical axis. Shrouds 19 and backstays 20 are connected to eyes 25 on top 18 and also to appropriate locations (not shown) on the deck 17. On both the fore and aft sides of the mast 11 and running substantially the entire length thereof are track members 21 having inner flanges 22 fastened to mast 11 by screws 23 and having transverse webs 24 which are flush with the sides of the mast and spaced inward-turned flanges 26 which are spaced from flanges 22 a finite distance. Tracks 21 terminate a fixed distance above the deck 17 as indicated by reference numeral 27 in FIG. 4 for a purpose hereinafter described.

At vertically spaced intervals along the height of the mast are horizontal ribs 31 of a rigid material such as aluminum and formed with apertures 32 to reduce weight. The lift slide 33 of the rib is curved in the configuration of the top surface of a low speed aircraft wing or sail plane and the lower edge 34 is substantially flat. The forward nose 36 is streamlined and it should be noted with particular reference to FIG. 5 that the nose 36 is spaced considerably forward of the mast 11. The trailing edge 37 tapers as in conventional aircraft wings. The shape of rib 31 is thus similar to the corresponding rib in an aircraft wing. In the region of the mast 11, the edge 34 is cut out in an irregularly shaped aperture 38 which is substantially rectangular but has a pair of inward extending tongues 39 which extend into the space between the
tracks 21 on either side of the mast. Rollers 41 are suitably rotatably mounted on the tongues 39 and rolled between the flanges 26 and 22 of each track 21. Thus the ribs can slide up and down the mast, the rollers 41 rolling along the tracks 21. This arrangement holds the ribs 31 in alignment with the mast so that the ribs turn when the mast turns.

The sail comprises a sheet of fabric 46 which assumes the cross-section of the rib. Thus the sail 46 originates at one edge of aperture 39 as indicated by reference numeral 47, and then expands around the nose 36 of the rib thence along the curved side 33 to the trailing edge 37 and back along edge 34 to its terminus 48 on the edge of aperture 38 opposite point 47. A plurality of ribs 31 are spaced along the height of the sail, the number of ribs being sufficient to maintain a taut shape of the sail. To maintain the lowermost rib 31a horizontal, a pair of stretchers 49 may be used, one end of each stretcher being attached to the mast 11 and the outer end thereof being attached to the lowermost rib 31a.

It has been noted that the mast is hollow and the halliards 50 used to raise and lower the sail run up through hollow of the mast around pulleys 51 at the top of the mast and are attached to the uppermost rib 31b. The lower ends of the halliards 50 run below the subdeck 16 to a convenient point for hand hoisting or to a winch (not shown) as is well understood in the art of sailing. When the halliards 50 are fully hoisted, the sail assumes the full airfoil configuration shown in FIG. 1. When the sail is only partially hoisted as shown in FIG. 2, the lower ribs 31 fit on top of each other. However, the upper ribs maintain their spacing and hence the unfurled portion of the sail is of streamlined configuration even though the sail is only partially hoisted.

As best shown in FIG. 3, a different sail must be used when on the port tack than from the starboardboard and thus two complete sets of sails are required. To accommodate rapid changing of the sail, each sail is received in a furf box 56 (FIG. 6). The external configuration of box 56 is similar to that of the largest ribs 31 but slightly larger. A notch 57 is formed in one edge of each furf box (the particular edge depending upon the direction of the tack) and the opening 57 fits over the mast 11 when the furf box is in use. Track elements 58, similar in shape to tracks 21, are installed in the furf box and when the furf box is in position as shown in dot and dash lines in FIG. 4 the tracks 58 match up with the tracks 21. Hence, when the sail is furled, the ribs drop into the furf box 56 being held in position by the tracks 58. When the sail has dropped completely into the furf box 56, the furf box may be moved laterally relative to the mast 11 and the box, as well as its contents of sail and ribs, are rapidly removed, thereupon the opposite or mirror-image furf box and sail can be rapidly positioned on the mast, the halliard connected to the uppermost rib of the new sail and the new sail hoisted into place with a minimum of time and effort. When the sail is fully hoisted, the furf box 56 is removed and the stretchers 49 applied.

6. The construction of claim 5 in which said tracks are interrupted at the bottom of said mast for lateral withdrawal of said ribs and sail material for removal of the sail from the mast.

7. The construction of claim 6 which further comprises a furf box formed with an opening along one edge complementary to said mast, said box open at the top and of a height to fit below the lower termini of said tracks, said mast fitting into said opening, whereby on lowering said sail said sail drops into said box and can be removed from the mast while in the box.

8. The construction of claim 7 in which said box is provided with track sections, said sections positioned to constitute extensions of said tracks when said box is positioned on said mast.

9. The construction of claim 1 which further comprises a first rotatable member having a circular configuration fixed to the bottom of said mast, a second rotatable member receiving said first rotatable member, and means for mounting said second rotatable member on the boat, said mast, ribs and sail material rotatable relative to the boat upon relative rotation of said first and second rotatable members.

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