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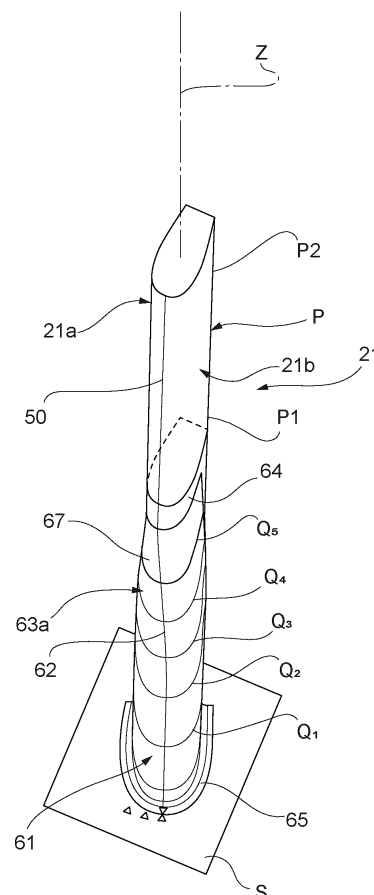
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(54) MAIN MAST OF A SAILING BOAT

(57) A mainmast (21) has a support base (S) suitable to be fixed to a hull (11) of a sailing boat (1), and an upright (P), which extends along an axis from the support base (S), carries an airfoil, having a leading edge (62) and two lateral surfaces (63a,63b) opposite to each other, and is rotatable about its axis with respect to the support base (S) to position the leading edge (62); said airfoil is defined by a flexible fairing (60), which is arranged in front of a lower portion (P1) of the mainmast (P) and has a first and a second connecting portion (64,65) axially spaced apart from each other; the first connecting portion (64) is coupled to the upright (P) so as to rotate together with the latter with respect to the second connecting portion (65) and twist the airfoil of the fairing (60) due to the rotation.

**FIG. 4**

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application claims priority from Italian patent application no. 102023000027834 filed on December 22, 2023, the entire disclosure of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] The present invention relates to a mainmast of a sailing boat, which is designed, in particular, for offshore sailing competitions, to which the following description will make explicit reference without thereby losing generality.

[0003] In particular, the present invention finds advantageous but not exclusive application in a sailing boat having a single hull and provided with hydrodynamic lifting foils, usually indicated with the English term "hydrofoil", or more simply "foil", which are configured so as to have a hydrodynamic lift that is able to support the weight of the vessel and keep the hull out of the water when the vessel is sailing at relatively high speeds.

PRIOR ART

[0004] As is known, a sailing boat essentially comprises a hull, closed at the top by a deck, at least one mainmast that protrudes vertically from the hull and from the deck, a forestay that connects the upper end portion of the mainmast to the bow of the hull, a main sail known as mainsail, hoisted on the mainmast, and a front sail known as jib, hoisted on the forestay.

[0005] In regular sailing conditions, the mainsail is used to sail upwind, whereas the jib helps the boat tack correctly and allows to maintain control of the bow.

[0006] It is also known that hydrodynamic lifting foils, or hydrofoils or even more simply foils, are mounted on racing sailing boats, in order to keep the hull out of the water when given cruising speeds are reached, in a condition that is commonly referred to as "flying on the surface of the water", in order to reduce hydrodynamic resistance during navigation.

[0007] In recent decades, hydrofoils have been used both on multi-hull sailing boats, especially on trimarans, and on mono-hull sailing boats, in order to maximize the speed of the boats designed for sports competitions.

[0008] In order to try to obtain high speeds, especially for this type of racing boat, there is a strong need to increase the component of the wind force in the advancement direction of the boat and, consequently, minimize the lateral component and/or any losses.

[0009] In this regard, in the last decade, some solutions known from the world of racing cars (for example from the world of Formula 1), as well as from the aeronautical field, have been proposed and successfully applied to racing sailing boats. For example, sails have begun to be de-

signed as real airfoils capable of maximizing the wind thrust in the advancement direction for each apparent wind angle.

[0010] Furthermore, the mainmast has also been the subject of innovations, in particular by providing a cross-section area having an elongated drop shape, in order to define an aerofoil. In other words, the mainmast is defined by a symmetrical, vertically extruded profile, which often also has the ability to rotate about its vertical axis with respect to the deck of the hull, in order to try to align the front edge, or leading edge, of the airfoil defined by the mainmast with respect to the direction of the apparent wind, namely, the AWA ("apparent wind angle").

[0011] The presence of the jib in front of the mainmast generally has the effect of locally varying (in particular the effect of reducing) the angle of the air flowing towards the leading edge of the mainmast.

[0012] However, the effects of the jib on the direction of the air flow towards the leading edge of the mainmast vary with the height above the deck of the boat, essentially due to the fact that the jib sail swells with the wind and does not assume a constant profile shape as that height varies.

[0013] In other words, depending on the height above the deck, different flow conditions are obtained on the airfoil of the mainmast, due to the jib being arranged in front.

[0014] Given this variation of the air flow angle, in known solutions it is necessary to adopt a compromise in the adjustment of the mainmast angle about its vertical axis, namely, to seek a compromise in the positioning of the leading edge in order to maximize the longitudinal thrust force and, at the same time, avoid a possible stall of the airfoil.

[0015] However, obtaining said compromise is not easy, especially for mainmasts and jibs having a relatively high height.

[0016] In light of these considerations, there is a need to improve the aerodynamic performance of the mainmast, thus minimizing the effects due to variations in the incidence of the air flow as the height varies.

[0017] The object of the invention is therefore to satisfy the above-mentioned needs, preferably in a simple and/or effective and/or inexpensive manner.

SUMMARY OF THE INVENTION

[0018] The above-mentioned object is achieved by a mainmast of a sailing boat, as defined in claim 1.

[0019] The dependent claims define particular embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] Hereinafter, for a better understanding of the present invention, a preferred embodiment will be described by way of a non-limiting example, with reference to the attached drawings, wherein:

- Figure 1 is a simplified perspective view, with schematic parts, relating to a sailing boat provided with a mainmast according to the preferred embodiment of the present invention;
- Figure 2 is a different perspective view, with schematic parts, showing the mainmast shown in Figure 1; and
- Figures 3 and 4 are different perspectives, on an enlarged scale, showing a detail of the mainmast according to the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

[0021] In Figure 1, reference number 1 denotes, as a whole, a sailing boat, of the monohull type (illustrated partially and by simplifying some parts).

[0022] The sailing boat 1 comprises a hull 11 extending along a longitudinal axis X between a forward end or bow, indicated by reference 12, and a rear end or stern, indicated by reference 13. The longitudinal axis X coincides with a normal advancement direction V of the sailing boat 1.

[0023] The hull 11 extends, furthermore, in width and height along a transverse axis Y and along an axis Z, perpendicular to one another and to the longitudinal axis X, so as to form a Cartesian triplet of orthogonal axes, fixed with respect to the hull 11. The longitudinal axis X, the transverse axis Y and the axis Z are commonly referred to as the roll axis, the pitch axis, and the yaw axis, respectively.

[0024] The hull 11 is delimited laterally by opposite sides 14, 15, extending between the bow 12 and the stern 13, and is normally closed at the top by a deck 16.

[0025] The sailing boat 1 preferably comprises, furthermore, a keel or centreboard 18, which protrudes downwards along an axis parallel to the axis Z starting from a portion 19 of the hull 11 arranged in an intermediate position between the bow 12 and the stern 13, and centrally between the sides 14, 15 of the hull 11. Preferably, the centreboard 18 has a lower end that supports or defines a bulb 20, having a mass (for example of about 8-10 tons) so as to place the centre of gravity of the sailing boat 1 in a relatively low position, in particular to allow the self-righting of the sailing boat 1 even in the event of a totally capsizing.

[0026] Preferably, the sailing boat 1 is of the type suitable for offshore sailing competitions and is provided with lateral arms, known and not illustrated, provided with respective hydrofoils or more simply foils (also known and not illustrated) and connected to the hull 11 so as to be independently movable between a lowered position, in which they immerse their foil in the water, and a raised position, in which they keep their foil out of the water.

[0027] As shown in Figure 2, the sailing boat 1 comprises, furthermore, a mainmast 21 having a support base S mounted in a fixed position with respect to the hull 11 and an upright P, which protrudes upwards from

the support base S along an axis which, in the specific example illustrated, coincides with the axis Z. According to a preferred aspect of the present invention, the upright P of the mainmast 21 defines an airfoil or aerofoil, better shown in Figures 3 and 4: such airfoil is configured in order to have two opposite surfaces 21a and 21b, which are convex, extend from a leading edge 50 and are symmetrical with one another with respect to an ideal median plane, on which the axis Z and the leading edge 50 lie. In use, the surfaces 21a and 21b are arranged, one, upwind and, the other, downwind (in the example illustrated, the surface 21b is downwind).

[0028] Given the symmetry with respect to the aforementioned ideal median plane, the leading edge 50 of the upright P is rectilinear and parallel to the axis Z, and the cross-sections of its airfoil have an invariant shape throughout its axial height. Preferably, the dimensions of the cross-sections of the upright P also remain equal to one another, throughout its height, without tapering.

[0029] With reference to Figures 1 and 2, the sailing boat 1 comprises, furthermore, a mainsail 22, hoisted in a known manner and not described in detail on the mainmast 21. The mainsail 22 has opposite surfaces, arranged upwind and downwind, respectively.

[0030] Advantageously, the sailing boat 1 comprises, furthermore, one or more jibs, in the case illustrated two, indicated respectively with the references 25 and 26, which are arranged in front of the mainmast 21, namely, between the latter and the bow 12, and are configured, when cross-sectioned with horizontal section planes, according to given aerofoils in each cross-section.

[0031] The jibs 25 and 26 have respective opposite surfaces, arranged upwind and downwind, respectively.

[0032] Preferably, but not exclusively, the jibs 25 and 26 define respective slats with respect to the airfoil defined by a lower portion P1 of the upright P, which is immediately adjacent towards the stern.

[0033] In practice, the jibs 25, 26 are added to the aerofoil defined by the mainsail 22 and the mainmast 21, and increase the curvature of the profile overall exposed to the wind during navigation. For the same heeling moment, an increase in lift is obtained from the sail system of the sailing boat 1, defined by the mainsail 22 and the jibs 25 and 26, which facilitates the motion of the boat in flight condition on the surface of the water, as well as obtaining high speeds.

[0034] In more general terms, each jib 25, 26 has a shape and/or structure and/or dimensions such as to define an aerodynamic lift and/or aerodynamic resistance due to a relative speed with respect to the air during navigation.

[0035] As mentioned above, the jib 25 is arranged immediately adjacent to the lower portion P1 of the upright P of the mainmast 21. With respect to said lower portion P1, the jib 25 defines a slot 27 of given dimensions.

[0036] The jib 26 is instead arranged in front of the jib 25, precisely between the latter and the bow 12.

[0037] As shown in Figure 1, the jib 26 defines a slot 28 of given dimensions with the jib 25.

[0038] Preferably, the jib 25 comprises:

- a support element 29 with an elongated geometry along a respective main direction A having a prevalent extension with respect to the other dimensions, arranged in front of the mainmast 21 and protruding upwards with respect to the hull 11 along the aforementioned main direction A;
- a plurality of ribs 31, each defining a respective aerofoil and carried transversally in a cantilevered manner by the support element 29 in parallel positions and spaced apart from one another along the main direction A of extension of the support element 29; and
- a sail 33 fitted on the ribs 31 in the manner of a bag open at its opposite ends so as to form a respective closed loop around the ribs 31.

[0039] In the illustrated case, the aerofoils of the ribs 31 have dimensions that gradually taper upwards, to be fitted by a triangular sail 33; according to a possible alternative not illustrated, the aerofoils of the ribs 31 could also have constant dimensions.

[0040] Similarly to what has been shown for the jib 25, the jib 26 also preferably comprises:

- a support element 30 with an elongated geometry along a respective main direction B having a prevalent extension with respect to the other dimensions, arranged in front of the mainmast 21 and the support element 29 and protruding upwards with respect to the hull 11 along the aforementioned main direction B;
- a plurality of ribs 32, each defining a respective aerofoil and carried transversally in a cantilevered manner by the support element 30 in parallel positions and spaced apart from one another along the main direction B of extension of the support element 30; and
- a sail 34 fitted on the ribs 32 in the shape of a bag open at its opposite ends forming a respective closed loop around the ribs 32.

[0041] In the illustrated specific case, the support elements 29, 30 are defined by forestays that connect a portion of the upper end 21c of the mainmast 21 to a portion of the bow of the hull 11.

[0042] The main directions A, B having prevalent extension of the support elements 29, 30 are therefore oblique with respect to the vertical axis Z and transverse with respect to the plane identified by the longitudinal axis X and transversal axis Y.

[0043] Preferably, the sailing boat 1 comprises, furthermore, one or more actuators (not illustrated) to move the ribs 31, 32 and/or the support elements 29, 30 along planes transverse to the longitudinal axis X and to the

vertical axis Z. In the illustrated specific case, a first actuator is used to move the support element 29 and a second actuator, different from the first, to move the support element 30.

[0044] Preferably, the support elements 29, 30 engage respective through grooves 39, 40 obtained in the deck 16 and shaped like cams to define the movement trajectories of the support elements 29, 30.

[0045] According to one aspect of the present invention, with reference to Figure 2, lower portion P1 of the upright P is mounted on the support base S so as to be rotatable about the axis Z. In other words, the upright P can be oriented with respect to the support base S (and therefore with respect to the surrounding space) about the axis Z using known techniques, for example by operating an actuator 51 (schematically illustrated) carried by the support base S and/or arranged below deck.

[0046] In this way, it is possible to adjust the position of the leading edge 50 of the airfoil of the upright P as a function of the angle of incidence of the air flowing towards the upright P, in order to optimize the aerodynamic conditions of the mainmast 21.

[0047] In particular, this adjustment of the orientation about the axis Z is performed as a function of the configuration of the jib 25, which determines the angle of incidence of the air flowing in the slot 27 towards the lower portion P1 of the upright P.

[0048] In particular, the jib 25 has a height that is less than the one of the mainmast 21, so it influences the angle of incidence of the air flow only for the lower portion P1, but not for the remaining part of the upright P, defined by an upper portion indicated with the reference P2 in the attached figures.

[0049] Given the high height of the jib 25, and given the different curvatures that the cross-section of the jib 25 assumes as the height varies (with respect to the deck 16 and/or the support base S), the air flow that impacts the lower portion P1 of the upright P has an angle of incidence that varies precisely as the height varies. In other words, the aerodynamic operating conditions of the mainmast 21, caused by the air flows directed towards the upright P, are potentially different as the height position along the upright P varies.

[0050] To compensate for the different directions of incidence of said air flows along the lower portion P1, according to the present invention the mainmast 21 comprises a fairing 60, which is arranged in front of at least a part of the lower portion P1, so as to cover the same towards the bow. The fairing 60 is formed by a relatively thin-walled semi-shell, made of flexible material, namely, elastically deformable, having two surfaces opposite to one another, one facing the lower portion P1 of the upright P and the other, indicated by the reference 61, exposed to the wind. The surface 61 defines an airfoil which, in practice, covers and replaces that of the lower portion P1. In other words, with reference to Figure 4, the surface 61 comprises a leading edge 62 and two lateral surfaces 63a and 63b, which extend from the leading

edge 62 on opposite sides of the fairing 60 so as to form a series of aerofoils (illustrated schematically and indicated with the references Q1, Q2, Q3, etc.) when the fairing 60 is cross sectioned by any section plane orthogonal to the axis Z.

[0051] The fairing 60 comprises a first and a second connecting portion, indicated with the references 64 and 65, arranged in positions spaced apart from one another along the axis Z and coupled so as to support the fairing 60 and keep the same in front of the lower portion P1. According to the present invention, the connecting portion 64 is coupled to the upright P so as to rotate together with the upright P about the axis Z with respect to the connecting portion 65 and therefore twist the airfoil defined by the surface 61 due to the rotation. In particular, Figures 3 and 4 show, by way of example, a rotation of the upright P in a clockwise direction, with respect to a reference condition in which the leading edge 62 lies in the ideal median plane of the upright P. It is evident that, due to the twisting of the airfoil of the fairing 60, the leading edge 62 no longer lies in the ideal median plane of the upright P, but takes on a curved shape. Furthermore, the aerofoils Q1, Q2, Q3, etc. (corresponding to the various cross-sections of the airfoil of the fairing 60) are progressively rotated about the axis Z, with increasingly greater rotation angles going from the connecting portion 65 towards the connecting portion 64, or vice versa.

[0052] As shown in Figures 3 and 4, the connecting portion 65 is coupled to the support base S. Alternatively, it could be coupled to a different support element, however fixed with respect to the hull 11. The connecting portion 65 is defined by a lower end of the fairing 60, and is fixed to the support base (S), for example, by gluing, rivets, screws, etc.

[0053] The connecting portion 65 is wider than the upright P and is spaced from the leading edge 50 of the lower portion P1, so as to define, in a radial direction with respect to the axis Z, an inner cavity between the fairing 60 and the same lower portion P1. Said spacing facilitates the elastic deformation of the fairing 60 during the rotation of the upright P about the axis Z.

[0054] At the lateral surfaces 63a and 63b, the fairing 60 ends with respective end flaps 66, which extend parallel to the axis Z along the lower portion P1 and rest on the surfaces 21a and 21b, respectively, in positions that are substantially diametrically opposite to one another.

[0055] The connecting portion 64 is defined by an upper end of the fairing 60 and is fixed to the upright P, for example by gluing. At this upper end, the fairing 60 completely rests onto the airfoil of the upright P, namely, it completely rests onto the surfaces 21a and 21b and on the leading edge 50, without defining any empty space with respect to the upright P; in other words, at the upper end, the airfoil of the fairing 60 and the airfoil of the upright P overlap and, given the negligible thickness of the fairing 60, they extend along the axis Z one after the other substantially without interruption.

[0056] In addition, the fairing 60 comprises a tapered portion 67, arranged in an axial position that is intermediate between the connecting portions 64 and 65 and is immediately adjacent to the connecting portion 64. At the tapered portion 67, the cross-sections of the fairing 60 (defining the aerofoils Q1, Q2, Q3, etc., mentioned above) have different dimensions one from the other, based on the different height position, as well as having a different orientation (or angle) based on the rotation of the upright P about the axis Z.

[0057] From the foregoing, it is evident that the fairing 60, by deforming, automatically adapts the orientation of the leading edge 62 based on the height position, in response to the rotation of the upright P. This automatic twisting of the airfoil of the fairing 60 allows the orientation of the aerofoils Q1, Q2, Q3, etc., to be automatically adapted to the different angle of incidence of the air flow coming from the jib 25. In fact, the curvature of the leading edge 62 along the lower portion P1 of the upright P tends to substantially follow the curvature of the trailing edge of the jib 25, so that the leading edge 62 tends to be arranged according to the direction of the air guided by the jib 25. This optimised positioning allows to avoid (or at least limit) stall phenomena on the mainmast 21.

[0058] Furthermore, at higher heights, i.e. at the connecting portion 64, the airfoil of the fairing 60 aligns with that of the upright P and is interrupted. In other words, the fairing 60 is absent along the upper portion P2, on which the jib 25 has no influence.

[0059] Therefore, the variation of the aerodynamic conditions provided by the flexibility of the fairing 60 is present only where it is actually necessary, in addition to being progressive along the upright P.

[0060] In conclusion, thanks to the twisting of the airfoil of the fairing 60 carried by the upright P, it is possible to set the orientation of the upright P about the axis Z in an optimal way, thus improving the air flow conditions on the mainmast 21 as a function of the height, compared to known solutions without the fairing 60.

[0061] The proposed solution, moreover, is extremely simple, and easy to install.

[0062] Finally, it is clear that modifications and variations can be made to the mainmast 21 and to the sailing boat 1 described and illustrated herein with reference to the attached figures that do not go beyond the scope of protection defined by the claims stated in the following.

[0063] In particular, the presence of the fairing 60 in front of the lower portion P1 of the mainmast 21 is independent of the type and number of jibs that are provided in front of the mainmast 21 (for example, the jib sails could be of the traditional type, without ribs).

[0064] Furthermore, the external profile of the fairing 60 could be different from that illustrated by way of example in the attached figures.

[0065] Furthermore, the fairing 60 could be coupled to the upright P and to a fixed support element of the boat in ways other than those indicated above, possibly also by way of the interposition of intermediate elements and/or

by way of a coupling that does not define a rigid fixing.

[0066] Finally, the axis of the upright P may not coincide with the yaw axis of the boat 1 and/or may not be straight: for example, the upper portion P2 could be canted towards the stern.

Claims

1. A mainmast (21) for a sailing boat (1), the mainmast comprising:
 - a) a support base (S) suitable to be fixed with respect to a hull (11) of said sailing boat (1);
 - b) an upright (P), which extends along an axis from said support base (S);
 - c) an airfoil carried by said upright (P) and having a leading edge (62) and two lateral surfaces (63a,63b), which extend from said leading edge (62) and are opposite to each other;

wherein said upright (P) is rotatable about said axis with respect to said support base (S) to vary the position of said leading edge (62);

wherein the mainmast further comprises a flexible fairing (60) defining said airfoil;

characterized in that said flexible fairing (60) is arranged exclusively at a lower portion (P1) of said upright (P) and in front of said lower portion (P1), and comprises a first and a second connecting portion (64,65) axially spaced apart from each other, said first connecting portion (64) being coupled to said upright (P) so as to rotate together with said upright (P) with respect to said second connecting portion (65) and to twist said airfoil due to the rotation.
2. The mainmast according to claim 1, wherein said second connecting portion (65) is coupled to said support base (S).
3. The mainmast according to claim 2, wherein said second connecting portion (65) is defined by a lower end of said flexible fairing (60).
4. The mainmast according to claim 2 or 3, wherein said second connecting portion (65) is fixed with respect to said support base (S).
5. The mainmast according to any one of the preceding claims, wherein said second connecting portion (65), at said leading edge (62), is radially spaced apart from said upright (P).
6. The mainmast according to any one of the preceding claims, wherein said flexible fairing (60), at said lateral surfaces (63a,63b), ends with respective end flaps (67) which rest onto said opposite faces (21a,21b) of said upright (P).
7. The mainmast according to any one of the preceding claims, wherein said first connecting portion (64) is fixed to said upright (P).
8. The mainmast according to any one of the preceding claims, wherein said first connecting portion (64) is defined by an upper end of said flexible fairing (60).
9. The mainmast according to claim 8, wherein said upper end completely rests onto said upright (P).
10. The mainmast according to claim 9, wherein said upright (P) defines a further airfoil, which extends along said axis, substantially without interruption with respect to the airfoil of said flexible fairing (60) at said upper end.
11. The mainmast according to any of the preceding claims, wherein a mainsail (22) is hoisted on the mainmast.

FIG. 1

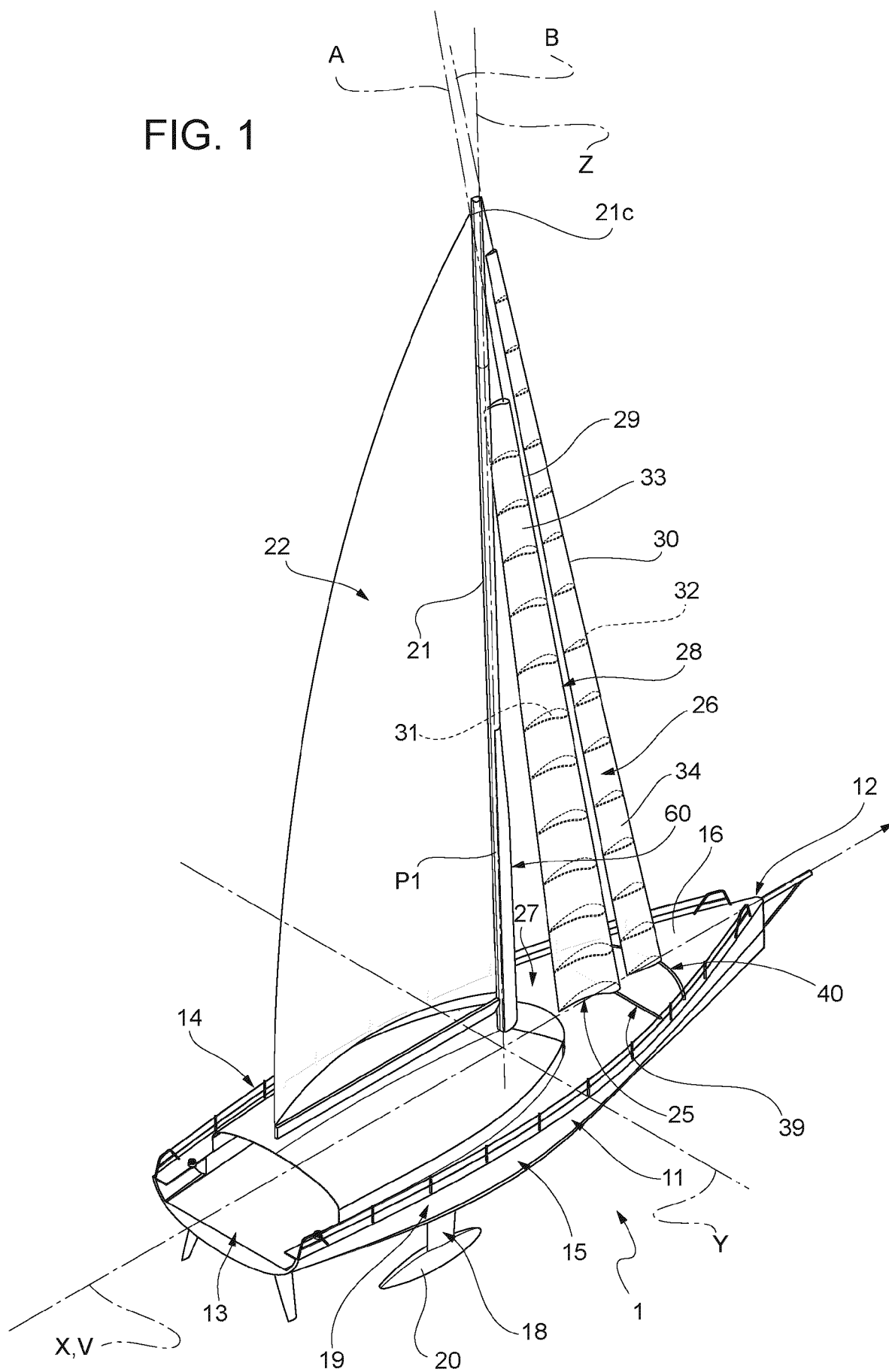
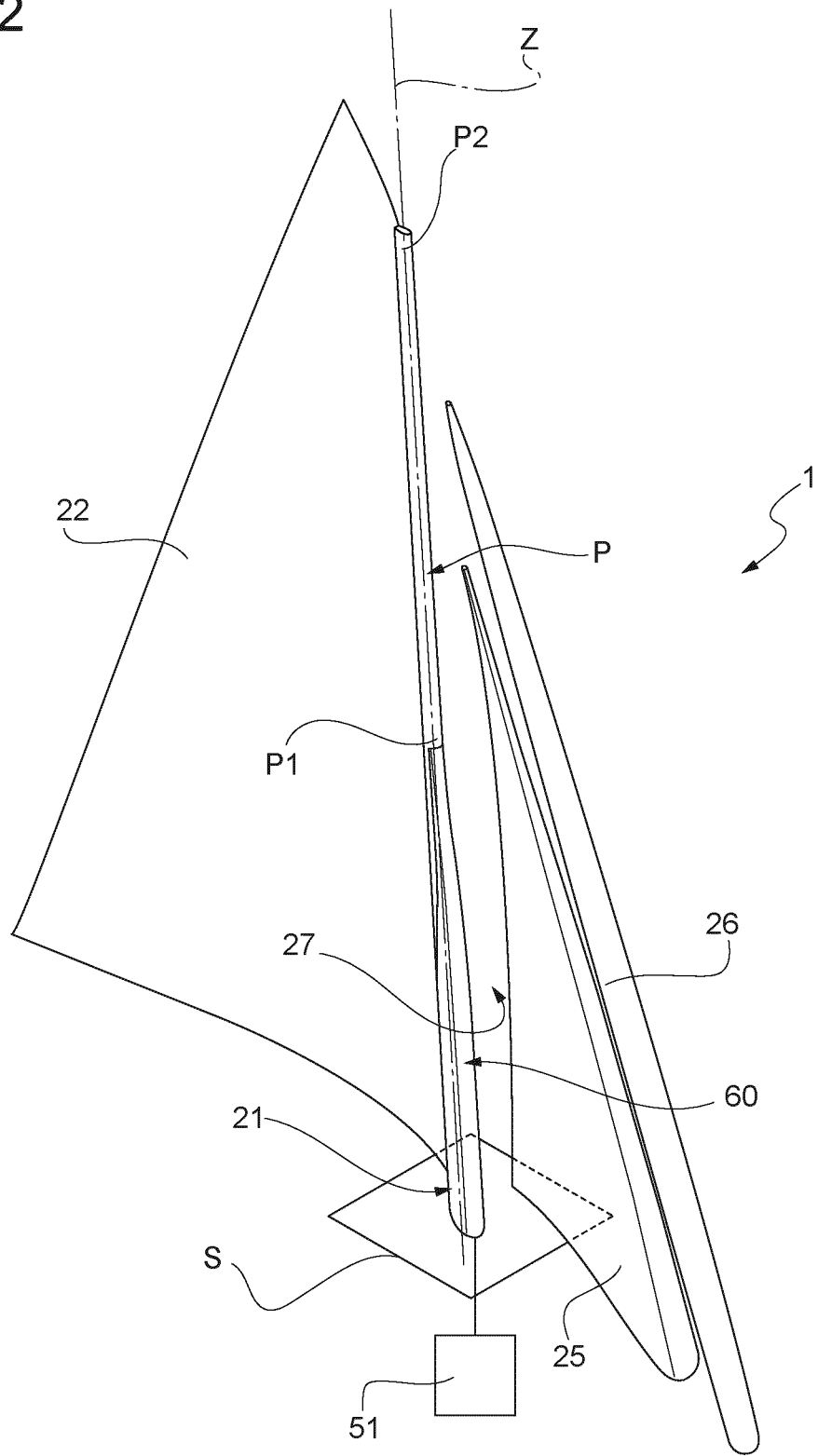


FIG. 2



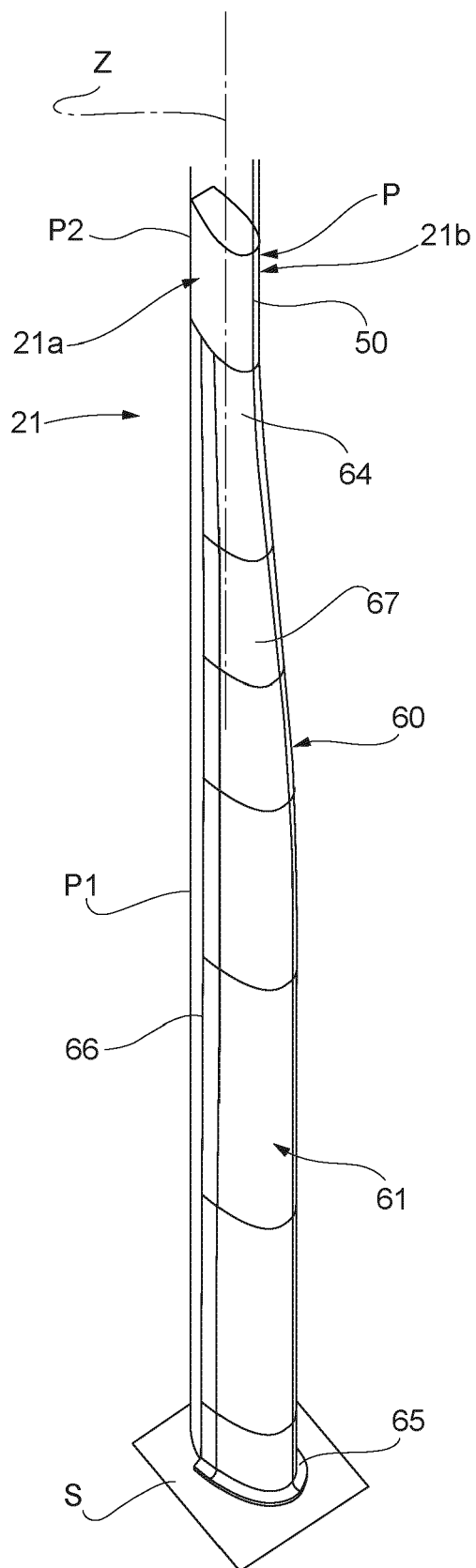


FIG. 3

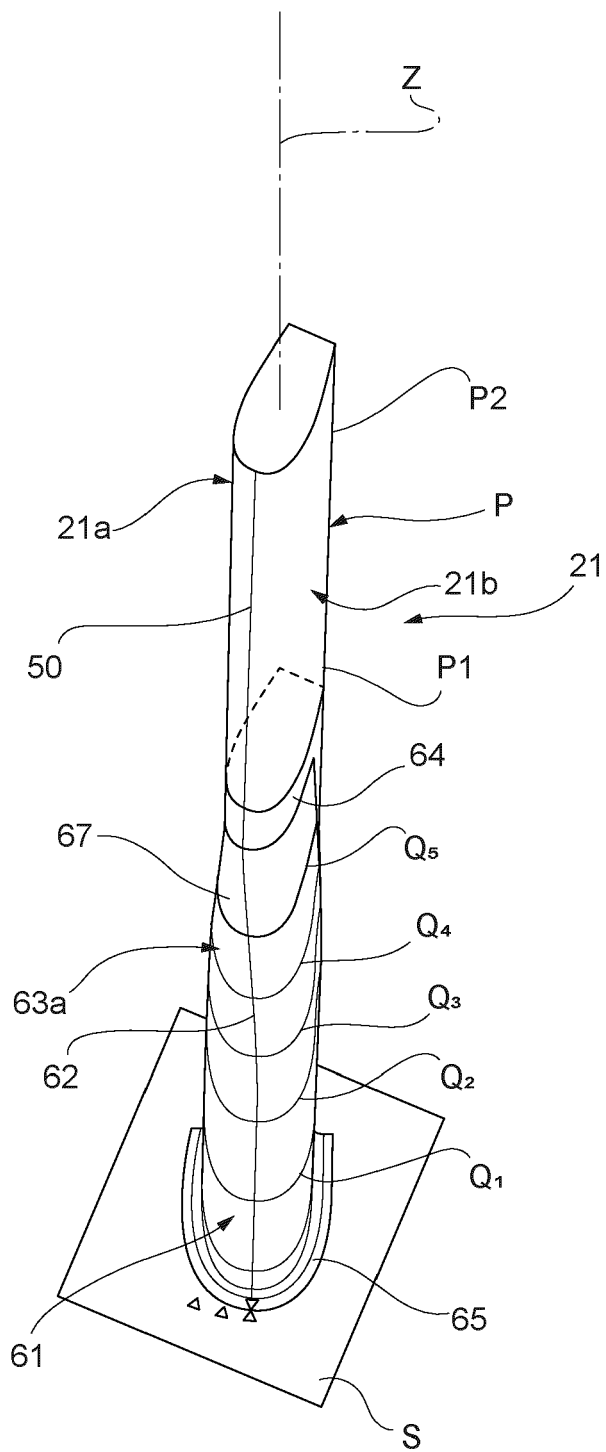


FIG. 4



EUROPEAN SEARCH REPORT

Application Number

EP 24 21 6085

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			TECHNICAL FIELDS SEARCHED (IPC)
			B63H B63J B63B
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		11 February 2025	Ibarrondo, Borja
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 24 21 6085

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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