United States Patent [19]

Matthews

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[54] **HYDROFOIL CONTROL MEANS**

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[52] **U.S. Cl.** ..... **114/66.5 H**

[51] **Int. Cl.** **B63b 1/28**

[58] **Field of Search** ..... 114/66.5 H, 66.5 R, 66.5 P; 115/70; 9/310 R, 310 C

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[57] **ABSTRACT**

An attitude control for a primary lifting hydroplane in the form of a control surface attached to the forward tip of the primary plane by a vertical support. The control plane maintains the primary plane at a fixed depth. Hydraulic dampers including stops control the rate and maximum amount of angular motion of the primary plane.

2 Claims, 2 Drawing Figures

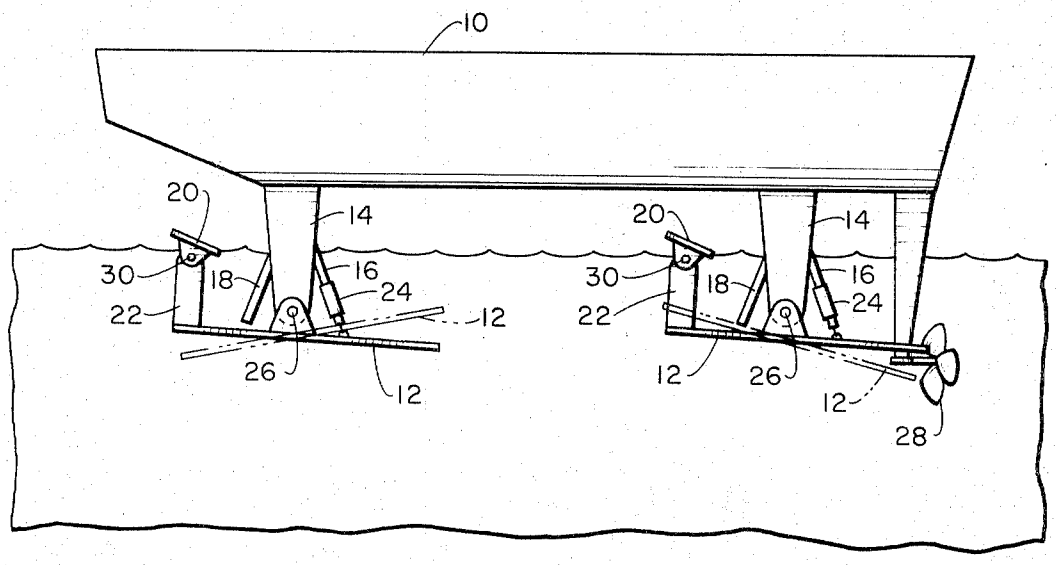


Fig. 1.

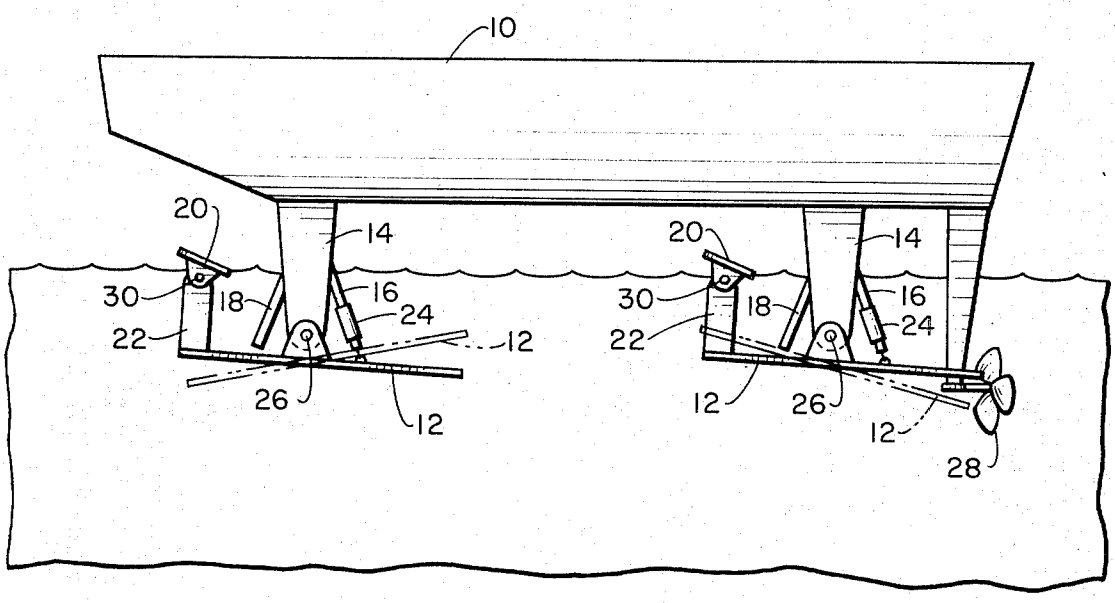
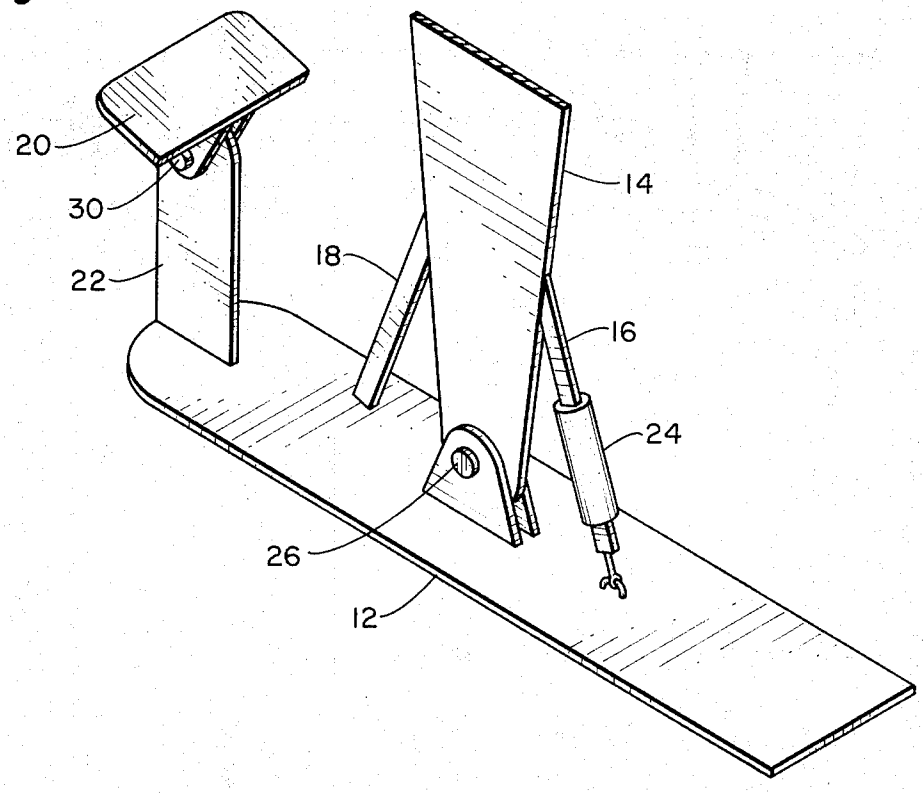

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Fig. 2.


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HYDROFOIL CONTROL MEANS

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

This invention relates to hydrofoils and more particularly relates to control devices for hydrofoils.

Hydrofoils are well known in the art and there are a number of methods of controlling them. When attached to a boat, the hydrofoils will lift the hull of the craft above the water at a certain predetermined speed. It is important that the angle of incidence of the hydrofoils be maintained to provide the desired lift. That is, that the hull of the craft be supported at a near constant height above the water surface.

It is also important that the hydrofoils remain at a certain level below the water. This is because hydrofoils which ride on the surface of the water provide a rough ride, especially in rough water.

One solution to this problem is by the use of a servo mechanism to control the angle of incidence of the hydrofoil. While this solution is generally satisfactory, it is complicated and expensive to build and maintain.

Yet another solution to the problem is to provide a float attached to the hydrofoil. While effective, the floating control is not entirely satisfactory. The float generally follows the contour of the water and could cause a rough ride in very choppy water.

SUMMARY OF THE INVENTION

The present invention is similar to the float control except that it provides a hydroplaning control surface attached to the tip of the hydrofoil, a predetermined distance above it. The control surface more or less skims the surface of the water and automatically changes the angle of incidence to maintain the hydrofoil at a substantially constant depth. The hydroplane surface is flat and tends to skim along and cut through choppy water to prevent the "bobbing" effect that the floating does. The control surface can also be adjusted and locked to increase or decrease the lift, if desired.

An additional feature is the provision of damping on the hydrofoil to prevent rapid changes of the angle of incidence. This also tends to smooth the ride in choppy or rough water. Included with the damping are stops to maintain the angle of incidence of the hydrofoil within predetermined limits.

STATEMENT OF THE OBJECTS OF THE INVENTION

It is an object of the present invention to provide automatic attitude control of hydrofoils.

Yet another object of the present invention is to provide automatic attitude control of hydrofoils with hydroplaning control surfaces.

Still another object of the present invention is to provide automatic attitude control of hydrofoils with hydroplaning control surfaces which are adjustable.

A further object of the present invention is to provide automatic attitude control of hydrofoils, including damping to regulate the rate of angular motion of the hydrofoils.

A still further object of the present invention is to provide automatic attitude control of hydrofoils with stops to limit the maximum angle of incidence.

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 illustrates a boat with the hydrofoil control of the invention.

FIG. 2 is a view of the hydrofoil with the attitude control surface.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a boat **10** with hydrofoils **12** attached fore and aft to struts **14.** The size and number of hydrofoils obviously will vary with the size of the boat. Usually there are four, two forward and two aft. In some smaller craft, there may be only one forward and two aft, spaced on either side of propeller **28.** The same principles of the invention apply regardless of the number of hydrofoils.

FIG. 2 illustrates the hydrofoil construction in greater detail. Hydrofoil **12** is supported on strut **14** by pivot **26,** which may be of any design. Hydrofoil **12** is attached to pivot **26** so that the surface area aft of the pivot is greater than the surface area in front of the pivot, not including the surface area of attitude control **20.** Thus, the pressure against the larger area of the primary plane aft of pivot **26** tends to cause a counterclockwise rotation (as viewed in FIG. **1**), forcing the tip of hydrofoil **12** down.

Attitude control plane **20** is attached to the hydrofoil **12** by vertical support **22** which may be any desired length (perhaps **20** inches). The attitude control **20** is fastened to vertical support **22** by a lockable pivot **30.** Generally, the attitude control will be at a slight upward angle with respect to hydrofoil **12.** With the pivotal mount **30,** attitude control **20** can be adjusted to give more or less lift as desired for optimum performance.

In operation, attitude control **20** moves through the water and a moment is generated which tends to rotate hydrofoil **12** clockwise (as viewed in FIG. **1**) so that the angle of attack of its primary plane increases. That is, attitude control **20** tends to force the tip of hydrofoil **12** up in the opposition to the pressure against the larger area of the hydrofoil primary plane aft of pivot **26.** This provides lift until the attitude control **20** emerges from the water. When attitude control **20** is out of the water, there is a moment generated by the dynamic pressure of the water acting on the greater area of the hydrofoil **12** aft of the pivot **26** which tends to force the tip of hydrofoil **12** down. This reduces lift, permitting the boat to sink in the water until the attitude control **20** is again submerged. With the proper forward velocity, the invention will maintain boat **10** at a position where hydrofoil **12** is submerged at an approximate depth equal to the length of the attitude control support **22.**

In order to limit the maximum angle of attack of hydrofoil **12,** stops **16** and **18** are provided. The angle limiting effect of stops **16** and **18** is shown in FIG. **1.** An additional feature is the inclusion of hydraulic damping by chamber **24.** This has the effect of limiting the angular rate of change of hydrofoil **12** which tends to

smooth out the ride. Generally, a 20° limit on the rotation of hydrofoil **12** is adequate as shown in FIG. **1.** Other methods of damping can be used, if desired, or none at all. For example, a flexible material similar to a spring could be attached to the hydrofoil and extend into stop **16** or a slip clutch could be provided at pivot **26.** Of course, whatever method is used, the material must be corrosion resistant for obvious reasons.

Thus, there has been disclosed a novel device for attitude control of a hydrofoil. The attitude control provides smooth and even riding by keeping the hydrofoil at a predetermined depth below the water. The flat shape of the attitude control cuts through choppy water averaging out the effect of the hydrofoil. This, coupled with damping of the hydrofoil motion, provides smooth and effective control of the boat.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

I claim:

1. Apparatus for controlling the attitude of a hydrofoil comprising:

means for pivotally mounting the hydrofoil so that the surface area aft of the pivot is greater than the surface area in front of the pivot whereby pressure against the larger area tends to cause a counterclockwise rotation, forcing the tip of the hydrofoil down;

a flat attitude control plane attached to the forward end of the hydrofoil by a straight vertical support; said attitude control plane being adjustably mounted with a slight upward angle with respect to the hydrofoil whereby a moment is generated when the attitude control moves through water, which tends to rotate the hydrofoil clockwise, forcing the tip up in opposition to the pressure against the larger area of the hydrofoil aft of the pivot;

a pair of arms attached to the hydrofoil pivotally mounting means extending forward and aft and acting as stops to limit the maximum angle of incidence of the hydrofoil to 20°; and

means attached to the aft extending arm for damping the angular rate of change of the hydrofoil.

2. The apparatus of claim **1** wherein said damping means comprises a hydraulic cylinder incorporated in said aft extending arm and attached to the aft end of the hydrofoil.

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