

WATER CRAFT SAIL ASSEMBLY AND WATER CRAFT COMPRISING SAME

TECHNICAL FIELD OF THE INVENTION

The present invention relates to a sail assembly for a watercraft and a watercraft comprising same. It applies, in particular, to the field of the sail-powered propulsion of a merchant vessel.

5 STATE OF THE ART

Sailing ship projects to lower the production of CO₂ all rely on a very simple equation making it possible to determine the aerodynamic force developed by a sail:

$$F = 0.5 \cdot \rho \cdot s \cdot v^2 \cdot \text{Coef}$$

Where:

10 F is the force, expressed in Newtons,

P is the air density,

S is the sail area,

V is the apparent wind speed, and

15 Coef is the coefficient of performance, which depends on the shape of the roughness extension, the Reynolds number, etc.

Some projects seek to increase the lift of the sail and reduce its drag by using thick profiles (plane wing type profiles). Other projects for increasing the aerodynamic force act on the speed by seeking the wind above the surface or by artificially creating overspeed by cylinder rotation.

20 The lift coefficient generated by an asymmetric thick profile reaches a maximum of around 1.7.

A symmetric thick profile requires two times more material than a thin profile, for example a flexible sail, which will have a somewhat similar lift coefficient, between 1 and 1.2. The relative reduction in drag with a thick profile will be a key advantage for configurations in which the apparent wind angle is very close to the course of the craft (racing multihull, or cargo ship using sails as
25 backup). The wind speed at 200 m above sea level is 50% stronger than at the surface and, as a result of the square of the speed, a doubling of the propulsive force can be expected for an equal surface area. It is sufficient to stabilise a kite with a surface area of several hundred square metres.

However, none of the sail assemblies described above have all the rigging qualities required for a merchant vessel:

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- a large surface area, since the average wind is relatively light;
 - an easily reduced surface area, since the wind can be strong or very strong;
 - limited clearance, the clearance being the total height of the rigging;
 - efficient profiles at low Rn, i.e. in light winds;
 - good resistance in strong winds;

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 - a small footprint on the deck, to facilitate port operations;
 - complete automation, so as to have no impact on crew levels;

- good retractability, i.e. able to be reefed very quickly with minimum resistance;
- be relatively inexpensive; and
- be sustainable.

Japanese utility certificate JP S60 110098 U is known, which discloses a watercraft whose rigid sail assembly comprises three half-sails, together forming a circular arc positioned on the top of a rotating mast. However, these three half-sails only form one sail positioned on just one side of the mast.

Chinese patent application CN 104 176 222 A is known, which discloses a sail assembly comprised of three rigid sails sliding along a mast. However, these three sails are positioned on the same side of the mast.

German patent application DE 37 18 414 A1 is known, which discloses a flexible sail assembly whose sails are superposed one on top of the other and fastened over the whole length of spars. Similarly, the sails are mounted on just one side of the mast.

US patent US 2021/163112 A1 is known, which discloses a rigid sail assembly comprising 5 sails superposed one on top of the other. However, these five sails only form a single large sail positioned on just one side of the mast.

SUMMARY OF THE INVENTION

The present invention proposes, with at least one biplane sail assembly, to obtain all or part of the qualities listed above.

BRIEF DESCRIPTION OF THE FIGURES

Other advantages, aims and particular features of the invention will become apparent from the non-limiting description that follows of at least one particular embodiment of the sail assembly that is the subject of the present invention, with reference to drawings included in an appendix, wherein:

- figure 1 represents, schematically and in perspective, the general inventive concept of the invention;

- figure 2 represents, schematically and in a top view, a first particular embodiment of the sail assembly that is the subject of the invention;

- figure 3 represents, schematically and in perspective, the sail assembly shown in figure 2, partially deployed and partially folded;

- figure 4 represents, schematically and in perspective, a second particular embodiment of the sail assembly that is the subject of the invention, partially deployed and partially folded;

- figure 5 represents, schematically and in a side view, a first particular embodiment of a watercraft that is the subject of the present invention;

- figure 6 represents, schematically and in a top view, different points of sail of a second particular embodiment of a watercraft that is the subject of this invention, all sail assemblies deployed;

- figure 7 represents, schematically and in a side view, a third particular embodiment of a watercraft that is the subject of the present invention, with sail assemblies partially deployed and partially folded;

- figure 8 represents, schematically and in a top view, the watercraft shown in figure 5, the masts being pivoted to disengage the deck of the craft;

- figure 9 represents, schematically and in perspective, a third particular embodiment of the sail assembly that is the subject of the invention, partially deployed and partially folded;

- figure 10 represents, schematically and in a top view, a mechanism for deploying and folding the sail assembly shown in figure 9;

- figure 11 represents, schematically and in a top view, different points of sail of a fourth particular embodiment of a watercraft that is the subject of the present invention;

- figure 12 represents, schematically and in a side view, a fifth particular embodiment of a watercraft that is the subject of the present invention;

- figure 13 represents, schematically and in a top view, a third particular embodiment of the sail assembly shown in figure 9;

- figure 14 shows, schematically and in a top view, different points of sail of a sixth particular embodiment of a watercraft that is the subject of the invention, all sail assemblies deployed; and

- figure 15 represents, schematically and in a top view, the sail assembly shown in figure 2, with sail assemblies deployed in various ways.

DESCRIPTION OF THE INVENTION

The present invention aims to remedy all or part of the inconveniences of the prior art. To this end, according to a first aspect, the present invention envisages a biplane sail assembly for a watercraft comprising a deck, which sail assembly comprises:

- a mast, extending along an axis, which is mounted at an incline with respect to the deck of the craft on a motorised shaft having an axis of rotation which is inclined with respect to the deck of the craft;

- a plurality of spars mounted at an incline with respect to the mast on either side of the mast;

- for each side of the mast, between the ends of two consecutive spars located on the same side of the mast, a sail and motorised means for deploying and folding this sail.

Thanks to these provisions, this provides a biplane sail with a low clearance. In addition, motorisation of the rotation of each mast makes it possible to adjust the position of the sails to the point of sail of the watercraft.

Moreover, a sail assembly that is biplane or has a small angle of incidence between its two sails on the same spar (e.g. 15°) has a better lift and does not come loose in the wind.

In some embodiments, the sail assembly comprises a yard at each end of each spar, each yard extending along an axis perpendicular to the axis of the mast, each sail being flexible and mounted between two parallel yards, the yards on one side of the mast being parallel to each other.

Thanks to these provisions, flexible sails, at a lower cost, can be implemented.

In some embodiments, the axis of a yard on one side of the mast is parallel to the axis of a yard on the other side of the mast.

In some embodiments, the axis of a yard on one side of the mast is secant to the axis of a yard on the other side of the mast. In some embodiments, the sail assembly comprises, for each flexible sail, a retention line between the yards going round the sail, this line being positioned windward of the yards and the motorised means for deploying and folding this sail comprises a furler of the sail consisting of a cylindrical tube turning around a fixed cable, the sail being linked to the furler by a bolt rope passing through a channel in the furler.

Thanks to these provisions, deployment of the sails can be motorised.

In some embodiments, the sail assembly comprises two parallel masts jointly bearing the spars.

In some embodiments, at least one sail comprises a rigid upstream half-sail and a rigid downstream half-sail which are connected together by a hinge mounted between the two ends of the consecutive spars.

In some embodiments, the half-sails on one side of a spar have the same orientation as the half-sails on the other side of this spar.

In some embodiments, the half-sails on one side of a spar have a different orientation from the half-sails on the other side of this spar.

Thanks to these provisions, the sail can be folded or deployed by rotation of a half-sail relative to the hinge shared with the other half-sail.

In some embodiments, each half-sail is a parabolic arc.

Thanks to these provisions, the shape of the deployed sail corresponds substantially with the shape of a flexible sail catching the wind.

In some embodiments, for each rigid sail, the motorised means for deploying and folding this sail comprises an actuator.

In some embodiments, the sail assembly comprises a means for controlling the motorising means for deploying and folding an upstream half-sail relative to the downstream half-sail, this control means being configured to fold the half-sails one on the other on tacking and jibbing, and to reverse the curve between the starboard and port tack.

According to a second aspect, the present invention envisages a watercraft comprising at least one sail assembly according to the invention.

In some embodiments, the watercraft comprises a sail assembly according to the invention around a foremast and a sail assembly according to the invention around a mizzenmast.

DETAILED DESCRIPTION

The present description is given in a non-limiting way, in which each characteristic of an embodiment can be combined with any other characteristic of any other embodiment in an advantageous way. Note that the figures are not to scale.

As can be seen from reading the present description, different inventive concepts can be implemented by one or more methods or devices described below, several examples of which are given here. The actions or steps carried out in the framework of realising the method or device can be ordered in any appropriate way. As a consequence, it is possible to construct embodiments in which the actions or steps are carried out in a different order from the one shown, which can include executing some acts simultaneously, even if they are presented as sequential acts in the embodiments shown.

The expression "and/or", as it is used in the present document and in the claims, must be understood as meaning "one or other, or both" of the elements thus connected, i.e. elements that are present conjunctively in some cases and disjunctively in other cases. The multiple elements listed with "and/or" must be interpreted in the same way, i.e. "one or more" of the elements thus connected. Other elements can possibly be present, other than the elements specifically identified by the clause "and/or", whether or not they are linked to these specifically identified elements. Therefore, as a non-limiting example, a reference to "A and/or B", when it is used in conjunction with open-ended language such as "comprising", can refer, in one embodiment, to A only (possibly including elements other than B); in another embodiment, to B only (possibly including elements other than A); in yet another embodiment, to A and B (possibly including other elements); etc.

As used here in the present description and in the claims, the expression "at least one", in reference to a list of one or more elements, must be understood as meaning at least one element chosen from among one or more elements in the list of elements, but not necessarily including at least one of each element specifically listed in the list of elements and not excluding any combination of elements in the list of elements. This definition also allows the optional presence of elements other than the elements specifically identified in the list of elements to which the expression "at least one" refers, whether or not they are linked to these specifically identified elements. Therefore, as a non-limiting example, "at least one of A and B" (or, equivalently, "at least one of A or B" or, equivalently, "at least one of A and/or B"), can refer, in one embodiment, to at least one, possibly including more than one, A, with no B present (and possibly including elements other than B); in another embodiment, to at least one, possibly including more than one, B, with no A present (and possibly including elements other than A); in yet another embodiment, to at least one, possibly including more than one, A and at least one, possibly including more than one, B (and possibly including other elements); etc.

In the claims, and also in the description below, all the transitive expressions such as "comprising", "including", "bearing", "having", "containing", "involving", "made of", "formed of" and others, must be understood as being open, i.e. meaning including, but not limited to. Only the transitive expressions "consisting of" and "consisting essentially of" must be understood as closed or semi-closed expressions, respectively.

Figure 1 shows a sail assembly 20 of a watercraft (not shown) comprising a deck 24. This sail 20 assembly comprises a mast 21 which is mounted at an incline with respect to the deck 24 of the craft on a motorised shaft (not shown) having an axis of rotation 25 which is inclined with respect to the deck of the craft. Generally, the mast and the axis of rotation 25 are vertical but, in some variants, they are inclined. The axis of the shaft generally corresponds with the axis of the mast 21. The sail assembly 20 also comprises a plurality of spars (not shown) mounted at an incline with respect to the mast 21 on either side of the mast 21. The sail assembly 20 comprises, on each side of the mast 21, at least one sail 22 and 23 and motorised means for deploying and folding this sail (not shown). For example, furlers (not shown) are positioned at the windward end of the yards, 34 and/or 36, and enable the flexible sails 32 and 33 to be deployed or folded. The system of furling the sails is generally comprised of a cylindrical tube turning around a fixed line. The sail is linked to the furler by a bolt rope passing through a channel in the furler.

The sail assembly 20 is therefore biplane, with sails 22 and 23 allowing it to harness a larger portion of the wind's power.

In the first embodiment of the sail assembly, shown in figures 2 and 3, the mast 31 bears several spars 35 at an incline with respect to the mast 31. In this embodiment, the spars 35 extend in planes perpendicular to the mast 31, at different heights on the mast 31. Each end of each spar 35 bears a yard, 34 and/or 36. The yards, 34 and/or 36, can be parallel to each other. Each yard, 34 and/or 36, extends along an axis, respectively, 26 and/or 28, parallel to a perpendicular plane, not shown, perpendicular to the axis 25 of the mast 31. Each sail is, for example, flexible and mounted between two parallel yards, 34 and/or 36. Preferably, the yards, 34 and/or 36, on one side of the mast 31 are parallel to each other. The yards 36 on one side of the mast 31 are preferably parallel to the yards 34 on the other side of the mast 31. In other words, the axes 26 of the yards 34 are preferably parallel to the axes 28 of the yards 36.

In some variants (not shown), the axes 26 of the yards 34 on one side of the mast 31 are secant to the axes 28 of the yards 36 on the other side of the mast 31. In other words, the yards 34 on one side of the mast 31 are parallel to each other. The yards 36 on one side of the mast 31 have, for example, orientations different from those of the yards 34 on the other side of the mast 31. In other words, the orientations of the yards 91 on one side of the mast 93 can be independent of the orientations of the yards 92 on the other side of the mast, the links between the yards and the spars being pivotable and motorised for this purpose. An acute salient angle, referred to as an "incident angle", not shown, formed by the secant axes, 26 and/or 28, can be less than or equal to

20°. An acute salient angle, not shown, formed by the secant axes, 26 and/or 28, is preferably less than or equal to 10°.

In some variants, the spars are in two parts mounted on a pivot link with an axis parallel to that of the mast, and motorisation can vary the angle between these two parts of the spars.

Between two successive yards, 34 and/or 36, on the same side of the mast 31 there is a flexible sail, for example made of canvas. The flexible sails on the left of the mast 31 are referenced 32 and the flexible sails on the right of the mast 31 are referenced 33. A line 37 connects two ends of successive yards, 34 and/or 36, on the same side of the mast 31, in front of the sail assembly (on the left in figures 2 and 3), i.e. windward. This line 37 holds the leading edge of the flexible sail 32 or 33. Figures 2 and 3 show, on each side of the mast 31, three taut flexible sails 32 and 33 between four yards, 34 and/or 36. Of course, the number of sails and yards can be different in some variants of this first embodiment of the sail assembly that is the subject of the invention.

Figure 2 shows, in the form of arrows F1 and F2, the resultants of the aerodynamic forces on the sails 32 and 33 for a cross wind. Note that these resultants F1 and F2 are to the rear of the axis of rotation 25 and therefore make the sail assembly 30 able to be retracted. More generally, the position of the aerodynamic force depends on the profile's incidence with the wind. In this case, this force is located at approximately 25% of the length of the chord. This situation is the most unfavourable for the rigging to be able to be retracted. It corresponds to a low incidence, of the order of 20°. When the incidence increases, the point of application of the force "moves back" to end at 50% of the chord for an incidence of 90°. In other words, if the rotation of the mast 31 is free around the axis of rotation 25, the sail assembly 30 is automatically oriented windward, which has the effect of cancelling out the resultants of the aerodynamic forces.

Figure 15 shows the sail assembly 30 with sails, 32 and/or 33, deployed in various ways. For example, furlers (not shown) are positioned at the windward end of the yards, 34 and/or 36, and enable the flexible sails 32 and 33 to be deployed or folded. A furler can deploy or fold one sail, 32 and/or 33, relative to the other.

The sail assembly 30 is, for example, free in rotation around the mast 31 while keeping its biplane configuration.

In some variants, the sail assembly 30 is free in rotation around the mast 31 while keeping the same acute salient angle formed by the axes, 26 and/or 28, of the yards, 34 and/or 36.

The second embodiment of the sail assembly 40 shown in figure 4 is similar to the first embodiment, with two flexible sails on each side of the mast, except that the mast 31 is replaced by two parallel masts 38 and 39 which jointly bear the spars 35 and the yards, 34 and/or 36.

Figure 5 shows a watercraft 50 equipped with two masts 31 on its deck 54 and two sail assemblies 30 around these masts 31. In this figure 5, all the sails 32 and 33 are deployed and taut.

As shown in figure 6, in the different points of sail of the watercraft 60 comprising the sail assembly 30, the motorised rotation of the mast 31 makes it possible to harness the wind's power, according to the sail orientations known in the prior art.

Figure 7 shows a watercraft 70 equipped with a sail assembly 30 around a foremast 31 and a sail assembly 40 around a double mizzenmast 38 and 39. In this figure 7, the top sails 32 and 33 are folded and the bottom sails 32 and 33 are deployed and taut.

Figure 8 shows the watercraft 50 with its sail assemblies 30 clear of the vertical of the watercraft's deck. To this end, the foremast 31 is turned around so that the maximum extension of the yards, 34 and/or 36, is turned towards the prow of the craft 50. Conversely, the mizzenmast 31 is in a position where the maximum extension of the yards, 34 and/or 36, is turned towards the stern of the craft 50. The implementation of the present invention thus makes it possible to free the central part of the deck 54 of the craft 50 of any overhanging sail assembly element, which facilitates the loading and unloading of equipment or other products.

In the first two embodiments of the sail assembly, 30 and 40, these sail assemblies are biplane, made of canvas, and automatically retractable. The yards are straight and the aerodynamic forces are to the rear of the axis of rotation 25 of the mast 31 or 38 and 39.

These first two embodiments 30 and 40 of the sail assembly that is the subject of the invention have the following advantages:

- a large sail area;
- limited clearance;
- good resistance in strong winds;
- a small footprint on the deck;
- automation of the mast rotation motor;
- automatically retractable.

In the third embodiment of the sail assembly, shown in figures 9 to 13, one mast 81 bears several spars 85 at an incline with respect to the mast 81. In this embodiment, the spars 85 extend in planes perpendicular to the mast 81, at different heights on the mast 81. Each end of each spar 85 bears a rotating shaft 89 (see figure 10) of a rigid half-sail 83 relative to a rigid downstream half-sail 82. A hinge 86 and a deploying and folding means 87 connect the downstream half-sail 82 to an upstream half-sail 83. Note that the rotating shafts 89 (see figure 10) borne by the ends of the spars 85 on the same side of the mast can be separate and set in rotation independently by several motors (not shown), or combined and, in that case, be set in rotation by the same motor (not shown). In figure 9, one upstream half-sail 83 is folded onto a downstream half-sail 82 and three upstream half-sails 83 are deployed.

As shown in figure 10, the deployment and folding means 87 folding the downstream half-sail 82 over an upstream half-sail 83 can be an actuator, for example electrical or hydraulic. Increasing the extension of this actuator allows the upstream half-sail 83 to be deployed. In

contrast, reducing the extension of the actuator allows the upstream half-sail 83 to be folded onto the downstream half-sail 82.

Figures 9 and 13 show, on each side of the mast 81, two sails articulated between three spars 85. Of course, the number of sails and yards can be different in some variants of this third embodiment of the sail assembly that is the subject of the invention.

In some embodiments, such as those shown in figures 9 to 13, each half-sail, 82 and/or 83, is a parabolic arc. In other words, the half-sails, 82 and 83, have, for example, a profile that is symmetrical with respect to an axis of rotation of the rotating shaft 89.

As shown in figure 11, in the different points of sail of a fourth embodiment of the watercraft 90 comprising the sail assembly 80, the motorised rotation of the mast 81 around the axis of rotation 25 and the deployment and folding of the rigid upstream half-sails 83 make it possible to harness the wind's power, according to the sail orientations known in the prior art. However, a means for controlling the means 87 for deploying and folding the rigid upstream half-sails 83 is configured to fold the half-sails 83 relative to the downstream half-sail when the watercraft 90 tacks and jibes and to reverse the curve of the deployed sail between the starboard and port tack.

On a single spar 85, the half-sails, 82 and 83, on one side of the spar are, for example, symmetrical to the half-sails, 82 and 83, on another side of the spar relative to an axis 95, the axis 95 being the axis of symmetry of the mast 93, perpendicular to the axis 25. In other words, the half-sails, 82 et 83, on one side of a spar 85 have, for example, the same orientation as the half-sails, 82 et 83, on another side of this spar 85.

Figure 13 shows a third particular embodiment of the sail assembly shown in figure 9. For a single spar 85, the half-sails, 82 and 83, on one side of the spar are, for example, asymmetrical to the half-sails, 82 and 83, on another side of the spar relative to an axis 95. In other words, the half-sails, 82 et 83, on one side of a spar 85 have, for example, a different orientation from the half-sails, 82 et 83, on another side of this spar 85.

Figure 12 shows a fifth embodiment of a watercraft 100 equipped with a sail assembly 80 around a foremast 81 and a sail assembly 80 around a mizzenmast 81. In this figure 12, the upstream half-sails 83 are folded. Note that, in a strong wind, the upstream half-sails 83 can be folded, while keeping the wind load so that the craft continues to move forward. In contrast, in a light wind, the upstream half-sails 83 are deployed to maximise the wind load.

Figure 14 shows different points of sail of a sixth particular embodiment of a watercraft 105 comprising the sail assembly 80. The orientations of the spars 85 of the upstream mast 81 can be different from the orientations of the spars of the downstream mast 81. The orientations of the half-sails, 82 and/or 83, of the upstream mast 81 can be the same as the orientations of the half-sails, 82 and/or 83, of the downstream mast 81, even if the respective spars 85 of the upstream mast 81 and the downstream mast 81 have a different orientation.

The third embodiment of the sail assembly 80 that is the subject of the invention has the following advantages:

- it can be retracted automatically in all wind conditions;
- it has a large surface area;
- it has limited clearance;
- it has efficient profiles at low R_n ;

- 5 - it has great resistance in strong winds;
- it has a small footprint on the deck;
 - it is easy to automate, with motorisation of the rotation of the mast around the axis of rotation 25 and motorisation of the rotation of the upstream half-sails around the axis of the hinges 86; and
 - it is sustainable.

- 10 Of course, as in the second embodiment of the sail assembly that is the subject of the invention, the mast 81 can be replaced by two parallel masts jointly bearing the spars 85.

CLAIMS

1. Biplane sail assembly (30, 40, 80) for a watercraft (50, 60, 70, 90, 100, 105) comprising a deck (54, 94), characterised in that it comprises:

- a mast (31, 38, 39, 81), extending along an axis (25), which is mounted at an incline with respect to the deck of the craft on a motorised shaft having an axis of rotation which is inclined with respect to the deck of the craft;

- a plurality of spars (35, 85) mounted at an incline with respect to the mast on either side of the mast;

- for each side of the mast, between the ends of two consecutive spars located on the same side of the mast, a sail (32, 33, 82, 83) and motorised means (87) for deploying and folding this sail.

2. Sail assembly (30, 40) according to claim 1, which comprises a yard (34, 36) at each end of each spar, each yard extending along an axis (26, 28) perpendicular to the axis of the mast (25), each sail (32, 33) being flexible and mounted between two parallel yards, the yards on one side of the mast being parallel to each other.

3. Sail assembly (30, 40) according to claim 2, wherein the axis (26, 28) of a yard (34, 36) on one side of the mast (31, 38, 39) is parallel to the axis (26, 28) of a yard (34, 36) on the other side of the mast.

4. Sail assembly (30, 40) according to claim 2, wherein the axis (26, 28) of a yard (34, 36) on one side of the mast (31, 38, 39) is secant to the axis (26, 28) of a yard (34, 36) on the other side of the mast.

5. Sail assembly (30, 40) according to one of claims 2 to 4, which comprises, for each flexible sail (32, 33), a retention line (37) between the yards (34, 36) going round the sail, this line being positioned windward of the yards and the motorised means for deploying and folding this sail comprises a furler of the sail consisting of a cylindrical tube turning around a fixed cable, the sail being linked to the furler by a bolt rope passing through a channel in the furler.

6. Sail assembly (30, 40) according to one of claims 2 to 5, which comprises two parallel masts (38, 39) jointly bearing the spars (35).

7. Sail assembly (80) according to one of claims 1 to 6, wherein at least one sail comprises a rigid upstream half-sail (83) and a rigid downstream half-sail (82) which are connected together by a hinge (86) mounted between the two ends of the consecutive spars (85).

8. Sail assembly (80) according to claim 7, wherein the half-sails (82, 83) on one side of a spar (85) have the same orientation as the half-sails (82, 83) on the other side of this spar (85).

5 9. Sail assembly (80) according to claim 7, wherein the half-sails (82, 83) on one side of a spar (85) have a different orientation from the half-sails (82, 83) on the other side of this spar (85).

10. Sail assembly (80) according to one of claims 7 to 9, wherein each half-sail (82, 83) is a parabolic arc.

10 11. Sail assembly (80) according to one of claims 7 to 10, wherein the motorised means (87) for deploying and folding this sail comprises an actuator.

15 12. Sail assembly (80) according to one of claims 7 to 11, which comprises a means for controlling the motorising means for deploying and folding an upstream half-sail (83) relative to the downstream half-sail (82), this control means being configured to fold the half-sails one on the other on tacking and jibbing, and to reverse the curve between the starboard and port tack.

13. Watercraft (50, 60, 70, 90, 100, 105) comprising at least one sail assembly (30, 40, 80) according to one of claims 1 to 12.

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14. Watercraft (50, 70, 100) according to claim 13, which comprises a sail assembly (30, 40, 80) according to one of claims 1 to 12 around a foremast (31, 81) and a sail assembly (30, 40, 80) according to one of claims 1 to 12 around a mizzenmast (31, 38, 39, 81).