June 23, 1964 J. MORGAN 3,138,130

BOAT HULL

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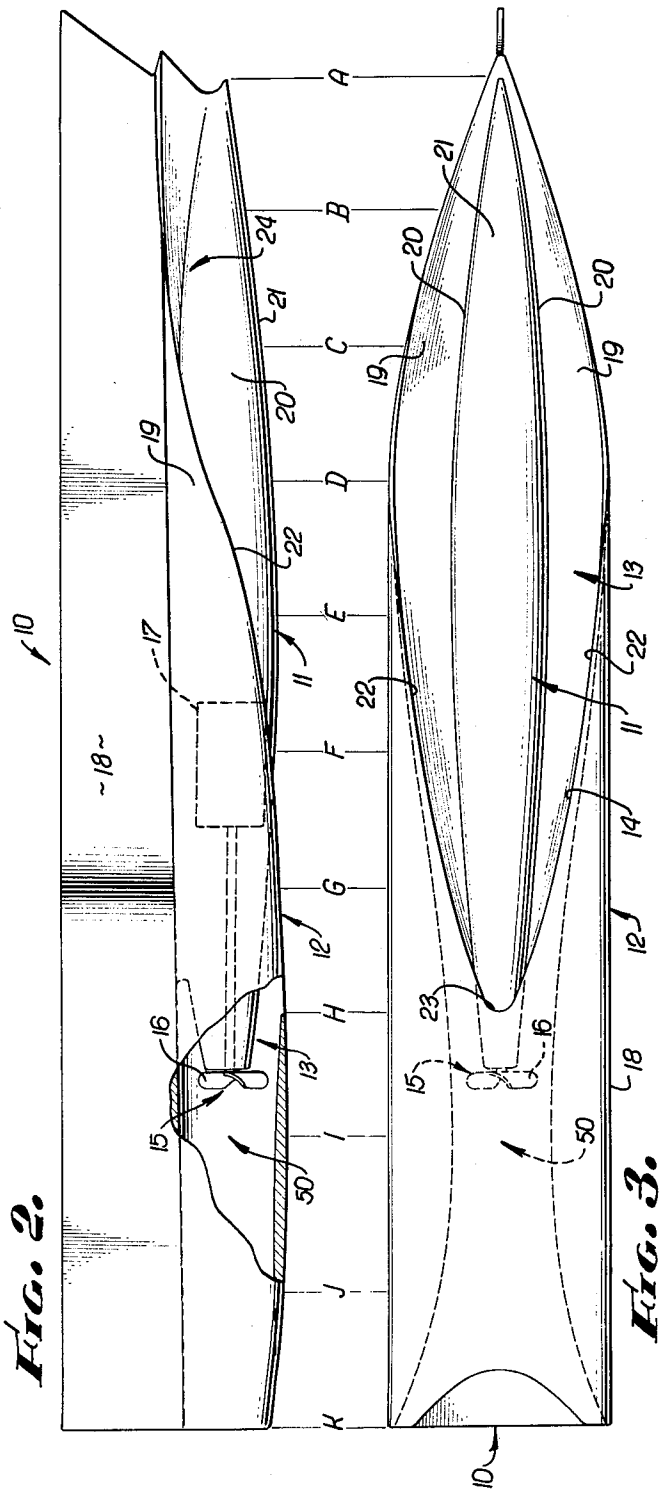


FIG. 2.

FIG. 3.

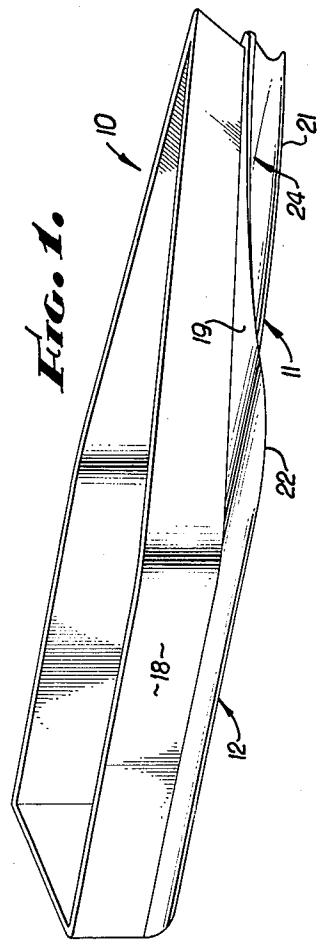


FIG. 1.

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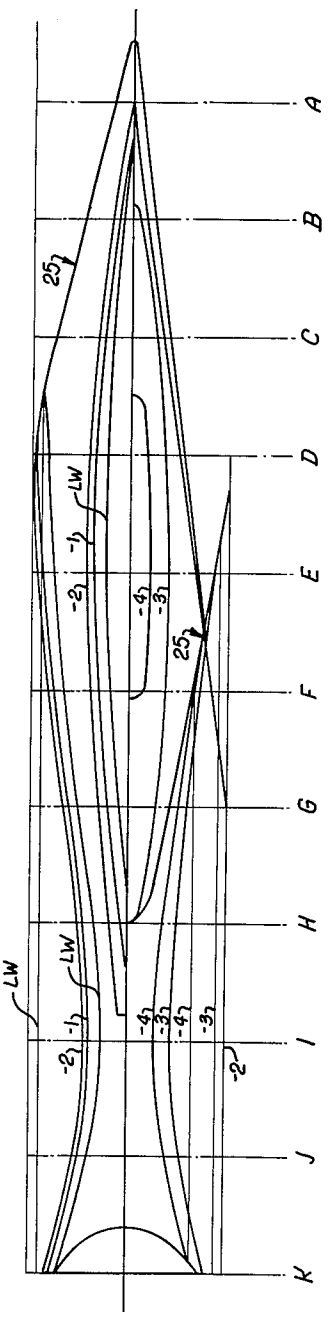


Fig. 4.

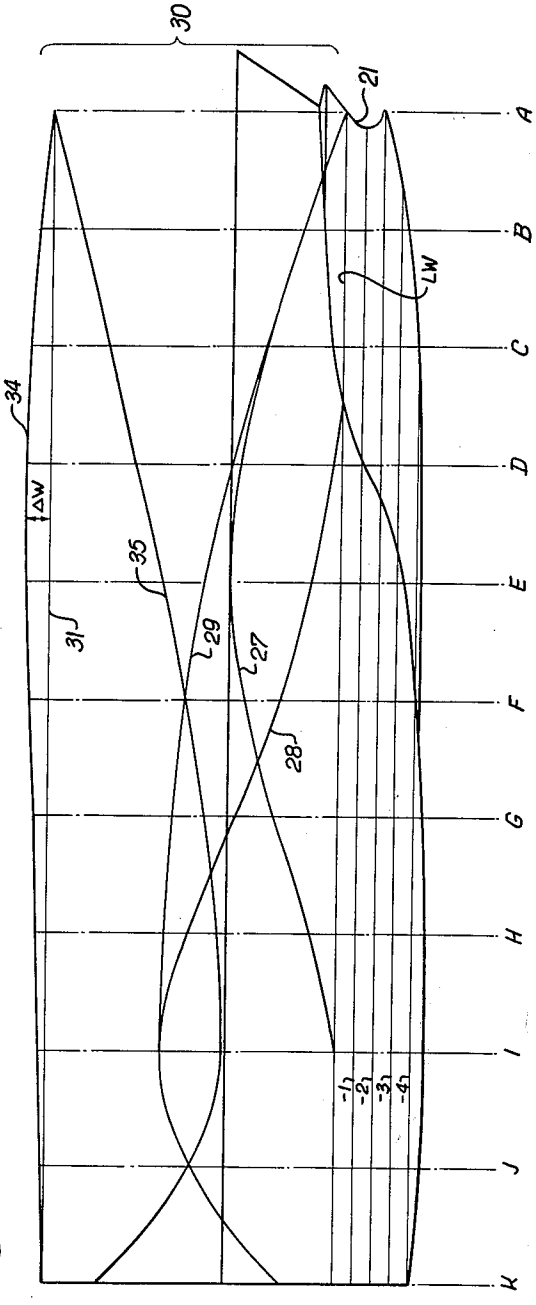


Fig. 5.

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FIG. 6.

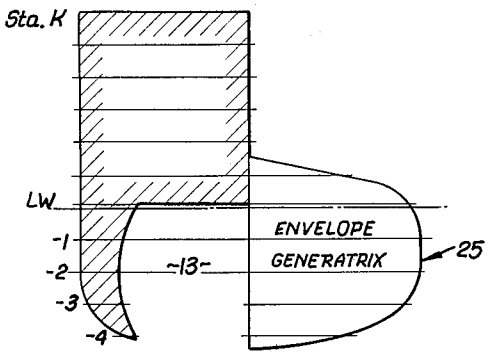


FIG. 7.

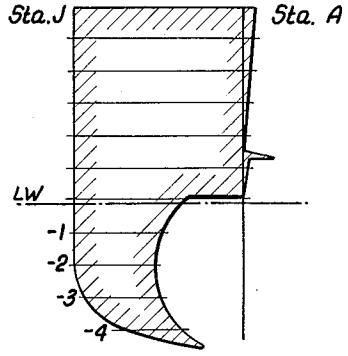


FIG. 8.

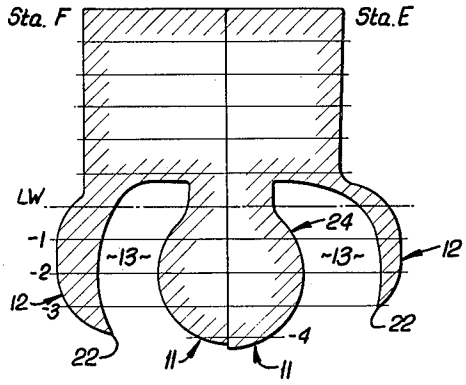


FIG. 9.

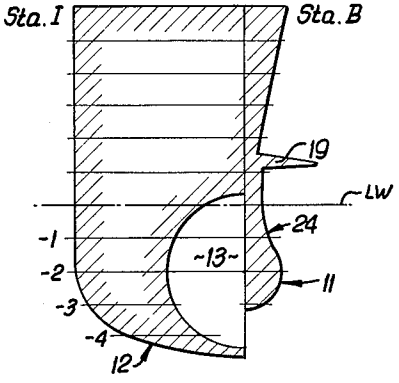


FIG. 10.

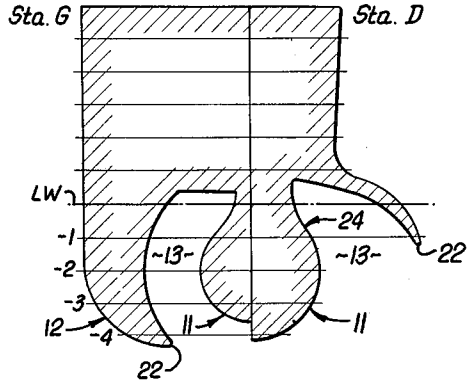
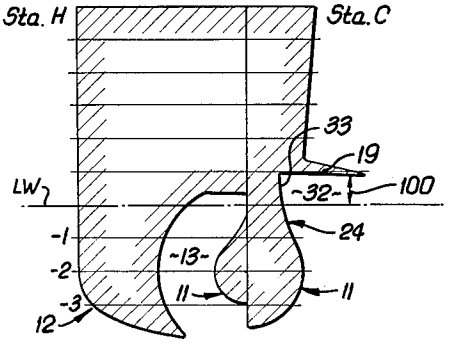


FIG. 11.



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BOAT HULL

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10 Claims. (Cl. 114—57)

This invention relates generally to the construction of ship hulls, and more particularly concerns improvements therein which result in greater surface craft speed, flatter resistance curve and no settling of the stern.

In general, surface craft to date have failed to utilize the energy that water must absorb when displaced by the fore part of the hull; and also have failed to prevent the stern from settling at the higher designed speeds. In nearly any type of hull, displacement of water starts ahead of the stem and continues till the displacement curve reaches its maximum.

In displacement hulls, while the displacement curve rises, a dynamic head is being created in the water forced away from the center line of the ship. This head is the result of power input. When not otherwise controlled, the constant atmospheric pressure on the water surface absorbs this power by offsetting the dynamic head by a reduction in static head, thereby creating a bow wave. This action not only absorbs the power put in; but also makes the subsequent conditions of propulsion more difficult.

When the sign of the slope of the displacement curve changes, deceleration of surrounding water commences with attendant wide boundary layer of turbulence. The steeper the downward slope of the after part of the curve the greater the deceleration and the greater the possibility of "breakaway" or "separation," all of which, in conjunction with the propeller action, help cause the stern to settle; which again aggravates the above condition.

The present invention is directed to a novel hull construction which substantially overcomes the above mentioned as well as other problems associated with energy loss, by materially reducing the traveling bow and stern waves, inducing natural rearward hydrodynamic flow and preventing the stern from settling at the higher designed speeds. As broadly considered, an outer and inner hull construction is provided to form a cavity extending generally lengthwise of the ship and characterized in that a substantial portion and typically all of the water displaced, is already rearwardly accelerated when it enters the cavity for relative flow therein. As will be brought out, the cavity preferably tapers rearwardly from the mouth thereof to cause the flow to further accelerate rearwardly therein and to a propulsion zone located forward of the cavity throat wherein the velocity of flow is such that when multiplied by the area of the throat the product will be substantially the same as the ship's velocity multiplied by the submerged area of its maximum external section. Also, the cavity may be venturi-shaped whereby the flow leaving the propulsion zone is subjected to the diffuser action of the rearwardly diverging portions of the cavity to regain pressure head without substantial loss of energy.

Another object of the invention is to serve the purpose of least loss of bow wave energy through the provision of outer hull structure overhanging the bow sides of the inner hull to protect the accelerated flow of water displaced by the bow from atmospheric pressure prior to entering the cavity mouth. In this regard, the forward part of the inner hull desirably has what is known as tumblehome or outward convexity curving inwardly from below the load water line up to overhanging deck structure or sponson. The fluid pressure being minimum along the moving surface, the accelerated water tends to move up and rearwardly along the hull. This upwardly displaced water has a high dynamic head, so that if the latter, as well as the static head above the surrounding water surface are

to be maintained at subatmospheric pressure, the latter should desirably, in effect, be excluded. In order to accomplish this, the deck structure must overhang to allow the atmospheric pressure to aid the rearward acceleration by acting only on the outer or lateral side of the accelerated stream, proper design maintaining this elevated flow until it becomes encapsulated by the entering edge of the outer hull, which desirably comprises a continuation of the edge of the overhanging deck structure. Accordingly the bow wave is substantially eliminated and the energy of the rearward flow in part maintained by the differential between surrounding standard conditions and the high velocity flow in the cavity. The entering edge, being a closed curve on the surface defined by a generatrix moving parallel to the center line of the vessel, causes no acceleration of water other than by shearing action. When this entering edge advances rapidly, substantially no pressure effect can be transmitted from the high velocity stream in the cavity to the undisturbed water outside the envelope. Accordingly, in a near perfect design, the water velocity at the entering edge relative to still water should be zero.

In order to achieve the desired initial acceleration of water around the inner hull as described, the rate and direction of displacement should be controlled, in accordance with the invention. In this regard, the inner hull has lengthwise defined shape characterized by a smooth displacement curve which increases and then decreases in a rearward direction between the bow and the said cavity throat. The displacement at any point on this curve is defined by the cross-sectional area of the inner static submerged section taken in a plane normal to the ship's axis and erected as an ordinate at a corresponding point along the load waterline. Also, the outer hull which further augments the velocity of flow in the cavity has a lengthwise shape characterized by a smooth displacement curve starting where the entering edge crosses the load waterline, referred to as LW, and increasing to a maximum in a rearward direction at the cavity throat, the curve then decreasing rearwardly of said throat. Finally the inner and outer hulls together have a shape characterized by a smooth displacement curve which increases to a maximum in a rearward direction between the bow and the cavity throat, the curve then decreasing rearwardly of that zone.

These and other objects and advantages of the invention, as well as the details of an illustrative embodiment, will be more fully understood from the following detailed description of the drawings, in which:

FIG. 1 is a perspective showing of a boat or ship incorporating the invention;

FIG. 2 is a side elevation, partly broken away, showing the FIG. 1 boat;

FIG. 3 is a bottom plan view of the FIG. 1 boat;

FIG. 4 is a plot of different waterline planes passed through the inner and outer hulls;

FIG. 5 is a plot of the displacement curves of the inner and outer hulls taken individually and collectively, and also of the decreasing sectional areas of the accelerated water in the cavity from bow to the cavity throat; and

FIGS. 6 through 11 show sections taken at stations A through K shown in FIGS. 4 and 5.

Referring first to FIGS. 1 through 3, the ship **10** includes an inner and outer hull construction generally indicated at **11** and **12**, and forming a forwardly opening cavity generally indicated at **13** which extends lengthwise of the ship. As will appear in greater detail, the cavity is characterized in its shape and function in that a substantial portion of the water displaced by the ship enters the cavity for relative flow therein rearwardly of the ship. In this regard, the preferred form of cavity illustrated tapers generally rearwardly from the mouth **14**, whereby the flow entering the cavity accelerates rearwardly therein. The taper shown is such that the cavity is

generally venturi-shaped, a propulsion zone being located generally at 15 somewhat forward of the cavity throat 50. One means of propulsion is illustrated as provided by a propeller 16 within the propulsion zone 15 and driven by suitable drive mechanism 17 contained within the hull 11 it being understood that the drive 17 may be located elsewhere. Super structure shown at a sufficient distance from the entering edge as to have no material bearing on the relative motion of hull and water is generally indicated at 18 as being carried by the inner hull, outer hull and deck.

The outer hull is shown to include structure generally indicated at 19 which overhangs the sides 20 of the bow 21, thereby to guide rearwardly the flow of water displaced by the bow beneath such structure 19 for entrance into the cavity through generally oval mouth 14. Such structure 19 may be considered to comprise a deck or sponson, and it has a leading or forward edge 22 on the generated surface of a somewhat cylindrical envelope, the axis of which is generally parallel to the center line of the ship. This entering edge 22 appears in the bottom plan view of FIG. 3 to have an oval shape between the bow and the rearwardmost portion 23 of the mouth 14. Since the entering edge considered in vertical elevation normal to the ship's axis, is on a closed curve on the surface of the generally cylindrical envelope, it causes no acceleration of water other than by shear action. Accordingly, if the entering edge advanes rapidly, substantially no pressure effect can be transmitted from the high velocity stream flowing relatively into the cavity, to the undisturbed water outside the entering edge.

In regard to the above, the forward part of the inner hull has tumblehome or sections curving inwardly from below the load water line up to the overhanging deck or sponson 19, the tumblehome designated generally at 24. The fluid pressure being minimum along the moving surface, the water accelerated by the bow tends to move up and leftwardly along the hull, and specifically along the tumblehome. This upwardly displaced water has a high dynamic head and if such head, as well as the static head above the surrounding water surface, are to be maintained, the atmospheric pressure should be substantially excluded. The overhanging deck structure 19 accomplishes such exclusion, whereby atmospheric pressure acts primarily on the outer side or face of the accelerated stream. Proper design maintains this elevated flow until it becomes encapsulated by the entering edge 22 of the outer hull, which is a continuation of the edge of the sponson deck structure. Accordingly, the bow wave is substantially eliminated and the energy of the displaced water partially retrieved.

Referring now to FIGS. 6 through 11, these show the inner and outer hulls at different stations along the ship length. They also show the load water line location indicated by the letters LW, as well as other waterline planes below the LW plane whereby the plan views of the inner and outer hulls are determined. These are plotted in FIG. 4, which more specifically relates the locations of the inner sections at stations I and E shown in FIGS. 9 and 8. Further in regard to FIGS. 6 through 11, each of these is split by a center vertical line into a pair of half sections, further identified by the capital letters corresponding to the stations taken along the ship's hull. FIG. 6 shows the fixed generatrix line 25 on which all points of the entering edge 22 lie when longitudinally projected into the plane of line 25 in FIG. 6.

FIG. 5 relates the shapes of the inner and outer hulls to displacement curves. The latter are drawn by taking the submerged areas of the sections at stations A through K, and plotting them as ordinates on the load water line LW as a base or abscissa. Line 27 indicates the displacement curve which characterizes the inner hull bulk distribution. This curve increases and then decreases in a rearward direction between the bow 21 and the cavity throat 50.

Curve 28 characterizes the shape of the outer hull, and increases to a maximum in a rearward direction between the intersection of entering edge and LW plane between stations C and D, and the cavity throat. The curve then decreases rearwardly of station I in conformance with the diffuser or diverging shape of the cavity rearward of the venturi throat 50. Curve 29 characterizes the sum of the displacements of the inner and outer hull sections submerged below the line LW. This curve increases rearwardly of the bow to a maximum at the station I and then decreases to section K.

Curve 35 represents the decreasing areas of section of the accelerated water. This curve is constructed by plotting the submerged area of the envelope section defined by generatrix 25 as an ordinate 30, and drawing a line 31 parallel to the load waterline. The product of the thus defined ordinate and the load water line length between station A and K represents the volume of water under consideration. However, due to the design of the inner hull, some dynamically displaced water is raised above the surrounding level defined by the load waterline, and it is therefore necessary to add this dynamically displaced volume to that represented by the rectangle defined by ordinate 30 and horizontal line 31. For example, this dynamically displaced water is represented in section by the numeral 32 at the station C in FIG. 11, and is bounded by the static water level line LW, the inner hull region 33, the overhanging deck 19 and the vertical 100 representing the surface of water supported by the atmospheric pressure. The areas of such sections are added as ordinates above the line 31 in FIG. 5, and the smooth curve 34 is drawn through these added ordinates ΔW. The difference in ordinate height as between curve 34 and curve 29 is shown by curve 35 and represents approximately the diminishing areas of the cavity sections through which the constantly accelerating water passes to the cavity throat since these areas are inversely proportional to the velocity of the accelerated flow.

The inner hull may be extended aft so as to terminate near the aft termination of the outer hull, in which event the cavity between the two hulls may be considered to include two non-merging cavity sections at opposite sides of the inner hull. This construction may, for example, be used where jet propulsion is substituted for propeller propulsion.

I claim:

1. In a ship, means including an inner and outer hull construction for enveloping the water displaced and accelerated by the forwardly traveling inner hull and for maintaining said accelerated water generally out of equilibrium with the atmosphere-water interface along said inner hull, said means forming a forwardly opening cavity extending generally lengthwise of the ship and characterized in that at design speeds substantially all of the water displaced by the bow of the inner hull as a created wave enters the cavity for relative flow therein rearwardly of the ship, the outer hull including rearwardly flaring sponson structure overhanging the bowsides of the inner hull above the load waterline level, the outer hull having forward edges continuing rearwardly and downwardly relative to the sponson structure at opposite sides of the inner hull and then continuing rearwardly and inwardly toward one another beneath the inner hull, said edges extending closely proximate a generally cylindrical envelope parallel to the lengthwise extending center line of the ship.

2. In a ship, means including an inner and outer hull construction for enveloping the water displaced and accelerated by the forwardly traveling inner hull and for maintaining said accelerated water out of equilibrium with the atmosphere-water interface along said inner hull, said means forming a forwardly opening cavity extending generally lengthwise of the ship along its major length and characterized in that at design speeds substantially all of the water displaced by the bow of the inner hull as

a created wave enters the cavity for relative flow therein rearwardly of the ship, the cavity tapering generally rearwardly of the cavity forward mouth creating a pressure decrease whereby the flow entering the cavity accelerates rearwardly therein at sub-atmospheric pressure, the forward edge of the outer hull being spaced from the inner hull so that substantially no pressure effect is transmitted to the undisturbed water outside said edge and in response to said flow into the cavity, the outer hull including rearwardly flaring sponson structure overhanging the bowsides of the inner hull above the load waterline level, the outer hull having forward edges continuing rearwardly and downwardly relative to the sponson structure at opposite sides of the inner hull and then continuing rearwardly and inwardly toward one another beneath the inner hull, said edges extending closely proximate a generally cylindrical envelope parallel to the lengthwise extending center line of the ship.

3. In a ship, means including an inner and outer hull construction for enveloping the water displaced and accelerated by the forwardly traveling inner hull and for maintaining said accelerated water out of equilibrium with the atmosphere-water interface along said inner hull, said means forming a generally venturi-shaped and forwardly opening cavity extending generally lengthwise of the ship along its major length and characterized in that at design speeds substantially all of the water displaced by the bow of the inner hull as a created wave enters the cavity for relative flow therein lengthwise of the ship, the cavity tapering generally rearwardly of the cavity forward mouth creating a pressure decrease and the ship including a propulsion zone forward of the cavity throat whereby the flow entering the cavity accelerates rearwardly therein at sub-atmospheric pressure and toward said propulsion zone, the forward edge of the outer hull being spaced from the inner hull so that substantially no pressure effect is transmitted to the undisturbed water outside said edge and in response to said flow into the cavity, the outer hull including rearwardly flaring sponson structure overhanging the bowsides of the inner hull above the load waterline level, the outer hull having forward edges continuing rearwardly and downwardly relative to the sponson structure at opposite sides of the inner hull and then continuing rearwardly and inwardly toward one another beneath the inner hull, said edges extending closely proximate a generally cylindrical envelope parallel to the lengthwise extending center line of the ship.

4. The invention as defined in claim 3 in which the inner hull forms the ship's bow and has tumblehome beneath said overhanging structure.

5. The invention as defined in claim 3 in which the inner hull displacement curve increases and then decreases in a rearward direction between said bow and said cavity throat, the displacement at any point on said curve being defined by the cross sectional area of the submerged portion of the inner hull section taken in a plane normal to the ship's axis and at a corresponding point along the load waterline.

6. The invention as defined in claim 3 in which the outer hull displacement curve increases to a maximum in a rearward direction between the intersection of said overhang structure with the load waterline and said cavity throat, and then decreases rearwardly of said throat, the displacement at any point on said curve being defined by the cross sectional area of the static submerged outer hull section taken in a plane normal to the ship's axis and at a corresponding point along said load waterline.

7. The invention as defined in claim 3 in which the inner and outer hulls have a combined displacement curve which increases to a maximum in a rearward direction between the bow and said cavity throat, and then decreases rearwardly of said throat, the displacement at any point on said curve being defined by the sum of the cross sectional areas of the inner and outer hull sections below the load waterline and taken in a plane normal to the ship's axis and at a corresponding point along said load waterline.

8. The invention as defined in claim 3 in which the outer hull houses said propulsion zone, and including propelling means in said zone.

9. The invention as defined in claim 8 including means carried by said inner hull for driving said propelling means.

10. The invention as defined in claim 8 in which the cavity portion rearward of said throat is formed by said outer hull and comprises a diffuser for the flow therethrough.

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