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[54] **SAILING HYDROFOIL CRAFT**

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[51] **Int. Cl.**..... **B63b 39/06**

[58] **Field of Search**..... 114/39, 66.5 H, 126; 280/213; 244/105, 106, 108

[56] **References Cited**

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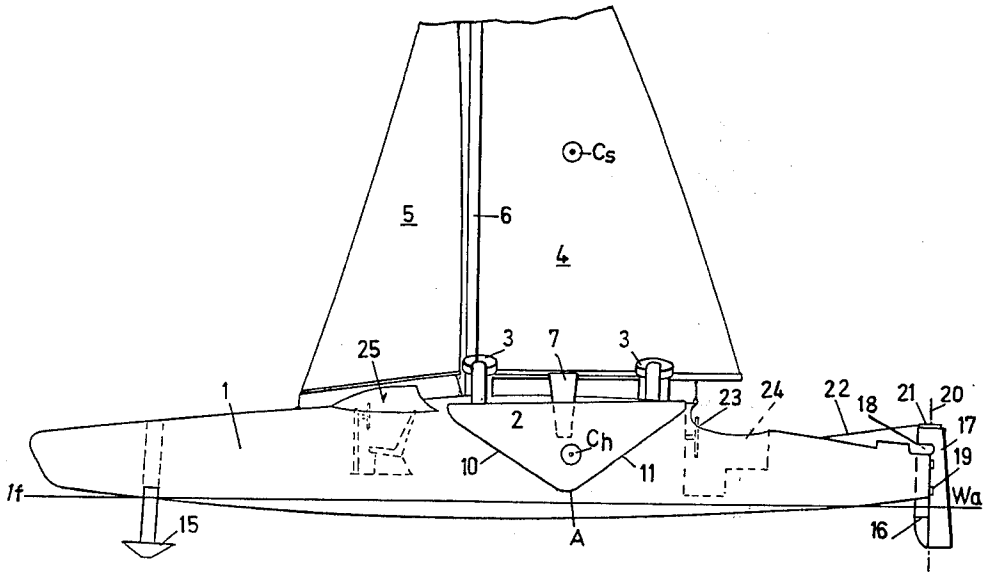
[57] **ABSTRACT**

A monohull sailing hydrofoil craft having one or more foils on either side of the craft arranged so that the heel of the craft caused by the wind whilst sailing causes the windward foil or foils to lift clear of the water without any action by the helmsman, the foils being designed so that the righting force they apply by virtue of their shape and without the action of any buoyancy in the foils is such as to counteract the heeling forces.

8 Claims, 3 Drawing Figures



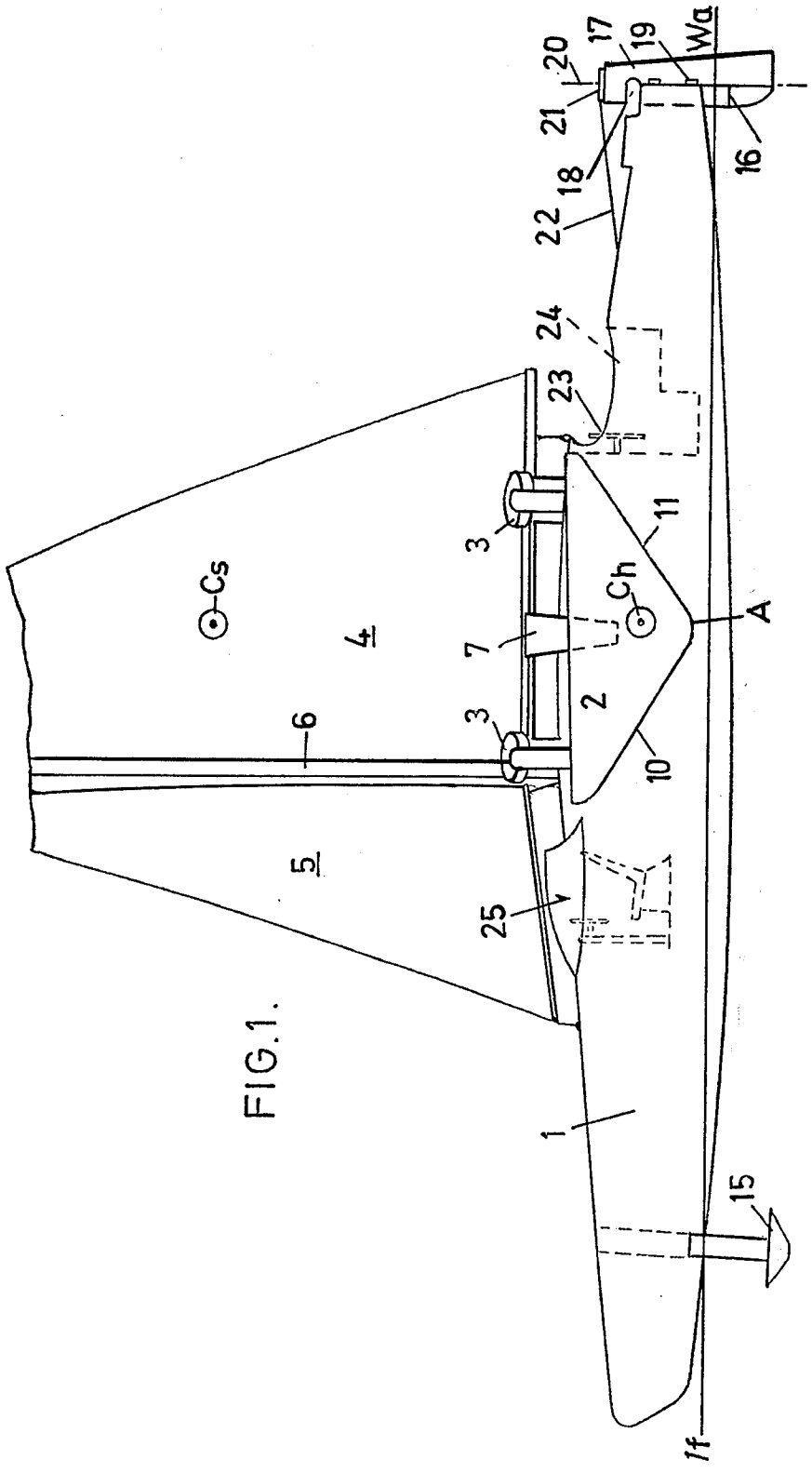


FIG.1.

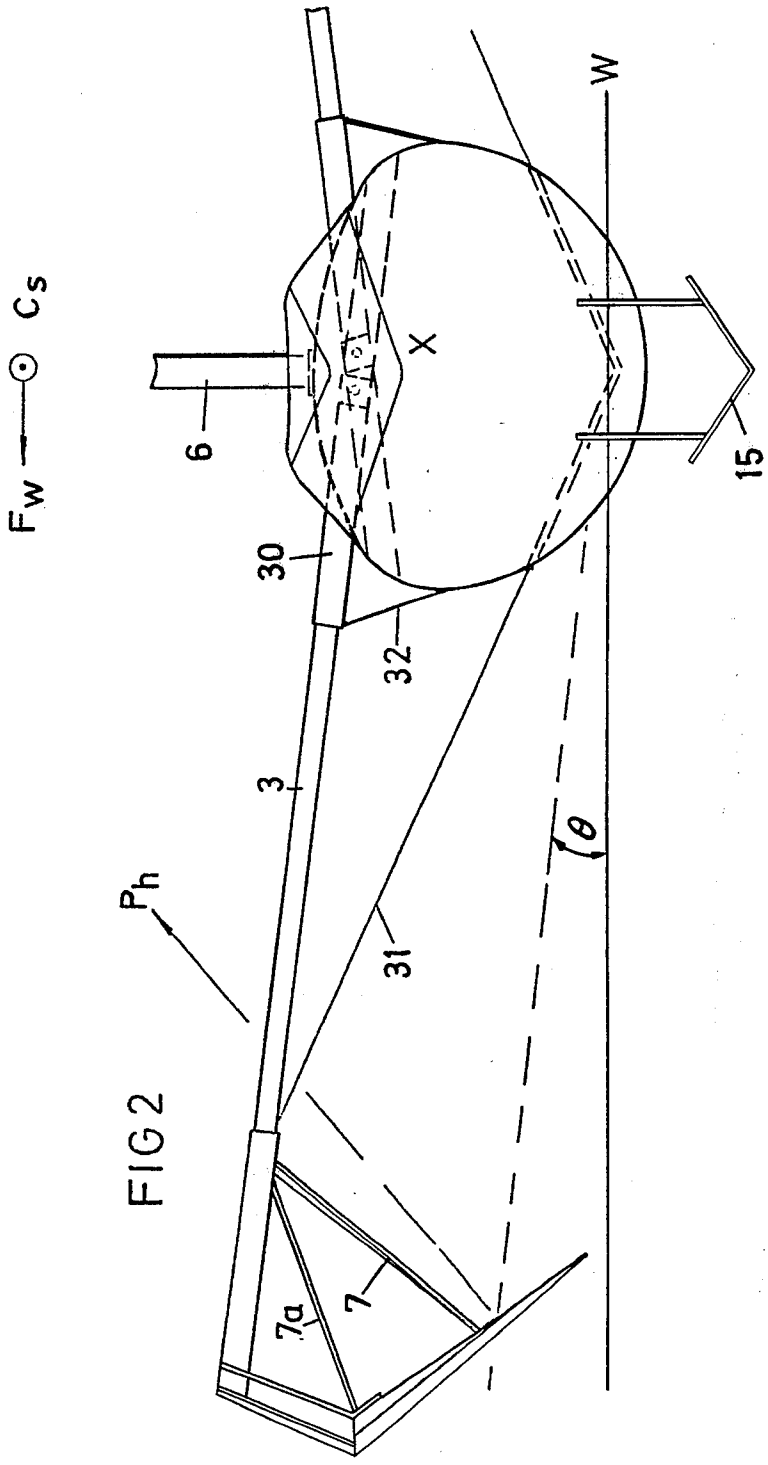


FIG 2

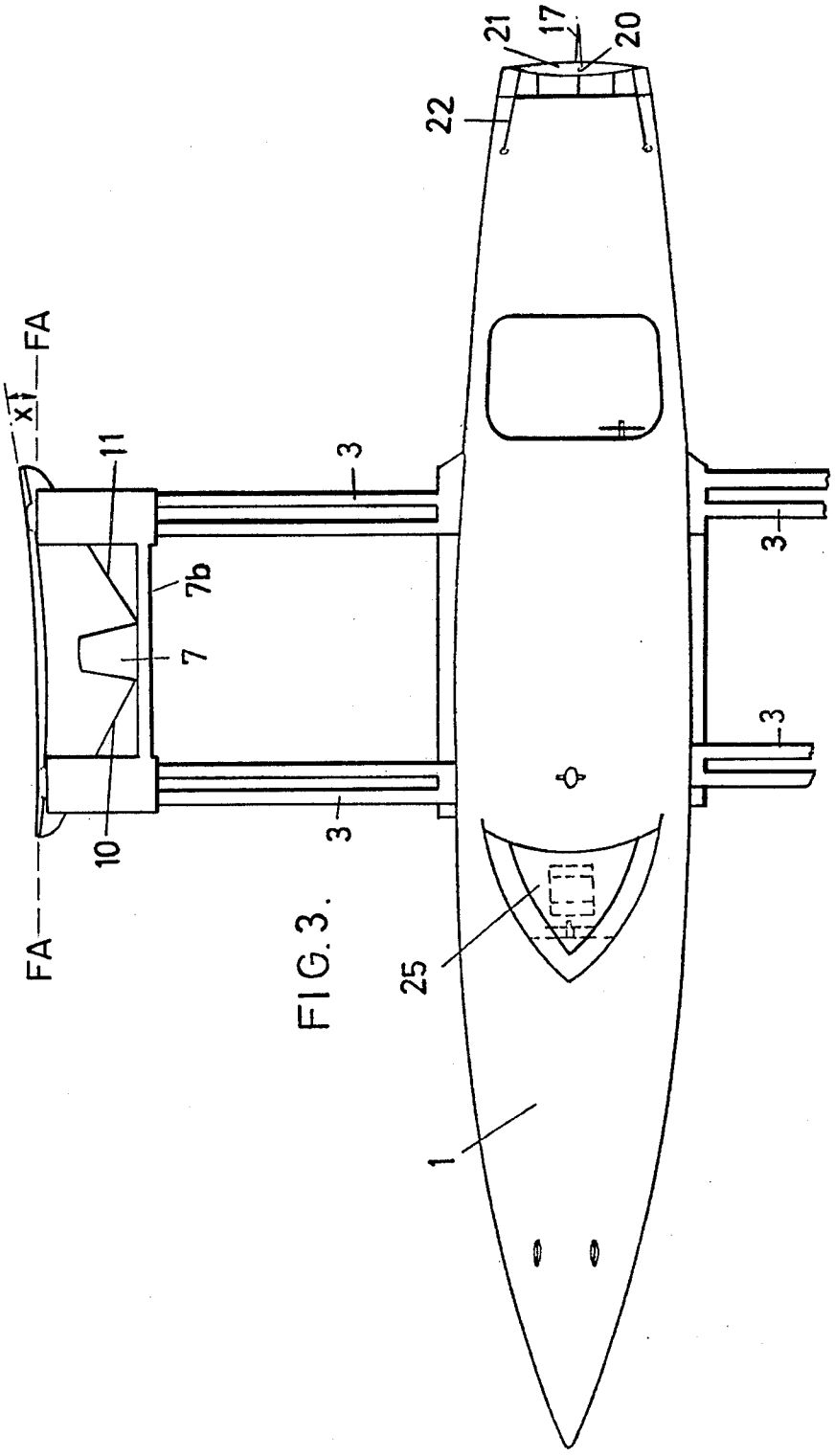


FIG. 3.

SAILING HYDROFOIL CRAFT

The present invention relates to sailing hydrofoil craft.

In a conventional sailing craft, the design is such as to attempt to maintain the craft in as upright a condition as possible in order to achieve the best aerodynamic conditions for the sail or sails and to reduce the hull resistance to a minimum. Such a craft uses a keel and/or ballast and a small craft may be assisted by the crew 'sitting out' on the windward side, in order to obtain the best sailing condition.

Further improvements in performance have been obtained by increasing the length of a craft in proportion to the breadth or beam of the craft. This results in a reduction of lateral stability which conventionally may be counteracted by providing out riggers or floats or by making the craft as a multi-hulled craft. Reductions in drag have recently been achieved by the use of hydrofoils which lift the hull of a craft out of the water.

Unfortunately the various attempts at combining the effect of a hydrofoil with a high length to beam ratio craft has usually resulted in a craft which though perhaps in theory in a light wind might appear to offer a successful design. Yet, when applied to a practical craft it has been found not to measure up to the performance of conventional craft because either the strain on the equipment was too much or the craft was unmanoeuvrable, the contrivance was too delicate to stand up to being left at moorings or difficult to beach and transport.

The problem, therefore was to provide a stable and practical craft which used hydrofoils in such a way as to attempt to maintain a sailing craft in a near upright condition whilst reducing immersed surfaces, ballast and weight to a minimum. Those immersed surfaces which existed should present as low a beam or width in proportion to their length and the unnecessary provision of floats or bouyant hydrofoils on outriggers which only added to the bulk weight and drag should be avoided. Retention, meanwhile of well tried and conventional methods of manoeuvring when sailing into the wind would be retained and the craft tacked in a normal manner.

Accordingly the present invention consists in a monohull sailing hydrofoil craft having hydrofoils mounted rigidly on outriggers either side of the craft at such a height above the load water line so that on a reach or tack the windward hydrofoil or hydrofoils is or are lifted clear of the water.

Such a craft has the advantage that the windward hydrofoil or hydrofoils do not counteract the effect of the leeward foils and that when the craft is tacked or wears the non-engaged hydrofoil hydrofoils are heeled into an active condition whilst the former leeward hydrofoil are lifted clear of the water. The helmsman, meanwhile can ignore the hydrofoils and concentrate on obtaining a correct trim of the sails or sails.

In a preferred embodiment the craft may have the centre of pressure of the hydrofoils in substantially the same plane as the centre of effort of the sail or sails. This ensures that the craft is stable as regards steering and it may be possible with careful triming of the sail or sails for the craft to steer itself.

The hydrofoils may be formed with a substantially triangular shape mounted so that the apex of the triangle is downward, the side of the triangle opposite the apex being substantially parallel with the fore and aft designed water line, the two remaining sides being equal, and the apex angle being between 90° and 110° and preferably 100°.

These triangular hydrofoils ensure that the greater the immersion, the proportionally greater the area of area of hydrofoil is engaged with the water and this helps to achieve a stable opposing moment to the heeling force due to the wind pressure on the sail or sails.

The hull may have a semi-circular cross-section below the water line and the curve of the semi-circle may extend above the water line to meet a deck.

This feature ensures that the immersed surface of the hull remains substantially constant with a variation of heel.

The hydrofoils are preferably shaped so that the leading edge is parallel with a fore and aft line of the craft, whilst the trailing edge is turned outboard at an angle of 5° to 2½° to the fore and aft line. This feature assists stability in steering.

The outriggers may be slidably mounted in the hull of the craft, so that when the craft is moored or being transported the overall beam is reduced.

The hydrofoil area may be between 4½% and 10% of the sail area.

In the accompanying drawings :

FIG. **1** is an elevation taken from the port side of a craft according to the invention,

FIG. **2** is a cross-sectional view taken across the craft of FIG. **1**, and

FIG. **3** is a plan of the craft shown in FIG. **2.**

In carrying into effect the invention according to one convenient mode by way of example the drawings show a hydrofoil sailing craft having a hull **1** of length of 52 feet and a beam of 8 feet 9 inches being a scaled up version of a 20 feet 5 inches × 2 feet 11 inches prototype. On either side of the hull **1** are hydrofoils **2** mounted on outriggers **3.** The hydrofoil area is about 35 square feet. The boat has a single bermudan main sail and foresail **5** and a conventional mast **6.** At the outboard end of the outriggers **3** the hydrofoils **2** are mounted with a dihedral of 45° to 55° and maintained at that angle by struts **7** and *7a*. Struts **7** act from a point near the centres of area of the foils to a cross bar *7b* between the outriggers **3.**

As may be seen in FIG. **1** the shape of the foils is triangular with the apex A downward and the side opposite the apex, being the upper side, mounted so as to be substantially parallel with the designed water line W_fW_a. The triangular shape of the foil has a leading edge **10** and trailing edge **11** of approximately equal length and the angle at the apex A is preferably about 100° but optionally between 90° and 110°. The shape of the foil can be changed from a triangular shape which from experiment would seem to be necessarily isosceles in shape, to a right curved shape such as a semicircle.

As may be seen in FIG. **3** the foils are slightly dished so that the leading edge **10** cuts the water at an angle parallel to the fore and aft line FA, whilst the trailing edge **11** trails at an angle of approximately 2½° away from the fore and aft line FA, the prototype using an angle of about 5°.

It will be seen in FIG. **1** that the centre of effort C_s of the sail **5** is in the same substantially vertical plane as the centre of pressure C_h of the port or leeward hydrofoil. In FIG. **2** it can be seen that the starboard or

windward foil is out of the water so that it has no effect apart from its weight on the transverse stability of the craft. An angle of heel of 12½° is obtained before the windward foil enters the designed water line. It will also be seen from FIG. **2** that the transverse stability is in the main due to a balance of the horizontal component P_h, of the hydrofoil righting force P_h acting in opposition to the horizontal transverse component F_w of the pressure acting on the sail through the centre of effect C_a, the components P_h, and F_w acting about the axis of rotation X. The triangular shape of the foils ensures that with a greater value of F_w, a greater area of immersion of the foil is caused which proportionally increases the value of P_h, until equilibrium is again achieved. The effect of the foils is such that listing angle ϕ is small and the mast of the craft is maintained in a fairly upright condition, thus ensuring a good performance from the sail.

By increasing the performance of the sail, the weight and drag of the craft can be reduced and assisted by the low drag of the thin and light bow and stern foils **15** and **16**, a very high speed craft may be obtained. In trials such a craft has reached speeds of over twice wind speed.

It is clear from the previous description of the forces involved that by increasing the transverse distance from the hydrofoil to the centre line of the craft, a greater sail area can be carried.

In FIG. **1** can be seen that the bow foil **15** is arranged to be retractable for stowage and use in shallow water. The rudder **17** and stern foil **16** is mounted on a horizontal pivot **18** so as to ensure that it may also be retracted or rather lifted clear of the water. A snap pin **19** is provided so that if an obstruction is hit the rudder **17** and foil **16** may lift and not be damaged. The rudder **17** is stearable about a vertical pivot **20** in a conventional way by means of a tiller **21** and wires **22** connected is a steering wheel **23** in the cockpit **24.** A forward steering position **25** is provided.

In FIG. **2,** there can be seen the arrangement for slidably mounting the outriggers **3** in the hull. The hull is provided with glass reinforced plastic tubes **30** laid up into the hull and a bulkhead so that the outriggers **3** can slide 10 feet right through the hull so as to project 5 feet 9 inches on the opposite side, thereby reducing the overall beam from 40 feet to approximately 20 feet. A bracing wire **31** and stainless steel strip **32** are provided to strengthen the outriggers.

Sails for the 52 feet craft are anticipated as being approximately 380 square feet for the mainsail, 110 square feet for the foresail with the addition of a further foresail area 90 square feet if required.

The hull is manufactured from glass fibre reinforced plastics material with P.V.C. rigid foam bulkheads.

I claim:

1. A sailing craft comprising: a monohull with accommodation for a helmsman, outrigger means extending in an athwartship's direction either side of the monohull, at least one port and starboard hydrofoil having a negative buoyancy characteristic mounted rigidly on the outboard end of the outrigger means, "the leading edge of the port and starboard hydrofoils being shaped so as to be parallel with the fore and aft line of the craft," the entire lower surface of at least the trailing portion of each hydrofoil being disposed at an angle outwardly turned with respect to a fore and aft line, divergent in plan and downwardly convergent in an athwartships vertical plane to exert a righting moment on the craft when submerged during forward movement having a horizontal component acting in opposition to the horizontal component of the force of the wind on the sail, "said hydrofoils being slightly dished between said leading edge said trailing portion," and said hydrofoils being mounted to position the lowermost extremities of both said hydrofoils substantially no lower than the designed water level, whereby the heel of the craft when sailing raises the windward hydrofoil above the water and at least partially submerges the leeward hydrofoil.

2. The sailing craft of claim **1** wherein the hydrofoils are mounted to position the centre of pressure of the hydrofoils in substantially the same vertical plane as the centre of effort of the sail or sails.

3. The sailing craft of claim **1** wherein the port and starboard hydrofoils are of a substantially triangular shape mounted so that the apex of the triangle downward, the side of the triangle opposite the apex being substantially parallel with the fore and aft designed water line, the two remaining sides being equal and the apex angle being between 90° and 110° and preferably 100°.

4. The sailing craft of claim **1** wherein the hull has a semi-circular cross-section at least amidships and below the water line.

5. The sailing craft of claim **1** wherein the trailing edge is turned outboard at an angle of 5° to 2½° to the fore and aft line.

6. The sailing craft of claim **1** wherein the outrigger means comprise port and starboard outriggers slidably mounted in the hull of the craft, whereby the beam of the craft can be reduced when the craft is not sailing.

7. The sailing craft of claim **1** wherein the area of the hydrofoil or hydrofoils on each side is between 4½% and 10% of the sails area.

8. The sailing craft of claim **1** wherein further hydrofoils are provided at or near the bow and stern.

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