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(54) Landing craft with fixed and retractable azimuthing drives

(57) A marine vessel (10) used for loading and offloading vehicles and cargo that has both excellent seakeeping and beaching properties. The vessel (10) is provided with azimuthing or steerable thrusters (20,22) below the waterline at the bow (12) and stem (14) of the ship, with the stern end thrusters (22) being retractable into the hull during beaching operations. Because the vessel (10) is beached "stem first" the bow (12) may be designed with better wave breaking and seakeeping features than are on prior landing craft designs.

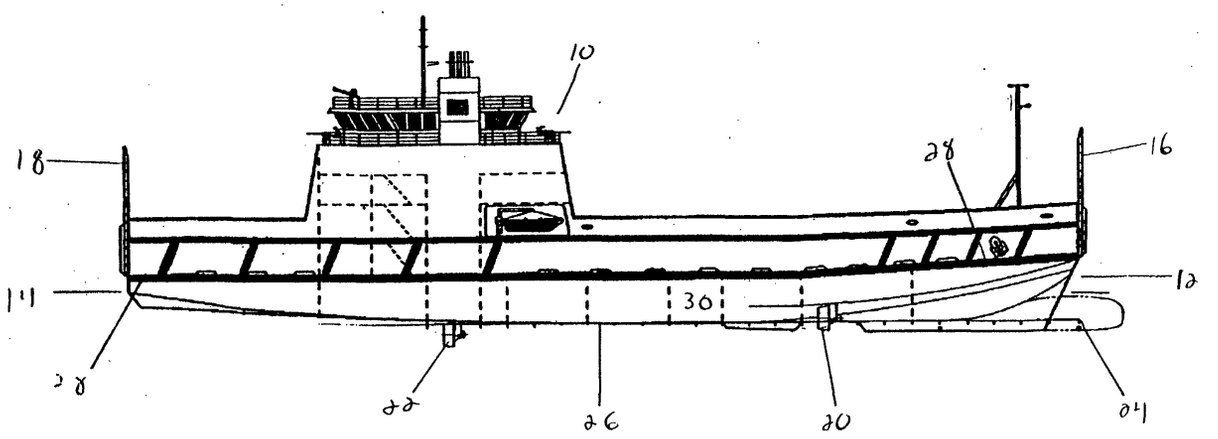

FIG. 1

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Description

BACKGROUND OF THE INVENTION

Field of Invention

[0001] This invention relates to a marine vessel, and more particularly, to a landing craft that uses fixed and retractable azimuthing drives in combination with an improved bow shape to obtain both excellent seakeeping and beaching abilities.

Description of Prior Art

[0002] Throughout the history of modem military operations, there has been a requirement to transfer men and'materials from ships to a beachhead. Without docking facilities, such transfers are difficult to accomplish. In the twentieth century, particularly during the Second World War, specialized landing craft were developed to facilitate such transfers. Unfortunately, such craft were limited to transporting a relatively small group of men, one or two vehicles, or an inadequate amount of cargo, due to their limited size and cargo weight capacity. Larger marine vessels were limited for such operations due to their inability to effectively and safely "beach" themselves to unload cargo and then return to normal seakeeping operations.

[0003] Some of the aforementioned problems where addressed with the development of socalled "roll-on, roll-off" vessels. Used in both military and commercial applications, vehicles and other cargo are loaded onto a marine vessel, typically by way of a ramp on the bow or stern of the ship. The vehicles or cargo are then unload by way of the same ramp used for loading. An obvious disadvantage of using one ramp is that vehicles must be "rolled-on" in reverse, such that they can be driven off the vessel in a forward orientation so that they can be immediately used.

[0004] When loading/unloading ramps are provided at both the bow and the stern of the ship, such vessel still suffer from several disadvantages, particularly if used during beaching operations. In such prior art vessels, vehicle, cargo, etc. were loaded at the stern of the ship. Beaching operations were conducted with the bow portion of the ship being beached, and the materials offloaded by a ramp or similar means at the bow. However, the use of ramps and other offloading systems located on the ship's bow affected the seakeeping ability of the ship as design compromises must be made to the hull design which affect the ability to sail through the water and break waves. Furthermore, due to the compromised designs of such hulls, the bow ramps would suffer damage from the force of wave impacts, beaching and general sailing operations.

[0005] Prior art landing craft are also destabilized by the surf slamming into the flat stern of the ship when beached. When extricating from beach, such craft must operate in reverse—i.e., they drive stern first into the surf, operating its propellers or other propulsion system in reverse. Operation of the propulsion system in this manner is inefficient and taxing on the mechanical systems. Once clear of the shallow draft of the beach area, such ships must perform a broad turn to point the bow of the ship forward, towards the sea, for normal seakeeping operations. This is difficult in rough surf and can result in loss of vessels during combat operations.

[0006] It is conventionally known in the art that steerable or azimuthing drives may be used to orient marine vessels in different directions. U.S. Patent No. 5,522,335 to Veronesi *et al.* describes a combined azimuthing and tunnel auxiliary thruster which can be retracted inside of a boat hull if hazards are present, the contents of which are hereby incorporated by reference. However, there is no discussion in Veronesi *et al.* of utilizing the disclosed thrusters in combination with a vessel configuration which is appropriate for both seagoing and beaching operations.

[0007] U.S. Patent No. 5,660,131 to Gulling, *et al.* describes an icebreaking attachment for use with a parent vessel. This attachment, when connected to the parent vessel, provides an ice knife at the bow for increased icebreaking ability and protection. The icebreaking attachment also provides fully rotatable z-axis drives to steer the parent vessel, or the icebreaking attachment alone when detached, during icebreaking operations. While incorporating conventionally known z-axis drives to increase maneuverability, the disclosure of Gulling, *et al.* does not contribute to the problems associated with prior art landing craft.

[0008] Another representative example of a marine vessel utilizing steerable drives is U.S. Patent No. 5,966,520 to Arpiainen, *et al.* which discusses an icebreaking method and icebreaker. The icebreaker of Arpiainen, *et al.* uses a relatively narrow hull and first and second propulsion mechanisms to propel the icebreaker through an ice field in a direction at a substantial angle to the keel line of the ship to open a wide opening in the ice. Again, while the use of steerable drives is discussed, the apparatus and method of Arpiainen does not disclose how such drives, or the hull configuration of the ship, can be used to accomplish beaching operations while maintaining good seakeeping abilities.

[0009] It is therefore an object of the present invention to provide a marine vessel that is capable of engaging in beaching operations and maintain good seakeeping abilities while doing so and when traveling in open water.

[0010] It is a further object of the present invention to provide a marine vessel that is capable of moving in multiple directions including traveling bow forward as well as stern forward.

[0011] It is yet another object of the present invention to provide a marine vessel which cargo can be loaded and unloaded quickly and easily.

[0012] An additional object of the present invention is to provide an agile craft capable of turning in a short

radius and handling well in surf and landing operations.

SUMMARY OF INVENTION

[0013] The marine vessel described herein has the ability to travel in multiple directions, particularly stern forward, during landing operations on a beach or other unimproved water/land interface. The high maneuverability of the disclosed marine vessel is accomplished through the use of conventional steerable or azimuthing drives mounted below the waterline on the bow and stern portions of the craft.

[0014] Unlike prior landing craft, which beach bow first, the ship disclosed herein uses the combination of fixed and retractable azimuthing drives to beach the vessel stern first. The stem azimuthing drives are adapted to retract into the hull of the ship such that they are not damaged by the shallow waters in the beaching area.

[0015] The first advantage of this system is it allows a "drive-through" cargo deck. Vehicles, such as tanks, trucks, and humvees, are driven into the cargo area at a loading depot from the bow. The front of the vehicles will then face towards the stern of ship. Once the ship is beached at the designated landing zone, the vehicles can drive off the ship, right onto the beach in a forward gear. By unloading vehicles and other cargo astern of the vessel, the bow of the ship can be designed for excellent seakeeping and wave breaking ability since it is not used for beaching. This feature is also effective for getting on and off the beach since the effects of high surf near the beach are minimized because the efficient, wave breaking bow of the vessel is pointed towards the surf. This eliminates the problem with past landing craft and logistic support vehicles that have had problems getting on and off the beach due to the flat stern slamming into the surf or being pushed by the surf while beaching.

[0016] The azimuthing drive propulsion system adds two advantages over traditional drive systems. First, the bow azimuthing drives provide the capability of full bollard thrust in both directions and are therefore extremely effective for powering off a beach. Second, with at least three drives operating (bow and stern), the vessel has full dynamic position capability while at sea.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] Specific embodiments of the invention have been chosen for purposes of illustration and description, and are shown in the accompanying drawing, forming a part of the specification wherein:

FIG. 1 shows a side view of a symmetric vessel according to the invention

FIG. 2 shows a front, or bow, profile view of a vessel according to the invention.

FIG. 3 shows a rear, or stern, profile view of a vessel according to the invention.

FIG. 4 shows a cut-away view of the stern end of the vessel according to the invention illustrating the stern azimuthing thrusters in operational and retracted positions.

FIG. 5 shows a perspective view of the bottom of the vessel according to the invention.

FIGS. 6A-B show top cut-away views of an alternative embodiment of the vessel according to the invention containing clamshell doors on bow of the vessel.

FIGS. 7A-C show the beaching procedure of the vessel according to the invention.

FIGS. 7D-E show extracting the vessel according to the invention from a beach.

FIG. 8 illustrates a panoramic view of beaching operations utilizing the vessel according to the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0018] Referring to Fig. 1, vessel **10** generally contains a boat hull **30** having a bow portion **12,** a stern portion **14** and a keel **26.** Located at the bow **12** is a bow ramp **16.** The bow ramp **16** is generally used to load vehicles or other cargo onto the vessel **10.** Located at the stern **14** is a stern ramp **18** that is generally used to offload vehicles or other cargo, particularly during beaching operations. Below the waterline of the vessel **10** are two sets of azimuthing or steerable thruster drives **20** and **22.** At least one drive **20** is located on the bow portion **12** or the vessel. Similarly, at least one drive **22** is located on the stern portion **14** of the vessel. In the preferred embodiment of the invention, vessel **10** contains two bow thrusters **20** and two stern thrusters **22**. However, as shown in FIGS. 2 and 3, one stern thruster **22** may be used in combination with two bow thrusters **20.**

[0019] Referring to FIGS. 1 and 2, the bow portion **12** of the vessel **10** incorporates, to the extent possible, characteristics of a well designed sea-going vessel. The bow portion shape is ship-like (i.e., not flattened to accommodate a beaching ramp), having a deep forefoot and fine "V" sections on the port and starboard sides of the bow.. The bow end **12** is also fitted with a bulb **24** to reduce calm water resistance. The bow ramp **16** and deck **28** are r above the waterline unlike prior art landing craft. This allows an improved ship-like shape of the bow and serves to prevent damage to the bow ramp **16** during seakeeping operations. As a result of this design, the bow portion **12** is optimized for a high-sea-state en-

vironments resulting in improved controllability and performance of the vessel **10.** Further, when extracting the ship from a beach, the bow portion **12** is facing seaward to reduce wave impacts and the vessel **10** does not have to be turned around to return to sea.

[0020] Referring to FIGS 1 and 3, the stern portion **14** of the vessel **10** incorporates features that are designed to enhance the movement of vehicles and other cargo onto a beach. The deck **28** is close to the waterline, which serves to reduce ramp **18** length and break angle, or the angle between the deck and the beach. As is shown in FIGS. 1 and 3 the stern portion bottom shape is flat and broad, improving the stability of the vessel **10** when beached.

[0021] In the preferred embodiment of the invention, the azimuthing drives **20** and **22** are powered by DC electric motors **30,** as shown in FIG. 4 The azimuthing drives are conventionally known in the art and may be obtained from several producers such as Rolls-Royce (United Kingdom) and John Crane-Lips (United Kingdom). The stem end thrusters **22** can be retracted into the vessel hull **30** such that they are above the keel **26.** This operation is shown in shadow in FIG. 4. Any typical means for retracting the stern thrusters **22** into the hull **30** may be used, such as hydraulic lifts or mechanical lifts. This allows efficient beaching operations without damaging the stern thrusters **22** on the beach/sea floor. The stem thrusters **22** are also fitted with fixed pitched propellers, which are optimized for open water speeds. In contrast, the bow end thrusters **20** are non-retractable. In the preferred embodiment, the bow thrusters **20** are also fitted with fixed pitch propellers which are mounted in nozzles optimized for maximum bollard (zero speed of advance) thrust. In open-sea or transit conditions, 60% of the power is preferably directed to the stern end thrusters **22** while the other 40% of power is directed to the bow thrusters **20.** In the preferred embodiment of the invention, this is done because the stern end thrusters **22** have a higher propulsive efficiency and the bow end thrusters are limited in diameter and therefore would be prone to cavitation if more power was applied. Because, by their very nature, azimuthing thrusters have complete rotation about a vertical axis, the direction of the vessel is preferably changed by movement and/or different directional alignment of the bow and stern thrusters. This configuration is shown in FIG. 5. which shows the bow thrusters **20** and stern thrusters **22** at different angles. However, as is known in the art the vessel may also be turned through the use of variable power to the thrusters when all are facing the same direction, i.e., all are pointing to the stern of the ship.

[0022] In general, the waterline of the vessel is fairly fixed, particularly during open sea operations. The ship also has an operating draft, defined herein as the distance between the keel **26** and the sea floor. The operating draft generally varies, depending on the distance between the sea floor and the top of the water. Quite obviously, when closer to the beach, the operating draft is reduced. To further decrease or increase the operating draft during beaching operations, the vessel of the instant invention contains an adjustable ballast and means to adjust such ballast. As is know in the art, tanks or other storage areas are located throughout the ship, such that the operating draft of the ship can be lowered or raised by adding or removing ballast, typically sea water, from the ballast tanks. The adjustable ballast system assists extraction of the vessel from the beach upon completion of unloading operations by allowing the stern portion **14** of the vessel, and to lesser extent the bow **12,** to float off of the beach.

[0023] In another embodiment of the invention, shown in FIGS.6A and 6B, the bow portion of the ship **12** may be additionally fitted with clamshell doors **34** ahead of or proximal to the bow ramp **16.** Preferably, the clamshell doors **34** are split and open vertically, i.e., to the port and starboard sides of the ship, as shown in FIG. 6A. FIG. 6B illustrates the clamshell doors **34** in the closed position. When at sea, the vessel **10** will certainly experience repeated wave impacts to the bow ramp **16** which will slow the vessel and may ultimately damage the bow ramp. The addition of clamshell doors will protect the ramp and provide an even truer ship-shaped bow **12.**

[0024] The operation of the previously disclosed structures in connection with beaching operations is shown in FIGS. 7A-E and FIG. 8. In FIGS. 7A-E, the heavy arrow, in all cases, points to the direction of the beach. Referring now to FIG. 7A, the vessel **10** is in open water **36** approaching the beach **38** (not shown) with the bow **12** pointed toward the beach. Bow thrusters **20** and stern thrusters **22** are pointed toward the stem portion **14** of the vessel Once the vessel reaches a predetermined distance from the beach, the thrusters **20** and **22** are turned, such that the stern **14** is pointed toward the beach, as shown in FIG. 7B. The stern thruster **22** is retracted into the hull **30** while the bow thruster **20** is pointed towards the bow **12** (i.e., the open sea). The vessel **10** is shown beached in FIG. 7C. The stern **14** of the vessel is on the beach **38** while the bow is still floating in the water **36** with the bow thruster **20** inactive. The stern ramp **18** is lowered upon the beach **38** for cargo unloading. FIG. 8 illustrates a beached vessel **10** on unloading tanks **40** upon the beach **38** by way of stern ramp. A second vessel **110** is shown in the water **36.**

[0025] When the beaching operations are complete, the vessel **10** is extracted from the beach. As shown in FIG. 7D, the stern ramp **18** is retracted and the bow thruster **20** is oriented toward the beach. By removing ballast and operating the bow thruster **20,** the ship is extracted from the beach. Once the vessel is sufficiently clear of the beach, the stern thruster **22** deploys from the hull **30**, and in combination with the bow thruster **20** propels the vessel away from the beach and toward open water.

[0026] In addition to the structures, sequences, and uses immediately described above, it will be apparent

to those skilled in the art that other modifications and variations can be made the method of the instant invention without diverging from the scope, spirit, or teaching of the invention. Therefore, it is the intention of the inventors that the description of instant invention should be considered illustrative and the invention is to be limited only as specified in the claims and equivalents thereto.

Claims

1. A marine craft which is capable of seaward movement and beaching operations, for carrying and landing cargo comprising:

a) a boat hull having a waterline, a generally v-shaped bow portion for good seakeeping and wavebreaking capabilities and a stern portion adapted for beaching operations;

b) a first ramp mounted on said, bow portion above the waterline for loading and unloading cargo from a dock or other fixed structure;

c) a second ramp mounted on said stern portion for unloading and loading cargo during beaching operations;

d) a least one azimuthing drive mounted below the waterline on the bow portion of the hull; and

e) at least one azimuthing drive mounted below the waterline on the stern portion of the hull,

whereby the craft is able to load cargo in the proper orientation for unloading during beaching operations, traverse open seas bow forward with excellent stability and speed, approach a designated beaching area, orient the craft from a bow forward position to a stern forward position by way of the azimuthing drives, beach the stern of the craft and unload the cargo while minimizing the effects of high surf near the beach, and sailing off of the beach with the bow pointed toward open water.

2. The landing craft of Claim 1, wherein the bow portion contains a deep forefront.

3. The landing craft of Claim 1 further comprising a keel and means for retracting the stern azimuthing drives above the keel and into the hull, whereby said azimuthing drives are protected during beaching operations.

4. The landing craft of Claim 1, further comprising a pair of clamshell doors mounted on said bow, proximal to the bow ramp, whereby the seakeeping abilities of the landing craft are improved and the bow ramp is protected from wave damage.

5. The landing craft of Claim 1, wherein the bow below the waterline is fitted with a bulb to reduce calm water resistance.

6. A marine landing craft comprising:

a) a boat hull having a keel, a waterline, a bow and a stern;

b) said bow having a deep forefront adapted for wavebreaking and seakeeping operations;

c) a ramp for loading and unloading cargo on said stern;

d) at least one propulsion drive mounted below the water line at the bow of the hull, said at least one bow propulsion drive being adapted for full rotational movement about a horizontal plane; and

e) at least one propulsion drive mounted below the waterline at the stern of the hull, said at least one stern propulsion drive being adapted for full rotational movement about a horizontal plane and for retraction into the hull above the keel,

whereby the landing craft is capable of movement in multiple directions and beaching stern first and extracting from the beach bow first

7. The landing craft of Claim 6, wherein the means for loading and unloading the cargo from both the bow and the stern are retractable ramps.

8. The landing craft of Claim 6, wherein the at least one propulsion drive mounted below the waterline at the stern of the hull further comprises a fixed pitch propeller mounted within a nozzle.

9. The landing craft of Claim 6, wherein the at least one propulsion drive mounted below the waterline at the stern of the hull provides 60% of thrust power and the at least one propulsion drive mounted below the waterline at the bow of the hull provides 40% of thrust power.

10. The landing craft of Claim 6 further comprising an operating draft and an adjustable ballast whereby the waterline of the hull may be adjusted above or below the operating draft.

11. A method of delivering cargo on a beach or other unimproved land-water interface, the method comprising;

providing a marine vessel having a hull, a waterline, a bow end, and a stern end. the marine vessel including steerable propulsion mechanisms mounted below the waterline at the bow and stern ends of the hull respectively, a ramp on the bow end of the vessel and a ramp on the stern end of the vessel;

loading the cargo onto said marine vessel by way of either the bow ramp or the stern ramp;

operating the steerable propulsion mechanisms to orient the marine vessel to a position in which the stern end of the vessel faces the beach;

beaching said vessel upon said beach; and

unloading the cargo onto the beach by way of the stern ramp.

12. The method of Claim 11, further including the step of retracting the at least one steerable propulsion mechanism located on the stern end of the vessel into the vessel prior to beaching said vessel.

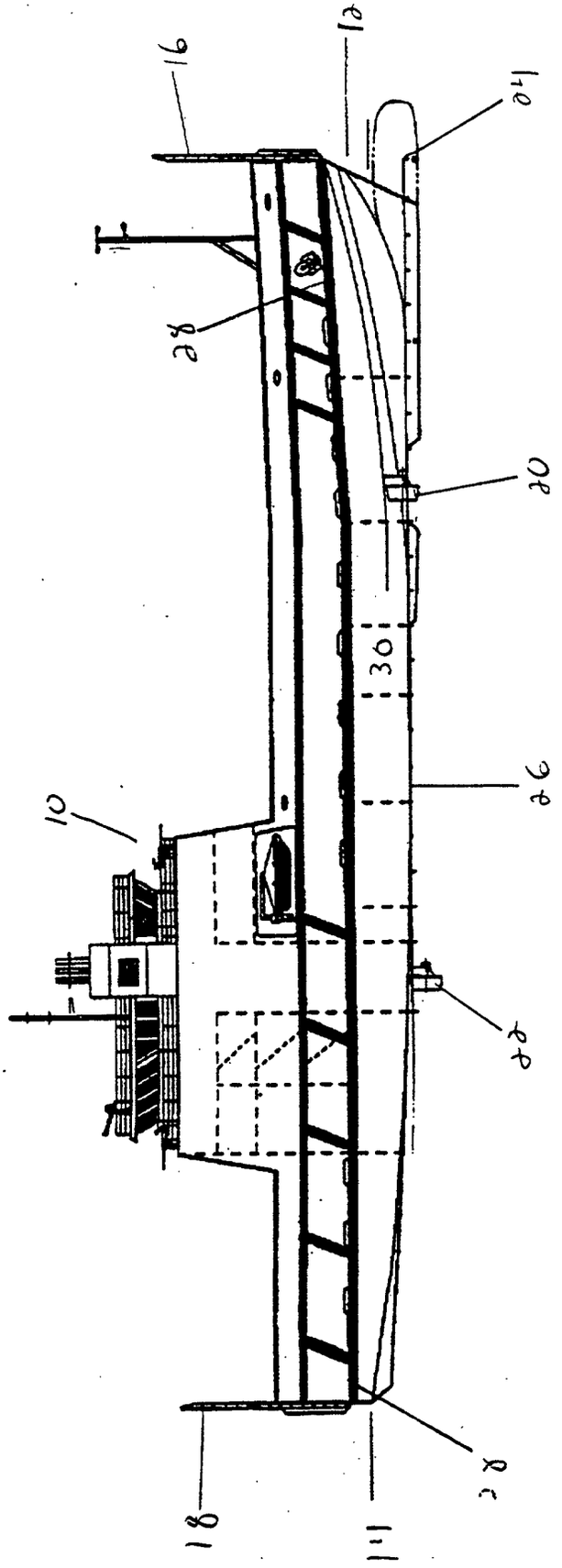

FIG. 1

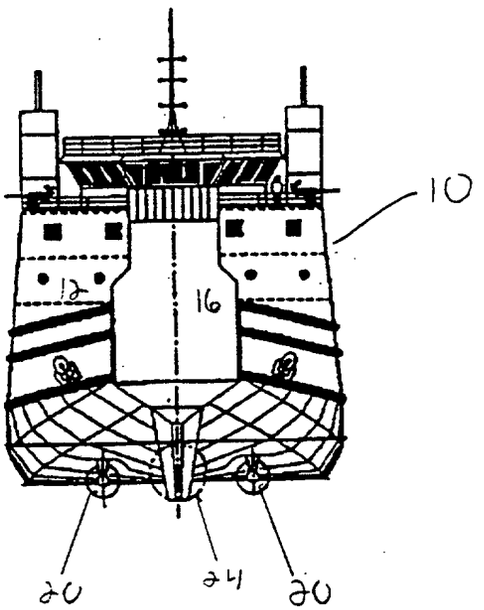

FIG. 2

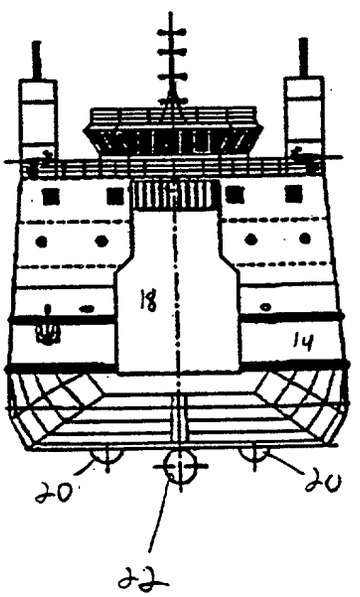

FIG. 3

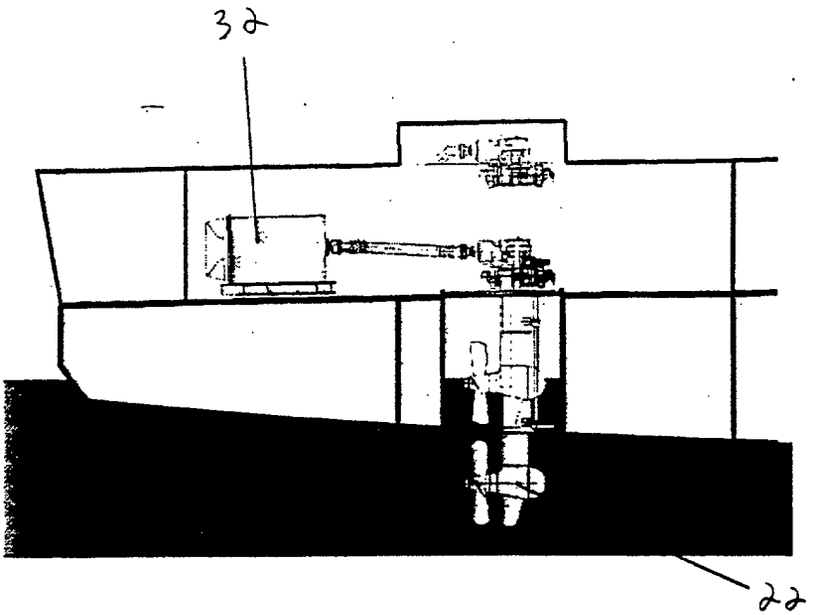

FIG. 4

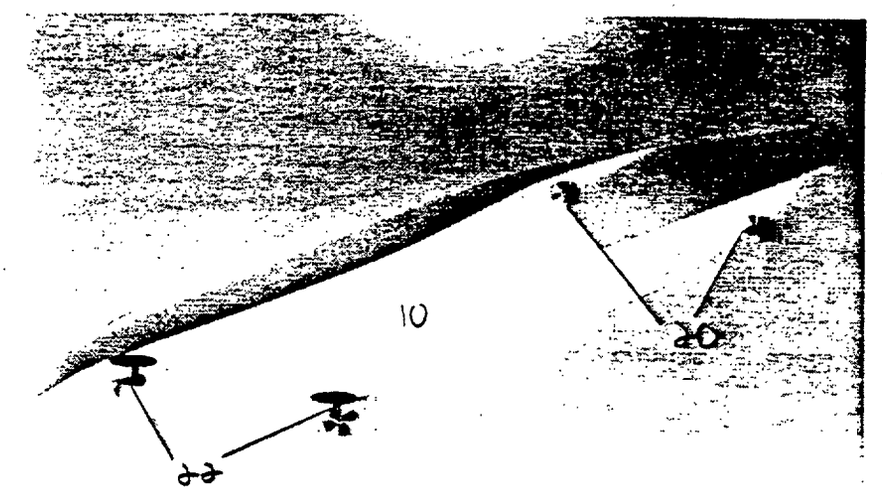

FIG. 5

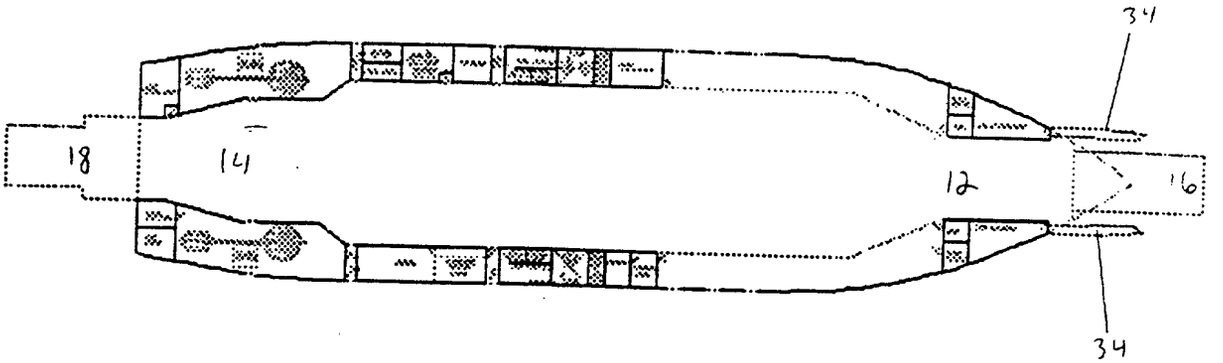

FIG. 6A

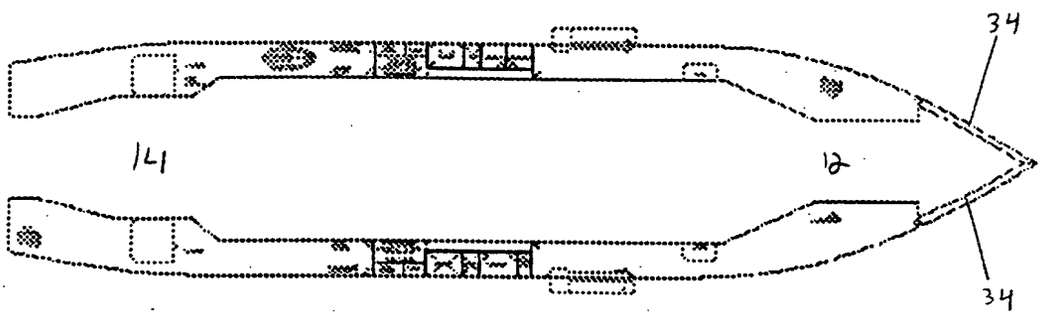

FIG 6B

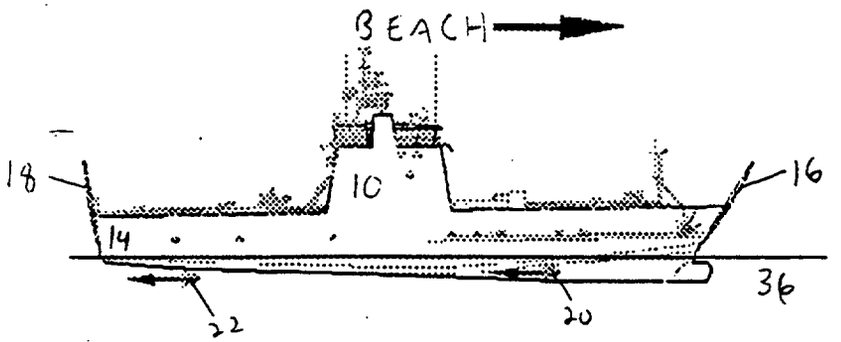

FIG. 7A

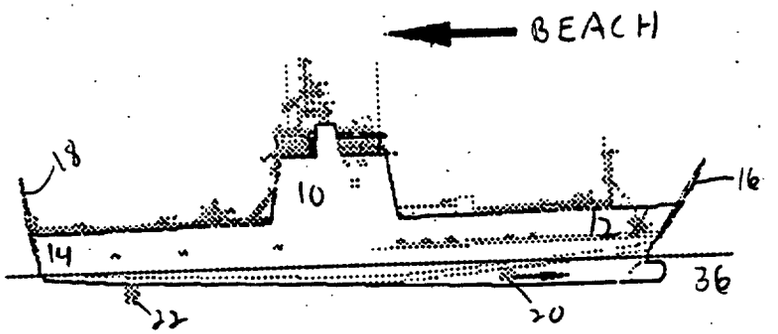

FIG. 7B

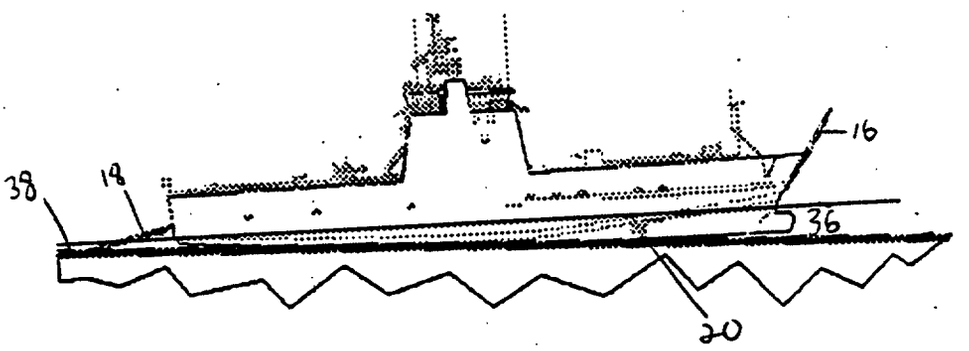

FIG. 7C

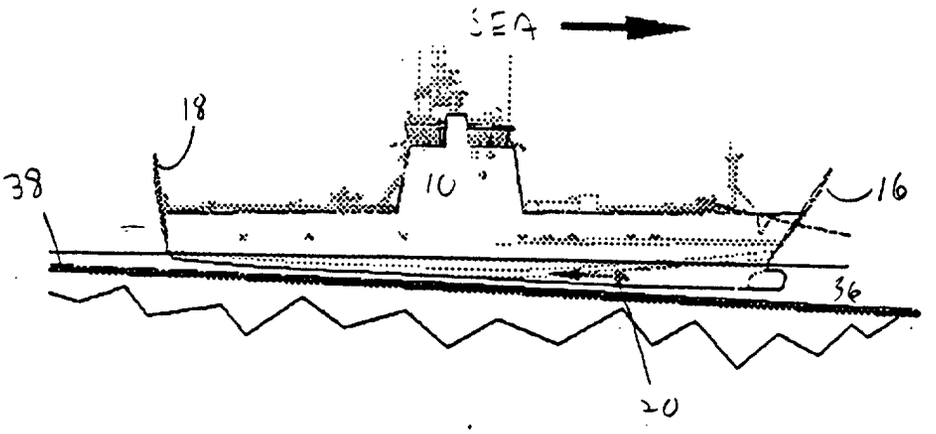

FIG. 7D

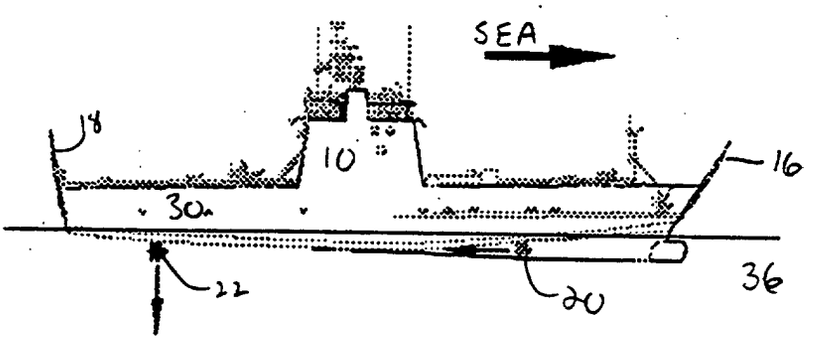

FIG. 7E

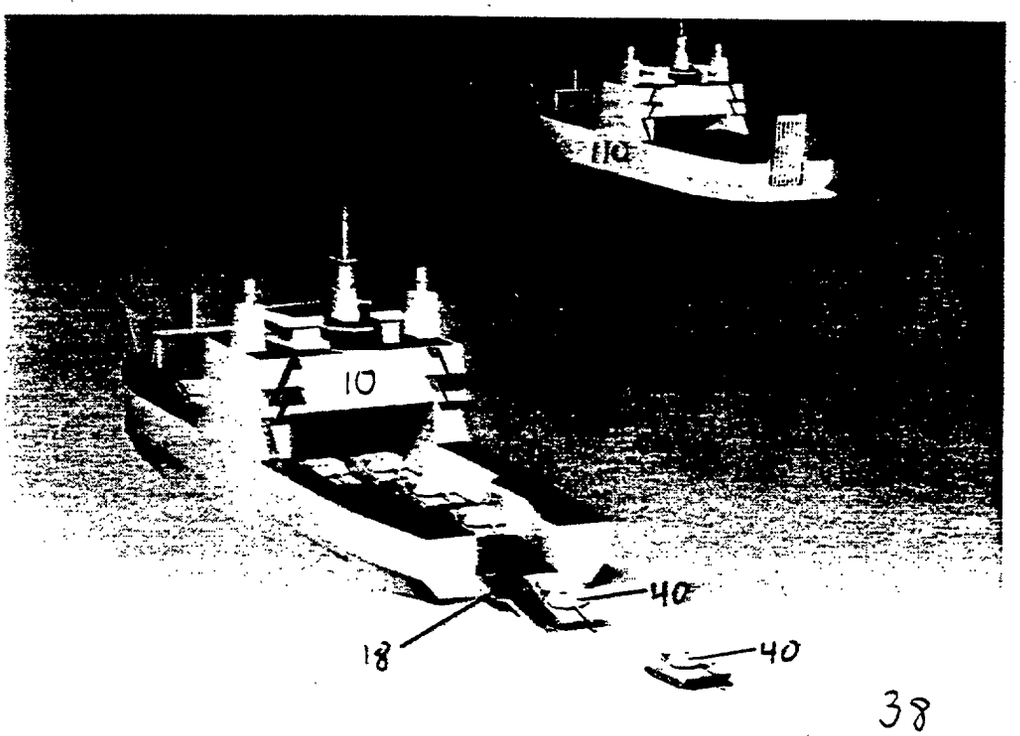

FIG. 8