United States Patent [19]

Lang

[11] **3,897,744**

[45] **Aug. 5, 1975**

[54] **HIGH SPEED SEMISUBMERGED SHIP WITH FOUR STRUTS**

[76] Inventor: **Thomas G. Lang,** 5354 Calle Vista, San Diego, Calif. 92109

[22] Filed: **Mar. 27, 1972**

[21] Appl. No.: **238,681**

Related U.S. Application Data

[62] Division of Ser. No. 200,252, Nov. 18, 1971, which is a division of Ser. No. 20,204, March 17, 1970, Pat. No. 3,623,444.

[52] **U.S. Cl.** ..... **114/61;** 114/66.5 H

[51] **Int. Cl.²** **B63B 1/12**

[58] **Field of Search** ..... 114/61, 66.5 H, 126, 152, 114/43.5, .5 D, 16 F

[56] **References Cited**

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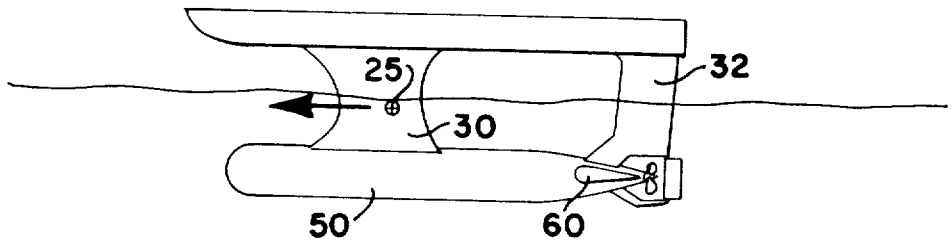
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Primary Examiner—Trygve M. Blix
Assistant Examiner—Stuart M. Goldstein
Attorney, Agent, or Firm—Richard S. Sciascia; Ervin F. Johnston; Thomas Glenn Keough

[57] **ABSTRACT**

A high speed ship is formed of at least one elongate hull section submerged completely beneath the water's surface supporting a platform above the surface waves by a plurality of struts dependent from the platform to provide support and stabilization by reason of their configuration and location. High speed dynamic pitch stability is ensured by including a stabilizer member on the aft portion of the submerged hull having a horizontally oriented control surface sufficiently sized to locate the greatest composite, vertical pressure surface substantially aft of the ship's centroid. Controlling the angle of the stabilizer member in accordance with changing wave conditions and speed provides a highly stable cargo transport capability as well as a superior weapons platform.

1 Claim, 36 Drawing Figures



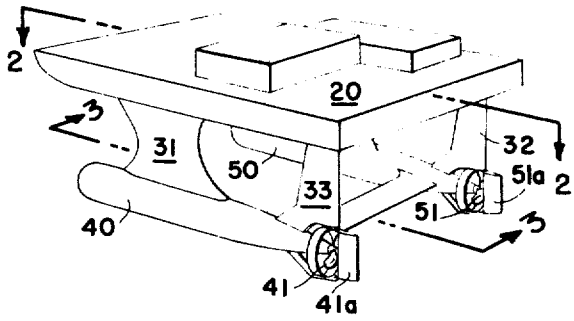


FIG. 1

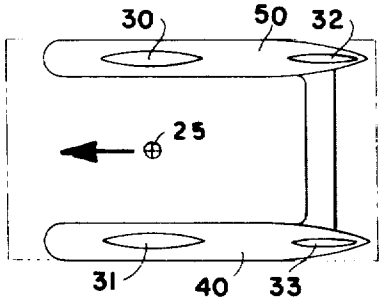


FIG. 2a

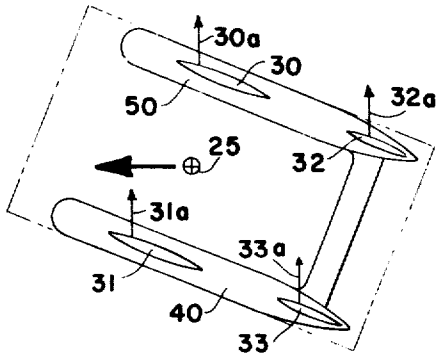


FIG. 2b

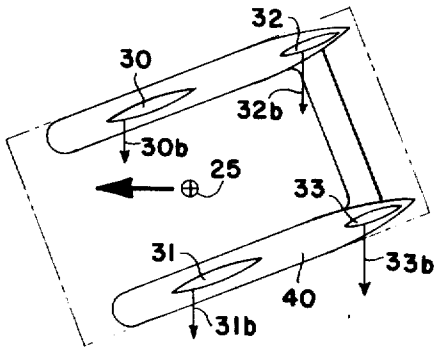


FIG. 2c

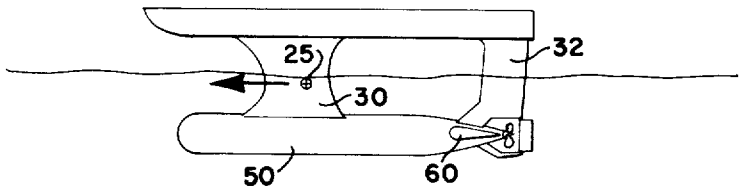


FIG. 3a

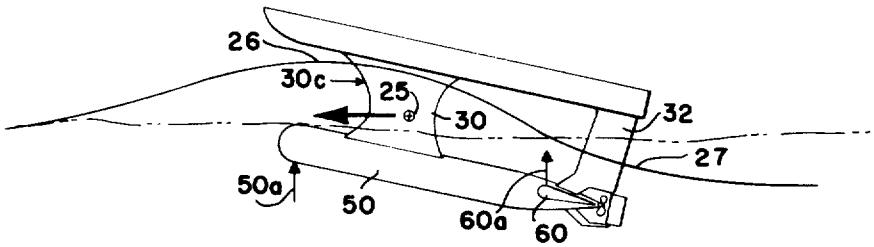


FIG. 3b

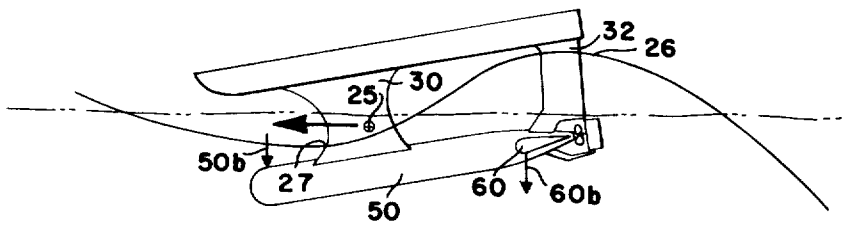


FIG. 3c

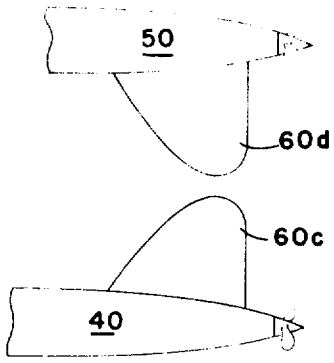


FIG. 4a

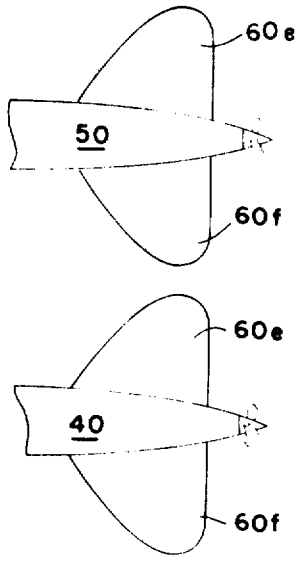


FIG. 4b

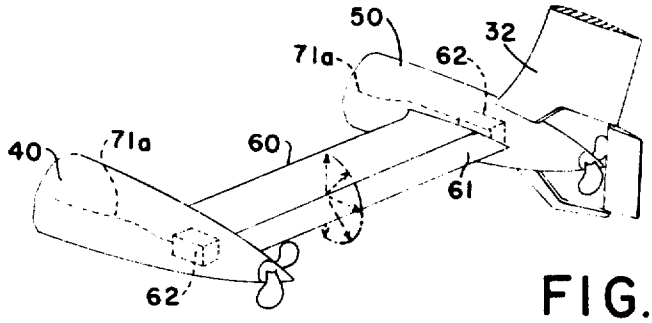


FIG. 5a

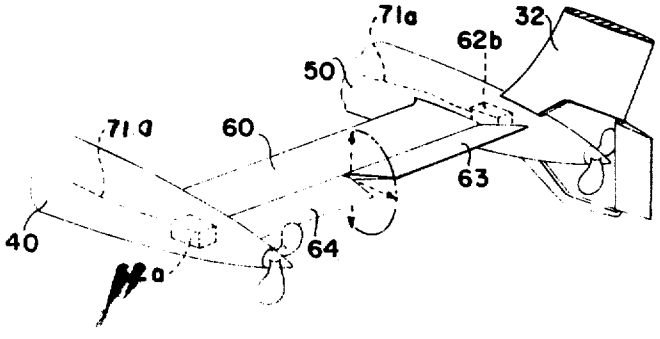


FIG. 5b

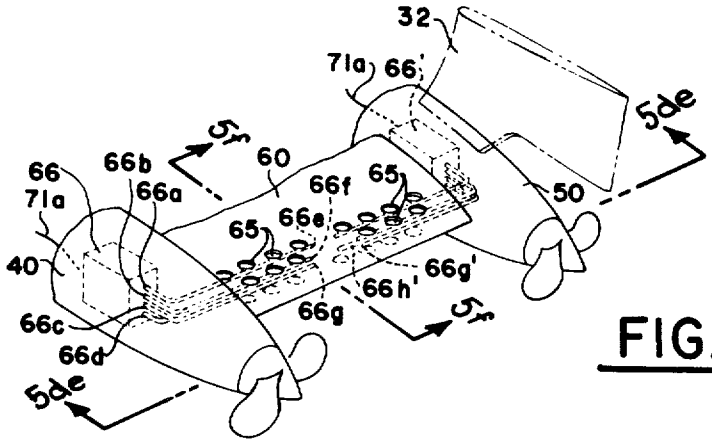


FIG. 5c

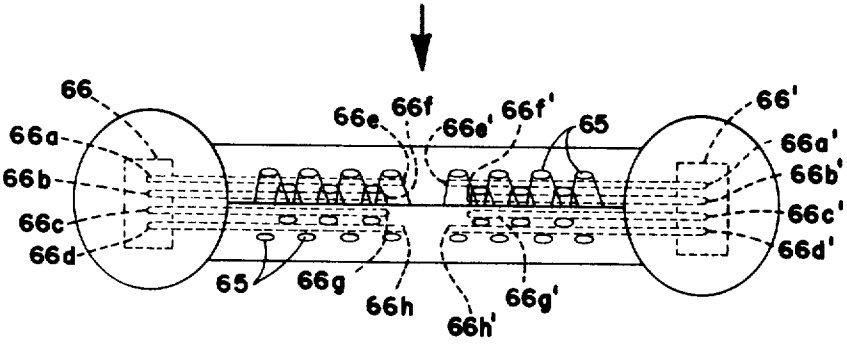


FIG. 5d

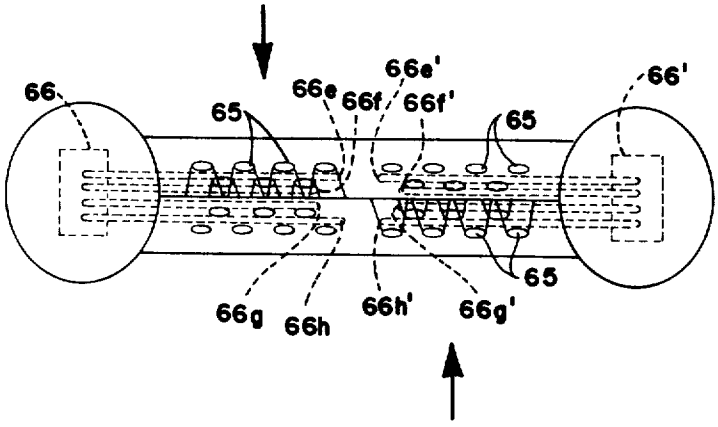


FIG. 5e

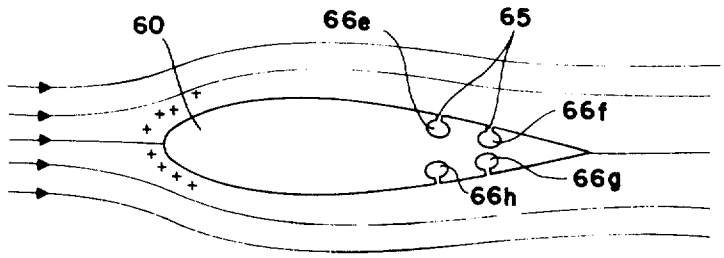


FIG. 5f

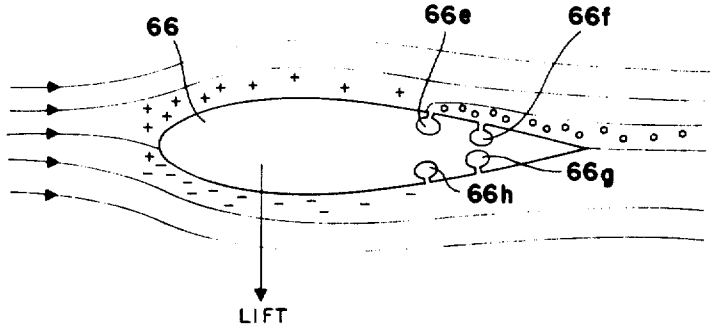


FIG. 5f'

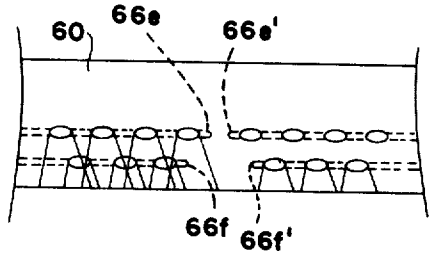


FIG. 5g

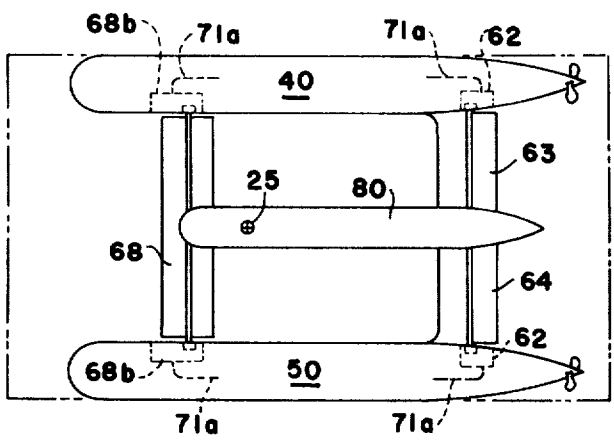


FIG. 6

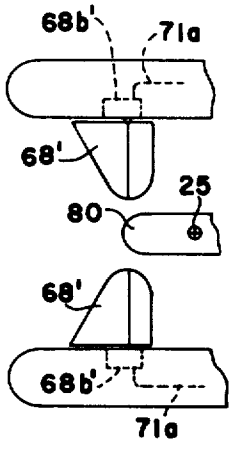


FIG. 6a

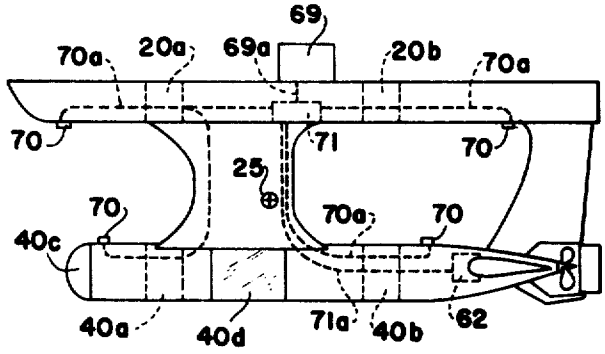


FIG. 7

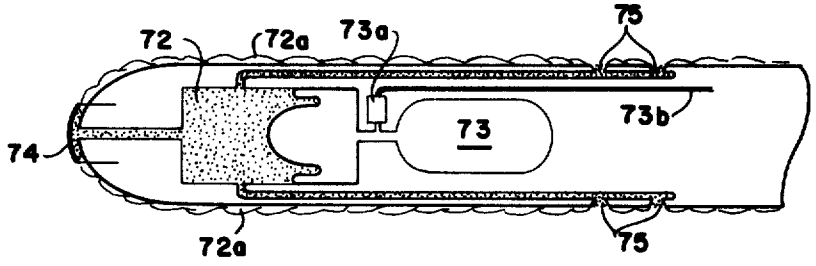


FIG. 8

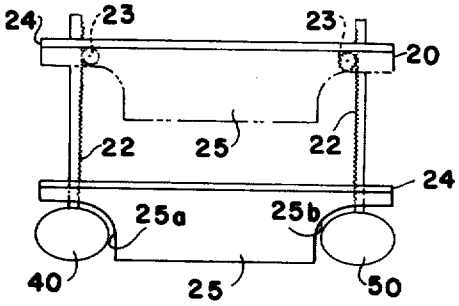


FIG. 9

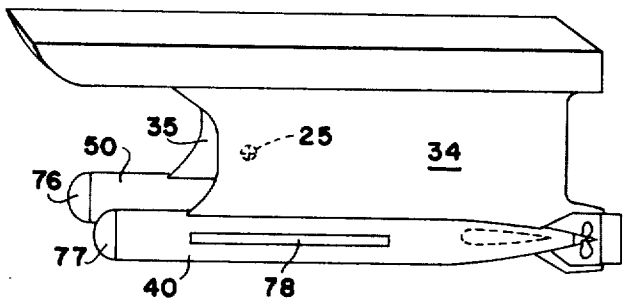


FIG. 10

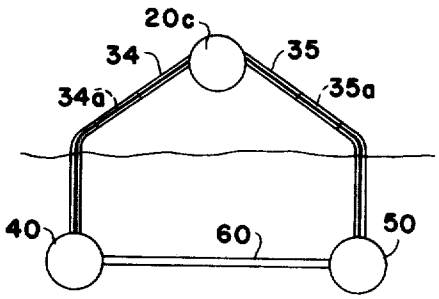


FIG. 11

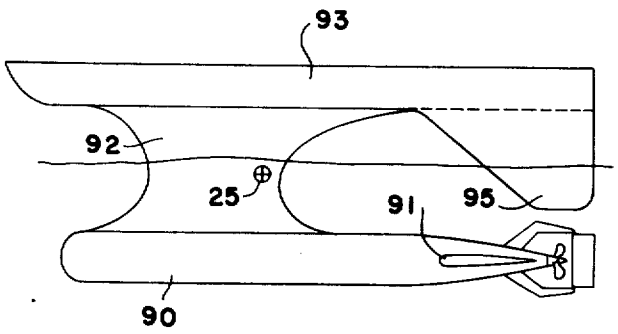


FIG. 12

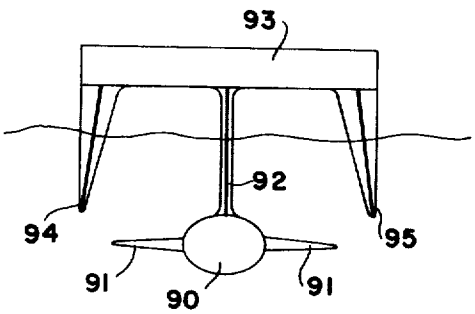
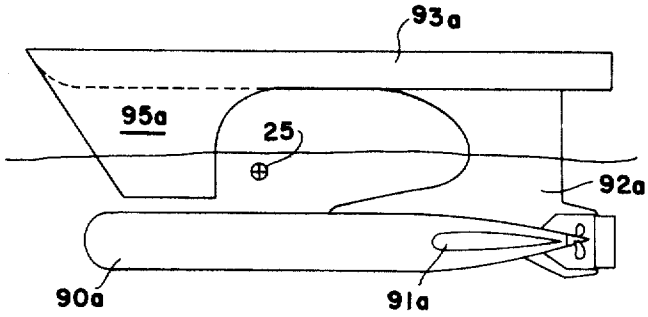


FIG. 13

FIG. 14



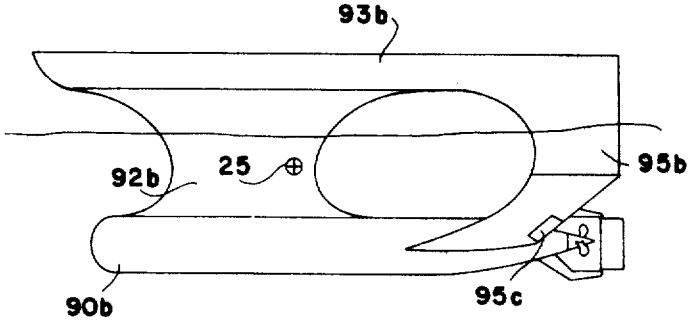


FIG. 15

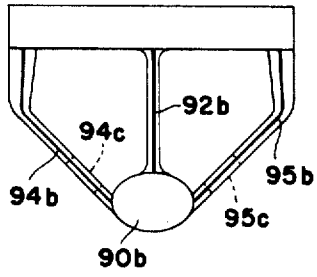


FIG. 16

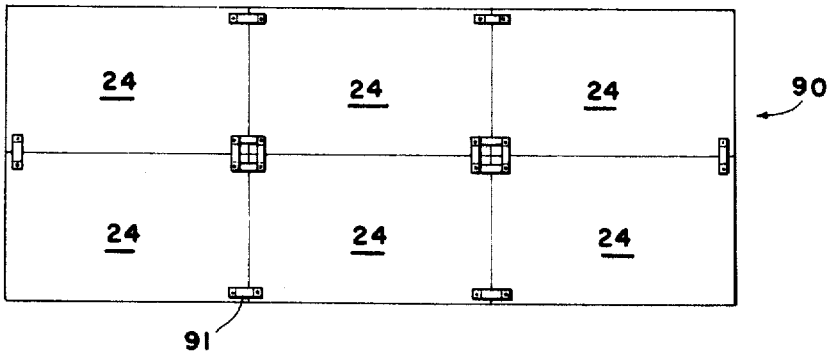


FIG. 17

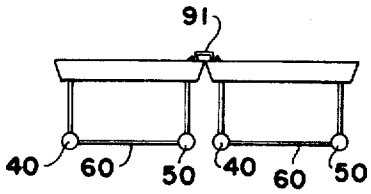


FIG. 18

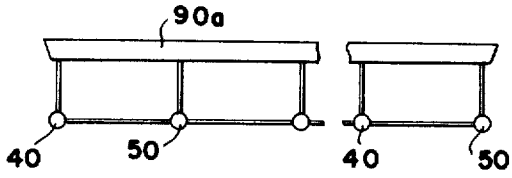


FIG. 18a

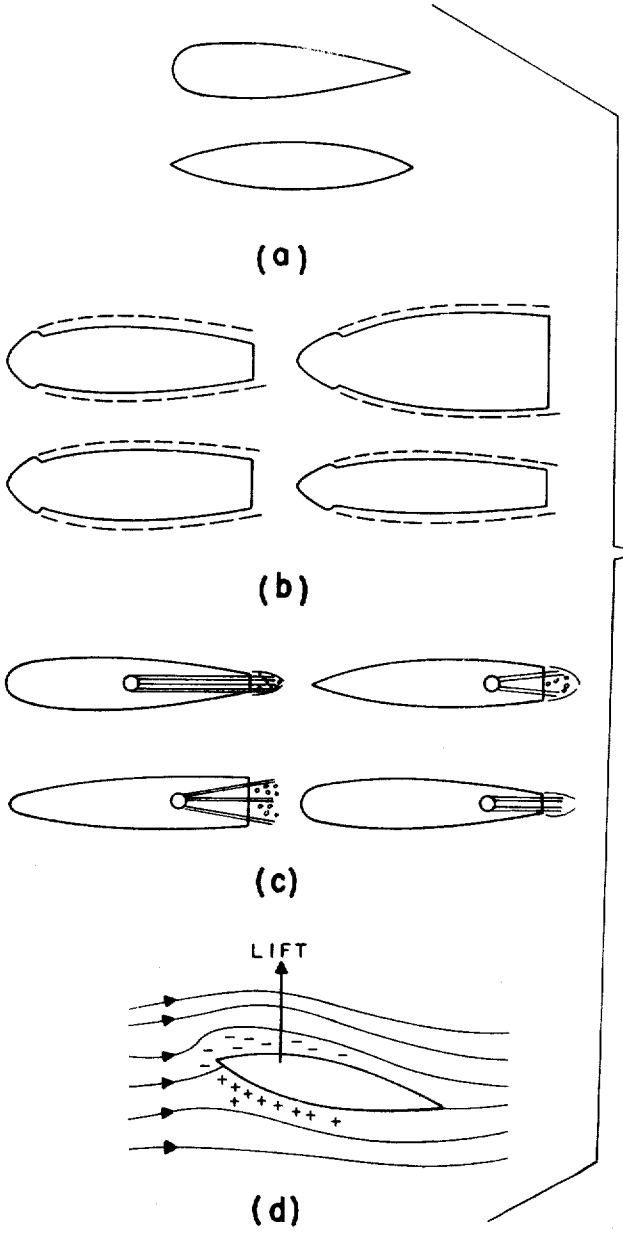


FIG. 19

HIGH SPEED SEMISUBMERGED SHIP WITH FOUR STRUTS

This is a division, of application Ser. No. **200,252,** filed Nov. **18, 1971** of Thomas G. Lang for "High Speed Ship with Submerged Hull" which was a copending divisional of Ser. No. **20,204,** filed **3-17-70** now issued U.S. Pat. No. **3,623,444** issued Nov. **30, 1971** of Thomas G. Lang for "High Speed Ship with Submerged Hulls."

STATEMENT OF GOVERNMENT INTEREST

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.

BACKGROUND OF THE INVENTION

In relatively calm seas, conventionally designed ships attain a rate of speed satisfactory for most requirements. As higher speeds are called for, wave drag and water surface drag impose maximum speed limitations. As the sea state varies, or more precisely, as increased wave activity is encountered, speed and stability of surface ships fall off markedly due to their inherent pitch, heave, and roll tendencies. One well known way of avoiding wave drag to achieve higher speeds is to construct a submarine configured ship having a large sized hull portion disposed beneath the surface of the waves with some sort of a control tower extending above the water's surface. Another approach for increasing speed by limiting water surface drag is to employ a pair of shallow draft, semisubmerged hull portions in a catamaran-like fashion supporting a platform above the surface of the water. While, in part, these designs have been successful, they have not eliminated the major speed and stability reducing limitations, that is, at high speed under adverse sea conditions, dynamic pitch, heave, yaw, and roll motions are not checked by the aforementioned designs. One attempt at damping these objected-to motions combines the previous teachings by separating a pair of submerged hulls, catamaran-like fashion, by a rectangular cross-member extending between the submerged hulls their entire length. However, as is readily apparent, the effect of such a manner of construction is to magnify pitching and heaving motions at high speeds in high sea states since the aggregate of the total, vertically reacting, stabilizing control surfaces, provided by the cross-member, is forward, or at best, at the ship's centroid. To elaborate, wave action causing upward or downward pressures ahead of, or near to, the centroid magnifies pitch and heave. Another endeavor to achieve high speed stability modifies a single, bulbous submerged hull with a pair of dihedrally oriented struts supporting a control room above the surface of the water and with a pair of nominally sized fins carried on the rear of the hull. Although the mall fins provide a marginal vertically reacting stabilizing surface, the aggregate of the vertically reacting control surfaces is substantially at the centroid of the vessel and high speed dynamic pitch, roll, and, in particular, yaw remain an obstacle to acceptable performance. The state-of-the-art does not ensure the markedly improved dynamic stability achieved by including a large horizontally oriented stabilizer on the aftmost extension of submerged hull portions, hydrodynamically functioning in much the same manner as do the vanes or feathers which aerodynamically stabilize the flight of an arrow.

SUMMARY OF THE INVENTION

The present invention is directed to providing a high speed marine vessel having improved static and dynamic stability including a platform member and an elongate, submerged buoying means interconnected by at least two water surface piercing strut members. The strut members are disposed with sufficient lateral spacing to ensure partial stability and with a sufficient longitudinal reach to provide additional stability and are configured in accordance with basic hydrodynamic design considerations. Mounted on the elongate buoying means, a horizontally oriented stabilizer sized to ensure the location of the greatest vertically reacting control surface aft of the centroid of the vessel, greatly increases the stability of the marine vessel irrespective of the relative speed or surrounding sea state.

Therefore, it is the prime object of the invention to provide a marine vessel having superior dynamic stability over wide ranges of speed under adverse sea states.

Yet another object is to provide a horizontally disposed stabilizer sized and positioned to ensure the location of the vertically reacting stabilizing surface substantially aft of the vessel's centroid.

A further object of the invention is to provide a marine vessel having a submerged hull portion supporting a platform by struts configured to minimize surface wave reaction and to provide static pitch, heave, and roll stability.

Still another object is to provide a high speed ship having angularly controllable flaps sized and positioned to ensure improved dynamic pitch, heave, and roll stability.

Another object is to provide a semisubmerged high speed ship having submerged, selectively vented, horizontally disposed control surfaces to ensure immediate correction for pitch, roll, and have motions at high speeds under adverse sea states.

Another object is to provide a pair of elongate hulls sufficiently laterally separated beneath the surface of the water supporting a platform with a plurality of struts, all being configured for minimal hydrodynamic drag and maximum hydrodynamic stability and separated by a laterally extending stabilizer carried between the hull's aft portions for markedly increasing dynamic stability.

Another object is to provide a high speed ship having a high speed burst capability by including a system for ejecting drag reducing polymers in a complete layer over a buoying submerged hull.

Still another object is to provide a high speed ship having a hull portion disposed beneath the water surface including a plurality of ballasting chambers, upon the selective evacuation thereof, reducing the ship's draft to enable shallow water operation.

Still another object is to provide a high speed ship having means for raising and lowering a platform section to provide both a further reduced draft and a variable silhouette.

Another object is to provide a high speed ship configured to induce minimal hydrodynamic turbulence making the ship adaptable for use as a relatively silent sonar platform.

Yet another object is to provide a high speed vessel having the dynamic and static stability to ensure reliable delivery of ordnance.

An ultimate object of the instant invention is to provide a large stable platform having an aircraft accommodation capability formed from a plurality of the high speed ships.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric view of a preferred form of the invention in high speed, dynamic pitch, heave, and yaw stability.

FIG. 2*a* is a schematic top view taken along lines 2—2 in FIG. 1.

FIG. 2*b* is a schematic top view generally taken along lines 2—2 in FIG. 1 showing high speed yaw correction.

FIG. 2*c* is a schematic top view taken along lines 2—2 in FIG. 1 also showing yaw correction.

FIG. 3*a* is a schematic top view taken along lines 3—3 in FIG. 1.

FIG. 3*b* is a schematic view generally taken along lines 3—3 in FIG. 1 showing pitch correction.

FIG. 3*c* is a schematic, view taken along lines 3—3 in FIG. 1 also showing pitch correction.

FIG. 4*a* is a top depiction of a variation of the rearwardly disposed stabilizing means.

FIG. 4*b* is a top depiction of another variation of the stabilizing means.

FIG. 5*a* is an isometric view of a stabilizer means having a single variable single flap portion for imparting dynamic pitch correction.

FIG. 5*b* is an isometric view of a stabilizer means having an aileron capability for imparting dynamic pitch and roll correction.

FIG. 5*c* is an isometric depiction of a vented stabilizer means.

FIG. 5*d* is an end view of the stabilizer means taken generally along line 5*de*—5*de* in FIG. 5*c*, showing the creation of a vertically exerted, pitch stabilizing force.

FIG. 5*e* is an end view of the stabilizer means taken generally along line 5*de*—5*de* in FIG. 5*c* showing the creation of a counterclockwise exerted, roll stabilizing force.

FIG. 5*f* depicts uninterrupted water flow over a vented hydrofoil taken along line 5*f*—5*f* in FIG. 5*c*.

FIG. 5*f'* depicts creation of a downward lifting force over a vented hydrofoil taken along line 5*f*—5*f* in FIG. 5*c*.

FIG. 5*g* is a top view of the vented stabilizer.

FIG. 6 is a bottom view of a modified form of the invention additionally including a forwardly located lateral vane and a longitudinally extending storage pod.

FIG. 6*a* is a variation of the embodiment shown in FIG. 6 having a pair of delta-shaped vanes in place of a single forward vane.

FIG. 7 is a side view of the invention showing the longitudinal location of the ballasting chambers, water level sensors, and the viewing ports.

FIG. 8 is a cross-sectional view of a nose section of one of the submerged hulls schematically showing a polymer ejection system.

FIG. 9 is a front view schematically depicting an optionally included variable height platform.

FIG. 10 is an alternate form of the preferred embodiment.

FIG. 11 is a frontal view of a variation of the preferred embodiment of the invention showing a smaller platform supported by angularly disposed struts.

FIG. 12 is a side view of a variation of the invention having only a single, elongate hull.

FIG. 13 is a frontal view of the variation set forth in FIG. 12.

FIG. 14 is yet another variation having the supporting strut depending from the platform to the aftmost extension of the elongate hull.

FIG. 15 sets forth still another embodiment having a pair of dihedrally oriented aft struts.

FIG. 16 is a frontal view of the embodiment set forth in FIG. 15.

FIG. 17 is a top view of several marine vessels secured together to form a large stable platform.

FIG. 18 is a front view of the stable platform shown in FIG. 17.

FIG. 18*a* is a frontal view of a modified large stable platform.

FIGS. 19*a*, *b*, and *c* are typical types of hydrofoils employed in the construction of the invention to minimize drag and turbulence according to the overall design requirements of the vessel and the conditions expected to be encountered.

FIG. 19*d* depicts creation of a lifting force by a fully wetted hydrofoil.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Marine designers have long known that surface wave drag as well as high sea states severely limit the maximum speeds and stability of oceangoing vessels. Thus, a ship's efficiency, a scaler function of the product of displacement and maximum speed divided by the installed power, sharply falls off as surface wave drag is intensified by high sea states.

Realizing this, the current state-of-the-art shows semisubmerged ships that reduce, to some extent, a ship's surface wave drag and static reaction to increasing sea states by locating substantially all of the bulky, heavy machinery, fuel, supplies, etc. in a hull section beneath the surface of the water as far as practically possible since wave action caused by increasing sea states diminishes exponentially as the depth below the surface increases.

However, merely locating a bulky hull beneath the surface of the water does not, by itself, materially provide for increased dynamic stability, especially at high speeds in high sea states.

The configuration of the present invention ensures high speed stability by strategically locating hydrodynamically designed struts and stabilizers. In the preferred form depicted in FIG. 1, a pair of essentially tubular-shaped parallel submerged hulls **40** and **50** provide a buoying support for a platform hull **20** through four vertically extending struts **30, 31, 32,** and **33.**

Each of the hulls is formed in the shape of a torpedo and advantageously incorporates the advancements of this particular technology, for example, choice of the optimum width-to-length ratios, weight distributions, power plant requirements, etc. Hulls, having a circular cross-sectional area, are selected as being the most suitable since this shape best resists water pressure when the hulls are submerged several hull diameters below the surface, although other shapes are optionally used.

Individual propellers **41** or **51** are connected through a suitable transmission to individual power plants to provide the forward and reverse thrust for locomotion and a rudder member **41***a* or **51***a* is carried immediately aft each screw to ensure a responsive means for controlling the marine vessel's heading. In the alternative to having a massive transmission connected to each of the propellers, they are of a variable pitch type enabling bidirectional thrust. In either case, the blades are optionally streamlined blades, base-vented blades, or super-cavitating blades depending on the cruise, operational, and dash speeds desired. Although not shown in the drawings, a pair of counterrotating propellers is included in lieu of each single propeller, or a hydrojet propulsion nozzle is carried on the aftmost end of each hull for propulsion and steering purposes.

By mounting the rudders in line with the variable pitch propellers, the marine vessel has a selective **360°** vectored motion capability while substantially at rest and while. maintaining a pre-established heading. With such a capability, cargo and passenger transfer operations are facilitated as well as where a precise hovering control is required to negate drift attributed to ocean currents.

Platform **20,** depicted in FIG. **1,** has a typical commercial superstructure for storing materials or supplies and, because of its large flat area and inherent stability, includes a helo-landing pad. The platform is constructed with watertight bulkheads, this being especially desirable when modified for military applications to provide emergency flotation if the elongate hulls become damaged or ruptured. At this point, let it suffice to say that the platform is fabricated to provide crews quarters, storage holds, ordnance mountings, etc. in accordance with sound shipbuilding practices. Novel modifications of the platform will be pointed out later in the specification.

The supporting struts are in keeping with contemporary strength of materials and hydrodynamic design criteria while providing a minimal drag and noise producing turbulence. FIG. **19** sets forth three representative sets of hydrofoils which are used as guides in fabricating struts **30, 31, 32,** and **33** to minimize drag and noise-producing cavitation.

Cavitation is characterized by the formation of small cavities filled with water vapor which appear and collapse in the low pressure region of a hydrofoil surface. As cavitation increases, there is a corresponding increase in the number and degree of such undesirable noise characteristics such as noise, drag, surface pitting, reduction in the lift, and unsteady performance. Cavitation is avoided by reducing speed, in particular, but since a highly stable, high speed marine vessel is the desired end, cavitation with its attendant noise, unsteady performance, and drag must be eliminated or brought within tolerable limits by the proper choice of hydrofoils.

The hydrofoils in set **19***a* shows streamlined, fully wetted hydrofoils having excellent performance characteristics, such as freedom from noise and drag, at speeds up to the beginning of cavitation. However, cavitation begins at moderate speed when these foils are surrounded by a nominal pressure. Fully wetted hydrofoil sections are quite satisfactory on the lower portion of the struts when the water depth causes a considerable ambient pressure to contain cavitation tendencies at higher speeds.

Other types are superventilated hydrofoils, see set **19***b*. These hydrofoils operate with their surfaces entirely covered by a gas such as air or engine exhaust, except for their water-breaking nose portions. Having the strut sides covered by the gas cavity reduces drag.

Fur sustained performance at high speeds, a third type hydrofoil, a base-vented hydrofoil, see FIG. **19***c*, feeds gas from the atmosphere, or from a centrally disposed duct, through a plurality of trailing vent ports to create a steady gas envelope adjacent to the trailing surface. The overall effect is to create a steady cavity of noncondensing, noncollapsing gas in contact with its surface to eliminate drag and noise produced by otherwise cavitating hydrofoils. Thus, a routineer is free to choose a hydrofoil having only one cross-sectional configuration or a composite hydrofoil suitably stressed for the speed ranges expected and tolerable noise. Since cavitation is more prone to occur at shallow depth where there is less ambient presssure, a vertical strut which varies from a streamlined strut at the bottom to a base-vented or fully-vented strut at the top is a preferred form for very high speed ships.

While struts composed of the three types of hydrofoils referred to above are selected primarily as a weighted product of strength, speed, and noise considerations, they all experience substantially identical, composite forces when passing through water. No resultant lateral force is created when the velocity of the ambient water flow is equal on opposite sides and when the hydrofoil's angle of attack is parallel with the direction of water flow.

Rotating a fixed hydrofoil angularly to cut across the direction of water flow, schematically represented in FIG. **19** *d* by water flow arrows, creates a positive pressure area on the upstream side of the hydrofoil nose portion, shown as + signs, and further creates an area of lower pressure on the downstream side of the hydrofoil nose portion, indicated by the − signs. Hydrodynamic engineers have mathematically and empirically established that a rigidly held hydrofoil's center of pressure, under such flow conditions, is approximately one-quarter of the hydrofoil's length behind its leading edge. Therefore, the area of high pressure on the upstream side of the hydrofoil and the area of low pressure on the downstream side of the hydrofoil additively create a lifting force, represented by the large arrow LIFT in FIG. **19***d*, on the hydrofoil's center of pressure.

Thus, irrespective of the use of the hydrofoil, as a strut or as a stabilizer, laws of hydrodynamics dictate that substantially identical forces are created, the controlling factors being the velocity and the angle of impingement of the surrounding water.

Conventional ships as well as catamaran-type ships experience random forces which initiate yawing motions. These forces arise from wave and wind action as well as the water medium's reaction to the ship's propulsion plant.

A close examination of FIGS. **2***a*, 2*b*, and 2*c* shows how the strategically located struts eliminate yaw. By looking downward below the platform, the ship's centroid, or center of gravity, **25,** is located in the same lateral plane as are main supporting struts **30** and **31.**

In calm seas with no lateral forces applied, as the marine vessel travels at high speed in the direction indicated by the arrow in FIG. **2***a*, no clockwise or counterclockwise yawing motions about centroid **25** are experienced. Wave and water surface drag on the vertically

extending pressure surfaces, forming the lateral surfaces of struts **32** and **33**, produce equal and opposite, self-cancelling moments about the centroid and the ship's heading remains constant.

A possible yawing action, caused by wind and waves, imparts a greatly exaggerated clockwise rotation, shown in FIG. **2***b*. With the ship's direction of travel as indicated by the large arrow, the passage of the struts through the water differential pressures to be built up along the vertically extending pressure surfaces forming on the lateral sides of all the struts. Forces, created by the angularly impinging water, represented by subarrows struts **30***a* and **31***a* on **30** and **31** respectively, increase the clockwise yawing rotation. However, a yaw-correcting, counterclockwise moment is produced by forces exerted on the trailing struts **32** and **33**, schematically represented by subarrows **32***a* and **33***a*. The initial clockwise yawing motion, augmented by the clockwise moments produced by forces generally indicated at **30***a* and **31***a*, is overcome by the much greater counterclockwise moments produced by forces **32***a* and **33***a* acting on struts **32** and **33**. These latter forces, **32***a* and **33***a*, are transferred through a lever arm reaching from the struts to the centroid to create a yaw-correcting counterclockwise moment greatly in excess of the opposing torsional forces. Thus, the marine vessel automatically realigns itself on the direction of travel indicated by the large arrow.

In a similar manner, the marine vessel self-initiates the automatic correction of a counterclockwise yawing motion, shown greatly exaggerated in FIG. **2***c*. A counterclockwise torgue-producing force acts on struts **30** and **31**, noting subarrows **30***b* and **31***b*, and tends to increase counterclockwise yaw. Rapid realignment of the marine vessel to its arrow direction of travel results from additive clockwise moment-producing forces, generally indicated by the subarrows **32***b* and **33***b*, which rotate the ship in a clockwise direction. Because of the lengthy lever arm reaching between the centroid and vertical pressure responsive surfaces on struts **32** and **33** the yaw correcting forces in this case clockwise moments, quickly overwhelm the opposing moments to realign the vessel.

The rapid realignment of the marine vessel is owed to the strategic mounting of the vertical struts to locate the aggregate, rotation-imparting, horizontally exerted pressure surfaces aft of the marine vessel's centroid to ensure high speed dynamic yaw stability.

Inherent yaw correction is present in an alternate form of the preferred embodiment, depicted in FIG. **10**, having a single, longitudinally extending strut **34** or **35** extending from each hull to support the platform. Here again, the aggregate, vertically extending pressure surfaces, the sides of the struts **34** and **35**, are disposed to ensure the location of the aggregate, horizontally exerted pressure surfaces aft of the vessel's centroid **25***a*, noting that the leading edges are backward near the lateral projection of the vessel's centroid. Having a pair of struts joining each hull to the platform, as depicted in the FIG. **1** embodiment, allows better maneuverability than the FIG. **10** configuration since the forward struts act like a keel and undergo smaller angles of attack in turns which reduces drag and lessens the tendency to cavitate. Also, the smaller surface area cutting through the waves reduces wave and frictional drag, and reduces the vessel's wave response.

The lateral, cross-sectional schematic representation of the marine vessel of FIGS. **3***a*, **3***b*, and **3***c* gives insight into how the vessel's superior, high speed, dynamic pitch stability is achieved by a substantially horizontally oriented stablizer **60**. While the drawings show the stabilizer reaching between and somewhat forward of the aftmost end portions of the hulls, the stabilizer is optionally located at any longitudinal position behind the centroid **25**; however, the greatest stabilizing force is created when the stabilizer is carried between the aftmost end portions of the hulls.

The stabilizer, in its least sophisticated form, is a rigid member having an overall rectangular shape secured at opposite ends between the two parallel elongate hulls. The cross-sectional configuration of stabilizer **60**, optionally, is no more than a rectangularly-shaped vane, but preferably is one of the hydrofoils set forth in FIG. **19**. During operational speeds below that at which cavitation occurs, the fully wetted hydrofoils shown in FIG. **19***a* are best because of their low drag and low noise. When high speeds are anticipated, base-vented hydrofoils shown in FIG. **19***c* are employed to reduce drag and noise. Irrespective of the cross-sectional configuration, stabilizer **60** is fabricated to provide additional structural rigidity between the aftmose portions of the hulls and to effectively transmit upward and downward forces to stabilize the vessel's attitude.

In FIG. **3***a* a ship, traveling at a high rate of speed through a relatively calm sea, maintains a level attitude in accordance with predetermined ballasting and trimming with little or no rocking motions about the lateral projection of centroid **25**.

When the ship encounters high sea states, the vessel experiences pitching and heaving tendencies, shown greatly exaggerated in FIG. **3***b* for the purposes of explanation. The bow of the vessel is pitched upward and the stern is plunged downward by a bow-on, the combined motion defining a clockwise angular displacement generally about the centroid **25**. The crest **26** of the wave submerges a much greater portion of strut **30** and strut **31**, the latter not shown, producing a buoying, upward pitching force on the bow. The trough of the wave, indicated by reference character **27**, laterally contains the parallel rear struts **32** and **33**, **33** not being shown, and causes an additive clockwise dipping motion generally about centroid **25**. The clockwise motion is, in turn, augmented by another rotational force, generally shown as subarrows **30***c*, created as flowing water bears against strut **30** as it is being plowed deeper into wave crest **26**.

With the direction of travel generally indicated by the large arrow, a vertical heaving force additionally is created by water pressure exerted on the submerged hulls, schematically represented by subarrow **50***a*, as the vessel travels through the water. This heaving force, is a composite force substantially the same as the LIFT force shown in FIG. **19***d*, having a first component generally attributed to a positive upward pushing force exerted by the water on the lower half of the rounded nose section of each hull. The other component is attributed to a lifting force produced as the water flow velocity is increased over the upper half of the rounded nose section of each hull creating an area of lower pressure, or a negative pulling force. Together, all the components impart a combined upwaard heaving motion and pitching motion.

Due to the unique configuration of the instant invention, the aforedescribed pitching and heaving motion normally experienced by, for that matter, any oceangoing vessel traveling at a high rate of speed through high sea states, is dampened and nullified by the reacting forces acting on substantially horizontally oriented stabilizer **60.**

As the vessel travels through the bow-on wave in the direction indicated by the large arrow, a vertical lifting force due to impinging water and indicated by subarrow **60***a* is generated on stabilizer **60,** to rotate the entire marine vessel generally about centroid **25** in a counterclockwise direction. Rotation in the counterclockwise direction relieves water flow pressure from the nose portions of the hulls to eliminate the upwardly heaving force and, simultaneously, the pitching motion of the vessel, its previous clockwise motion, is also negated.

In the opposite extreme, when the bow dips into a wave trough following a bow-on wave as depicted in FIG. **3***c* in a greatly exaggerated excursion, immediate compensation again begins by the rearwardly mounted stabilizer. The bow-dipping-pitching motion is augmented by water flow pressure, represented by subarrow **50***b*, pushing downward on both the hulls creating a sinking motion. Struts **30** and **31,** now being in trough **27** and aftstruts **32** and **33** being on crest **26** of the wave, generate a generally additive counterclockwise dipping, pitching motion about centroid **25.** Stabilizer **60** immediately rectifies the sinking and pitching tendencies of the vessel to ensure stable high speed operation by its reaction to downward force **60***b* produced as water flows over it. This downward force exerts a clockwise torque about centroid **25** that is much greater than the counterclockwise, pitch-producing forces, due to the fact that the force is transmitted about the centroid through the considerable longitudinal lever arm extending from the stabilizer to the centroid. Thus, correction for a simultaneous, bow-dipping, pitching motion and sinking motion immediately commences. When the vessel encounters following seas, the sequence depicted by FIGS. **3***b* and **3***c* is reversed but with substantially the same hydrodynamic stabilizing forces involved.

In conclusion, superior stability is ensured in dynamic yaw by the relative size and location of the vertically extending struts **30, 31, 32,** and **33,** and superior dynamic heaving and pitching stability is provided by a horizontally oriented stabilizer **60,** to respectively place the aggregate vertically oriented stabilizing surfaces and horizontally oriented stabilizing surfaces substantially aft of the vessel's centroid to function in much the same, if not identical, manner as do the vanes or feathers stabilize the trajectory of an arrow.

Static stability, freedom from pitching, heaving, and rolling motions while the vessel is at rest, is also optimized by the configuration and spatial orientation of struts and hulls with respect to the platform. The transverse spacing of the struts and their fore and aft reach are designed using conventional engineering formulae to provide static stability. Because of the hulls' considerable mass coupled with their being disposed more than one hull diameter beneath the surface of the water and separated a distance equal to several hull diameters, reaction to surface wave action is small when the vessel is at rest.

A slight tendency to pitch and roll is created by the waves buoying alternate ones of the struts. This tendency is reduced in the preferred embodiment, already described, by shaping the struts with cross-sectional areas in the form of one of the hydrofoils schematically represented in FIG. **19,** to present a low surface wave drag and to reduce the vessel's power-consuming wave making drag. The cross-sectional areas are designed to ensure static stability and structural rigidity yet displace a minimum volume of water to reduce unstabilizing buoying forces when the struts becomes more or less completely immersed in water with repeat of each other. Considering, therefore, the total volumes of all the struts piercing the water's surface and their relative lateral and longitudinal spacing, it is obvious that surface wave reactions are small when, for example, the volume of change in strut displacement due to fluctuating waves is small.

If slight pitching and rolling motions are created by the waves, the relatively broad horizontally projected surfaces of stabilizer **60** and hulls **40** and **50** inertially produces opposing, damping forces. Thus, having a large sized, rearwardly mounted stabilizer, in addition to ensuring superior dynamic stability, also helps to maintain static stability.

As alternates to the basic rectangular, horizontally oriented stabilizer **60,** FIG. **4***a* sets forth a pair of opposing delta-shaped stabilizing fins **60***c* and **60***d* mounted on either side of the aftmost extersions of each of the hulls, although these fins are optionally carried on the outside of the hulls extending in opposite directions. Still another modification of the stabilizer takes the form of pairs of diametrically opposed double deltas **60***e* and **60***f*, shown in FIG. **4***b*, carried on each of the hulls for increasing the stabilizer effect as well as permitting greater reliability due to redundancy of stabilizing surfaces.

One of the drawbacks of having a completely rigid stabilizer becomes apparent when it is noted that correction of the vesssel's attitude follows the vessel's becoming slightly off course; that is, with respect to dynamic pitching upward and downward motions, stabilizing forces exerted on the stabilizer result from the vessel's experiencing a pitching motion beforehand. It is obvious, therefore, that providing a means for anticipating, or immediately monitoring, wind and wave conditions to accelerate and augment the production of counteracting stabilizing forces by the stabilizer results in a more stable oceangoing vehicle.

Looking ahead to FIG. **7,** a means for anticipating ambient conditions takes to form of a source of command-control signals, schematically represented by a block **69** carried on the platform. The source is, for example, electrically switched representations of a helmeman's observations or attitude indications coming from a gyrostabilized navigational device fed to a command-control lead **69***a*.

If automatic sensor signals giving indications of ambient wave conditions are desired, sonar, radar, or light sensors **70** are mounted at longitudinal and lateral extremes of the hulls and platform to provide sensor signals representative of relative variations in the water's surface with respect to the location of the sensor. The sensor signals are fed from each of the sensors, via lines **70***a*, to a centrally located common command-sensor control center **71** to generate and couple appropriate

driving signals from the center to a drive-control lead 71*a*.

The common-sensor control center, responsive to either command-control signals or sensor signals, is, in its simplest form, a visual readout interpreted by an operator who, by electromechanical linkages, switches the proper driving signal to drive-control lead 71*a*. Although, there is a time lag between initiation of the command signals or sensor signals, and the transfer of the proper driving signal, such an arrangement is adequate to provide responsive control of a large marine vessel in moderate seas. However, well-known automatic computer-like devices or any of a number of servocontrols contemporarily widespread are preferably adaptable to deliver a responsive driving signal upon receipt of a discrete command or sensor signal. Due to the fact that these computer-like devices and servocontrols are universally known and employed, detailed examples are omitted in the specification for the sake of simplicity.

In FIG. 5*a*, improved control of the dynamic pitch, heave, and roll tendencies of the marine vessel is provided by modifying stabilizer **60** with a single, elongate flap portion **61** carried on its trailing edge. Two rotation-imparting mechanisms **62** are separately secured at opposite ends of the flap and are responsive to driving signals appearing on drive-control lead 71*a* to impart a representative angular displacement to the flap. In the alternative, stabilizer **60** and flap **61** are constructed as an integral unit with the shaft extending through and journaled in the rotation-imparting mechanisms **62** to be rotated as an entire unit to correct pitching motions.

A more preferred mechanism for controlling the dynamic pitch tendencies of the marine vessel while having a simultaneous capability for controlling the dynamic roll tendencies of the vessel calls for conventional fixed horizontally oriented stabilizer **60** having a pair of aligned aileron-like flaps **63** and **64**. These flaps are on the trailing edge of the stabilizer in a coplanar relationship and are individually controllable by a separate rotation imparting mechanism **62***a* or **62***b* see FIG. 5*b*.

When underway in bow-on or following seas, signals originating in source **69** or sensors **70** are passed through the leads **69***a* or **70***a* to center **71**. Appropriate driving signals are generated to actuate the independent rotation-imparting mechanisms **62***a* and **62***b*. The aileron-like flaps **63** and **64** are rotationally displaced, simultaneously, to function like an elevator (identical to the operation of flap **61**).

While turning, or when in beam or quartering seas, the vessel exhibits a tendency to roll in addition to experiencing pitching and heaving forces. Under these conditions, the aileron-like flaps are angularly displaced oppositely producing a counteracting banking rotational force since the laterally separated sensors **70**, or source **69**, pass signals to center **71**, to indicate that the ship is canted or the surface of the water is higher on one side than on the other.

In a beam sea, independent counteracting driving signals are fed to the rotation-imparting mechanisms and opposite angular displacements are imparted to the aileron-like flaps to maintain roll stability.

In a quartering sea, sensor output signals cause the generation of driving signals in the center driving the mechanisms to rotate the flaps in a simultaneous aileron and elevator fashion to stabilize the vessel with respect to the surrounding conditions.

During high speed operation, severe stresses are developed within mechanically rotatable flaps when immediate, violent dynamic pitol, heave, and roll compensations are demanded. In speeds over **35** knots, nonreinforced flaps and their rotation-imparting mechanisms are prone to fail, such failure possibly having disastrous results, especially in high seas. When the mechanically displaceable flaps are strengthened to withstand high speed operation, the weight and cost of bearings and suitable journaling mechanisms have been found to be prohibitive.

Thus, it is that a third structure of maintaining high speed dynamic stability in the instant marine vessel has been devised and is set forth in the stabilizer depicted in FIGS. 5*c*, 5*d*, 5*e*, 5*f*, 5*f'*, and 5*g*.

A low cost, highly reliable controllable stabilizer is provided including two lined columns of vents **65** disposed on the dorsal and ventral sides of the horizontally oriented stabilizer. One-half of each of the vent columns is joined by a common lateral passageway connecting them in groups in common fluid communication with each other. Noting in particular FIGS. 5*d* and 5*e*, lateral passageways **66***e*, and **66***f*, are each connected to one-half of a separate column of upwardly facing vents on the left side of the stabilizer, and passageways **66***g*, and **66***h* are connected to separate columns extending one-half the distance across the ventral side of the stabilizer. In a mirror image of the stabilizer's left side, the right side has passageways **66***e'* and **66***f'* linking columns of vents disposed on the stabilizer's upper surface and passageways **66***g'* and **66***h'* joining downwardly facing vents on the right hand of the stabilizer.

In each hull **40** or **50**, a source of pressurized gas **66** or **66'** is provided with outlet ducts **66***a*, 66*b*, 66*c*, and **66***d*, or **66***a'*, 66*b'*, 66*c'*, and **66***d'*, respectively, connected to feed matered volumes of pressurized gas to passageways **66***e*, 66*f*, 66*g*, and **66***h*, or **66***e'*, 66*f'*, 66*g'*, and **66***h'*. Each of the sources of pressurized gas is a conventional air compressor, bank of compressed gas bottles, or an equivalent potential source of gas cable or being immediately valved by a self-contained valving unit in substantial amounts to the dorsally and ventrally facing vents.

Upon receiving driving signals from center **71**, via driving control lead 71*a*, suitable volumes of pressurized gas are valved through selective ones of the outlet ducts to their interconnected discrete traverse passageways and pressurized gas flows through the vents creating a trailing cone of air as the high speed marine vessel passes through the water.

Observing the schematic representations of water flow around vented stabilizer **60** in FIGS. 5*f* and 5*f'*, 5*f* shows uniform water flow as long uninterrupted symmetrical flow arrows around the symmetrical stabilizer as it passes through water at high speed. Equal upward and downward pressure is exerted on the upper and lower sides of the forward edge of the stabilizer as schematically represented by the small +s.

However, when the driving signals valve pressurized gas through traverse passageways **66***e* and **66***f*, a trailing cone-shaped volume of pressurized gas **66***k* is extruded through the vents, over the upper trailing surface of the stabilizer. Formation of the gas cone causes disruption of the aforementioned uniform water flow

and it assumes essentially the shape of the flow arrows in FIG. 5*f'* creating a composite shown by downward force, the LIFT arrow. This composite force is mainly attributed to the area of low pressure, generally designated by the − signs on the stabilizer's leading lower edge and side, and the high pressure area, generally designed by the + signs disposed about the stabilizer's leading upper edge and side. Similarly, an overall upward LIFT force is created by valving gas through the ventrally facing vents.

Thus, when driving signals, indicating an attitude correction for pitching, are passed to both sources of pressurized gas **66** and **66'**, pressurized gas is valved through upper traverse passageways **66***e*, 66*f*, 66*e'*, and **66***f'*. A composite downward force is created, schematically represented by a large arrow in FIG. 5*d*, by the pressurized gas valve through all the dorsally facing vents.

On the other hand, if driving signals indicate that an immediate counterclockwise roll compensating force be provided by the stabilizer, then pressurized gas is selectively vented to the dorsally facing vents on the stabilizer's left side and the ventrally facing vents on the stabilizer's right side, noting that FIG. 5*e* shows the creation of a counterclockwise moment by passing pressurized gas through passageways **66***e* and **66***f*, and **66***g'* and **66***h'* to their fluidly communicating vents.

The vertically upward and vertically downward forces on the stabilizer are intensified when the entire trailing edge of the stabilizer is completely covered by an envelope of pressurized gas. However, a partial upward or downward force is selectively generated by venting only one of the two parallel columns of vents on either side of the stabilizer when a lesser force is needed to ensure stability.

Directing attention toward FIG. 5*g*, in which both dorsal columns of vents are passing pressurized gas on the left-hand side while only the trailing column of dorsal vents passes pressurized gas on the right side, reveals that a simultaneous, composite downward force is exerted on the entire length of the stabilizer while a partial counter-clockwise moment is created to enable simultaneous, compensating correction for a pitching motion and a rolling motion by the vented stabilizer.

As mentioned before, the advantage of having a stabilizer vented as opposed to including rotatable vanes resides in the fact that having no moving parts ensures inherent greater, higher reliability and immediate response. Thus, high speed maneuvering and attitude correction for a sustained period of time is provided when employing a vented stabilizer to allow a full-time operational capability for the superiorly designed marine vessel disclosed herein.

A marine vessel constructed in accordance with the above teachings with a displacement of **5,000** tons attains a speed of between **30** and **40** knots with conventional propellers and power plant. Higher speeds are reached by mounting gas turbines in the hulls driving sophisticated base-ventilated propellers or pumpjets for operation in sea states up to, and beyond, sea state **6.** At present, there is no other surface vessel of this size capable of smooth, continuous operation in such a high sea state; conventionally designed ships must reduce their speed to a few knots in such seas simply to survive.

Modifying the horizontally oriented stabilizer in accordance with the teachings of FIGS. 5*a*, 5*b*, and 5*c* *gives the marine vessel a capability to weather sea states producing waves greatly in excess of the vessel's* overall height. The typical **5,000** ton displacement marine vessel, referred to above, has supporting struts of **50** feet in length. It naturally follows that in seas having waves less than **50** feet from crest to trough, the vessel can maintain a level attitude by appropriately controlling the stabilizer. However, when the sea states increase to galelike proportions, the controllable stabilizer is best used not to hold the marine vessel in a relatively level attitude, but is controlled to allow the vessel to ride over huge waves which would otherwise swamp it. Riding over huge waves is optionally controlled from a helmsman feeding appropriate driving signals through driving leads **71***a* or by sensor signals originating from the plurality of sensors **70.**

Further control of the vessel's heaving tendencies is aided by mounting a forwardly located control vane **68,** see FIG. **6,** on a shaft **68***a* journaled at opposite ends in separate rotation-imparting, vane control mechanisms **68***b*. The vane control mechanism is controlled by driving signals, fed via leads **71***a* emanating from center **71** to angularly displace the control vane in a hydrodynamically cooperating relationship with horizontally oriented stabilizer **60.** The angular displacement of the vane is coordinated with the rotation of flaps **63** and **64** to provide the desired heaving and pitching control forces and moments. For example, when extreme heave is encountered, both the vane and the stabilizer are simultaneously rotated in the same direction to produce a unidirectional upward or downward force to oppose the heave. On the other hand, when extreme pitching needs correction, the vane is angularly displaced in one direction to produce a pitch counteracting force while the stabilizer is rotated in the opposite direction to additionally help counteract the pitch. When no control force is needed by the vane, the vane is feathered to align itself with the water flow so as not to interfere with the stabilizing action of stabilizer **60.**

The spatial disposition of the hulls coupled with their location a considerable distance beneath the surface of the water minimizes wave making and eddy noise and, accordingly, provides an ideal location for carrying backward-looking sonar, towed array sonar, towed whip sonar, or a housing for submersibles, ordnance, etc. A pod-like fairing **80** is mounted on the underside, or coplanar with the stabilizer, and, as shown in FIG. **6** is connected between stabilizer **60** and a traverse forwardly located control vane **68.** Being mounted a distance below the surface is particularly desirable in military operations, aside from noise considerations, since the package carried in pod **80** is not subject to scrutiny by distant observers. The fairing pod, when connecting the control vane to the stabilizer, is advantageously stressed to strengthen the structural linkages between the two elongate hulls and, of course, is streamlined to reduce drag and noise.

Modification of the forwardly mounted control vane in the shape of a pair of opposing delta-shaped control vanes **68'**, necessitates each being supported by a shaft journaled in a suitable rotation-imparting control **68***b'* receiving driving signals over individual driving leads **7***a*. The fairing pod optionally is joined to the delta-shaped control vanes; however, cantilevering the pod from the rear stabilizer is adequate, barring the creation of extreme stresses, note FIG. **6***a*. As in the preceding example, the delta-shaped control vanes and the

stabilizer have hydrodynamically coordinated angular displacements to enhance heave and pitch dampening.

Placing the twin hulls several hull diameters below the surface of the water gives the marine vessel a deep draft to prevent its entry into most harbors and preclude shallow water operation. In FIG. 7, ballasting chambers **20***a* and **20***b*, carried in the platform section, ballasting chambers **40***a* and **40***b* in hull **40**, and chambers **50***a* and **50***b* in hull **50**, not shown, are included to permit their selective evacuation allowing the hulls to be buoyed to the surface of the water and enable shallow water ferrying of the vessel.

Further draft reduction is provided by adding a rack and pinion-like mechanism **22** and **23** to the struts and platform, noting in FIG. **9**. In a first modification the pinion mechanism and its controlling machinery are carried on platform **20** in a dependent platform hull section **25** having a pair of longitudinal recesses **25***a* and **25***b*. Upon lowering the platform hull with the machinery driving the pinions downward along the racks, the lower portion of the platform hull section is brought in contact with the surface of the water and forced below. Forcing the hull section below the surface creates an additional buoying force further reducing the overall draft of the marine vessel. The longitudinal recesses are configured to conform to the rounded outer surfaces of both hulls **40** and **50** when the platform hull section has been fully lowered, platform hull section **25** shown schematically in FIG. **9**. completely lowered, and in phantom, completely raised.

With platform **20** carrying a topmost flat portion **24**, along with a dependent hull section **25**, an elective modification is provided using the lifting and lowering capabilities of the rack and pinion mechanism. This modification permits the selective vertical displacement of the flat portion along with or independent of the hull section. Having the capability for raising and lowering the entire platform enables smoother cargo transfer operations when docks of different heights are encountered and, also provides a variable silhouette capability which, from a military standpoint, promises reduced vulnerability as well as facilitating camouflage and concealment.

Because the struts extending upwardly from the submerged hulls through the water's surface have only a minimal cross-sectional area designed to provide a minimal surface wave drag and wave making drag, the maximum speed limitation on the marine vessel is generally stated as being a function of the propulsion plant's power overcoming the water surface drag or frictional drag along the outside of the two submerged hulls.

Speed is markedly increased, as shown in FIG. **8**, by providing a reservoir of water-soluble polymers **72** within each of the hulls and a valved source of pressurized gas **73**, or similar mechanism for expelling a polymer layer **72***a* through a vented nose sieve **74**. The valve **73***a* is actuated by an ejection signal appearing on lead **73***b* from center **71** and a polymer layer is ejected to cover the nose section and the longitudinal reaches of each hull greatly reducing the frictional drag and giving the marine vessel a high speed burst capability with no increase in power plant output. Supplemental slots **75** along the hull, also operatively connected to the reservoir, ensure that the layer is not broken to keep down the frictional drag.

In the twin hull configuration of FIG. **10**, inclusion of a pair of forward looking sonars **76** and **77** in each of the nose sections of the hulls enables superior three-dimensional sonar resolution. In addition, a planar, conformal sonar **78** is ideally adaptable for mounting on the outside, outwardly facing submerged hulls. Both the forward locking and the conformal sonars permit highly accurate readouts since they are fixed on the relatively large hulls a considerable distance below the area of noise-producing surface waves and eddy vortex resulting in greater reliability in the composite sonar systems. Including a fairing pod **69** housing a towed sonar array or whip array along with forward locking sonars **76** and **77** and planar sonar **78** provides even greater resolution.

Forming a plurality of marine vessels with platforms **20** having an essentially flat portion **24**, schematically represented in FIG. **9**, permits a modular-like construction of a single, large, stable floating platform **90**, noting FIG. **17**. Individual marine vessels are joined by a mechanism as simple as a large U-shaped bolt **91** inserted in vertically disposed bores provided in each of the flat portions. Such a platform **90**, thusly constructed, accommodates heavily loaded aircraft and supplies. If each marine vessel is outfitted to serve a particular function, for example, one vessel serving as a tanker while another is a command headquarters, crew quarters, supply depot, etc., the vessels can be separately deployed from widely separated supply points to rendesvous at a predetermined point for a combined operation. In the alternative of simply constructing a large stable floating platform from a plurality of the marine vessels, the platform is an integral member **90***a*, see FIG. **18***a*, supported by struts anchored on elongate hulls **40** and **50**, separated by a horizontally disposed stabilizer **60**.

Employing the inventive concept of providing the submerged hulls with strategically spaced struts and a large horizontally oriented stabilizer located aft the vessels's centroid permits simple reloaction of the struts to form the alternate embodiments shown in FIGS. **12** through **16**.

In the embodiment of FIGS. **12** and **13**, a single elongate hull **90**, displacing an elliptical cross-sectional area, has a pair of essentially delta-shaped stabilizers **91** carried on the aft portion of the hull. The stabilizers are fixed or, if rotational, are linked to a suitable driving mechanism used in the previous embodiments, to eliminate dynamic pitch or heave. A single supporting strut **92** supports a platform **93** and a pair of outrigger-like water surface piercing struts **94** and **95** emplace the aggregate vertically oriented, horizontal pressure control surfaces substantially aft of the centroid of the vessel to eliminate yaw. Struts **94** and **95** are preferably base-vented to aid in quiet high speed operation and displace a sufficient volume of water to maintain lateral and longitudinal static stability. Since the large delta-shaped stabilizer locates the vertical pressure exerting control surface considerably aft of the centroid, pitch, heave, and roll stability is guaranteed.

A side view of an alternate embodiment of the modification of FIGS. **12** and **13** appears in FIG. **14**. An elongate hull **90***a* supports a platform **93***a* through a single strut **92***a* from its aft portion and a pair of forwardly located water surface piercing struts **95***a* and **94***a*, the latter not shown, are laterally disposed with the same separation as struts **94** and **95** shown in FIG.

13. The total laterally exposed surface of rear strut 92a aft of centroid 25 is considerably more than the wetted area of depending struts 95*a* and 94*a* (latter not shown) to stabilize the vessel in dynamic yaw. The horizontally oriented stabilizer 91*a*, being optionally fixed or controllable, ensures stability from dynamic pitch, heave, and roll substantially in the same manner as disclosed above.

In FIGS. 15 and 16, a single vertically extending strut 92*b* supports a platform 93*b* from an elongate hull 90*b*. The strut supports the platform generally through the vessel's centroid 25, but a pair of dependent struts 94*b* and 95*b* reach down from rearward lateral extremes of the platform to form a dihedral angle at their juncture point on the hull. A pair of controllable flaps 94*c* and 95*c* are optionally included on the dihedral sections of the struts and, by an internal driving mechanism and sensors, the flaps are displaced to correct for pitching, heaving, and rolling tendencies of the vessel. Additional delta-shaped horizontal control vanes (not shown) may be mounted near the nose of the hull for augmented pitch and heave control. Here, again, consistent with the disclosed inventive concept of locating the aggregate horizontal control surfaces and the vertical control surfaces substantially aft of the centroid of the marine vessel, in the instant embodiment, the aggregate horizontal and vertical control surfaces are located substantially aft of the centroid by strategically locating the dihedral struts 94*b* and 95*b*, and, the dihedral portions mounting the flaps 94*c* and 95*c*.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings, and it is therefore understood that within the scope of the disclosed inventive concept, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A high speed marine vessel having a static and dynamic stability comprising:

a platform member;

two parallel elongate hulls operationally disposed below the level of surface waves laterally separated a distance equal to at least two hull diameters each hull is provided with a canard fin mounted on the forward portion of each hull for improving said stability;

a first water surface piercing strut member shaped with a hydrofoil cross-sectional configuration for reduced spray and wave drag and reaching from the forwardmost extensions of each elongate hull and a second water surface piercing strut member shaped with a hydrofoil cross-sectional configuration for reduced spray and wave drag and reaching from the aftmost extensions of each elongate hull to support said platform member, both of the first strut members lie in the same forward lateral projection and both of the second strut members lie in the same aft lateral projection, said first strut members and said second strut members are sized to present a reduced lateral water projection area and are sufficiently longitudinally separated to enhance said stability; and

a pair of opposed cantilevered vanes reaching toward one another from separate ones of said elongate ulls operationally disposed below the level of said surface waves mechanically coupled to said hulls and longitudinally disposed to ensure the creation of the vanes' dynamic center of vertically exerted pressure substantially aft the centroid of said marine vessel to yet further improve said stability.

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