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(71) Applicant: **3Madmen**
98000 Monaco (MC)

(72) Inventors:
- **Viviani, Albert**
  98000 MONACO (MC)
- **Laniado, Arye**
  98000 Monaco (MC)
- **Laniado, Joshua**
  98000 MONACO (MC)
- **Le Jeune, Yann**
  06230 VILLEFRANCHE SUR MER (FR)
- **Lagioia, Pietro**
  70125 BARI (IT)

(74) Representative: **Ström & Gulliksson AB**
P.O. Box 4188
203 13 Malmö (SE)

(54) **Wakesurfing boat and hull for a wakesurfing boat with ballast system.**

(57) A wakesurfing boat includes a hull. A bottom of the hull defines a W-shape in cross-section, the W-shape including a central inverted V-shaped portion. A ballast system includes a plurality of sets of ballast tanks. The boat has a plurality of modes: a cruising mode with ballast tanks empty, a first portion of the bottom in contact with the water, a stern-down trim θ_1; a ballasted static mode with ballast tanks filled with ballast water, the hull displacing more water, a larger portion of the bottom in contact with the water, a bow-down trim θ_2, and a dynamic surfing mode with ballast tanks filled with ballast water, an intermediate portion of the bottom in contact with the water, and an intermediate trim θ_3. A wake wave, generated in the dynamic surfing mode is larger than a wake wave generated in the cruising mode.

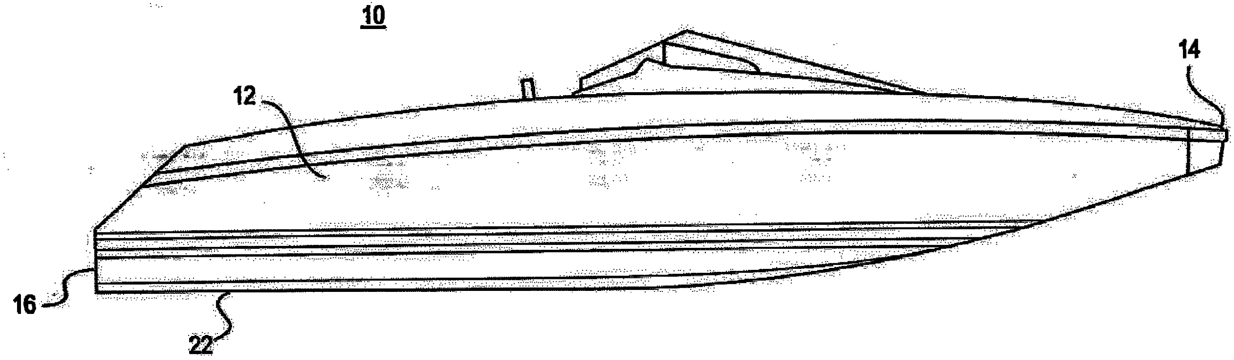

FIG. 1

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Description

Field of the Invention

[0001] The present invention relates to boats and boat hulls. More particularly, the present invention relates to wakesurfing boats, and hulls used for wakesurfing boats.

Background of the Invention

[0002] Wakesurfing is a watersport that is growing in popularity. A wakesurfer, initially being towed behind a boat via a tow rope, rises to his feet on a surf board in a body of water, (*e.g.*, an ocean, a sea, a lake, or a river) similar to a waterskier or a wakeboarder. Ideally, the boat should generate in its wake a wave that mimics a size, a shape, and a duration of an ocean wave. If the wake wave reaches a sufficient size, the wakesurfer, unlike a waterskier or a wakeboarder, releases the tow rope, and rides the board on a crest and/or a face of the wake wave, traversing back and forth on the wake wave face as desired, similar to an ocean surfer.

[0003] Until now, wakesurfers have been attempting to surf primarily in the wakes of existing cruising boats, waterskiing boats and wakeboarding boats. These classes of boats typically are designed for speed, seaworthiness, and handling characteristics. A problem with attempting to wakesurf behind traditional cruising boats, waterskiing boats, and wakeboarding boats, however, is that such boats fail to generate sufficiently large, sufficiently well-shaped, and sufficiently long-lasting wake waves to give the wakesurfer a long, satisfying ride.

[0004] As is well known in the field of fluid dynamics, a boat, when passing through a body of water, creates separate waves that move in the boat's wake. In general, separate wake waves originate, respectively, from the boat's bow, centerline, quarter, and stern. Each wake wave generally forms the arms of a V, with the source of the respective wake wave being at the point of the V (the boat), and transverse curled wave crests forming offset from the path of the boat. Wake wave height (W_h) is a function of several factors, including for example a speed of the boat hull in the body of water, resistance to the boat hull as it moves through the body of water, Froude number, a shape of the hull, a length of the hull, a length/beam ratio (L/B) of the hull, a speed/length ratio (SLR) of the hull, an amount of the boat hull bottom in contact with the body of water, and an amount of water displaced by the boat as it moves through the body of water. Cruising boats, wakeboarding boats, and waterskiing boats typically are configured with planing hulls L/B = 4.0 - 7.0, light displacements, minimal hull resistance when moving through the body of water, and optimal seaworthiness and handling characteristics.

[0005] A self-propelled wakesurfing boat, and a hull for a wakesurfing boat, are desired which will generate the largest, best-shaped and longest-lasting wake waves possible in view of the boat's size, displacement, and speed.

SUMMARY OF THE INVENTION

[0006] Accordingly, the present invention is directed to a wakesurfing boat for wakesurfing in a body of water, and a hull for a wakesurfing boat, that substantially obviates one or more of the problems caused by the limitations and disadvantages of the related art.

[0007] A wakesurfing boat operable in a body of water in accordance with the present invention includes a hull. The hull includes a bow, a stern, a port bulwark, a starboard bulwark, a bottom, a length (L), and a beam (B).

[0008] A trim-altering ballast system is supported by the hull. The trim-altering ballast system includes a plurality of ballast tanks, configured to alternately and selectively receive and discharge ballast water, in order to trim the hull, in one of a plurality of modes, including:

[0009] (i) a cruising mode, wherein the hull is moving through the body of water, the ballast tanks are substantially empty, the hull has at least a first weight, thereby displacing at least a first amount of water, and a first portion of the hull bottom is in contact with the body of water,

[0010] (ii) a ballasted static mode, wherein the hull is static in the body of water, the ballast tanks are filled or at least partially filled with ballast water, the hull has at least a second weight, displacing at least a second amount of water corresponding to the second weight, the second amount of displaced water being greater than the first amount of displaced water, and a second portion of the hull bottom is in contact with the body of water, the second portion of the hull bottom being greater than the first portion of the hull bottom,

[0011] (iii) a dynamic surfing mode, wherein the hull is moving through the body of water, the ballast tanks are filled or at least partially filled with ballast water, the hull has at least the second weight, displacing at least the second amount of displaced water, and a third portion of the hull bottom is in contact with the body of water, the third portion of the hull bottom being intermediate the first portion and the second portion.

[0012] In the cruising mode, the hull has a first trim θ_1, down by the stern.

[0013] In the ballasted static mode, the hull has a second trim θ_2 down by the bow.

[0014] In the dynamic surfing mode, the hull has a third trim θ_3, intermediate the first trim θ_1 of the cruising mode and the second trim θ_2 of the ballasted static mode.

[0015] Preferably, the ballast tanks comprise a plurality of sets of dual tanks, each set of dual tanks being positioned at generally symmetrical locations with respect to one another along the length of the hull.

[0016] In the dynamic surfing mode, separate ballast tanks can be selectively filled, or partially filled, with ballast water, to vary the weight and displacement of the hull, and to trim the hull with a plurality of alternate trim angles $\theta_4 ... \theta_n$.

[0017] In accordance with the invention, the bottom of the hull is configured in part as a central inverted V in cross-section, with the central inverted V commencing at the bow and extending to the stern. An apex angle a of the central inverted V changes at preselected positions as the inverted V extends from the bow to the stern, *i.e.*, $\alpha_1 ... \alpha_n$. More specifically, the entire bottom is configured substantially as a W in cross-section, wherein the W extends from the port bulwark to the starboard bulwark. The W includes port and starboard nadirs and a central apex, wherein the central apex of the W defines the central inverted V.

[0018] In accordance with the invention, the central inverted V defines a funnel through which water passes when the hull moves through the body of water. More water passes through the funnel in the dynamic surfing mode than in the cruising mode.

[0019] In accordance with the invention, as the hull moves through the body of water in the dynamic surfing mode, the combination of the ballast tanks being filled or partially filled with ballast water, the at least second weight and the corresponding at least second displacement, the third portion of the V-shaped hull bottom being in contact with the body of water, the hull being in the third trim θ_3, and the increased amount of water passing through the funnel defined by the central inverted V, results in an increase in resistance to the hull.

[0020] In accordance with the invention, when the hull moves through the body of water in the cruising mode, with relatively minor resistance to the hull, it generates at least one wake, W_1 having a first wake height, W_{h1}. When the hull moves through the body of water in the dynamic surfing mode, however, with the increased water resistance to the hull, it generates at least one wake wave W_2 having a second wake wave height W_{h2}. The second wake wave height W_{h2} of the at least one wake wave W_2 is greater than the first wake height W_{h1} of the at least one wake W_1.

[0021] Preferably, the second wake wave height W_{h2} of the at least one wake wave W_2 is approximately 0.5 meters to approximately 2.7 meters, depending on the length of the hull.

[0022] A plurality of hull lengths are within the scope of the invention, e.g., 20 feet - 60 feet, including but not limited to a 43 foot yacht, a 35 foot cruiser, and a 28 foot sport boat. Regardless of the hull length selected, the beam is selected such that the length to beam ratio (L/B) of the hull is less than or equal to 3.0, *i.e.,* $L/B \leq 3.0$.

[0023] In accordance with the invention, the boat hull is self-propelled, preferably by two inward-rotating propellers.

[0024] In another aspect of the invention a hull for a wakesurfing boat operable in a body of water includes a bow, a stern, a port bulwark, a starboard bulwark, and a bottom extending between the bow and the stern, and from the port bulwark to the starboard bulwark, wherein the entire bottom is configured substantially as a W in cross-section, the W extending from the port bulwark to the starboard bulwark, including a port nadir, a starboard nadir, and a central apex, the central apex defining a central inverted V portion extending from the bow to the stern; and a trim and displacement altering apparatus, comprising a plurality of ballast tanks, selectively altering a trim, an amount of the hull bottom in contact with the body of water, and an amount of displaced water displaced by the hull, thereby providing the hull with a plurality of modes, including:

[0025] (i) a cruising mode, wherein the hull is moving through the body of water, the ballast tanks are substantially empty, the hull displaces at least a first amount of displaced water, a first portion of the hull bottom is in contact with the body of water, and the hull has a first trim θ_1 down by the stern.

[0026] (ii) a ballasted static mode, wherein the hull is static in the body of water, the ballast tanks are filled or at least partially filled with ballast water, the hull displaces at least a second amount of displaced water greater than the first amount of displaced water, a second portion of the hull bottom is in contact with the body of water, the second portion being greater than the first portion, and the hull has a second trim θ_2 down by the bow;

[0027] (iii) a dynamic surfing mode, wherein the hull is moving through the body of water, the ballast tanks are filled or at least partially filled with ballast water, the hull displaces at least the second amount of displaced water, a third portion of the hull bottom is in contact with the body of water, the third portion being intermediate the first portion and the second portion, and the hull has a third trim θ_3 intermediate the first trim θ_1 and the second trim θ_2.

[0028] In the cruising mode, the hull creates at least one first wake W_1, having a first wake height W_{h1}. W_{h1} Is approximately 10-15 cm.

[0029] In the dynamic surfing mode, the hull creates at least one second wake wave W_2, having a second wake wave height W_{h2}, which is greater than W_{h1}. W_{h2} is approximately 0.5 meters to approximately 2.7 meters, depending on the length of the hull.

[0030] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory, and are intended to provide further explanation of the invention as claimed.

[0031] The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of the specification, illustrate the presently preferred embodiment of the invention, and together with the description, serve to explain the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] Figure 1 is a side view of a wakesurfing boat in accordance with the invention;

[0033] Figure 2 is a side view of a 43 foot hull of a wakesurfing boat in accordance with the invention, with numbered cross-sectional lines drawn at preselected locations between a bow and a stern of the hull;

[0034] Figure 3 is a bottom view of the hull of Fig. 2, with the numbered cross-sectional lines drawn at the same preselected locations between the bow and the stern of the hull, as depicted in Fig. 2;

[0035] Figures 4A-4N are longitudinal cross-sectional views of the hull, viewed from the stern, the cross-sections taken along each numbered cross-sectional line on the side and bottom of the hull depicted in Figs. 2 and 3, showing an apex angle α of a central inverted V in a center of the hull bottom;

[0036] Figure 5 is a view of the bottom of the hull depicted in Fig. 2;

[0037] Figure 6 is a view from the bow of the hull depicted in Fig. 5;

[0038] Figure 7 is a view from the stern of the hull depicted in Fig. 5;

[0039] Figure 8 is a view from the bottom of the hull in accordance with the invention, while the hull is in motion through a body of water, depicting a flow of water moving into and through a funnel defined by the central inverted V-shaped bottom of the hull;

[0040] Figure 9 is a view of the hull depicting locations of the sets of ballast tanks in a trim-altering ballast system, in accordance with the invention;

[0041] Figure 10 is a side cross-sectional view of a hull in accordance with the invention in a Lightship condition, with the ballast tanks empty;

[0042] Figure 11 is a side cross-sectional view of a hull in accordance with the invention, with the ballast tanks 50% filled with ballast water;

[0043] Figure 12 is a side cross-sectional view of a hull in accordance with the invention, with the ballast tanks 00% filled with ballast water;

[0044] Figure 13 is a graph depicting draft versus displacement for a 43 foot hull in accordance with the present invention;

[0045] Figure 14 is a side view of a prior art power boat in motion in a body of water;

[0046] Figure 15 is a side cross-sectional view of a 43 foot hull in accordance with the invention, with ballast tanks empty, operating in a cruising mode;

[0047] Figure 16 is a side cross-sectional view of a 43 foot hull in accordance with the invention, with the ballast tanks 100% filled, in a ballasted static mode;

[0048] Figure 17 is a side cross-sectional view of a 43 foot hull in accordance with the invention, with the ballast tanks 100% filled, operating in a dynamic surfing mode;

[0049] Figure 18 is a side cross-sectional view of a 43 foot hull in accordance with the invention, with the ballast tanks 50% filled, operating in the dynamic surfing mode;

[0050] Figure 19 is a graph depicting expected wake wave height versus hull length, determined via extrapolation, for a hull in the dynamic surfing mode in accordance with the invention;

[0051] Figures 20A-20C are drawn-to-scale cross-sectional views of a 20 foot hull in accordance with the invention;

[0052] Figures 21A-21C are drawn-to-scale cross-sectional views of a 28 foot hull in accordance with the invention;

[0053] Figures 22A-22C are drawn-to-scale cross-sectional views of a 35 foot hull in accordance with the invention;

[0054] Figures 23A-23C are drawn-to-scale cross-sectional views of a 60 foot hull in accordance with the invention;

[0055] Figure 24 is a chart depicting changes in static dimensions of the hull, including (in order): length at the Waterline, beam at the waterline, immersed volume, displacement, length at the center of buoyancy, Block coefficient, amidship transversal section immersed area, amidship transversal section coefficient, waterplane area, length at the center of flotation, prismatic coefficient, and immersed hull surface, for a 43 foot hull at varying drafts (i.e., "immersione"), from 0.46 meters to 0.74 meters, measured in 0.02 meter increments;

[0056] Figure 25 is a graph depicting wake wave height versus distance from the boat's transom, for a boat in accordance with the invention, while operating in the dynamic surfing mode;

[0057] Figure 26 is a graph depicting waves in the wake of the boat while operating in the dynamic surfing mode in accordance with the invention;

[0058] Figure 27 is a graph depicting wave height versus distance from a centerline of the boat and distance from a transom, while operating in the dynamic surfing mode in accordance with the invention; and

[0059] Figure 28 is a view of the stern of the boat in accordance with the invention, depicting the transom and inward-rotating propellers.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0060] Reference will now be made in detail to the presently preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings.

[0061] A presently preferred embodiment of a wakesurfing boat in accordance with the present invention is shown in Fig. 1 and is designated generally by reference numeral 10.

[0062] As broadly embodied herein and referring to Fig. 1, the wakesurfing boat 10 includes a hull 12.

[0063] Referring to Figs. 1-3, hull 12 includes a bow 14, a stern 16, a port bulwark 18, a starboard bulwark 20, a length L, and a beam B.

[0064] Preferably, hull 12 is a planing hull. Different hull lengths are possible and within the broad scope of the invention, including, without limitation, a 43 foot yacht, a 35 foot cruiser, and a 28 foot sport boat. Other hull lengths also are within the scope of the invention e.g., 20 feet through 60 feet. In accordance with the invention, regardless of the boat length L selected, a maximum beam B always is selected such that the length to beam ratio L/B of the respective hull 12 is less than or equal to 3.0, *i.e.*, $L/B \leq 3.0$.

[0065] As further broadly embodied herein, with reference to Figs. 2-7, the hull 12 includes a bottom 22. Bottom 22 extends from the bow 14 to the stern 16, and from the port bulwark 18 to the starboard bulwark 20. Bottom 22 preferably is configured, when viewed longitudinally, in cross-section, substantially in a W-shape, with a central inverted V-shaped portion 26 extending from the bow 14 to the stern 16. Referring to Figs. 4A-4N, the inverted V-shaped portion 26 has an apex angle α, which differs at selected locations $\alpha_1 ... \alpha_n$ along the length L of the hull. The apex angles $\alpha_1 ... \alpha_n$ are depicted in Figs. 4A-4N as $\alpha_1 ... \alpha_{14}$, with a cross-sectional cut taken at regular intervals along the length L of the hull, extending between the bow 14 and the stern 16. Preferably, the apex angles α vary from α_1, approximately 178°, proximate the bow 14, as shown in Fig. 4A, through a sequence of steeper and shallower apex angles $\alpha_2 ... \alpha_{14}$, *e.g.*, α_7, approximately 152°, proximate a point roughly amidships, as shown in Fig. 4G, to α_{14}, approximately 179°, proximate the stern 16, as shown in Fig. 4N.

[0066] To port and starboard of the central inverted V-shaped portion 26, the bottom 22 further includes an inclined portion 30 on the port side of the hull, and an inclined portion 32 on the starboard side of the hull, connecting the central inverted V-shaped portion 26 to the port and starboard bulwarks 18 and 20, respectively, thereby defining the substantial cross-sectional W shape of the bottom 22. The W shape forms the entire bottom 22 of the hull 12, from the port bulwark 18 to the starboard bulwark 20. The W shape, defined by the inclined portions 30 and 32, and the central V-shaped portion 26 further includes a port nadir 24 at the bottom of the inclined portion 30, a starboard nadir 25 at the bottom of the inclined portion 32, and a central apex 27 at the inverted peak of the V-shaped portion 26.

[0067] The central inverted V-shaped portion 26 defines a funnel 28. As depicted in Fig. 8, when the hull 12 moves through a body of water, agitating a surface microlayer thereof, water is deflected by the nadirs 24 and 25 of the W-shaped bottom into and through the funnel 28 defined by the V-shaped portion 26. Water exiting the funnel 28 at the stern of the boat will help define wake waves.

[0068] As broadly embodied herein, the wakesurfing boat 10 further includes a trim and displacement-altering ballast system 34, supported within the hull 12. Referring to Fig. 9, the system 34 includes a plurality of dual sets of ballast tanks 36a/36b, 37a/37b, and 38a/38b, positioned at selected symmetrical positions along the length of hull 12. As embodied in Fig. 9, a first set of dual ballast tanks 36a/36b are positioned proximate the port and starboard bulwarks 18 and 20, respectively, and are the farthest forward of all of the sets of ballast tanks. As further embodied in Fig. 9, a second set of dual ballast tanks 37a/37b are positioned proximate the port and starboard bulwarks 18 and 20, respectively aft of ballast tanks 36a/36b, and approximately amidships. As further embodied in Fig. 9, a third set of dual ballast tanks 38a/38b are positioned proximate the port and starboard bulwarks 18 and 20, respectively, proximate the stern 16 of the hull 12. The different sets of ballast tanks have different volumes, and accordingly, when filled or partially filled with ballast water, have different weights, correspondingly displacing different amounts of water beneath the hull, as roughly set forth in the chart below, with tolerances of approximately 10%, as would be understood by one of ordinary skill in the art of naval architecture:

Ballast Tanks	**36a/36b**	**37a/37b**	**38a/38b**
Individual Tank Volume	1,295 liters/tank	1,965 liters/tank	1,330 liters/tank
Combined Ballast Tank Volume	2,590 liters	3,930 liters	2,260 liters
Total Ballast	9,180 liters		
Total Weight	**22,629 Kg**		

[0069] The approximate total weight (ballast + weight of the half-loaded boat) listed above is calculated taking into consideration the presence of frames, structures and valves in the ballast tanks, which take up approximately 6% of the volume of each tank, (approximately 100 liters/ballast tank), *i.e.*, 9,180 liters - .060 (9,180 liters) = 8,629 liters x 1,000 kg/m^3 (*i.e.*, density of fresh water) = 8,629 Kg + 14,000 Kg (*i.e.*, weight of the half-loaded boat) = 22,629 Kg. As noted, the density of fresh water, (*i.e.*, 1,000 kg/m^3) was used in this calculation. A person of ordinary skill in the art will recognize that the results of this calculation will differ if the density of salt water (*i.e.*, 1,025 kg/m^3 -1,035 kg/m^3) is used in the calculation. The wakesurfing boat of the invention is buoyant and operable both in fresh water and in salt water.

[0070] Since, under Archimedes Principle, a weight of the hull 12 corresponds to a weight of water displaced by the hull 12, a ballast tank-empty (*i.e.*, "Lightship") displacement, M_{LCC}, of the half-loaded hull 12 = 14,000 Kg.

[0071] As shown above, a ballast tank-filled displacement, M_{LDC}, of the half-loaded hull 12 = 22,629 Kg.

[0072] As broadly embodied in Fig. 10, when the hull 12 is in the Lightship condition, with the ballast tanks empty, water rises on the hull to a first waterline WL_1.

[0073] As broadly embodied in Fig. 11, when the ballast tanks are 50% filled, the water rises to a second waterline WL_2.

[0074] As broadly embodied in Fig. 12, when the ballast tanks are 100% filled, the water rises to a third waterline WL_3.

[0075] Fig. 13 graphically depicts drafts for various displacements of the hull 12 in accordance with the invention.

[0076] Fig. 14 broadly depicts a traditional power boat, such as a traditional waterskiing boat, cruiser, or sport boat, moving through a body of water.

[0077] The hull 12 in accordance with the invention, with ballast tanks empty or nearly empty, cruising through a body of water in a "cruising" mode, is depicted in Fig. 15. The resistance of the water against the planing hull lifts the bow 14 up, correspondingly pushing the stern 16 down, so that the hull 12 is a trimmed stern down with a first trim angle θ_1. In this operating mode, only a relatively small first portion 52 of the hull bottom 22 contacts the body of water. In addition, a first amount of water is forced through the funnel 28 defined by the inverted V-shaped bottom 12. With these parameters, the water provides a relatively minor first amount of resistance to the hull, as the hull passes through the body of water.

[0078] Fig. 16 depicts the hull 12 in accordance with the invention, with ballast tanks 100% filled with ballast water, sitting static in the water in a ballasted static mode. A second portion 53 of hull bottom 22 is in contact with the body of water. Because of the greater weight added by the ballast water, the hull 12 squats lower in the water. For this reason, the second portion 53 of the hull bottom is greater than first portion 52 of the hull bottom when the hull 12 is operating in the cruising mode. Also, in this ballasted static mode, the hull is trimmed bow down, with a second trim θ_2.

[0079] Fig. 17 depicts the hull 12 in accordance with the invention, with the ballast tanks 100% filled with ballast water, and the hull 12 moving through the body of water in a dynamic surfing mode. This is the operating mode intended for the surfer to wakesurf, in accordance with the invention. The bow 14 of the hull 12 is pushed partially upward by force of the water, but due to the increased weight of the ballast water in the filled or at least partially-filled ballast tanks, the bow 14 is not pushed upward as high as it is in the cruising mode. The hull 12, therefore, is trimmed in an intermediate third trim θ_3, intermediate the stern-down trim θ_1 of the cruising mode and the bow-down trim θ_2 of the ballasted static mode. Moreover, the extra ballast water in the ballast tanks, causing the hull 12 to squat lower in the water, combined with the lower bow 14 associated with the intermediate trim θ_3, results in a third portion 54 of the W-shaped hull bottom 22 being in contact with the body of water. The third portion 54 of the W-shaped hull bottom 12 is intermediate the first portion 52 of the hull bottom 22 contacting the body of water in the cruising mode, and the second portion 53 of the W-shaped hull bottom 22 contacting the body of water in the ballasted static mode, *i.e.*, more of the W-shaped bottom 22 is in contact with the body of water in dynamic surfing mode than it is in the cruising mode. In addition, in the dynamic surfing mode, a second larger amount of water is forced through the funnel 28 defined by the inverted V-shaped bottom 12. The combination of the increased weight due to the ballast water, the resultant increased displacement, the increased third portion 54 of the W-shaped bottom 12 being in contact with the water, the intermediate trim θ_3, and the increased amount of water passing through the funnel 28 are parameters which increase resistance to the hull 12 as it passes through the body of water.

[0080] Moreover, when the hull 12 moves through the body of water in the cruising mode, with the ballast tanks substantially empty, having a first weight, displacing a first amount of displaced water, having the stern-down trim angle θ_1, the first amount 52 of hull bottom 22 in the water, the first amount of water forced through the funnel 28 defined by the inverted V-shape of the bottom 12, and the relatively minor amount of water resistance, at least one first wake W_1 is generated, with a first wake height W_{h1}, of approximately 10 - 15 cm.

[0081] When the hull 12 moves through the body of water in the dynamic surfing mode, with the ballast tanks 100% filled or at least partially filled, having at least the second weight greater than the first weight, displacing at least the second amount of displaced water greater than the first amount of displaced water, having the third trim θ_3 intermediate the stern-down cruising mode trim θ_1, and the bow-down ballasted static mode trim θ_3, the larger portion 54 of the W-shaped hull bottom 22 in contact with the body of water, the increased second amount of water forced through the funnel 28 defined by the central inverted V-shape of the bottom 12, and the increased amount of water resistance, at least one wake wave W_2 is generated, having a wave height W_{h2}. W_{h2} of wake wave W_2 generated in the dynamic surfing mode is greater than the wake height W_{h1} of the wake W_1 generated in the cruising mode.

[0082] Preferably, the height W_{h2} of at least one wake wave W_2 is approximately 0.5 meters to approximately 2.7

meters, depending on the length of hull 12. Fig. 19 graphically depicts projected wave heights for hull lengths from 20 feet to 60 feet, respectively.

[0083] In addition, the trim and displacement-altering ballast system of the present invention allows the operator to fill or partially fill selected ones of the respective ballast tanks, to achieve various different moment arms, displacements, and trims, as desired, to change wake wave heights. When selected ones or all of the ballast tanks are filled or partially filled with ballast water, and the boat operates in the dynamic surfing mode, with the hull still squatting lower in the water, though not as low as with the ballast tanks 100% filled, the hull is trimmed with a plurality of trim angles $\theta_{4.}$ .. θ_n. Fig. 18, for example, depicts hull 12 in the dynamic surfing mode, with the ballast tanks 50% filled.

[0084] The hull depicted in Figs. 2-3 and 15-18 is a 43 foot yacht hull. As stated above, however, the present invention is not limited to this hull length. Figs. 20A-20C depict a 20 foot hull. Figs. 21A-21C depict a 28 foot sport boat hull. Figs. 22A-22C depict a 35 foot cruiser hull. Figs. 23A-23C depict a 60 foot hull.

[0085] Fig. 24 broadly depicts changes in several static dimensions, of a 43 foot hull at different drafts from 0.46 meters to 0.74 meters, measured at 0.02 meter intervals.

[0086] Fig. 25 graphically depicts wake wave heights generated by the hull in the dynamic surfing mode, versus distance from the boat's transom at the boat's centerline CL, and also at one meter and two meters away from the boat's CL (all wake wave heights being measured from the bottom of the boat, with the baseline representing a surface of the body of water). Fig. 25 depicts wave height W_{h2} of at least one wake wave W_2 of a plurality of dynamic surfing mode wake waves W_2. The wave height W_{h2} of wake wave W_2 depicted in Fig. 25 is approximately 1.5-2.0 meters.

[0087] Fig. 26 graphically depicts a plurality of wake waves generated in the wake of the hull during the dynamic surfing mode.

[0088] Fig. 27 depicts a height of one wake wave generated by the hull during the dynamic surfing mode versus distance from the boat's centerline and distance from the boat's transom.

[0089] Figs. 25-27, viewed together, demonstrate that at least one wake wave W_2 generated by the hull in the dynamic surfing mode is relatively large and extends for a relatively long time and distance in the wake of the hull 12, thereby enabling the wakesurfer to have a much longer ride, limited only by the surfer's leg strength, skill, and physical conditioning.

[0090] Further in accordance with the invention, the wakesurfing boat 10 is self-propelled. One or more engines (not shown) are linked via appropriate shafts, gears, and linkages (also not shown), to a pair of counter-rotating propellers 45 and 46, projecting from a transom 48 at the stern 16 of hull 12. Fig. 28 depicts inward-rotating propellers 45 and 46. As broadly depicted in Fig. 22, propeller 45 rotates in a clockwise direction ϕ_1, and propeller 46 rotates in a counter-clockwise direction ϕ_2.

[0091] It will be apparent to those skilled in the art that various modifications, and variations can be made to the preferred embodiment described above, without departing from the spirit or scope of the invention. The present invention covers any such modifications thereof, provided they fall within the scope of the claims and their equivalents.

Claims

1. A wakesurfing boat operable in a body of water, comprising:

a hull comprising a bow, a stern, a port bulwark, a starboard bulwark, a bottom, a length L, and a beam B; and
a ballast system supported by the hull, the ballast system comprising a plurality of ballast tanks, configured to alternatively and selectively receive and discharge ballast water, in order to trim the hull, in one of a plurality of modes, including:

(i) a cruising mode, wherein the ballast tanks are substantially empty, the hull is moving through the body of water, the hull has at least a first weight, displacing at least a first amount of displaced water corresponding to the first weight, and a first portion of the hull bottom is in contact with the body of water;
(ii) a ballasted static mode, wherein the ballast tanks are filled or at least partially filled with ballast water, the hull is static in the body of water, the hull has at least a second weight greater than the first weight, displacing at least a second amount of displaced water corresponding to the second weight, the second amount of displaced water being greater than the first amount of displaced water, and a second portion of the hull bottom is in contact with the body of water, the second portion being greater than the first portion; and
(iii) a dynamic surfing mode, wherein the ballast tanks are filled or at least partially filled with ballast water, the hull is moving through the body of water, the hull has at least the second weight, displacing at least the second amount of displaced water, and a third portion of the hull bottom is in contact with the body of water, the third portion being intermediate the first portion and the second portion;

wherein in the cruising mode, the hull has a first trim θ_1 down by the stern;

wherein in the ballasted static mode, the hull has a second trim θ_2 down by the bow; and
wherein in the dynamic surfing mode, the hull has a third trim θ_3 intermediate the first trim and the second trim.

2. The wakesurfing boat of claim 1, wherein the bottom is configured as a central inverted V in cross-section, with the central inverted V commencing at the bow and extending to the stem.

3. The wakesurfing boat of claim 2, wherein the central inverted V defines a plurality of apex angles $\alpha_1...\alpha_n$ at preselected positions extending from the bow to the sternm.

4. The wakesurfing boat of claim 1, wherein a length to beam ration (L/B) of the hull is less than or equal to 3.0.

5. The wakesurfing boat of claim 1, wherein the ballast tanks comprise a plurality of sets of dual tanks, each of the ballast tanks of each being positioned on the hull at generally symmetrical locations with respect to one another.

6. The wakesurfing boat of claim 5, wherein the sets of dual tanks are configured such that, when selected tanks are filled or at least partially filled with the ballast water in the dynamic surfing mode, the hull is trimmed with a plurality of trim angles $\theta_{4.}$ .. θ_n.

7. The wakesurfing boat of claim 1, wherein the hull bottom extends from the starboard bulwark to the port bulwark, and from the bow to the stern, the bottom in its entirety being configured as a W in cross-section, including port and starboard nadirs, and a central apex, wherein the central apex of the W defines a ventral inverted V, the central inverted V extending from the bow to the stern.

8. The wakesurfing boat of claim 1, wherein when the hull operates in the body of water in the cruising mode, it generates at least one wake W_1 having a first wake height W_{h1}.

9. The wakesurfing boat of claim 8, wherein when the hull operates in the body of water in the dynamic surfing mode, it generates at least one wake wave W_2 having a second wake wave height W_{h2} that is greater than the first wake height W_{h1}.

10. The wakesurfing boat of claim 1, wherein the hull further comprises a transom, and is self-propelled by a pair of inward-rotating propellors projecting from the transom.

11. A hull for wakesurfing boat, comprising:

a bow;
a stern;
a port and starboard bulwarks;
a length L and a beam B;
a bottom extending from the bow to the stern, and from the port bulwark to the starboard bulwark, the bottom in its entirety being configured substantially as a W in cross-section, including port and starboard nadirs and a central apex, wherein the central apex defines a central inverted V portion extending from the bow to the stern, the central inverted V portion having an apex angle α changing at preselected positions between the bow and the stern; and
a trim and displacement altering system selectively altering a trim and an amount of water displaced by the hull, including a plurality a ballast tanks and ballast water, thereby providing the hull with a plurality of modes, including:

(i) a cruising mode, with the hull moving through the body of water, the ballast tanks substantially empty, displacing at least the first amount of displaced water, a first portion of the bottom being in contact with a body of water, and creating at least one first wake W_1 in the body of water, the first wake having a first wake height W_{h1};
(ii) a ballasted static mode, with the hull static in the body of water, the ballast tanks filled or at least partially filled with ballast water, displacing at least a second amount of displaced water greater than the first amount of displaced water, and having a second portion of the bottom in contact with the body of water, the second portion being greater than the first portion; and
(iii) a dynamic surfing mode, with the hull moving through the body of water, the ballast tanks filled or at least partially filled with ballast water, displacing at least the second amount of displaced water, a third portion of the bottom in contact with the body of water, the third portion being intermediate the first portion

and the second portion; and creating at least one second wake wave W_2 in the body of water, the second wake wave having a second wave height W_{h2}.
wherein in the cruising mode, the hull has a first trim θ_1 down by the stern;
wherein in the ballasted static mode, the hull has a second trim θ_2 down by the bow; and wherein in the dynamic surfing mode, the hull has a third trim θ_3 intermediate the first trim and the second trim.

12. The hull of claim 11, wherein the plurality of ballast tanks are configured to be, alternately and selectively, substantially empty of, filled with, or partially filled with, ballast water.

13. The hull of claim 11, wherein the length of the hull is selected from the group consisting of 20 feet, 28 feet, 35 feet, 43 feet, and 60 feet.

14. The hull of claim 11, wherein the second wake wave height W_{h2} is greater than the first wake height W_{h1}, and is approximately 0.5 meters to approximately 2.7 meters.

15. The hull of claim 11, wherein a length to beam ration L/B is less than or equal to 3.0.

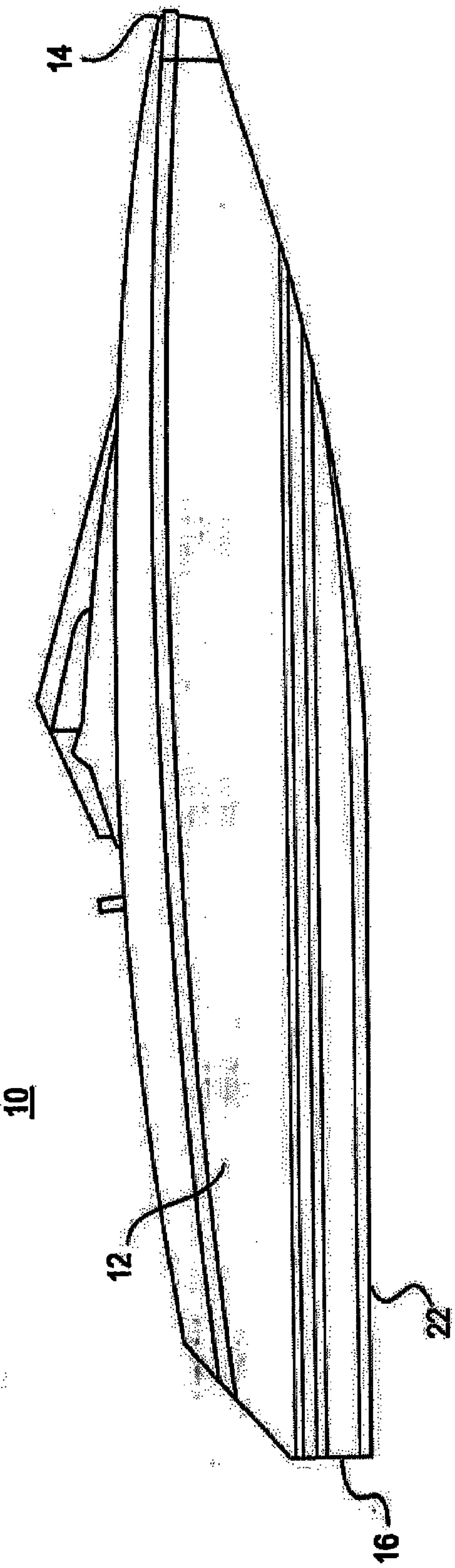

FIG. 1

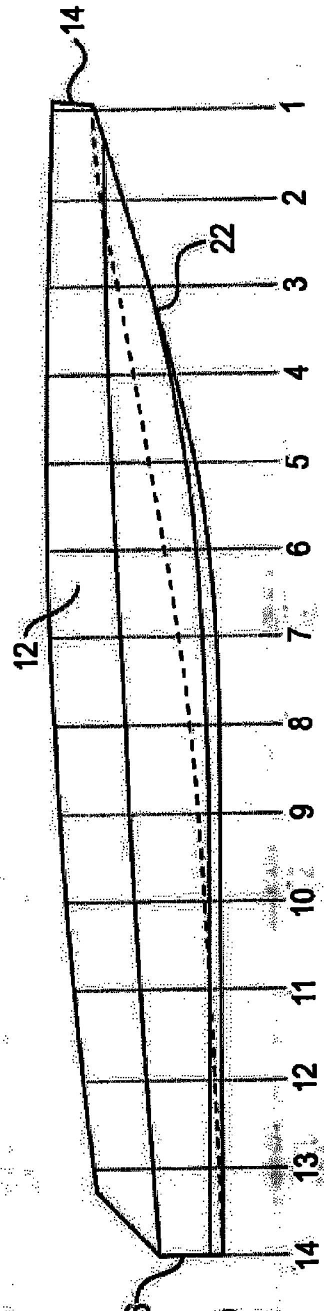
14
12
22
16
1
2
3
4
5
6
7
8
9
10
11
12
13
14

FIG. 2

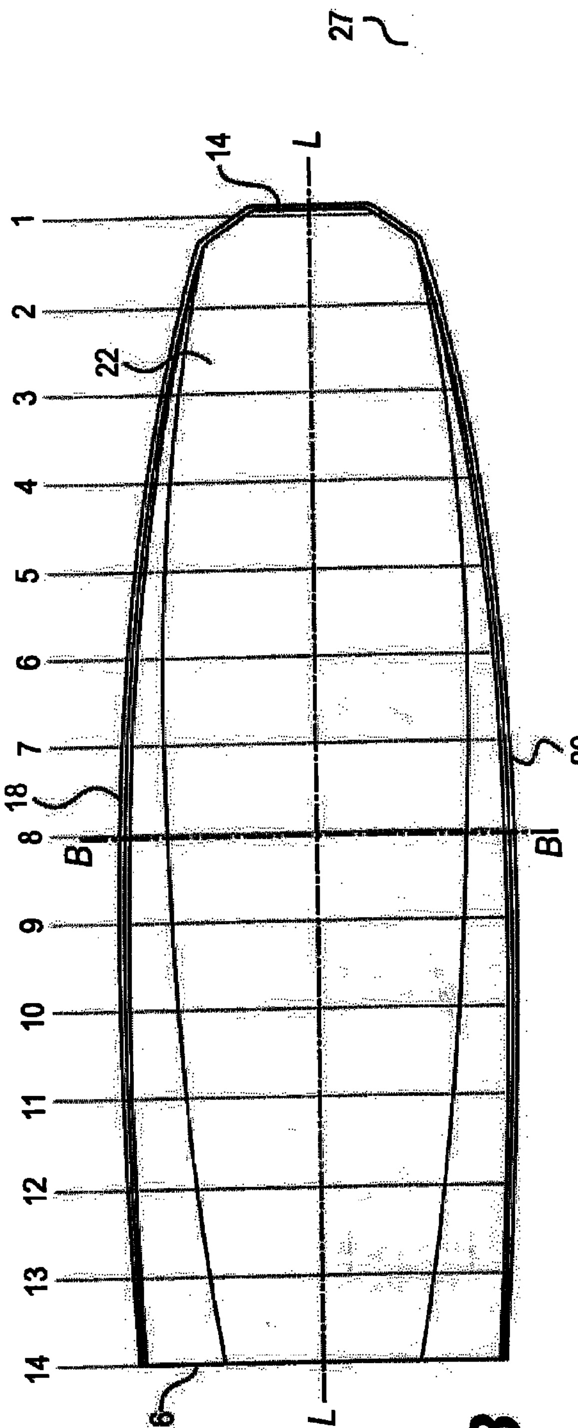
27
14
L
22
18
20
B
B
16
L
1
2
3
4
5
6
7
8
9
10
11
12
13
14

FIG. 3

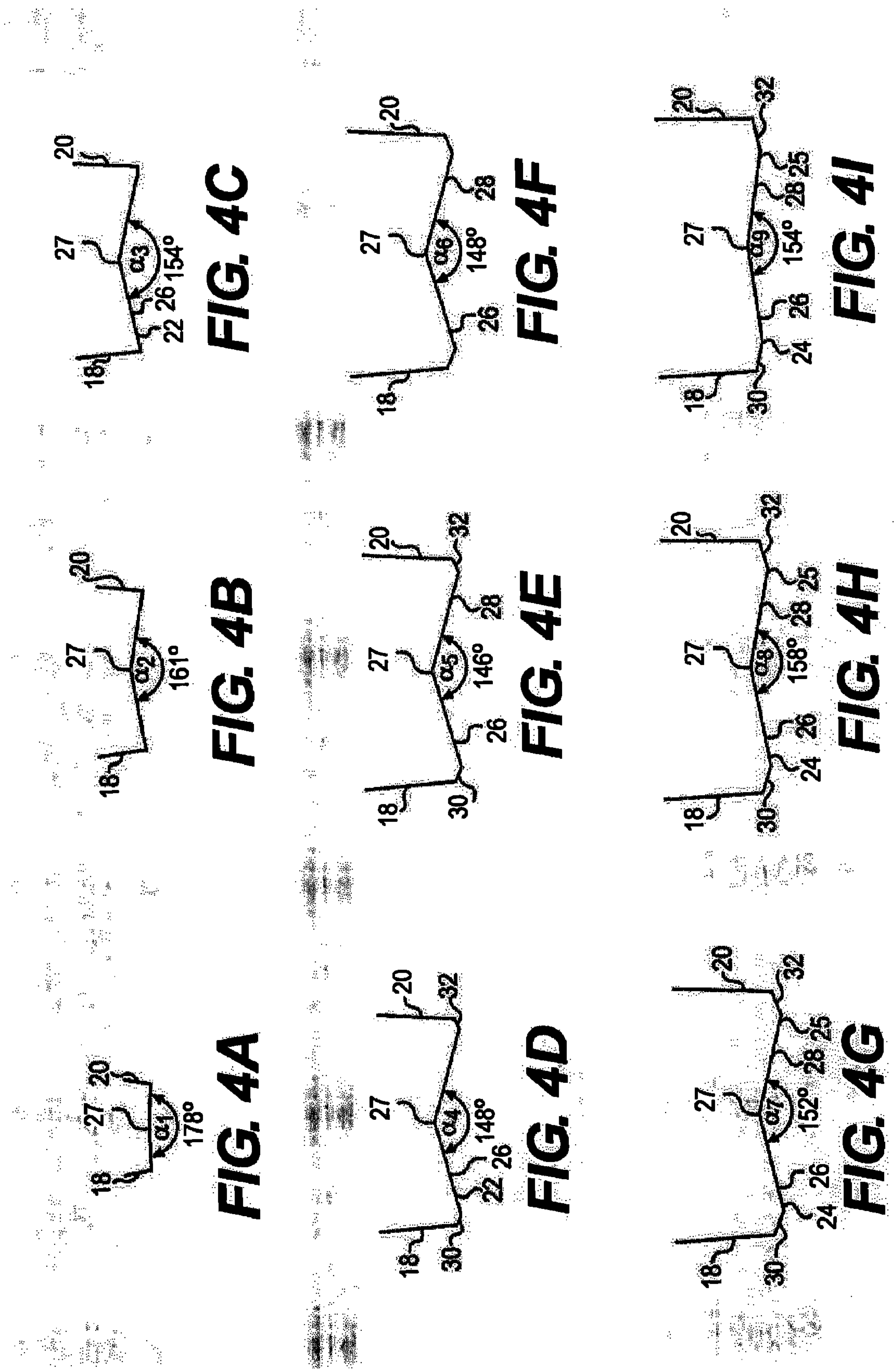

FIG. 4A FIG. 4B FIG. 4C FIG. 4D FIG. 4E FIG. 4F FIG. 4G FIG. 4H FIG. 4I

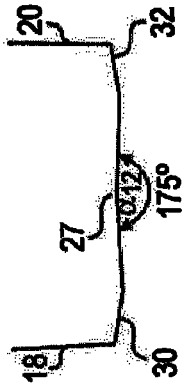

FIG. 4L

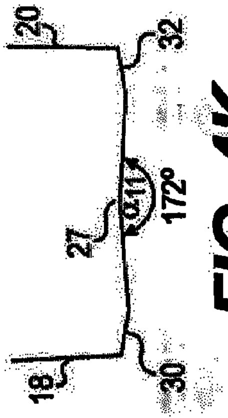

FIG. 4K

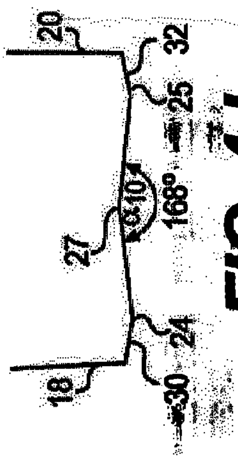

FIG. 4J

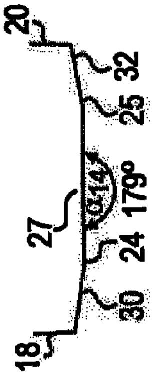

FIG. 4N

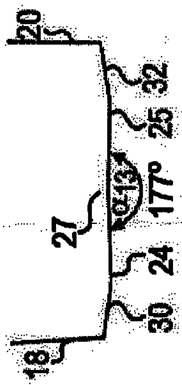

FIG. 4M

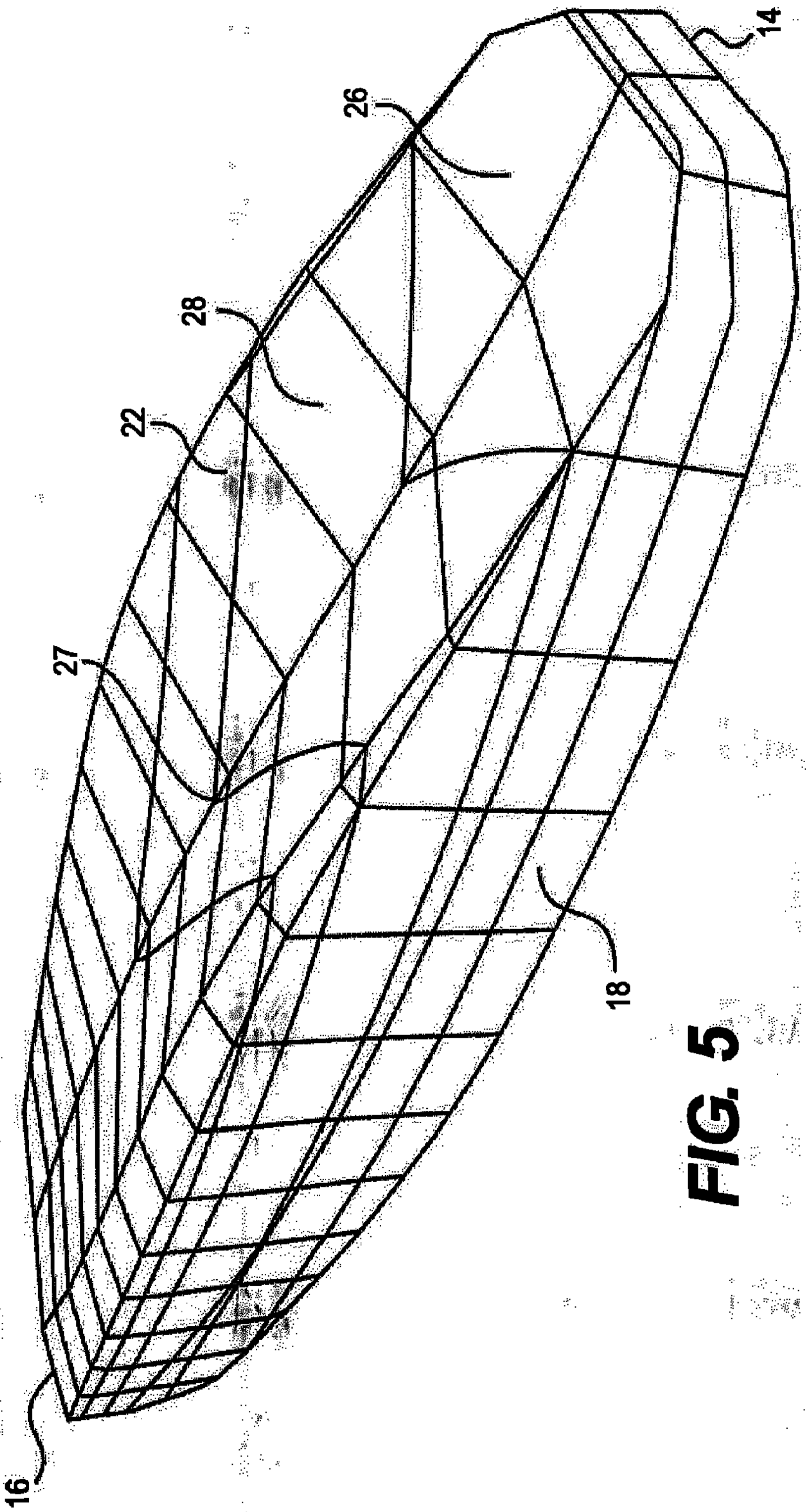

FIG. 5

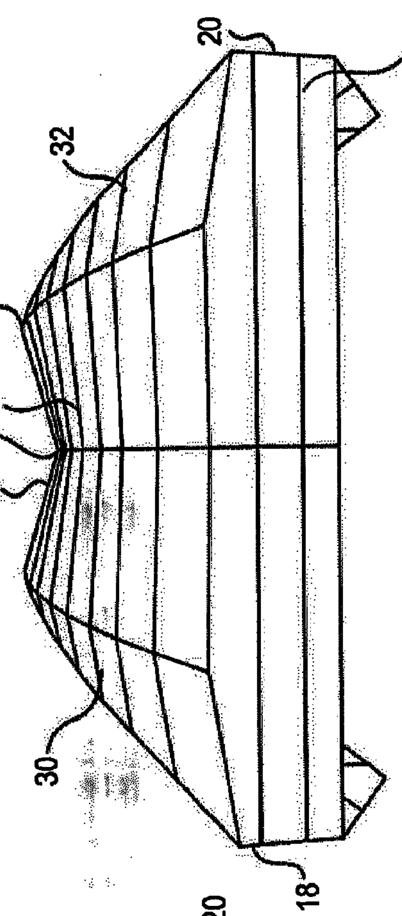

FIG. 7

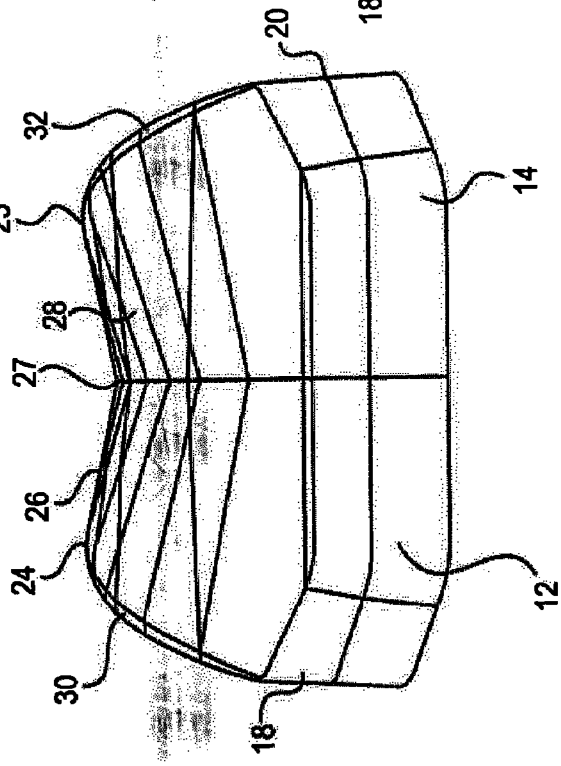

FIG. 6

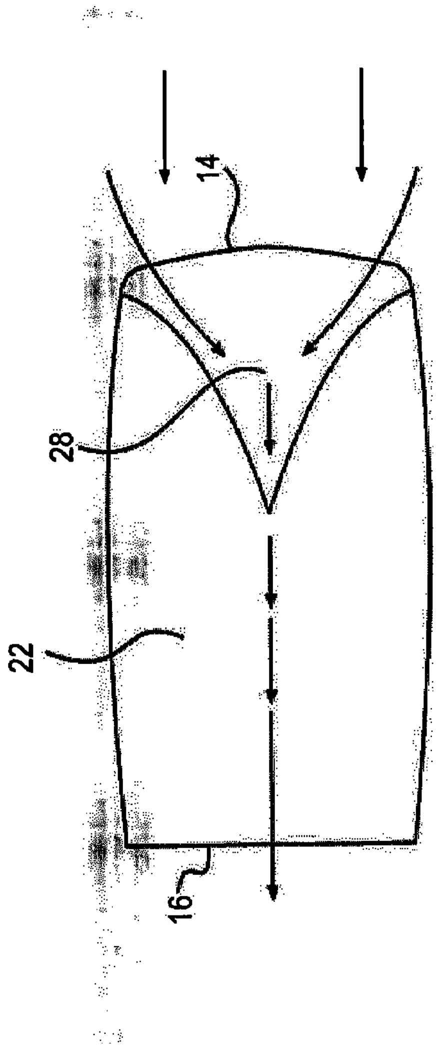

FIG. 8

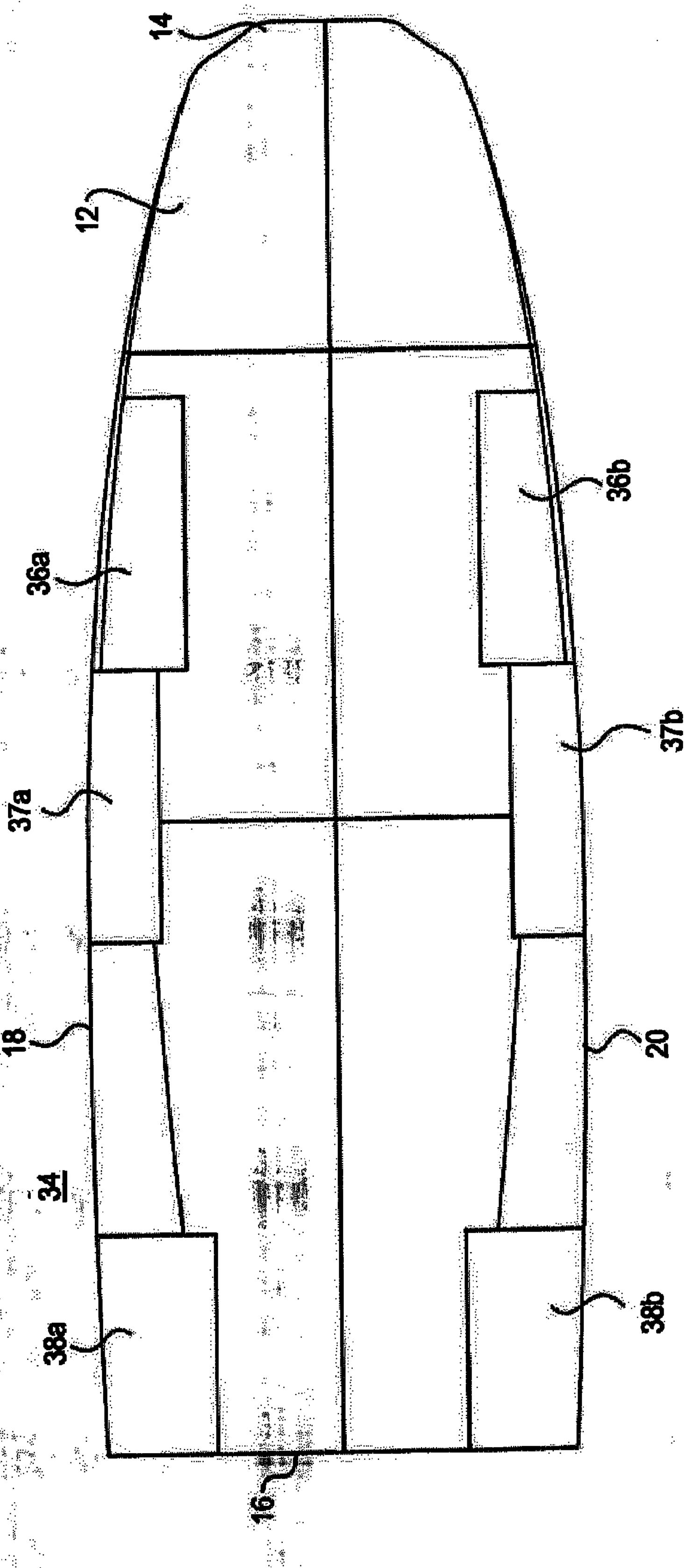

FIG. 9

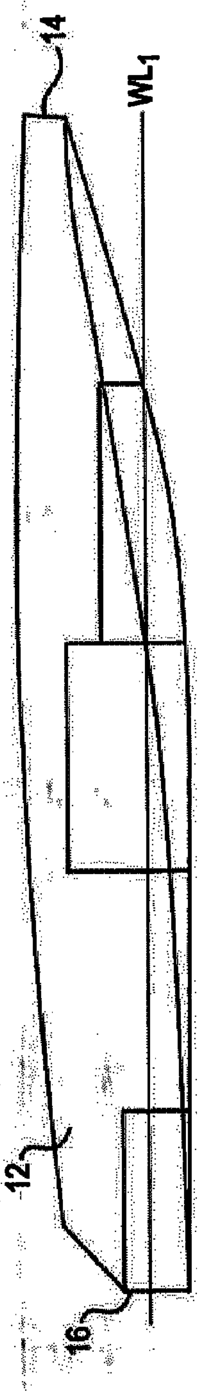

FIG. 10

FIG. 11

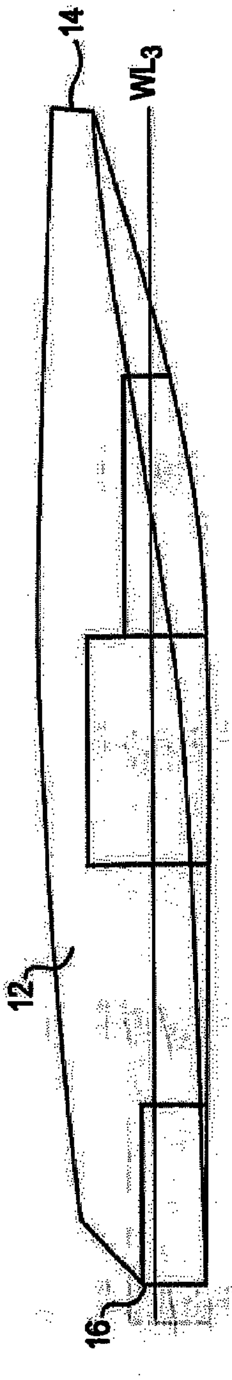

FIG. 12

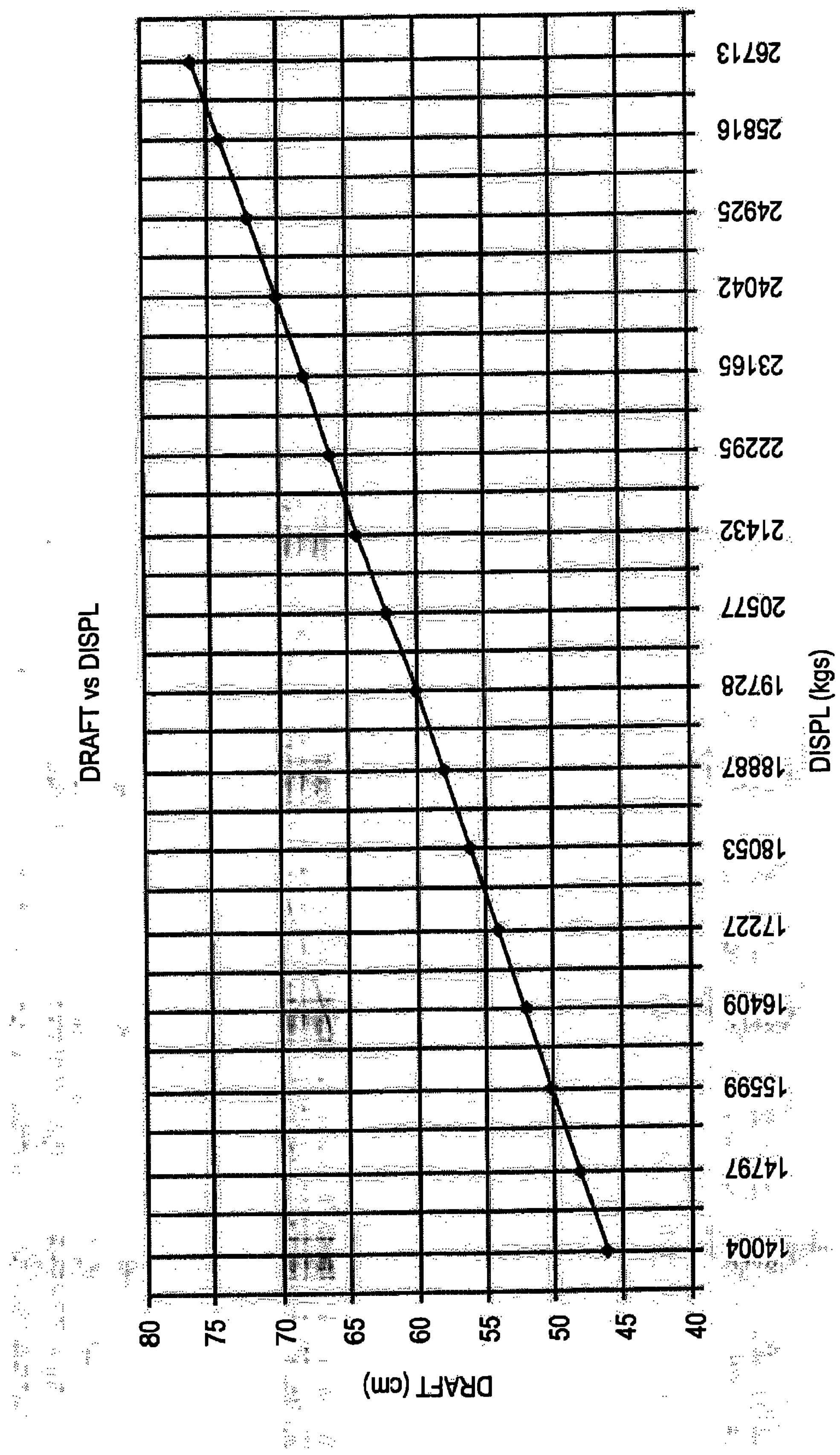
DRAFT vs DISPL
DRAFT (cm)
80
75
70
65
60
55
50
45
40
DISPL (kgs)
14004
14797
15599
16409
17227
18053
18887
19728
20577
21432
22295
23165
24042
24925
25816
26713

FIG. 13

FIG. 14
PRIOR ART

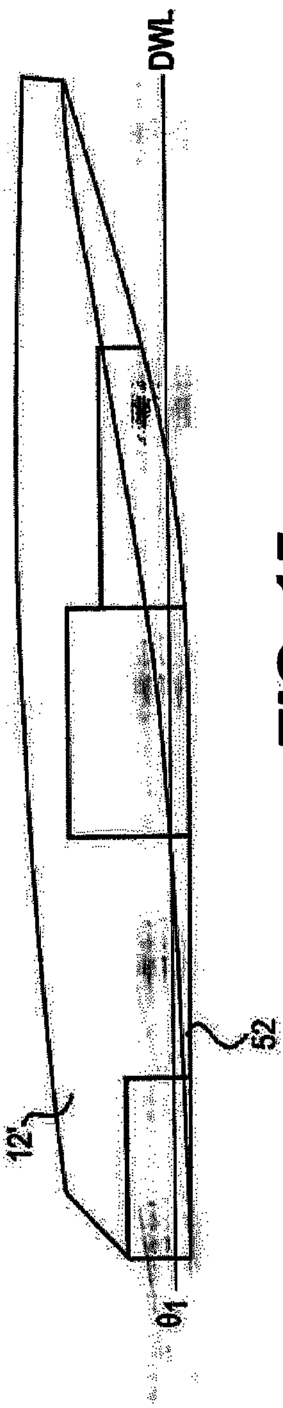

FIG. 15

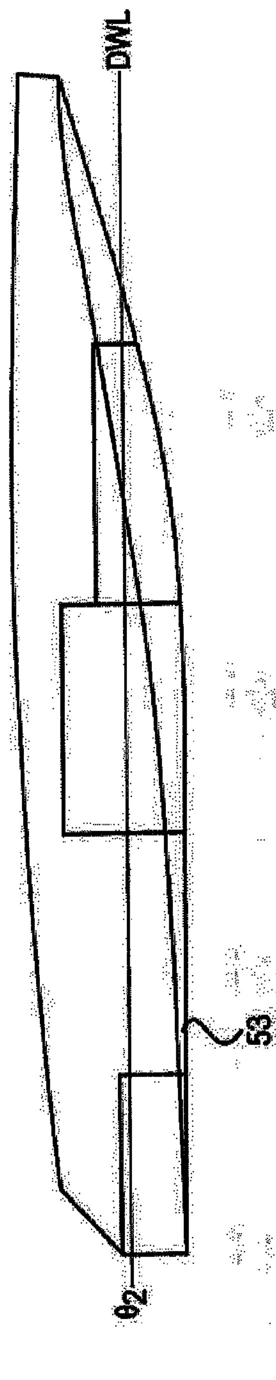

FIG. 16

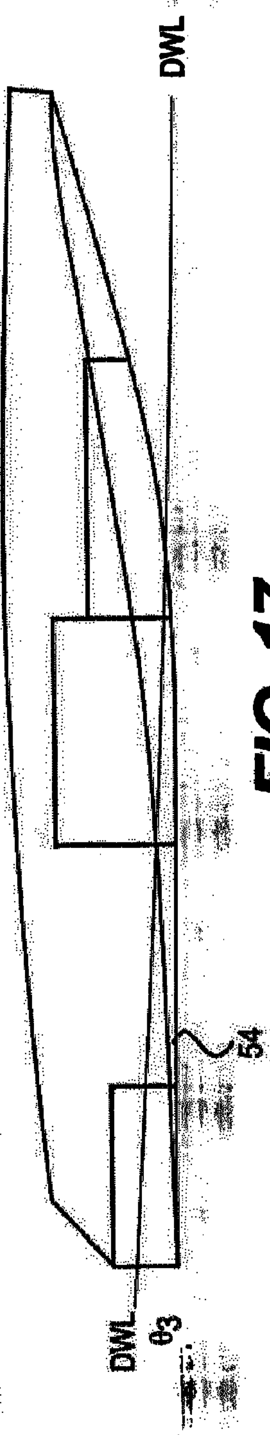

FIG. 17

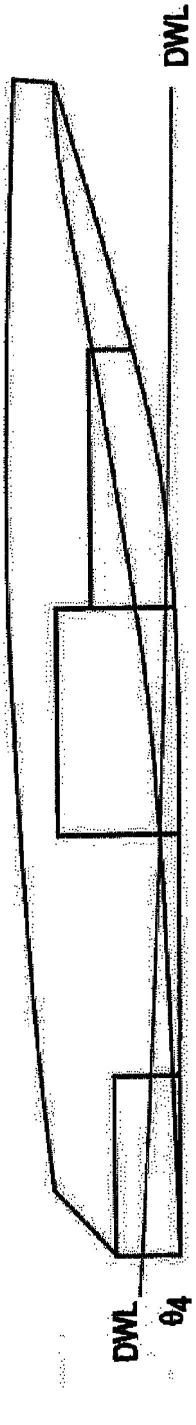

FIG. 18

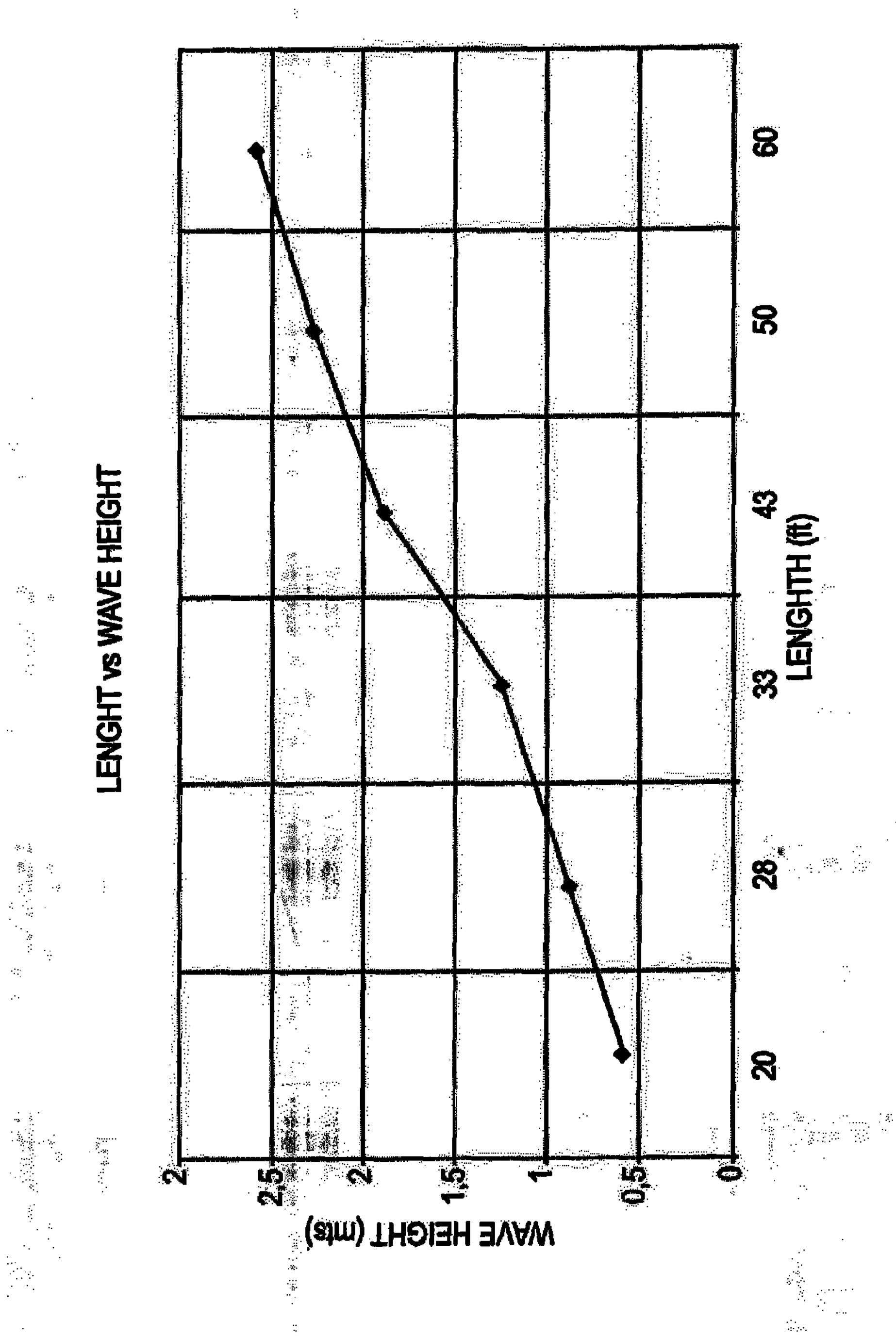
LENGHT vs WAVE HEIGHT
WAVE HEIGHT (mts)
2
2,5
2
1,5
1
0,5
0
20
28
33
43
50
60
LENGHTH (ft)

FIG. 19

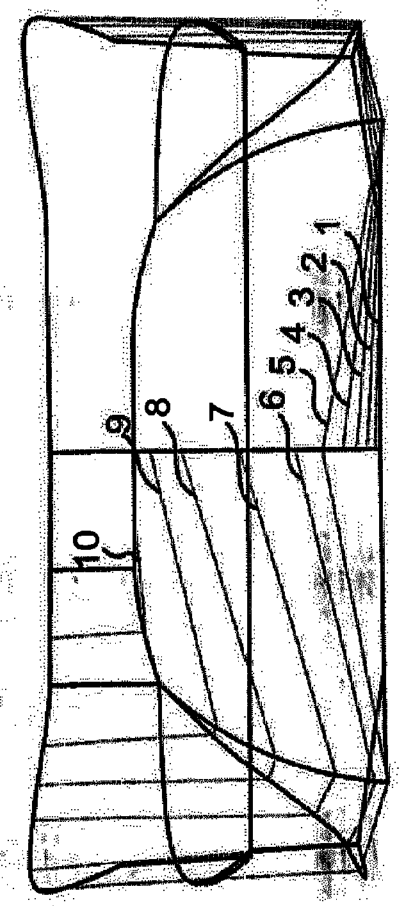

FIG. 20A

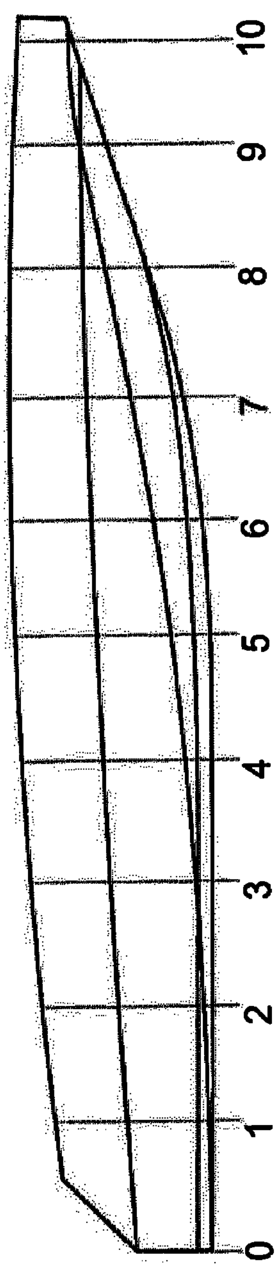

FIG. 20B

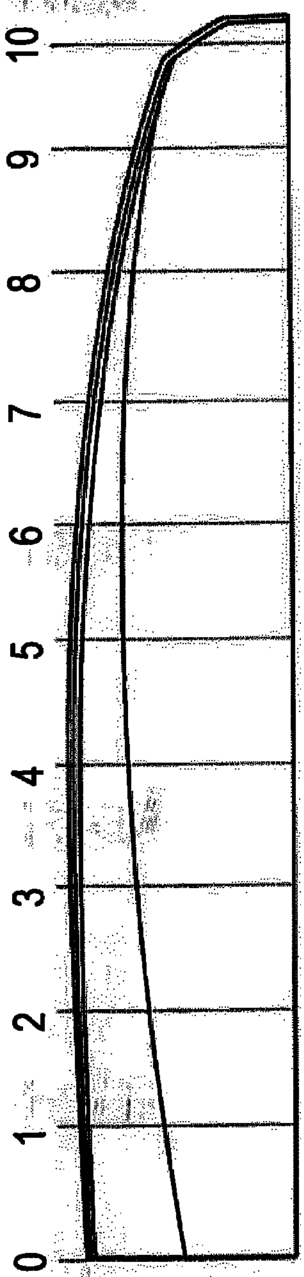

FIG. 20C

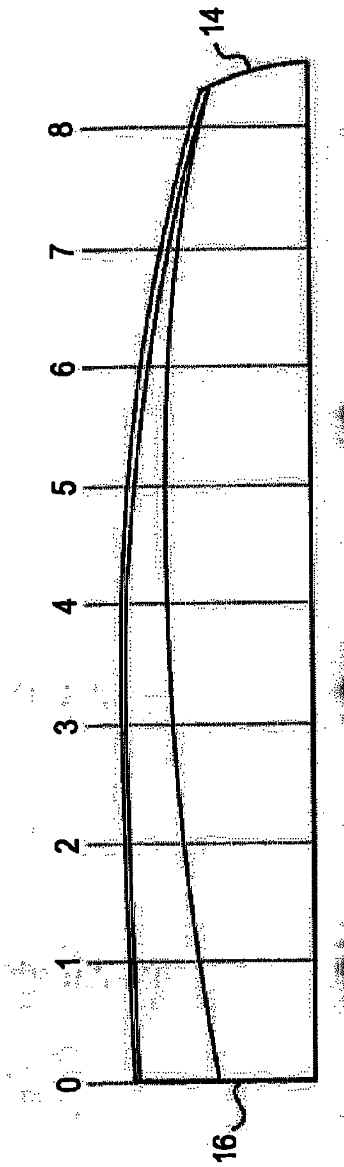

FIG. 21A

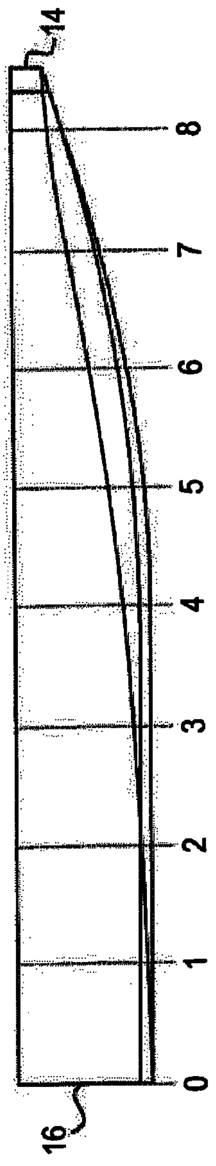

FIG. 21B

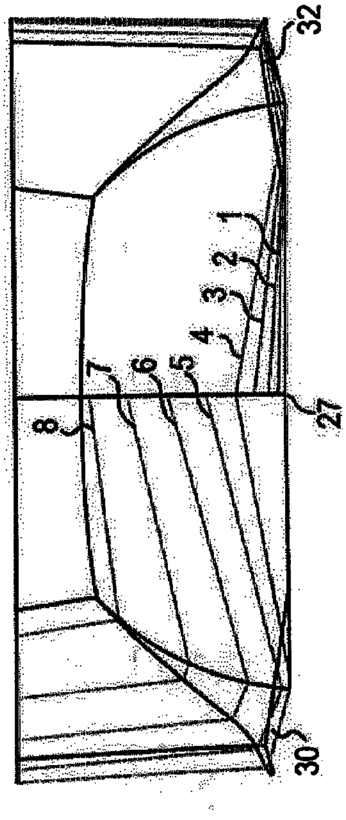

FIG. 21C

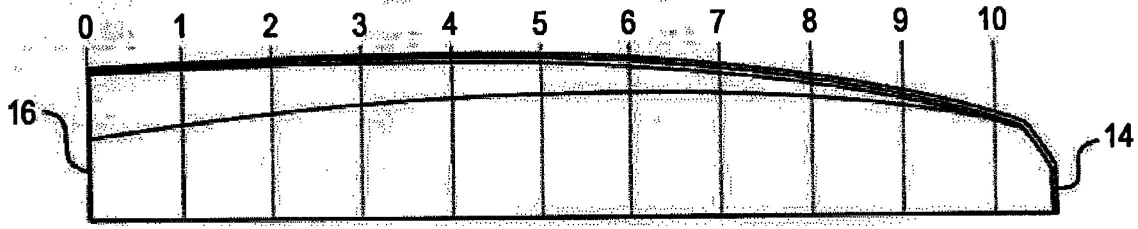

FIG. 22A

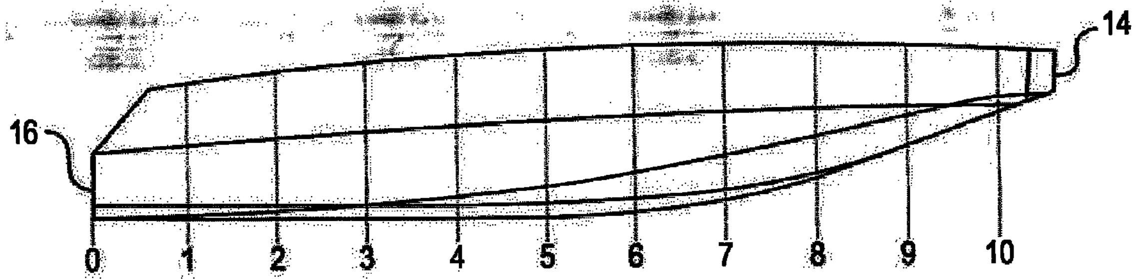

FIG. 22B

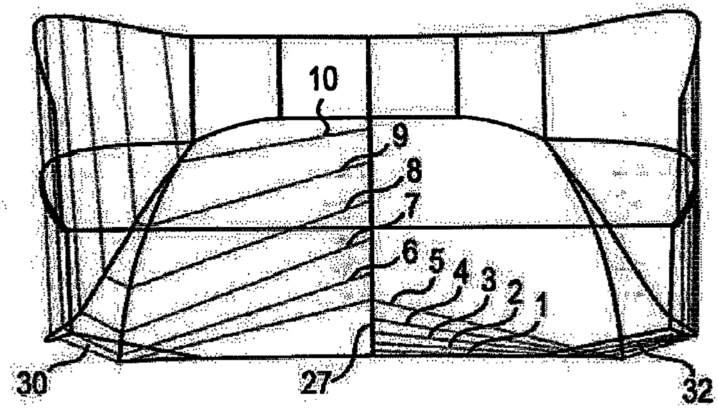

FIG. 22C

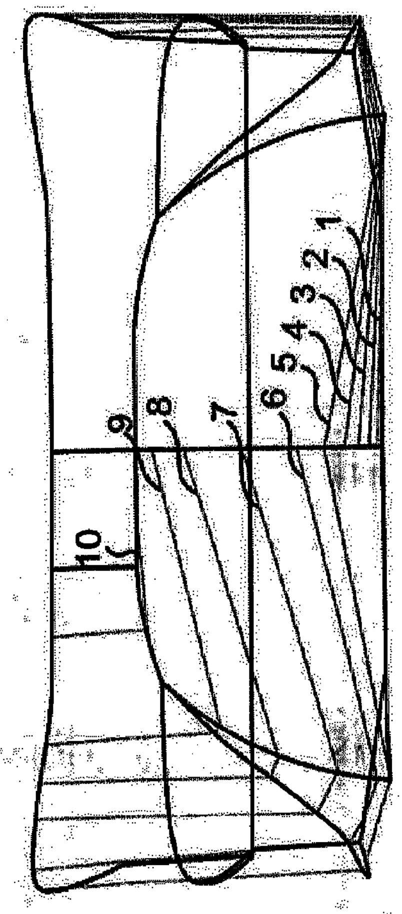

FIG. 23A

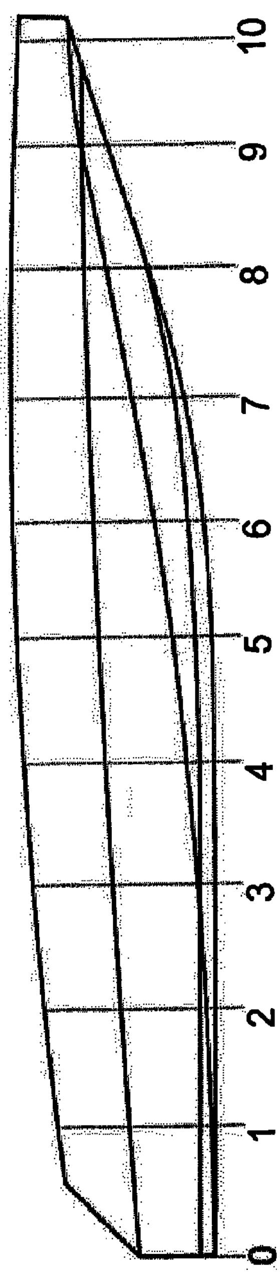

FIG. 23B

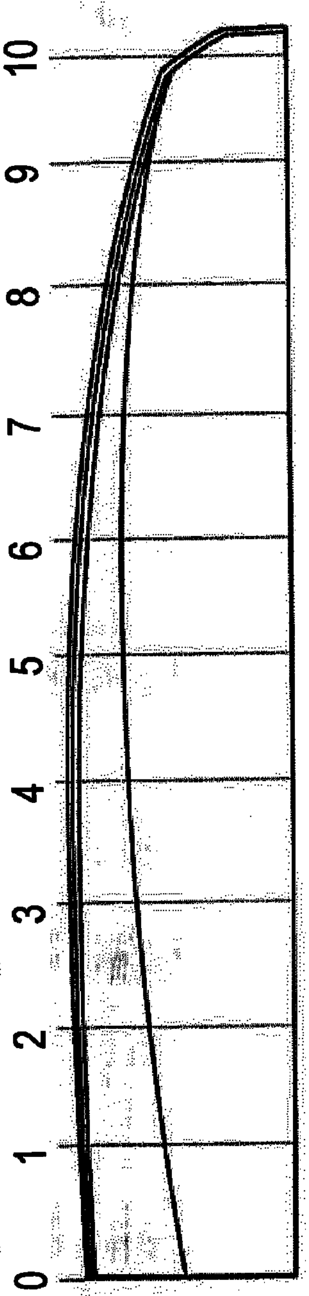

FIG. 23C

TRIM: 0.000 m

IMMERSIONE	LWL	BWL	VOLUME	DISPL	LCB	CB	CB	AM	CM	AW	CW	LCF	CP	S
m	m	m	m3	tonnes	m			m^2		m^2		m		m^2
0.460	10.142	4.421	13.662	14.004	3.904	0.505	0.505	1.365	0.661	38.495	0.654	4.523	0.764	47.007
0.480	10.215	4.422	14.436	14.797	3.938	0.511	0.511	1.452	0.674	38.913	0.661	4.568	0.759	47.912
0.500	10.288	4.423	15.218	15.599	3.972	0.517	0.517	1.539	0.685	39.320	0.668	4.612	0.755	48.809
0.520	10.360	4.424	16.009	16.409	4.005	0.523	0.523	1.625	0.696	39.716	0.675	4.656	0.751	49.699
0.540	10.431	4.425	16.807	17.227	4.037	0.529	0.529	1.712	0.706	40.102	0.681	4.698	0.749	50.583
0.560	10.501	4.426	17.613	18.053	4.068	0.534	0.534	1.799	0.715	40.479	0.688	4.739	0.747	51.459
0.580	10.570	4.427	18.426	18.887	4.098	0.540	0.540	1.886	0.724	40.850	0.694	4.780	0.746	52.333
0.600	10.639	4.428	19.247	19.728	4.128	0.545	0.545	1.973	0.732	41.214	0.700	4.820	0.744	53.202
0.620	10.708	4.430	20.075	20.577	4.158	0.550	0.550	2.060	0.740	41.570	0.706	4.859	0.744	54.065
0.640	10.776	4.431	20.910	21.432	4.186	0.555	0.555	2.147	0.747	41.920	0.712	4.898	0.743	54.926
0.660	10.843	4.432	21.751	22.295	4.215	0.560	0.560	2.234	0.754	42.264	0.718	4.936	0.743	55.783
0.680	10.911	4.433	22.600	23.165	4.242	0.565	0.565	2.321	0.760	42.602	0.724	4.973	0.743	56.637
0.700	10.978	4.434	23.455	24.042	4.270	0.569	0.569	2.408	0.766	42.934	0.730	5.010	0.743	57.487
0.720	11.045	4.435	24.317	24.925	4.297	0.574	0.574	2.495	0.772	43.265	0.735	5.047	0.744	58.338
0.740	11.112	4.436	25.186	25.816	4.323	0.578	0.578	2.582	0.777	43.590	0.741	5.084	0.744	59.186
0.760	11.179	4.437	26.061	26.713	4.349	0.583	0.583	2.669	0.782	43.909	0.746	5.119	0.745	60.031

FIG. 24

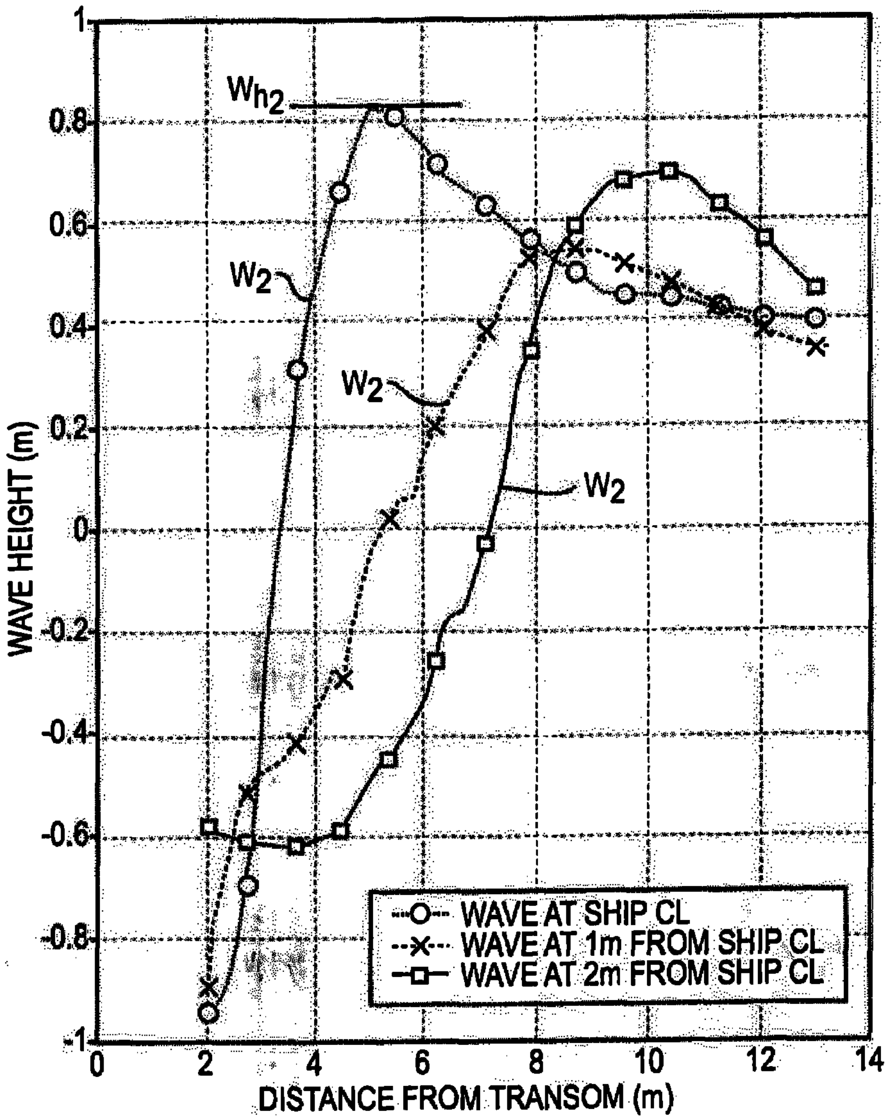
Wh2
W2
W2
W2
WAVE HEIGHT (m)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
2
4
6
8
10
12
14
DISTANCE FROM TRANSOM (m)
WAVE AT SHIP CL
WAVE AT 1m FROM SHIP CL
WAVE AT 2m FROM SHIP CL

FIG. 25

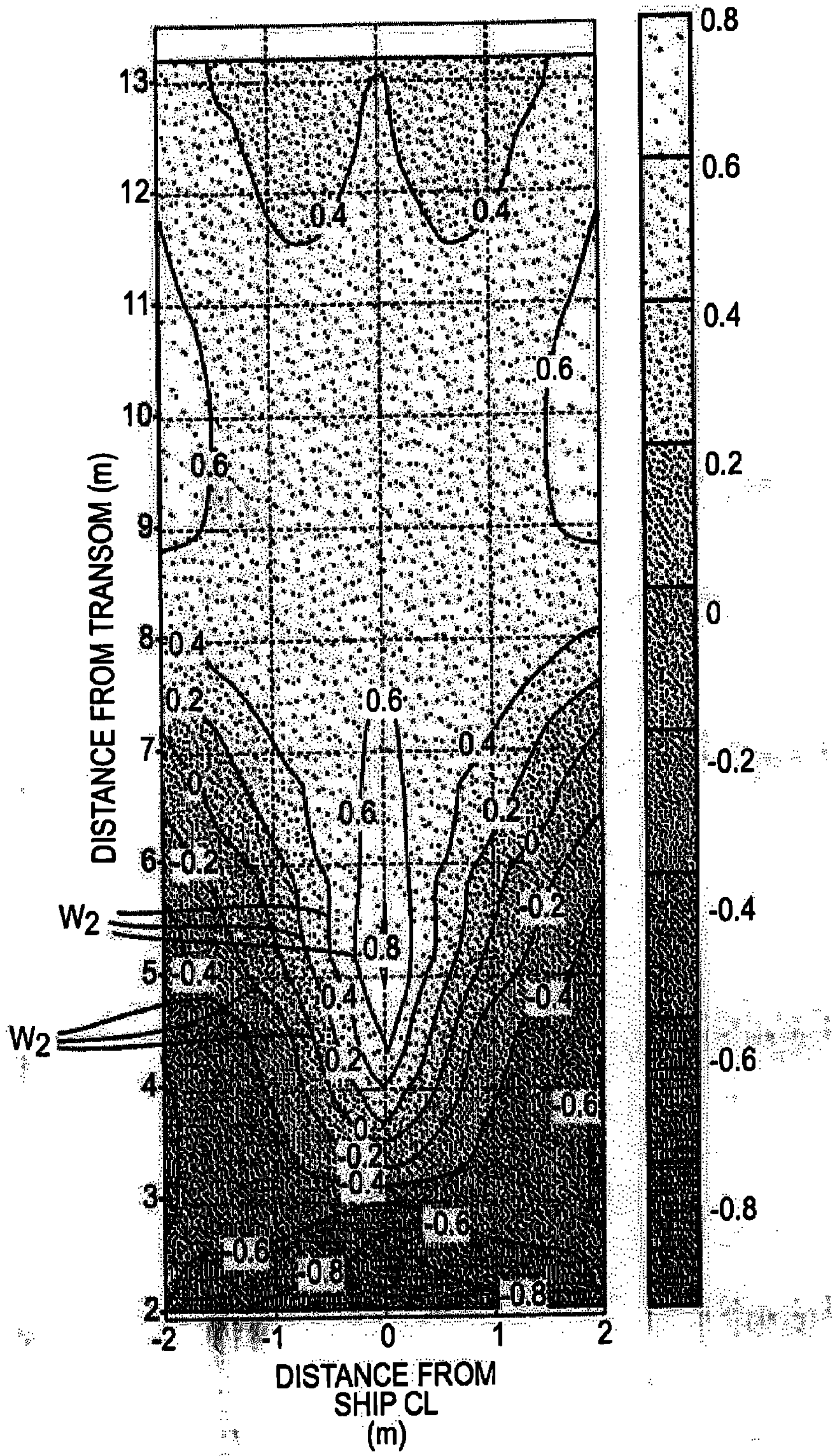
DISTANCE FROM TRANSOM (m)
13
12
11
10
9
8
7
6
5
4
3
2
-2
-1
0
1
2
DISTANCE FROM SHIP CL (m)
W2
W2
0.4
0.6
0.2
0
-0.2
-0.4
-0.6
-0.8
0.8

FIG. 26

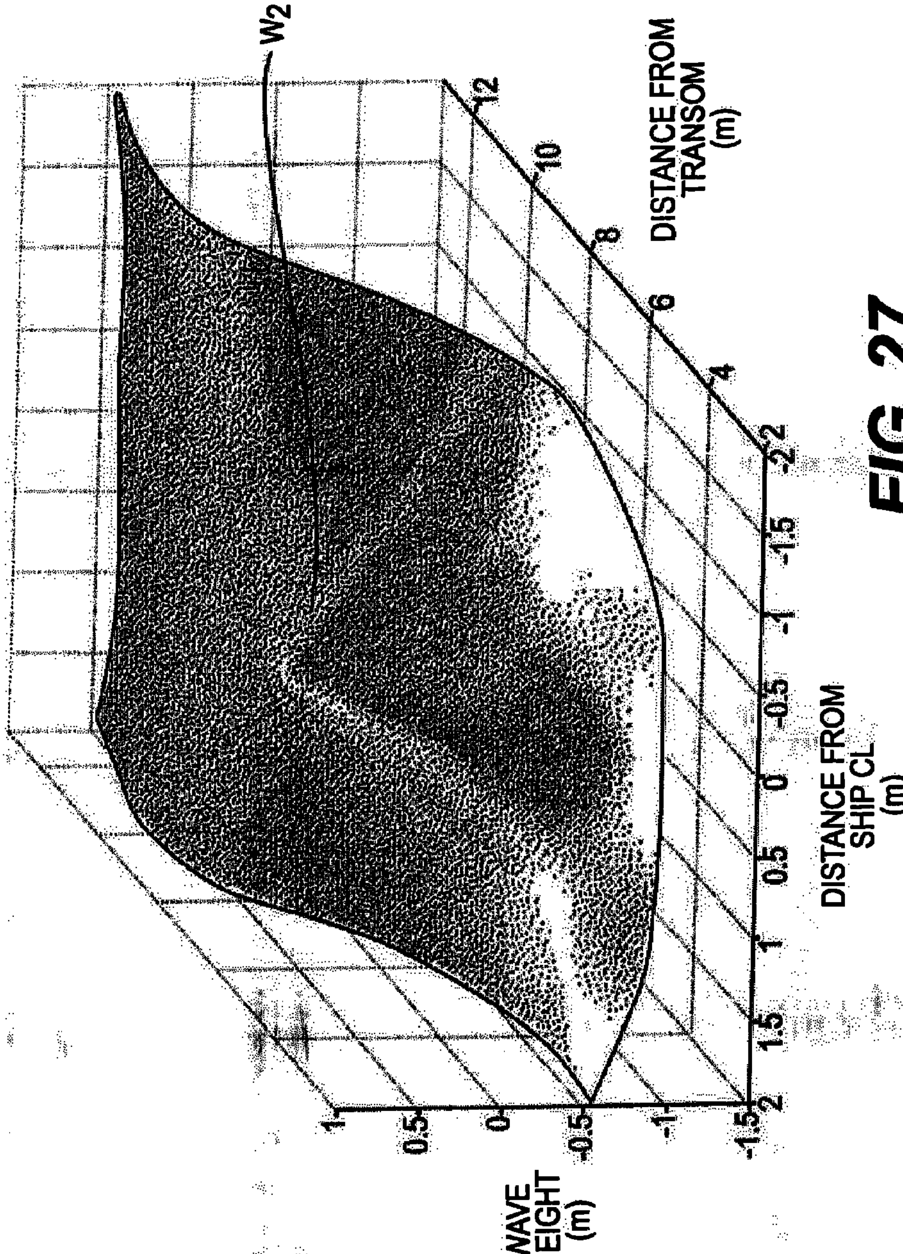
W2
WAVE HEIGHT (m)
1
0.5
0
-0.5
-1
-1.5
DISTANCE FROM SHIP CL (m)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
DISTANCE FROM TRANSOM (m)
2
4
6
8
10
12

FIG. 27

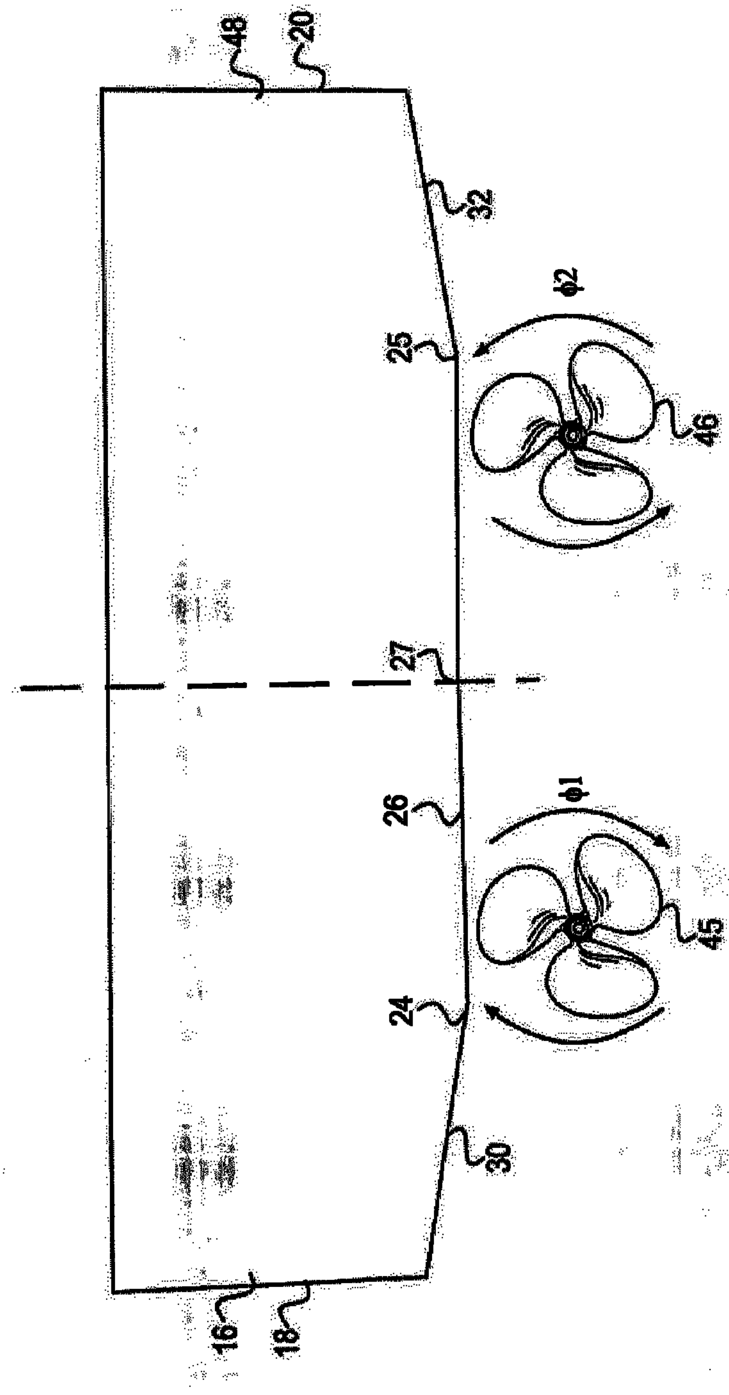

FIG. 28

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 12 19 6282

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 3 503 358 A (MOESLY CARL) 31 March 1970 (1970-03-31) * column 2, line 12 - column 3, line 51; figures 1-6 *	1-15	INV. B63B43/06
X	US 6 374 762 B1 (LARSON BORDEN M [US] ET AL) 23 April 2002 (2002-04-23) * column 4, lines 26-65; figures 1-3 *	1-15	
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Place of search	Date of completion of the search	Examiner
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