

# United States Patent

Smith

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## [54] AEROHYDROFOIL STEERING CONTROL

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[51] Int. Cl. .... **B63b 1/18, B63b 35/00**

[58] Field of Search.....114/39, 66.5, 66.5 H

3,295,487 1/1967 Smith.....114/66.5 H

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## [57] ABSTRACT

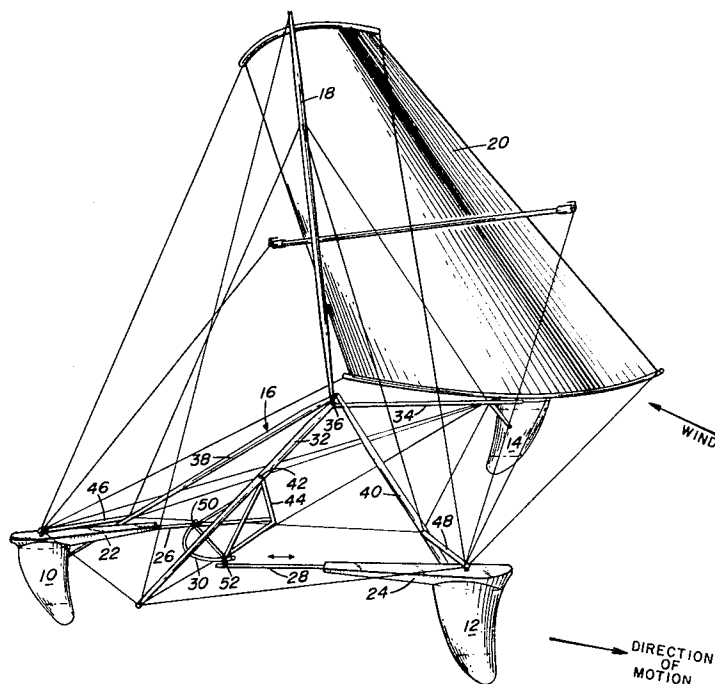
A hydrofoil sailboat having a rotatable bellcrank member to provide a single control for maneuvering and steering the boat on all points of sailing. The bellcrank member has its ends pivotally connected to two push rods which slide in hydrofoil extensions and rotate the hydrofoils to control the direction of travel of the hydrofoil craft. By rotation of the single bellcrank member, simultaneous control of the two windward hydrofoils is achieved.

## [56] References Cited

### UNITED STATES PATENTS

3,094,961 6/1963 Smith.....114/66.5 H

**3 Claims, 2 Drawing Figures**



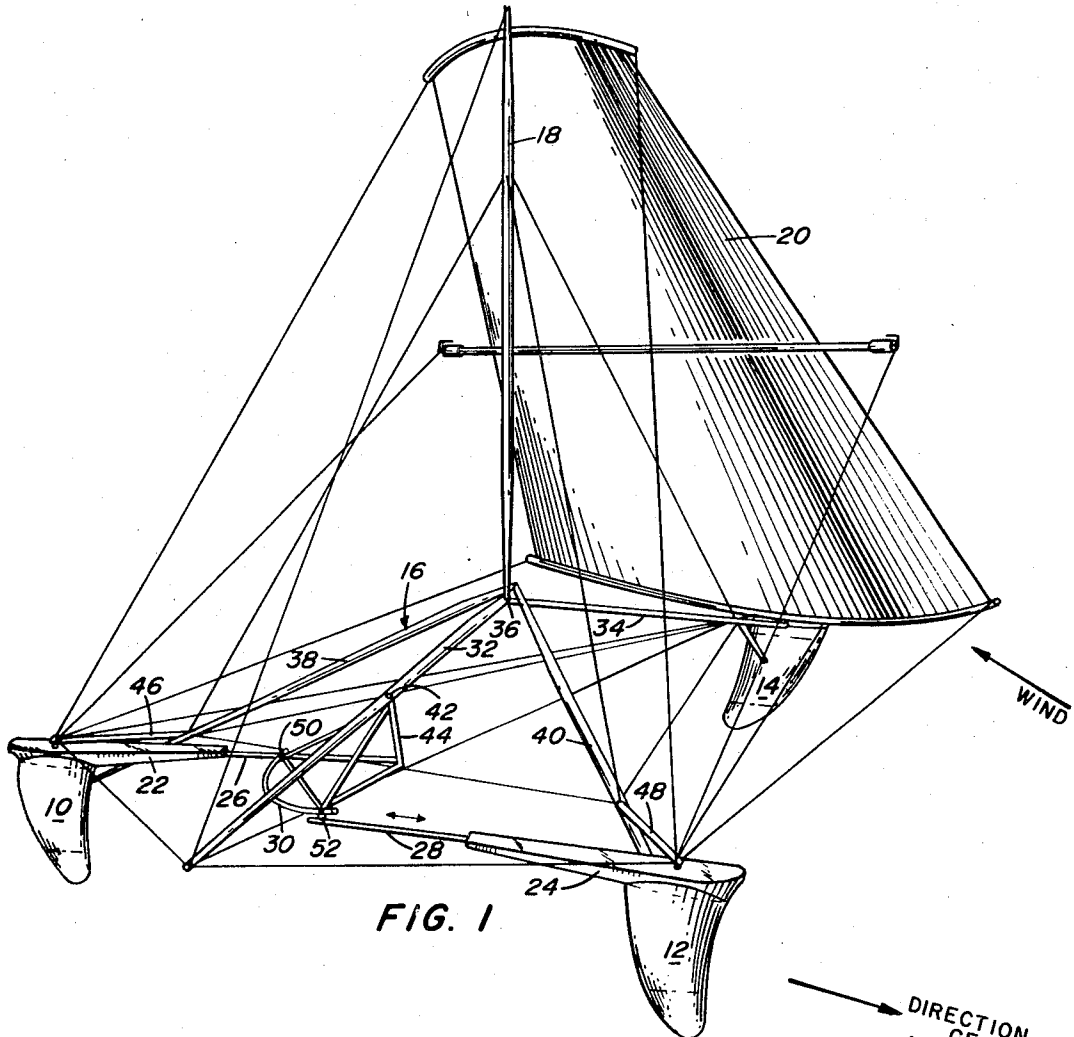
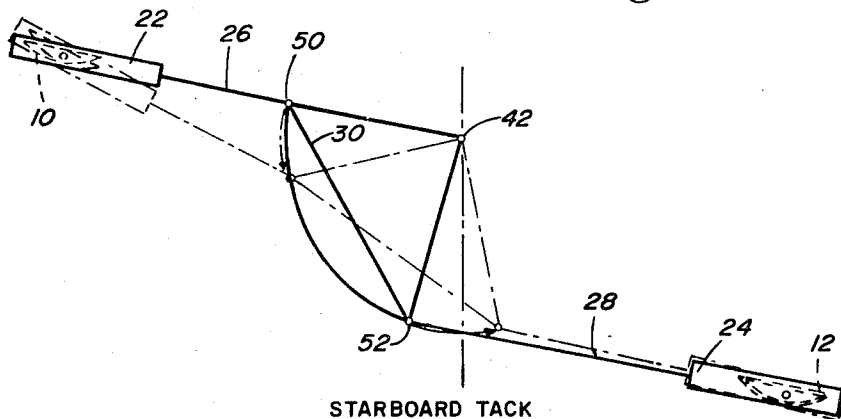


FIG. 1



STARBOARD TACK  
FIG. 2

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## AEROHYDROFOIL STEERING CONTROL

## STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

## BACKGROUND OF THE INVENTION

The present invention relates generally to improvements in hydrofoil sailboats, and more particularly it pertains to a new and improved steering arrangement for hydrofoil sailboats.

In the field of hydrofoil sailboats, it has been the general practice to employ two independent controls for steering. The prior art use of dual control systems for steering and maneuvering the two windward hydrofoils has been unsatisfactory in that a complex and costly system is necessary. Moreover, with such mechanisms, any adjustment to the angle of attack of the foils is awkward and cumbersome.

However, some progress has been made in the prior art to simplify and improve the steering control system to some extent. An example of this type of device is disclosed in U.S. Pat. No. 3,295,487 to Smith wherein a cable and pulley arrangement is used to simultaneously regulate the inclination of both windward hydrofoils. Although, in general, these devices have performed satisfactorily, these prior art devices have not been found to be entirely suitable in applications wherein an instantaneous and more positive response is desired. Moreover, such devices have not separated the directional or steering control from the pitch control. On a left turn the sailboat will pitch down and on a right turn the boat will pitch up.

The above disadvantages are overcome by the present invention which provides a single control for steering both windward hydrofoils without material affect on the pitch of the craft.

## SUMMARY OF THE INVENTION

The general purpose of the invention is to provide a single control for maneuvering and steering the hydrofoil sailboat on all points of sailing. By rotation of a single bellcrank member, simultaneous steering control of the two windward hydrofoils is achieved. A simple and inexpensive device is used to vary and regulate the angle of attack of the hydrofoils without materially affecting the pitch of the craft. Another advantage of the present invention over the prior art use of independent controls for steering is that the coupling together of the controls for the two windward hydrofoils simplifies the system. Both windward hydrofoils may thus be simultaneously set by the use of a single control or bellcrank member.

## OBJECTS OF THE INVENTION

An object of the present invention is to improve the maneuverability, speed and handling convenience of a hydrofoil craft through the use of simplified controls.

Another object is the provision of a single, interconnected mechanism for steering and controlling the angle of attack of the hydrofoils without affecting the pitch of the hydrofoil craft.

A further object of the invention is the provision of a mechanism for simultaneous movement and control of the windward hydrofoils.

Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the hydrofoil craft of the present invention; and

FIG. 2 is a diagrammatic view of this invention, illustrating the controls of the windward hydrofoils.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring in detail to the drawing, in which the invention is illustrated in highly simplified form, essentials comprise hydrofoils 10, 12 and 14 constructed and oriented to produce certain desired forces, a rigid frame 16 for maintaining the hydrofoils in spatial relationship, and means for applying a propelling force to the frame and its attached hydrofoils, such as a mast 18 secured to the frame and a sail 20 secured to the mast. Hydrofoils 10, 12 and 14 provide both the buoyant and dynamic support for the sailboat. The hydrofoils differ from those employed with hydrofoil boats having buoyant hulls in that they provide the entire buoyant supporting forces for the craft when it is at rest. When in motion, however, they produce lift forces, analogous to the lift forces produced by the hydrofoil of a hull-type hydrofoil boat and other stabilizing and steering forces as will subsequently appear.

The frame 16 has the additional feature of being collapsible and therefore can be stored and handled more conveniently. As shown in the drawing, mast 18 and spars 32 and 34 are hinged at 36 by a horizontal pin passing through ears in the spars. Spars 38 and 40 are hinged by a similar pin whose axis is perpendicular to the first horizontal pin. A screw, with the head shouldering on the second pin, passes through second pin and engages threads in the first pin. Thus, by turning the single screw, the two pins are brought closer together, thereby erecting and stressing the entire aerohydrofoil frame. Removing the screw, completely frees the first pin from the second pin, allowing the entire structure to fold up and collapse into a small package.

Hydrofoil 14 and sail 20 are nonarticulating components, held to the frame with struts and wires in a fixed orientation. Windward hydrofoils 10 and 12 are each pivotally connected to the frame by struts 22 and 24, respectively, and may be simultaneously rotated to the desired position by the use of push rods 26 and 28 and bellcrank member 30.

The control system for regulating the angle of attack of hydrofoils 10 and 12 is illustrated in FIG. 2. Push rods 26 and 28 slide in hydrofoil extensions or struts 22 and 24, respectively. The inner ends of push rods 26 and 28 are pivoted at 50 and 52, respectively, on arms of the control means or bellcrank 30. Bellcrank 30 is pivotally attached at 42 to spar 32 and the vertical pivot axis of the bellcrank is shown at 44. Bellcrank 30 may be rotated about axis 44 either manually or by various powered means (not shown). Rods 46 and 48 are pivotally attached to the struts 22 and 24, respectively, and spars 38 and 40 are pivotally connected to hydrofoils 10 and 12, respectively. In this manner, rod 46 and spar 38 define a vertical hinge axis about which hydrofoil 10 rotates and rod 48 and spar 40 define another vertical hinge axis about which hydrofoil 12 rotates. Directional control is obtained by articulating foils 10 and 12 about these vertical hinge axes.

In operation, foil 14 and sail 20 are kept to leeward; foils 10 and 12 to windward. FIG. 1 illustrates how foils 10 and 12 are manipulated for tacking to the right. Foil 12 is then the forward foil and is turned counterclockwise about 10 degrees from a plane passing through the hinge or pivot axes of foils 10 and 12. When bellcrank 30 is adjusted for a right tack as shown in FIG. 2, rotation of 30 has little effect on hydrofoil 12, but maximal effect on hydrofoil 10. Thus foil 12 is essentially fixed and foil 10 can be "ruddered" with small motions of bellcrank 30. To change tacks, bellcrank 30 is rotated counter clockwise about 90 degrees, which reverses the roles of foils 10 and 12. Foil 10 is turned clockwise 10 degrees and held fixed and foil 12 becomes the rudder. As is now apparent, simultaneous steering control of the two windward hydrofoils 10 and 12 is achieved by rotation of the single bellcrank member 30, without materially affecting the pitch of the craft.

It will be observed from FIG. 2 that the windward foils 10 and 12 rotate in opposite directions about their respective vertical hinge axes as bellcrank 30 is rotated. A total range of foil rotation of approximately 20 degrees is considered sufficient

to provide the necessary directional control of the hydrofoil craft.

It should be understood, of course, that the foregoing disclosure relates to only a preferred embodiment of the invention and that numerous modifications and alterations may be made therein. For example, the steering control of the present invention is not limited to curved or buoyant hydrofoils. The foils may be straight and the craft may have a hull to provide the required directional control of the

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings.

What is claimed is:

- 1. A hydrofoil craft comprising:
  - a frame for carrying a load;
  - said frame adapted to be supported above and out of contact with the water by a triangular arrangement of a first, second and third hydrofoil;
  - means rotatably mounting said first and second hydrofoils on the craft for pivotal movement of said hydrofoils about substantially vertical axes;
  - said third hydrofoil being rigidly affixed to the craft;

control means coupling together said first and second hydrofoils, whereby selective simultaneous pivotal movement of said first and second hydrofoils may be achieved by actuation of said control means in order to provide directional control of the path of the craft;

said control means including a single rotatable bellcrank member to control said first and second hydrofoils and to steer the craft; and means carried by said craft for propelling it.

2. A hydrofoil craft according to claim 1 wherein said bellcrank member is rotatable about a fixed axis and is pivotally connected to two push rods which slide in hydrofoil extensions to control said first and second hydrofoils.

3. A hydrofoil craft according to claim 2 wherein said means rotatably mounting said first and second hydrofoils include rodlike members which define a vertical hinge axis for each of said first and second hydrofoils whereby the angle of attack of said hydrofoils is changed by rotation about said axes.

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