United States Patent [19]

Burtis

[11] **3,753,415**

[45] **Aug. 21, 1973**

[54] **HYDROFOIL-SHAPED STABILIZING OR ATTITUDE-AFFECTING MEANS FOR BOATS**

[76] Inventor: **Samuel G. Burtis,** Sherman Point Rd., P.O. Box 367, Camden, Maine 04843

[22] Filed: **Nov. 30, 1971**

[21] Appl. No.: **203,341**

[52] **U.S. Cl.** **114/126,** 114/127

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

[58] **Field of Search** ..... 114/126, 127, 135, 114/136, 142, 143, 66.5 H; 115/28 R, 28 A, 4

[56] **References Cited**

UNITED STATES PATENTS

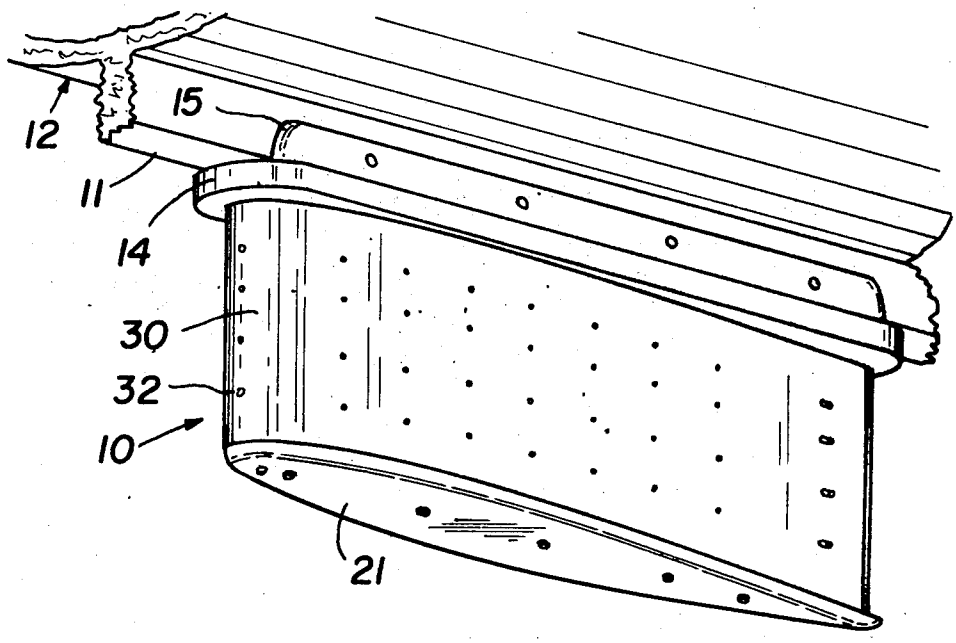
3,118,639 1/1964 Kiceniuk ..... 115/28 A

Primary Examiner—Milton Buchler
Assistant Examiner—E. R. Kazenske
Attorney—Edgar N. Jay

[57] **ABSTRACT**

A hydrofoil-shaped stabilizer or attitude-changing means for boats, having an elongated frame assembly adapted to be connected to a submerged portion of the hull of a boat with its longitudinal axis parallel to the fore-to-aft axis of the boat. A flexible curtain assembly extends about the frame assembly and is fixed thereto but free to move laterally and to a more limited extent longitudinally relative to the frame assembly. The interior of the curtain assembly communicates with the surrounding water and is deflected to one side or the other relative to the frame assembly by its displacement relative to the water caused by a change in the attitude of the boat so as to form a hydrofoil having a camber for generating forces to oppose the change in attitude to one side or the other when the boat is underway.

8 Claims, 7 Drawing Figures



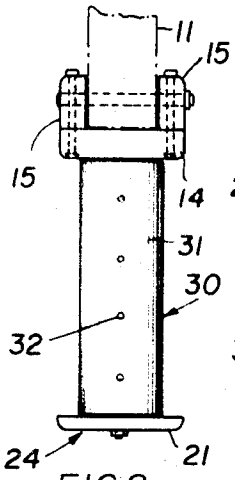


FIG. 2

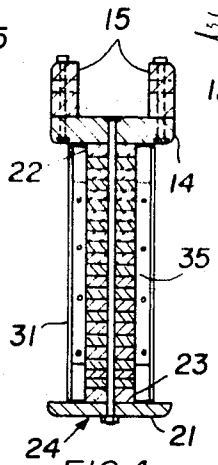


FIG. 4

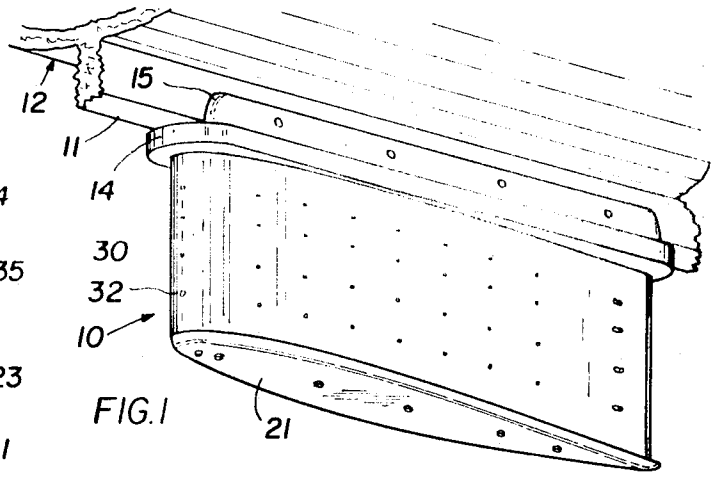


FIG. 1

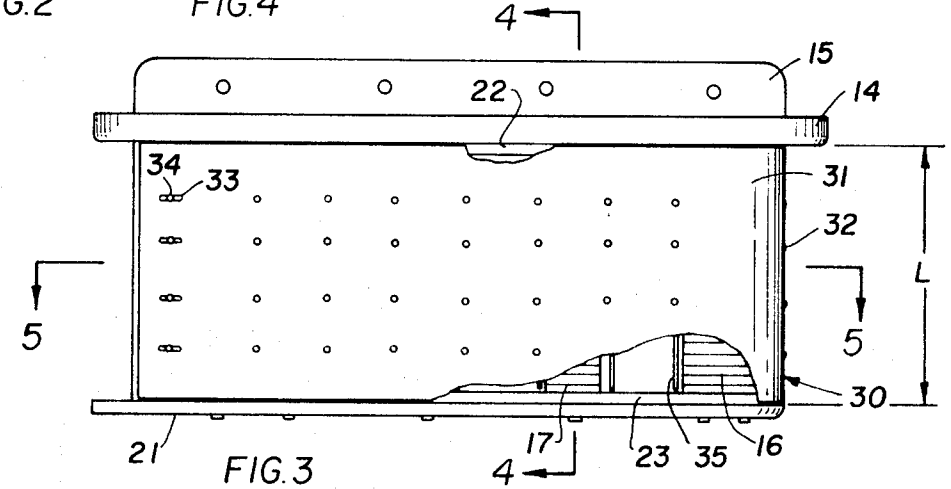


FIG. 3

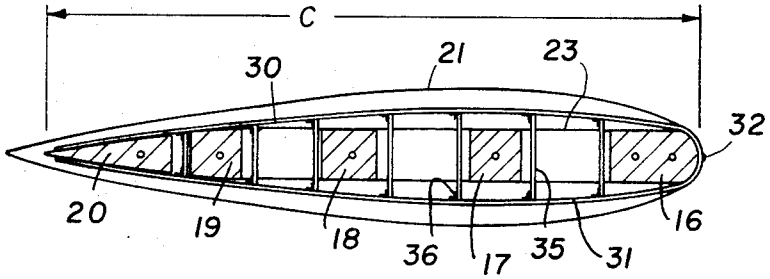


FIG. 5

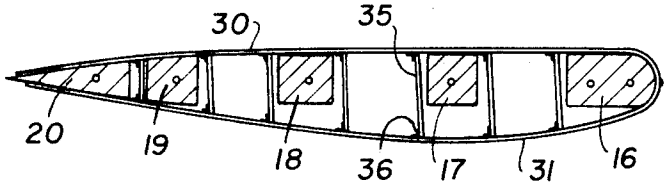


FIG. 6

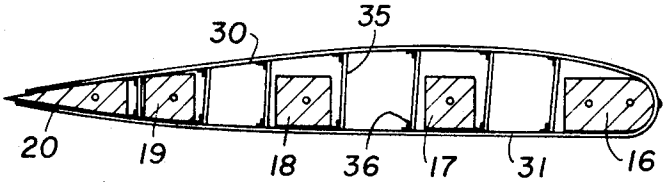


FIG. 7

HYDROFOIL-SHAPED STABILIZING OR ATTITUDE-AFFECTING MEANS FOR BOATS

This invention relates to a water-borne vessel stabilizer or attitude-affecting means and, more particularly, to such a device which in response to forces generated by water flowing thereover as when the boat rolls to one side or the other, varies its camber so that with the boat underway a force is generated acting in the direction to oppose and retard the boat's change in attitude whereby the motion of the boat is stabilized.

Widely different types of boat stabilizing systems utilizing fins or hydrofoils have hitherto been provided varying from relatively simple arrangements such as the modified centerboard of U.S. Pat. No. 3,538,879, suited only for relatively small sailing boats, in which the centerboard is intended to function as a stabilizing hydrofoil with a manually movable tail flap, to highly complex and costly systems in which fins (with or without adjustable tail flaps) are automatically controlled in response to a sensor which may include one or more acceleration responsive devices. However, such arrangements are very often either inadequate except for relatively small sailboats or are complex and require large amounts of power.

It is therefore a principal object of this invention to provide an improved boat stabilizer of very simple construction which, in response to the roll of the boat to either side, automatically adjusts its camber to provide a hydrofoil shape which, with the boat underway, generates forces to oppose and diminish the roll.

A more specific object is to provide such a stabilizer which does not require any parts to extend or to be sealed through the hull of the boat and which can be used to stabilize a wide variety of types and sizes of vessels.

In carrying out the present invention, one or more stabilizer assemblies are mounted to extend longitudinally from fore to aft along the center line of the vessel. Instead or in addition, such stabilizers can be mounted on the bilges symetrically spaced from the center line. Each stabilizer has a central or inner frame structure fixed to the hull of the boat which supports a flexible wall or curtain assembly forming an enclosure therefor which is free to move laterally with respect thereto and, to a more limited extent, is free to move fore to aft relative to its inner supporting structure all in response to the transverse flow of water relative to the stabilizer assembly caused by rolling of the vessel. When the vessel is underway with little or no rolling, the flexible wall of the stabilizer assumes its neutral position with substantially equal camber on both sides of the stabilizer. As the vessel rolls to one side or the other assuming an initially vertica' attitude, transverse displacement of the flexible wall of each stabilizer assembly alters the camber thereof so that the upwardly presented surface of the wall forms a shorter fore-to-aft stream line than the downwardly presented surface. Consequently with the vessel underway, the forces generated act on the stabilizer in the direction to urge it downward and thus to oppose the roll of the vessel.

The foregoing as well as additional objects and advantages of the present invention will be apparent from the following description of a preferred embodiment and the accompanying drawing in which

FIG. 1 is a perspective view broken away for convenience of a preferred embodiment of the present invention showing the hull of a vessel with a hydrofoil-shaped stabilizer mounted on the keel thereof with its port side presented to view;

FIG. 2 is a front elevational view of the stabilizer shown in FIG. 1;

FIG. 3 is a side elevational view thereof with its starboard side presented to view;

FIGS. 4 and 5 are cross-sectional views taken respectively through the lines 4—4 and 5—5 of FIG. 3;

FIGS. 6 and 7 are views taken from above similar to FIG. 5 but diagrammatic for convenience and showing the operation of the stabilizer just after the start of a roll to the right (starboard) and a roll to the left (port) respectively.

Referring now to the drawings, stabilizer assembly 10 is a preferred embodiment of my invention which I have found well suited for use on a power cruiser boat having a semi-displacement type hull with a soft chine, an overall length of about 37 feet, a maximum beam of about 12 feet 4 inches, a displacement of about 11 tons, and a cruising speed of about 10 to 11 knots. I have mounted and used successfully two such stabilizer assemblies 10 in line along the keel 11 of the boat 12. While my invention will now be described in detail in connection with such stabilizer assemblies 10 (only one of which is shown in the drawing), it is to be understood that variations in the design shown can be made, and other materials than those designated can be used without departing from my invention.

Stabilizer assembly 10 comprises a top plate 14 fixed to the bottom of the keel 11 by means of a pair of elongated clamps 15 preferably formed of suitably treated wood such as oak to which the top plate 14 is bolted and which are in turn bolted to opposite sides of keel 11. Fixed to the top plate 14 are frame members 16, 17, 18, 19 and 20 which depend from the top plate 14 and are arranged in spaced relation from fore to aft in the sequence stated. The bottom ends of the frame members 16–20 are secured to a bottom plate 21. Preferably, for reasons to be pointed out hereinbelow, upper and lower auxiliary plates 22 and 23 are respectively interposed between the upper and lower ends of the frame members and the top and bottom plates 14 and 21.

The spacing between adjacent frame members 16–20 is not critical, but should be enough to permit free lateral displacement of the water within the enclosure formed by the flexible curtain assembly 30 yet to be described as well as to facilitate mounting and operation of the flexible curtain assembly 30.

The frame members 16–20 can be formed of any material suitable for marine use, but preferably are built up of marine plywood laminated with a suitable marine glue and are bored for the passage therethrough of bronze carriage bolts by which they and the various plates are fastened together. Other materials contemplated for use in making the frame members 16–20 are bronze or suitably reinforced fiber glass constructed to readily break away in the event the stabilizer assembly should collide with an obstruction in spite of its advantageously short span. Before the lower auxiliary plate 23 and the bottom plate 21 are fixed to the lower ends of the frame members 16–20, the flexible curtain assembly, which will now be described in detail, is mounted on the frame members.

The flexible curtain assembly 30 comprises a wall or curtain member 31 formed of flexible material sufficiently strong to withstand the substantial forces gener-

ated in operation and capable of effectively preventing the passage of water through it after long periods of immersion. I have found a three-ply fiber glass curtain member reinforced with an epoxy resin provided satisfactory results. As shown, the height or vertical span of the curtain **31** is close to but just less than the distance between the top and bottom plates **14** and **21** so that the curtain **31** can move freely between them. At the same time, the span of the curtain **31** should be sufficiently larger than the distance between the auxiliary plates **22** and **23** so that in its lateral movement in one direction or the other, motion of the curtain **31** is limited by its engagement on one side or the other with the corresponding sides of the plates **22** and **23.** Along its forwardly presented vertical center line, curtain **31** is fixed to the center of frame member **15** by bronze screws **32.**

Adjacent to its trailing edges, curtain **31** is provided with a plurality of horizontally elongated openings **33** by means of which both sides of curtain **31** are movably connected to the trailing end portion of frame member **20** by fasteners **34** fixed to the frame member **20** and provided with oversize heads for retaining the curtain member **31** while leaving both of its sides free to move fore and aft a limited extent. A plurality of cross-members or plates **35** extend between and are fastened to the opposite sides of the curtain **31** by means of elongated hinges **36.** The cross-members **35** are made of three-ply reinforced fiber glass, as in the case of curtain **31,** and each is riveted or otherwise suitably fastened to its hinges **36** which in turn are similarly fastened to the curtain. One of the cross-members **35** extends in the space between the frame members **19** and **20** while the remainder extend two by two in spaced relation in the remaining three spaces between the frame members **16–17, 17–18,** and **18–19.**

As is shown most clearly in FIG. **5,** the lengths of the cross-members **35** are varied from front to back so that the curtain **31** when at rest in its central neutral position provides a well streamlined shape in the water as the boat **12** moves ahead. Assuming no substantial relative lateral motion between the stabilizer **10** and the water passing under the boat as it moves ahead, the curtain **31** remains substantially centrally disposed about the frame members because of the cross-members **35** and its own inherent stiffness. Because the curtain **31** is fixed to the frame assembly **24** only along its forward vertical center line, it is free to move to a limited extent to one side or the other, when the boat begins to roll, under the influence of the water which then, in addition to its fore-to-aft motion relative to the boat and the stabilizer, also has a substantial transverse component whereby the curtain **31** is forced to the right relative to the frame assembly **24** at the start of a roll to the right and as observed from above. (It is to be noted that in the sake of clarity all references to the right or left of or in relation to the stabilizer **10** throughout this application will correspond to the starboard and port sides respectively of the boat, that is to say as the stabilizer is observed from above by an observer facing the bow of the boat.)

At the start of a roll to the right, the curtain **31** is shifted from its central neutral position shown in FIGS. **2** and **5** to the position shown in FIG. **6** with substantially increased camber on the now downwardly presented right side and with the upwardly presented left side of curtain **31** engaging the left side of the frame members **16-20.** Thus, stabilizer **10** provides a hydrofoil of small aspect ratio. While the dimensions are not at all critical, it may be well to note that in the stabilizer assemblies tested, the span "L" (FIG. **3**) equaled about 13 inches and the length of the chord "C" (FIG. **5**) was about 37 inches so that the aspect ratio (L/C) was therefore 13/37. The length of the chord of the stabilizer corresponds substantially to the length of either side of the frame assembly **24.** It may be also well to note that the width of frame members **16, 17** and **18** was about 3 inches, and the width of the widest plates **35** was such that the outside width of the curtain **31** was 4½ inches.

Assuming the condition of the sea in which the boat is moving ahead was such as to induce a 15° roll to starboard, the configuration of the stabilizer, until the start of the return roll, in view of the increased length of the stream lines along the downwardly presented surface of curtain **31** and the minimized length of the stream lines along its upwardly presented surface results in a net average downwardly force on the stabilizer in a direction to oppose the roll of the boat to the right.

At the start of the return roll, the relative lateral motion between the water and the stabilizer is reversed and while the boat is rolling back to its vertical position and on into its roll to the left, the camber of the stabilizer is reversed as shown in FIG. **7** so that the return roll and the roll to the left are also opposed by the forces acting on the stabilizer.

The volume within the curtain **31** is filled with water during operation. With the pressure differential across the stabilizer generated in keeping with Bernoullis' theorem, the effect thereof would be diminished to the extent that water from the high pressure side (the upwardly presented surface as seen in FIG. **6** and the downwardly presented surface as seen in FIG. **7**) could flow through the stabilizer to the low pressure side. However, the upper and lower auxiliary plates **22** and **23** function to impede the transverse flow of water because of the engagement therewith of the upper and lower peripheral portions of the curtain **31** on the high pressure side of the assembly. It may also be well to note here that on each side, the shape of the auxiliary plates conforms to the chord of the hydrofoil shape formed by the actuated curtain assembly **30** so that in forming a stop for the edges of the curtain, the auxiliary plates **22** and **23** not only prevent transverse flow of water but also aid in ensuring the desired foil shape.

The terms and expressions which have been employed are used as terms of description and not of limitation, and there is no intention in the use of such terms and expressions of excluding any equivalents of the features shown and de-scribed or portions thereof, but it is recognized that various modifications are possible within the scope of the invention claimed.

I claim:

1. A hydrofoil-shaped attitude-affecting means for a boat, comprising elongated mounting means, means for connecting said mounting means to the hull of a boat with the longitudinal axis of said mounting means extending substantially parallel to the fore-to-aft axis of said boat, a longitudinally extending frame assembly connected to and depending from said mounting means so as to be normally submerged in use, flexible curtain means substantially enclosing both sides of said frame assembly, means supporting said flexible curtain means so that the later is free for limited lateral displacement

to either side relative to said frame assembly between two extreme positions in response to and depending upon the direction of the displacement of said frame assembly and flexible curtain means relative to the water surrounding the same, the interior of said flexible curtain means being free to communicate with the water surrounding the same when the latter is submerged, said flexible curtain means in said one of its extreme positions has one side thereof engaging one side of said frame assembly and the other side thereof spaced from the other side of said frame assembly, said flexible curtain means in said other of its extreme positions has its other side engaging the other side of said frame assembly and said one side of said flexible curtain means is spaced from said one side of said curtain assembly, and said flexible curtain means in cooperation with said frame assembly in one of its said extreme positions having a camber for generating forces in one direction normal to the longitudinal axis thereof and in the other of its said extreme positions having a camber for generating forces in the direction opposite to said one direction, whereby said attitude-affecting means functions on a boat underway ahead to inhibit changes in the attitude thereof.

2. A hydrofoil-shaped boat stabilizer, comprising elongated mounting means, means for connecting said mounting means to the normally submerged portion of the hull of a boat with the longitudinal axis of said mounting means extending substantially parallel to the fore-to-aft axis of said boat, a longitudinally extending frame assembly connected to and depending from said mounting means, flexible curtain means substantially enclosing both sides of said frame assembly, means supporting said flexible curtain means so that the later is free for limited lateral displacement to either side relative to said frame assembly between two extreme positions in response to and depending upon the direction of the displacement of (*a*) said frame assembly and flexible curtain means relative to (*b*) the water surrounding the same, the interior of said flexible curtain means being free to communicate with the water surrounding the stabilizer when the latter is submerged, said flexible curtain means in said one of its extreme positions has one side thereof engaging one side of said frame assembly and the other side thereof spaced from the other side of said frame assembly, said flexible curtain means in said other of its extreme positions has its other side engaging the other side of said frame assembly and said one side of said flexible curtain means is spaced from said one side of said curtain assembly, and said flexible curtain means in cooperation with said frame assembly in one of its said extreme positions having a camber for generating forces in one direction normal to the longitudinal axis thereof and in the other of its said extreme positions having a camber for generating forces in the direction opposite to said one direction, whereby said stabilizer functions on a boat underway ahead to inhibit rolling thereof and thereby stabilize the same.

3. A stabilizer as set forth in claim **2** wherein means are provided for inhibiting the movement of water from along one side of said curtain means into the interior thereof while said curtain means is in each of its said two extreme positions.

4. A stabilizer as set forth in claim **3** wherein said means for inhibiting the movement of water comprises a pair of auxiliary plates for engaging the upper and lower peripheral portions of said curtain means along one side of said curtain means depending upon which of said extreme positions is occupied by said curtain means.

5. A stabilizer as set forth in claim **2** wherein said curtain means comprises two water-impervious courses one extending along each side of said frame assembly, and a plurality of cross-members extending between and pivotally connected to said courses.

6. A stabilizer as set forth in claim **5** wherein said curtain means is fixed to said frame assembly substantially only along the forwardly presented vertical center line thereof.

7. A stabilizer as set forth in claim **5** wherein said frame assembly comprises a plurality of spaced frame members depending from said mounting means and aligned along said longitudinal axis, and said cross-members extend between said frame members.

8. A stabilizer as set forth in claim **7** wherein said curtain means is fixed to the forward one of said frame members substantially along the vertical center line thereof, and the rearward end portion of said curtain means is movably connected to the rearmost one of said frame members and is free for limited longitudinal movement with respect thereto.

* * * * *