Oct. 31, 1961 J. A. JOHNSON 3,006,307

MARINE CRAFT SUPPORTING HYDROFOIL HAVING DEPTH CONTROLLING SLOTS

Filed Oct. 12, 1960 2 Sheets-Sheet 1

Fig.2.

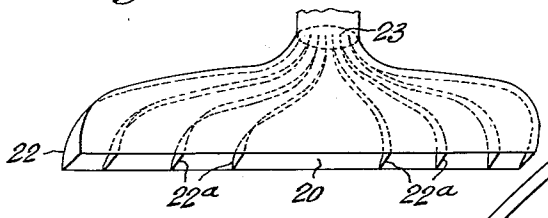


Fig.1.

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Fig. 3.

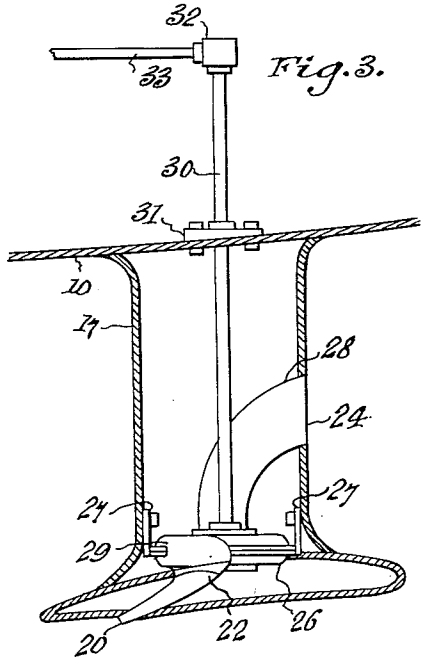


Fig. 5.

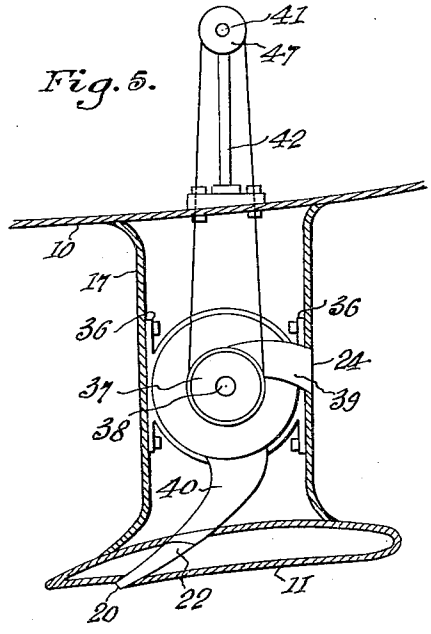


Fig. 4.

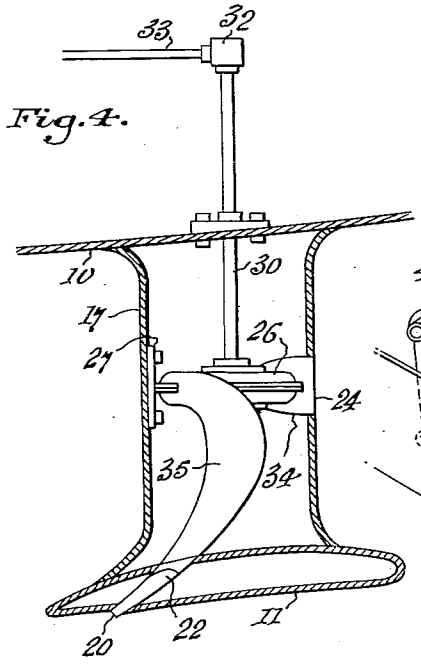
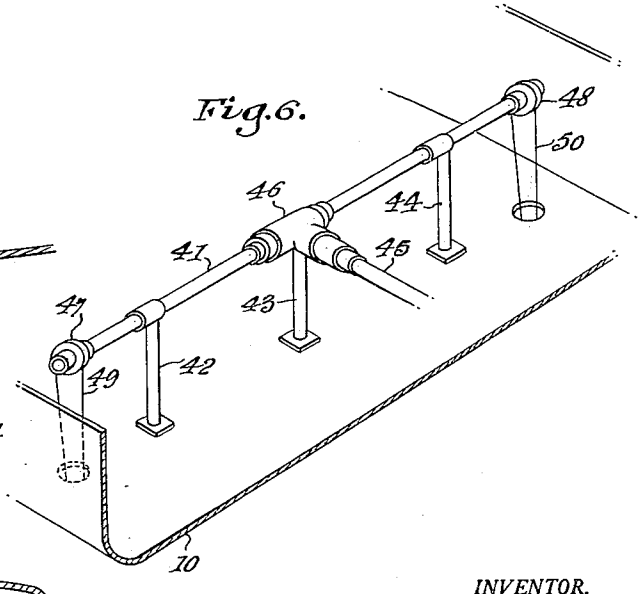


Fig. 6.



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MARINE CRAFT SUPPORTING HYDROFOIL HAVING DEPTH CONTROLLING SLOTS

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6 Claims. (Cl. 114—66.5)
(Granted under Title 35, U.S. Code (1952), sec. 266)

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

The invention relates to marine craft or boats and more particularly to the type having submerged hydrofoils for supporting the hull of the boat out of the water.

In the past, difficulty has been encountered in maintaining the hydrofoils at the proper level of submersion throughout the full range of speeds. This normally required the full time and attention of an operator who would consequently be taken away from other duties.

In the prior devices which have dealt with this problem, the depth of submersion has been controlled by using water pressure responsive devices for changing the angle of the hydrofoil and thereby changing the lift. These devices have not proved sufficient for all purposes due to the inertia and friction in the linkage connecting the pressure responsive devices and the pivoted hydrofoil portion.

The present invention obviates the aforementioned difficulties since the change in the lift is supplied by the water as it leaves a nozzle in the bottom of the hydrofoil. The present invention contemplates the control of the depth of submersion of the hydrofoil by the receipt of water through an opening in the hydrofoil support at a point which would correspond to the surface of the water when the hydrofoil is at the proper level of submersion. The water may be accelerated by a pump and passed through a nozzle in the bottom of the hydrofoil giving an increased lift to the hydrofoil.

It is therefore an object of the present invention to provide a device to maintain a constant depth of the hydrofoils over a wide range of boat speeds.

It is a further object to provide increased lift to a hydrofoil below a set depth of submersion and a decreased lift above said set depth.

It is a still further object to provide increased lift to a hydrofoil below a set depth of submersion and a decreased lift above said set depth sufficient to maintain the hydrofoil at said set depth independently of the speed at which the hydrofoil moves through the water.

Other objects and many of the attendant advantages will become apparent and the invention will be better understood by reference to the following description and the accompanying drawings in which:

FIG. 1 is a view of the bottom of the boat embodying the present invention;

FIG. 2 is a detail of the nozzle in the hydrofoil;

FIG. 3 is a fragmentary sectional view of the hydrofoil shown in Fig. 1;

FIG. 4 is a fragmentary sectional view of the hydrofoil showing a modified position of the pump;

FIG. 5 is a fragmentary sectional view of the hydrofoil showing a further modified pump arrangement; and

FIG. 6 is a fragmentary perspective view showing portions of the drive for the pump shown in FIG. 5.

Referring now to FIGS. 1 through 3 of the drawing, a marine craft or boat **10** has a forwardly positioned or front supporting hydrofoil **11** and a rearwardly positioned or rear supporting hydrofoil **12**. The hydrofoils **11** and **12** are disposed below the bottom of the boat **10** and perpendicular to a vertical plane which extends through

the longitudinal center line of the boat and bisects the longitudinal extent of the hydrofoils.

The rear hydrofoil **12** it attached to the hull of the boat **10** by spaced apart, substantially vertical struts **13** and **14**. The rear hydrofoil **12** may carry propellers **15** and **16**, driven by a suitable engine (not shown) for the propulsion of the boat. The rear hydrofoil **12** does not require depth controlling devices since variations in the depth of the forward or front hydrofoil **11** will change the angle of incidence of the rear hydrofoil and cause the rear hydrofoil to seek to maintain the boat on a substantially level keel at the current depth of the front hydrofoil.

The front hydrofoil **11** it attached to the hull of the boat **10** by spaced apart, substantially vertical, hollow struts **17** and **18** and an upwardly and forwardly inclined brace **19**. The brace **19** extends from the mid-length location of hydrofoil **11** and the struts **17** and **18** extend from the hydrofoil at locations symmetrically positioned at respectively opposite sides of the brace **19**.

A pair of longitudinally spaced apart and longitudinally extending slot openings **20** and **21** are provided in the bottom surface of hydrofoil **11**. Mounted in the hydrofoil **11** is a slot wall formation or nozzle **22** having the discharge end mounted in the slots **20** or **21**. The nozzle **22** has a throat opening **23** opposite the slot opening **20** or **21**, which communicates with the interior of the corresponding strut **17** or **18**. The slot openings **20** and **21** have an area that is no larger and which is preferably smaller than the area of the throat opening **23** so that water entering the nozzle **22** through the throat opening can be discharged as a high velocity jet from the slots **20** or **21**. Guide vanes **22***a* are mounted in the nozzle **22** to guide the water from the throat opening **23** to the slot openings **20** or **21**.

Water inlet openings **24** and **25** are provided in the forward edges of struts **17** and **18** respectively. These openings are located in such a position vertically that the openings **24** and **25** will be partly above and partly below the surface of the water when the hydrofoil **11** is supporting the bow of the boat **10** at the desired distance above the surface of the water. If the bow is too low, the openings **24** and **25** will be completely below the surface of the water and a large volume of water will flow through the openings and out of the slots **20** and **21** to increase the lift of the hydrofoil and raise the bow. If the bow is too high, a quantity of air will flow through the openings and be mixed with the water flowing from the slots **20** and **21** to decrease the lift of the hydrofoil **11** and lower the bow. Thusly, when the bow is at the proper distance above the surface of the water, the mixture of air and water is such as to maintain the lift of the hydrofoil **11** substantially constant. The hydrofoil **11** will therefore automatically seek the proper level to maintain the bow of the boat **10** at the predetermined distance above the surface of the water when the boat is under way.

While a certain amount of lift is applied to the hydrofoil **11** by the passage of water through nozzle **22** at all speeds of the boat **10**, it is only at the higher speeds that such lift is of such magnitude as to maintain the bow of the boat at the proper distance above the surface of the water. To provide an adequate flow of water over a wide range of operating speeds, a pump **26** is mounted in each of the hollow struts **17** and **18**. The pump **26** is secured in the struts by brackets **27** with an intake conduit **28** connecting the intake of the pump with the openings **24** or **25** and an outlet conduit **29** connecting the outlet of the pump with the throat opening **23** of the nozzle **22**. A drive shaft **30** extends upwardly from the pump **26** through the hollow struts **17** or **18** and a bearing **31** in the bottom of the boat **10** to an angle drive **32**. A shaft

33 extends from the angle drive 32 to an engine, not shown, to furnish the power for driving the pump 26.

In the modification shown in FIG. 4, the pump 26 is mounted substantially at the level of the water inlet opening 24 or 25 in the strut 17 or 18 with a short inlet conduit 34 leading from the opening 24 or 25 to the inlet of the pump and an elongated conduit 35 leading from the pump outlet to the throat opening 23 of the nozzle 22.

Referring to the modification shown in FIGS. 5 and 6, the pump 26 is mounted in the strut 17 or 18 with its rotational axis horizontal instead of vertical. The pump is supported by brackets 36 and has a belt pulley 37 on one end of its shaft 38. An inlet conduit 39 leads from the inlet opening 24 or 25 to the inlet of the pump and an outlet conduit 40 leads from the outlet of the pump to the throat opening 23 of the nozzle 22.

A shaft 41 extends transversely of the boat 10 above the upper ends of the struts 17 and 18 and is supported in bearings carried at the upper ends of vertically disposed stanchions or brackets 42, 43 and 44 mounted at their lower ends on the bottom or deck of the boat 10. The shaft 41 is driven by any suitable engine, not shown, through a shaft 45 and angle drive 46. Belt pulleys 47 and 48 are fixed to shaft 41 near its opposite ends and are connected to belt pulleys 37 on the pumps 26 in the struts 17 and 18 by belts 49 and 50.

In operation, as the boat 10 moves, water is forced into the inlet of the pumps 26 through openings 24 and 25 and inlet conduits 28. The water is pumped through the nozzles 22 by the pumps 26. The jet effect of the water passing through the nozzles 22 provides a lift to the hydrofoil 11 which is directly proportionate to the volume of water passing through the nozzles 22. Therefore, as the hull of boat 10 is lifted out of the water, the openings 24 and 25 will seek a position partly above and partly below the surface of the water where the volume of water passing through the nozzles 22 will be just sufficient to maintain the hull of boat 10 at the proper distance above the surface of the water.

Without the pumps 26, the volume of water passing through the nozzles 22 wound depend upon the speed at which the boat 10 was moving. Through the use of the pumps 26, the volume of water passing through the nozzle 22 and hence the lift applied to the hydrofoil 11 can be controlled independently of the speed of the boat 10. The pumps 26 could be driven at a constant speed which would give the same lift at all speeds of the boat or could be driven at a speed inversely proportionate to the speed of the boat 10. The latter arrangement would give the greater lift at slow speeds and a lesser lift at higher speed.

While the foregoing description and accompanying drawings are directed to a preferred illustrative embodiment of the instant invention and its manner of use, it will be understood that structural details may be modified to suit the invention to particular specific adaptations without departing from the spirit of the invention, and that, accordingly, it will be understood that it is intended and desired to embrace within the scope of the invention such modifications and changes as may be necessary or desirable to adapt it to varying conditions and uses as defined by the scope of the appended claims.

I claim:

1. In a boat having a hull adapted to be supported out of the water, a pair of submerged hydrofoils for supporting said hull, at least one pair of struts connecting each of said hydrofoils to said hull and means for controlling the depth of submersion of at least one of said hydrofoils, said means including water reception openings formed in the struts connecting said one of the hydrofoils to the hull and positioned to be partly above and partly below the surface of the water when the said one hydrofoil is at the desired operating depth, and water discharge openings formed in the bottom of said one of the hydrofoils, pump means having an inlet conduit connected to the water reception openings and an outlet conduit connected to the water discharge openings, and nozzle means in said outlet conduit for providing a high velocity jet of water to provide increased lift to said one of the hydrofoils, the proportion of air to water in said jet of fluid and consequently the lift of said one hydrofoil being varied with changes in the operating depth of said one hydrofoil.

2. In a marine craft having a buoyant hull and hydrofoils for supporting the hull above the surface of the water at operating speeds of the craft wherein said hydrofoils comprise unitary members extending transversely of the hull one near the stern and one near the bow in fixed position relative to the hull and at least the bow hydrofoil is connected to the hull by spaced apart hollow struts of streamline cross sectional shape, and a brace disposed medially of the distance between the struts, means automatically controlling the operating depth of said hydrofoils when supporting said hull above the water comprising fluid outlet passages in the form of elongated narrow slots in the under surface of said bow hydrofoil disposed near the trailing edge of this hydrofoil and at respectively opposite sides of the mid-length location thereof, a fluid inlet passage in the leading edge of each of said hollow struts positioned to extend above and below the surface of the water when the hydrofoil is at the desired operating depth in the water, a nozzle structure connected between the fluid inlet passage in each hollow strut and the corresponding fluid outlet passage in said bow hydrofoil, vanes in each nozzle structure uniformly distributing the fluid received through the fluid passage in said bow hydrofoil, and a power driven fluid pump connected with each nozzle structure to accelerate the fluid flowing through the nozzle structure from the fluid inlet passage in the corresponding strut to the corresponding fluid outlet passage in said bow hydrofoil to thereby augment the lift effect of the hydrofoil, the depth of submergence of said fluid inlet passages controlling the proportion of air to water in the fluid flowing through said nozzle structures and the proportion of air to water in said fluid directly affecting the lift of said bow hydrofoil substantially at a constant operating depth.

3. In a marine craft having a buoyant hull and hydrofoils for supporting the hull above the surface of the water at operating speeds of the craft wherein said hydrofoils comprise unitary members extending transversely of the hull one near the stern and one near the bow in fixed position relative to the hull and at least the bow hydrofoil is connected to the hull by spaced apart hollow struts of streamline cross sectional shape, means automatically controlling the operating depth of said hydrofoils when supporting said hull above the water comprising fluid outlet passages in the form of elongated narrow slots in the under surface of said bow hydrofoil disposed near the trailing edge of this hydrofoil and at respectively opposite sides of the mid-length location thereof, a fluid inlet passage in the leading edge of each of said hollow struts positioned to extend above and below the surface of the water when the hydrofoil is at the desired operating depth in the water, conduit means connected between the fluid inlet passage in each hollow strut and the corresponding fluid outlet passage in said bow hydrofoil, and power driven fluid pumps connected with said conduit means to accelerate the fluid flowing through the conduit means from the fluid inlet passages in said struts to the corresponding fluid outlet passages in said bow hydrofoil to thereby augment the lift effect of the hydrofoil, the depth of submergence of said fluid inlet passages controlling the proportion of air to water in the fluid flowing through said fluid outlet passages and the proportion of air to water in said fluid directly affecting the lift of said bow hydrofoil to maintain the hydrofoil substantially at a constant operating depth.

4. In a marine craft having a buoyant hull and hydro-

foils for supporting the hull above the surface of the water at operating speeds of the craft wherein said hydrofoils comprise unitary members extending transversely of the hull one near the stern and one near the bow in fixed position relative to the hull and at least the bow hydrofoil is connected to the hull by spaced apart hollow struts, means automatically controlling the operating depth of said hydrofoils when supporting said hull above the water comprising a fluid outlet passage in the form of at least one elongated narrow slot in the under surface of said bow hydrofoil disposed near the trailing edge of this hydrofoil, a fluid inlet passage in the leading edge of each of said hollow struts positioned to extend above and below the surface of the water when the hydrofoil is at the desired operating depth in the water, means including a power driven pump connecting the fluid inlet pasage in each hollow strut and the corresponding portion of the fluid outlet passage in said bow hydrofoil to accelerate the fluid flowing from the fluid inlet passage in the corresponding strut to the fluid outlet passage in said bow hydrofoil to thereby augment the lift effect of the hydrofoil, the depth of submergence of said fluid inlet passages controlling the proportion of air to water in the fluid flowing from said fluid inlet passages to said fluid outlet passage and the proportion of air to water in said fluid directly affecting the lift of said bow hydrofoil to maintain the hydrofoil substantially at a constant operating depth.

5. In a marine craft having a buoyant hull and hydrofoils for supporting the hull above the surface of the water at operating speeds of the craft wherein said hydrofoils comprise unitary members extending transversely of the hull one near the stern and one near the bow in fixed position relative to the hull and at least the bow hydrofoil is connected to the hull by spaced apart hollow struts, means automatically controlling the operating depth of said hydrofoils when supporting said hull above the water comprising fluid outlet passages in the form of elongated narrow slots in the under surface of said bow hydrofoil disposed near the trailing edge of this hydrofoil, a fluid inlet passage in the leading edge of each of said hollow struts positioned to extend above and below the surface of the water when the hydrofoil is at the desired operating depth in the water, conduit means connecting the fluid inlet passage in each hollow strut and the corresponding fluid outlet passage in said bow hydrofoil for the passage of fluid from the fluid inlet passage in the corresponding strut to and out of the fluid outlet passages in said bow hydrofoil to thereby augment the lift effect of the hydrofoil, the depth of submergence of said fluid inlet passages controlling the proportion of air to water in the fluid flowing through said struts and said hydrofoil and the proportion of air to water in said fluid directly affecting the lift of said bow hydrofoil to maintain the hydrofoil substantially at a constant operating depth.

6. In a marine craft having a buoyant hull and hydrofoils for supporting the hull above the surface of the water at operating speeds of the craft wherein said hydrofoils comprise unitary members extending transversely of the hull one near the stern and one near the bow in fixed position relative to the hull and at least one of said hydrofoils is connected to the hull by spaced apart hollow struts, means automatically controlling the operating depth of said hydrofoil when supporting said hull above the water comprising at least one fluid outlet passage in the form of an elongated narrow slot in the under surface of said one hydrofoil disposed near the trailing edge of this hydrofoil, a fluid inlet passage in the leading edge of each of said hollow struts positioned to extend above and below the surface of the water when the hydrofoil is at the desired operating depth in the water, conduit means connecting the fluid inlet passage in each hollow strut and the fluid outlet passage in said one hydrofoil, and a power driven fluid pump connected with said conduit means to accelerate the fluid flowing through the conduit means from the fluid inlet passage in the corresponding strut to the fluid outlet passage in said one hydrofoil to thereby augment the lift effect of the hydrofoil, the depth of submergence of said fluid inlet passages controlling the proportion of air to water in the fluid flowing through said conduit means and the proportion of air to water in said fluid directly affecting the lift of said one hydrofoil to maintain said one hydrofoil substantially at a constant operating depth.

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