Sept. 29, 1959 H. BOERICKE, JR 2,906,229

HYDROFOIL

Filed Dec. 23, 1955 4 Sheets-Sheet 1

FIG. 1.

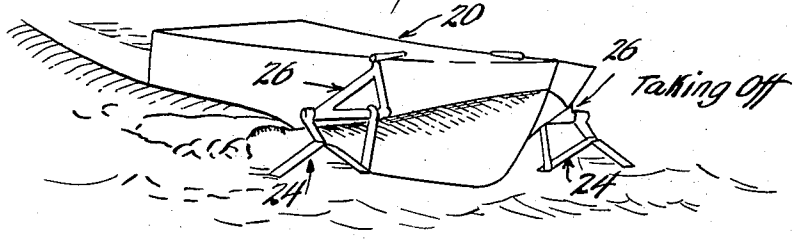
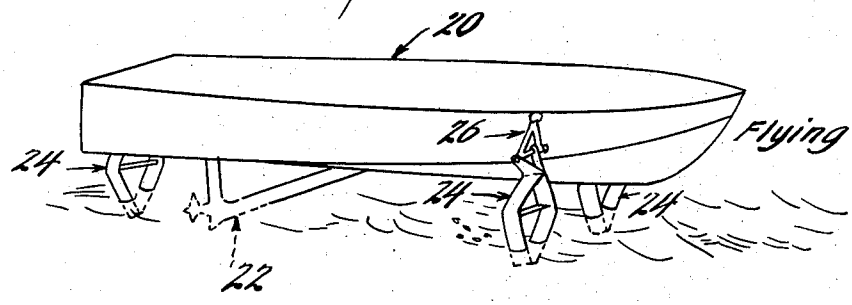


FIG. 2.



INVENTOR

Harold Boericke, Jr.,

BY George Sipkin

B. L. Langwell

ATTORNEY

Sept. 29, 1959 H. BOERICKE, JR 2,906,229

HYDROFOIL

Filed Dec. 23, 1955 4 Sheets-Sheet 2

FIG. 4.

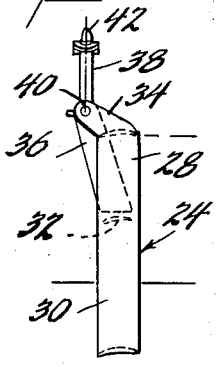


FIG. 3.

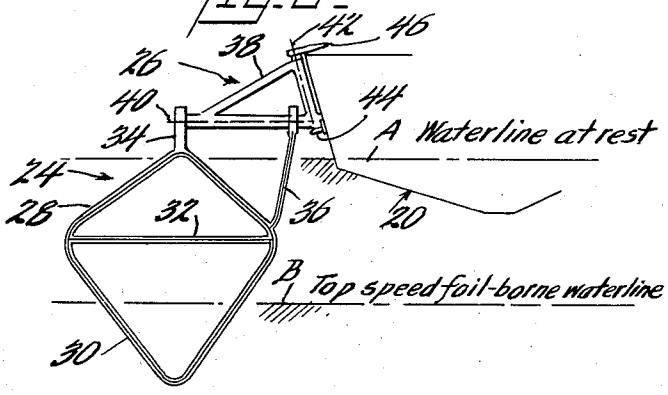


FIG. 6.

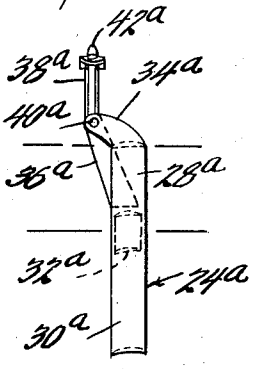
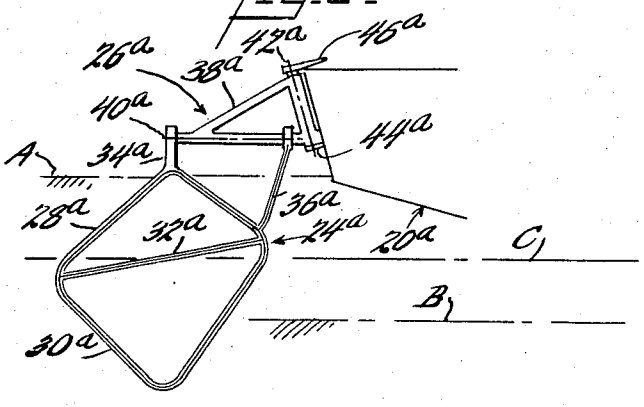


FIG. 5.



INVENTOR

Harold Boericke, Jr.,

BY George Sipkin

B. L. Zanguill

ATTORNEY

Sept. 29, 1959 H. BOERICKE, JR 2,906,229

HYDROFOIL

Filed Dec. 23, 1955 4 Sheets-Sheet 3

FIG. 8.

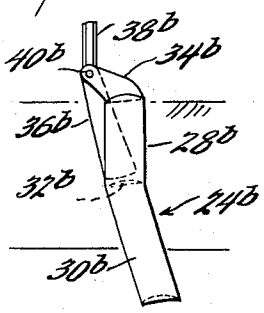


FIG. 7.

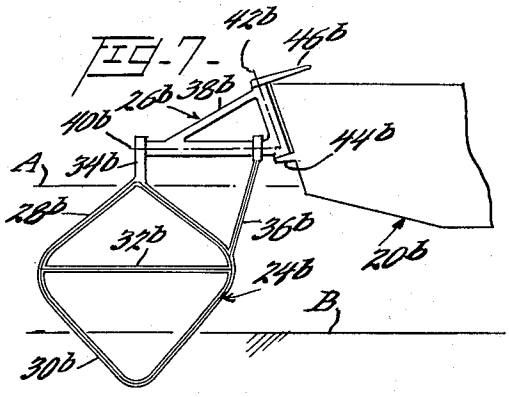


FIG. 10.

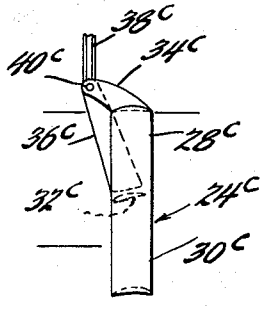
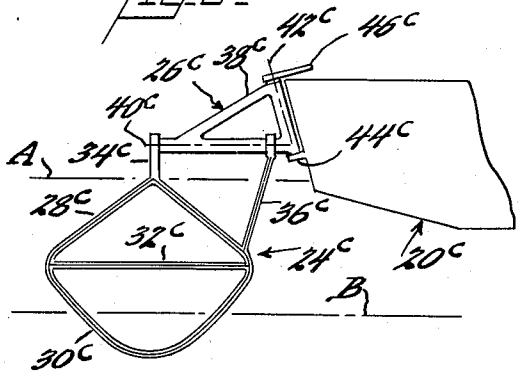


FIG. 9.



INVENTOR

Harold Boericke, Jr.,

BY George Sipkin

B. L. Zangaril

ATTORNEY

Sept. 29, 1959 H. BOERICKE, JR 2,906,229

HYDROFOIL

Filed Dec. 23, 1955 4 Sheets-Sheet 4

FIG. 12.

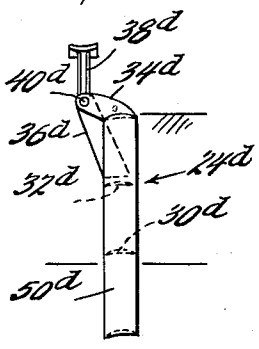


FIG. 11.

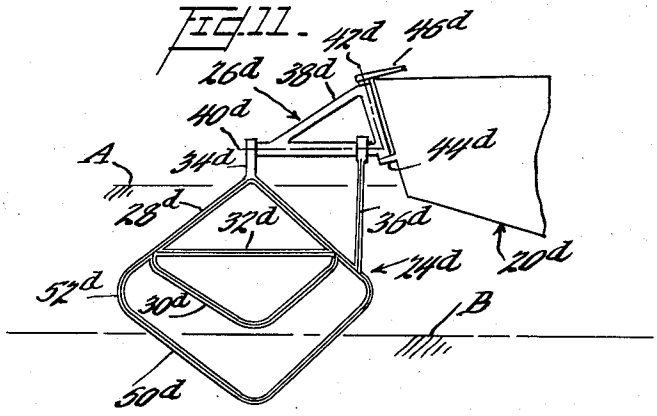


FIG. 14.

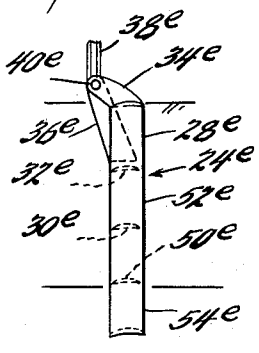
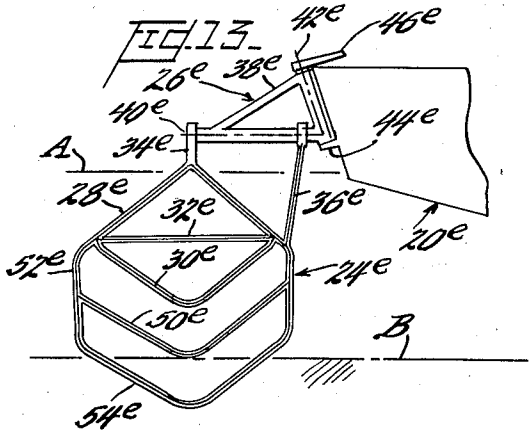


FIG. 13.



INVENTOR

Harold Boericke, Jr.,

BY George Sipkin

B. L. Zangwill

ATTORNEY

United States Patent Office 2,906,229 Patented Sept. 29, 1959

2,906,229

HYDROFOIL

Harold Boericke, Jr., Washington, D.C.

Application December 23, 1955, Serial No. 555,212

19 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 of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to hydrocrafts and particularly to hydrofoils for use with such crafts. More particularly this invention relates to surface-piercing hydrofoils.

Generally, prior surface-piercing hydrofoils consist of a single downward-pointed V, supported at the two upper ends by vertical struts which are tied together at the top by a horizontal bar. In other similar foils, the lifting surface is a submerged horizontal foil supported in the above manner. Also, arcuate shaped foils similar to the bottom half of a circle have been used. Each of these prior art hydrofoils has a single lifting surface extending from side to side of the foil. In order to get sufficient lifting area for a slow take-off speed, these foils must be made very wide. This great width means that the foil panels are long, giving great moment arms to the lift forces. The large bending moments experienced then need thick foil sections to resist them, resulting in high profile lift-drag ratios, and also a heavy foil. Such conventional single lifting surfaces provide little reserve lifting area when the operating surface is fouled or loses lift due to wave action, allowing the boat to lose flight suddenly and drop through a considerable vertical distance onto the water.

Briefly and basically, the instant invention consists of a hydrofoil, hereinafter referred to as a "diamond-shaped" hydrofoil, including an upper or inverted V and a lower V, connected at the horizontal corners by a brace which also serves as a lifting foil, hereafter called the "foil brace." This configuration is supported at the upper corner of the top V by a first strut and at the inboard corner at the juncture of the two V's by a second strut. The struts are in turn supported by a bracket attached to the craft, which bracket may either allow retraction about a horizontal axis, or may not, as the case may be; or may allow steering about a near-vertical axis. At rest, the foil is nearly immersed so that the upper V, lower V, and foil-brace all act as lifting surfaces. As the speed increases, the foil progressively lifts out of the water, so that at convenient operational speeds, the foil immerses only part of its bottom V, thus providing clearance between the hull of the craft and the water, and having only a small lifting area in the water for low drag at high speed. Occasionally at high speed when the craft inadvertently tends to "crash" because of loss of lift on one or more foils due to various causes, the foil brace provides a suddent increment of lifting area which prevents a large drop in height of the hydrofoil boat.

The structural arrangement of this hydrofoil and its supporting struts is essentially that of a truss, which minimizes the bending moments encountered in the joints. With triangular truss panels of the instant invention, the structure is relatively rigid, particularly at high speed when operating on the bottom V. Shorter panels on the lifting surfaces can be used because three surfaces provide the lifting area instead of one as in conventional foils. Because of this consideration, and because of the truss arrangement, the diamond-shaped hydrofoil can be designed for lower bending moments in the foils, which permits a thinner hydrofoil profile section to be used.

This reduces the weight of the foil and increases the profile lift/drag ratio at all speeds, and is particularly advantageous at the highest speeds. Here, thin profile sections are necessary for cavitation-free operation, a condition which imposes an upper limit on the practical operating speed. Thus, if the power is available and can be applied effectively for propulsion, a vessel fitted with diamond-shaped hydrofoils, in accordance with this invention, can be driven at a higher cavitation-free speed than one fitted with conventional foils stressed the same amount and of the same material.

In the present state of the art, a boat supported by surface-piercing hydrofoils progresses from a so-called flying attitude to a waterborne attitude in a fairly abrupt decelerating glide which, when premeditated, is usually gentle, but which, when unforeseen, can only be called a crash. If for any reason as fouling by seaweed, wave action or other causes, the foils lose lift suddenly, there is a rapid loss of vertical height on a boat fitted with conventional surface-piercing hydrofoils. Because they have a single lifting surface, these conventional hydrofoils, when fouled, lose lift irretrievably.

With the diamond-shaped hydrofoil, having at least three lifting surfaces arranged vertically, when the bottom V loses lift, there is a loss of height only until the foil brace is immersed. If this suddent incrment of lift is not enough to halt the drop, the upper V will add to its lift. By adding additional unfouled lifting surfaces with high lift-drag ratios, the drop will be lessened or halted, and the boat can proceed on its way with only a partial loss of flight.

The diamond-shaped hydrofoil, in accordance with this invention, preserves the inherent smooth surface-following advantages of a surface-piercing hydrofoil, has the advantage of small size and thin section, and provides the low take-off speed and anti-crash advantages of a ladder foil.

The diamond-shaped hydrofoil can be fitted to a boat in three places with two forward to each side forward, and one aft on center, or two aft and one forward on the bow. The diamond-shaped hydrofoil can also be fitted in four places, one on each corner of the boat. It can be fitted forward with a submerged-type foil aft with combined foil and propeller nacelle. It may be mounted fixed to the side of the boat, or be pivoted about a near-vertical axis for steering purposes. Provisions for rotating the hydrofoil back about a horizontal axis for retraction combined with a rotation forward about a near vertical axis may also be used for retraction, which folds the foil forward, upside down, and against the side of the boat in the retracted position. The optimum shape appears to be one with the top of the upper V at the still waterline, the foil brace at a level just below the bottom of the boat, and the bottom V projecting below this level.

In addition to the above alternate ways of mounting diamond-shaped hydrofoils on a hydrofoil boat, such hydrofoils may be mounted on a seaplane in three retractable foils, two of which retract into engine nacelles and one into the empennage. Hydroskis may be provided alternatively as a tail support of large, heavy planes.

With the foregoing in view, an object of this invention is to provide a hydrofoil having a large maximum lift within small physical dimensions.

A further object of this invention is to provide a hydrofoil that is relatively strong and stiff within small physical dimensions.

A still further object of this invention is to provide a hydrofoil having relatively thin foil sections, which provide low foil drag and high cavitation-free speeds of the hydrofoil craft.

A further object of this invention is to provide a

hydrofoil incorporating the advantages of surface-piercing V foils and ladder foils, while substantially eliminating the disadvantages of such prior art foils.

A further object of this invention is to provide in a hydrofoil a brake against sudden loss of flight of the hydrocraft.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings in which like reference numerals designate like parts throughout the several figures thereof and wherein:

Fig. 1 is a perspective view illustrating the hull of a watercraft with hydrofoils, constructed in accordance with the present invention, attached thereto and showing the craft taking off with the hull supported partly by the hydrofoils and partly by the water;

Fig. 2 is a perspective view similar to Fig. 1 and showing the craft flying with the hull supported clear of the water by the hydrofoils;

Fig. 3 is a front elevational view of a hydrofoil in accordance with a preferred embodiment of the invention, and showing a manner of attaching the foil to the hull and the relative waterlines with the hull at rest and at top, foil-borne speed;

Fig. 4 is a side elevational view of the hydrofoil and attaching mechanism shown in Fig. 3;

Fig. 5 is a front elevation similar to Fig. 3, illustrating a first modified form of hydrofoil in accordance with this invention;

Fig. 6 is a side elevational view of the hydrofoil and attaching mechanism shown in Fig. 5;

Fig. 7 is a front elevation similar to Fig. 3, illustrating a second modified form of hydrofoil;

Fig. 8 is a side elevational view of the hydrofoil and attaching mechanism shown in Fig. 7;

Fig. 9 is a front elevational view similar to Fig. 3, illustrating a third modified form of hydrofoil;

Fig. 10 is a side elevational view of the hydrofoil and attaching mechanism shown in Fig. 9;

Fig. 11 is a front elevational view similar to Fig. 3, illustrating a fourth modified form of hydrofoil;

Fig. 12 is a side elevational view of the hydrofoil and attaching mechanism shown in Fig. 11;

Fig. 13 is a front elevational view similar to Fig. 3, illustrating a fifth modified form of hydrofoil, and;

Fig. 14 is a side elevational view of the hydrofoil and attaching mechanism shown in Fig. 13.

It is to be noted that each of the several modified hydrofoils illustrated in Figs. 5–14, inclusive, incorporate the generic invention of the basic, diamond-shaped hydrofoil illustrated in Figs. 3 and 4.

Referring now to Figs. 1 and 2 of the drawing, wherein for purpose of illustration there is shown a watercraft having a hull **20** equipped with a conventional propeller mechanism **22**. Fitted to the hull of the craft are three substantially identical hydrofoils **24**, with two such hydrofoils forward to each side forward, and one aft on center. The two forward hydrofoils are attached to the hull by strut and bracket mechanism **26**, to be referred to in detail hereafter. The aft hydrofoil is fitted to the hull in any suitable manner, not shown, but preferably retractable.

Referring now to Figs. 3 and 4, in accordance with this invention each of the hydrofoils **24** basically includes a four-sided figure referred to herein as a "diamond-shaped" hydrofoil. This diamond-shaped hydrofoil includes an upper or inverted V **28** and a lower or upright V **30** joined into an integral structure and connected at the horizontal corners thereof by a brace **32**, hereafter referred to as a "foil brace." If desired, the foil brace **32** may serve merely as a structural member and not as a lifting foil by making the angle of attack zero and the foil section symmetrical. In practice the upper and lower V's **28** and **30**, may be formed of a single strip of metal bent in the form of a diamond, as shown in Fig. 3, with the two ends of the strip butt-welded. Then the foil brace **32** may be welded within the opposite horizontal corners of the diamond, and the welded joints smoothed and polished for low drag. The cross-sectional shape of the metal strip is optional depending upon the intended use of the hydrofoil and such shape is conventionally shown in broken lines at the bottom of Fig. 4. Also, as shown in Fig. 4, the two V's that make up the diamond-shaped foil are in the same near-vertical plane, with the bottom of the lower V slightly forward of the top of the upper V, for reasons pointed out hereinafter.

The chords of the upper and lower V foil sections may be made to vary in any way improving lift-depth characteristics. Increasing the lower V chord from the bottom to top will improve the high-speed efficiency over a constant-chord arrangement. Such a configuration, due to a smaller bottom chord, will operate at a greater aspect ratio. Since depth in itself means more efficient operation, and greater aspect ratio means greater lift, both features make for greater lift force per unit area. The cambers of the upper and lower V foil section may be made to vary in order to give a combination of lower drag at top speed with low take-off speed.

Referring still to Figs. 3 and 4, the diamond-shaped foil **24** is supported at the upper corner of the top V by a strut **34**, which, as shown in Fig. 4, projects upward and rearward, and at the inboard corner, the foil is supported by a strut **36**. The struts, **34** and **36**, are in turn supported by a triangular bracket **38** which may either allow retraction about a horizontal axis **40** or may not, as the case may be; or may allow steering about a near vertical axis **42**, which vertical axis is provided in a second bracket **44** attached to the outside of the hull. A lever **46** is provided for steering.

As shown in Fig. 4, the diamond-shaped hydrofoil **24** is supported on the axis **40** on a line to the rear of the plane of the foils so that the lift forces of the foils tend to rotate the bottom of the hydrofoil forward. This tends to counterbalance the effect of the drag force of the hydrofoil tending to rotate the bottom of the hydrofoil aft. Thus, hydrodynamic balance is obtained.

In operation, the waterline at rest is substantially as shown at A in Figs. 3 and 4, with the hydrofoil nearly immersed so that the upper V, lower V, and foil brace all act as lifting surfaces. As the speed increases, the foil progressively lifts out of the water, so that at take-off (Fig. 1) only the foil brace and lower V are immersed and act as lifting surfaces. At top speed the foil-borne waterline is substantially at B (Fig. 3) with only part of the bottom V immersed, thus providing clearance between the hull and the water for low drag at high speed. Occasionally at high speed when the vessel inadvertently tends to "crash" because of loss of lift on one or more foils due to various causes, the foil brace provides a sudden increment of lifting area which prevents a large drop in height of the hydrofoil boat. The structural arrangement of this hydrofoil and its supporting struts is essentially that of a truss, which minimizes the bending moments encountered in the joints. With triangular truss panels, the structure is relatively rigid, particularly at high speed when operating on the bottom V. Shorter panels on the lifting surfaces can be used because three surfaces provide the lifting area instead of one as in conventional foils. Because of this consideration, and because of the truss arrangement, the diamond-shaped hydrofoil can be designed for lower bending moments in the foils which permits a thinner hydrofoil profie section to be used. This reduces the weight of the foil and increases the profile lift/drag ratio at all speeds, and is particularly advantageous at the highest speeds. Here, thin profile sections are necessary for cavitation-free operation, a condition which imposes an upper limit on the practical operating speed. Thus, if the power is available

and can be applied effectively for propulsion, a vessel fitted with diamond-shaped hydrofoils can be driven at a higher cavitation-free speed than one fitted with conventional foils stressed the same amount and of the same material.

Thus, it is seen that the diamond-shaped hydrofoil preserves the inherent smooth surface-following advantages of a surface-piercing hydrofoil, has the advantages of small size and thin section, and provides the low take-off speed and anti-crash advantages of a ladder foil. and anti-crash advantages of a ladder foil.

Referring now to Figs. 5 and 6, wherein there is shown a first modified embodiment of the invention and wherein parts like those of Figs. 3 and 4 are designated by like reference numerals, except in Figs. 5 and 6, for purposes of distinction, the reference numerals are accompanied by the subletter "*a*." In this first modified embodiment of the invention, there is shown a skew diamond-shaped hydrofoil **24***a* generally similar to the hydrofoil **24** of Figs. 3 and 4, except that the juncture of the upper and lower V's, **28***a* and **30***a* are not in the same horizontal plane and the foil brace **32***a* is arranged at an angle with respect to the water lines.

In operation of the embodiment illustrated in Figs. 5 and 6, when a wave strikes the angled foil brace **32***a*, lift is applied gradually to the foil because lifting area is immersed gradually. With the diamond-shaped foil shown in Figs. 3 and 4, the lift is developed suddenly, by the horizontal foil brace **32**. The jolt thus given by the horizontal foil may induce an undesirable longitudinal oscillation of the craft. For this reason the skew diamond-shaped hydrofoil may be preferred for certain installations. The mounting and operation of the skew diamond-shaped hydrofoil otherwise is substantially the same as that described above for the diamond-shaped hydrofoil of Figs. 3 and 4.

Referring now to Figs. 7 and 8, wherein there is shown a second embodiment of the invention and wherein parts like those of Figs. 3 and 4 are designated by like reference numerals, except in Figs. 7 and 8 the reference numerals are accompanied by the subletter "*b*." In this second modification of the invention, there is shown a swept forward diamond-shaped hydrofoil in that the lower V **30***b* is not in the same near-vertical plane as the upper V **28***b*, but rather is at an angle forward of such upper V.

The primary purpose of the swept forward, diamond-shaped foil is that with certain installations of the diamond-shaped foil of Figs. 3 and 4, considerable loss of lift is caused at high angles of attack by air sucked down along the top surface of the hydrofoil. The negative pressure developed along the top surface is responsible for such phenomena. If the angle of attack of the hydrofoil is great enough to cause a large negative pressure, air enters and forms a fixed cavity, limiting the lift which may be developed. The swept forward, diamond-shaped foil, shown in Figs. 7 and 8, protrudes forward into the water, wiping off any bubbles of air which travel downward along the upper face of the foil. Thus a larger negative pressure may be maintained, and a higher lift developed. The mounting and operation of the swept forward, diamond-shaped hydrofoil otherwise is substantially the same as that described above for the diamond-shaped hydrofoil of Figs. 3 and 4.

Referring now to Figs. 9 and 10, wherein there is shown a third modified embodiment of the invention, and wherein parts like those of Figs. 3 and 4 are designated by like reference numerals, except in Figs. 9 and 10 the reference numerals are accompanied by the subletter "*c*." In this third modified embodiment of the invention there is disclosed a parabolic lower chord, diamond-shaped hydrofoil **24***c* generally similar to the diamond-shaped hydrofoil of Figs. 3 and 4, except that the lower chord **30***c* instead of being a V-shaped is shaped in a parabolic arch, which parabolic arch gives a more uniform distribution of stresses over the lower chord. The diamond-shaped hydrofoil, as in Figs. 3 and 4, develops a maximum bending moment at the bottom of the V, and high stresses are experienced at this point. To withstand these stresses relatively thick sections are required, which cause cavitations at low speeds. A parabolic shaped lower chord, as shown in Figs. 7 and 8, reduces the maximum stress and also the section thickness required. A higher cavitation-free speed is then possible. For certain installations, other factors being equal, the parabolic-shaped lower chord of Figs. 7 and 8 is preferred to the V-shaped lower chord of Figs. 3 and 4. The mounting and operation of the parabolic lower chord, diamond-shaped hydrofoil of Figs. 7 and 8 is otherwise substantially the same as that described above for diamond-shaped hydrofoil of Figs. 3 and 4.

Referring now to Figs. 11 and 12, wherein there is shown a fourth modified embodiment of the invention and wherein parts like those of Figs. 3 and 4 are designated by like reference numerals, except in Figs. 11 and 12 the reference numerals are accompanied by the subletter "*d*." In this fourth modified embodiment of the invention there is disclosed a double lower chord, diamond-shaped hydrofoil **24***d*. That is, a second V **50***d* is located below the otherwise lower V **30***d* of the diamond, resulting in two lower V's one above the other, and is thus analogous to a ladder foil, having its low take-off speed characteristics and anti-crash advantages. The linear increase of area with imersion gives this double lower chord, diamond-shaped hydrofoil the response of lift with depth of a surface-piercing foil, together with its excellent lift/drag properties. The truss-shaped configuration of this foil gives it a rigidity possessed by no other ladder type foil.

Referring still to Figs. 11 and 12, it is advantageous to give the upper bottom V foil **30***d* a little more dihedral than the lower bottom V foil **50***d*. This will keep the vertex of the former out of water when operating at high speeds, at times when only the lower bottom V is in the water. As shown in Fig. 11, the intersection of the upper bottom V foil **30***d* with the side struts **52***d* may be below the intersection of the foil brace **32***d* with the side struts with little loss of rigidity. By thus separating these points of intersection the interference drag is reduced.

The double lower chord, diamond-shaped hydrofoil, shown in Figs. 11 and 12, is particularly advantageous for use with large hydrofoil boats requiring foil retraction, since the ladder type of foil offers some security against accidental loss of flight, especially disadvantageous in large boats. In addition, these foils have the large area necessary for low take-off speeds required especially in large hydrofoil craft.

Referring now to Figs. 13 and 14, wherein there is shown a fifth modified embodiment of the invention and wherein parts similar to those of Figs. 3 and 4, and Figs. 11 and 12 are given like reference numerals with the addition of the subletter "*e*." In this fifth modified embodiment of the invention a third bottom V **54***e* is added. The triple lower chord, diamond-shaped hydrofoil shown in Figs. 13 and 14 is intended for use on large hydrofoil boats and it possesses the same advantages outlined above in connection with the double lower chord, diamond-shaped hydrofoil shown in Figs. 11 and 12. However, due to the lack of the truss configuration on the bottom V's **50***e* and **54***e* in Figs. 13 and 14, there will be a slight loss of rigidity compared with a foil having only two bottom V's, as in Figs. 11 and 12.

Without further description, it will thus be seen that each of the modified embodiments of the invention shown in Figs. 5 to 14, inclusive, incorporate the generic invention and the basic advantages of the diamond-shaped hydrofoil shown in Figs. 3 and 4 and, while several specific embodiments of the invention have been shown and described, the invention obviously may take

other forms and be variously applied in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically illustrated and described.

What is claimed is:

1. A hydrofoil for watercraft, comprising an element secured to said craft, said element including upper, lower and intermediate portions each forming planes to produce lifting forces to the craft for elevating the latter outwardly of the water as the speed thereof increases, said upper, lower and intermediate portions of said element being united into two substantially triangular truss structures having the intermediate portion as a common base so constructed and arranged as to increase the stiffness of and reduce bending moments on individual portions thereof.

2. A hydrofoil as set forth in claim 1 wherein said upper and lower portions of said elements are constructed and connected in a manner so as to form a substantially diamond shaped element, and wherein said intermediate portion is a straight horizontal member connecting opposite corners of said diamond-shaped element.

3. A hydrofoil as set forth in claim 2 wherein said upper, lower and intermediate portions are arranged wholly within substantially the same near-vertical plane.

4. A hydrofoil as set forth in claim 1 wherein said upper and lower portions of said element are constructed and connected in a manner so as to form a skew diamond-shaped element, and wherein said intermediate portion is arranged at an angle to the horizontal and having opposite ends thereof connected to corners of said skew diamond-shaped element at different elevations.

5. A hydrofoil as set forth in claim 4 wherein said upper, lower and intermediate portions of said element are arranged in substantially the same near-vertical plane.

6. A hydrofoil as set forth in claim 1 wherein said upper and lower portions of said element are constructed and connected in a manner that the lower portion is at an angle to the upper portion and forward thereof.

7. A hydrofoil as set forth in claim 1 wherein the upper portion of said element is substantially V-shaped, the lower portion is substantially parabolic and the intermediate portion is substantially straight with opposite ends thereof joined to opposite ends of the V and parabolic shaped portions.

8. A hydrofoil as set forth in claim 7 wherein the upper, lower and intermediate portions of said element are arranged in substantially the same near-vertical plane.

9. A hydrofoil as set forth in claim 1 wherein said element includes a second lower portion connected to said upper, lower and intermediate portions in a manner as to form a substantially diamond-shaped element.

10. A hydrofoil as set forth in claim 9 wherein said upper and each of said lower portions is substantially V-shaped.

11. A hydrofoil as set forth in claim 10 wherein said element includes a third substantially V-shaped lower portion connected to the upper, lower and intermediate portions in a manner as to form a unitary structure.

12. A hydrofoil for a watercraft, comprising a lower substantially triangular foil section, an upper substantially triangular foil section and an intermediate straight foil section, said intermediate foil section forming a common base for the upper and lower triangular sections, and said sections being joined one to the other by continuous surfaces with all such sections mounted on the watercraft in a common near-vertical plane transversely of such craft and in a manner as to provide three vertically disposed lifting surfaces.

13. A hydrofoil as set forth in claim 12 wherein the intermediate straight foil section acts as a brace and tension member for the lower and upper triangular sections.

14. A hydrofoil as set forth in claim 12 wherein the lower angular foil section comprises a V section, the upper angular foil section comprises an inverted V section, and wherein the lower and upper V sections are joined into a substantially diamond-shaped hydrofoil.

15. A hydrofoil as set forth in claim 14 wherein the intermediate straight foil section is joined to the upper and lower extremities, respectively, of the lower and upper V sections.

16. A hydrofoil craft comprising a hull, a hydrofoil, means mounting the hydrofoil on the hull, said hydrofoil having upper and lower foil sections mounted in a near-vertical plane substantially transverse of the longitudinal axis of the hull, the mounting of the hydrofoil in the near-vertical plane being such that the bottom of the hydrofoil is slightly forward and the top of the hydrofoil is slightly rearward of a true vertical plane, and said mounting means including a strut attached to an upper portion of the hydrofoil and projecting rearwardly of the near-vertical plane of such hydrofoil, an arm secured to the hull and having an outer portion thereof secured to a rearward portion of said strut to the rear of the near-vertical plane of the hydrofoil, the construction and arrangement of said hydrofoil and said connecting means being such that lift forces of the hydrofoil tend to rotate the bottom of the hydrofoil forward to thereby counterbalance the effect of drag forces of the hydrofoil tending to rotate the bottom of the hydrofoil aft.

17. A hydrofoil craft as set forth in claim 16 wherein said attaching means includes a second or inboard strut connecting an inboard portion of the hydrofoil to an inboard portion of said arm near its connection to the hull thereby forming a truss structural system in the mounting means.

18. A watercraft comprising a hull, a hydrofoil pivotally mounted on the hull for lifting the hull outwardly of the water by the speed of the craft, said hydrofoil comprising an upper section, a lower section and an intermediate section each constituting foil sections forming planes to produce lifting forces to the hull for elevating the latter outwardly of the water as the speed of the craft increases, said upper and lower sections each being formed with a pair of diverging legs with the ends of one pair of legs joined to the ends of the other pair of legs to form a continuous unitary substantially diamond-shaped structure, said intermediate section constituting a straight foil and brace section wholly within the confines of the diverging legs of at least one of the upper and lower sections and having opposite ends thereof joined to the ends of the legs of the upper and lower sections at the juncture thereof to thereby divide the diamond-shaped structure into two triangular sections having the intermediate section as a common base.

19. A hydrofoil as set forth in claim 18 which includes means securing the hydrofoil to the hull of the watercraft, which means includes a first strut connected to the top of the upper section, a second strut connected to the hydrofoil adjacent one of the junctures of the upper, lower and intermediate sections, and a third strut joining the first and second struts and having a portion thereof pivotally connected to the hull in a manner as to render the hydrofoil a rudder for steering the craft.

References Cited in the file of this patent

UNITED STATES PATENTS

1,410,872	Baldwin	Mar. 28, 1922
1,410,875	Bell et al.	Mar. 28, 1922
2,576,744	Anderson	Nov. 27, 1951
2,584,347	Hazard	Feb. 5, 1952
2,720,180	Schertel	Oct. 11, 1955
2,749,869	Bush	June 12, 1956
2,767,678	Vertens	Oct. 23, 1956

FOREIGN PATENTS

274,436	Italy	May 21, 1930
517,519	Germany	Feb. 4, 1931
851,374	France	Oct. 2, 1939