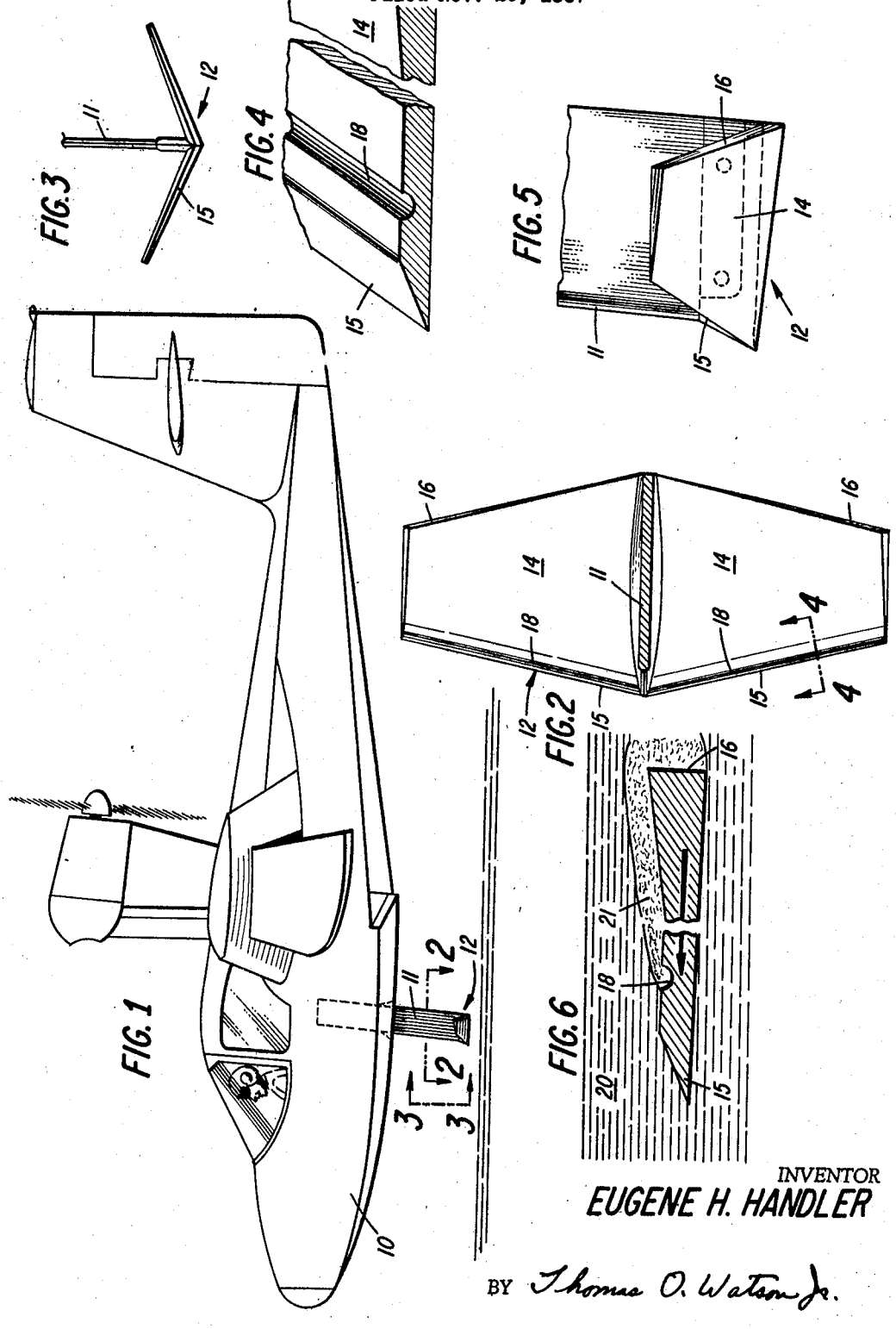
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SUPERCAVITATING HYDROFOIL

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SUPERCAVITATING HYDROFOIL

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ABSTRACT OF THE DISCLOSURE

A supercavitating hydrofoil having a sharp leading edge, a blunt trailing edge, and a spanwise sharp edged slot of small depth and width machined a small percentage of the hydrofoil chord behind the leading edge on the low pressure (upper) hydrofoil surface. The slot provides a line of detachment of the cavity from the upper surface of the hydrofoil and serves to stabilize the cavity.

Statement of government interest

The invention defined 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.

Background of the invention

The present invention relates to supercavitating hydrofoils and more particularly to supercavitating hydrofoils incorporating geometry which defines a fixed line of detachment for the cavity whereby the cavity is stabilized and predictable lift/drag ratios may be obtained.

The phenomenon of cavitation on a body proceeding through water is related to the shape of the body, the speed of the body and its depth below the surface of the water. In particular, it is governed by the minimum pressure experienced on the body. If this pressure drops below the vapor pressure of water, about 3 p.s.i., bubbles of water vapor will be formed. When hydrofoils are operated at high speed, the pressure on the upper surface of the foil is reduced below the vapor pressure of water and water vapor bubbles begin to form at the region of lower pressure. As the water flow carries these water vapor bubbles past the region where they are formed, the pressure increases again and the bubbles collapse. The shock of collapse is concentrated at a tiny point, generally on the surface of the hydrofoil. This shock results in a particle of the metal being eroded away, a process which, if continued, will cause vibration and damage to the foil, as well as adversely affecting the lift/drag characteristics of the foil. The formation and collapse of water vapor bubbles as aforedescribed is called variable or destructive cavitation and because of this, present hydrofoil boats have been designed for top speeds less than about 50 knots.

Recent investigations have developed hydrofoil and strut shapes which can operate continuously at cavitating speeds without damage to the metal. Characterized by a generally fixed water vapor bubble which extends for the length of the hydrofoil and trails beyond it, this type of operation is known as supercavitating flow. Chordal sections of hydrofoils designed for supercavitating flow are generally of a wedge-shape with a sharp edge forward and a blunt edge aft. Since, when operating under supercavitating conditions, the top surface of the foil contacts only water vapor, and the bottom surface is the only one which is wetted, the drag is relatively low and the efficiency can be excellent. Foils designed for such conditions are not limited by any top speed presently known, and thus greatly extend the speed capabilities of hydrofoil boats and aircraft.

However, the supercavitating hydrofoils of the prior art have all suffered from the same drawback, namely, the unpredictability of their lift/drag characteristics when operating in any but the smoothest of waters. The apparent horizontal movement of water subjected to wave action is an optical illusion. Wave action is actually produced by vertical motion of the water near the surface of a body of water. Thus, a horizontally moving hydrofoil is disposed at right angles to the line of action of the water through which it is moving. This perpendicular relationship of lines of motion results in variation of the apparent or effective angle of attack of the hydrofoil from the negative through large positive values. The resultant pressure variations on the surfaces of the foil cause changes in the shape of the cavity and constant shifting of the line of detachment of the cavity over the upper surface of the foil. This in turn results in variation in the lift/drag characteristics of the hydrofoil which precludes predictability of operation.

Summary of the invention

The present invention enables the construction of a supercavitating hydrofoil having superior and predictable operating characteristics. The present invention further contemplates a supercavitating hydrofoil; the lift/drag characteristics of which will not be adversely affected by wave motion in the body of water in which it is operated. The general purpose of this invention is to provide a supercavitating hydrofoil that has all the advantages of similarly employed supercavitating hydrofoils and yet has none of the above described disadvantages. To attain this, the present invention provides a supercavitating hydrofoil having unique geometry whereby instability of the cavity is avoided.

Objects of the invention

It is a primary and general object of the present invention to provide a new and improved supercavitating hydrofoil.

It is another object of this invention to provide a supercavitating hydrofoil capable of high speed operation without cavity instability.

It is a further object of this invention to provide a supercavitating hydrofoil having a configuration which assures a fixed line of cavity detachment.

It is yet another object of this invention to provide a supercavitating hydrofoil whose lift/drag characteristics will remain predictable and substantially unaffected by wave motion.

Brief description of the drawing

Other objects, advantages and novel features of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings, wherein like reference numerals designate like parts throughout the several views, and wherein:

FIG. 1 illustrates the hydrofoil of the present invention mounted on a seaplane;

FIG. 2 is an enlarged sectional view taken along the line 2—2 of FIG. 1 and illustrates the hydrofoil in plan;

FIG. 3 is an enlarged front elevation of the hydrofoil and a portion of the mounting strut taken along the line 3—3 of FIG. 1;

FIG. 4 is a further enlarged fragmentary section view taken along the line 4—4 of FIG. 2 and illustrates the spanwise slot which induces cavity separation;

FIG. 5 is an enlarged side elevation of the hydrofoil and strut of FIG. 1 and illustrates the mode of strut attachment; and

FIG. 6 is a sectional view similar to FIG. 4 showing

the hydrofoil immersed in water and the water vapor cavity detached from the upper surface of the hydrofoil at the edge of the spanwise slot during conditions of supercavitating flow.

Referring now to the drawings, and more particularly to FIGS. 1, 2, 3 and 5 thereof, there can be seen a seaplane **10** having a retractable strut **11** projecting through the bottom of the hull of the seaplane.

The supercavitating hydrofoil of the present invention, designated generally by the reference numeral **12**, is fixed to the lower end of the strut **11**. The hydrofoil **12** comprises a main body portion **14**, a sharp leading edge **15** and a blunt trailing edge **16**. The upper or lifting surface of the hydrofoil **12** is provided with a spanwise slot **18** formed a short distance behind the leading edge **15**. This construction is best illustrated in FIG. 4.

Operation

In order that a better understanding of the invention might be had, its mode of operation will now be described. Attention now is directed to FIG. 6 of the drawing wherein the supercavitating hydrofoil of the present invention, illustrated in section, is depicted moving through a body of water **20** at a speed sufficient to produce supercavitating flow. The cavity **21** separates cleanly from the upper surface of the hydrofoil along the forward edge of the slot **18** and trails beyond the trailing edge **16**. It will be noted that the strut **11** is provided with a blunt trailing edge which creates a void in the water adjacent the trailing edge and intersecting the cavity when the strut is moved at supercavitating speeds. This configuration is well known as a base ventilated strut. Atmospheric air moves through the void behind the strut and ventilates the cavity during supercavitating operation. This configuration of strut and hydrofoil has been found to perform in a manner superior to the performance of prior art supercavitating hydrofoils.

Conclusion

In conclusion, it is believed that it has been made clear that the present invention possesses numerous advantages not found in the prior art. The hydrofoil configuration of the present invention insures cavity stability; provides a fixed and constant line of cavity separation; and enables supercavitating operation in water at various sea states.

Obviously many modifications and variations of the present invention are possible in the light of the above

teachings. For example, the spanwise slot can be of various cross-sectional configurations provided the forward edge thereof is sharp. Also, ventilation of the cavity may be accomplished with internal passages in the strut and hydrofoil communicating with the spanwise slot. And further, the concept of a slot behind the leading edge to stabilize the cavity may obviously be extended to high speed marine propellers to eliminate destructive cavitation. Therefore, it is to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A supercavitating hydrofoil comprising a main body having:
- a sharp leading edge,
- a blunt trailing edge, and
- a spanwise sharp-edged slot formed in the low pressure surface to define a line of detachment of the cavity.

2. The hydrofoil of claim **1** wherein said slot is of small depth and width relative to the hydrofoil chord.

3. The hydrofoil of claim **1** wherein the distance between said leading edge and said slot is a small percentage of the hydrofoil chord.

4. A supercavitating hydrofoil comprising a main body having:
- a sharp leading edge,
- a blunt trailing edge, and
- a spanwise sharp edged slot formed in the low pressure surface to define a line of detachment of the cavity, said slot being semi-circular in cross-section.

5. A supercavitating hydrofoil comprising a main body having:
- a sharp leading edge,
- a blunt trailing edge, and
- a spanwise sharp-edged slot formed in the low pressure surface to define a line of detachment of the cavity,
- the distance between said leading edge and slot being a small percentage of the hydrofoil chord, and
- the cross-section configuration of said slot being a semicircle of small radius relative to the hydrofoil chord.

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