Aug. 30, 1932. J. PLUM 1,875,135

SPEED BOAT

Filed Jan. 28, 1931 2 Sheets-Sheet 1

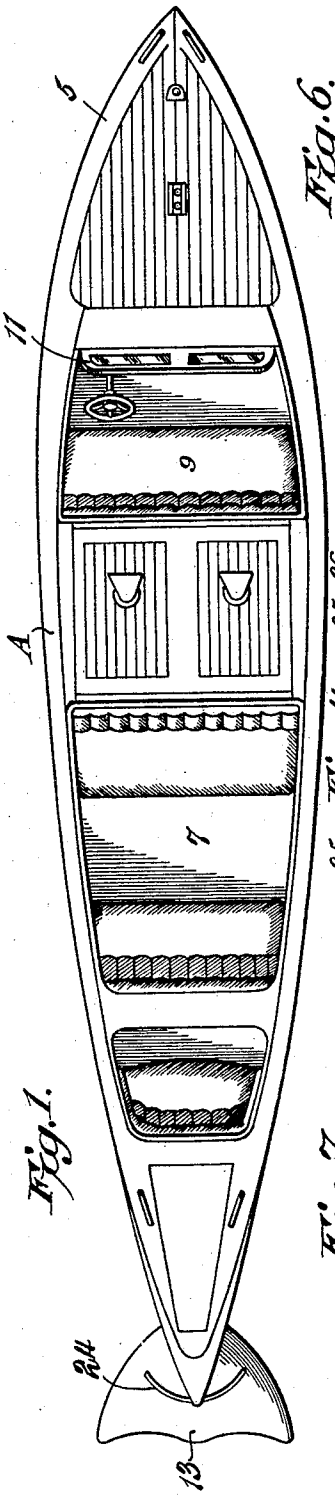


Fig. 1.

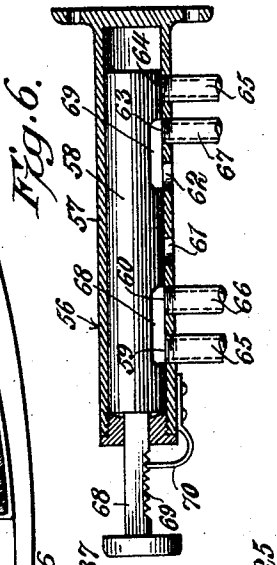


Fig. 6.

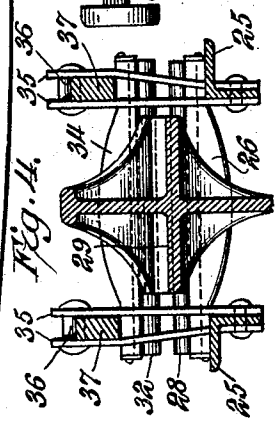


Fig. 4.

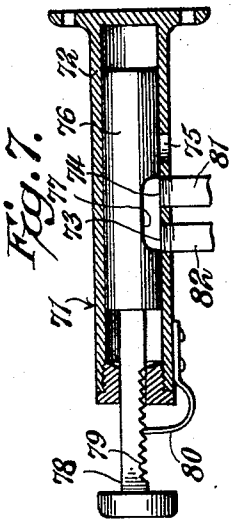


Fig. 7.

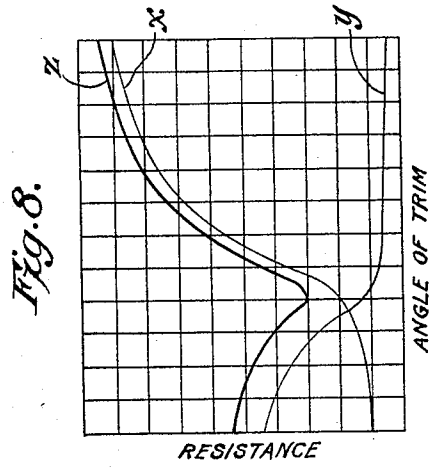


Fig. 8.

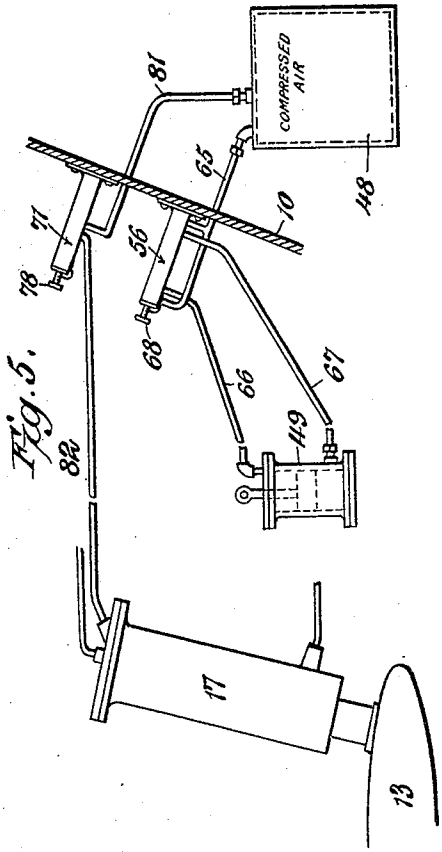


Fig. 5.

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SPEED BOAT

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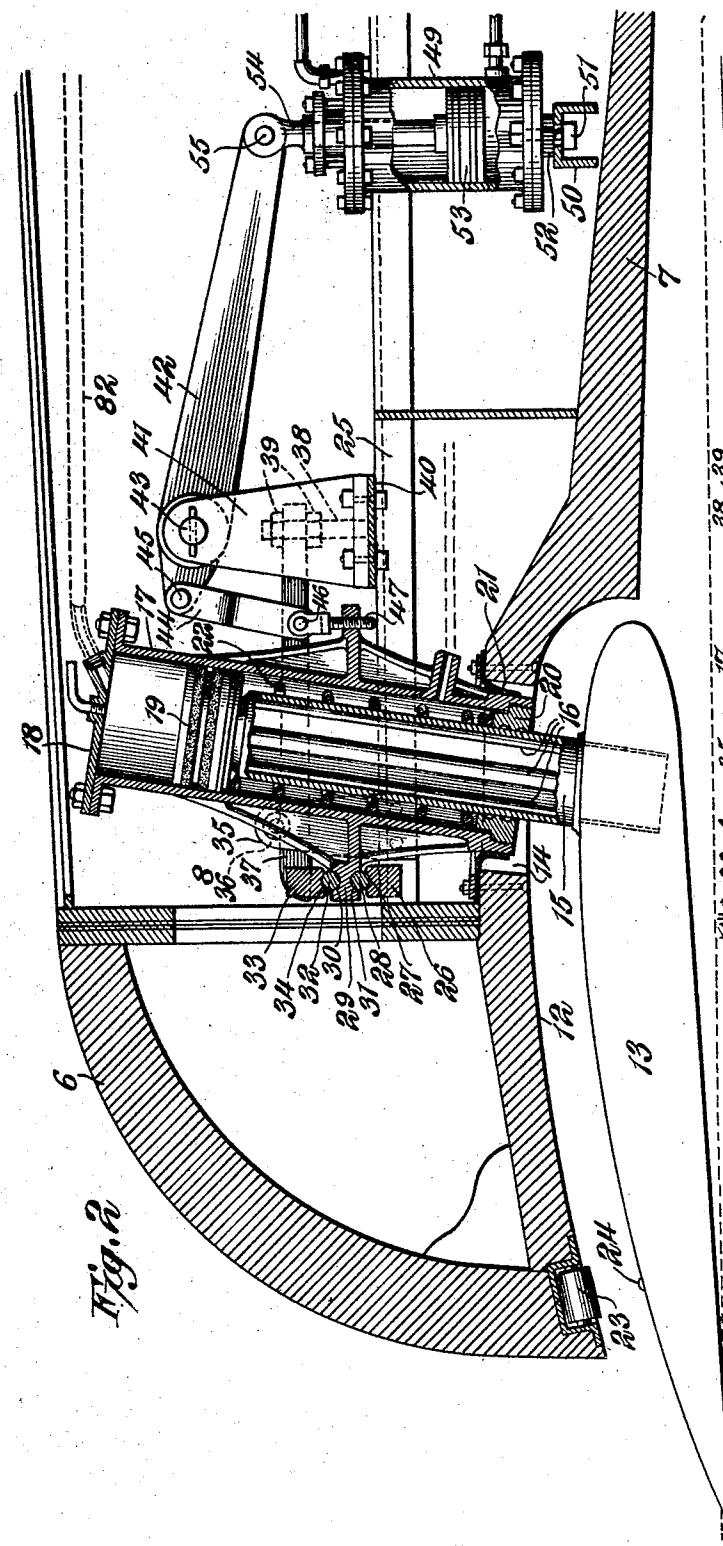


Fig. 2.

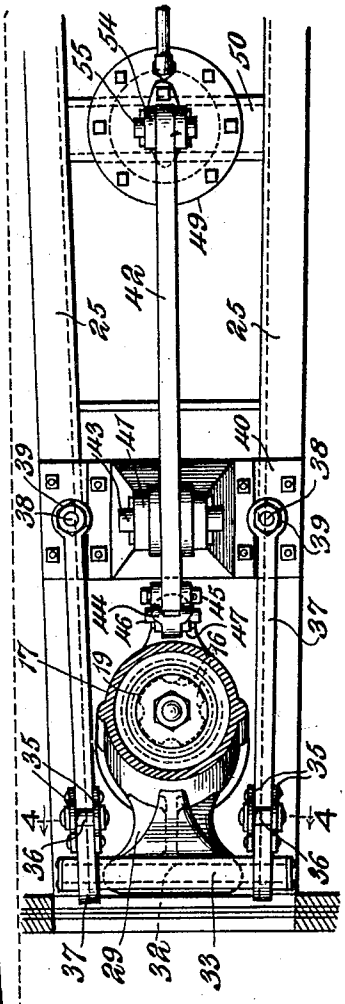


Fig. 3.

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Patented Aug. 30, 1932 1,875,135

UNITED STATES PATENT OFFICE

JOHANNES PLUM, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR TO FANTAIL BOAT CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

SPEED BOAT

Application filed January 28, 1931. Serial No. 511,853.

This invention relates to new and useful improvements in speed boats of the hydroplane type.

The main object is to provide a boat of the planing type with means of such a nature as will permit the boat, together with a heavy load carried thereby, to be raised to the water surface for the planing condition.

With these and other objects in view which will more fully appear, the nature of the invention will be more clearly understood by following the description, the appended claims, and the several views illustrated in the accompanying drawings.

In the accompanying drawings:—

Figure 1 is a top plan view of a speed boat embodying my invention,

Figure 2 shows the position of the sternplane when the boat has been adjusted to the "optimal planing-angle" and is skimming over the surface,

Figure 3 is a top plan view thereof,

Figure 4 is a cross sectional view taken on the line 4—4 of Figure 3,

Figure 5 is a diagrammatic view showing the fluid pressure circuits for controlling the sternplane,

Figure 6 is an enlarged sectional view of the valve for adjusting the boat to the "optimal trim-angle",

Figure 7 is an enlarged sectional view of the valve for controlling the planing angle of the boat, and

Figure 8 is a view of a chart showing certain curves and the component thereof.

When the functions of a hydroplane speed boat are considered, the differences between two important conditions must be clearly understood.

The first condition exists during the period the boat is endeavoring to gain sufficient speed to give its bottom portion so much dynamic lift that it will rise to the surface for planing action.

The second condition comes into effect when and after the boat has obtained planing action.

During the first condition the boat functions mostly as a displacement boat carried by the water it displaces, and the object should be to give the boat the best angle of trim relative to the horizontal which from the very start will produce the greatest lift with the smallest resistance. I have called this angle of trim the "optimal trim-angle" because it is the trim which gives the maximum ratio of lift to drag. I have found that the "optimal trim-angle" is a function of the ratio of the beam to the length of the bottom portion receiving dynamic lift when the boat is moving forwardly, so that the smaller the ratio the greater will be the "optimal trim-angle". During the first period of the boat's run, its whole bottom portion from the step to the bow receives dynamic lift and consequently the ratio of beam to length is small and the "optimal trim-angle" is large. However, as the speed is accelerated and the boat lifted to some extent the length of the bottom portion which receives dynamic lift is decreased, while the beam remains constant, and consequently the ratio of beam to length increases and the "optimal trim-angle" decreases. In other words, I have found that the "optimal trim-angle" of a hydroplane speed boat varies with speed being greatest at low speeds. I have furthermore found that if the "optimal trim-angle" can be attained during the period of the first condition when the boat endeavors to rise to the water surface, much greater loads can be successfully lifted to the surface for the planing condition than otherwise would be. The structure disclosed in the accompanying drawings shows means for varying the trim angle of the boat. It is quite clear that by changing the inclination of the axis on which the plane swings, will change the pitch of the plane, i. e., its angle relative to the water line, and that the changing of this angle will necessarily change the angle of trim of the whole boat. During the first period of the first condition when the object is to produce the greatest ratio of lift to drag, the plane functions in the same manner as the horizontal rudder of a submarine, which also controls the angle of trim of the craft when it moves forward through the water.

During the second condition, when the boat has obtained planing action, it is mostly

carried by the dynamic lift of the water. I have found that the most efficient planing action of a hydroplane boat involves a delicate balance between the planing area, the planing angle and the speed. At each speed for any given hull lines there is an angle for which the total resistance is definitely a minimum. I have called this angle the "optimal planing-angle" because it is the angle giving the best speed with a given power, or, in other words, it is the angle requiring the least power for a given speed. The great importance and the critical nature of the optimal planing angle are clearly shown by means of the diagram shown in Figure 8. In this figure there are three curves respectively representing the total resistance and its two components as a function of the angle of trim. The curve marked x indicates the wave-making or turbulence resistance which has a minimum value at zero degrees and increases as the angle of trim is increased. The curve marked y indicates the resistance due to the viscosity of the water which is usually called "skinfriction". It is greatest at zero degrees where the wetted surface of the planing area of the boat is greatest and it decreases as the angle of trim is increased. The curve marked z indicates the total resistance or the sum of the wave-making and the viscuous resistances. The total resistance is comparatively large at zero degrees, and as the angle of trim is increased, it first decreases to minimum value at the "optimal planing-angle" and then increases again. These curves are schematic only and are intended to illustrate the relation existing at some given speed. Similar curves exist for each speed with a given set of hull lines. My tests have shown that the optimal angle (alpha) is almost entirely a function of the lines of the planing surface and the speed, and that it is apparently not affected by the load carried. I have found that the "optimal planing-angle" varies inversely with planing speed in accordance with an empirical equation of the form

$$\alpha = \frac{K_1}{V + K_2}$$

where V is the speed in miles per hour and K_1 and K_2 are constants for any given set of lines. The average value of K_1 and K_2 appears to be 100 and 10 respectively so that

$$\alpha = \frac{100}{V + 10}$$

and the average variation of the "optimal planing-angle" with speed is:—

M. P. H. =	20	30	40	50	60
Angle =	3.3°	2.5°	2.0°	1.7°	1.4°

From the foregoing it will be observed that if the "optimal planing-angle" can be attained during the second condition when the boat endeavors to plane entirely on the water surface, much greater speed and much heavier loads can be successfully carried with a much smaller horse power than would otherwise be necessary.

Referring to the accompanying drawings, A indicates the hull of a speed boat which includes the usual bow 5, stern 6, and bottom 7. The stern is provided with a cock-pit 8 and the boat is provided with an operator's seat 9. In front of the seat is an instrument board 10 as shown in Figure 5, and above this board is the windshield 11 as shown in Figure 1.

The bottom of the stern is formed with a recess 12 in which is located a normally horizontally disposed fan-tail shaped hydroplane or sternplane 13, and the bottom 7 at the stern is formed with an opening 14 which communicates with said recess. Rigidly secured to the forward end of the plane is a pivot post 15 which extends upwardly into the cock-pit 8 through the opening 14. This post is preferably of hollow formation and is strengthened by longitudinal ribs 16. The longitudinal axis of this post inclines forwardly and upwardly in a vertical plane extending longitudinally of the hull. The post 15 is mounted to freely oscillate within a cylinder 17 mounted in the cock-pit 8 to swing about a horizontal axis. The lower end of the cylinder registers with the opening 14 and in fact extends slightly into said opening. The upper end of the cylinder is closed by a head 18 and the upper end of the post 15 is provided with a piston 19 which has sliding contact with the wall of the cylinder. A plug 20 closes the lower end of the cylinder and the lower end of the post 15 extends therethrough and has sliding contact therewith. The opening 14 is sealed by a gasket 21. A coil spring 22 is disposed around the post 15 between the closure plug 20 of the cylinder and the piston 19 and functions to yieldably retain the sternplane 13 within the recess 12. A roller 23 is journaled to rotate about a fixed axis mounted in the bottom of the stern, the roller projecting into the recess 12 and cooperating with an arcuate track 24 formed in the upper surface of the sternplane 13.

In order to support the cylinder 17 so as to swing about a horizontal axis within the narrow cock-pit 8, I have provided the following construction:—

Mounted in the cock-pit is a pair of spaced longitudinally extending girders 25, 25 and resting upon the girders in rear of the cylinder 17 is a bearing shoe 26 having a longitudinally extending seat 27 formed in its upper surface for receiving a bearing rod 28. A bearing arm 29 extends laterally and rearwardly from the cylinder intermediate its upper and lower ends and this bearing arm is provided with upper and lower recesses 30 and 31 respectively, the latter being seated

on the bearing rod 28. A pressure rod 32 is seated within the recess 30 and a pressure shoe 33 is disposed above the pressure rod 32 and is provided with a seat 34 in its lower face for engaging said rod. Disposed in front of the bearing assembly just described and rigidly secured to each girder 25 is a pair of upwardly extending plates 35, 35. These plates extend upwardly above the pressure shoe 33 and are connected together by a cross arm 36. A clamping bar 37 is disposed between each of the plates 35, 35 and below the cross arm 36. The rear ends of the clamping bars 37 rest on the opposite ends of the pressure shoe 33, and the forward ends of these clamping bars 37 are connected to the girders 25 by means of bolts 38 and associated adjusting nuts 39 by means of which the clamping bars 37 may be adjusted to exert more or less pressure as desired upon the pressure shoe 33 and thereby permit the cylinder 17 to be oscillated about its horizontal axis and at the same time prevent the cylinder from becoming bodily displaced from the girders. When the cylinder 17 is swung about the bearing rod 28, the bearing shoe 33 will have sliding contact with the rear ends of the clamping bars 37.

In order to provide means for swinging the cylinder 17 about its horizontal axis, and thereby varying the angle of inclination of the longitudinal axis of the post 15 relative to the vertical and in a plane extending longitudinally of the hull, I have provided the following mechanism:—

Supported by the girders 25 is a plate 40 and mounted on this plate is a standard 41 to which a lever 42 is pivoted adjacent its rear end as at 43. A link 44 has its upper end pivotally connected as at 45 to the rear end of the lever 42 and the lower end of said link is pivotally connected as at 46 to a bolt 47 which is adjustably connected to an ear fixed to the cylinder 17 at a point diametrically opposite the pivot of said cylinder. Thus by operating the lever 42 the cylinder 17 together with the post 15 and the sternplane 13 can be oscillated about the horizontal axis of said cylinder and thereby vary the angular relation of the plane relative to the planing surface of the hull. In order to actuate the lever 42, I have provided a fluid pressure circuit which includes a tank 48 or source of compressed air. A cylinder 49 is mounted in the cock-pit 8 upon a transverse beam 50 through the medium of bolts 51 and an intermediate elastic cushion 52, the openings through which the bolts pass being of sufficient size to permit the cylinder to have a slight rocking movement. Mounted within the cylinder is a piston 53 and a piston rod 54 extends upwardly and is pivotally connected as at 55 to the front end of the lever 42. The fluid pressure circuit includes a control valve 56 which includes a cylinder 57 and a longitudinally movable piston 58. The cylinder 57 is provided with two groups of ports 59, 60 and 61, and 62, 63 and 64. A pipe 65 connects the compressed air tank 58 with the ports 59 and 64. A pipe 66 connects the upper end of the cylinder 49 with the port 60, and a pipe 67 connects the lower end of the cylinder with the port 63. The ports 61 and 62 are exhaust ports. The piston 58 is provided with two recesses or passages 68 and 69. These passages are respectively correlated with the ports 59, 60 and 61 and with the ports 62, 63 and 64. Thus in one position of the piston 58 as shown in Figure 6, the compressed air tank 48 is in open communication with the upper end of the cylinder 49, and the lower end of the cylinder is in open communication with the exhaust port 62. Thus pressure is applied to the cylinder 49 above the piston and the forward end of the lever 42 is moved downwardly. When the piston 58 is moved inwardly, the compressed air tank 48 will be placed in open communication with the lower end of the cylinder 49 and the upper end of the cylinder will be placed in open communication with the exhaust port 61, thereby providing means for swinging the lever 42 in the opposite direction. In order to provide means for manipulating the piston 58 and for retaining the same in any position of adjustment, the piston is provided with a handpiece 68 having a plurality of teeth 69 formed therein for co-operation with a spring 70 fixed to the cylinder 57.

Under some conditions, it is desirable to apply pressure to the upper end of the cylinder 17 so as to effect a relative movement between the pivot rod 15 and said cylinder. For this purpose, I have provided a fluid pressure circuit which is connected to the compressed air tank 48 and which includes a control valve 71. The control valve 71 includes a cylinder 72 having three ports 73, 74 and 75 arranged in alinement. A piston 76 is slidably mounted in the cylinder and is provided with a peripheral recess 77 adapted in one position of the piston to register with the ports 73 and 74, and in another position to register with the ports 74 and 75. The piston 76 is provided with a handpiece 78 having a series of teeth 79 formed thereon. A spring 80 is fixed to the cylinder 72 and is in constant engagement with certain of the teeth 79 so as to retain the piston 76 in any position of adjustment. A pipe 81 communicates with the compressed air tank 48 and with the port 73, and a pipe 82 communicates with the port 74 and with the upper end of the cylinder 17 above the piston 19. The port 75 is an exhaust port. Thus when the piston 76 is in the position shown in Figure 7, the compressed air tank 48 is in open communication with the upper end of the cylinder 17 so as to effect a relative movement

between the piston 19 and the cylinder 17. When the piston 76 is moved to the other position, the upper end of the cylinder 17 will be disposed in open communication with the exhaust port 75 so as to permit the spring 22 to return the pivot rod 15 to its upper position within the cylinder 17.

In operation, at the very start of the boat's run, the sternplane 13 is disposed within the recess 12 with the roller 23 in engagement with the rail 24, and the plane is yieldingly held in the position by the spring 22. The "trim" valve 56 is actuated so as to admit pressure to the lower end of the cylinder 49 and to exhaust the air from the upper end of the cylinder, to thereby swing the upper end of the cylinder 17 forwardly and the lower end thereof rearwardly about the horizontal pivot of the cylinder. This movement of the cylinder carries the pivot rod 15 and the plane 13 therewith, and consequently the plane is pitched downwardly and forwardly but with the track 24 in engagement with the roller 23. This inclination of the plane will necessarily force the hull into a comparatively large trim angle. As the speed of the boat increases, the "trim" valve 56 is actuated to slowly admit pressure to the top of the cylinder 49 and to exhaust air from the bottom of the cylinder, to thereby change the angle of inclination of the cylinder 49 and the pivot post 15 to a less forward inclination, which will give to the plane a more upward inclination relative to the horizontal. During both adjustments of the plane, the rail 24 remains in contact with the roller 23. The boat is now in its planing condition and is traveling at a comparatively large inclined angle of incident. The "planing valve" 71 is now actuated to slowly admit pressure to the top of the cylinder 17 which results in moving the cylinder together with the stern of the boat upwardly relative to the sternplane 13 which is planing on the surface of the water. This lifting movement of the stern not only compresses the spring 22, but also effects separation between the rail 24 and the roller 23. Thus, the boat is being flattened out toward the "optimal planing-angle". When the "optimal planing-angle" is approached the acceleration of the boat is increased suddenly and the planing valve 71 is closed which leaves the boat planing in the right angle for the amount of power used. Before the boat stops and the motor is entirely throttled down, both the trim valve and the planing valve should be pushed all the way in.

The sternplane 13, by reason of the pivot post 15 being mounted for free oscillations in the cylinder 17, is capable of oscillating or fluttering laterally during forward travel and turning of the boat, to thereby prevent the boat from turning over which would otherwise occur. When it is desired to reverse the direction of the boat, the spring 22 will press the plane upwardly against the roller 23 and therefore the plane will be held against lateral swinging movements owing to the inclination of the axis of the plane causing the latter to maintain its central contact with the roller.

I claim:—

1. In a speed boat, the combination with a hull, of a plane pivoted to the stern of the hull to swing about an axis disposed at an angle to the horizontal plane of the hull and means for varying the angle of inclination of the axis of the plane relative to the vertical and for adjusting the position of the plane vertically.

2. In a speed boat, the combination with a hull, of a plane pivoted to the stern of the hull to swing about an axis disposed at an angle to the horizontal plane of the hull, means for varying the angle of inclination of the axis of the plane relative to the vertical and for adjusting the position of the plane vertically, and means for retaining said axis in its adjusted position.

3. In a speed boat, the combination with a hull, of a plane pivoted to the stern of the hull to swing about an axis disposed at an angle to the horizontal plane of the hull, power operated means for varying the angle of inclination of the axis of the plane relative to the vertical and for adjusting the position of the plane vertically, and means for controlling said power operated means.

4. In a speed boat, the combination with a hull, of a substantially horizontally disposed plane located at and below the stern of the hull and having a forwardly and upwardly inclined pivot post rigidly secured to the forward end thereof, and means carried by the hull for freely supporting said post for oscillations about its longitudinal axis and for supporting said post for oscillations about a horizontal axis.

5. In a speed boat, the combination with a hull, of a substantially horizontally disposed plane located at and below the stern of the hull and having a forwardly and upwardly inclined pivot post rigidly secured to the forward end thereof, means carried by the hull for freely supporting said post for oscillations about its longitudinal axis and for supporting said post for oscillations about a horizontal axis, and means for effecting a relative raising and lowering movement between the hull and the plane without disturbing the supporting means of the plane.

6. In a speed boat, the combination with a hull, of a substantially horizontally disposed plane located at and below the stern of the hull and having a forwardly and upwardly inclined pivot post rigidly secured to the forward end thereof, means carried by the hull for freely supporting said post for oscillations about its longitudinal axis and for supporting said post for oscillations about a

horizontal axis, and means to swing the post about its horizontal axis to vary the angle of inclination of the post relative to the vertical and in a vertical plane extending longitudinally of the hull.

7. In a speed boat, the combination with a hull, of a substantially horizontally disposed plane located at and below the stern of the hull and having a forwardly and upwardly inclined pivot post rigidly secured to the forward end thereof, means carried by the hull for freely supporting said post for oscillations about its longitudinal axis and for supporting said post for oscillations about a horizontal axis, means to swing the post about its horizontal axis to vary the angle of inclination of the post relative to the vertical plane extending longitudinally of the hull, and means for effecting a relative raising and lowering movement between the hull and the plane without disturbing the supporting means of the plane.

8. In a speed boat, the combination with a hull, of a substantially horizontally disposed plane located at and below the stern of the hull and having a forwardy and upwardy inclined pivot post rigidly secured to the forward end thereof, means carried by the hull for freely supporting said post for oscillations about its longitudinal axis and for supporting said post for oscillations about a horizontal axis, power operated means to swing the post about its horizontal axis to vary the angle of inclination of the post relative to the vertical and in a vertical plane extending longitudinally of the hull, and means for controlling said power operated means.

9. In a speed boat, the combination with a hull, of a substantially horizontally disposed plane located at and below the stern of the hull and having a forwardy and upwardy inclined pivot post rigidly secured to the forward end thereof, an arcuate track secured to the upper face of the plane, and a roller journaled on the hull for engagement with the track.

10. In a speed boat, the combination with a hull, of a substantially horizontally disposed plane located at and below the stern of the hull and having a forwardly and upwardly inclined pivot post rigidly secured to the forward end thereof, an arcuate track secured to the upper face of the plane, a roller journaled on the hull for engagement with the track, and a spring mounted on the hull around the post and cooperating with the latter to yieldably maintain the track and roller in engagement.

11. In a speed boat, the combination with a hull, of a subtsantially horizontally disposed plane located at and below the stern of the hull and having a forwardly and upwardly inclined pivot post rigidly secured to the forward end thereof, means carried by the hull for freely supporting said post for oscillations about its longitudinal axis and for supporting said post for oscillations about a horizontal axis, an arcuate track secured to the upper face of the plane, and a roller journaled on the hull for engagement with the track.

12. In a speed boat, the combination with a hull, of a substantially horizontally disposed plane located at and below the stern of the hull and having a forwardly and upwardly inclined pivot post rigidly secured to the forward end thereof, means carried by the hull for freely supporting said post for oscillations about its longitudinal axis and for supporting said post for oscillations about a horizontal axis, an arcuate track secured to the upper face of the plane, a roller journaled on the hull for engagement with the track, and a spring mounted on the hull around the post and cooperating with the latter to yieldably maintain the track and roller in engagement.

13. In a speed boat, the combination with a hull having an opening in the bottom of the stern, of a cylinder located in the hull with one end in register with said opening, means carried by the hull for supporting the cylinder to swing about a horizontal axis, a substantially horizontally disposed plane located at and below the stern of the hull and having a forwardly and upwardly inclined pivot post rigidly secured to the forward end thereof and extending through the opening of the hull into the cylinder for free rotation therein, means for sealing the opening, and means to swing the cylinder together with the post and plane about the horizontal axis of the cylinder.

14. In a speed boat, the combination with a hull having an opening in the bottom of the stern, of a cylinder located in the hull with one end in register with said opening, means carried by the hull for supporting the cylinder to swing about a horizontal axis, a substantially horizontally disposed plane located at and below the stern of the hull and having a forwardly and upwardly inclined pivot post rigidly secured to the forward end thereof and extending through the opening of the hull into the cylinder for free rotation therein, an arcuate track secured to the upper face of the plane, a roller journaled on the hull for engagement with the track, a spring mounted on the hull around the post and cooperating with the latter to yieldably maintain the track and roller in engagement, and means to swing the cylinder together with the post and plane about the horizontal axis of the cylinder.

15. In a speed boat, the combination with a hull having an opening in the bottom of the stern, of a cylinder located in the hull with one end in register with said opening, means carried by the hull for supporting the cylinder to swing about a horizontal axis, a substantially horizontally disposed plane located

at and below the stern of the hull and having a forwardly and upwardly inclined pivot post rigidly secured to the forward end thereof and extending through the opening of the hull into the cylinder for free rotation therein, means for sealing the opening, a piston fixed to the upper end of the post, a coil spring located within the cylinder between the lower end thereof and said piston for normally urging the plane upwardly towards the hull, fluid pressure means cooperating with the cylinder above the piston to lift the boat stern relative to the plane and against the tension of the spring, and means to swing the cylinder together with the post and plane about the horizontal axis of the cylinder.

16. In a speed boat, the combination with a hull having an opening in the bottom of the stern, of a cylinder located in the hull with one end in register with said opening, means carried by the hull for supporting the cylinder to swing about a horizontal axis, a substantially horizontally disposed plane located at and below the stern of the hull and having a forwardly and upwardly inclined pivot post rigidly secured to the forward end thereof and extending through the opening of the hull into the cylinder for free rotation therein, means for sealing the opening, a piston fixed to the upper end of the post, a coil spring located within the cylinder between the lower end thereof and said piston for normally urging the plane upwardly towards the hull, fluid pressure means cooperating with the cylinder above the piston to lift the boat stern relative to the plane and against the tension of the spring, means to swing the cylinder together with the post and plane about the horizontal axis of the cylinder, said swinging means including a lever having connection with the cylinder at a point diametrically opposite the horizontal pivot thereof, and a fluid pressure circuit including a cylinder and piston having operative connection with the lever.

17. In a speed boat, the combination with a hull, of a substantially horizontally disposed plane located at and below the stern of the hull and having a forwardly and upwardly inclined pivot post rigidly secured to the forward end thereof, means carried by the hull for freely supporting said post for oscillations about its longitudinal axis and for supporting said post for oscillations about a horizontal axis, means to swing the post about its horizontal axis to vary the angle of inclination of the post relative to the vertical and in a vertical plane extending longitudinally of the hull, and means for retaining said post in an adjusted position of inclination.

In testimony whereof I affix my signature.

JOHANNES PLUM.