Oct. 9, 1934. O. G. TIETJENS 1,976,046

WATERFOIL

Original Filed Nov. 6, 1931 2 Sheets-Sheet 1

Fig. 1.

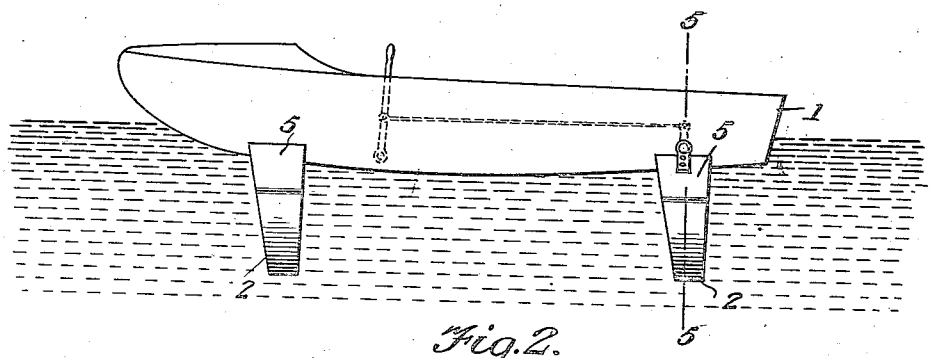


Fig. 2.

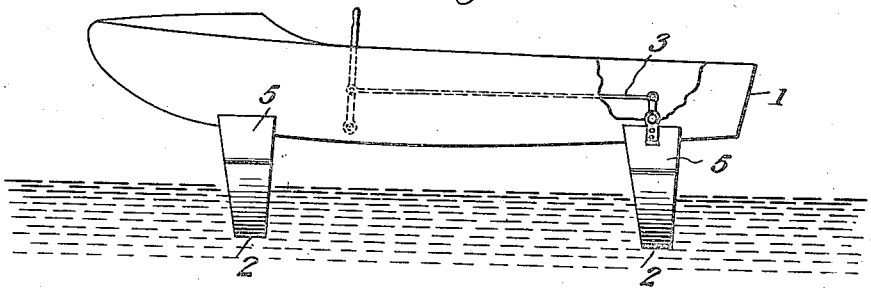


Fig. 3.

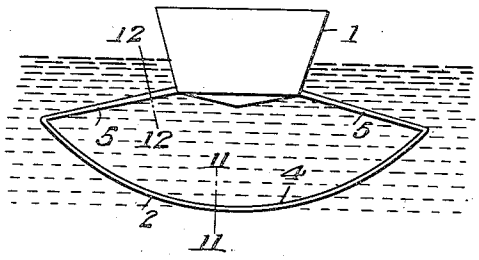


Fig. 4.

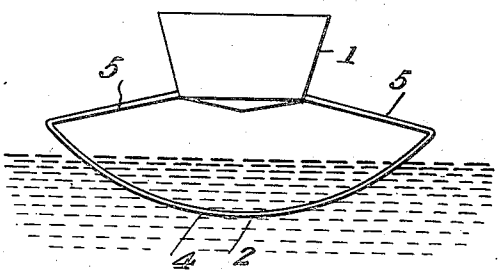
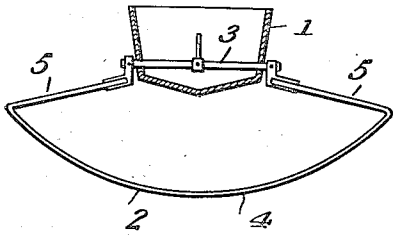


Fig. 5.



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Fig. 6.

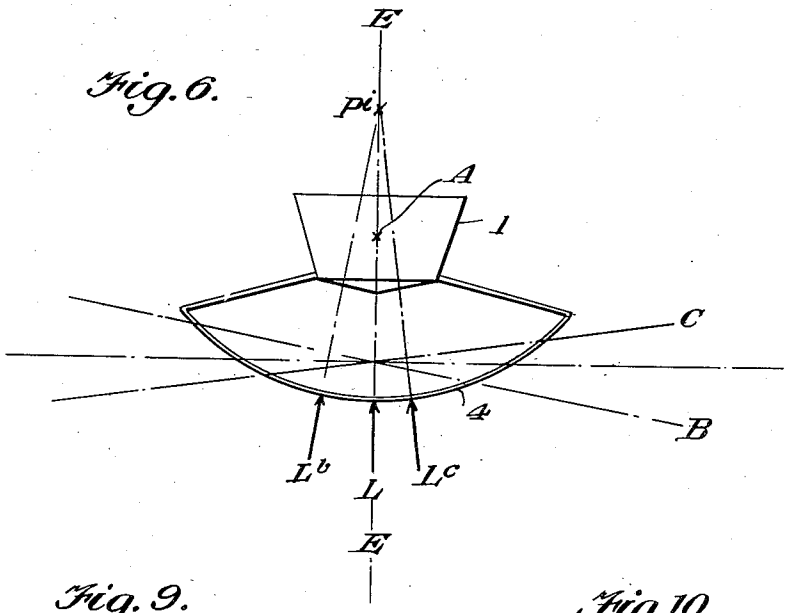


Fig. 9.

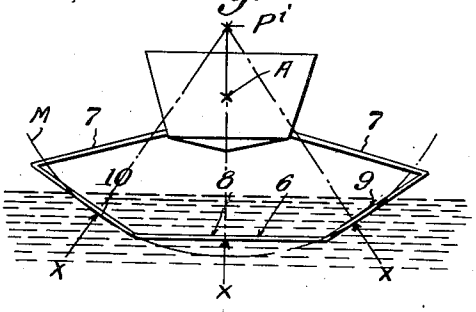


Fig. 10.

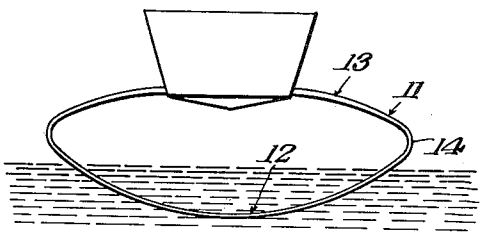


Fig. 7.

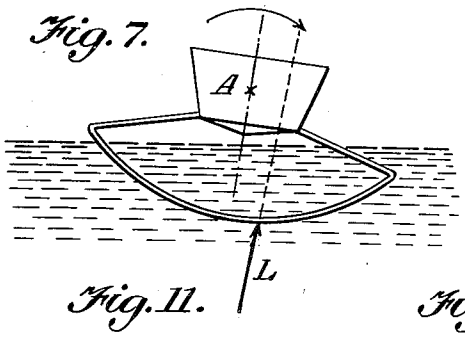


Fig. 8.

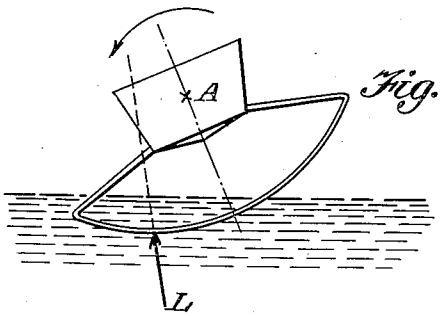


Fig. 11.



Fig. 12.

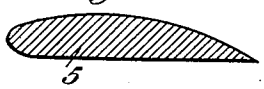


Fig. 13.



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Patented Oct. 9, 1934 1,976,046

UNITED STATES PATENT OFFICE

1,976,046

WATERFOIL

Oscar G. Tietjens, Swarthmore, Pa.

Application November 6, 1931, Serial No. 573,459
Renewed December 14, 1933

7 Claims. (Cl. 114—66.5)

This invention relates to hydrocrafts and more particularly to hydro-foils especially adapted to decrease resistance between a craft and the water for the purpose of permitting excessive speeds to be obtained with an expenditure of a minimum amount of motive power and said device is capable of lifting the hull of the craft further and further out of the water as the speed increases until the hull is entirely clear of the surface of the water so that water resistance will be reduced to a minimum.

Another object of this invention is the provision of hydrofoils so shaped and constructed that they will be capable of producing maximum lifting forces with minimum contact with the water and which are capable of producing their greatest lifting forces when the hull of the craft is within the water to assure quick and easy rise of the hull of the craft from the water as the speed thereof increases.

A further object of this invention is the provision of hydrofoils which always terminate above the surface of the water when the hull of the hydrocraft is travelling at high speeds and which are so constructed as to counteract any tendency of the hull to turn about its longitudinal axis due to some foreign force acting thereon while supported clear of the water thus increasing the stability of the device to a maximum.

With these and other objects in view, this invention consists in certain novel features of construction, combination and arrangement of parts to be hereinafter more fully described and claimed.

For a complete understanding of my invention, reference is to be had to the following description and accompanying drawings, in which

Figure 1 is a side elevation illustrating a hull of a water craft with hydrofoils attached thereto and constructed in accordance with my invention and showing the hull resting within the water.

Figure 2 is a view similar to Figure 1 illustrating the hull of the craft supported clear of the surface of the water by the hydrofoils and in a position occupied while travelling at excessive speed.

Figure 3 is an end elevation illustrating the hull of the craft resting within the water.

Figure 4 is a view similar to Figure 3 showing the hull supported above the surface of the water.

Figure 5 is a detail sectional view taken on the line 5—5 of Figure 1 illustrating means for varying the incidence of the rear hydrofoil.

Figure 6 is a diagrammatical view illustrating the lines of force created by the hydrofoil should the hull of the craft tilt or turn about its longitudinal axis.

Figure 7 is a diagrammatical view showing the hull tilted in a clockwise direction by a foreign force.

Figure 8 is a similar view showing the hull tilted in a counterclockwise direction by a foreign force.

Figure 9 is an end elevation illustrating a modified form of my invention wherein the hydrofoil comprises angularly related portions.

Figure 10 is a view similar to Figure 9 showing another modified form of my invention.

Figure 11 is a sectional view taken on the line 11—11 of Figure 3.

Figure 12 is a sectional view taken on the line 12—12 of Figure 3.

Figure 13 is a sectional view illustrating a modified form of upper structure to the hydrofoil.

Referring in detail to the drawings, the numeral 1 indicates the hull of a watercraft to which hydrofoils 2 are secured and it is to be understood that two or more hydrofoils may be successfully employed on the hull of a craft and the number of hydrofoils are preferably increased in accordance with the increase in lengths of different hulls. However, I have found that a hydrofoil such as 2 is capable in itself of giving the required lift as well as maintaining the desired stability about the longitudinal axis of smaller hulls. The hull shown in Figures 1 and 2 is of the size or length usually employed in watercrafts especially adapted for high speeds and a hull of this size has hydrofoils secured thereto adjacent its bow and stern as shown in the drawings. The rear hydrofoil is shown as pivotally connected to the hull and is provided with an operating medium whereby the incidence of the respective hydrofoil may be varied, however, the rear hydrofoil may be fixed to the hull similar to the connecting of the front hydrofoil to the hull.

Each hydrofoil includes a lower plane element 4 which is arranged transversely and below the bottom of the hull and has formed integral with its ends upper plane elements 5 that extend inwardly and upwardly toward the sides of the hull and are suitably secured thereto. The plane element 4 is of any suitable shape in cross section and preferably as shown in Figure 11 and the upper plane elements 5 are preferably of an increased thickness over the element 4 and may be of any desired shape, preferably as shown in Figure 12 or if desired, the cross sectional shape of the elements 5 may be as shown in Figure 13, frequently termed tear shape. The purpose of con-

structing or designing the upper plane elements 5 of greater thickness than the lower element 4 is to provide the greatest lifting force to the hull when the latter is resting within the water, it being understood that the upper plane elements 5 create lifting forces in an upward direction along with the lifting forces produced by the lower plane element 4 as the hull begins to move forwardly in the water. As the speed of the hull increases the hydrofoils lift it more and more out of the water until the hull is clear of the water and assumes a position substantially as shown in Figure 2 and when in the latter named position, the water resistance to the craft is reduced to a minimum. With the hull travelling in a position as shown in Figure 2 it is desirable as the speed increases to cause the bow of the hull to move slightly in a downward direction and in order to accomplish this the rear foil may be adjusted slightly to vary its incidence of attack on the water.

The center line of the hull 1 is indicated by the line E—E and the longitudinal axis through the center of gravity of the hull is indicated at A. The radius of curvature of the lower plane element 4 is greater than the distance between said element 4 and the longitudinal axis A so that the lifting forces created by the foil will cross the center line E—E of the hull at points above the longitudinal axis and these lines of force are indicated by L^b and L^c in Figure 6 and when the hull due to some foreign force tilts or moves about its longitudinal axis into any of the positions indicated by the lines in Figure 6 the lifting forces will always cross the line E—E at a point above the longitudinal axis. For instance, should the hull have a tendency to move about its longitudinal axis in a clockwise direction and the hydrofoil assume the position indicated by the line C, the lifting force of the lower element of said hydrofoil will be upwardly and across the center line E—E above the longitudinal axis A as shown at P^i which force counteracts the forces having a tendency to turn the hull in the stated direction about the longitudinal axis and thereby bring about a righting of the hull. Should the hull due to a foreign force have a tendency to rotate about its longitudinal axis in a counterclockwise direction and assume the position indicated by the line B in Figure 6 the force of the lower element of the hydrofoil counteracts the tendency of the hull to turn in a counterclockwise direction by crossing the center line E—E of the hull above the longitudinal axis A. It is understood that only the immersed parts of the hydrofoils create the lifting forces. The hull when tilted by a foreign force about its longitudinal axis, the upper portion of the hydrofoil which enters the water will create a lifting force upwardly to one side of the longitudinal axis in opposition to the foreign force and overcomes the latter to aid in righting the hull. Thus it will be seen that the hydrofoils besides efficiently raising the hull out of the water as the speed increases they also will efficiently stabilize the hull which is extremely desirable when travelling at excessive speeds.

In order to obtain stability of watercrafts of the foregoing described type it is essential that the hydrofoils be so arranged that there will be a restoring moment if the hull is given a slight angular rotation or turn about its longitudinal axis.

Referring to my modified form of invention as shown in Figure 9, the hydrofoil includes a lower plane element 6 and upper plane elements 7 similar in construction to the upper plane elements 5. The lower plane element 6 includes portions 8, 9 and 10, the portion 8 being disposed substantially straight and arranged transversely of the hull and below the bottom thereof, with the portions 9 and 10 disposed angularly thereto and inclining upwardly and outwardly therefrom and formed integral with the outer ends of the portions 7. The hydrofoil 6 constructed in accordance with the foregoing will have approximately the same lifting ability as the hydrofoil shown in Figures 3 and 4 and also approximately the same stability. Referring to stability and particularly to Fig. 9, it will be noted that, in a manner similar to that shown in Fig. 6, the immersed parts of the portions 8, 9, and 10 are disposed substantially in the arc of a circle M, the center of the arc being located at P^i, beyond the axis A. Also, that the immersed parts 8, 9, and 10 exert forces x which are normal thereto and which intersect at P^i.

Referring to Figure 10 wherein another modified form of my invention is disclosed the hydrofoil 11 includes the lower plane element 12 similar in construction to the lower plane element 4 and merges into the upper plane elements 13 by arcuately curved end portions 14.

While I have shown and described the preferred embodiment of my invention, it will be understood that minor changes in construction, combination and arrangement of parts may be made without departing from the spirit and scope of my invention, as claimed.

Having thus described my invention, what I claim is:

1. A hydrofoil comprising an element arranged below and transversely of the hull of a watercraft and secured to the hull, said element including lower and upper portions forming planes to produce a lifting force to the hull for elevating the latter outwardly of the water as the speed thereof increases, said lower portion being arcuately curved and the radius of curvature of said lower portion being greater than the distance between said lower portion and the longitudinal axis of the hull, said lifting force passing by the longitudinal axis of the hull at the right side when some foreign force turns the hull in a clockwise direction about its longitudinal axis, and said lifting force passing by the longitudinal axis of the hull at the left side when a foreign force turns the hull about a longitudinal axis in an opposite direction.

2. A hydrofoil comprising a lower curved portion, upper portions extending from the ends of the lower portion and arranged at an angle thereto and secured to a hull of a water craft, the radius of curvature of said lower portion being greater than the distance between the lower portion and the longitudinal axis of the hull to produce a lifting force to the hull which extends through the center line of the hull above the longitudinal axis of said hull when a foreign force acts to turn the hull about its longitudinal axis.

3. A hydrofoil comprising an element arranged below and extending transversely of the hull of a watercraft and secured to said hull, said element including lower and upper portions forming planes to produce a lifting force to the hull for lifting the latter outwardly of the water as the speed thereof increases, said lower portion consisting of angularly related connected portions, the immersed part of which, for any normal position of the watercraft lies substantially in a circle, the center of said circle being located

above the longitudinal axis which passes through the center of gravity of the watercraft.

4. A hydrofoil for a watercraft comprising an element disposed below and extending transversely of the hull of the watercraft and secured to said hull, said hydrofoil including lower and upper longitudinally extending sustaining planes whereby the hull is lifted outwardly from the water by the speed of the craft, said lower planes having an immersed portion which for any normal position of the craft lies substantially in a circle the radial center of which is located above the longitudinal axis which passes through the center of gravity of the watercraft.

5. A hydrofoil for a watercraft comprising an element disposed below and extending transversely of the hull of the watercraft and secured to said hull for lifting the hull outwardly of the water by the speed of the craft, said hydrofoil having an immersed portion which for any normal position of the craft lies substantially in a circle the radial center of which is located above the longitudinal axis which passes through the center of gravity of the watercraft.

6. A hydrofoil for a watercraft, comprising a sustaining plane disposed below and extending transversely of the hull of the watercraft and secured to said hull, whereby the hull is lifted outwardly from the water by the speed of the craft, said sustaining plane having an immersed portion which, for any normal position of the craft, lies substantially in a circle, the radial center of which is located above the longitudinal axis which passes through the center of gravity of the watercraft.

7. A hydrofoil for a watercraft, comprising a member disposed below and extending transversely of the hull of the watercraft and of such longitudinal cross-section as to lift the hull outwardly of the water by the speed of the craft, said lifting member including angularly connected elements, the immersed portions of said elements exerting, for any normal position of the craft, lifting forces substantially perpendicular to the immersed portions and in directions which intersect beyond the longitudinal axis of the hull.

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