

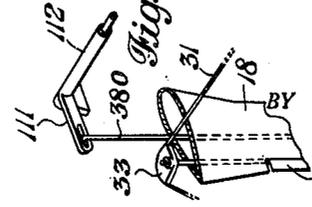
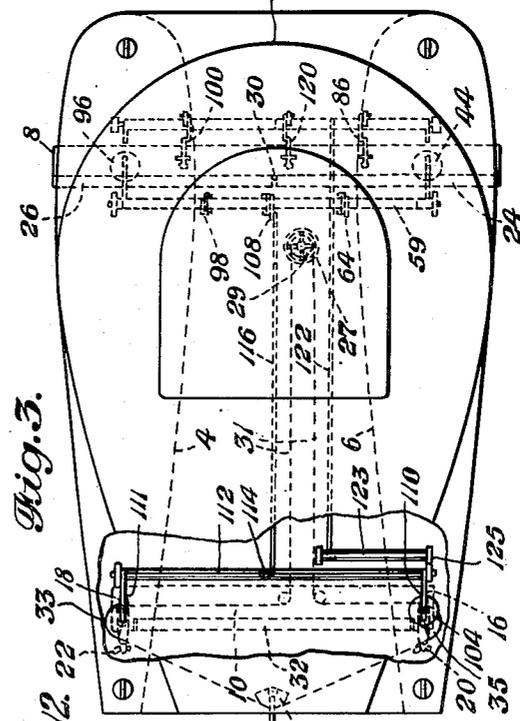
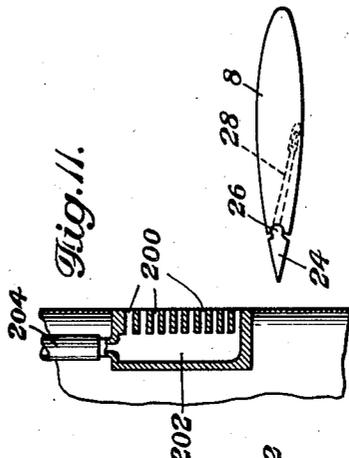
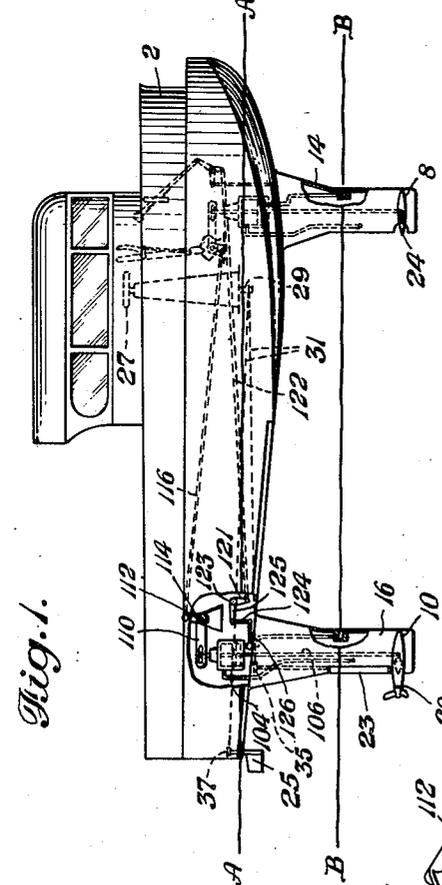
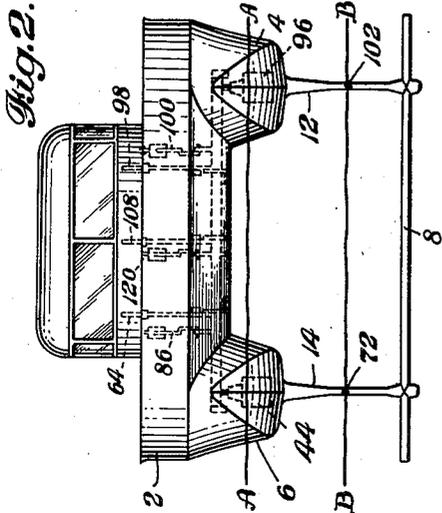
June 7, 1955

V. BUSH ET AL
HYDROFOIL CRAFT

2,709,979

Filed July 14, 1950

3 Sheets-Sheet 1



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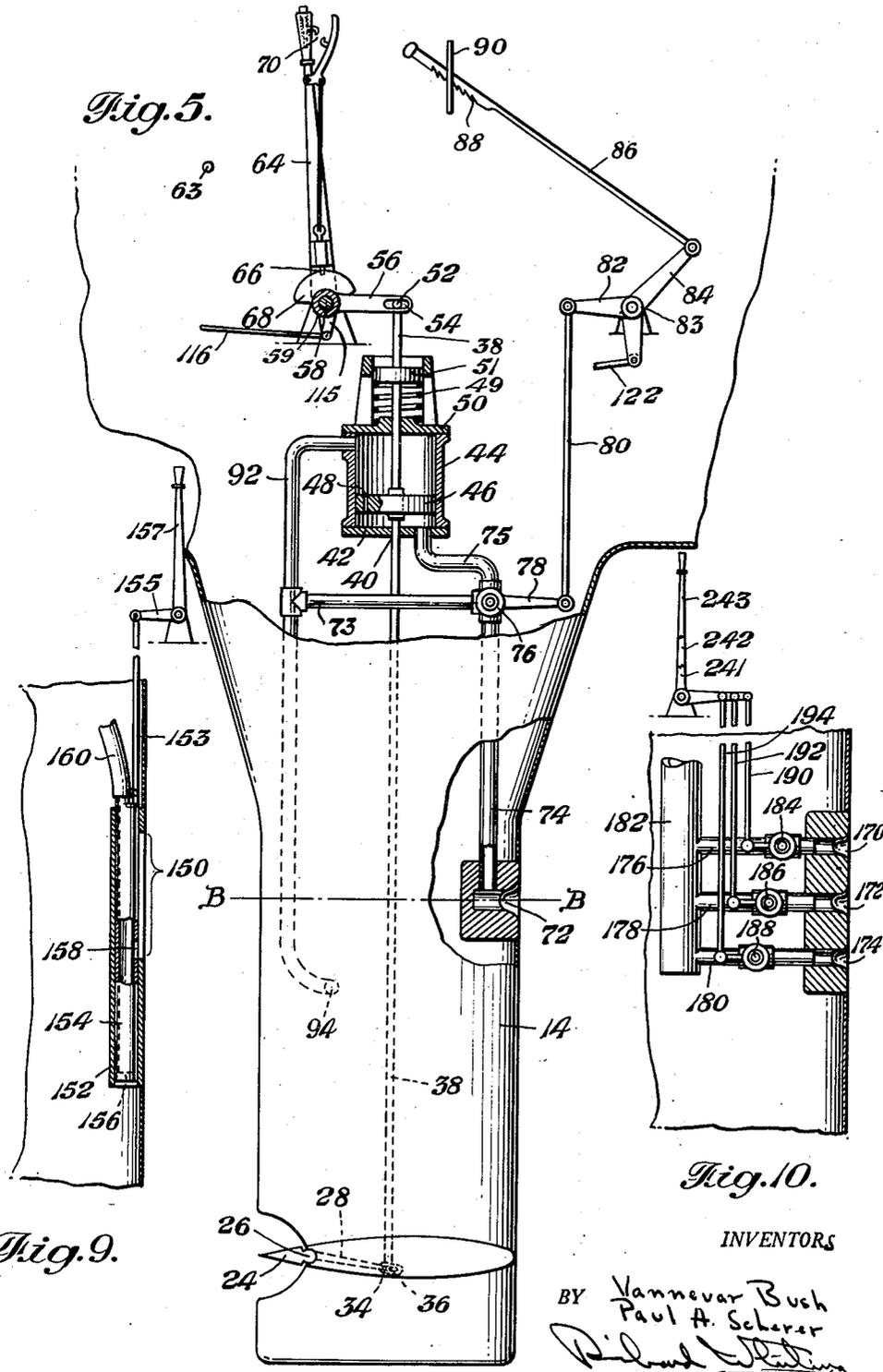


Fig. 5.

Fig. 9.

Fig. 10.

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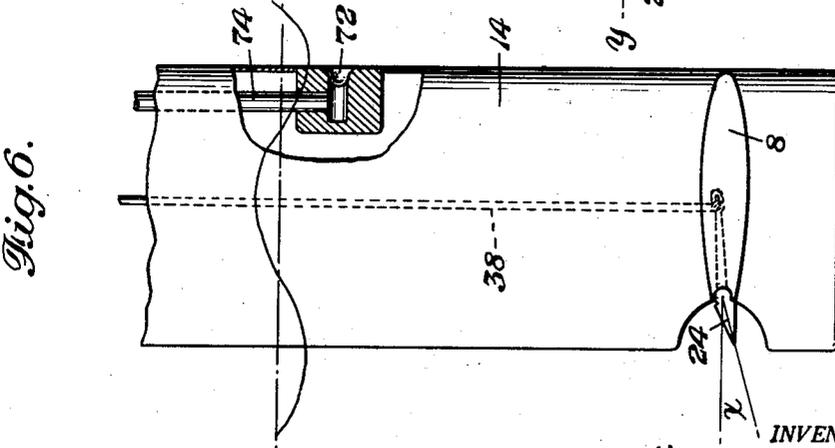
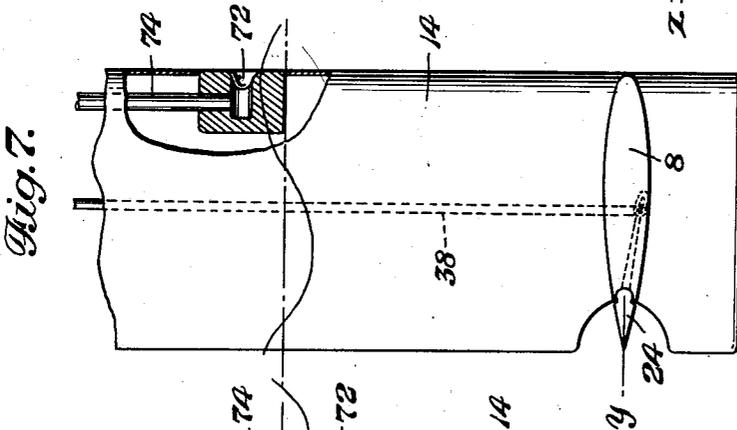
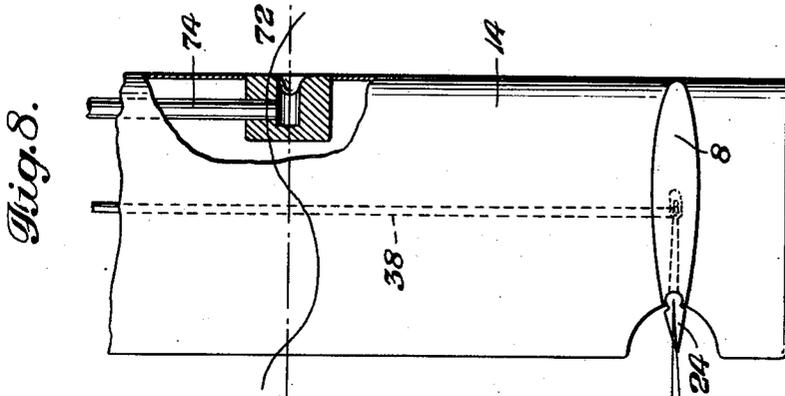
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3 Sheets-Sheet 3



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2,709,979

HYDROFOIL CRAFT

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16 Claims. (Cl. 114—66.5)

This invention relates to marine craft of the type having submerged water foils for support of the hull out of the water at cruising speeds.

In accordance with a preferred embodiment of the invention, novel automatic controls are provided which maintain the entire foil surface submerged to a substantially constant operating depth in comparatively undisturbed water throughout a range of craft speeds by control mechanism which operates in response to the dynamic pressure of the water against the moving craft. The need for control elements riding on the water surface is obviated and the control mechanism may be contained within hull, foil and strut structure of conventional configurations. By this invention, undesirable effects of wave impact on the control mechanism, as well as on the hull itself, may be eliminated, thus conserving power and contributing to increased speeds and smooth operation. The controls are effective to maintain substantially constant submergence of the foils below an average water level in the case of waves so that smooth transit is obtainable in rough water.

Modified embodiments are also provided which afford maneuverability, banking on turns, and the like, as well as a wide latitude of adjustability to adapt for varying loads, speeds and other operating conditions.

In the drawings:

Fig. 1 is a side elevation view of craft embodying this invention;

Fig. 2 is a front end elevation view of the craft;

Fig. 3 is a plan view of the craft;

Fig. 4 is a detail end elevation view indicating diagrammatically the profile of a suitable foil and flap;

Fig. 5 is an enlarged side elevational view of the forward starboard strut showing the flap operating mechanism;

Figs. 6, 7 and 8 are diagrammatic views illustrating the operation of the orifice-actuated mechanism;

Figs. 9, 10 and 11 are vertical sections through the forward starboard strut showing three different modifications; and

Fig. 12 is a perspective view of an aft strut detail.

To illustrate the construction and mode of operation of apparatus embodying one form of the invention, there has been selected a craft having a hull 2 provided with port and starboard pontoons 4 and 6 for support of the craft as a displacement vessel, when the water line is disposed as indicated at A—A, or thereabouts. Forward and aft foils 8 and 10, respectively, are provided for dynamic support of the craft after it gets under way, when the water line is disposed as indicated at B—B and the hull 2, including the pontoons 4, 6 are raised entirely out of the water with a clearance above the water surface adequate to avoid substantial wave impact against any portion of the hull. The hull body is mounted on the forward foil 8 by means of port strut 12 and starboard strut 14 and there are also two aft struts 16 and 18. The struts are shaped for low resistance. The craft is driven by propellers 20, 22 and may be steered by

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suitable flaps, one on each aft strut as indicated at 23, Fig. 1, and by rudder 25, the latter effective when the craft rides as a displacement hull. Mechanism for operating the steering flaps and rudder is diagrammatically indicated by the hand wheel 27 by which pulley 29 is rotated to move operating cable 31 trained around flap operating pulleys, 33, 35 and rudder operating sector 37.

Variation in foil lift is obtained by a flap such as indicated at 24 (Fig. 4) pivoted at 26 to the rearward portion of the foil. Lever 28 secured to the flap may be operated in a manner to be described to rotate the flap for varying the foil lift coefficient, elevation of the lever 28 counter-clockwise from its position shown being effective to increase the lift coefficient, as will be understood. The showing is diagrammatic and in practice the discontinuity of surface indicated between foil and flap would be avoided by appropriate means conventional in aircraft.

In the craft illustrated, the forward foil 8 has two flaps 24 and 26 substantially coextensive with the foil except for endwise clearance at 30. The rear foil 10 has a single flap 32.

Referring to Fig. 5, the free end of lever 28 has an elongated slot 34 receiving a pin 36 by which the lever is attached to and operated by the vertically extending rod 38. The rod passes through a suitably packed opening 40 in the bottom 42 of a cylinder 44 and is rigidly fixed to a piston 46 working in the cylinder. A small aperture 48 affords restricted communication between opposite sides of the piston within the cylinder. The rod 38 extends upwardly from piston 46 through a packed opening in the cylinder head 50 and is surrounded by compression spring 49 working between cylinder head 50 and collar 51 fixed to rod 38. The spring urges the rod 38 upwardly and counteracts the weight of the rod and the parts which move with it in automatic operation. The rod 38 terminates at a pivot pin 52 working in elongated slot 54 on the free end of a lever 56 fixed to a sleeve 59 rotatable on shaft 58. This sleeve may be manually rotated for variation in flap position and hence in foil lift by hand lever 64, loose on the sleeve and provided with a manually-operable, spring-pressed detent 66 which cooperates with the slotted segment 68 fixed to the sleeve to move the flap to selected position. Detent 66 may be held out of its locking position in engagement with the slots of segment 68 by latch 70 when automatic, as contrasted with manual, operation of the flap is performed in a manner which will appear.

The apparatus for automatic operation includes an orifice 72 formed in the leading edge of the strut 14 and communicating by pipe 74 through valve 76 and pipe 75 with cylinder 44 below piston 46. Valve 76 is provided for selectively restricting the flow of water from orifice 72 to cylinder 44 to effect a regulation in operation as will be described or, selectively, to shut off the flow of water from the orifice to the piston entirely when the flap 24 is to be operated manually by hand lever 64, rather than automatically by the orifice-actuated mechanism. The valve has a channel connecting pipe 75 to the pipe 73 communicating with pipe 92, to be referred to, so that the piston is free to be moved manually when communication is shut off between the orifice and cylinder. The valve has operating lever 78 connected by link 80 to lever 82 fixed to rotatable sleeve 83 also carrying fixed to it a lever 84 which is connected to pull rod 86 having ratchet teeth 88 cooperating with a slotted fixed plate 90 to provide manual adjustability to a fixed position.

Cylinder 44 is connected to pipe 92 above piston 46; the pipe terminates at opening 94 on the side of strut 14, below the water surface B—B, at a point of negligible dynamic pressure.

The parts above described for selective manual and automatic operation of the forward starboard flap 24 are substantially duplicated for the forward port flap 26, as indicated diagrammatically in Figs. 2 and 3 by cylinder 96 which corresponds with cylinder 44 and hand operated lever 98 which corresponds with hand lever 64. Pull rod 100, corresponding with pull rod 86, is provided on the port side for similarly adjusting a valve in the pipe leading from the forward port orifice to the cylinder 96. The forward port orifice is designated 102.

Similar mechanism, with appropriate modification, is also provided for operating the aft flap 32. The cylinder is designated 104 (Fig. 1) and the rod leading downwardly therefrom 106. The flap is actuated from both ends by the single cylinder for which purpose the lever 110 (Fig. 1) pivoted to the upper end of rod 106 is fixed to a rotatable sleeve 112 extending athwartship to a port side bearing adjacent which is a lever 111 (Fig. 12) corresponding with the lever 110, fixed to the sleeve and similarly linked to a vertically movable rod 380 for operating the flap from the port side. For convenience in manual operation of the aft flap from the forward control room, sleeve 112 is provided with a lug 114 connected at its free end to link 116 extending forwardly to lever 115 depending from a segment, corresponding with segment 68, and hand-operated by lever 108 (Fig. 2). A manually operated valve control lever 120 for the after flap is located in the forward control room and is connected to rod 122 extending aft to a lever 121 depending from a sleeve 123 having fixed to its starboard end a horizontal lever 125 connected by link 124 to the valve operating lever 126.

For operating convenience the form of the manual controls would depart considerably from the system as shown for simplicity, and in practice controls, of the nature of aircraft controls could be used effectively, including a stick for elevation, foot levers for steering and, if desired, a wheel for aileron action of the flaps.

Referring now to the automatic operation of the three flaps by the three cylinders, the valve 76 in the line between each orifice and its cylinder is open, and the hand levers 64, 98 and 108 are unlocked and at rest against appropriate stops 63 with their segments free to move under the influence of the controls. The automatic operation is diagrammatically shown by a comparison of Figs. 6, 7 and 8.

Taking the orifice 72 (Fig. 5) as typical, the piston 46 will be subjected to dynamic water pressure through pipe 74 from the orifice when the craft advances with the orifice submerged. This pressure tends to raise the piston and rotate the flap toward its angle x of maximum lift. The cylinder and piston need not be unduly large to move the flap toward maximum lift against the dynamic pressure of the water against the flap tending to rotate the flap clockwise to decrease the lift. A simple leverage system is adequate to supply whatever mechanical advantage may be needed and the weight of the parts is compensated by the spring 49. Since the dynamic pressure on the piston from the orifice when submerged tending to increase the lift, and the dynamic pressure of the water against the flap at any given angle tending to decrease the lift, both depend directly upon the square of the craft speed, mechanical advantage sufficient to rotate the flap toward its angle x of maximum lift at one speed will be sufficient for such rotation at any operating speed.

If the craft advances with the orifice out of the water (Fig. 7) there is a release of the dynamic water pressure against the underside of piston 46 so that the pressure of the water against the flap will be effective to rotate it clockwise toward the zero angle indicated at y in which position the foil lift is less than that needed to support the weight of the craft so that the craft will descend.

On starting, the craft runs with its hull supported by water displacement, as indicated by the water line A—A (Fig. 1). As the speed of the craft increases, the pres-

sure in cylinder 44 becomes adequate to rotate the flap to its angle x of maximum lift and thereafter, at some predetermined speed, the craft will begin to rise on its foils. This will continue until the orifice breaks through the troughs of the waves when the pressure felt in the cylinder will become a pulsating one from the alternate effect of waves and troughs, producing an effective pressure which is less than the constant pressure derived from constant orifice submergence. The flap will respond to the decrease in effective pressure by a resultant rotation toward a decrease in lift. The rapidity of this response is determined by the time constant of the system, which is a function of the fluid resistance in the pipes and the inertia of the moving parts. This time constant should be long enough to permit averaging of short waves without undue lag in operation and is readily adjustable to accommodate waves of different frequencies by manual regulation of the valve 76 (Fig. 5) to change fluid resistance. Thus the craft will soon settle back with its orifice at an average level indicated in Fig. 8. In the event that the upward movement of the craft was over-compensated following initial emergence of the orifice from the water, the flap will soon adjust itself to increase its effective lift coefficient to a value which will stabilize the craft. In that position the effective pressure against the piston 46 exerts a force on rod 38 tending to increase the effective lift coefficient which is equal to the opposite force on that rod derived from water pressure against the flap, tending to decrease the effective lift coefficient.

A change in craft speed while in stabilized position will automatically be accommodated and the craft will again become stabilized.

Referring to Fig. 5 the aperture 48 in piston 46 and the pipe 92 leading from the cylinder above the piston to an opening 94 at the side of the strut below the water level B, compensate for static head. Thus, on starting with the craft at rest and the water at level A—A the forward cylinders 44 and 96, being below the water line, would normally be full of water. As the craft rises on its foils so that the cylinders move above the water line, the water level in the cylinders does not recede, the connection from the top of the cylinder through pipe 92 to the opening below the water line assures that the dynamic pressure of the water entering orifice 72 is not utilized to maintain the static head of the column of water to the piston regardless of the position of the piston relative to the water line. If for any reason air should become entrapped in the system the aperture 48 in the piston permits water flow adequate to purge the system.

In Fig. 9 is shown a modification in which the orifice, instead of being fixedly mounted on the strut, is mounted for adjustment vertically of the strut. In this form the leading edge of the strut has an elongated slot 150 leading to a cylinder 152 closed at the bottom and suitably secured on the inner face of the strut, covering the slot. Vertically slidable within the cylinder 152 is a tube 154 having a closed end 156 and an orifice 158. The tube 154 communicates at its upper end by a flexible conduit 160 to the bottom of an operating cylinder. A control lever 157 linked at 155 to rod 153 secured to the tube 154 permits manual adjustment of the tube to different vertical positions. The orifice 158 may be the same size as the orifices of the previously described embodiment and the slot 150 through which it communicates with the water is vertically elongated to permit passage of water through the orifice in any position to which the orifice is vertically adjusted.

By this means, the stabilized position of the craft relative to the water line when running on foils may be varied. For example, if the sea is relatively smooth so that the foils need not be deeply submerged, the orifices may be adjusted to low positions so that the craft rides high in the water, reducing the wetted area of the struts, reducing drag, and increasing speed. If the sea is rough, a higher adjustment of the orifices will insure that the

foils keep submerged in the wave troughs. For certain purposes the relative positions of the orifices need not be the same all around. Thus, for example, if two forward flaps and two rear flaps are used and controlled by four vertically adjustable orifices, adjustments by an equal amount of lowering of the port side orifices fore and aft, or an equal raising of the two starboard orifices, or both, will raise the port side of the craft relative to the starboard side, such as for banking on a starboard turn which is desirable in certain types of craft. This maneuverability is obtainable as well with two forward and one rear flap as shown but in that event the rear flap would not, of course, be effective for banking and the orifice which operates it should be in mid position athwartship.

A further use for adjustability of the orifice position is in the operation of getting under way and rising on foils from a hull displacement position. The foils particularly if there are many, may not lift their loads equally at the same time so that the craft may tilt before it arrives at a stable position. This can be remedied by vertical adjustment of the orifices. To that end it may be desirable to start with all orifices in uppermost positions and gradually lower all orifices equally, or, if desired, differently, in arriving at cruising position.

Fig. 10 shows a further embodiment in which three superposed orifices 170, 172 and 174 communicate by individual pipes 176, 178 and 180 to a header 182 closed at the bottom and leading upwardly to communicate with an operating cylinder. The pipes 176, 178 and 180 are provided with valves 184, 186 and 188 respectively which may be manually operated through rods 190, 192 and 194, each leading to a suitable hand-operated lever as indicated. This embodiment is obviously adapted for many of the uses described above for the sliding adjustment of orifices and in addition it has other uses. Thus, in the event that the water is so smooth that there are no waves of a size comparable to the diameter of the orifice, so that the averaging effect of a single orifice cannot occur as above described, the multi-orifice mechanism can be operated to minimize or eliminate vertical oscillations of the craft such as might occur in a single orifice hunting for the water surface. With the three orifices all submerged while getting under way on foils and assuming that the valves 184, 186 and 188 are full open, when the upper orifice comes out of the water, a less abrupt effect occurs than if it were the only orifice. The pressure in the control cylinder will drop, but not to zero. When the second orifice emerges, the pressure in the cylinder will again drop, but it will not be until the third orifice leaves the water that the pressure in the cylinder becomes zero. Thus, a variation in pressure is obtainable in an amount depending upon the number and positions of the orifices and the fluid resistance of the system. In instances it may be advantageous to vary the relative valve openings to adjust the gradient in pressure from such multiple orifices.

A convenience in such multiple interconnected orifices is the provision of a spare orifice in the event of plugging despite appropriate screening of the orifice entrance. Instead of using a header leading to a single cylinder, individual orifices may communicate with individual cylinders operating the same flap to afford a complete spare mechanism, and also for operational purposes.

Where individual orifice adjustability is not required and a more gradual pressure change is desired, the multi-orifice arrangement of Fig. 11 is effective wherein a large number of orifices 200 open into a common plenum chamber 202 communicating by pipe 204 with the cylinder. For some purposes this may be supplemented with a sliding valve type of aperture, as in Fig. 9, by the use of a tube 154 with orifice 158 vertically adjustable to communicate with one, or with a selected group, of the orifices 200.

Considerable flexibility of control is afforded by the orifice actuated mechanisms above described which will

operate effectively whether the craft is carrying heavy or light loads. Regardless of load, the flap angle α of maximum lift (Fig. 6) may be the same for lifting the craft on its foils using higher speeds to lift the craft with heavier loads. In the stabilized position of Fig. 8, the flap angle α will be greater when cruising with heavier loads than with light loads and this variation in cruising flap angle is effected by a deeper average submergence of orifice 72 in the stabilized position of Fig. 8 with heavier loads than with lighter loads. A wider range of adaptability to different loads in cruising position may be accomplished by the use of multiple orifices as in Fig. 10 or Fig. 11. The addition of manual control to the orifice actuated automatic control contributes to a still greater flexibility. For example, on starting the flaps may be maintained manually at their positions of minimum lift coefficient and hence of minimum drag until the craft has gained speed and the flaps may then be rotated manually or automatically to their lift positions for rising on foils.

Further modifications will suggest themselves to adapt the invention to particular requirements. Thus, the dynamic pressure of the water through which the craft moves need not be utilized as the source of power for moving the flap, as it may control an independent hydraulic, pneumatic, electrical or other system, particularly if more power is needed to vary the lift, and this may be desirable, although not essential, where the foil as a whole is rotated for variation in lift or where the foil is fixed and the struts are rotated to vary lift. If an orifice is used, it may be disposed on the rear of the foils and operated by minus pressure. Other apparatus for sensing the air-water interface, such as electric, electronic, photoelectric, electrolytic, sonic or mechanical means may be employed. The control mechanism herein disclosed may be employed with all types of submerged hydrofoils, regardless of whether their submergence is partial or entire. This invention is not to be limited to such structural details except as the appended claims require.

We claim:

1. Marine craft having a hull supported out of the water by submerged hydrofoils connected to the hull by struts which are shaped in foil profile form for reduced resistance, and depth responsive mechanism for automatically controlling the depth of submergence of a supporting foil, including a water pressure receiving element in the leading edge of a said strut adapted to run alternatively totally submerged through waves and totally emerged above wave troughs and coupled with fluid pressure actuated and pressure throttling means responsive to the relative duration of submergence and emergence of the element to adjust the foil lift coefficient for stabilization of the foil at a desired distance below the mean water level.

2. Marine craft having a supporting foil of adjustable lift coefficient including a low lift coefficient, an intermediate lift coefficient and a high lift coefficient, variable pressure fluid operated means associated with the foil to change its lift coefficient in the order of increased lift coefficient from increased pressure, an element in said pressure operated means responsive to the dynamic pressure of the water open to and exposed to the water as the craft moves therethrough, the said element openly communicating with the water at a predetermined distance above the foil equal to the desired distance of submergence of the foil, said element having an area such as to produce a pressure which adjusts to the high lift coefficient when the element is completely submerged and to the intermediate lift coefficient when the element has a predetermined partial submergence, the area of said element being insufficient to exert pressure, when exposed solely to dynamic air pressure, to adjust the foil to higher than said low lift coefficient.

3. Marine craft supported by at least one submerged

hydrofoil having means for automatically controlling the depth of submergence of the foil including pressure responsive mechanism for varying the foil lift coefficient upon variation of pressure within the mechanism, and a plurality of elements adapted to run submerged as the craft advances connected to the mechanism to communicate dynamic pressure thereto in an amount which varies as the number of elements submerged is varied, the said elements being vertically arranged to be disposed on both sides of the average water level when the foil is submerged to the desired depth to impart to the mechanism an intermediate pressure effective to resist departures of the foil from said desired depth of submersion.

4. The craft as defined in claim 3 in which the pressure responsive mechanism increases the foil lift coefficient upon increase of pressure in the mechanism and in which the pressure communicated to the said mechanism increases as the number of elements submerged increases.

5. Marine craft supported by at least one submerged hydrofoil and having mechanism for automatically controlling the depth of submergence of the hydrofoil, the said mechanism including a surface sensing element and a connection between said element and the hydrofoil to change the lift of the foil automatically in response to the surface sensing operation of said element, manually operable means for changing the lift of the foil independently of the operation of said automatic control mechanism, and means for selectively inhibiting the operation of the automatic control mechanism when the said manually operable means are utilized.

6. A marine craft comprising a hull, submerged hydrofoils having variable lift effect mounted beneath the hull for supporting the hull above the water surface, actuating means connected to said hydrofoils for varying their lift effect, a member connected to the hull and extending downwardly therefrom into the water, said member being shaped in profile form for reduced resistance to forward motion through the water, and fluid actuated control means including a depth sensing water pressure receiving element disposed within the approximate profile of said member and connected to the actuating means for controlling movements of said actuating means in response to water pressure changes.

7. A marine craft comprising a hull, struts shaped in a foil profile form extending downwardly from the hull submerged hydrofoils mounted on the struts having variable lift effect mounted beneath the hull for supporting the hull above the water surface, actuating means positioned within the struts connected to said hydrofoils for varying their lift effect, a conduit having an orifice within each strut opening forwardly of the craft and positioned to receive water under pressure when submerged and moving through the water, and means responsive to the pressure of water in said orifice for controlling the position of the actuating means.

8. A marine craft comprising a hull, struts shaped in foil profile form extending downwardly from the hull submerged hydrofoils mounted on the struts having variable lift effect mounted beneath the hull for supporting the hull above the water surface, actuating means connected to said hydrofoils positioned within the struts for varying their lift effect, a conduit having an orifice within each strut opening forwardly of the craft and positioned to receive water under pressure when submerged and moving through the water, means responsive to the pressure of water in said orifice for controlling the position of the actuating means, and means for vertically varying the effective position of said orifice.

9. A marine craft comprising a hull, struts shaped in foil profile form extending downwardly from the hull submerged hydrofoil means having variable lift effect mounted beneath the hull and carried by the struts for supporting the hull above the water surface during movement of the craft through the water, a water pressure actuated motor having a movable element, means con-

necting said movable element to the hydrofoil means for varying the lift effect in response to movements of said movable element, and a conduit having an orifice within each strut opening forwardly of the craft for reception of water under pressure during its submerged movement under water and connected to said motor for conveying water under pressure thereto for actuation of the motor, said orifice being positioned in relation to the hydrofoil means to maintain the latter at a predetermined depth.

10. In marine craft, the combination with a hull of hydrofoil means, on which the hull is mounted, adapted to run submerged through the water to support the hull out of the water during cruising, struts shaped in foil profile form extending downwardly from the hull, water pressure operated mechanism having a water-receiving element mounted on each strut of the craft, for movement between water and air at their interface as the position of the craft vertically in the water is varied, and operable to transmit water under pressure to said mechanism during submersion of said element in water, a connection between the mechanism and the foil means, said mechanism being operable to increase the lift of the foil means when the element is in water and to decrease the lift when the element is in air, and a mounting securing the water-receiving element within each strut in preselected fixed spaced relationship to the foil means so that departures of the foil means from a predetermined depth of submersion are automatically resisted.

11. Marine craft supported by at least one submerged hydrofoil comprising at least one strut shaped in foil profile form extending downwardly from the craft mechanism for controlling the depth of foil submergence including a water-receiving element positioned within said strut for sensing the air-water interface, and manually adjustable means for varying the position of said element within said strut relative to the foil to vary the controlled depth of foil submergence.

12. Marine craft supported by at least one submerged hydrofoil comprising at least one strut shaped in foil profile form extending downwardly of the craft, mechanism for controlling the depth of foil submergence including a plurality of water-receiving elements positioned within said strut arranged vertically of each other, and valve means for selectively activating said elements for selective control of the depth of foil submergence.

13. Marine craft supported by at least one submerged hydrofoil comprising at least one strut shaped in foil profile form extending downwardly of the craft, having mechanism for controlling the depth of foil submergence including an intake element adjustably mounted upon a leading edge of the strut for sensing the air-water interface at the port side and an intake element adjustably mounted upon a leading edge of the strut for sensing the air-water interface at the starboard side, and means for independently adjusting the vertical position of said intake elements so that the controlled depth of submergence of the foil may be varied on one side independently of the other.

14. Marine craft having a hull supported out of water by submerged hydrofoils, struts shaped in foil profile form connecting the hydrofoils to the hull, depth responsive mechanism to control the depth of submersion of a hydrofoil, including a dynamic pressure liquid intake located on the front surface of the struts, open to the water, and adapted to run alternatively totally submerged through waves and totally emerged above wave troughs, and means openly communicating with the liquid intake responsive to the relative duration of submergence and emergence of the intake means to adjust the foil lift co-efficient for stabilization of the foil at a desired distance below the mean water level.

15. Hydrofoil supported craft for transporting loads at high propulsive efficiency having control mechanism for stabilizing the position of the foils relative to the

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water surface, struts depending from the craft to carry the foils, the said mechanism having movable parts adjustable in position for varying the lift of the foils, variable fluid pressure responsive means movable in response to direct dynamic water pressure from advance of the craft, a water pressure receiving element in the leading edge of said strut operatively connected to said pressure responsive means adapted to sense the air-water interface, and to run alternatively totally submerged through waves and totally emerged above wave troughs, pressure throttling means in connection with said pressure responsive means, the movable parts of said mechanism including said pressure responsive means being enclosed so that they are shielded from moving water as the craft is propelled, whereby to obviate water turbulence and drag therefrom.

16. In a marine craft supported by at least one submerged hydrofoil, mechanism for automatically stabilizing the depth of foil submergence, including a water pressure motor and a surface sensing water pressure

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receiving element and mechanism for automatically changing the foil lift in response to the surface sensing operation of said element, and manually operable controls for selecting the surface sensing position of said element to vary the depth of submergence at which the foil is automatically stabilized.

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